DAIRY STOCK DEVELOPMENT

AND MILK PRODUCTION WITH SMALLHOLDERS

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DAIRY STOCK DEVELOPMENT

AND MILK PRODUCTION WITH SMALLHOLDERS

De ontwikkeling van jongvee en melkproduktie

met kleine boeren

Rijk de Jong

Proefschrift
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Stellingen

1. De ontwikkeling van de lokale melkveehouderij is meer gebaat bij een producentvriendelijk prijs- en investeringsklimaat dan bij technologieontwikkeling gericht op besparingen op de variabele kosten.
dit proefschrift

2. Inspanningen gericht op verhoging van de melkproductie en uitbreiding van de melkveestapel in ontwikkelingslanden zijn effectiever wanneer deze gericht worden op kleine boerenbedrijven dan op (semi-)staatsbedrijven of op de invoer van drachtig vee.
dit proefschrift

3. Het regelmatig meten van de borstomvang van jongvee door boeren, voorlichters en onderzoekers stimuleert de aandacht voor een goede ontwikkeling van het jonge dier met als resultaat een eerdere en hogere melkproductie.
dit proefschrift

4. Het meten van dieren bevordert de wetenschappelijke kennis van de ontwikkeling van jongvee onder sterk variërende bedrijfs- en gezinsomstandigheden.
dit proefschrift

5. Horizontale integratie van veehouderij en akkerbouw in plattelandsontwikkeling vereist de actieve participatie van velen voor de ontwikkeling en implementatie van een gevarieerd pakket van mogelijke verbeteringen die aansluiten op de grote verscheidenheid aan bedrijfssystemen en gezinsomstandigheden.
dit proefschrift

6. Verticale integratie van de melkproductiekolom vereist grote betrokkenheid van veehouders met betrekking tot melkkwantiteit en -kwaliteit, het aantrekken van hoogwaardig technisch, commercieel en administratief management en sterk boerenleiderschap; een stapsgewijze benadering van investeringen en intensieve technische, economische en organisatorische begeleiding zijn essentieel voor het verkrijgen van een sterke positie in de zuivelsector.
dit proefschrift

7. Kleinvee is het grote geld voor de arme boerin.

8. Goedkeuring van projectvoorstellen en verlenging van projecten gericht op onderzoek, voorlichting en dienstverlening in de veehouderij met kleine boeren gaan dikwijls gepaard met langere tussenkalftijden dan reeds gebruikelijk op kleine boerenbedrijven. Beide types tussenkalftijden dienen drastisch te worden verkort om grotere armoede, sekse-ongelijkheid en uitmergeling van de bodem in ontwikkelingslanden te voorkomen.

9. Alhoewel *el cuy* niet tot het geslacht der runderen behoort, is het toch, om meerdere redenen, het *melkkoeitje* van 'la Pastuza'.

10. Om het succes van melkveehouderijprojecten in de tropen te vergroten dienen deze gericht te zijn op stimulering van het gezinsbedrijf, verlaging van de leeftijd bij eerste afkalven en verkorting van de tussenkalftijd, de verwerking van de melk tot melkproducten met een hoge toegevoegde waarde en een verhoging van de organisatiegraad van kleine boeren.

11. Het is betreurenswaardig dat de lijnende mens zich zo weinig laat inspireren door het gezonde melk-bloed dieet van de Maasai en de daarbij behorende levenswandel met alle aandacht voor hun vee in harmonie met de gevarieerde natuurlijk omgeving.

12. Het is nog maar de vraag of de geringe consumptie van hondenvlees gebaseerd is op dezelfde overwegingen ten aanzien van hondsdolheid als de daling in consumptie van rund- en schapenvlees na de publiciteit over de 'gekke-koeien-ziekte'.

13. *Democratie* lijkt steeds meer gebaseerd op de macht van massa, kennis en geld in plaats van op de kracht van vrijheid, gelijkheid en broeder/zusterschap.

14. Terwijl de verstedelijking in de geindustrialiseerde landen na de oorlog gepaard ging met een sterke groene lobby voor de agrarische producent, blijkt de verstedelijking in ontwikkelingslanden slechts te leiden tot consumentenlobby's van burgers en militairen.

Stellingen behorend bij het proefschrift ' Dairy stock development and milk production with smallholders'.
Rijk de Jong, 6 september 1996.

VOORWOORD

Nooitgedacht was de naam van de boerderij waarin ik geboren ben en dat zou ik boven dit proefschrift willen zetten. Nooit gedacht (...toch verkregen), want in de ontwikkelings-samenwerkingsprojecten waarin ik werkte, stonden noch het onderzoek noch de onderzoeker, laat staan zijn universitaire promotie op de voorgrond. Daarnaast bleek het schrijven, corrigeren en publiceren van wetenschappelijke artikelen, mede op basis van studentenonderzoek uitgevoerd in de tropen, een zaak van lange adem en ongelooflijk veel geduld.

Door aanmoedigingen van dr. Jan Boon en de continue zachte druk van dr. M.N.M. Ibrahim kwam het, na het stopzetten van het Small Farmer Dairy Project in Sri Lanka in 1991, tot het scheppen van orde in jarenlang verzameld materiaal. Van 1991 tot 1993 volgden analyse en publikatie van lange termijn resultaten van projecten. Dr. Ibrahim's suggestie om mijn "sabbatsjaar" door te brengen in Sri Lanka, en de goedkeuring door de Landbouwuniversiteit van het voorstel voor onderzoek naar de resultaten van kalveropfokprojecten en de horizontale integratie van vee en gewassen op kleine bedrijven, resulteerden in een omvangrijk veldonderzoek dat ik met O.W. Jayawardena en M.G. Ariyaratne heb uitgevoerd. De gegevens van dit onderzoek vormen de kern van dit proefschrift.

De langst stimulerende adem kwam van prof.dr. Dick Zwart die me met veel interesse en geduld aanspoorde om dit boekwerk te beginnen en af te ronden. Beide promotoren prof.dr. Dick Zwart, hoogleraar in de Tropische Veehouderij, en zijn opvolger prof.dr.ir. Herman van Keulen, hoogleraar in de Duurzame Dierlijke Produktie, bedank ik graag voor het kritisch lezen van de hoofdstukken, de constructieve suggesties voor inhoud en tekst en de bespreking ervan.

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Furthermore, I thank all colleagues, compañeros, farmers, campesinos and officials who during my work extended their great friendship and exchanged knowledge and experiences in dairy farming in rural development. Here, I also wish to include the four-legged ladies with their faithful eyes and colourful bodies.

Het geven van onderwijs en het begeleiden van studenten vormde met projectwerk een unieke, stimulerende driehoeksverhouding gedurende mijn Wageningse tijd. Vooral de stages en onderzoeken van studenten hielpen om de aandacht voor een goede kalveropfok te initiëren dan wel aan te wakkeren. Ik noem een aantal namen met dank voor jullie werklust en enthousiasme: Jos van Doren, Nick van Eekeren, Nelleke de Kroes, Marcel Luttikhuis, Jan de Rond, Jan Paul Wagenaar en Floor van der Wilt.

De jeugd rondom me (Carola+Arjan, Riske, Arend; Wijnand, Tom), die dit produkt langzaam maar zeker zag groeien achter het "Tulip" notebook, bedank ik voor hun passiebloemen en morele steun tijdens het gehele proces, hun interesse en assistentie bij de uiteindelijke presentatie en de lay-out.

Het begin van deze prestatie dateert al van 1966 toen ik Cora Goedhart leerde kennen in Wageningen, alras gevolgd door een schriftelijke communicatie tussen 'tropische plantenteelt in Suriname' en een 'nomadisch bestaan in Noord Afrika en het Midden Oosten'. Later, met twee ingenieursdiploma's op zak leefden en werkten we in Kenya, Tanzania, Colombia, Nederland, Ecuador, Nederland en nu weer in Kenya. Haar steun ook bij het tot een goed einde brengen van deze proeve van bekwaamheid waardeer ik zeer en laat zich het best vatten in de volgende gevleugelde en veelzeggende woorden waarmee ik dit 'boekje' aan haar opdraag.

Cora et labora

CONTENTS

1. INTRODUCTION

When visiting developing countries on missions to dairy development projects, I was often asked about experiences in dairy development in the Netherlands, Europe, New Zealand, Australia, USA and about the situation in other developing countries. Dairy project progress and evaluation reports are hardly exchanged among projects, and distribution outside the official channels is more an exception than a rule.

Comparative studies of dairy development within countries and among countries are scarce, although the number of international seminars has increased in the late 1980s and 1990s to facilitate exchange of experiences on dairy policies. Five year plans and even ten year livestock development plans are being prepared but seldom contain long-term plans of policies on import/export regulations, pricing of products and inputs for the producer, margins for the industry, and consumer prices of products.

Livestock technicians and policy makers in developing countries emphasize that the local stock has a limited milk potential and a low reproduction rate. This limits the possibilities to expand local dairy production by higher milk yields and/or larger numbers of dairy stock to reduce the gap between increasing local demand and stagnating supply of locally produced milk. On the other hand, local cattle and buffaloes are better adapted to the climate, disease risk and management practices.

Generally, national dairy development programmes in (sub)tropical countries were based either on high-cost, large-scale schemes such as:

a) import of young (pregnant) dairy stock or even whole dairy complexes in the form of turnkey projects;
b) multiplication of foundation stock on (para)statal farms or cross breeding of local stock with exotic bulls through natural service or artificial insemination (AI);

or, on more small-scale, local smallholder schemes such as:

c) improvement of veterinary services and livestock extension;
d) organization of farmers, their input supply, processing and marketing facilities.

Unfortunately, little emphasis has been given to an appropriate economic environment of local milk production and/or the internal generation of dairy stock by smallholders themselves. Main reasons are the availability of (subsidized) milk powder and butter oil on the world market, an artificially low price of dairy stock enforced by governments in spite of scarce breeding stock, and ineffective extension focused more on milk production and artificial rearing and less on growth performance of young stock, the future cows.

From the 1970s onwards many developing countries have approached the Government of the Netherlands for assistance in dairy or sometimes wider livestock development. A variety of projects has been executed. A first large-scale evaluation of Dutch involvement in the large ruminant sector took place in the mid eighties over 1978-1984 (DGIS/IOV, 1987) and resulted in a livestock development policy guideline for future Dutch involvement (DGIS, 1992). This guideline emphasized that the focus of dairy development should be producer-oriented, integrating dairy farming horizontally within the agro-ecological system (highlands, humid, arid sparsely and arid densely populated) and vertically from input supply to marketing of produce. Hence, at this moment, it seems appropriate to review progress in dairy farming in developing countries in the light of this new policy guideline.

Therefore, the **main objectives** of this thesis are:

1) to study the technical, economic and organisational changes in dairy farming/development in the Netherlands, other industrialized countries and in developing countries in the tropics, *i.e.* has the production of milk per cow, per ha or farm increased and/or has the number of dairy cattle and dairy farmers increased and/or decreased;

2) to consider the options for smallholder dairy development aimed at more self-reliance and less dependency on foreign aid; and

3) to examine whether small-scale dairy farmers can be motivated to rear their calves and heifers on their own farms to generate sufficient stock for replacement and supply to aspirant dairy farmers.

Chapter 1 starts with the introduction of global developments in land use, (agricultural) population, crops and livestock production, followed by dairy development in the Netherlands, large dairy competitors in Europe, North America and Oceania, and dairy farming in (sub)tropical areas.

Chapter 2 presents organizational aspects and prices and characteristics of dairy production systems in milk production and dairy stock development with some detailed information on land, labour and capital productivity of dairy farming in Kenya, Sri Lanka, and selected countries in South America as examples of the three continents. Chapter 3 gives a historical overview (1980-1993) of experiences with dairy development projects by lending agencies, multinational organizations and changes in approaches to rural development. Chapter 4 is a review of dairy development projects in Africa and Asia supported by Dutch Development Cooperation. Chapter 5 is a record of own experiences in livestock production in rural development in South America, illustrated by a case study of mixed small farm (horizontal) development in the Pasto Project in Colombia (1973-1984)followed in Chapter 6 by experiences in (vertically) integrated projects in the cooperative dairy sector of Colombia (1977-1992), and the model project for integrated dairy development in Ecuador (1990-1994). Performance of integrated crop-livestock systems at small-scale training cum demonstration farms in Sri Lanka (1984-1992) as observed through backstopper's eyes is presented in Chapter 7 and that of aspirant dairy farmers on abandoned tea lands in Sri Lanka (1984-1993)in Chapter 8. Chapter 9 reviews calf rearing schemes and projects of dairy stock development in Sri Lanka based on reports and visits to Sri Lanka in 1993 and 1994. Chapter 10 reviews changes in dairy production from 1980-1993in selected countries and results of various programmes and projects in Africa, Asia and Latin America, and evaluation of policies and strategies. Chapter 11 presents a general discussion and main conclusions on the performance of dairy development projects, with special emphasis on technical and economic productivity of animal, land, labour and returns on investment as well as on the internal generation of dairy stock, the "future" dairy cows.

I hope that a wider audience will benefit from this documentation that analyses, in addition to personal experience and literature, some technical, economic and organizational characteristics of milk production and dairy stock development in the temperate and (sub)tropical areas.

1.1 Global developments in land use, (agricultural) population and agricultural production

Starting with the land base, relative land use in the world and per geographical region in 1978 and 1993 for arable (annual and permanent) cropping, permanent pastures, forest and wood lands and other land (land not covered by agriculture, *i.e.* roads, towns, barren land) is presented together with the total land area in Table 1.1. World area with arable (annual and permanent) cropping increased with 0.13% per year, permanent pastures with 0.31% against reductions of 0.22% in forest/woodland and 0.01% per year in other land.

Table 1.1. Relative land use in arable and permanent cropping, permanent pastures, forest and woodlands, and other lands in 1978 and 1993 in the world and per geographical region.

Land use (in %)	Arable cropping		Change (%/yr)	Permanent pastures		Change (%/yr)	Forest & woodlands		Change (%/yr)	Other lands		Change (%/y)	Total land area 10^9 ha (%)
Year	1978	1993		1978	1993		1978	1993		1978	1993		
World	10.9	11.0	0.13	24.5	25.6	0.31	33.0	31.9	-0.22	31.6	31.5	-0.01	13.1 (100)
Africa	5.9	6.3	0.50	28.6	28.8	0.05	26.6	25.7	-0.23	39.0	39.2	0.04	3.0 (23)
Central America	12.3	12.8	0.24	30.8	31.8	0.22	26.1	25.2	-0.23	30.8	30.3	-0.12	0.3 (2)
South America	5.5	5.9	0.38	26.8	28.3	0.36	51.2	48.3	-0.39	16.5	17.6	0.42	1.8 (13)
Asia	17.0	17.5	0.19	25.4	29.9	1.08	20.9	20.0	-0.29	36.7	32.7	-0.78	2.7 (20)
North America	12.5	12.4	-0.07	14.0	14.2	0.10	33.7	41.5	1.39	39.7	31.9	-1.46	1.9 (14)
Europe	30.0	28.8	-0.28	18.3	16.9	-0.54	32.8	33.5	0.14	18.9	20.8	0.65	0.5 (4)
Oceania	5.6	6.1	0.58	53.1	50.6	-0.31	19.1	23.7	1.43	22.2	19.6	-0.82	0.8 (6)
USSR (former)	10.6	10.6	-0.01	14.7	14.8	0.08	47.9	44.9	-0.44	26.8	29.7	0.68	2.2 (17)

Source: FAO Production Yearbook (1994).

Human population and those depending on agriculture in 1980 and 1994, population increase in %/yr and indexed in 1994 (1980 = 100), and the index in 1994 for the increase in crop and livestock production between 1980 (av. 1979-1981) and 1994 is given in Table 1.2.

Table 1.2. Total population and % dependant on agriculture in 1980 and 1994, increase in population (1980-1994), and index 1994 level of population, food, crop and livestock production (av. 1979-1981 = 100) in the world and per geographical region (for former USSR index levels refer to 1991).

	Total population 10^6 persons		People in agriculture (% of total population)		Population increase	index	Food prod. index	Crop. prod. index	Livestock prod. index
Year	1980	1994	1980	1994	(%/yr)	1994	1994	1994	1994
World	4,444	5,630	49.4	43.4	1.70	127	130.3	129.6	126.6
Africa	475	708	65.3	58.3	2.88	149	141.6	142.8	132.5
Central America	119	159	38.0	29.9	2.13	134	122.8	121.9	126.6
South America	240	315	29.1	21.4	1.95	131	145.4	140.3	140.2
Asia	2,586	3,333	63.4	55.1	1.83	129	164.7	147.9	221.6
North America	252	290	4.0	3.0	0.99	115	124.7	129.7	119.4
Europe	483	506	12.6	7.2	0.32	105	102.2	102.0	99.3
Oceania	27	28	19.4	15.8	1.55	124	112.2	112.0	114.9
USSR (former)	265	288	20.0	13.0	0.60	109	107.7	93.9	115.8

Source: FAO Production Handbook (1994).

In Europe, food crops, total crop and livestock production increases are lower than the already low population growth, which has to do with the setting of production quotas to reduce surplus production. In the other geographical regions, increases in food, crop and livestock production are higher than population increases, except in Africa, Central America and the former USSR.

General trends in world livestock production of meat, milk, eggs and wool from 1989 to 1994 are presented in Table 1.3. Generally, wool production is decreasing except in Asia, while meat and egg production rises faster than milk in Africa, Asia, North and Central (data could not be separated), and South America.

Table 1.3. Total production of meat, milk, eggs and wool (10^6 tons) and annual change in the world from 1989 to 1994 and proportionally per geographical region.

Livestock products	Meat 1989	1994	Change (%/yr)	Milk 1989	1994	Change (%/yr)	Eggs 1989	1994	Change (%/yr)	Wool 1989	1994	Change (%/yr)
World	171.8	194.7	2.53	535.7	526.6	-0.34	34.4	39.4	2.76	3.0	2.7	-2.46
Proportional (%)												
Africa	4.9	4.6	1.37	3.9	4.1	0.34	4.3	4.2	2.29	7.9	8.6	-0.77
N&C America	20.5	21.1	3.12	15.4	16.8	1.40	16.7	16.1	2.06	1.6	1.4	-4.67
South America	8.0	8.7	4.25	5.9	6.4	1.52	6.4	6.4	3.40	10.0	9.1	-4.40
Asia	27.8	35.0	7.14	19.3	23.5	3.60	37.6	46.3	7.14	17.6	20.2	0.33
Europe	24.8	21.1	-0.71	32.6	29.8	-2.13	20.7	17.5	-0.64	10.5	9.3	-4.79
Oceania	2.4	2.4	2.44	2.6	3.2	3.99	0.7	0.6	-1.70	36.8	38.0	-1.81
USSR (former)	11.7	7.2	-7.02	20.3	16.2	-4.67	13.7	8.7	-6.06	15.7	13.4	-5.46

Source: FAO Production Yearbook (1994).

Developments of livestock production in relation to food crop development, total crop production and total agricultural production for the periods 1980-1987, 1987-1993 and 1980-1993 as well as the annual increase per capita are given in Table 1.4. Worldwide changes in production are all positive, except in Europe (1987-1993) and the former USSR (food and crops 1987-1990). Changes per capita showed generally increases over 1980-1993, except in Africa for food crops, total crops and livestock production, in North and Central America for food and total crop production, and in Oceania only for food crops.

Table 1.4. Quantitative change (%/yr) in food crops, total crops, livestock and agricultural production, and per capita availability between 1980 and 1993 in the world and per geographical region.

	Food crops				Total crops				Livestock				Agriculture			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
World	2.25	1.76	2.02	0.31	2.11	1.69	1.92	0.21	2.39	1.37	1.92	0.21	2.24	1.67	1.98	0.31
Africa	2.47	2.51	2.49	-0.38	2.58	2.41	2.50	-0.37	2.32	2.03	2.19	-0.67	2.39	2.32	2.36	-0.38
N&C America	0.23	2.27	1.17	-0.21	-0.52	2.73	0.97	-0.40	1.43	1.63	1.52	0.14	0.13	2.26	1.11	-0.21
South America	2.46	2.77	2.60	0.63	2.90	1.79	2.39	0.42	1.47	3.48	2.39	0.42	2.27	2.46	2.36	0.63
Asia	3.76	3.70	3.73	1.86	3.23	2.62	2.95	1.09	5.71	5.99	5.84	3.92	3.82	3.56	3.70	1.86
Europe	1.20	-0.62	0.35	0.10	1.42	-0.98	0.31	0.05	0.91	-0.80	0.12	-0.14	1.21	-0.67	0.34	0.10
Oceania	1.11	1.60	1.34	-0.19	2.62	1.89	2.28	0.75	1.15	0.85	1.01	-0.51	1.43	1.04	1.25	1.25
USSR (former)	2.37	-0.10	1.63	0.78	1.57	-1.40	0.67	-0.17	2.62	0.78	2.07	1.22	2.18	-0.22	1.45	0.78

(1) annual change from 1980 (av. 1979-1981) to 1987 (av. 1986-1988); (2) annual change from 1987 to 1993 (av. 1992-1994); for USSR 1987 to 1990 (av. 1989-1991); (3) annual change from 1980-1993 (for USSR 1980-1990); (4) annual change/capita 1980-1993 (for USSR 1980-1990). Source: FAO Production Yearbook (1994).

1.2 Dairy development in the Netherlands

The Netherlands has a long history of increasing milk production per cow, ha and per farm and the intensive use of both female and male young stock (either for breeding or fattening). In Table 1.5, some characteristics covering the period from 1930 to the early nineties are presented (PR, 1990; 1992 and LEI/CBS, 1961; 1971; 1981; 1990; 1991 and 1994; LEI, 1951; Boerderij, 1995a and 1995b).

In 1994, of the 10.8 million tons of milk, 6.45 million was processed into cheese and 1.6 million went into the consumption milk sector. Butter, skim milk powder, other milk powder, and condensed milk production amounted to 130,000, 38,000, 136,000 and 341,000 tons, respectively (Boerderij, 1995a).

Cattle numbers increased from 2.4 million in 1930 to 5.5 million in 1984 when the quota system for milk was introduced. Although this increase in the dairy cow population seems impressive, on an annual basis it is only 1.9%. The total number of cattle increased slightly faster at 2% per annum. After 1984, the number of dairy cows has been reduced and the milk quotas are produced with less cows and a still increasing yield per cow. The number of calves below one year did not decline much, because most farmers have surplus milk and grassland to rear young stock for a higher replacement rate at their farms and for export.

Table 1.5. *Number of dairy farms, cattle population, milk production and prices in the Netherlands (1930-1994).*

	1930	1940	1950	1960	1970	1980	1984	1990	1993/4
Farms with dairy cows ('000)				185	116	67	60	47	40.5
Number of cows per farm				8.8	16	35	42.5	40	43
Grassland per farm (ha)				7.2	11.3	18	18.3	23.4	23.8
Cattle population ('000)									
- Dairy cows	1,068	1,520	1,518	1,628	1,896	2,356	2,549	1,878	1,747
- Calves younger than one year	502	424	516	725	758	870	866	806	737
- Heifers one year and older	419	504	572	770	893	1,038	1,066	880	836
- Breeding bulls ≥ 1 year	26	33	24	25	37	54	47	43	41
- Fattening calves				78	434	582	638	602	656
- Young stock for beef production	119	143	64	187	242	292	315	598	624
- Beef cows				94	56	44	35	120	156
Total cattle ('000)	2,366	2,690	2,723	3,507	4,314	5,226	5,516	4,926	4,797
Milk production (mln tons/yr)*	4.5	5.2	5.7	6.7	8.3	11.9	13.5	11.5	10.8
- Milk production (kg/cow/yr)	3,250	3,420	3,770	4,205	4,390	5,080	5,300	6,070	6,970
- Concentrates (kg/cow/lact.)	400		450	825	1,200	2,000	2,200	2,100	2,200
- Milk production per ha (kg)				5,015	6,195	8,915	10,085	8,835	9,030
- Milk production/farm (kg/yr)						71,750		239.580	266.500
Milk price (Dfl per 100 kg)	6.7	8.0	21.2	28.5	35.3	60.5	73	80	78
Price of dairy cow (Dfl)	250	200	650	750	900	1,500	2,000	1,650	1,900
Price of dairy cow in calf (Dfl)	400	300	1,000	1,200	1,500	2,500	3,000	2,100	2,500

* Dutch milk quota amounted to 10.7 mln tons in 1992 (Schukking, 1992).

The milk price rose from 6.7 Dfl per 100 kg milk in 1930 to as much as 80 Dfl in 1990. Wheat prices per 100 kg increased less from 7 Dfl in 1930 to about 67 Dfl in 1983, and subsequently declined sharply to Dfl 30 in 1993/4, after the EU reduced the minimum price (Boerderij, 1995b). Dairy cow prices followed the milk price pattern, although large fluctuations are seen after 1983, due to the introduction of milk quota and large cattle exports by Eastern Europe. Differences between prices for dairy cows and dairy cows in calf provide an indication of the relative high value of the calf in the Netherlands for the white veal sector.

The number of dairy farms decreased rapidly over the last three decades with 4.5% per annum, while remaining dairy farmers increased the area and the number of cows on their farms. Milk production per cow increased annually by 0.9% (1960-1984), but per ha milk production increased by 2.8% as a result of higher external inputs, *i.e.* fertilizers and concentrates. From 1984 to 1994 milk production per cow increased annually by 2.8%.

Female calves are used for an annual replacement of about 30% of the dairy cows, another part (10-40,000 per year) is exported as breeding stock (see also Figure 2.2, Chapter 2) to initiate or stimulate dairy development in other countries. In addition, most male calves and surplus female calves are used for white, pink and red meat production. Annually, about 1.0 million veal calves and about 350,000 bulls (170,000 from imported calves) for red meat are produced (Schukking, 1992).

As cattle are housed inside for half of the year, preparation of winter feed, both quantitatively and qualitatively, is very important to secure milk production in winter. Most dairy plants pay a bonus price for winter milk. Winter feed preparation shifted from mainly grass hay making in the 1960s to production of silage of wilted young grass and forage maize in the 1990s (Schukking, 1992). Before the 1960s fodder beets were an important source of winter feed but labour-intensive in thinning, weeding and harvesting. After 1970, introduction of-short-cycle maize varieties and of the forage harvester allowed the switch to maize cultivation and silage preparation (Table 1.6).

Table 1.6. Area of fodder, fertilization rate and relative forage dm ration in winter and share (%) of inputs and services by cooperatives in the Netherlands (1930-1994).

	1930	1940	1950	1960	1970	1980	1984	1990	1993/4
Area for cattle ('000 ha)									
- Grassland	1,308	1,328	1,317	1,327	1,330	1,198	1,100	1,004	965
- Fodder beets/maize				40	16	141	170	205	231
N fertilizer (kg/ha grassland)*			50	100	200	285	315	300	280
Composition of ration in winter (dm, %)									
- Grass hay				75	70	20		10	5
- Grass silage				25	28	55		65	70
- Maize silage					2	25		25	25
Share of inputs/services by Cooperatives									
- Milk intake				88		88	88	84	84
- Cattle for slaughter				18		14	14	16	16
- Concentrates				51		54		52	52
- Fertilizers				63		60		48	48
- Savings						42	40	40	40
- Credits						90	90	90	90

* pers. com. Van der Meer (1995).

Provision of inputs and services is approximately equally shared between private companies and cooperatives for concentrates and fertilizers. Milk collection, processing and marketing is mainly in cooperative hands while cattle marketing is in the hands of private trade (NCR, 1986; LEI/CBS, 1994). Savings are deposited mainly in private banks, but dairy farm credit is almost exclusively provided by the cooperative bank (Rabobank).

A large proportion of Dutch dairy cattle is registered in herdbooks and individual cows are being recorded for quantity and quality of milk (kg, % fat and % protein). First inseminations in 1984 (2,177,365), 1991 (1,911,584) and 1993 (1,834,659) were with semen of milk breeds (65, 64 and 69%), dual purpose breeds (32, 19 and 21%) and beef breeds (3, 15 and 9%), respectively (Commission for cattle AI of the Farmers Board and the Dutch Cattle Syndicate (NRS) in LEI/CBS, 1994).

Information on the economics of farming is collected by the Agricultural Economic Research Institute (LEI-DLO) differentiated per type of farming (arable, dairy, horticulture, pigs and poultry) and per region, related to main soil types. Results for 1991/92 of specialized dairy farms are presented together with those of the average farm in 1981/82 in Table 1.7.

Generally, according to economic calculations, taking into account the opportunity costs of labour and capital, and calculating land cost on the basis of land rent, the average net result (revenues minus costs) of dairy farms is negative. Nevertheless, farmers, or rather farm families pay taxes, manage to operate their farms and invest in land, machinery and milk quota (immaterial assets), as illustrated for large samples of Dutch specialized dairy farms in the book year 1991/92 (LEI/DLO, 1994) and the average farm in 1981/82 (LT, 1984) in Table 1.7. The main clues in survival are low family consumption and acceptance of a lower reward for their (family) capital, labour and management than other workers in the economy.

Sociologically, within more or less homogeneous regions in the Netherlands, farming styles show considerable variation (Table 1.8) in technical and economic farm productivity as shown for dairy farms on (i) peat soils in South Holland (Van der Ploeg and Roep, 1990), (ii) the sandy region of the Achterhoek in the Eastern part of the Netherlands (Roep *et al.*, 1991) and (iii) the sandy, high ground regions in North and South-West Friesland (De Bruin and Van der Ploeg, 1991).

Table 1.7. Net farm result (Dfl), composition of family income, financial farm means and their application in specialized dairy farms (1991/92) and that of the average farm (1981/82) in the Netherlands and the index in 1991/92 (1981/82=100).

Farm economics/finances	1981/82	1991/92	Index		1981/82	1991/92	Index
Net farm result	-24,100	-65,600	-272	Use of family income			
+ Calculated farmer labour	55,500	100,000	180				
+ Incidental income	2,700	1,100	- 41				
+ Calculated interest	8,300	18,100	218	Paid taxes	9,800	22,300	228
+ Calculated family labour	22,400	20,600	92	Family consumption	45,600	61,400	135
+ Off-farm family income	14,200	21,400	151	Savings	23,600	12,700	-54
Family income	79,000	96,400	122	Total use family income	79,000	96,400	122
Financial farm means				Use of financial means:			
- Depreciation	19,900	47,500	239	Farm investments			
- Savings	23,600	12,700	-54	- land	4,900	26,400	539
- Inheritance/gifts \		4,700		- buildings	8,900	20,100	226
- Investment subsidies /	9,000	2,000	-74	- machinery/equipment	10,000	17,000	170
- Other		-2,300		- livestock	5,600	- 500	- 9
				- immaterial assets		24,500	
Total own means	52,500	64,600	123	Investment off-farm	2,300	3,300	143
New loans	8,400	54,900	654	Loan repayments	15,600	34,900	224
Long-term credits		-2,000		Changes in stocks		-3,500	
Short-term credits		200		Changes in liquidity	13,600	-4,500	-33
Total borrowed	8,400	53,100	632				
Total financial means	60,900	117,700	193	Total use of fin. means	60,900	117,700	193

Source: LT (1984); LEI/CBS (1994).

Table 1.8. Characteristics of cattle farms in three regions of the Netherlands according to farming style.

Region/dairy farmer style	Farmers (%)	Farm size (ha)	Labour (person)	Cows (n)	Yield/cow (kg/yr)	Conc./cow (kg/yr)	N(kg/ ha)	Gross margin (Dfl/ person)(range:± sd)
South Holland								
-"Modern" dairy farmers	20	31.7	1.5	63	7,095	2,238	298	107,200(59-153,000)
-Dairy cow farmers	29	27.2	1.3	44	7,120	2,136	263	75,125(49-118,000)
-Dual purpose cattle farmers	27	22.8	1.6	46	6,357	1,935	248\	
-"Mechanization" cattle farmers	9	21.3	1.3	40	6,180	1,975	237/	77,200(26-139,000)
-Pioneer farmers	10	18.7	1.2	30	6,418	2,133	278\	
-Retiring dairy farmers	5	15.5	1.0	26	6,000	2,115	137/	41,700(11- 65,000)
Average 55 farmers		25.0	1.4	46	6,696	2,087	263	
Achterhoek						Milk/ha		
-"Modern" dairy farmers	15	28	1.8	58	6,703	13,185	404	
-Dairy cow farmers	33	20	1.8	44	7,098	15,300	393	
-Dual purpose farmers	10	19	1.6	42	6,444	12,800	376	
-"Mechanization" dairy farmers	7	22	1.7	45	6,267	12,355	337	
-Practical farmers	23	22	1.6	52	6,720	15,455	394	
-Economic farmers	13	20	1.8	42	6,503	14,450	358	
Average 104 farmers		22	1.7	48	6,757		385	
Friesland						Conc./cow		
-"Modern" dairy farmers	31	46	1.7	79	6,679	1,350	348	71,000 ± 19,000
-Dairy cow farmers	20	39	1.6	64	7,456	1,515	331	70,000 ± 28,000
-Conservative farmers	37	27	1.4	39	5,977	1,218	265	59,000 ± 21,000
-Pioneer farmers	13	21	1.2	27	5,640	1,203	259	45,000 ± 15,000
Average 87 farmers		34	1.6	55	6,440	1,314	303	

Source: Van der Ploeg and Roep (1990); Roep *et al.* (1991); De Bruin and Van der Ploeg (1991).

In general terms, the following categories can be distinguished: (i) "modern" or intensive dairy farmers aiming at maximum economic results; (ii) dairy cattle breeders or dairy cow farmers paying maximum attention to offspring and individual care of cows; (iii) dual purpose farmers interested not only in milk but also in elevated livestock sales per calf and culled stock; (iv) pioneer farmers associated with interests in other farming activities; (v) retiring farmers having no successors; (vi) economic farmers economizing on costs; (vii) practical farmers that try to carry out all practices well; (viii) conservative farmers expanding their farms according to family labour availability: (ix) machinery farmers enjoying very much the mechanization parts of dairy farming such as roughage harvesting, milking (mechanization farmers); and (x) expansion farmers aiming at more land and higher milk quota to increase the scale of operation.

Economically, total gross margins per person between farming styles but also within a style (ranges in South Holland, and standard deviation in Friesland) indicate a wide variation in the outcome of overall management and purpose of farming.

Dairy farm styles also show substantial differences in gross margin per cow and per ha, livestock dynamics (sales-purchases of stock and change in inventory between end and start of the year) per unit milk production, costs of bought feed per cow, and total external inputs (feed, fertilizers, contracted work) per 100 kg milk as shown by NRLO (1994) in a study of 300 dairy farmers in the clay region of North Friesland (Table 1.9).

Table 1.9. Some economic characteristics (Dfl) per dairy farming style on 300 farms in the clay region of North Friesland (NRLO, 1994).

Dairy farmer style	Gross margin per cow	Gross margin per ha	Livestock dynamics* per 100 kg milk	Bought feed costs per cow	Costs of external inputs per 100 kg milk
Intensive farmers	4,809	9,580	12.66	1,363	27
Dairy cattle breeders	4,899	6,906	14.15	1,135	25
Dairy cow farmers	5,237	8,719	9.54	966	20
Expansion farmers	4,561	7,939	11.19	1,053	24
Economic farmers	4,624	7,550	13.31	845	24

* Stock inventory at the start + sales - purchases - stock inventory at the end of the year.

Milking in the Netherlands took about 200 hours per cow per year in 1940 with another 45 hours for feed conservation, 25 hours for fertilization and 70 hours for general farm work or 340 hours per cow. Total farm labour declined to 40 hours per cow per year in the 1990s with 20 hours for milking. Introduction of milking machines in the 1950s reduced milking time with 70 hours per cow per year. Farm mechanization with tractors, haybalers, fertilizer and manure spreaders reduced dairy farming time with 50 hours per cow per year. Further perfection of machine milking (no more hand stripping), the change from haymaking to mechanized preparation of wilted silage, and the introduction of the cubicle housing with mechanized manure removal or the manure slurry system (deep gutters and slurry cellars) reduced dairy farming time to 80 hours per cow in 1970. During the 1970s, introduction of the forage collection wagon, cyclo-mower, herringbone milking parlour and milk tank and after 1980 the forage chopper and concentrate feeding computer, reduced total farm labour further to 40 hours per cow. The introduction of the milking robot may further reduce these labour requirements with a few more hours, reaching a point where dairy farmers can handle 100 cows per person (Boerderij, 1995b).

Differences in technical performance among Dutch dairy farms are very large. Milk production per cow on 20 highly productive Dutch dairy farms was 3,500 kg higher (10,773 vs 7,220 in 1992-1993) than on the average of all recorded Dutch dairy farms. Average milk production per ha on the 20 farms was 16,500 kg, with 3,000 kg of concentrate per cow/year and application of 40 m^3 manure (80 kg N) and 360 kg N from artificial fertilizer per ha. On 30%

of these farms milking three times a day is practised, resulting in a 300 kg higher milk production per cow associated with an additional 500 kg dm in concentrates (Meijer *et al.*, 1994; 1995).

1.3 Dutch dairy situation compared with others in Europe, Oceania and the USA

To compare the Dutch situation to that of other important milk producing countries, use has been made of the study by the Agricultural Economics Research Institute (LEI) and the Agricultural Research Department (DLO) of the Ministry of Agriculture, Nature Management and Fisheries, and published by Rabobank (1995). Selected technical and economic characteristics have been compared with those of strong competitors in the European Union (EU), *i.e.* Germany, France and Denmark, and in the world market, *i.e.* New Zealand, Australia and the USA (Table 1.10).

Table 1.10. Selected characteristics of milk production (1992) in the Netherlands, EU, New Zealand, Australia and the USA (adapted from Rabobank, 1995).

	Netherlands	Germany	France	Denmark	New Zealand	Australia	USA
Share agriculture in GNP	3.6	1.2	2.9	3.4	5.4	2.9	1.8
Share milk in agricultural GNP	25.8	25.4	15.7	23.1	8	9	11
Number of dairy farms (000)	48	275	199	21	14	14	182
Average farm size (ha)	29	29.4	38.4	36	88	150	158
Cows per farm	40	17.3	25	35.8	200	118	54
Cows per ha of forage	1.7	1.3	0.8	1.7	2.3	0.8	0.3
Annual milk production(mln tons)	10.9	28.0	26.0	4.6	8.4	7.3	68.3
Annual milk sales to milk plants							
in 1991 (mln tons)	10.5	25.6	22.9	4.4	7.4	6.3	66.4
in 2000 projected (mln tons)					8.5	8.9	74.6
Animal productivity							
- milk/cow/year (kg)	6,600	5,200	4,800	5,900	3,550	4,568	6,447
Land productivity							
- milk per ha forage (kg)	11,220	6,760	3,840	10,030	8,170	3,654	1,934
Economics of production							
- % fixed costs	22	12	17	24	8	13	12
- % depreciation	17	22	15	11	10	9	n.a.
- % variable costs	62	66	68	64	80	n.a.	76
- feeds in % of variable costs	40	35	35	45	11	n.a.	42
Family income (in % of revenues)	23	22	20	14	n.a.	18	30
% own capital in farm investment	70	80	70	40			80
Milk price 1992 (Dfl/kg)	0.80	0.78	0.75	0.89	0.26	0.39	0.67
- % income from milk	74	60	67	70	67	85	92
- % income from stock changes	13	20	18	13	17	14	8
Cost price milk (Dfl/kg)	0.95	1.20	0.94	1.18			
Organization milk handling (1991)							
- % milk to cooperative plants	84	75	50	90	98	70	13
- total milk plants	22	315	998	67	16	58	1,600
- plants with cheese production	18	237	864	44	12	42	724
Specialized farms (%)	69	43	52	67	100		68
- Cows/unit of labour	31	17	19	25			
- % paid labour in total costs	6						11

The share of milk in the agricultural Gross National Product (GNP) in the Netherlands, Germany and Denmark is around 25%, which is much higher than the 8-11% in New Zealand, Australia and the USA. Farm size is smallest in the Netherlands, but with the highest milk production per cow and per ha of forage. Economically, feed costs as a percentage of variable costs are between 35 and 45, with the exception of 11% in New Zealand. Fixed costs are high in Europe due to winter housing, costs of land and the value of milk quota. Labour productivity on specialized farms is high in the Netherlands with 31 cows compared to 17-25 in other major dairy nations in Europe.

Over 1980-1990 the number of EC dairy farmers declined from 1,739,000 to 1,080,000. Average milk production per cow increased from 4,222 to 4,606 kg, and average number of dairy cows per farm from 14.3 to 19.5 (Bolhuis and Schelhaas, 1993).

Dairy cow numbers in New Zealand increased from 1.7 million with 2,400 litres per cow in the 1940s to 2.1 million with 3,200 litres per cow in the period 1980-1985. Herd size increased to 140 dairy cows in 1985 operated by 1.13 units of family labour and 0.23 units of non-family labour. High stocking rates of 2.5 cow equivalents per ha are applied to achieve maximum per hectare milk production on grass (NZ, 1988). Under high stocking rates individual cow performance is 10-20% less (Hughes, 1994). Gadsby (1993) mentioned a typical farm size of 65 ha with 165 cows for the New Zealand cooperative dairy industry with 15,000 dairy farmers and 14 manufacturing dairy plants.

The average Holstein Friesian dairy farm in the USA holds 75-80 cows, reaching 400 in California. Most offspring from the Dutch imports in the seventeenth century did not perform well, contrary to offspring of Dutch Holsteins imported during the second part of the nineteenth century. From 1945 to 1975 (30 years) dairy cow numbers declined from 25 million in 1945 to 11 million in 1980, while beef cows increased from 10 to over 40 million (Cunningham, 1992). Milk production per cow increased from 2,500 in 1945 to more than 5,000 in 1975 and reached over 7,000 kg in 1985 for Holstein Friesians (Rakes, 1987).

1.4 Dairy farming in (sub)tropical areas

In tropical areas, milk production per cow is much lower than the world average of about 2000 litres per cow per year. Some trends in the production per cow and the increase in number of milking cows and total milk production for the period 1970 to 2000 are presented in Table 1.11 (FAO, 1989 in: Kaasschieter *et al.*, 1992). From 1970-1985, milk production increased in Latin America and West Asia/North Africa (WANA) associated with increased cow numbers, while in Sub-Saharan Africa and Asia (excluding China) it increased both through more milking cows and increased yields per cow.

Table 1.11. Milk yield and relative growth rates for number of milking cows and total milk production per region per year (FAO, 1989 in: Kaasschieter et al., 1992; FAO Production Yearbook 1994).

	Milk/cow (kg/year)				Number of milking cows (growth rate in %/year)			Total milk production (growth rate in %/year)		
Area/Year/Period	1970*	1980*	1985*	2000	1970-1980	1980-1985	1985-2000	1970-1980	1980-1985	1985-2000
Region:										
Sub-Saharan Africa	296	320	322	402	1.5	1.6	2.5	2.3	1.7	4.0
Latin America	1,034	1,018	1,041	1,327	3.4	0.9	1.9	3.3	1.3	3.6
West Asia/North Africa	668	712	731	1,052	2.7	0.7	1.2	3.4	1.2	3.7
Asia (excl. China)	680	735	837	880	2.6	2.5	2.2	3.4	4.8	2.5
Developing countries	708	751	807	941	2.7	1.8	2.0	3.3	3.0	3.1
World		1,970								

* 1970 (average 1969-1971); 1980 (average 1979-1981); 1985 (average 1984-1986).

The situation in 1980 and 1993 and annual increase in number of cows, buffaloes, sheep and goats and their milk production in the world and proportionally per geographical region are given in Table 1.12.

Table 1.12. World number of dairy cows, buffaloes, sheep and goats and their milk production in 1980 (average of 1979-1981) and 1993 (average of 1992-1994) and annual change in the world and the proportional distribution (in % of the world) per geographical region (FAO Production Yearbook 1994).

Dairy animals	Dairy cows			Cow milk			Buffaloes			Buffalo milk			Sheep and Goats			Sheep and Goat milk		
Units	10^6 head		change	10^9 kg		change	10^6 head		change	10^9 kg		change	10^9 head		change	10^9 kg		change
Area/year	1980	1993	(%/yr)	1980	1993	(%/yr)	1980	1993	(%/yr)	1980	1993	(%/yr)	1980	1993	(%/yr)	1980	1993	(%/yr)
World total:	213.6	226.4	0.45	420.8	460.7	0.70	121.7	148.3	1.53	27.8	47.3	4.18	1.5	1.7	0.74	14.9	18.2	1.63
Proportional (%):																		
Africa	12	14.9	2.14	2.7	3.3	2.02	1.9	2.2	2.60	4.5	5.5	1.52	20.6	22.3	1.35	21.3	18.5	0.53
Central America	3.9	4.2	0.86	2.5	2.1	-0.36							1.3	1.2	0.19	2.1	0.9	-4.73
South America	11.8	14	1.79	5.7	7.6	2.88	0.4	1.0	8.35				7.9	7.0	-0.17	1.1	1.2	1.95
Asia	22	26.2	1.80	8.8	14.4	4.62	97.1	96.5	1.48	95.2	96.5	4.30	37.8	41.2	1.40	45.0	53.1	2.92
North America	5.9	4.8	-1.14	15.6	16.8	1.29							0.9	0.7	-0.70			
Europe	22.2	26.2	-1.97	40.3	33.5	-0.71	0.3	0.1	-7.48	0.3	0.3	2.83	8.7	8.8	0.78	27.7	23.8	0.43
Oceania	1.9	2.0	0.80	2.9	3.5	2.07							13.1	11.3	-0.42			
USSR (former)	20.2	17.8	-0.55	21.5	18.8	-0.35	0.3	0.2	0.57				9.6	7.5	-1.14	2.7	2.6	1.22

Annual cow milk production increases (1980-1993) for Asia are higher at 4.62% than projected for Asia (excl. China) at 2.5% between 1985-2000. Actual growth rates of cow milk in the whole of Africa at 2.02%, in South America at 2.88% and in Central America at -0.36% are lower than projected for Sub-Saharan Africa at 4% and for Latin America at 3.6% for 1985-2000. Increases of milk production per cow are highest in Asia (2.82%), followed by South America (1.09%), while in Africa and Central America increases were based on increased numbers only. Annual increase in buffalo milk production was higher than in cow milk (0.70%) through increased numbers (1.53%) but also through increased productivity (2.65%). Also total production of sheep and goat milk increased faster than that of cow milk but slower than that of buffalo milk. Camel milk was not recorded in the FAO Production Yearbook 1994, but estimated milk production was 20 million litres per day or 7.4 million tons per year (Wilson, 1984). Number of camels (about 74% in Africa and 24% in Asia) increased from 17 mln in 1980 to 18.7 mln in 1993 (Khanna and Rai, 1993), an annual increase of 0.72%.

Milk products as processed in 1980 and 1993 in the world and proportionally per geographical region and the annual increase are presented in Table 1.13. Cheese has the largest share followed by butter and ghee, evaporated milk, skim milk powder, whole milk powder and whey powder. Main elaboration of milk products is in Europe followed by North America. The share of Africa, Asia, Central and South America is small with the exception for Asia in butter, ghee and evaporated milk, and South America in whole milk powder.

Table 1.13. Milk products elaborated in 1980 (av. 1979-1981) and 1993 (av. 1992-1994) and annual change (%) in the world and proportional production per geographical region.

Milk products	Butter & ghee			Evaporated milk			Cheese			Whole milk powder			Skim milk powder			Whey powder		
Units	10^6 tons			10^6 tons			10^6 tons			10^6 tons			10^6 tons			10^6 tons		
Year(annual change)	1980	1993	(%)	1980	1993	(%)	1980	1993	(%)	1980	1993	(%)	1980	1993	(%)	1980	1993	(%)
World	6.9	6.8	-0.04	4.6	4.4	-0.21	11.5	14.8	1.95	1.7	2.2	2.11	4.2	3.4	-1.49	1.1	1.7	3.67
Proportional (%)																		
Africa	2.2	2.5	1.02	1.0	0.6	-4.31	3.2	3.3	2.11	0.9	0.6	-0.43	0.5	0.7	2.13			
Central America	0.7	0.6	-0.84	6.2	5.8	-0.73	1.3	1.2	1.32	2.4	2.6	2.71	0.2	0.5	5.31			
South America	2.4	2.3	-0.40	4.0	4.2	0.11	4.3	4.2	1.69	18.8	18.0	1.78	0.1	1.1	18.00			
Asia	17.0	28.3	3.99	12.7	18.3	2.63	5.5	5.8	2.59	6.3	4.5	-0.50	4.0	8.0	4.00			
North America	8.9	10.5	1.21	23.1	25.9	0.67	21.5	24.6	3.00	2.5	3.9	5.72	15.8	16.4	-1.21	35.6	35.7	3.68
Europe	43.9	30.9	-2.70	39.3	32.5	-1.65	49.0	47.5	1.70	47.5	43.5	1.43	65.3	46.1	-4.09	63.0	61.4	3.46
Oceania	5.0	5.5	0.69	1.9	2.3	1.20	2.1	2.5	3.49	9.3	17.2	7.05	6.2	9.7	1.99	1.4	2.8	9.31
(USSR)	20.0	19.4	-0.26	11.8	10.4	-1.13	13.3	11.0	0.47	12.5	9.7	0.17	8.0	17.4	4.63			

Source: FAO Production Yearbook (1994).

Herd and farm productivity

Livestock productivity per head of livestock in herds differs even more than per adult female between developing (mainly in the tropics) and developed countries (mainly in temperate zones), *i.e.* 12 and 80 kg of carcass weight equivalent and 3, respectively 7 kg carcass in small ruminants and 90, respectively 900 litres milk in cattle (Tacher, 1992).

Farm productivity in the early 1980s in technical terms, *i.e.* kg milk and meat production per animal, unit of land, labour and capital, and in economic terms, *i.e.* gross margin per unit of land, labour and capital may vary considerably among different farming systems within a country as illustrated for Kenya (Table 1.14), Sri Lanka (Table 1.15), various countries in South America (Table 1.16), and Colombia in Table 1.17 (only milk data). For the conversion of local currencies in US$, the exchange rates mentioned in FAO Trade Yearbook (1993) have been used for the particular period.

Table 1.14. Productivity of four main smallholder milk production systems in Kenya (compiled from Stotz, 1983 by KARI/KIT, 1995).

Smallholder milk production system	Zebus grazing permanent pasture (Kikuyu)	Crosses grazing permanent pasture (Kikuyu)	Grade cattle semi-zero grazing	Grade cattle zero grazing
Land productivity				
- Milk (kg/ha/yr)	185	523	1,719	6,667
- Meat (kg/ha/yr)	121	102	142	397
Labour productivity				
- Milk (kg/manday)	6	13	25	34
- Meat (kg/manday)	1.8	2.8	2.1	2.0
Capital productivity				
- Milk (kg/US$ 1,000)	488	1,015	1,939	2,730
- Meat (kg/US$ 1,000)	178	197	161	164
Gross margin*				
- US$/ha forage area	50	78	183	657
- US$/manday	0.74	1.89	1.90	2.65
- US$/US$ 1,000 capital	134	151	148	212
Animal productivity**				
- milk (kg/cow/lactation)	450	1,600	2,200	2,500

* at overall farm gate milk price of K sh 2/l (1 US $=13,19 Ksh, June 1983)
** Source: Stotz, 1981 in: Abate *et al.*, 1987.

Table 1.15. Productivity of milk production systems in Sri Lanka (1983) (adapted from LPU, 1984).

Production system	Dairy production under coconut palm		Mixed farming forest garden	Zero grazing(tea estates) (high/wet)	(high/dry)	Grazing dry zone indigenous herds		Intensive z.grazing
District	Colombo	Kurunegala	Kandy	Nuwara Eliya	Badulla	(1)	(2)	Jaffna
Land productivity								
- Milk (kg/ha/yr)	3,268	846	2,080	3,134	2,044	1,583	1,837	10,969
- Meat*(kg/ha/yr)	61	45	34	47	34	218	105	114
Labour productivity								
- Milk (kg/manday)	8.9	4.0	4.9	6.9	4.9	6.7	8.0	21.0
- Meat*(kg/manday)	0.17	0.21	0.08	0.10	0.08	0.71	0.46	0.22
Capital productivity								
- Milk (kg/US$ 1,000)	1,007	3,500	6,225	7,700	5,975	2,300	5,775	9,125
- Meat*(kg/US$ 1,000)	140	185	103	113	98	318	333	95
Gross margin**								
- US$/ha forage area	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
- US$/manday	0.59	0.47	0.38	0.48	0.72	0.90	28.7	66.2
- US$/US$ 1,000 capital	485	417	482	533	90	403	830	1,149
Animal/farm productivity								
- Milk/cow (kg/yr)	624	300	936	1,546	1,073	173	268	1,493
- Milk/farm (kg/yr)	2,310	1,050	1,592	2,319	1,717	2,088	2,737	5,375
Milk price (US$/l)	0.13	0.14	0.12	0.13	0.12	0.14	0.13	0.20

* meat based on cattle sales divided by Rs 8 per kg liveweight ** excluding interest on capital and family labour cost; n.a. not available and difficult to estimate because of use of communal forage outside farms (roadsides, ravines).
(1) Batticaloa (2) Polonnaruwa.

Table 1.16. Productivity in selected milk production systems of South America (adapted from Jarvis, 1986).

Milk production system Country Area	Extensive grazing Bolivia San Javier	Mixed farms crops/pasture Paraguay Filadelfia	Semi intensive grassland Brazil Valle de Paralbo	Intensive irrigated Bolivia Santa Cruz	Specialized dairies with concentrate Colombia Sabana de Bogotá
Land productivity					
- milk (kg/ha/yr)	250	201	652	676	6,470
- meat (kg/ha/yr)	117	64	n.a.	118	257
Labour productivity					
- milk (kg/manday)	23.8	17.9	34.8	87.9	131.8
- meat (kg/manday)	11.1	5.7	n.a.	15.3	5.2
Capital productivity					
- milk (kg/1000 US$)	n.a.	631	262	410	568
- meat (kg/1000 US$)	n.a.	201	n.a	72	23
Gross margin					
- US$ per ha forage	62.6	49.2	110	689	1,214
- US$ per manday	6.0	4.4	6.0	32.1	24.7
- US$ per 1000 US$ invested	n.a.	154	45.4	150	106.7
Animal productivity					
- Milk/cow (kg/yr)	334	536	1.527	824	3.558
- Beef (kg/head/yr)	155	171	n.a.	144	141

* n.a. = not available

Table 1.17. Selected characteristics of dairy farming systems in Colombia (adapted from Gonzalez, 1983)

Farming system Cattle breed Area	Indigenous herds (seasonal milk) Criollo, Zebu Guajira	Dairy ranching (dual purpose) Holstein*Brown Swiss*Zebu Cesar	Small-scale mixed farms Holstein* Criollo Pasto,Nariño	Medium-scale mixed farms Holstein Tuquerres,Nariño	Specialized large-scale dairy farms Holstein Cundinamarca
Dairy farms (n)	6,750	3,000	200	20	4,000
Farm size (ha)	200	500	5	40	120
Breedable cows (n)	10	100	3	30	80
Workers/farm (n)	2	8	4	4	5
Milk production					
- per cow (kg/yr)	250	735	840	1,800	2,745
- per farm (kg/yr)	2,500	73,500	2,520	54,000	219,600
- per area (tons/yr)	16,000	165,000	504	1,680	650,000
Milk price (US$/kg)	0.18	0.25	0.25	0.25	0.25
Land productivity					
- milk per ha (kg/yr)	125	147	504	1,450	1,830
Labour productivity					
- milk (kg/manday)	3.4	25.2	1.7	37	120.3

Large differences in land productivity can be observed in Kenya (Table 1.14) between grazing Zebu cattle and grade cattle kept under zero grazing; in Sri Lanka (Table 1.15) between Kurunegala with mainly Indian crossbred cattle grazing under coconuts and crossbred Jersey-Indian breeds intensively fed on crop-residues and by-products in Jaffna; in South America (Table 1.16) between extensive grazing and specialized dairy farms with concentrate feeding; and in Colombia (Table 1.17) between seasonal milk production of Criollo and Zebu cattle and Friesians on large-scale specialized farms.

Variations in labour and capital productivity are less pronounced than in land productivity, but are substantial among systems. Gross margins per manday are higher in South America than in Kenya and Sri Lanka (except for large indigenous herds in Polonnaruwa district and the intensive dairying in Jaffna district). Especially in Sri Lanka, smallholders dairying under coconuts, in the forest gardens and in the tea estates have low gross margins per manday. The same applies to the labour-intensive indigenous herds in Batticaloa district.

Average milk prices are higher in Kenya and South America than in Sri Lanka. In Kenya, where a standard milk price was used of Ksh 2 per litre, milk prices differed also per area and source of outlet for milk (Nkanata *et al.*, 1983). Under zero grazing with grade cattle, average producer prices over the period 1981-1983 ranged in dairy cooperative societies from 1.52 to 2.12 Ksh per litre (av. 1.81 = US$ 0.17), while direct local sale prices ranged from 2.46 to 3.57 Ksh per litre (av. Ksh 3.18 = US$ 0.29). Within Sri Lanka, milk prices differ also among areas. In Jaffna the milk price is higher since dealings are directly between producer and consumer. The lower milk prices are paid by milk collection centres that further vary because of different butterfat and solid non fat (SNF) contents of the milk. In Kandy, Nuwara Eliya and Badulla districts crossbreeds with exotic European stock prevail with low butterfat and SNF, while crossbreeds with Indian breeds in the Coconut Triangle and indigenous cattle in Batticaloa and Polonnaruwa have higher butterfat and SNF.

More detailed information per production system in Colombia (Table 1.17) is provided by the number of farms and breedable cows, and consequently total milk produced, an important figure for the relative contribution to and importance of a region or production system in national milk production. This is especially relevant, when farmers want to negotiate government or donor support with respect to prices, inputs and services. Dairy development projects and programmes, oriented to poor people in limited areas that have small shares in total milk production may find large difficulties in negotiating sufficient counterpart funding and personnel.

DISCUSSION AND CONCLUSION

Milk production characteristics in the Netherlands changed over time from 3,250 to 6,970 kg milk per cow (1930-1994), from 5,015 to 10,085 kg milk per ha farm land (1960-1984) and from about an estimated 40 to 1,500 kg milk per manday (1940-1994). In 1992 in industrialized countries, milk per cow varied from 3,550 in New Zealand to 6,600 kg in the Netherlands, milk per ha forage varied from 1,934 kg in the USA and 8,170 kg in New Zealand to 11,220 kg in the Netherlands. Contrary to the ha production in New Zealand, ha production in the Netherlands included the use of about 3,500 kg concentrates from outside the farm.

Milk production characteristics in developing countries in the early 1980s varied for Kenya in Africa from 450 kg per cow in traditional grazing of local Zebus to 2,500 kg per stallfed grade cow, from 185 to 6,667 kg per ha and from 6 to 34 kg milk per manday. In Sri Lanka milk per cow varied from 173 kg from Indian crossbred cows grazing under coconuts to 1,546 kg from Jersey crossbred cows fed intensively with tree fodder, straw and stover and crop by-products, from 846 to 10,969 kg per ha and from 4 to 21 kg per manday. The high Sri Lankan figures for milk production per ha included the use of off-farm resources (roadsides, ravines) for supply of roughages. In South America milk production varied from 334 kg per criollo cow under extensive grazing in Bolivia to 3,558 kg per grade cow in specialized dairy farms with concentrate and silage feeding in Colombia, from 200 to 6,470 kg per ha and from 18 to 132 per manday. Milk per US$ 1,000 farm investment varied in Kenya from 488 to 2,730 kg, in Sri Lanka from 1,000 to 9,125 kg, and in South America from 262 to 631 kg milk. Capital outlay of farms in South America includes generally more investment in land, fencing and milking facilities, while the farm outlay in Sri Lanka is limited to a simple low-cost cowshed, compared to more spacious and expensive stalls in Kenya. For the same reasoning the gross margins per US$ 1,000 investment in Sri Lanka (US$ 90-1,149) are higher than in Kenya (134 to 212) and South America (45-154).

Economically, dairy farming in the Netherlands, despite its high output per cow, per ha and per manday has a cost price for milk higher than the received milk price. In practice farmers or rather farm families accept lower returns for their labour and management than is common in other sectors of the economy in exchange for being their own boss on the enterprise of their liking. Milk prices in Europe in 1992 were considerably higher than in the USA and especially New Zealand and Australia. In the selected developing countries, milk prices were intermediate with economic returns per manday varying from US$ 0.74-2.65 in Kenya, from US$ 0.38-66 in Sri Lanka, and from US$ 4.40-32.10 in South America. The highest gross margins per manday in Sri Lankan and South America are related to better milk prices in the vicinity of the urban consumer or the milk plant.

Within more or less homogeneous dairy producing regions in the Netherlands, different farming styles of farmers showed large variations between styles and even more within styles pointing to the individual farmer or farm family as the most important determinator of technical and economic coefficients in dairying.

In conclusion, milk production characteristics showed a large variation among industrialized and developing countries and within countries. A closer study of characteristics of dairy production systems may reveal important details on how development of milk production and stock numbers have been or can be organized, incorporating differences in climate (cold and warm, wet and dry periods), genetic make up of the animals, animal feed resource base, use of external inputs (fertilizers, concentrates), animal disease incidence, prevention and control.

2. CHARACTERISTICS OF (TROPICAL) DAIRY PRODUCTION SYSTEMS

INTRODUCTION

Dairy production systems vary from subsistence milk production to commercial production for the market. Qualitative and quantitative demand for milk products and the milk price resulting from the ratio between supply and demand are important characteristics governing the transition from subsistence to commercial production.

Milk production depends on the genetic make-up (breed and/or type), age and lactation number (milk yields increasing first with lactation number and diminishing subsequently), stage of lactation (lactation curve and persistency), environmental factors like climate and management factors, like nutrition, housing and health care.

Care of the new-born calf and rearing it to a well-developed heifer at the age at first calving is the starting point for future milk production. Lifetime dairy production can be measured in calves and milk, distributed over a number of lactations with corresponding milk yields and calving intervals (lactation length and dry period between subsequent calvings) until the animals die or are culled. For a herd of dairy cattle, important reproduction characteristics are calving rate, calf mortality, growth rate of young stock, age at first conception of heifers and "open" days between calving and next conception in cows. Milk production, covering both production and reproduction, can be expressed as milk per day of calving interval. Including also the rearing period, milk yield can be expressed per lifetime day. Further precision can be made, taking into account the milk quality, expressing milk production in Fat Corrected Milk (FCM) at 4% butterfat, and maintenance requirement, expressing production per kg metabolic weight (Kiwuwa, 1987).

Non-productive periods in dairy farming are the calf rearing and heifer raising periods and the dry periods to prepare the cow for the next lactation. Aiming at keeping these costly periods as short as possible, implies going for an early age at first calving and for calving intervals of about 1 year with a dry period of 45-60 days. Economically, an early age at first calving may imply additional calf rearing costs because of intensive feeding with better quality and more expensive feeds. Short dry periods require accurate oestrus detection, timely mating arrangements and a low number of services per conception.

In this chapter a closer look is given to: (2.1) organizational aspects and price developments; (2.2) milk production development; (2.3) dairy stock development; (2.4) lifetime dairy production and (2.5) different approaches to dairy stock development.

2.1 Organizational aspects and price developments

In the organization of dairy development one can distinguish four main aspects, *i.e.* production, collection, processing and marketing. The production of milk can be highly seasonal in the case of nomadic herds, dual purpose cattle farms or ranches and even specialized dairy farms based on pasture. Milk production is less seasonal on small-scale, medium- or large-scale farms operated by the private sector or state sector using pasture, crop residues and by-products, sometimes complemented with irrigation and forage conservation facilities.

Milk collection can be done by the consumer, trader or by collection networks of the producers or processors. Milk processing may be done at the farm, village, regional or national level. Milk marketing can be direct from producer to consumer or at increasing costs through organized channels of traders, processors, wholesalers, retailers, shopkeepers, milk bar operators and supermarkets.

Milk is bulky, heavy and highly perishable, and is produced by large numbers of small farmer families, requiring an agile system of transport to the consumer or transformation into products with a longer shelf life (butter, ghee, sour milk, cheese, pasteurized or sterilised milk, condensed milk or milk powder).

A survey in 1984 conducted by the International Dairy Federation (IDF) in 21 countries, accounting for 55% of the world's milk supplies, showed that producer organisations handled 86% of milk supplies from farms, 85% of butter production, 70% of cheese production and 56% of liquid milk processing. Banerjee (1994) quotes as one lesson from the Indian experience, that success in dairying, or in any other agricultural field, depends on ensuring that control of the resources it creates remains with the producers. To encourage more commercial milk production, the small-scale producer needs a secure market and price guarantee (Empson, 1993). Dairying in India provides a good illustration.

Dairying in India

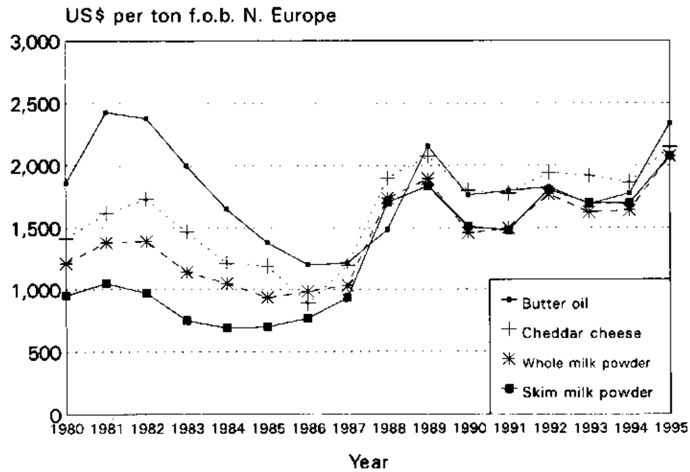
From 1951-1970 the Government of India stimulated "milk schemes" in large cities to provide hygienic milk to the growing urban population, and milk production improvement was encouraged by "Key Village Schemes" (with studbulls supplied to villages) and the "Integrated Dairy Development Projects" (with AI and bull services and a milk collection network). However, in the absence of a stable and secure market throughout the year for the milk producers, milk production more or less stagnated, growing at less than 1% per annum (Banerjee, 1994). During the 1960s various strategies were applied by State departments, such as running their own farms, and setting up milk colonies outside the urban centres, but milk collection and trade remained with contractors and middlemen, exploiting both producers and consumers (Banerjee, 1994).

However, another type of development took place in Kaira district. Milk producers went on strike, after having been refused a share by Polson's dairy (private sector) in the profitable milk trade with Bombay, that resulted in the establishment of the Kaira District Cooperative Milk Producers Union (popularly known as AMUL, Anand Milk Union Ltd.) that was registered in 1946 and obtained the monopoly rights for sale of rural Kaira milk to the Bombay Milk Scheme. Milk was collected through Village Milk Producers Cooperative Societies whose representatives formed the District Cooperative Union. All Unions in a State form a State Dairy Federation responsible for marketing milk and milk products outside the State. At national level there is the fourth tier, the National Cooperative Dairy Federation of India, that formulates policies and programmes designed to safeguard the interests of all milk producers (Banerjee, 1994).

Whereas Bombay was also committed to buy all milk from the Aarey milk colony (some 16,000 town cows moved to Aarey outside Bombay), surplus milk in the flush season in Kaira district was turned into milk products through a UNICEF-donated plant from 1955. An additional dairy plant was built in 1965, followed by a product manufacturing unit in 1971 to cope with improved milk procurement. In 1993, a fully automated modern dairy was under construction, adjacent to the original AMUL plant (Banerjee, 1994).

Fluctuating world market in dairy products

The influence of the world dairy produce market, basically a surplus market operating with fluctuating prices (Figure 2.1) upon domestic milk production represents a general, international problem. Practical arrangements to deal with the fluctuations and low levels of international prices vary from country to country: imports under licence or within certain quota limits are used in India and the USA; an elaborate system of variable import duties and counter-balancing export refunds harmonize domestic and international price levels in the European Union; import allotments based on ratios imported and collected local milk are used in some countries in South East Asia (Thailand, Indonesia). Other countries try to protect the local industry with minimum import prices and some use anti-dumping duties. However, nominal protection coefficients (ratio between agricultural price levels at national level and at world market level) in industrialised countries are normally above 1 varying from 1 to 3 and for developing countries less than 1 (World Development Report, World Bank 1986 In: De Hoogh, 1990). Organisation of a balance between imported dairy products and domestic milk supplies is invariably crucial to the development of domestic production (Empson, 1993).



Source: Dairy Board, Rijswijk, The Netherlands

Fig. 2.1. *Development of international market prices (average per year) for whole (full cream) milk powder, skim milk powder, butter oil and cheddar cheese (1980-first quarter 1995).*

Dairy stock prices

Pricing of dairy stock has received little attention in literature on dairy development. A general tendency exists among governments in developing countries to keep prices down to facilitate distribution of dairy stock to starters in dairy farming and to make dairy farming feasible on scarce credit resources. Therefore, many state and parastatal farms were often forced to sell animals at low prices, making their own operations non-sustainable at the moment government funding was reduced or stopped. However, low stock prices do not motivate the private sector to rear calves and raise heifers, and many valuable calves are left to die or are sold or shared to others. Sharing is often practised by resource-poor farmers to neighbours and family members who may have the labour to feed the animal. Generally, they do not have the means for supplementing minerals and concentrates, and for preventive animal disease control (deworming, deticking, vaccination) to rear shared female calves to well-developed heifers.

Producer milk prices

In Figure 2.2, producer milk prices in 1990 for selected countries are presented, to illustrate the large variation (Anonymous, 1992 and estimated for Colombia, Ecuador, Kenya, Tanzania, Sri Lanka and Indonesia).

The highest milk prices are received by Swiss farmers (milk mainly processed in products) followed by Japan and South Korea. Prices in Europe and the USA are considerably higher than in New Zealand and Uruguay (both based on seasonal milk from pasture). Large variations also occur within countries as illustrated for Kenya (high for direct local sales in warm areas and low for sale at milk collection society in wet, hilly areas) and Tanzania (high in urban area and low in distant, rural areas in Kagera region).

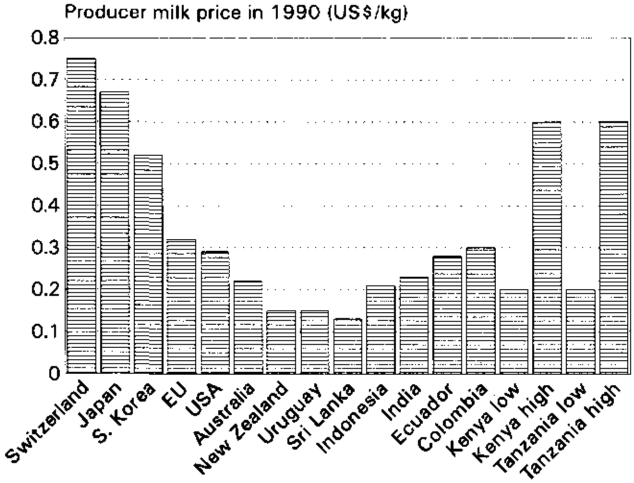


Fig. 2.2. *Producer prices for milk (3.5-4% fat) in 1990 in selected countries.*

2.2 Milk production development

Milk production characteristics, *i.e.* lactation yield and length, calving interval and age at first calving among (cross)breeds are shown in Table 2.1. Milk production of buffaloes varies from 1,000 in the dual purpose type (Egypt) to 2,000 kg in the milk buffalo (India) per lactation during 254 to 355 days. Age at first calving is late between 38-47 months and calving intervals are long varying from 425 to 594 days. Indian dairy breeds with 1,100-1,900 kg/cow/lactation produce more than non-descript cattle with 630 kg per lactation, but less than the 2,300-3,000 kg of crossbreeds with Holstein Friesian, Jersey, Danish Red and Brown Swiss. Age at first calving in crossbreeds is about one year lower and calving intervals are also shorter. Purebred exotic breeds show a large variation ranging from 2,800 to 7,000 kg per lactation for Friesians and a single record of 2,800 kg for Jerseys.

Age at first calving and standard 305-day milk yields of crossbred cattle with different levels of local, Jersey and Friesian blood in India is given in Figure 2.3 (BAIF, 1986).

Calving intervals and services per conception

Calving intervals are generally much longer in the tropics than the recommended standard of 365 days in temperate countries. Where milk production of Friesians is high, some delay in first service is recommended to save on labour and semen (McDowell, 1989; Ouweltjes, 1994). Where milk yield is low, late breeding will cause economic loss.

Table 2.1a. Dairy production characteristics of various breeds in the (sub)tropics.

Breed	Country	Records (n)	Cows (n)	Period	Milk yield/ lactation (l)	Lactation length (d)	Age at 1st calving (mo)	Calving Interval (d)	Source
Buffalo	Iraq	410	144	1969-80	1,434± 29	273± 3	38.1±0.5	425±7	Juma and Al-Samarai, 1985
Buffalo	Egypt	735	735		1,078± 36	254± 8	38.2±0.3		Mohamed *et al.*, 1993
Nili-Ravi	China	two farms			1,863± 774	271±60		441±16	Huanq and Wu, 1987
Nili-Ravi	India	396	396	30 years	1,701± 52	356± 8	37.3±1.1	580±13	Singh *et al.*, 1987
Buffalo	India			1960	1,620± 540	269±78	40.2±4.4		Singh *et al.*, 1989
	India			1973	1,833± 431	289±63	45.3±6.5		
Surti	India				1,772± 10	350± 5	44.5±2	461±15	Achariya, 1983
Murrah	India	144	144				47.2±2.4		Rao and Sreemannarayana, 1991
	India	20	20		1,731	317	<42	594	
	India	69	69		1,964	355	42-48	589	
	India	37	37		1,738	319	48-54	535	
	India	18	18		1,876	330	>54	583	
Murrah	India	Survey on 140 farms:			1,991	362	48.5	557	Sharma and Singh, 1994
Non-descript	India	86 small,			1,061	349	57.2	609	
Crossbred cows	India	63 medium,			1,726	319	30.8	412	
Non-descript	India	51 large farms.			630	285	54.2	546	
Local	Kerala	191			686	281	48.2	604	Nair, 1992
Sunandini	Kerala	266			1,486	342	33.3	515	Nair, 1992
Mpwapwa	Tanzania				1,271	282		459	Kanuya *et al.*, 1991
Kankrej	India	1,551	Central herd register		1,738	297	47.3	483	Mathur & Uppal, 1993
Sahiwal	India				1,719±36	284± 2	40.2±0.2	458±18	Achariya, 1983
Red Sindhi	India				1,605±25	284± 2	41.7±0.6	448±18	Achariya, 1983
Tharparkar	India				1,659±53	280± 6	49.4±0.4	451±24	Achariya, 1983
Hariana	India				1,137±34	233± 4	58.7±0.4	595±15	Achariya, 1983
Tharparkar	India	202	202	28 years	1,106± 27	261± 4	46.2±0.6	416±7	Sengar *et al.*, 1987
Tharparkar	India	117	117	1976-87	1,095± 26	285± 6	44.1±0.7	528±14	Panneerselvam *et al.*, 1990
Kankrej	India	1,551	1,551		1,738	297	47.3	638.7 (n=483)	Mathur and Uppal, 1993
Gir	India	595	225	15 years	1,887	316		488	Singh-Jhamman and Shukla, 1986
Gir	Brazil	11,982	3,492	1962-88	2,629± 15	249± 1	49.0±0.3	510±3	Queiroz *et al.*, 1993
Sahiwal	India	424	424		2,352± 39	345± 4	39.8±0.4	475±6	Gandhi and Gurnani, 1988
Sahiwal	India	22		1975-86	1,696± 21	280± 2		487±6	Yadav *et al.*, 1992.

Table 2.1b. Dairy Productivity of various breeds in the (sub)tropics (continued).

Breed	Country	Records (n)	Cows (n)	Period	Milk yield/ lactation (l)	Lactation length (d)	Age at 1st calving (mo)	Calving Interval (d)	Source
Karan Swiss	India	593	593	1966-88	3,089± 53	319± 4		397±4	Hegde and Bhatnagar, 1986
Karan Swiss	India		999		2,845±1087	339±86	35.8±5.0	432±94	Kumar and Bhatnagar, 1989
Karan Fries	India		521		3,140± 59	325± 7		392	Singh and Tomar, 1990
HFxZebu	India	Survey of 319 farms							Singh *et al.*, 1986
< 50% HF	India				2,289	293		399	
50% HF	India				3,655	305		388	
> 50% HF	India				3,556	310		398	
Danish Red x									Parmar *et al.*, 1986
Sahiwal (RS)	India	104			3,070	347	30.4	421	
HFxRS	India	74			3,263	396	27.4	456	
F1s	Bangladesh								Nahar *et al.*, 1989
-Friesian	Bangladesh				1,992	362	38.3	435	
-Jersey	Bangladesh				1,529	341	32.2	415	
-Sahiwal	Bangladesh				1,042	296	43.2	436	
-Red Sindhi	Bangladesh				998	269	46.1	452	
F1 cross 50% HF	Malawi				1,950	382	36.7	488	Agyemang and Nkhonjera, 1990
F2 cross 75% HF	Malawi				2,452	401	40.1	482	
Holstein-Fr.	Mozambique	30	30	1976-79	3,498±848	330±43	30 ±2		Alberro, 1980
Dutch Friesian	Mozambique	25	25	1976-79	2,816±644	320±40	31 ±2		
Fr.x Africander	Mozambique	20	20	1976-79	2,457±535	296±30	36 ±2		
Bunaji	Nigeria	46	46	1989-93	1,005±216	202± 9			Olutogun *et al.*, 1995
Bunajix Fr	Nigeria	34	34	1989-93	4,145±252	292±10			
Friesian	Nigeria	87	87	1989-93	7,044±160	323± 6			
Friesian	Ghana	103	35	1974-82	4,225±161	332±15		428	Kabuga and Agyemang, 1984
Friesian	Egypt	1646		1981-88	4,028	304	27.5	381	Afifi *et al.*, 1992
Friesian	Indonesia	survey 246 farms		1990	3,457	323		404	Widodo *et al.*, 1994
Jersey	India	468	221	1977-87	2,824	345		453	Ramachandraiah *et al.*, 1990
Jersey	India	1065	4 farms	1969-84			27.5±0.2	444±4	Murdia and Tripathi, 1990

Number of services per conception varies widely between hot and cold months as noted in Saudi Arabia (Hunter, 1987), Iraq (Van Velzen, 1988), and especially in buffaloes (Shah, 1990). Conception rates varied during March - December in Saudi Arabia in lactating cows (from 22-52%), dry cows or heifers (50-62%), the latter two categories having less problems with heat stress (Hunter, 1987).

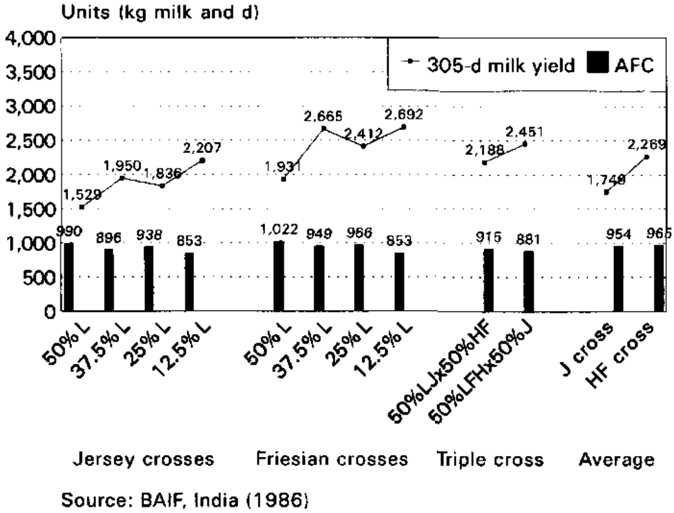


Fig. 2.3. *Age at first calving and standard first lactation milk yield in crossbreeds in India.*

The mating system (AI or natural mating) can have an effect as shown by Haile-Mariam *et al.* (1993) at Abernossa ranch, Ethiopia with calving intervals of 465, 552, 525 and 487 days for Boran cows naturally mated to Boran and Friesian bulls, and Boran and F1 cows artificially inseminated with Friesian semen, respectively. The number of services per conception was 1.81, 1.61 and 1.69 for Boran, F1 Boran-Friesian and 3/4 Friesian heifers, respectively. Elving *et al.* (1979) found on 33 government farms in Kenya from 1971-1975, an average calving rate of 87% with two inseminations per conception (conception rate of 51% after first service) and a calving interval (n = 5175) of 413 days.

Effect of altitude was demonstrated by the monitoring unit in the area San Carlos, Costa Rica for the low, medium and high zones with respectively conception rates after first service of 43, 50.9 and 52.2% with 2.1, 1.78 and 1.69 services per conception (Galina and De Jong, 1994).

2.3 Dairy stock development

Dairy stock development starts with *oestrus detection, selection of the bull, followed by* mating or artificial insemination of the cow. In the Netherlands, calf birth registration is a useful instrument in the identification of bulls with easy calving (important especially for heifers), while herdbook registration and milk records, and their analysis are used for judgement of dairy qualities as milk production, udder placement and form, milking ease, and quality of feet and claws.

In the tropics considerably less attention is paid to sire quality in terms of easy calving, bull fertility and transmission of desirable qualities such as feet, udder and milk composition. An example is the general complaint of low butterfat in the milk of Holstein Friesians and their crosses. In most cases this is based on using American Holsteins with low butterfat, while this could be avoided by using (Holstein) Friesians from Europe that have been bred for both, milk yield and butterfat.

Heat stress has a negative impact on most factors affecting reproductive success and genetic improvement in *Bos taurus* breeds. These include expression of oestrus, conception rate (fertilization and embryonic survival), fetal growth and postnatal survival (Fuquay, 1995). Pregnancy rate, *i.e.* the product of heat detection and conception rate, is markedly reduced during seasonal periods of heat stress (Thatcher, 1995), delaying the calf crop in the tropics.

Some farmers try to improve the body condition of their cows just before calving, in preparation for the next lactation (steaming up). In many cases this results in increased calf size, leading to large calves for a too small dam, and subsequently to difficult calvings, that are disastrous to both dam and calf. Also calving in a dirty environment (kraal, poorly cleaned stall or calving area) poses problems for the newborn calf and her dam and may result in navel infections (iodine applications are rare) and endometritis, respectively. Poor supervision after calving on the onset, frequency and amount of colostrum taken by the calf, makes that the calf starts with little maternal immunity to the diseases prevailing at the farm.

Calf mortality

Calf losses may occur through embryonic losses, abortions (calves dropped before 7 months of pregnancy), stillbirths, underfeeding and diseases of the young calf. Simensen (1986) studied calf mortality from surveys in European countries. Stillbirth ranged from 3-7% and total mortality from 7-16% of calves born. NRS/IKC (1993) estimated Dutch calf mortality around calving at 5% and another 10% during the raising period. Calf mortality in 65 Danish herds up to 6 months of age, over a 1 year period, amounted to 7%, including abortions (Agerholm *et al.*, 1993).

In a review of publications since 1973, Vaccaro and Pearson de Vacarro (1990) compared the survival rates of European dairy breeds with those of Zebus and European x Zebu crossbreeds. The unweighted means of published losses (%) due to abortions were 12.1 for imported cattle and 6.7 for Zebu and crosses, stillbirths amounted to 9.2 and 6.2, calf mortality was 37.6 and 19.9 and calf culling 1.4 and 1.9, respectively. Mortality after 1 year for heifers averaged 3.9%, with further culling of 6.6%. On top of these losses, about 15% of the imported stock did not reach first calving or completed a year in the tropics.

In pastoral systems calves compete for milk with men, especially with stockmen that are paid in milk, and in small nomadic herds where the diet of the family depends on milk consumption. Tethering young calves near the encampment, will not be detrimental to their health if they receive a suitable feed supplement, *e.g.* bran with butter milk. More often, however, hunger forces them to eat absolutely anything leading to mortality rates in the first year of 20-35%, or even 45% in some regions. Obstruction of the abomasum by sand, diarrhoea and septicaemia engendered by micro-organisms normally present in a saprophytic situation, are the most frequent causes of morbidity and mortality (Pagot, 1992). Corten (1991) found calf mortalities up to one year of 24.4% in females and 20.7% in males in monitored, traditional cattle keeping in Western Province, Zambia.

Calf mortality of Indian indigenous dairy and crossbreeds is given in Table 2.2 with higher mortalities for males and for indigenous breeds and the Karan Swiss.

Table 2.2. Overall mortality rates of different dairy breeds among different age groups in India.

	Male						Female					
Period (months)	Birth-1	1-2	3-6	Birth-6	6-12	0-12	Birth-1	1-2	3-6	Birth-6	6-12	0-12
Indigenous breeds												
Tharparkar	10.2	7.2	2.9	19.5	6.0	25.5	8.0	7.8	3.1	17.9	3.5	21.4
Sahiwal	9.8	4.5	2.7	16.3	3.0	19.3	8.4	4.1	2.2	14.2	1.5	15.7
Red Sindhi	9.2	5.1	2.2	15.8	1.6	17.4	6.9	4.7	2.1	13.2	1.2	14.4
Crossbreeds												
Karan Swiss	11.6	4.5	2.6	20.5	2.9	23.4	9.6	5.4	1.7	16.1	2.6	18.7
Tharparkar x Holstein	3.5	4.0	3.5	12.1	0.0	12.1	2.8	2.6	0.4	5.7	2.8	8.5
Tharparkar x Brown Swiss	5.1	3.2	3.0	12.2	0.0	12.2	5.4	0.0	0.0	5.4	0.0	5.4
Tharparkar x Jersey	0.9	2.4	0.7	4.0	0.0	4.0	1.2	0.0	0.0	1.2	0.0	1.2
Buffalo												
Murrah	16.3	7.0	6.2	27.7	4.8	32.5	17.2	5.7	3.6	24.8	3.7	28.5

Source: NDRI (1980) in Dairy India (1992).

In specialized dairy farms calf mortality can be rather high if not enough milk is given, or feed supply is insufficient. Noegroho *et al.*, (1991 in: Ibrahim *et al.*, 1991) found in 4 villages of the Malang regency in East Java a calf mortality of 26.4%. Calf mortality varied from 11 to 100% of calves born out of various lots of imported cattle totalling 696 Holstein-Friesian and American Brown Swiss cows and heifers in the 1970s into Bolivia. Even out of 301 calves born alive, over 100 died in spite of skilled veterinary attention (Khan, 1990). Katoch *et al.* (1991) found in Gujarat, India in 1,145 calves of 6 genetic groups that mortality up to 1 year of age increased with the level of exotic inheritance. Lighter calves were more susceptible than heavier ones. Calf mortality varied from 20.0% in Friesian crossbreds to 44.5% in 7/8 Jerseys. Mortality rates for male and female calves were 41.3 and 24.4%, respectively. In a Research cum Development Project (1986-1991) in Maharasthra, India, calf mortality in 1,255 recorded births was 41% and in female calves even 46.2% (Kulkarni *et al.*, 1993). In Jersey-Sindhi cattle (1974-1984) Veerapandian *et al.*, 1993 found calf mortalities varying between 6.17 and 22.34% in different years.

Calf mortality up to 12 months of age in 4,035 Surti buffalo calves (1773 males) over 1980-1990 amounted to 9.84% (8.91% in males and 10.57% in females) in Karnataka, India (Patil *et al.*, 1992).

In the small East African Zebu, reduction in calf mortality was attempted through supplementation of the cows and/or a change from continuous suckling to restricted suckling (Tegegne *et al.*, 1992). Calf mortality declined from 40 to 20% through molasses-urea supplementation or from 36 to 23% through restriction of suckling. In addition, the reproduction status of the dams improved: within 8 months after calving, 53 to 65% of the cows showed oestrus with 33 to 37% pregnant without and with supplementation, and 42 to 74% showed oestrus with 22 to 46% pregnant in continuous and restricted suckling, respectively. Calf mortality, estimated at 20% in 1980 was reduced considerably by programmes on calf rearing (individual housing and artificial rearing) in Kenya. Calf mortality on 99 smallholder farms in the Kenya Dairy Development Project was 8% in 1983/84 and 9% in 1984/85 (bull calves 12% and heifer calves 8%): young stock 6.4% and 5.3% (male 11% and female 4%); cows 5.4% and 7.3% (Van Noort, 1985).

In conclusion, calf mortalities in the tropics are generally very high not only in imported cattle and crossbreeds, but also in more adapted Indian dairy breeds and zebu cattle. Depending on the future of the male and female calves considerable difference in calf mortality may occur.

Male calves of dairy breeds have higher mortalities, while female calves in draught breeds (cattle and buffalo) die (or are left to die) at higher rates.

Feeding of calves

Various systems can be applied for the feeding of calves: natural suckling, restricted suckling and artificial rearing. Specialized dairy farms often use artificial rearing, where possible using artificial milk replacers to cut on whole milk cost, and early weaning with high quality roughage and concentrates. In dual purpose cattle, restricted suckling is common to stimulate milk-let-down and to raise calves on milk up to sufficient weaning weights to continue growth on fodder alone. Observations and experiments in the tropics have shown that calves may suck 400-800 kg milk from their dams per lactation in 210 days to reach weaning weights of 80-100 kg (Pagot, 1992).

Preston (1983, 1989) indicated that in all comparative trials between artificial rearing and restricted suckling both cows and calves responded well to restricted suckling. Cows with high proportions of *Bos indicus* genes have longer lactations and give more milk when the calf is used to stimulate milk-let-down and subsequently sucks the residual milk. Milk breeds of European origin such as the Holstein also give more milk and have less udder diseases when they nurse their calves after machine or hand milking. This stimulus to higher yields appears to persist, even if the calves are weaned in early lactation (6-12 weeks). Reproduction is not affected, provided natural mating is used to cover cows that have "silent " heats.

In a literature review on calf rearing practices and milk yields, Ryle and Ørskov (1990) concluded that feeding of milk substitutes is likely to be economically inappropriate for resource-poor farmers in developing countries, especially if a healthy calf is regarded as a significant asset. Moreover, as a well-fed cow can respond to the stimulus of suckling after milking by producing *more milk in total, early weaning as propagated* by *most trainers and extensionists may in fact* not lead to an increase in the amount of saleable milk.

Little *et al.* (1991) studied restricted suckling and bucket feeding in calves of Friesian-Boran cows in Ethiopia and found a 0.22 kg higher growthrate per day up to weaning for restricted suckling and a liveweight difference of 20 kg that persisted till the end of the experiemnt at 9 months. Milk uptake by the calves was the same for both systems. Restricted suckled cows returned later to oestrus (101 vs 41 days), required fewer services per conception (1.3 vs. 1.9), produced 15% more milk per lacatation and had longer calving intervals (391 vs. 355 days). Wongarikeo *et al.* (1990) found in swamp buffaloes in Thailand that cows with restricted suckling, from 30 days after calving lost less weight after calving than cows under continuous suckling and showed earlier postpartum ovarian activity. Moreover in a second experiment temporary calf removal for 72 hours at day 91 to 93 after calving induced ovarian activity in anoestrus buffaloes in village herds within 14 days. Similarly, Moore (1984) in a review on early weaning for increased reproduction rates in tropical beef cattle reported also that restricted nursing or temperary removal of calves stimulated early ovarian activity, increased the calving rate and reduced calving intervals.

Pagot (1992) indicated that well nourished young Zebu animals can grow fast. Young Gobra Zebus fed on Sahelian pasture and with ad lib access to concentrates reached liveweights in two years of 490 kg for males and 388 for females, against 230 and 220 kg at the same age on pasture only.

In conclusion, restricted suckling should receive more merit in training and extension on calf rearing in smallholder farms to produce more saleable milk as well as well-developed calves that will experience less weaning stress than is often seen after early weaning. It will also reduce the incidence of mastitis which will increase milk production further. Supplementation after weaning is important to achieve well-developed stock.

Age at first calving.

As indicated in Table 2.1, age at first calving strongly varies among breeds, Zebus and buffaloes calving late for the first time, dairy crossbreeds and pure dairy breeds calving much earlier. This variation was illustrated by Haile-Mariam *et al.* (1993) on Abernossa ranch, Ethiopia with an average age at first calving of 46.8 months for Borans inseminated with Friesian semen and 31.5 months for F1 crosses on the same ranch.

Other factors also have an effect such as altitude, farm type (government, private, urban, village, small-scale, large-scale), liveweight development and/or the level of supplementary feeding during heifer raising. The monitoring unit in the San Carlos area found for the low, medium and high zone, respectively average ages at first calving of 952, 941 and 878 days (Galina and De Jong, 1994). Elving *et al.* (1979) found on 33 government farms in Kenya over 5 years (1971-1975) an average age at first calving of 32.7 months in purebred and grade dairy cattle. Sahiwals are slow breeders and in the villages they are seldom bred before 30-36 months of age. At government farms in Pakistan breeding starts earlier, at an average age of 18-24 months, because of better feeding and management (PARC, 1985). Rao (1993) found in a field study on Jersey-Deshi cattle that 20 cows in organized farms and 40 in village herds had an age at first calving of 26.7 ± 1.23 and 37.6 ± 2.8 months, respectively, followed by 4.35 ± 0.52 and 4.45 ± 0.63 completed lactations, respectively.

Earlier ages at first calving are beneficial to total milk production, especially if accompanied by sufficient liveweight development. Ahmed *et al.* (1971) reported from 3,812 lactation records of 967 Sahiwal cows on a breeding farm in Pakistan, that Sahiwals calving for the first time between 30 and 33 months of age had 1.77 more lactations (4.98 vs 3.21) and produced in total 3,377 kg more milk (10,884 vs 7,507) than animals calving between 62.3 and 65.6 months old for the first time. Jadhav *et al.* (1990) found on military farms in Meerut, India in 570 HF-Sahiwal cows that calving for the first time between 25 and 27 months old resulted in the highest milk yields over 6 lactations, and those that were >41 months old at first calving had the lowest yields. Total costs and feed costs per unit of milk production tended to increase with increasing age at first calving. Parshchukov (1992) found in Russia that Friesians cows calving for the first time at ≤ 27 months showed higher longevities, lifetime and monthly milk yields and shorter periods of open days than those calving at > 27 months of age. Dhangar and Patel (1992) found in Gujarat, India that age at first calving of 28-30 months old with associated liveweights > 360 kg favoured high first lactation milk yields (average 2481 ± 86 kg) and short periods from calving till service (average 113 ± 8 days) in Jersey-Kankrej cows.

Very early ages, *i.e.* 24 months or less at first calving may result in lower milk production during the first lactation. El Bayomi (1993) studied 2,528 records of Friesian cows in Egypt from 2 stations of the Dallah Agricultural Investment and Animal Production Company, India and found maximum 305-day and total lactation yields (5,109 and 5,498, respectively) at first age of calving at 36 months against lowest yields (4,253 and 4,761 kg, respectively) at ≤24 months. Dvorak (1991) found in Czechoslovakia on 6 farms with mainly Czech pied cattle in 1689 heifers grouped in animals that calved at ≤ 23, 24-27, 28-29, 30-32 and > 32 months of age, milk yields in the first lactation averaging 2429, 2735, 2808, 2752 and 2686 kg, respectively. Analyses of all Dairy Herd Improvement Association (DHIA) records in Pennsylvania (540,411 Holsteins and 15,847 Jersey records between 1985-1990) revealed an average age at first calving of 26.64 months for Holsteins and 25.36 for Jerseys with a decrease of 0.6 and 0.3 months over the 6 years, respectively. Actual first lactation yields increased with 661 and 418 kg, respectively. Differences in 305-day yields between calvings at 24 vs 30 months amounted to less than 100 kg in favour of the ones calving at 30 months (Heinrichs and Vazquez-Anon, 1993).

Generally, an early age at first service and at first calving requires supplementary feeding. Ishaq (1969) showed for Sahiwals in Pakistan that supplementary feeding of concentrates from the age of 6, 10 or 12 months reduced the age at first conception to 640, 690 and 756 days and services per conception to 1.33, 1.50 and 1.67 against 946, 819 and 877 days and 2.83, 2.17 and 2.17 services in the control groups on forage alone. Additional costs of concentrate feeding of the experimental groups were compensated in 77, 64 and 17 days of milk production, respectively, at an average daily yield after calving of 5.34 kg.

Singh *et al.* (1988) found in 488 Karan Fries cows an average age at first calving of 32.45 ± 0.26 month and significant genetic correlation between age at first calving and birthweight (-0.65 ± 0.05), 1st-lactation milk yield (-0.58 ± 0.23), herd life (-0.54 ± 0.18), age at culling (-0.55 ± 0.18), lifetime milk yield (-0.57 ± 0.17) and total days in milk (-0.60 ± 0.46).

In conclusion, age at first calving in the tropics is higher than the 24-30 months in breeds in temperate climates, but reductions through improved feeding appear feasible and result in earlier milk production that pays for the additional feed costs. It requires, however, willingness of farmers and availability of funds to such investments in calf rearing and heifer raising.

Experience in dairy farming

Experience in dairy farming may also affect the technical characteristics, as illustrated by surveys in three villages in Pujon (> 15 years experience in dairying), Batu (10-15 years) and Karang Ploso district (< 10 years) in East Java, Indonesia in 1991 (Table 2.3; Sarwiyono *et al.*, 1992). The large standard errors indicate large variations among farms and a tendency for a lower age at first service and calving in the area with most dairy experience where also more natural mating was practised.

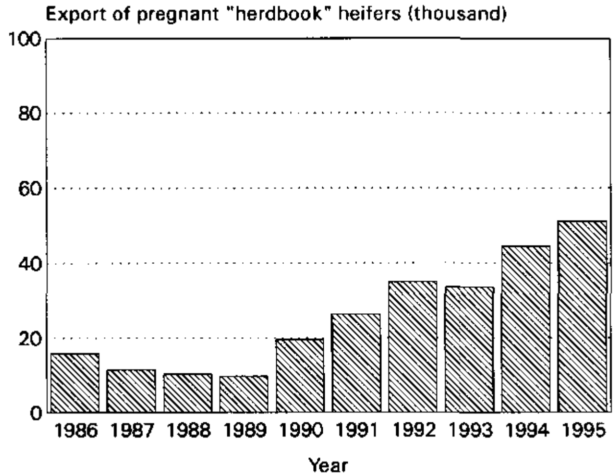
Table 2.3. AI coverage, age at first service/calving and services per conception in three areas of East Java, varying in length of experience with dairying.

Areas Dairy experience (yr)	Pujon > 15	Batu 10-15	Karang Ploso < 10
AI coverage (%)	66.6	81.8	100
Age at 1st service (months)	18.0 ± 2.6	23.4 ± 4.8	21.3 ± 3.0
Age at 1st calving (months)	28.2 ± 3.6	32.8 ± 4.3	30.8 ± 4.1
Services/conception	2.5 ± 0.6	2.4 ± 0.7	2.3 ± 0.8

2.3.1 Dairy stock development in the Netherlands

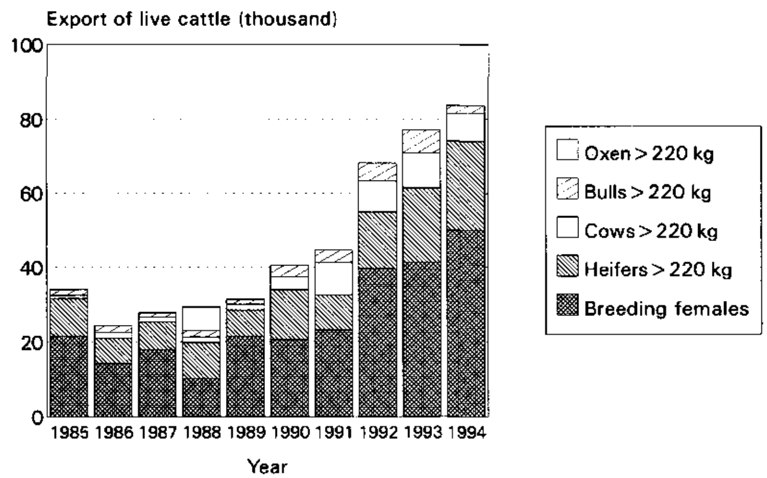
Development of dairy stock is a long term investment that needs financing capacity and keen interest of farmers. In the Netherlands, the demand for breeding stock from other countries keeps prices high for heifers, and stimulates farmers to rear more female stock than needed for replacement. The majority of male calves is fattened on special farms for white or pink veal or for young red bull meat. Calves born in the Netherlands (1,672,000 in 1960 and 2,384,000 in 1988) showed a mortality rate ranging from 9% in 1960 up to 11.7% in 1988, immature slaughters decreased from 20 to 0.4%, export of calves increased from 3 to 10%, slaughters as grass-fed or fat calves increased from 22 to 46.4% and calves slaughtered as young stock or added to the herd decreased from 46 to 31.5% over the same period (PR, 1990).

After the European Community (EC) imposed milk production quotas in 1984, the proportion of inseminations from beef bulls increased from 3% in 1984 to 15% in 1991. Subsequently, they returned to 8% in 1993 (PR, 1994) due to growing demand for export of dairy herdbook heifers (Figure 2.4, data provided by Veepro, 1995) and all live cattle exports (Figure 2.5, data provided by PVV, the commodity board for animals and meat "Produktschap voor Vee en Vlees", 1995).



Source: Veepro, 1995

Fig. 2.4. *Export of Dutch herdbook cattle (1986-1995).*



Source: Produktschap voor Vee en Vlees (1995)

Fig. 2.5. *Export of live cattle from the Netherlands (1985-1994).*

Despite good prices for calves and breeding heifers in the Netherlands, mortality rates are still fluctuating between 9 and 13% per year. In the top 20 Dutch dairy farms calf mortality was only 6% (Meijer, 1994), while at regional research centre farms over 1988-1993 calf mortality averaged 9% in the first fortnight after calving (Hanekamp *et al.*, 1994).

In addition to reduced calf mortality and prevention of calfhood diseases, high growth rates are needed to produce a well-developed, early calving heifer and consequently a high producing cow of to-morrow.

Boxem (1989) observed that Dutch heifers at first calving at about two years of age with liveweights of animals ranging from 420 to 520 kg, showed differences in first lactation yields up to 800 kg in 305 days. Each additional kg of bodyweight after calving was associated with 8 kg extra milk. He also reported that similar positive correlations were found in East Germany (8 kg milk per extra kg liveweight in a range between 400 and 500 kg), Ireland and Denmark (milk yields ranging from 17.2 to 19.3 kg per day during the first 84 days after calving with liveweights ranging from 420 to 520 kg).

Differences persisted also in the second lactation as observed in a study of first and second lactation yields at the central research farm "Waiboerhoeve" in the Netherlands (Table 2.4).

Table 2.4. Liveweight (kg) after first calving and first and second lactation yields (kg FCM, 305 days) at the Dutch central research farm.

Liveweight after 1st calving	Milk production First lactation	Milk production Second lactation	Difference 2nd-1st lactation
430	5,010	6,430	1,420
465	5,350	6,535	1,185
490	5,520	6,660	1,140
520	5,700	6,575	875

Boxem (1989) also found more complete realization of expected breeding values at higher liveweights at first calving of Holstein Friesians and Meuse-Rhine-IJssel (MRY) cows (Table 2.5) at three regional research centre farms in the Netherlands.

Table 2.5. Liveweight at first calving, milk production (FCM, 305 days) and breeding value at three regional research centre farms (ROC) in the Netherlands.

Regional research centre	ROC Zegveld		ROC Cranendonck		Waiboerhoeve	
Breed	>50% Holstein Friesian		MRY		Holstein Friesian	
Weight at first calving	< 500 kg	> 500 kg	< 500 kg	> 500 kg	Low	High
Number	29	35	52	62	21	18
Average weight (kg)	455	525	471	526	442	495
First lactation yield (kg)	5,690	6,250	4,940	5,375	5,235	5,637
Breeding value expected	+180	+190	+80	+75	+231	+235
Breeding value realized	+169	+208	+56	+80	+215	+229
Third lactation yield					7,923	7,951
Breeding value realized					+187	+234

Over time, differences in first lactation yields, expressed in Fat Corrected Milk (FCM) at 4% butterfat in 305 days, decreased in animals participating in the milk recording scheme and calving at about 2 or at about 2.5 years of age reduced from about 300 kg in 1975 to about 100 kg in 1987 (Table 2.6) (Boxem, 1989). Similarly, Heinrichs and Vazques-Anon (1993) found in Holstein-Friesian records between 1985-1990of the Dairy Herd Improvement Association (DHIA) in Pennsylvania, USA that the difference in 305-day milk yield between those calving for the first time at 24 vs. 30 months of age was less than 100 kg.

Table 2.6. Production level (FCM, 305 days) at early and the difference with that at late calving in Black and White and Red and White Friesians participating in milk recording in the Netherlands.

Breed	Black and White Friesian		Red and White Friesian	
Age at first calving	about 2 years	about 2.5 years	about 2 years	about 2.5 years
1975	4,040	+ 320	3,920	+ 285
1980	4,625	+ 265	4,420	+ 250
1985	5,030	+ 155	4,520	+ 190
1987	5,945	+ 75	5,145	+ 105

Hanekamp *et al.* (1994) found on eight Dutch regional research centre farms, from records of 886 Friesian Holstein heifers that calved for the first time at an average liveweight of 540 kg (decreasing by 42 kg during the first three weeks after calving), an average milk yield of 7,000 kg milk with 4% fat and 3.3% protein in 305 days. Linear regression showed that an additional 10 kg at calving yielded 55 kg more milk. However, liveweight at calving explained only 6% of the variation, while 39% was explained by farm, year and season of calving. Other factors contributing to well developed heifers are health care and especially feed supply: good quality forage is very important for a good milk yield; animals should grow according to a regular growth pattern; autumn pasturing should be limited; and unlimited feeding of maize silage is not recommended for heifers over one year to avoid excessive fat deposition.

Reasons for culling and age, lactation day, relative lactation value at culling stage and cause in % of total culled animals (average culling rate was 30%) over 1988-1993 at research centre farms are presented in Table 2.7. Also incorporated is the culling pattern and rate (average 33%) for 40 dairy farms in Friesland studied between 1985 and 1989 (Pasman and Oldenbroek, 1990) and for New Zealand dairy farms (NZ, 1988). Total culling rates on Dutch research centre farms and dairy farms in Friesland are similar, but much higher than culling rates (ranging between 16-18%) in New Zealand.

Table 2.7. Culling stage (lactation day, relative lactation value and age) and culling causes in % of total culled cows at ROCs (May 1988-April 1993), on 40 Friesland (FR) dairy farms (1985-1990), and on dairy farms in New Zealand.

Reason for culling	Culling stage				Culling cause (% of culls)		
	Lactation day	Lactation Value	Age (years)				
Farms	RRC	RRC	RRC	FR	RRC	FR	NZ
Reproduction	287	98	5.01	4.75	28.5	30	17.7
Milk production	156	86	4.01	4.92	26.2	25	29.4
Udder problems	131	95	5.06	5.17	17.6	17	5.9
Legs/claws	141	93	5.06	5.75	6.9	9	
Dead/emergency slaughter	81	97	5.04	\	6.5	\	\
Miscellaneous	143	95	5.02	/5.08	14.3	/20	/43.5
Bloat							3.5
Overall culling rate					30	33	17

Reported animal disease incidence on regional research centre farms for 1988-1992 (Hanekamp *et al.*, 1994) revealed that on average 20% of the cows contracted mastitis at least once per lactation (at a cost of Dfl 150 per average cow present), leg and claw problems (Dfl 50 per cow) occurred in 34% of the cows present, and 17 (1988) to 22% (1992) of the cows (excluding first calvers) suffered from milk fever. Reproduction problems (Dfl 105 per cow present) were associated with 20% of the cows showing irregular heat periods and 11% having a white discharge from the vulva. Proportional distribution of total number of reported disease cases in cattle on 40 dairy farms in Friesland between 1985-1989 was 50% for reproduction problems, 19% for udder, 18% for legs and claws, 9% for metabolic disorders and others 4% (Pasman and Oldenbroek, 1990).

Fertility status of the regional research centres' herds in 1993/94 indicated an average 2.04 inseminations per cow, 42% pregnancy after first service and 84% in total with a calving interval of 380 days. Economic costs of animal disease and reproduction setbacks amounted to Dfl 500 per cow in the Netherlands according to a study of Dijkhuizen mentioned in Hanekamp *et al.* (1994). Calf disease and economic effects, based on 916 calf cases on research centre farms, were studied by Dijkhuizen *et al.* (1994) and showed the following disease incidence: lung diseases 35%, diarrhoea 16%, leg problems 11% and navel ill 8%. Growth rates of affected calves were 50 gram per day lower during milk feeding (654 versus 703) and subsequently 20 gram till the age of one year. Age at first calving was delayed with 19 days (780 versus 761), but first lactation yield was not affected.

2.3.2. Dairy stock development in the tropics

Liveweight development

Liveweight development is considered a better indicator of puberty and maturity than age, but liveweight data are scarce and most records refer to research stations. McDowell (1989), in a review of the influence of environment (°N, climate and nutrition) on liveweight development, showed for different breeds: dam weights, birth weights of female calves and the relative liveweight development at birth, at the age of 3 months and 15 months. Table 2.8a presents the performance of Holstein Friesian in commercial farms (except Venezuela) and Table 2.8b gives data for (cross) breeds on research centres in different countries.

Table 2.8a. Influence of environment in Holstein Friesians on ratio of dam postpartum 30-day body weight to birthweight of female calves and rate of development to 15 months of age (McDowell, 1989).

Country/ State	Breed group	Age dam	Dam weight kg	Birthweight female calf kg	Birthweight/ dam weight %	Weight at 3 mos/ birthweight %	Weight at 15 mos/ mature weight %
New York	Holstein	All ages	680	42.1	6.2	234	54
North Carolina	Holstein	1st lact.	522	32.5	6.1		
Puerto Rico	Holstein	All ages	620	38.4	6.1		
		Normal	530	31.2	5.9	228	56
		Poor season*	520	20.0	3.8	all sold	
Venezuela	Holstein	All ages	524	30.3	5.8	254	49
Jamaica	Holstein	All ages	511	28.4	5.6	235	56
		Low nutr.**	500	17.6	3.5	247	48

* Cows calving in six dairies July-October 1986 following unusual hot season
** Low producing cows with long calving interval used as nurse cows

Birthweights relative to dam weights were generally around 6% except in cases of insufficient feed supply (Table 2.8a) and in case of the N'Dama-Jersey cross (Table 2.8b). For normal rate of development, heifer calves at 3 months of age should achieve 225 to 250% of birthweight, otherwise permanent stunting may occur. By 15 months of age, heifers should reach 50-55% of mature weight. Dam weights of Holstein Friesian (originating between 50-53 °N) are reduced in lower latitude, from 680 kg in New York State, USA (40-42 °N, cool climate) to 524 kg in Venezuela (8 °N, hot humid climate) and 511 kg in Jamaica (13 °N, warm humid climate). Daily temperatures exceeding 27 °C may cause depressions in appetite affecting allocation of nutrients to the fetus in late pregnancy and subsequently calf survival and birthweight (McDowell, 1989).

Table 2.8b. Influence of environment in (cross)breeds on ratio of dam postpartum 30-day body weight to birthweight of female calves and rate of development to 15 months of age (McDowell, 1989).

Country/ State	Breed group	Age dam	Dam weight kg	Birthweight female calf kg	Birthweight/ dam weight %	Weight at 3 mos/ birthweight %	Weight at 15 mos/ mature weight %
USA	HFxAyrshire	All ages	613	36.8	6.0	255	48
	Red Sindhi-Jersey (F1)	All ages	451	29.5	6.5	251	59
	RSxHF	All ages	583	35.9	6.2	253	55
India	Sahiwal	All ages	348	21.0	6.0	171	54
	SahxB.Swiss	All ages	360	21.8	6.0	202	55
Pakistan	HFxSah.(F1)	All ages	380	24.1	6.3	260	55
	(F2)	All ages	367	24.0	6.5	250	51
Ivory Coast	N'Dama***	All ages	287	16.7	5.8	307	47
	N'DamaxJer.	All ages	347	17.7	5.1	310	47

*** Calves received all of dam's milk (against others being entirely or almost completely hand fed after colostrum period).

In Figure 2.6, liveweight development of various other cattle breeds is presented as reported by Pagot (1992). From left to right breeds are from the smallest trypanosomiasis-tolerant breeds to the largest dual purpose pure Zebu breeds.

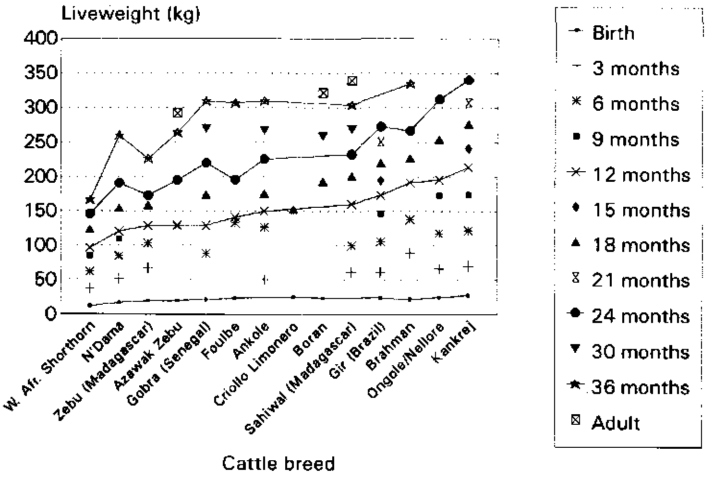
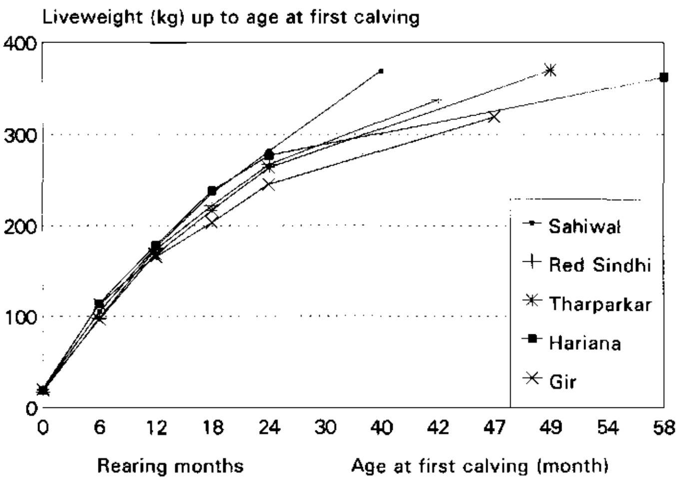


Fig. 2.6. *Liveweight development of dual purpose cattle breeds.*

Liveweight development as reported by Pagot (1992) illustrated large variations in birthweights, weights at 12, 24 and 36 months in dual purpose cattle breeds in the tropics. Indian dairy breeds showed not much difference in liveweight development in the first year but differences became larger and especially age at first calving differed considerably. HF crosses with Indian dairy breeds grew faster, and reached the age at first calving much earlier and at higher liveweights (Figures 2.7 and 2.8). For details on liveweight development of Friesians in the Netherlands and in Sri Lanka, see Chapter 9).

For Indian dairy cattle breeds liveweight development up to age at first calving is given in Figure 2.7. Liveweight development up to age at first calving of Holstein Friesian (HF) crosses with Indian dairy breeds are presented in Figure 2.8.



Source: ICAR (1982)

Fig. 2.7. *Liveweight development in Indian dairy cattle breeds during rearing (0-24 months) up to age at first calving (40-58 months).*

2.4 Lifetime dairy production

Lifetime production

The age at first calving and subsequent calvings result in a lifetime production of milk and calves before the animal eventually dies or is culled. In the Netherlands, average lifespan of dairy cows is about 5 years composed of an age at first calving of 2 years and a productive life of 3 lactations and calving intervals of 383 days.

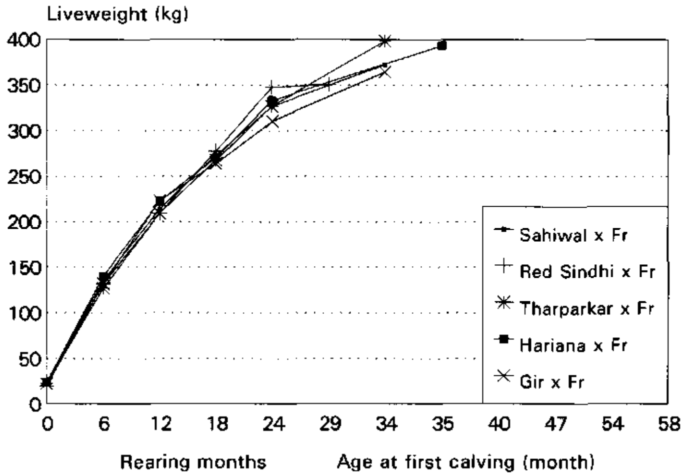
Mukasa-Mugerwa (1989) stated in a review of reproductive performance of female *Bos indicus* cattle that productive life was between 5 and 8 years with an average production of 3 to 5 calves.

Mangurkar *et al.* (1986) found for 86 Holstein-Friesians and 58 Jersey heifers, imported to India from Canada, lifetime records of pregnancies of 3.29 and 3.17, with 3.09 and 2.86 completed lactations and total milk yields of 15,327 and 10,191 kg, respectively. For 35 Canadian Holstein-Friesian, introduced in 1974 in the Ashanti region of Ghana, Kabuga and Agyemang (1984) found an average lifetime milk yield of 16,186 kg. Average lifetime milk production of imported British Friesian cows amounted to 9,392 kg in 4.5 lactations after first calving at the age of 39.6 months (Adeneye and Adebanjo, 1978).

In Poland, Hibner (1991) reported the effects of crossbreeding with Holstein Friesians on first lactation yields and lifetime yields. Local Lowland Friesians produced 3,279 and 11,559 kg, F1s with 50% Holstein produced 3,956 and 16,029 kg and F2s with 25% Holstein produced

3,367 and 12,678 kg in first lactation and during lifetime, respectively.

In the Sudan, Ward *et al.* (1988) found for 456 Kenana stock at the research station, that calved between 1958-1972, an average production of 4.02 calves, after first calving at 4.2 years of age and average calving intervals of 534 days. Wilson (1986) found in Central Mali less than 3 calves as lifetime production in the agropastoral system.



Source: ICAR (1982)

Fig. 2.8. *Liveweight development of crossbreeds of Indian dairy cattle with Holstein Friesian during rearing (0-24 months) and up to age at first calving (29-35 months).*

In India, Singh and Tomar (1988) found in 634 Karan Fries cows an average lifetime milk production of 9,538.5 ± 294.5 kg in 3.58 ± 0.11 lactations. Lifetime production of 744 Sahiwal cows in Karnal, India was 3.73 ± 0.10 calves of which 3.61 ± 0.10 were born alive: 1.80 ± 0.05 were female calves of which 1.26 ± 0.05 reached the milking stage indicating that a cow must produce 3 calves to replace itself (Rawal and Tomar, 1994). Basu *et al.* (1983) found for 958 Tharparkar cows calving between 1932 and 1972 an average lifetime milk yield of 7,977 ± 432 kg in 3.68 ± 0.18 lactations. Lifetime yields of 86 Jersey-Kankrej cows on a livestock research station in Gujarat, India averaged 8,766 ± 801 kg from 3.7 ± 0.28 lactations (Dhangar and Patel, 1991). Lifetime calf production of 936 Murrah cows in Karnal, India showed a total production of 3.59 ± 0.08 calves with 3.40 ± 0.08 born alive: 1.61 ± 0.05 were females of which only 0.75 ± 0.03 entered the dairy herd.

Rao (1993) found a longer lifespan of 7.9 ± 2.1 and 9.4 ± 2.8 years in 20 cows followed in organized farms and 40 in village herds, respectively. Corresponding numbers of completed lactations of these Jersey x Desi halfbred cows were 4.35 ± 0.52 and 4.45 ± 0.63, respectively with a productive life of 5.7 ± 1.2 and 6.3 ± 1.35 years. Gatenby *et al.* (1989) found on 183 farms in the Koshi hills in Nepal an average production of 10.7 calves in buffaloes (local and Murrah crosses) and 9.6 calves in cows (local and Jersey crosses) with 59, respectively 53 months for the age at first calving and calving intervals of 20.7 and 18.1 months, respectively.

Productive life in 13 studies of Mexico cattle raised under tropical conditions amounted to an average production of 3.4 ± 1.1 calves (Russell *et al.*, 1990). At high altitude lifetime calf production averaged 2.9 with culling at an average age of 5.5 years (Rivera-Rebolledo, 1988).

Ponce de Leon and Gomez (1988) found in 1,254 Holstein-Friesians in Cuba an average calf production of 3.96 ± 0.01 at an average culling age of 6.3 ± 0.08 years. Lifetime calf production in 712 Gir cows in Brazil averaged 4.0 ± 0.1 (Oliviera-Filho *et al.*, 1985).

Vaccaro and Pearson de Vaccaro (1990) found in a review of imported and locally born European purebreds in the tropics since 1973, that imported ones produced only 0.74 replacement heifers alive at first calving and locally born ones 0.98.

Level of calf rearing and lifetime milk production

In the 1950s Danish and Swedish cattle experiments showed that cows reared at a high nutrition level had shorter productive lives than those fed less during early growth. At a 66% level of normal allowance, a lifespan of 95 months against 75 months on 140% was found (Reid *et al.*, 1964). In Cornell experiments, plane of nutrition during lactation had a more pronounced effect on milk production than the level imposed during the rearing period (low or 62%, medium or 100% or high *i.e.* 146% of the Morrison standards (Morrison, 1959). Risk of difficult calving was higher in low-level fed heifers and the butterfat content in the milk was lower. Even up to the fifth calving high-level fed cows weighed 23.8 and 26.5 kg more than low- and medium-level cows, respectively. Main cause of culling was sterility in high-level and mastitis in medium-level reared animals. Appreciably more fat corrected milk (FCM) per unit of metabolic weight ($G^{0.73}$) was produced by the low and medium-level reared group over 4 lactations (Reid *et al.*, 1964).

Data on 67,000 Swedish dairy cows that calved for the first time between 1982 and 1988 showed that a higher age at first calving was associated with a lower lifetime performance, even though productive life slightly increased (Strandberg, 1992).

Animal health aspects

In the tropics, next to specific problems of exotic cattle with tick-borne diseases (especially East Coast Fever), trypanosomiasis and streptothricosis (a skin disease), there are health problems related to milk production levels, although the disease relevance may vary from region to region. As examples of the most important diseases, incidence in dairy herds in Saudi Arabia (Kopel, 1987) and regional research centres (Hanekamp *et al.*, 1994) and 40 Friesland dairy farms (Pasman and Oldenbroek, 1990) in the Netherlands are presented in Table 2.9.

Table 2.9. Animal health problems (number per 100 cows) associated with various levels of milk production in Saudi Arabia (Kopel, 1987), lactation values on regional research centre (RRC) farms (Hanekamp et al., 1994) and on 40 Friesland (FR) dairy farms in the Netherlands (Pasman and Oldenbroek, 1990).

	Saudi Arabia lactation yields			NL-ROC farms lactation values					NL-FR dairy farms
Type	5.500 l	7.500 l	9.500 l	< 86	86-95	96-105	106-115	>115	
Dystocia	25	25	7						
Metritis	25	25	9	38	32	32	32	45	50
Irregular heats									
Milk fever	3	9	2						
Ketosis	2	8	3	20	27	27	25	19	9
Abomasal displacement	0	3	<1						
Fatty liver syndrome	0	2	<1						
Mastitis	3	2	<1	19	17	20	16	5	19
Pneumonia	5	3	1						
Lameness	7	7	3	28	27	30	33	36	18
Other									4
Total	70	84	<30	107	103	109	106	105	90

In conclusion, lifetime production of calves ranges from less than 3 in agropastoral systems up to 4-5 calves in dual purpose cattle. Specialized local and exotic dairy breeds produced in average 3-4 calves. With a need for three calves to replace the dam, this does not leave much room for selection. In some cases reproduction rates were insufficient to replace the dam (exotic and local born pure dairy breeds in the tropics and Murrah buffaloes in India). Lifetime milk productions varied from about 8,000 kg in Indian dairy breeds to about 10,000 kg in crossbreeds and Jerseys and up to 16,000 kg in Holstein Friesians in the tropics. Extreme high feeding levels during calf rearing may lead to more sterility during productive life, but extreme low feeding levels in calf rearing may induce more difficult calvings. The actual incidence of fertility problems, metabolic disorders and lameness in specialized dairy farms, illustrated with data from Saudi Arabia and the Netherlands indicates the actual difficulty in optimal management of high yielding cattle.

2.5 Different approaches to dairy stock development

Dairy stock can be obtained in various ways:

(i) Imported from other countries;
(ii) Surplus stock of established state, parastatal and private dairy farms:
(iii) Crossbreeding of local beef or dual purpose stock with dairy bulls or semen;
(iv) Surplus stock from urban and peri-urban dairy farmers; and
(v) Sharing of cattle from others;
(vi) Heifers-in-Trust (HIT) schemes;
(vii) Calf rearing and heifer raising schemes.

Import of stock

During colonial times, most import of cattle took place by European settlers, armymen and merchants to satisfy their own demand for milk products, and by-products (skim milk) for their labour force on farms, plantations, army and enterprises. Male offspring was often given to the labourers for rearing and some crossbreeding occurred with local stock. After independence, many countries embarked on the import of dairy stock to increase milk production for the urban areas. A large number of these imports were realized in the framework of development aid and loans.

In the 1960s, with aid from various donor agencies, large numbers of purebred Canadian and American Holsteins were imported in Barbados, Guyana, Jamaica and Trinidad. In Jamaica some 11,000 Holstein cows were imported between 1963 and 1973. Severe intolerance to tropical heat and humidity and susceptibility to tick fever resulted in deaths, abortions and low milk production. Deficient planes of nutrition prevented cows from expressing their genetic potential and problems in re-breeding resulted in extended calving intervals (George, 1993). Two hundred imported Canadian Holstein heifers, supplied to smallholders in Barbados showed a 20% mortality in the first year due to management and health problems (Blackman, 1993). Introduction of high-yielding Holstein Friesians and Brown-Swiss in Cuba failed, because of the rough tropical climate, disease problems and low standards of management (Krostitz, 1991).

Imports in Tanzania amounted to 1,039 heifers from New Zealand and the USA supplied to parastatal farms under an IDA credit (1975-1983). Performance has not been up to expectations. Cattle performed below their potential due to unfavourable climatic conditions, diseases and poor nutrition. Milk production per cow per lactation of purebred and grade exotic cattle on parastatal farms amounted to 1,600 kg. In contrast, smallholders, owning approximately

60% of the dairy cattle in Tanzania manage to realize milk yields of over 2,000 kg per crossbred cow per lactation, due to improved extension services, level of feeding and general dairy husbandry practices (Massae, 1994).

China imported in the 1980s 10,838 head of dairy cattle based on grants of overseas countries and through commercial imports. These imports played an important role in developing the local dairy industry together with crossbreeding of local cattle with exotic stock. Number of dairy stock increased from 55,700 in 1979 to 162,700 in 1985 or annually with 19.6% (DSP, 1989). In Burma, performance of imported dairy heifers from New Zealand was poor with a mortality of 30% (Frankel, 1982).

McDowell (1989) evaluated the performance of commercial Holstein herds (except for Venezuela) in relation to latitude in parts of the USA, Mexico, Puerto Rico, Colombia and Venezuela (Table 2.10). In relation to cattle performance in the cool environment of New York, reproduction, milk production and survival rate were a little lower in the warm, humid climate of North Carolina, mainly because of high standards of feeding and management. When going South, production and reproduction characteristics are considerably more unfavourable.

Table 2.10. Influence of latitude on milk production and reproductive performance of Holsteins[a].

Location	Latitude (°N)	Climate type	Milk yield (kg)	Butter fat (%)	Age 1st calving(mo)	Days open(d)	Calving interval(d)	Days dry(d)	Survival rate (%)[b]
New York	40-42	Cool	7,718	3.63	28.8	116	396	63	53.3
North Carolina	35	Warm, humid	7,528	3.64	29.1	122	401	60	51.6
Mexico	18-28	Hot, dry	7,156	n.a.	28.2	162	442	81	45.8
Puerto Rico	18	Hot, humid	5,464	3.11	31.2	157	437	108	46.1
Colombia	3- 7	Warm, humid	4,771	n.a.	36.1	179	459	87	42.2
Venezuela	8	Hot, humid	3,656	3.31	28.7	206	486	181	38.3

[a] All herds are commercial dairies except in Venezuela and all areas drew sires from AI in the USA or Canada
[b] Proportion of those calving which survive to 54 months of age.
Source: McDowell (1989).

Results of some exotic cattle imports into Africa were reported by Kerstens (Veepro, 1988) for Tunisia, Van Velzen (1988) for Kenya and Euroconsult (1987) for Egypt.

Plans for improvement of milk production in Tunisia were supported by the Government of the Netherlands in a first project involving 900 cows in 1970 and a second one starting in 1975 involving 3,000 cows. Cattle were kept in 200-cow units in 4 groups of 50. After the import of 900 pregnant Dutch Friesians by the Office des Terres Dominiales (O.T.D) and more animals later on, O.T.D. herds reached in 1981 2,000 dairy cows which developed into 4,000 cows in 1984. Annual milk production per cow increased from 3,400 kg in 1978 to 4,550 kg in 1983. In comparison, annual milk production per cow in the private and state sector rose from 2,900 and 3,200 to respectively 3,600 and 4,000 kg (Veepro,1988) over the same period.

In Kenya, two lots of Dutch Friesians were imported at the Naivasha Dairy Cattle Research Project in the 1970s: (A) as pregnant heifers (51) at 18-24 months of age and (B) as heifer calves (59) between 6-12 months old. Later on, large groups of heifer calves were imported to be raised at Kitale at a parastatal farm of the Agricultural Development Corporation. Performance data of the three groups are listed in Table 2.11 (Van Velzen, 1988).

In addition, some lactation data are included from the Damietta pilot farm in Egypt that received Dutch Friesians in 1978 and from 1982-1984 (Euroconsult, 1987). Poor results of the Kitale group and the Damietta group in 1987 were related to lack of feed and regular feeding (Van Velzen, 1988 and Euroconsult, 1987).

Van der Grinten (project manager: pers. com., 1995) indicated that Dutch Friesians on a turnkey project by HVA in Libya under expatriate management, produced on average 9,000 kg per lactation, based on irrigated fodder and high amounts of imported concentrates.

Reports on import of Dutch stock into Asia related to Iraq (Van Velzen, 1988) and Sri Lanka. Out of 800 pregnant Dutch Friesian heifers imported into Iraq, 94% calved and 86% completed first lactation with an average production of 4,114 kg, and 82.4 % calved for the second time (Van Velzen, 1988). Calving intervals varied from 397 to 454 days depending on time of calving in the coolest or the hottest trimester, respectively and fertility varied from 1.6 (cool season) to 5.8 (hot season) services per conception, showing effects of extreme summer temperatures (25 °C at 6 a.m. to 45 °C at 2 p.m.).

Import of 779 Dutch Black and White Friesians (50% pregnant and 50% between 6-12 months old) in Sri Lanka in 1978-1979 was less successful: only 80% of 740 recorded heifers produced a first calf at an average age of 33 months and 56% calved for the second time with a calving interval of 485 days (Brouwer and Van Wageningen, 1985). Average first lactation yield of 272 records was 2,316 litres in 378 days.

Table 2.11. Performance of groups of imported Dutch Friesian cattle in Kenya in the 1970s and in Damietta, Egypt in 1980s.

Group	Number	Weight at 640 days (kg)	Age at 1st calving (months)	Pregnant after 1st service (%)	Services per pregnancy	Lactation data milk (kg)	records (n)	days (d)	Calving interval (d)
First lactation									
- Naivasha lot A*	51	421	25			3,983	43		
- Naivasha lot B**	59	403	26	36	2.1	4,191	57		
- Kitale group	2,500	320				1,950			
- Damietta in 1984			30	55		3,631	99	321	
- Damietta 1987			29			3,161	230	348	
Second lactation									
- Naivasha lot A				32	2.7	4,864	43		424
- Naivasha lot B				64	1.9	5,287	51		379
- Kitale group						1,920			
- Damietta 1984						4,095	84	299	
- Damietta 1987						3,391	122	313	
Third lactation									
- Naivasha lot A				67	1.7	5,953	36	371	
- Damietta 1984						4,953	169	313	
- Damietta 1987						4,240	111	325	

* imported as pregnant heifer ** imported at the age of 6-12 months.

In conclusion, imports of exotic stock should be accompanied by excellent feeding regimes to reach productions of some 4,000-6,000 kg per lactation. Availability of sufficient high quality forage, preferably in the form of hay or silage (Van Velzen, 1988), concentrates and top management, appear major pre-requisites, together with sufficient protection against high temperatures and humidity and absence of tick-borne diseases.

Surplus stock of (para)statal and large-scale private farms

In most countries government established research and breeding farms. Often they have been or are still used for breed comparison, defining nutritional packages and testing management practices. Most breeding farms are nowadays in the hands of parastatal organizations to avoid that farm returns go directly to Treasury and that farms are dependent on annual, small allocations of the government budget. However, the often intended, more independent, decentralized operations still experience government ties in setting farming objectives, prices, investment allocations, etc. In addition, there may be some large-scale private farms originating from the colonial times as is the case in Kenya, Zambia and Zimbabwe. In Indonesia nucleus estate farms exist that multiply (imported) stock for smallholder dairy schemes attached to the nucleus. They assist in provision of breeding stock, commercial feeds as well as training, extension and milk collection. In Cuba and China this type of assistance to the private and collective sector has to be provided from the state farms.

Generally, the large-scale farms have more qualified management and are expected to produce more stock than needed for replacements that can be made available to others (often loan schemes or government projects). Most smallholder dairy development schemes have to rely, at least initially, on improved breeding stock from these farms.

Price settings for parastatal products (milk and cattle) have been on the low side for political reasons, that interfered with profitability, necessary investments and replacements of machinery and equipment. Salaries have been kept close to those of the state sector, demotivating management and farm output. Under the structural adjustment programmes most large-scale farms are now in the process of planning or execution of privatization. Poor perspectives of the many run-down (para)statal farms and of large-scale livestock farming in the country may lead to a quick sale of assets and livestock by the new investors. A better alternative would be to split up these farms for smallholder farming, reducing in the mean time the expansion hunger of neighbouring villages.

Large-scale crossbreeding

In Kerala, an Indo-Swiss project introduced crossbreeding with Jersey and Brown Swiss in 1963. Cow milk production increased from 173 million litres in 1964/65 to 1,134 million in 1986/87 with an increase of the crossbred contribution from 0 to 75%. For the period 1977-1978 to 1987-1988 milk production increases were attributed to increased cow numbers (indigenous 12.6% and crossbred 7.7%) and higher productivity (yields of indigenous cows 1.4% and crossbreed cows 72.5%) and 0.8% was from interactions. Total milk production, including buffalo milk, increased from 204 million litres in 1964/65 to 1,600 million in 1989/90 (Nair, 1992). A network was developed including six regional semen banks, 11 liquid nitrogen plants and 1,400 AI centres with some 400,000 inseminations in 1973 that increased steadily to 1.4 million in 1988 for a breedable cow population of 1.55 million (Schneider, 1990).

BAIF, India had in 1986 some 215 livestock development centres covering some 300,000 farmers with 4.5 million head of cattle and spread over 6,000 villages in 6 states. Annually some 100,000 cattle were bred through AI at the doorstep of farmers, resulting in 30-40,000 crossbred female offspring (Rangnekar, coordinator research, pers. com. 1986).

Cuba, after the failure of imported stock, moved to crossbreeding of the beef herd with Friesians, leading to the Siboney type (5/8 Friesian and 3/8 Zebu). For this purpose, 30,000 Holstein Friesian heifers and cows and 10,000 bulls were imported between 1965 and 1975. The dairy cattle proportion of the total cattle herd increased from 31% in 1970 to 94% in 1989. Friesian purebred and grade cows increased to 200,000 Friesian, held in about 160 state farms of 120 and 280 standard cow-units. Annual milk production increased from 431 to 930 million litres (WFP/CFA, 1991).

Shortage of suitable dairy cattle is one of the major factors constraining dairy development in Tanzania. Crossbreeding is practised on parastatal heifer breeding units and state owned Livestock Multiplication Units (LMUs). Annual production of 2,000 F1 heifers from LMUs is not sufficient to meet the annual demand of 8,000 heifers, and LMUs will not be sustainable at selling in-calf heifers at US$ 200 against a cost of US$ 300. The number of dairy cattle rose slowly from 144,000 in 1984 (livestock census) to an estimated 257,000 in 1993 (Massae, 1994).

In India, there were 13 million crossbreed cattle in 1982 (livestock census), varying from 0.2% in Madhya Pradesh to 46.9% in Kerala State. Tandle *et al.* (1993) reviewed crossbreeding in India and showed that crossbreeding at village level of non-descript cows with Holstein resulted in an overall increase over Zebu of 21.7% in milk yield and 42% in lactation length and with an overall reduction of 21% in age at first calving and 17% in length of calving interval (Table 2.12).

Table 2.12. Characteristics of different dairy cattle breeds in India.

Characteristics	Indian dairy breeds	Exotic dairy breeds	Crossbreeds
Age at first calving (months)	40 - 45	20 - 24	30 - 35
Lactation yield (l)	900 - 1,200	3,500 - 6,200	1,800 - 2,200
Lactation period (d)	240 - 290	290 - 320	280 - 310
Dry period (d)	90 - 120	60 - 80	60 - 70
Calving interval (months)	15 - 18	12 - 13	12 - 14

Malawi, after successful crossbreeding of Malawi stock with Friesians, initiated milk collection through bulking groups of smallholder farmers which supplied over 60% of the milk to three urban dairy plants. Transport costs were shared between the (parastatal) Malawi Dairy Industry and the farmers (40%). The sector had insufficient numbers of breeding stock for supply to potential smallholder dairy farmers, but hopes are now focused on participation of commercial estates that may in time generate more surplus dairy stock and contribute to a rapid increase in production (Nzima, 1994).

In China, through intensive AI programmes on state farms, the number of dairy cows and crossbred China Black and White cows increased from 12,000 head in 1949 to 222,200 in 1988, an average annual increase of 7.8%, which was equal to the 7.8% increase in dairy goats, much higher than a 2.6% increase in Yaks and a 1.9% increase in buffalo numbers. Numbers of Yellow cattle increased at 1.9% (China/EC, 1989).

Surplus stock from urban and peri-urban dairy farms

In India, private milk contractors take away the best dairy animals from the villages to establish cattle stables in the cities. Most calves are starved to death and many dairy animals were slaughtered after their lactation, causing an immense genetic set-back (OF, 1979). Generally (peri) urban farmers concentrate more on dairy cows and milk production and calves are sold or left to die (especially male calves), soon after birth. However, in state farms in the urban areas of China calves are raised and made available to collective and private farms.

Sharing of livestock

It was a common feature of early agriculture for wealthy farmers or landholders to loan breeding stock to the less wealthy for their mutual benefit. In Malaysia such systems are known as "Pawah schemes" (Camoens, 1976). In Kagera region, Tanzania local chiefs distributed local stock to individuals who obtained the benefit of manure production for establishment of their coffee/banana fields while the chiefs benfitted through herd expansion without feeding constraints (De Wolf, teamleader KALIDEP, pers. com., 1989). Smallholders, that tend to keep their cows till old age, provide stock to relatives through sharing, since they produce more young stock than needed for their own replacements.

Heifer-in-Trust schemes

Heifer-in-Trust (HIT) schemes supply in-calf heifers as the term says in trust. The recipient becomes owner once he has passed on a similar farm born in-calf heifer. This scheme has been propagated very much for cattle and goats into Africa by Heifer Project International (HPI) a non-government organization located in Little Rock, Arkansas, USA. The focus is on groups of some

30 poor people per area or organization that receive the animals as a one-time gift to pass on the offspring to others in that area or organization. The group is assisted by an extensionist and by training sessions.

In Tanzania the scheme has also been adopted by WFP funding to support poor farmers that can not afford US$ 300 per in-calf heifer, after constructing the cattle shed from local materials in Tanzania (Massae, 1994). HPI assisted from 1973 to the end of 1992 a total of 4,685 needy families in 12 regions of Tanzania (Massae, 1994). Unfortunately, no monitoring data are available on the number of pass-on heifers, mortalities, etc.

Experiences of the Evangelical Lutheran Church in Tanzania (ELCT) in part of the HIT programme supported by both HPI and the Lutheran World Relief in Tanga region indicated that 116 heifers (US$ 271,491, including technical guidance costs) supplied during 1984-1986 resulted in 19 in-calf heifers passed on in 1991, and from 214 heifers (US$ 334,200) supplied during 1987-1989, 109 pass-on heifers had been produced in 1991 (Sudi *et al.*, 1991).

Experiences in the HIT scheme funded by WFP funds in Dutch supported projects in Kagera (KALIDEP, 1993) and Tanga region (TSDDP, 1992) are presented in Table 2.13. In addition, data from the Damietta project in Egypt are presented where smallholders were supplied in kind with 2 in-calf heifers and shed building materials and had to repay two one-year old heifers and two 3-months old bull calves (Euroconsult, 1987).

Table 2.13. Performance of Heifer-in-Trust schemes in Egypt (19801987), Kagera (1984-1989)and Tanga (1989-1992) in Tanzania.

	Damietta, Egypt	Kagera, Tanzania	Tanga, Tanzania
Study period	1980-1987	1987-1989	1989-1992
Farmers supplied with HIT heifers	\305	567	596
Farmers with pass-on heifer	/	66	11
Replacement heifer received	32	7	16
Total HIT heifers supplied	610	640	623
HIT heifers dead/stolen/slaughtered	35	58	22
Animals withdrawn	8	13	8
Farmers with animal (not yet paid)	115	503	582
Farmers that paid back	92	66	11

Table 2.14. Livestock development and farmers reached by HIT schemes starting with 100 animals and pass-on rates (p) of 50%, 62.5 and 70% (Houterman *et al.* 1994).

Generation	Year	Number of farmers Pass-on rate 50%	Cumulative no. of farmers	Number of farmers Pass-on rate 62.5%	Cumulative no. of farmers	Number of farmers Pass-on rate 70%	Cumulative no. of farmers
1	0	100	100	100	100	100	100
2	4	50	150	63	163	70	170
3	8	25	175	39	202	49	219
4	12	13	188	24	226	34	253
5	16	6	194	15	241	24	279
6	20	3	197	9	250	17	296
7	24	1	198	6	256	12	308
8	28			4	260	8	316
9	32			3	263	6	322
10	36			2	265	4	326
11	40			1	266	3	329
12	44					2	331
13	48					1	332

Project staff in Tanzania indicated that HIT schemes are effective in reaching women and poor rural farmers, but that strict selection of clients is necessary to ensure that beneficiaries have sufficient resources to feed the animals and to buy acaricides, especially during the initial period when the animal does not produce milk, and later on, during the dry period of the cow. Intensive follow-up by extension staff was identified in the projects as a pre-requisite to guarantee properly fed and developed offspring to pass-on to others. In all HIT schemes the rate of pass-on is low. Houterman *et al.* (1994) illustrated that at the actual performance in Kagera with a generation interval of about 4 years between supply of the original animal and the pass-on, and a 62.5% pass-on rate (due to mortality and withdrawal), it would take 8 years to double the number of participating farmers. Pass-on rates below 100% cause also a termination of the pass-on process (Table 2.14).

The performance of the HIT programme from actual supplies by WFP over time is given in Table 2.15 (KALIDEP, 1995).

Table 2.15. Performance of the HIT scheme in Kagera region (1987-1994/95).

Year	1987	1988	1989	1990	1991	1992	1993	1993/94	1994/95	Total
Supply WFP	55	85	60	114	218	204	136	255	538	1665
Replaced	2	8	7	3	11	10	13	26	35	115
Drop-out										
before payment		2	2	8	15	29	8	20	47	131
after payment		1	3	4	9	20	5	15	58	115
Repayment			19	17	17	36	13	76	159	337

Calf rearing and heifer raising schemes

Unfortunately, records of calf rearing schemes are scarce in literature. Mishra *et al.* (1990) reported on a large calf rearing scheme in Orissa, India. Selected farmers were supplied with subsidized feed and veterinary assistance in two areas: one with and one without organized milk marketing. Results were 591 (organized sector) and 573 crossbred Jersey calves (unorganized), respectively, with an age at first calving of respectively, 30.7 ± 0.7 months and 33.3 ± 0.6 ($P < 0.05$) and corresponding liveweights of 282 ± 5 kg and 264 ± 3 ($P < 0.05$). Both parasitic load and mortality were higher in the unorganized area.

Service companies have started calf rearing operations for farmers in Indonesia, and also in China calf rearing farms are contemplated for improved calf rearing compared to poor standards at dairy farms. In Barbados, the Greenfield Heifer Rearing Scheme already purchases calves from farmers and offers them back as heifers at least three months pregnant (Blackman, 1993). Experiences with calf rearing and heifer raising schemes in Sri Lanka are further analyzed in Chapter 9.

DISCUSSION AND CONCLUSIONS

The organization of dairy production is very diverse by farm type, seasonality of production, systems of milk collection and marketing. Producer milk prices showed large differences among countries but also within the country depending on who collects and pays for the milk. Fluctuating world market prices are counteracted by high protection levels in Europe and North America, with less protection in developing countries and in Oceania. Prices for dairy stock are generally kept low in developing countries to facilitate distribution to others but at the expense of profitable production units.

Milk production varies considerably with genetic make-up of the animals, quantity and quality of feed provided, disease control measures and overall management of reproduction. Age at first calving is often late in developing countries, followed by late rebreeding, more services per conception and subsequently long calving intervals. Calf mortality varies from 10 to 45% depending on the sex of the calf and its future purpose. Lifetime production of calves varies from less than three in agropastoral systems to five calves in other systems. This together with the high mortalities does not leave much selection room in female calves for future replacements. Given the right attention to the calves during rearing and heifer raising facilitates an early age at first calving and allows for a better expression of their genetic potential. In the tropical environment heat stress tends to reduce birth weight and liveweight development resulting in smaller animals of local as well as exotic types. Imports of high yielding exotic stock experienced problems with climate, feed situation and diseases and low standards of management, although there are exceptions where high standards of feeding and management were provided. Crossbreeds perform generally better in the given circumstances at less costs. One of the large problems is creating enough crossbreeds for the large demand.

The provision of dairy stock to new farmers, especially to the poor and needy people has been done in the form of a gift (heifer-in-trust) with the obligation to pass on a similar female offspring to others. So far the pass-on rate is rather slow, because of mortalities and long calving intervals.

3. HISTORICAL OVERVIEW OF EXPERIENCES IN DAIRY DEVELOPMENT

INTRODUCTION

A brief review is presented on dairy development issues, options and experiences in Africa, Asia and South America as reported by lending agencies such as World Bank, Asian Development Bank (ADB) and the African Development Bank Group, and international organizations as the Food and Agriculture Organization (FAO) and World Food Programme (WFP). Subsequently, experiences, conclusions and recommendations of recent seminars on dairy development and policies are presented. Finally, historical development in the approaches to programmes and projects in rural development will be discussed.

3.1 Lending agencies

World Bank

De Haan (1991) mentioned the following main factors determining success or failure in livestock development projects: (i) adequacy of producer incentives, (ii) appropriateness of technologies used, and (iii) capacity of the responsible institutions for project planning and implementation.

Removals of price controls in Chile and Uruguay (Frankel, 1982) had significant effects and producers came back with investments in the early eighties. Protection against competition from food aid milk powder in Madagascar spurred recently private investment in milk collection and processing (De Haan, 1991).

Free or subsidized services generally improved project performance during implementation but can often not be sustained by Treasury after completion leading to poor after-project sustainability. (De Haan, 1991). Subsidies on inputs and services are not sustainable in the absence of a tax base willing and able to keep up such payments (De Haan, 1991)

High import tariffs and price subsidies in Mediterranean and East European countries induced high-tech, capital expensive but economically inefficient production systems based on high levels of mostly imported feed grain. Phasing out protection and subsidies resulted in major challenges faced by producers (De Haan, 1991).

The increasing trend, although conceptually very desirable, to integrate livestock projects into general agricultural development projects, does force departments into a generally difficult and not very efficient operation (De Haan, 1991).

In input supply, agro-processing and marketing, the classical success story is constituted by the Indian dairy projects that developed an efficient multi-tier cooperative system providing a broad range of services to millions of farmers, collecting and processing millions of litres milk daily. However replication of the model in neighbouring countries failed due to lack of leadership and autonomy of the Indian model to command adequate government support and appropriate producer prices (De Haan, 1991)

Walshe (1994) concluded from a World Bank review (Frankel, 1982) of 75 projects in 45 countries for dairying or with an important dairy component, that overall project implementation was good and in most cases exceeded appraisal expectations. Other observations were:

- the costs of milk production were lowest in pasture-based systems in New Zealand and highest in concentrate-based systems in the USA, with as intermediate the low-input low-output systems of pasture-based, dual purpose cattle farming in Latin America and especially Central America;

- the trend in developing countries was to attract and support smallholders to become commercial milk sellers;
- the dangers (high mortality and poor disease resistance) of relying on large or continuous imports of exotic dairy breeds favour upgrading or crossing local cattle with imported dairy breeds, and a role for AI if effectively managed;
- the importance of better feeding levels calls for developing the most productive grass/forage/grazing system including feeding of crop residues and the use of stable manure to obtain maximum yields from existing resources;
- the special importance of disease control; and
- the long-term aspects of relying on reconstituted milk from heavily subsidized imported or donated dairy products work out negatively on dairy production on the local level.

In Sub-Saharan Africa, Walshe *et al.* (1991) noted in a World Bank study on dairying as main constraints: lack of improved feeds and feeding practices; tsetse and tick challenges; shortage of water and management; little generation of technology; weak organization and provision of services; parastatals suffering from interference in management and government pricing; farmers' organizations have both social and commercial goals.

Promising dairy development was noted in Kenya with the zero-grazing package. It was further stressed that an effective AI service along the lines of the moderately successful Kenya programme would in the long term provide the most economic transition from local Zebu to higher producing crossbreeds. Specialized, government-operated heifer and bull breeding farms were considered the best approach to the provision of improved dairy stock in the medium term. Large-scale import of cattle proved unsuccessful and was considered inappropriate (disease challenges, feeds and management) in the East African environment. Positive results in dairying were mentioned by De Haan (1992) in smallholder dairy development in Zambia with direct sales of sour milk (although dairy farm development was scaled down to one third) and very active smallholder dairy development around many African towns like Dakar, Bamako, Khartoum and Addis Ababa. Key factors for success were the direct sale of raw milk from producer to consumer and the use of crossbreed animals to justify the investment of on-farm structure and in the operation of the collection network.

In South Asia (Walshe, 1994), dairy development projects in India, Sri Lanka and two livestock projects with a dairy component in Burma and Pakistan were supported. Successful development of well managed cooperatives in milk handling and provision of support services was noted under Operation Flood in India; fairly satisfactory replication of the Indian/AMUL model in Sri Lanka (after disappointing experiences with farm development and import of stock); and project failure in Burma due to insufficient support for the smallholder sector by the Socialist Government. In Pakistan project performance fell short of expectations due to less institution building and government support than in India for implementing appropriate pricing and marketing policies.

In East Asia the Bank supported projects in Korea, Malaysia and the Philippines. Dairy farming in Korea was highly successful in financial terms for the farmers, with milk production coefficients reaching or even exceeding levels set at project appraisal, but they were judged by the Bank to have negative economic rates of return when opportunity costs of imported products were taken into account. In Malaysia, the import of 6,600 heifers on Government heifer raising centres ran into serious problems with pasture development much slower than anticipated and poor performing stock. Government support was oriented more to large-scale public and private enterprises than to smallholders.

Over the period 1982-1990 the World Bank supported 18 projects with a dairy component, of which two large ones in India and Pakistan (Walshe, 1994) and none in Latin America and the Caribbean region. The reduction in support of dairy projects was partly compensated by strengthening livestock research, extension and veterinary services as well as structural adjustment and sectoral lending, aiming at a favourable economic environment, a pre-requisite for successful dairy development (Walshe, 1994). Three main reasons are given for the reduction in support to dairying. Firstly, the Bank reduced its lending portfolio in agriculture including livestock. Secondly, some of the earlier African projects in the late 1960s and early 1970s that all supported parastatal ranching, were given in virtually all cases, negative ratings at evaluation. Thirdly, in the 1970s and 1980s economic viability of dairy projects was always low, because calculated economic rates of return (ERR) were based on comparison with reconstituted milk from skim milk powder and butter oil at world market prices (strongly reduced by sales of highly subsidized products from the EU and the USA). If comparisons would have been made with fresh unprocessed milk at points of sale to consumers, it would have been difficult to find unsatisfactory ERRs. In addition, the fact that domestic pasteurized and especially domestic fresh milk usually commands a substantial price premium of 20 to 30% over reconstituted milk, because of better taste and higher butterfat content, was often omitted in the comparison (Walshe, 1994).

Important factors affecting dairy development identified by Walshe (1994) are profitability, government economic policies, management, climate, choice of genotype (breed), nutrition, reproduction, and economics of feeding, labour, animal health and type of marketable products with the following details.

Profitability requires a long-term secure market, a low level of investment, and especially low opportunity costs of (family) labour that can give smallholders a considerable advantage over large farms and parastatals. Overvalued currencies exacerbate serious competition with reconstituted milk using imports to suit urban consumers. Additional negative effects are that foreign exchange costs in inputs are not reflected in the price paid by farmers, even if a full cost recovery policy in local currency is in place. Government price controls often contribute to failures of dairy projects that rely on state or parastatal production, processing and marketing of milk. Management is the most crucial factor in dairy projects with respect to milk production (farm level), support services (credit, inputs, extension, AI), collection, processing and marketing (institutional level), industry administration and economic policies (national level).

The performance of improved dairy breeds in the tropics is often below that in the temperate zone, because of high temperatures ($>27\,^{\circ}C$) and high relative humidity ($>80\%$). This leads to reduced feed intake, while at the same time feed availability and feed quality in the tropics are also lower.

The choice of cattle should be adapted to the feed resource potential of the area or farm for milk production:

- Indigenous breeds in areas with low endowments where resource quality can only sustain milk yields up to 1,500 kg per lactation;
- 25-50% *Bos Taurus* dairy crossbreeds, specialized Zebu dairy breeds such as Sahiwal and Red Sindhi or synthetic dairy breeds such as Australian Milking Zebu (AMZ), Australian Friesian Sahiwal (AFS), Jamaica Hope, Karan Swiss and Sunandini in low potential areas that support milk yields of 1,500-3,000 kg;
- 50-75% *Bos Taurus* dairy crossbreeds or suitable synthetic breeds for medium potential areas supporting 3,000-4,000 kg milk per lactation; and
- 75-100% purebred Friesians in high potential areas that can support more than 4,000 kg of milk per lactation.

Feeding is constrained by low quality grasses and forages in the (sub)tropics, availability of land, and costs of supplements (cultivated forages, fodder trees, shrubs and concentrates). Economic responses to feeding are determined by the dairy merit of cows, and the milk price received by the farmer in relation to the feed price. Roughages are normally less expensive than concentrate feeds per unit energy. In countries with rice, wheat and maize as staples large quantities of by-products (bran, pollard) may be available at low cost. Responses in milk yield to heavy concentrate feeding are close to 1 kg of milk per kg of concentrate in the (sub)tropics. Therefore, milk/concentrate price ratios above 1.5 are normally required to make commercial dairying economically attractive.

Availability of low-cost (family) labour favours manual operations in forage production, harvesting, feeding and milking at farm level as well as processing (ghee, white cheese) and distribution (direct deliveries, bicycle transport). Mechanized dairying requires more sophisticated technology and special support services, usually not available in developing countries.

Maintenance of animal health requires an efficient, reliable veterinary service taking account of technical issues (vaccination, disease diagnostics and cure), but also staffing and organization of the services on a sustainable basis (privatization and full cost recovery).

Marketability of products depends on distance to and type of demand. Sale of fresh milk to consumers is the first option, followed by cooled milk if time between milking the cow and delivery to the customer exceeds 3 hours. If extension of shelf life through cooling by 12-24 hours is not sufficient, then sale of loose, pasteurized or sour milk becomes the alternative. The options for processed products depend on existence of market and profitability of the process technology applied. Seasonal milk surpluses should be processed into cheese and butter in the surplus area (farm and village processing) to reduce transport costs of concentrated finished products and to avoid high risks, investments and costs associated with under-utilization of large sophisticated plants.

Asian Development Bank

The Asian Development Bank (ADB, 1990) reviewed its involvement in the livestock sector from 1969-1990, which included 37 technical assistance projects (4% of the total and 8.5% of those in agriculture). Main objectives of the Bank were improving livestock production and productivity per animal, increasing the supply of livestock products, expanding employment opportunities, maximizing the utilization of natural resources endowment, and strengthening institutions in the sector. The review noted the following essential factors for project success:

- Government planning and commitment for commodity or area development took place before project funding;
- Sharp development focus directed to one animal species and commodity;
- Concentration of development in a well-defined area or block;
- High level specialized training in project implementation;
- High intensity of supervision on project implementation;
- Development was private sector oriented;
- Staff was experienced in prior project implementation;
- No lack of funding for capital costs, operation and maintenance occurred;
- Incentive programs were instituted for implementation staff;
- Commodity produced had a ready market;
- Collection, transportation, processing and marketing facilities were adequate;
- Farmer groups were trained and organized by strong and motivated managers;
- Community effort was well directed;
- Credit facilities were available at rates and terms that made production remunerative;

- Feed resources were adequate and animal health services were effective;
- There was no competition from imports; and
- Project was suggested by participants and motivated by their needs.

Moreover, when countries translated policies into programs, action plans or projects, considerable progress in production was made, *e.g.* Republic of Korea (meat, eggs and milk), India and Pakistan (poultry), Indonesia (milk production increased from 79,000 tons of milk in 1979/81 to 230,000 in 1987) and Malaysia (poultry).

Generally, according to the Bank's experiences, there have been more restrictive policies (*e.g.* price controls) than development policies (*e.g.* producer incentives), *i.e* government policies protected more the politically active and clamorous urban consumer than that they encouraged the weak and timorous rural producer.

African Development Bank Group

This group consisting of the African Development Bank, the African Development Fund and the Nigerian Trust Fund has no specific livestock sector development policy and the livestock sector falls under the Agriculture and Rural Development Departments operating in two regions, *i.e* North and South (Taylor-Lewis, 1992). Livestock project lending in % of total lending varies from 4% in Southern Africa to 20% in the Sahel. After a study in 1988 into the different agro-ecological zones and production systems, future lending in livestock focuses more on long-term programmes than the past on-off short term credits based on sector studies that contain analyses and suggestions in land tenure, sustainability and environmental improvements. Projects of smallholder dairy, poultry, range improvement and wildlife for tourism appear the best suited for financing.

3.2 International organizations

Food and Agriculture Organization (FAO)

Phelan (1993) in his historical overview of global dairy development indicated that domestic milk production in developed market economies in the northern hemisphere has consistently exceeded demand at remunerative prices for over more than two decades. Surplus disposal schemes have included heavily subsidized schemes for school milk, milk for special groups, milk powder for livestock feeding, export support of milk products to compete in the low priced world market, and food aid. In the 1980s, three-quarters of the world exports (5-6% of total production) were heavily subsidized, and did not allow traditional low-cost producers (New Zealand and Australia) to take advantage of growing international markets. South American countries (Argentina, Uruguay and Chili) had to withdraw from the export scene.

Developing countries account for the majority of dairy product imports (12.5% of their total consumption), and 20% of these imports were in the form of food aid. Price increases from US$ 700 in the mid 1980s to US$ 1,000 per ton of milk powder in 1989-1990 and the virtual halt of USA dairy aid in 1989 reduced dairy food aid from an average 400,000 tons in the 1980s to 100,000 tons in 1989 (Mors, 1990).

FAO's dairy development activities from the late 1950s to 1966 were geared to joint operations of UNICEF-FAO through the "Milk Conservation Programme", *i.e* providing safe (pasteurized) milk to the poor urban population and, in particular, to women and children. UNICEF supplied equipment and FAO provided expertise in respect of dairy technology and plant management (Phelan, 1993).

With DANIDA funding, FAO Regional Dairy Development Training Teams (RDDTT) were operational in Bombay, India (1960/65), Los Baños, Philippines (till 1980) and Chiang Mai (Thailand) in Asia; Naivasha, Kenya in Africa; and Santiago in Chili in Latin America. The support lasted till 1991. Approximately 15,000 trainees (managers, teachers and technicians) from 82 developing countries have passed through more than 650 courses, workshops and seminars.

In 1972 the International Scheme for Coordination of Dairy Development (ISCDD) was established with trust funds of FINNIDA. In total, 85 requests from countries were received and 72 specialized missions sent (Far East 18, Near East 15, Latin America 25 and Africa 34) plus 94 technical missions. ISCDD assistance, evaluating bottlenecks for dairy development in many countries was followed by WFP assistance. A total of 370 development projects have been carried out and US$ 320 million committed to these projects.

After the dairy expert consultation in December 1984, FAO decided to reorient its dairy development activities. ISCDD and RDDTT merged into the International Dairy Development Programme (IDDP) in close collaboration with the regional offices (Bangkok, Santiago and Nairobi). The new strategy is based on regional model projects for integrated dairy development, using a modular concept; the programme aims at the training and development needs of the industry with special emphasis on the small producer. The following selection criteria were used (i) existence of a national dairy development policy, (ii) authentic small milk producers, (iii) a defined potential milkshed, (iv) potential to apply appropriate technology, (v) a suitable institutional structure to facilitate the participation and development of the producer, and (vi) a market for the milk and milk products generated by the project. Four countries were selected, each with an additional aspect to the common modular approach: Ecuador (pasture development) for Latin America and the Caribbean; Tanzania (crop/livestock integration) for Africa; Syria (potential of sheep milk) for the Near East; and Indonesia (role of national cooperative movement) for Asia and the Pacific. Donors were invited to participate by financing one or more modules of such integrated projects. So far funding has only been negotiated for the project in Tanzania and Ecuador.

In addition, FAO has channelled support through Technical Cooperation Projects (TCP) and United Nations Development Programme (UNDP) to assist in programme development and financial negotiations of smallholder dairy development and associated village-level processing of indigenous dairy products.

World Food Programme (WFP)

In 1984, annual food aid in the form of skim milk powder amounted to 250,000 tons, more than 55,000 tons were in support of dairy development projects, of which 20,000 tons through WFP (Pronk, 1984).

WFP approved projects in 30 countries of which by the end of 1987, 16 projects in various forms were operational (WFP/CFA, 1988). About US$ 598 million worth of WFP dairy food aid (WFP/CFA, 1988) was committed over 1963-1987to a number of developing countries in West Africa (US$ 6.2 million for Angola, Mali, Niger and Senegal), East and Southern Africa (US$ 156.7 million to Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Swaziland, Tanzania and Uganda), Mediterranean and Middle East (US$ 75.3 million to Malta, Morocco, Pakistan, Sudan, Syria), Asia and Pacific (US$ 242 million to China, India, Kampuchea and Nepal), Latin America and the Caribbean (US$ 117.5 million to Bolivia, Cuba, Ecuador, Guyana and Nicaragua). Only 3 planned projects (Sri Lanka, Bhutan and the one in Mali) were cancelled 4-6 years after approval.

The objective of WFP assistance to dairy development projects was not to make milk accessible to vulnerable groups, either free or at a subsidized price, but to support development of the dairy industry as a viable economic activity (WFP/CFA, 1982). Milk at lower prices can be brought within reach of a larger public by, *e.g.* cross-subsidizing. Sales of by-products such as cheese, cream, yoghurt, butter, ice cream and flavoured milk, that have a higher profit margin, can bring down the price of pasteurized milk. This is normal practice not only in WFP-assisted projects, but also as part of a product diversification strategy in industrialized countries.

In many developing countries, dairy development offers a real opportunity to stimulate economic growth and reduce poverty in rural areas. When aiming at small farmers, involved in labour-intensive milk production, it can contribute to both income and employment generation. In developing countries as a whole, small farmers own 70-90% of the cattle population, and sales of livestock products may account for up to 80% of cash income for small producers.

Centrally-planned economies have often opted for capital-intensive systems and state farms that were successful in Cuba and China that had the necessary organizational, technical and management skills. Performance of state farms in Africa (Tanzania and Ethiopia) has not been satisfactory.

Food aid for dairy development that generates local development funds requires an effective package, that takes care of necessary foreign exchange in case local currencies are not convertible, as well as technical and managerial assistance and support in policy analysis. Lack of foreign exchange can hamper project implementation, *e.g.* as happened in Bolivia, Ethiopia, Mozambique, Tanzania and Uganda (WFP/CFA, 1988).

3.3 International seminars/workshops

Dairying as an instrument for progress; the Indian experience

Experiences in dairy development in Asia, Africa and South America in the 1980s were reviewed in 1989 at a seminar in Anand, India organized by the National Dairy Development Board of India in association with the International Dairy Federation (NDDB, 1989).

Asia with 3.3 billion people (52% of the world population) on 20% of the world's land had 360 million head of cattle and 133 million buffaloes producing 64 million tons of milk in 1987 (144% of 1977 production). Feed resources are mainly from communal areas (road sides, marginal lands), crop residues and by-products; holdings are generally very small, animal productivity is low, mixed farms have small surpluses of marketable milk and the density of milk production per km^2 is low, with hardly any suitable marketing facilities; a large number of transnational companies operate milk plants on the basis of low priced milk powder and butter oil. Promising increases in milk production were noted in Operation Flood in India (4.7% annually), dairy farming organized through cooperatives in Thailand (18.9% annually) and Indonesia (15.1%), high producer milk prices and rapid rising milk production in Japan, Taiwan and Korea (8.1%) based on cattle and feed imports, increased milk production (8.1% annual increase) of state and private farms in China (Soni, 1989).

Africa with 551 million people in 1985/87, had 27 million dairy cows (average yield 477 kg/yr), produced 13.6 million tons of milk, and in addition, imported 5.2 million tons milk equivalents leading to an annual per capita availability of 33 kg milk. Regionally, large differences existed, *i.e.* per capita availability is 69 kg in North Africa (37% imported), 9 kg in Central West Africa (50% imported), 20 kg in East Africa (10% imported) and 73 kg in Southern Africa (7% imported). Milk production of local animals (mainly small Zebu) is low, although some European breeds have been introduced. Milk plants are supplied by (para)statal farms and with imported milk powder, while dealers' prices for rural milk are higher and limit collection and processing by the (para)statal industrial sector. A variety of organizations is involved in dairy development, but most are closely linked to the state (Empson, 1989).

In Latin America (including the Caribbean region) with 360 million people, milk production was estimated at 38 million tons from 36 million cows which, together with imports provided annually 110 litres per capita. The rural sector is characterized by low income and literacy rates, limited access to services, and little cooperation and communication within the sector; high inflation with low consumer prices based on reconstituting subsidized milk powder and butter oil. Promising developments were noted in the Swiss aided rural cheese plants in Peru and Ecuador, the Model Project on Integrated Dairy Development in Ecuador, and the modular approach in training units supported by the FAO/DANIDA regional training team (Baron del Castillo, 1989).

Influence of Dutch export of dairy produce in the third world, The Hague, the Netherlands

From every 10 litres of Dutch milk, 2 litres end up in the third world. Discussions during the seminar centred on the following questions: do Western dairy exports hamper local production or are they essential to combat hunger; can developing countries do without milk imports, and what are the consequences for the West (Mors, 1990). An illustrative brochure (FNZ, 1991) indicates the magnitude of Dutch exports; the regional differences in consumption patterns with very low consumption in areas with tsetse flies (Central and West Africa) and in areas with high incidence of malabsorption of lactose (large parts of Asia and Africa); the relatively slow annual increase in Western milk production (1-1.5%) against 4% increase in milk production in developing countries.

From the world trade in milk (only 5% of the total production), developing countries import about 17 million tons of milk equivalent (92.1% milk powder, 2.5% butter and butter oil, 5.4% condensed milk); Dutch dairy exports contribute annually Dfl 3 billion to the Dutch balance of payments and some 10,000 people in the industry depend on these exports; dairy food aid amounts to 10-15% of total imports in developing countries: 20% in emergency aid, and 80% can be sold to generate funds for local dairy development; baby milk powder can be an important source of protein and calcium for babies when mother milk ceases, and if fluid milk can be hygienically prepared; in cases of under-nutrition, milk can be an important supplement to single diets of cereals and tubers. Income is an important determinant for consumption of milk products, with a typical threshold of US$ 500 per capita annually. In countries with US$ 500-1,000income per capita, daily consumption of animal products starts to increase from 200 kcal to 400 kcal to reach some 1,200 kcal at income levels between US$ 10-20,000 in Western countries. Moreover, the brochure presents the subsidy proportion in % of the producer milk price over 1979-1989 in New Zealand (about 20%, being phased out in 1990), European community (fluctuating between 40-60%), USA (fluctuating between 50-80%) and Japan (fluctuating between 80-100%).

Livestock production in rural development; development of livestock policies

This workshop held in Wageningen, the Netherlands was attended by 38 participants from 28 countries in four continents (N.E.C.T.A.R., 1992). The presentations and discussions concentrated on the crucial role of livestock in the rural economy, rising demands for livestock products and the urgent need to stimulate local production. It looked at internal and external aspects of national livestock development policies and specific production systems as pastoral production, mixed farming, intensive livestock production and ranching.

In the recommendations, the need was emphasized to stimulate local livestock production for reasons of food security, employment, income generation, equity and reversing the urban bias. More attention is needed to price policies (levies or quota on import of products, more producer-oriented than consumer-protecting price setting), development policies (credit, land use and land tenure legislation, establishment and functioning of farmers' organisations), development of feeds and feeding regimes in various production systems.

Dairy development in the Caribbean region

This seminar was held in December 1992 in Jamaica and some 80 participants (50% from Jamaica) discussed past experiences and formulated conclusions and recommendations for dairy development in the Caribbean region (CTA/IDF/CARDI, 1993). Agriculture in the Caribbean, in common with most ACP countries is based mainly on crops rather than on livestock. Therefore, livestock products and feeds for livestock accounts for 53% of the food import bill (Delleré, 1993). The Caribbean region has a population of about 35 million, with 14 million cows and 2 million tons of milk produced locally and over 1 million tons imported milk equivalents. Human consumption of milk stands at 60 kg per capita with 40% coming from imports (Empson, 1993). Central America has 153 million people, 82 million cows and a milk production of 11 million tons with 2 million import (per capita 80 kg). In the Caribbean, milk production is low, imports are high and income (GNP) is low, creating a case for dairying if agricultural production, land and economic conditions permit. From a social point of view, limited employment opportunities exist, suggesting that small-scale family dairy farming with 2-3 cattle has great merit as a supplementary enterprise, making use of crop by-products and under-utilized grazing areas and providing additional family employment resulting in additional and regular family income (Empson, 1993).

Dairy development policy and implementation; sharing of experiences between Africa and Asia

The seminar held in July 1993 in Harare, Zimbabwe attracted 57 participants from 18 countries, including 4 from Asia and 37 from Africa, plus representatives from 6 European countries, the World Bank, ILCA and IDF (FAO, 1994). The experiences of Dutch development cooperation in dairy development in Africa (Kenya and Tanzania) and Asia (Sri Lanka, India and Indonesia) were presented (see Chapter 4; De Jong and Zwart, 1994), together with those of the participating countries and agencies. Participants in the seminar formulated the following recommendations:

- Formulation of a clear long-term dairy development policy with realistic targets for self-sufficiency;
- Technical cooperation among developing countries, and minimum direct involvement by governments;
- Implementation through the flexible modular approach, with realisation of locally available resource potential;
- Development of strong support services;
- Implementation of the lactoperoxidase system to conserve raw milk longer;
- Bull-oriented breeding;
- Human resource development with emphasis on the role of women and youth;
- Training with emphasis on improving smallholder productivity, fodder and crop residue utilization and milk hygiene, implemented via regional networks of relevant institutions; and
- Technology development with emphasis on processing of fresh milk.

Further development programmes should take into account possible marketing and distribution needs; use of cheaper packaging materials (*e.g.* plastic sachets and returnable bottles) and "bulk vending"; maximum utilization of locally manufactured equipment, and an integrated approach to links between rural producer and urban consumer, involving full participation of farmers' organizations.

3.4 Approaches to rural development

Over the past 30 years rural development has been supported with different goals and approaches (DGIS/IOV, 1991). Initially, it focused on increased agricultural production and area expansion with priority for more large-scale farming for export. Population increase and food shortage then focused the attention on food crops and small farms with modern technology such as improved varieties (Green Revolution). Subsequently, orientation shifted from emphasis on modernization and economic growth, to community development focusing on qualitative improvement of wellbeing in the rural area through support for local institutional development. Lack of improvement in rural areas in the early seventies resulted in a shift of attention from economic growth to income distribution aspects, and in the community development approach more attention was given to power relationships and socio-economic discrepancies in the rural society and the need for poverty alleviation.

Land reform and basic need fulfilment for the poor were considered pre-requisites to trigger rural development. Inclusion of off-farm employment in a complex rural economy, directed the attention to integrated rural development projects per area (political in districts or functional in watersheds).

In the mid 1970s, environmental aspects and the position of women were included as rural development issues. Poor financial conditions of national governments in the 1980s preventing the payment of rapidly increasing amounts for salaries of government employees, subsidies and parastatal losses called for a re-orientation. Structural adjustment policies were formulated (with a human dimension and a government role for an enabling production environment) giving more scope for the role of market forces and private initiatives.

Experiences discussed in a seminar in 1988 of the Development Assistance Committee (DAC) of the Organization for Economic Cooperation and Development emphasized the large influence of macro-economic policies on rural development and the need for an integrated approach. Increased productivity and income generation should be the core of rural development and require remunerative producer prices. Sustainable development requires early and active participation of the rural population and strengthening of local institutions.

World Bank support shifted from large-scale agriculture in the 1960s to small-scale agriculture and attention for poor groups (equity focus). Although loan amounts increased, weak project points were: only a small part reached the poor groups, projects aiming at increased food production were little successful and Integrated Rural Development Projects (IRDPs) yielded little results. Main causes for failure were inadequate macro-economic policies (price controls, overvalued exchange rates and weak organization of agricultural produce marketing), weak local institutions (and parallel management structures induced by projects), lack of baseline data and measurable mid- and long-term goals, insufficient detail on characteristics and position of poor groups, lack of insight in and attention to local power structures (land reform), people's basic needs and necessary social services in rural areas.

Experiences of the Inter-American Development Bank in rural development projects indicated strong constraints in reaching the poor people, limited success in IRDPs (high demands on management and coordination; problems with cost recovery in projects of drinking water and irrigation), limited access to credit by the poor, and lack of data for monitoring of performance and impact.

Poor people could efficiently make use of International Labour Organization (ILO) projects, but the poorest of the poor could not be reached and often were disadvantaged through project activities that took away their source of work and income. Training costs were high, reducing overall rentability of projects. Local elites stood often in the way of reaching the target group.

Projects based on or connected with organizations of the target group themselves did much better, but number and size are too small to alleviate poverty on a large scale.

Dutch development cooperation (1950-1970) started with financial aid to multilateral organizations and employment of experts and associate experts. The focus was on economic growth and concentration on modern sectors in financing current imports to be bought in the Netherlands. At the end of the 1960s the focus shifted to economic, political and social independence of developing countries (self reliance) and distribution of knowledge, power and income. From 1977, more priority was given to poor groups (target group policy) than to the other track of development cooperation (economic self reliance). In the 1980s a balanced synthesis of both tracks is pursued through the process approach in long-term cooperation commitments to arrive at structural poverty alleviation.

The approach to rural development in DGIS' policy document "Development Cooperation and Employment" of 1984 aimed at sustainable improvement of living conditions in rural areas by mobilizing their economic potential, creating employment and income. Typical of the approach was preferably small-scale integrated interventions, *i.e* capital-extensive, integrated with local institutions and cultural conditions, preference for productive activities, intensive use of appropriate technology and a high degree of participation. In a "World of Difference" in 1991, DGIS' policy of rural development was directed at improvement of income, employment, purchasing power and food production, focusing on support for small-scale production units, poor segments of society and a supporting government policy for production (DGIS, 1991).

Target groups of Dutch Development Cooperation became economically and socially backward groups: especially women, landless farmers, land renters, small farmers and land labourers.

After evaluation of experiences in Dutch support (1978-1984) to livestock activities in developing countries (DGIS/IOV, 1987), a first DGIS policy guideline for livestock production activities in the development cooperation programme was prepared, after ample discussions and exchange of ideas between officials involved and representatives of private organizations working in the field of livestock production in both the Netherlands and developing countries (DGIS, 1992). Focus is on improving the outlook of the overwhelming majority of poor and chronically undernourished people living in rural areas in the so-called "low-income developing countries" that attempt to make a living and improve their economic position by keeping livestock not only for providing basic nourishment, but especially as a means of livelihood (income, capital, etc.). These guidelines emphasise a thorough analysis of both the existing agro-ecological conditions (arid, sparsely populated zone, arid, densely populated zone, (sub) humid tropics and tropical highlands) and local production and marketing arrangements. Pre-project assessment will be required for identification of beneficiary groups, carrying capacity of the environment, constraints in input supply, services and infrastructure, and the existence or development of adequate policies at national and sectoral level (land tenure, livestock production research, extension and education, group formation and participation, availability, quality control and prices of inputs, services and produce). In addition, some special guidelines called for emphasis on smaller scale operations, heterogeneity of livestock production (many functions, different products, on-farm and off-farm linkages), a high degree of organization of the farming population, and small livestock (wider spread of risk, important activity of women for dietary and financial supplements).

In conclusion, experiences of lending agencies and international organizations show similar requirements for successes in dairy development: active involvement of recipient country and beneficiaries in planning and implementation, adequacy of producer incentives and technology development, and strong leadership and farmers organizations in the institutional sector to organize input supply and services to produce, process and market milk. Shifts in emphasis occurred from large-scale agriculture to smallholder farming and rural activities for gainful employment and income generation. Aspects of equity, gender and upkeep of the natural resource base gained importance in project identification, baseline data collection, project planning and implementation. Bank and donor financing of dairy projects has been reduced over time in view of low or negative profitability of dairy farms, because of generally, low ratios between official producer milk prices and costs of concentrates. Small-scale farming with a dairy component based on family labour and/or low-cost rural labour, use of improved feed (fodder and crop-byproducts) for feeding a crossbred dairy animal, and milk sales direct to the consumer appeared more viable options for increased milk production in developing countries.

4. EXPERIENCES OF NETHERLANDS DEVELOPMENT COOPERATION IN DAIRY DEVELOPMENT IN AFRICA AND ASIA[1]

R. de Jong[2] and D. Zwart[3]

ABSTRACT

Dutch experiences with assisting livestock development from 1978-1984 were published in 1987 and categorized in 5 phases: 1) supply of livestock and 2) large scale dairy farming; 3) *small-scale farming and 4) the integrated approach; and 5) the importance of a macro-economic* and agro-ecological frame work. The new Dutch policy view on livestock development in developing countries is briefly explained together with recent developments in dairying in selected countries. The National Dairy Development Project in Kenya is highlighted with its "zero grazing" package, Farm Liquidity Budget Form and Dairy Extension and Advice Forms. Dairy developments in Tanzania are described from the early attention to the large-scale farming sector towards livestock/dairy development programmes in Kagera and Tanga regions with integrated components of heifer breeding units, training, extension and veterinary supplies, attention to women farmers and a special credit scheme called Heifer-in-Trust. For Sri Lanka the efforts in dairy stock supply, training, extension, straw utilization, dairying in new settlement areas, calf rearing schemes, small-scale milk processing under a low milk price regime are discussed. Technical comments as well as questions asked by socio-economists on Operation Flood are presented for India. Dairy development in East Java, Indonesia is reviewed for the period 1980-1990 *with a large influx of imported cattle against the provision of feeds and price developments* over time. The paper concludes with prerequisites for dairy development in Asia and Africa: a producer friendly pricing environment, attention to surplus rural milk, integration of programme components including the internal generation of dairy stock, credit schemes for the rural poor and women, Napier grass and leguminous fodder tree development.

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[1] Paper presented, on behalf of the Directorate General of International Development Cooperation, at the FAO seminar held in Harare in July 1993 on Dairy Development Policy and Implementation: sharing experiences between Africa and Asia (De Jong and Zwart, 1994).

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INTRODUCTION

The Netherlands have for long been involved in livestock and dairy development activities in the world. This concerns both commercial projects, ranging from the supply of livestock up to full-size turnkey projects, and development cooperation programmes, both financial and technical aid. This paper will focus on Dutch experiences in livestock development in developing countries with emphasis on recent outcomes in smallholder dairy developments in Africa (Kenya, Tanzania) and Asia (Sri Lanka, India and Indonesia)

Early general experiences

In 1987, the Operations Review Unit (IOV) of the Directorate General for International Development Cooperation (DGIS) published a first overall account of experiences in the assistance of livestock development over the period 1978-1984 (DGIS/IOV, 1987). The report differentiates 5 phases (Table 4.1).

Table 4.1. Phase, period and main characteristics of Dutch support in livestock development (1978-1984).

Phase	Period	Main characteristics
1. Supply of livestock	1970-1980	Supply of pregnant heifers and calves
2. Large-scale modern dairy farming	1972-1980	Large-scale dairy farm management; mechanization, breeding and selection; artificial insemination; veterinary care
3. Small-scale farming	1978-1982	Small-scale dairying; extension; training; credit
4. Integrated approach	1980-	Credit facilities; role of women; animal traction; other livestock
5. Macro-economic & ecological framework	1985-	Markets and pricing policy; land-use plans; farmers' organisations

The supply of livestock meant to quickly bridge the gap between local supply and increasing domestic demand, turned out to be a difficult exercise. The exotic cattle did not match with the local climate and the management conditions of cattle care, feeding and disease control. Milk production was often disappointing, particularly in the humid tropics. High disease incidence, low reproduction rates and poor calf rearing caused that the anticipated multiplier effect of foundation dairy stock and the subsequent increase in milk production was not achieved. More recently Ørskov (1993) illustrated the problems of feed quality and climate for exotic dairy cows in Laos, Mongolia, Iran, Indonesia, Brazil and Mexico in his book "Reality in rural development aid with emphasis on livestock".

Dutch technical assistance to large-scale, mechanized dairy farms to produce large amounts of milk for the rapidly growing urban demand produced at occasions some short-term technical successes. In the long run, however, the complexity and foreign exchange cost of such ventures in management skills, spare part supply and high levels of concentrate feeding made the enterprises economically and financially unviable.

Attention to smallholders evolved slowly, since little surplus of improved cattle became available. These cattle were expensive and there was little or limited access to credit. Smallholders needed training and extension in the management (feeding, breeding, disease control) of the highly demanding exotic stock.

Following the evaluation report of the Operations Review Unit, a policy document "Livestock Production in Developing Countries" (DGIS, 1992) was prepared in the late eighties. These broad outlines were produced to provide insight into the considerations on which decisions are to be taken regarding Dutch support for proposals (projects/programmes) in the field of livestock production in developing countries.

The general framework of Dutch development policy for the nineties has been laid down in the policy document "A World of Difference" (DGIS, 1991). Central policy is the structural reduction of poverty and of inequalities based on class, race and sex, as well as the promotion of development of, for and by people. High priority is on rural development to reduce poverty at grassroots levels by improving incomes, employment, purchasing power and food production. This is to be achieved in the form of long-term, ecologically sustainable, integrated programmes. Support will likewise be given for the creation of labour-intensive employment, for improving infrastructure, for sector studies and research into low risk agricultural production and processing techniques. Two important additional policy goals are the promotion of the autonomy of women (within socio-economic reality and with the wishes of the women concerned) and the protection of the environment.

The new Dutch livestock policy (DGIS, 1992) stresses that livestock and dairy development will no longer be treated in isolation. They must be integrated as part and parcel of rural development, embedded in the right macro-economic and policy environment, and aim at increased market orientation with producer-entrepreneurs as partners in development (Kuiper, 1992). Sustainable livestock development aspects refer to the horizontal dimension (optimal interaction between livestock, arable farming, agro-forestry and other income generating activities) in agro-ecological zones and to the vertical column from producer to consumer with the necessary resources (land, feed, livestock, labour and capital), input supplies, services and the processing and marketing arrangements.

An International Workshop for senior policy planners and executives of developing countries and agencies on Livestock Production in Rural development with the emphasis on "Development of Livestock Policies" was held in January 1992 in Wageningen, the Netherlands, and elaborated further on the essential requirements for national policies on livestock development, for the livestock production systems, environmental and gender aspects, international trade and cooperation (N.E.C.T.A.R., 1992).

The target group of Dutch development cooperation will be oriented, even more than in the past, towards the poorest countries and segments of society. For livestock development, this means the focus will be on smallholders, pastoralists and landless livestock keepers with a attention to small stock, gender specific approach, the promotion of economic self-reliance, active participation and co-responsibility of the livestock keepers and their organisations (Konstapel and Nell, 1992).

As per FAO request some more recent Dutch experiences in dairying will now be discussed for Kenya, Tanzania, Sri Lanka, India and Indonesia.

4.1 Kenya

The Netherlands support to the dairy sector started in 1969 with the Dairy Cattle Research Project (1969-1977), the Dairy Extension Project working on Farmer Training Centres (1969-1974), and training assistance to the Department of Animal Science at Egerton College (1969-1974). Milk production did not take off during that period due to low and government controlled pricing. A follow-up, after a price revision and the creation of extra demand for milk through a school milk programme, came in 1980 with the National Dairy Development Project (NDDP) oriented to smallholders in mixed farming in high potential and densely populated areas. The "Zero Grazing" package was developed to solve constraints of land scarcity, overstocking and to improve on milk production and cattle reproduction through the introduction of cubicle housing for cattle, improved fodder (Napier grass) and recycling of manure.

The project evolved in five phases (Wainaina and van Woersem, 1992) as illustrated in Table 4.2. After the try-out phase with demonstration farmers, a grant scheme was developed to provide opportunities for those farmers with smaller farm operations and less favourable conditions of milk collection and marketing. Other financing was sought from the Agricultural Finance Corporation (AFC) and the means of the farmers themselves. In the consolidation phase the grant scheme was abandoned, the loan scheme anticipated under AFC at National level did not materialize, and the project concentrated more on full time farmers with sufficient means. During the expansion phase, 7 adjacent districts were included and more attention had to be given to integration, female farmers, research and monitoring of technical aspects and the link between research and extension. In the present phase the project operates in all "Zero Grazing" qualifying districts, while a systematic Training and Extension Plan is advocated to reduce local financial and personnel constraints.

Table 4.2. Phases and details of the National Dairy Development Project in Kenya (1980-1994).

Phase No.	Name of phase	Period	Number of districts	Approach
I	Orientation	1980-1981	6	20 demo farms/district
II	Introduction	1982-1983	7	Grant scheme and AFC loans Farm Liquidity Budget Form
III	Consolidation	1984-1987	7	Work through self-help groups/zero grazing clubs Reached - 2,020 farmers
IV	Expansion	Mid 1987-1990	7+7	Interact New & Old districts Dairy Extension & Advice Form Reached - 4,500 farmers - 200 farmers' groups
V	Present	1991-1994	25	All zero grazing districts Training and Extension Plan Target - 6,400 farmers Mid 1992- 5,400 farmers

The extension approach of NDDP is characterised by working with interested farmers, where possible organised in self help groups or zero grazing clubs to support one another in farm and dairy development. Farmers' real interest in the ins and outs of the zero grazing package is strengthened through workshops, field days and study tours to practising zero-grazers. The project further works with cow fertility calendars and videos on zero grazing (general awareness and 8 instruction series).

Individual inclusion in the project occurs after discussing the farmer's plan by means of the Farm Liquidity Budget (the format is given in Appendix 4.1). The Farm Liquidity Budget contains an inventory of the present mixed farm operation in acreage and livestock numbers multiplied by the gross margins per activity expressed in cattle equivalents (c.e.). The c.e. stands for the gross margin in keeping an improved dairy cow. Under the new situation the livestock and roughage plan has to balance the animal requirements, in Livestock Units (LU) times 365 days times 10 kg dry matter per LU per year, with the dry matter production (with area adjustment factor) from fodder, pasture and agricultural byproducts. When the feeding plan balances, the additional investments are described with the financing plan. Finally a farm cash flow is prepared indicating the annual commitments (family expenditure, hired labour, interest and loan repayment) against the expected cash surplus from crops, dairy and off-farm work. The commitments should not be higher than 80-90% of the expected cash surplus to make the plan financially viable and able to face the risk of drawbacks in performance.

To combat the shortages of feed supply in the dry season, late wet season fertilization of Napier grass, introduction of Desmodium species, and preparation of silage (joint efforts of farmers) were encouraged from the start. Later on, after a 1988 workshop and the 1990 annual seminar, the project embarked on the establishment of fodder trees for dry season feeding, feeding in early lactation and to even out irregular concentrate supply (Van Gelder and Voskuil, 1990). Four tree species are used: *Calliandra calothyrus, Leucaena leucocephala, Sesbania sesban* and *Gliricidia sepium* planted as hedges in triangle form with a plant distance of 30 cm.

The staff consists of dairy extensionists at field level guided by district dairy officers and 6 provincial dairy officers, with the support of 6 (now 4) expatriate coordinators. To motivate extensionists in-service training has been given in Kenya and the Netherlands. In 1992, a nine-months diploma training for Kenyan extensionists has been initiated at the Larenstein International Agricultural College in Deventer, the Netherlands to create upgrading possibilities for the best performers.

In addition, NDDP had a research officer working on-station and on-farm *e.g.* on cutting regimes and fertilization of Napier grass, silage preparations and on manure utilization. A monitoring officer at national level analyzed per district the on-farm technical and economic data, initially on the demonstration farms and later also on second phase farms differentiating "well" and "poorly" managed farms.

After 1987 monitoring changed towards annual surveys/farm visits to a much larger sample of farms recording technical performance data in relation to advice given to improve dairy management on the so-called Dairy and Extension Advice Forms (DEAF). Part I collects the data on livestock, milk marketing, animal health practices and mineral use. Part II indicates the status of the unit, roughage feeding, Napier grass and manure management and the cattle changes. For details see Appendix 4.2 & 4.3 (Van der Valk, 1990 and 1992).

In the present phase the project is strengthened with a training specialist to arrive at a more systematic training and extension plan to reduce the cost of individual farm visits. To reduce these costs further, discussions have started on combining dairy and poultry extension visits.

In order to strengthen the efforts of the Kenya Agricultural Research Institute (KARI), the Netherlands supports since 1990 the dairy and poultry research component at the National Animal Research Centre (NAHRC) at Naivasha. Main activities have been the rehabilitation of the Naivasha research facilities and some initial research on cattle feeding, fertility, deworming, calf rearing and economic modelling. Through a liaison officer of NDDP and hopefully soon one at NAHRC, extension and research will be linked closer. At Mtwapwa in Coast province, the NDDP is working closely together with KARI-ILCA and KARI-NAHRC on fodder tree development and utilization for dairy cattle.

Important NDDP issues for research are the soil depletion through Napier grass and sustained soil fertility through manure utilization as well as calf rearing practises, cattle fertility, and socio-economic research.

Other dairy development constraints are lack of AI services (and/or grade bulls) and the poor milk marketing and pricing in specific areas. The milk return was Ksh 25.25 per cow in 1991 with a variation of Ksh 15.36 in Kericho district to Ksh 45.51 in Kwale district. NDDP with KARI played a role in a national milk price policy change (decontrol of prices) but the Kenya Cooperative Creameries (KCC) has still a stronghold in buying the surplus milk.

The project performance shows that per mid 1992 5,400 registered farmers are attended (85% of the 1994 target). Strengthening of the process of group formation to make optimal use of local (in)formal farmers organizations is aiming at 5 local informal groups of about 2,100 farmers. This will enhance the institutional sustainability of the project.

Over time the milk production increased from 6.4 litres in 1982/83 to 7.9 litres per cow per day in 1991 against the target production of 9.0 litres in 1994. The calving intervals have been long throughout the project period and with 465 days in 1991 against the 1994 target of 435 days. Table 4.3 gives more details as well as interesting differences in performance between AI and bull services (Muma, 1992).

Table 4.3. Fertility data of farmers cattle under the National Dairy Development Project. Kenya.

Conception rate after one insemination/service	AI	Bull	Overall 1991		Overall 1990	
Old districts	60	74	61		60	
New districts	62	89	64		63	
Overall	61	78	63		60	
Inseminations/services per conception						
Old districts	1.7	1.4	1.6		1.7	
New districts	1.6	1.1	1.6		1.6	
Calving interval (days)			Mean	Median	Mean	Median
Old districts			468	433	461	424
New districts			460	416	441	414

4.2 Tanzania

In Tanzania, the Netherlands cooperated in the IDA supported 580 TA project (1975-1981) with the following technical assistance 1) a dairy officer to the Tanzania Rural Development Bank for channelling the IDA loan; 2) managers and group farm managers of large-scale farms; 3) mechanization personnel, supported by financial assistance in: 4) a central workshop and training facility in mechanised dairy farming, and through import support assistance for 5) a central drugstore and supply of veterinary medicine.

The 580 TA dairy project aimed at rehabilitation and establishment of large-scale dairy farms with 17 units of 350 cows, the pilot set-up of 20-25 cow units in 50 ujamaa villages, the establishment of a West Lake heifer breeding unit (6,000 cows) to supply crossbred dairy stock (1,800 F_1 heifers per annum) to the project and some expansion in collection and processing.

Support to the smallholder sector started in the early 1980s, when the main focus on large-scale farms and ujamaa dairy farms was relaxed and the new Tanzanian livestock development policy of 1983 included a shift to smallholder dairy development. In two areas in Tanzania, the Netherlands is supporting regional dairy or livestock development programmes, Kagera region in the North West and Tanga region in the North East. From 1984 to 1987 a coordinator for the Tanzania-Dutch livestock projects was active in economic analysis, which terminated the assistance to the large-scale farms and concentrated the support further completely on the smallholder projects.

4.2a Kagera region

Kagera region lies in the North-western part of Tanzania and the total area of 28,500 km^2 is subdivided in five districts, Bukoba (town with 45,000 inhabitants, and rural), Karagwe, Muleba, Biharamulo and Ngara.

The Kagera Livestock Development Programme (KALIDEP, 1990-1994)is the continuation of the following project components:

- Kikulula Heifer Breeding Unit (1976-now);
- Kagera Smallholder Dairy Extension Project (1982-now);
- Kikulula Farmers Training Centre (1982-now); and
- Kagera Indigenous Livestock Improvement Programme (1988-now).

The production of Friesian x Boran (F_1) heifers at Kikulula ranch (21,700 ha and 1,700 breeding cows) averaged 248 per year (1980-1990). In 1991, the Kikulula ranch merged with the adjacent Mabale ranch (total 30,000 ha and 8,500 cattle) to cater for sufficient replacement Boran stock and a future output of 300-400 F_1 heifers per year (Houterman and Omolo, 1992).

At a 40 ha block on Kikulula ranch, the Kikulula Farmers Training Centre is located. The centre was built with World Food Programme funds and the inventory provided by the Netherlands. Aspirant dairy farmers at the rate of 106 in 1984 to 469 in 1991/92 per year (and 6 to 53% women, respectively) are participating in one week courses on improved dairy farming. In addition in-service training of general livestock extensionists, dairy extensionists as well as dip committee members is carried out.

The Kagera Smallholder Dairy Extension Project (KSHDEP) was initiated in 1982 to reduce the high mortality at introduction of crossbred heifers at smallholder farms. The participation rose from 37 farmers (6.9% female) with 55 cows and 37 mated heifers or 132 total dairy stock to 1,435 farmers (23.8% female) with 1,700 cows and 416 mated heifers or 4,660 total dairy stock by mid 1992. Over the period a drop-out of 373 farmers was recorded mainly due to farmer transfers (30%), loss of interest (28%) of the farmers or death of the animals (26%).

Individual farm visits and veterinary supplies reduced the adult cattle mortality rate from 11.3% in 1983 to 2.7% in 1991/92 and the calf mortality from 28.6% to 8.1%, respectively. The calving rate dropped from 87% in 1983 (initial high % of pregnant Kikulula stock) to 66% in 1991/92 in spite of fertility cards and monthly check-ups on the fertility status. Calving intervals averaged from 467 (430 median) days for first calvers down to 409 (371 median) days for fifth calvers. The age at first calving was 1,006 days (median 957) for 697 heifers born at smallholder level compared to 1,211 days (1,190 median) at the Heifer Breeding Unit.

Milk production increased from 160,000 litres in 1983 to 2,923,000 in 1991/92 with a target of 5 million litres in 1994. Milk production per cow per year rose at an impressive rate from 1,123 to 1,842 litres over the same period with an average of 73% of the project cows in milk. Small-scale milk processing (butter and cheese) was started at Bukoba in 1990 and at the Kikulula Farmers Training Centre in 1992. Annual production of cheese is about 3,750 kg per year (3,000 kg sold) with a purchasing price of Tsh 70-80 per litre of milk and a sale price of Tsh 1,400 (whole sale) to Tsh 1,800 (retail) per kg cheese.

The Kagera Indigenous Livestock Improvement Programme (KILIP) operates at decentralized points in the districts on Farmers Extension Centres (FECs) with a model zero grazing set-up and fodder plots, food crop demonstrations of the agricultural section and tree nurseries and plots. Through the availability of veterinary supplies at cost, strict dipping regimes and a small disease diagnosis facility at the FECs, it is hoped to raise the productivity of the indigenous livestock but also to stimulate redistribution of livestock to provide a better distribution of manure, essential for coffee and banana production in Kagera.

Data in herd changes (births, deaths, sales, purchases, migration, slaughter) were collected by dip attendants in 35 villages of 9 FECs for 1990 and 1991. Out of the maximum number of 1,466 farmers which appeared in the surveys, per January 1990, 1991 and 1992 the trend in the number of farmers recorded with cattle indicated 1,084, 1,057 and 955 farmers respectively. Similarly for areas with dips working in 1991 this amounted to 659, 632 and 570 farmers with cattle. The respective herd size on the above dates stood at an average 15.4 (15 for dips working), 16.1 (15.4 for dips working) and 15.4 (15.1 for dips working), indicating a rather stable herd size sofar. A further analysis of technical parameters in 496 herds with complete data on the change in herd composition against Kagera data (8 FECs) is provided in Table 4.4 (KALIDEP, 1992).

The data will further be analyzed statistically by the monitoring section (added to the project per 1991), but these initial figures support the theory that dipping leads to a decrease in mortality and an increase in offtake.

Whereas the cost of dipping is increasing fast, the programme embarked on trials using Deltamethrin (Decatix) to combat at reduced intervals both tick-borne diseases and trypanosomiasis. Also a pump with filter is used to recycle the dip fluid by taking out the accumulated dirt.

Table 4.4. Technical parameters in 496 indigenous herds comparing villages with working and non-working dips in relation to Kagera region in 1990 and in 1991.

Parameter	Dips working 1991	Dips not working 1991	Kagera region 1990	Kagera region 1991
Calf mortality %	23.2	34.7	29.4	28.4
Adult mortality %	3.1	5.7	4.0	4.2
Overall mortality %	7.0	11.5	9.1	9.0
Calving rate %	41.2	40.7	44.7	41.0
Offtake %	9.6	7.8	9.3	8.8
Migration out %	27.3	20.7	40.1	24.4
Migration in %	24.9	18.9	39.3	22.2

Constraints of dairy development relate to the differences between the urban and rural areas. Bukoba town farmers have more capital, receive a higher milk price, and have easier access to extensionists, veterinary supplies and services, concentrates (molasses and cotton seed cake), but fodder is limited and less space is available for keeping bulls. A town AI scheme has been in operation since 1989 with conception rates from 59% (92 inseminations) in 1989/90 up to 84% (437 inseminations) in 1991/92. In the rural areas dispersed dairy cattle means a good milk price, but an expensive system of extension service, veterinary supplies and concentrates. On the other hand a cluster dairy approach reduces the milk marketing possibilities against easier access to extension, input supplies and veterinary services. AI in one of the rural areas started in 1990 but conception rates fluctuated down from 75% in 1990/91 to 52% in 1991/92 due to logistic problems.

Women participation in Kagera dairying was studied by Tibaijuka (1989) and amounted to only 12%. Problems encountered were allocation of pasture sites under the patrilineal inheritance of land, little initial investment and working capital, not enough time or lack of enough family (children) labour. From mid 1990 KALIDEP has a female officer in charge of the women's programme in dairying. Women farmers have joined either single or as groups with a total of 357 over the period 1982 to mid 1992 (261 since 1990), being 253 single women and 104 groups of women. The drop out is low with a remaining 240 female farmers and 102 female groups by mid 1992 or 24% of the 1,435 project dairy farmers.

A special heifer credit scheme exists under the name Heifer-in-Trust (HIT). Under such scheme poor farmers are selected by the church (Evangelical Lutheran Church of Tanzania under the USA based Heifer Project International) or a ward committee (under the WFP supported HIT scheme). Qualifying farmers repay the heifer-in-trust with her first in-calf heifer. Next to 58 farmers under HPI, a total of 636 farmers have benefitted under the WFP supported scheme by mid 1992. From 567 farmers supplied with pregnant heifers from 1986/87 to 1991/92, the drop out was 58 farmers (lost their animal due to their own mistakes), 7 farmers received a replacement heifer, 13 farmers had their animals withdrawn, 66 have repaid and 438 are still having their heifer without a repay. From 66 passed-on heifers (1988/89 to 1991/92) one drop out has been recorded.

Gross margins were calculated in September 1991 for 7 zones with as revenues the milk sales minus the costs consisting of hired labour, feeds (cotton seed cake, molasses, minerals) and veterinary expenses (Table 4.5). Striking are the large differences between Bukoba with a good milk price, the Karagwe zone where cattle herds supply large amounts of seasonal milk at a low milk price, and Ngara district where dairying has just started.

The organisation of dairy farmers has been limited, although grassroots level organisation of farmers is encouraged in dip committees, molasses distribution committees, HIT heifer distribution committees and FEC farmers committees. Three farmers are represented in the project steering committee. Only two groups of dairy farmers have succeeded sofar in obtaining the level of primary cooperative society.

Table 4.5. Gross margin calculations in relation to prevailing milk price in 7 dairy zones in Kagera region in Tsh (1 US $ = 200 Tsh.)

Areas in Kagera region	Gross margin per year	Gross margin per cow	Gross margin per month	Milk price
Bukoba urban	244,692	118,259	18,724	80
Bukoba rural	57,097	57,097	4,758	80
Karagwe (zone G)	45,228	45,228	3,769	70
Karagwe (nomads)	25,612	28,458	2,134	40
Muleba	39,854	42,830	3,287	60
Biharamulo	32,854	54,757	2,737	60
Ngara	97,988	122,485	8,165	100

4.2b Tanga region

The Tanga Smallholder Dairy Development Programme (TSDDP, 1992a,b,c) aims at integrating dairy at smallholder farms and has four components:

- Heifer Breeding Unit Mruazi/Magunga of Mkonge Livestock Company (MLICO) of the Tanzania Sisal Authority (1978-now);
- Farmers Training at Buhuri Dairy Practical Training Centre (1984-1991);
- Smallholder Dairy Extension Project (1985-now); and
- General: veterinary medicines, milk marketing and monitoring (1985-now).

Smallholder dairy extension was initiated as an outreach project of the Buhuri training centre, after the first farmers' course in June 1984 and a village farm survey in December 1984. During its 'pilot' phase from 1985-1987 the project proved technically that smallholder dairy development is viable through the training of farmers at Buhuri, close supervision afterwards and the organisation of dairy inputs.

Project continuation (1988-1993) was approved towards more integration of dairying in sustainable mixed farming, organisation and distribution of inputs increasingly through farmers organisations, and the introduction of the HIT scheme with WFP and EC counterpart funds to reach lower income groups.

The programme is per 1992 operational in all districts of Tanga region: Tanga urban and rural, Muheza (with Amani and Maramba subregions), Pangani, Korogwe and Lushoto. Even more than in Kagera region, the problem is availability of dairy heifers for Tanga farmers in view of competition for stock by Dar es Salaam clients, although sources of heifer breeding are fourfold in Tanga region (1 parastatal Heifer Breeding Unit, 1 state Livestock Multiplication Unit, a private ranch and internal generation).

The Heifer Breeding Unit at Mruazi/Magunga (3,000 ha and 1,700-2,000 breeding cows) was established in 1978/9 and produced 3,222 F_1 heifers from 1980 to 1990. Production is higher than in Kagera because of lower mortality rates and supplementary hay feeding in the dry season. Calving rates fluctuate below the targeted 65% due to low culling rate and slow replacement of foundation stock. Dutch support is only a forex facility for spare parts and semen.

Internal generation of stock at dairy smallholders level is higher than in Kagera through very low mortality rates of calves and adults (< 5%) in 1990-1992. The smallholder dairy cattle population increased from 7 in 1985 to 3,747 (1,357 cows and 349 mated heifers) in October 1992. The number of farmers increased from 5 in 1984 to 1,108 in November 1992. Most heifers are since 1989 supplied through the HIT scheme, and the pass-on procedure is functioning well by providing a certificate of ownership at a ceremonial pass-on transaction. Up to October 1992, 607 farmers received HIT heifers (including 11 pass-on heifers); 22 farmers are without cows due to death, theft and slaughter, 8 farmers had their animals withdrawn due to poor management, 16 received a replacement heifer due to unfortunate death; 3 farmers have a HIT cow without calves (still birth, abortion); 80 farmers have HIT in-calf heifers, while 494 farmers have HIT cows with calves (290 female and 204 male).

The Dairy Practical Training Centre at Buhuri provides a two weeks basic farmers course. Participation rose from 66 in 1984 up to 351 in 1992 and from 6 to 30% women participation. An impact study carried out in 1989 was very positive on the effect of Buhuri training of aspirant dairy farmers from virtually no dairy farming skills to persons being able to manage their dairy units. Dutch support stopped in 1991 and DPTC has now to rely on paid courses.

The Smallholder Dairy Extension Project attends to urban and rural dairy farmers. In Tanga town additional project assistance is on AI (for village breeding bulls) and monitoring of economic data in town dairy farming. In the rural areas the emphasis is on bull distribution programmes, mortality and fertility monitoring (number of cows in categories of open days). Feed generation such as the collection and drying of leucaena leaves (mixed with maize bran to replace dairy meal) and lately also guinea grass hay is rented out to schools and women groups for income generation.

A study on women participation was undertaken by Ngido and Mjema (1989) which indicated that 19% of the project dairy units were owned by women. The main factors hampering women participation were: the failure to raise capital, the instability of marriages, which causes a lack of long-term access to land, the already high workload of women and the high labour demand of a dairy unit. In 1991 there were 29% female project farmers. In 1992 35% of the HIT heifers went to female farmers.

The farmers organisations (6 with 1,229 members in 1992), initially used for project input distribution and active in HIT farmer selection, are increasingly handling dairy inputs. In 1993 they have joined hands for a process of negotiating a lease of part of the Tanga dairy factory facilities (4,500 litres per day) from Tanzania Dairies Limited. Surplus milk accruing in the various areas of the programme can in this way be processed and will start replacing the reconstitution of powder milk. The milk price varies from Tsh 60 per litre in isolated areas with low purchasing power to Tsh 160 in Tanga urban area. Two private transporters received a lorry loan (revolving fund) for collection of surplus milk in hilly areas of Lushoto and Amani.

4.3 Sri Lanka

Netherlands Development Cooperation supported a large number of projects in dairy development over time in Sri Lanka:

- Netherlands Dairy Project (1978-1985);
- Mid Country Livestock Development Centre (1982-1985);

- Straw Treatment Project (1982-1983);
- Straw Utilization Project (1983-1986);
- Extension to Draught and Dairy Programme in Mahaweli (1984-1986);
- Coconut Triangle Livestock Development Centre (1985);
- Dairy Development Phase II (1985-1988);
- Smallholder Dairy Development Project (1986-1989);
- Fibrous Feed Utilization Project (1986-1989); and
- Small Farmer Dairy Project (1990-1991).

The Sri Lanka-Netherlands Livestock Development Programme started in 1977 with a financial aid donation of some 900 heifers (6-18 months old), which arrived in 1978/79. The animals were meant to go to smallholders under the IDA supported Dairy Development Project in the Mid Country and Coconut Triangle. After raising the heifers on two farms of the National Livestock Development Board (NLDB) only 32 pregnant heifers went directly to smallholders. Another 83 went after calving down on the parastatal farms as pregnant young milking cows to ensure income from milk for the maintenance of these animals at the time of arrival. The others remained on the two NLDB farms for milk production and multiplication. Milk production of the imported stock was very low at 6-10 kg of milk per cow per day as a response to feeding insufficient roughage and concentrates. Calving intervals were long so that most offspring was needed for replacement. Technical assistance was given to the two parastatal farms but the problems of feed scarcity, low fertility and problems with the claws could not be solved sufficiently under the prevailing low input management. Only recently in 1992/93 under high input farm management the offspring of these imported stock are producing now 14 kg of milk per cow per day and the age of first calving has come down to below 30 months. High input farm management had been triggered off by profits generated from the growing of seed potatoes on these farms in the Hill Country. Charging commercial prices for surplus stock and the processing of 50% of the milk (1,000 litres per day) into cheese (for tourist hotels) on one of these farms assisted further in making these exotic cattle farms profitable in 1992.

The management of the exotic animals at smallholder level required training of farmers and extension staff. In 1982 the idea of the Mid Country Livestock Development Centre (MLDC) linking training, extension and stock supply within a setting of mixed farming (spices, coconuts, fruit trees and vegetables) was born (see Chapter 7 on performance of the MLDC demonstration cum training farms). Concern about dry season feeding resulted in a research project on straw treatment. MLDC concentrated on farmer and farm development (cattle shed, grass in open spaces and tree fodder along the borders, biogas, cattle management), and training of extension staff.

In 1983 the Straw Treatment Project became the Straw Utilization Project combining research and extension on the use of (un)treated straw in the different farming systems during periods of scarcity of grass. This was extended from 1986-1989 to the Fibrous Feed Utilization Project with a focus on demo-farmers and followers for development of fodder collection and sheds, feed troughs and improved feeding. With the abolition of the subsidy on N fertilizers, straw treatment has become too expensive under the prevailing milk prices.

The Sri Lanka-Netherlands Livestock Development Programme was also involved in support of the Dairy and Draught Development Project of the Mahaweli Authority of Sri Lanka in new settlement farms in the Dry Zone.

In another effort to increase dairy production area-wise, settlers in abandoned tea lands were supported with grass and tree fodder materials, cash crop seedlings and a pregnant heifer on credit (without interest) to restore fertility of the soils though livestock-crop integrated farming. Some 150 settlers benefitted, most of them repaid their loan from milk sales at the tune of 0.6 litres/day during 4 lactations (see also Chapter 8 on the performance of these settlers).

Whereas the availability and quality of dairy stock were very determining factors for dairy development, the attention under the Smallholder Dairy Development Project (1986-1989), operating in both Mid Country and Coconut Triangle, became more focused on calf rearing at the smallholder farms themselves. This resulted in various try-outs which a training and an incentive orientation. The attention to calves with incentive support proved the most successful way of keeping young stock on the farms and growing them out to good developed pregnant heifers. Heifer contract breeding for supply to other farmers was less successful since farmers were not keen on departing from a well-grown heifer (for more details, see Chapter 9).

In 1990/91 a calf rearing target growth scheme started under the Small Farmer Dairy Project (1990-1991) with the Mid Country Milk Union and registered 1850 calves in 6 months. Farmers received a mobile training by MLDC, had a measure tape and growth chart with quarterly targets to check on calf growth themselves. The following number of calves (and in %) received the bonus (US $ 7.50) quarterly (Table 4.6).

Table 4.6. Performance of the calf rearing (target growth) scheme by the Mid Country Milk Union.

Calves	Registered	Reaching target weight at month 3	6	9	12	15	18
Number	1850	1672	1484	1361	1242	1109	916
in %	100	90	80	74	67	60	50

The intended bonus for pregnancy below the age of 21 months (US $ 12.50) and the bonus for calving at an age below 30 months (US $ 12.50) had to be combined in view of problems with carrying out pregnancy diagnoses at all the participating farms. By mid 1993 the first 100 recorded heifers have calved down at an average age of 27 months (see further Chapter 9).

Parallel with these technical elements of the projects, under a climate of extremely low milk prices, the project evaluation in 1989 (Den Tuinder *et al.*, 1989) stressed that further continuation of Netherlands support would depend on progress made in the establishment of a pricing formula. The formula should provide farmers with a more remunerative milk price in relation to the consumer price for fluid milk (from 40 to 60%) and the whole sale price per liquid milk equivalent of imported milk powder (through a threshold price on imports). The increase in the chilling centre price from Rs 5.01 per litre in 1989 to Rs 8.50 in 1991 (and Rs 9.00 in 1993) was too little in relation to the indicated Rs 10.50 and the Dutch support to SFDP was stopped, after another evaluation, by mid 1991.

Neither calculations on cost of production nor developments on the real and nominal milk price over time (Table 4.7) nor milk price discussions between Milk Unions, Dairy Cooperatives representatives and the Government proved sufficiently powerful to convince the Government to raise milk prices to a remunerative price level. A better producer price in relation to the feed price is urgently needed to stimulate local milk production in view of the increasing imports of milk powder (30,000 tons at US $ 50 million in 1991/92). During 6 months in 1991 a try-out was done at keeping the price ratio milk/coconut meal at 1:2 which resulted in increased milk collection at MIDCOMUL from 8.5 million in 1990 to 11.5 million litres in 1991 (MADR, 1992)

Attempts to reorganize the dairy industry in the mid 1980s along a modified Operation Flood model (based on dairy farmers companies) with IBRD/WFP/EC and Dutch support failed. The Dutch contributed through consumer preference surveys and marketing studies and facilitated the collection of past information on farming systems, animal breeding, nutrition, health, training and extension, for the formulation of improved management packages for different agro-ecological zones.

The organisational framework with a Dairy Development Foundation, a Milk Industries Company of Sri Lanka, and Dairy Farmers Milkshed Companies became a struggle in itself of who would control the project: the money organiser (DDF), the milk processor (MILCO) or the producer (Milkshed Companies). Moreover the liberal imports of cheap milk powder did not foster local milk production. Early 1993 the MILCO has been peoplelized with 60% of the shares to a commercial group, leading to a milk industry hold by Nestle and MILCO and the farmers are now at the mercy of these two companies.

Table 4.7. Development of nominal producer milk price and of pasteurized milk, price index (1978=100), real producer milk price and milk collection in Sri Lanka.

Year	Nominal milk price (SL Rs)[1] producer	pasteurized	Price index[2]	Real price producer	Milk collection mln litres/year
1978	2.2	2.8	100	2.2	49
1979	2.2	2.8	111	2.0	62
1980	2.2	4.0	140	1.6	62
1981	2.7	4.2	165	1.6	58
1982	2.7	4.2	183	1.5	55
1983	3.2	5.8	208	1.5	54
1984	3.7	7.5	243	1.5	57
1985	4.3	7.5	246	1.7	67
1986	4.3	7.5	266	1.6	67
1987	4.3	8.3	287	1.5	68
1988	4.8	9.2	327	1.5	65
1989	5.8	11.0	364	1.6	61*
1990	6.6	12.5	441	1.5	64
1991	8.5	14.5	495	1.7	73
1992	8.5	15.8	551	1.5	80**
1993	9.0				

[1] 1 US $ = 47 Sri Lankan Rupees (1993)
[2] Consumer's price index Colombo: Central Bank of Sri Lanka
* Per 1989 and onwards, figures exclude the milk from East and North Sri Lanka
** estimated

Small-scale milk processing (100 to 1,000 litres per day) at the level of Dairy Producers Association (DPAs) and their Milk Producers Unions was supported under the SFDP as well. The effort was seen as providing for part of the milk added value through the conversion into yoghurt, curd, ghee, toffees and flavoured milk, and for keeping this milk in the area. The main problems in small-scale processing appear the expertise required to guarantee quality of the end products and the low salaries offered by cooperatives for this type of technicians.

4.4 India

The involvement of Netherlands Development Cooperation in India's dairy development was twofold. On the one hand there was the question on approving further EC Dairy Aid under Operation Flood (OF) and on the other hand there were the Indo-Dutch Studies on Development Alternatives.

Continuation of EC Dairy Aid was discussed within the Food Aid Committee of the Commission of European Communities (CEC) together with the Dutch Ministry of Agriculture. Although progress in OF was often behind the targets set for the different phases, most technical officers appreciated the enormous effort of OF oriented to the dairy producer in view of so many efforts where the urban bias prevailed in livestock projects. The technicians also supported the approach of using dairy aid for investment in the dairy sector, the control on imports of milk products, and the processing of value added high quality products to arrive at a better producer price.

The studies on development alternatives were coordinated by the Dutch Institute of Social Studies (ISS). A team of Indian and Dutch economists and sociologists studied Operation Flood very critically over time (Doornbos *et al.*, 1990 and Doornbos and Nair, 1990)

Three basic questions in development strategies were raised:

1) Can equal participation and benefits of the small producer be planned in projects and programmes as anticipated under OF?
2) Are project successes achieved within a specific socio-economic and ecological context, such as in Kaira District, replicable in other contexts?
3) Can programmes or projects created with large foreign support be sustained locally?

Generally the socio-economist believes that social and ecological differences in national projects will create different benefits to the project beneficiaries. Large external support (and consequently donor influence) will lead to loss of autonomy and self reliance. They also criticised the emphasis on higher milk output per animal by better feeding and breeding by questioning if the green revolution and a white revolution separately would be the only solution to cope with increased population. The dairy aid of the CEC was viewed as a result of accrued surpluses in the EC and not structural to the benefit of recipient countries. Full scale replicability of OF in other areas was doubted against the increasing advantages of Gujarat State had as an early starter. The cheap monetisation of skim milk powder and butteroil kept the consumer price down. This would mean a longer need for dairy aid before the Indian consumer would be prepared to pay a remunerative producer price for locally produced milk.

Focusing on development cooperation oriented to alleviate structural poverty ISS advocated for more attention and funds for the Indian poverty alleviation programme such as the Integrated Rural Development Project, and for differences in public programmes to create equal chances in development.

These studies were received with lots of criticism by Operation Flood staff. The ISS in their final reports contested with the explanation that the position of social researchers is fundamentally different from practical people. The latter tend to see positive and encouraging developments in projects, the social one is very critical and blames the technician for setting too high goals (unrealistic planning and insufficient implementation capacity).

Alternative strategies to combat rural poverty advocated by the ISS team were posed in the form of the following questions:

1) Why not replace dairy aid by vegetable protein aid? The latter is much cheaper and would benefit more people of the rural poor?
2) Why intensify dairying against intensifying of agriculture, departing from the traditional attention for both draught and milk?
3) Why not concentrate on more selection within the famous Indian dairy breeds (buffalo/cattle) instead of emphasizing crossbreeding with exotic cattle?
4) Why is the focus on buffaloes and cattle and not on milk production of sheep and camels which are important to poorer families and nomads?
5) Why is the traditional attention to rural milk consumption overtaken by the emphasis on luxury product processing?
6) Why not focus more on peri-urban cooperatives and dairymen close to the metropolitan cities to reduce the enormous transport cost of rural milk to the far away metropolitan

cities (the national grid in India is very large and costly)?

7) Why not insist harder in other areas on the Anand payment system for milk (twice a day) which ensures better that women get paid for the milk they produce?

8) Why does OF not consider other local dairy development alternatives (multi-model approach)? The National OF strategy is based on the strong organisation of the agricultural caste of Kaira district. and does not take into account regional differences in the organisation of people.

4.5 Indonesia

Dutch cattle went in the colonial period to large size units (100-300 cows) in the plantations to provide milk for the planters and their workers. Male calves were given to the labour for rearing outside and were used to cross with the local cattle which resulted in the Grati breed. After independence the plantation dairy herds were broken up and sold to smallholders. The milk was mainly sold to the large towns through middlemen with low prices for the farmers.

The establishment of commercial milk factories generated awareness of potential demand of the domestic consumption of milk but the cheap imported milk had a negative impact on domestic milk production. This dairy climate caused a lot of cooperatives and farmers to go bankrupt during the 1960s and 1970s. The Government of Indonesia prepared in her third five year development plan (1978-1983) a large dairy initiative with imported cattle to reverse this trend (Atmadilaga, 1992).

The Netherlands was asked for a feasibility study in East Java, but this mission (Bakker *et al.*, 1982) considered that the fodder base was insufficient to support large imports of dairy cattle. It was expected that a large influx of dairy cattle would reduce the fodder base for beef cattle, sheep and goats which formed the base for supplementary income for a large number of poor farmers. Official Dutch Cooperation from government to government therefore excluded attention to the dairy and cattle sector in Indonesia.

Under the interuniversity cooperation (NUFFIC) between the Brawijaya University in Malang, East Java and the Agricultural University in Wageningen, the Faculty of Animal Husbandry and the Department of Tropical Animal Production carried out a study (Ibrahim *et al.*, 1991) about 10 years of dairy development in East Java (1980-1990).

The study indicated that, although the dairy cattle population increased threefold (from 1 to 3% of the total cattle population), the number of beef cattle, goats and sheep increased with 14, 21 and 64%, respectively within 10 years. The number of buffaloes and horses decreased with 19% and 30% in favour of tractor hire and other transport facilities.

A further analysis of the dairy sector in East Java revealed that the dairy cattle importations which amounted to 38,122 from 1979-May 1990 pushed up the milk collection from 3.7 million kg in 1979 to 89 million kg per year in 1990. Table 4.8 shows further details on the distribution of dairy cattle which increased at smallholdings and was reduced on enterprises over time.

It is also interesting to note that the increase of the number of cows in lactation at the cooperatives, where most of the imported cattle went, is less than the numbers imported. Internal generation of dairy stock appears poor with high mortalities because of little feeding of milk and concentrates. Only lately more focus on calf rearing exercises have been advocated through Service Business Cooperatives, which rear farmers calves under contract.

The East Java study included a rough assessment of the nutrition and feed supply for the Malang and Pasuruan regions where 71% of the dairy cattle in East Java are kept. The combined effect of seasonal distribution, quality aspects and the number of dairy cows on feed availability studied indicated that in the Malang region enough feeds with sufficient energy and protein were left for other livestock. In the Pasuruan region the calculations showed that only 60-90% of the requirements for other livestock could be met from January to August. Similar calculations for other dairy areas indicated that the energy requirements could be met but that protein requirements were higher than supplies in parts of the year in most of the other areas.

Table 4.8. The distribution of dairy cattle over smallholdings, private enterprises and cooperatives in East Java (1979-1990).

Dairy cattle	1979	1980	1989	1990
Smallholdings	16,700		84,100	
Enterprises	8,200		6,600	
No of cows in lactation (cooperatives)		4,018		34,591
Total dairy stock at cooperatives		9,792		85,147

Through the concentration of dairy animals in areas (to facilitate marketing) farmers find it difficult to feed their animals enough roughage for maintenance. It was estimated that only 75% of the maintenance requirement could be met. This meant under the prevailing conditions of rationed (with subsidized wheat pollard) cattle feed at 1 kg per 3-4 kg milk, that farmers had to use about 4 kg rice bran extra to fill the gap.

A further survey in 1990 on 274 farms in 7 cooperatives in East Java (Widodo *et al.*, 1994) revealed that the profitability per cow decreased with the larger number of cow units. The cost of feeds and the roughage provision does not stimulate the increase of cow units per farm (Table 4.9).

Table 4.9. Main economic parameters ('000 Rupiah) per cow for four categories of dairy enterprises in East Java in 1990.

	One-cow unit	Two-cow unit	Three-cow unit	Four and more cows	Average farm
Number of units	70	122	50	32	274
Number of cows	1.0	2.0	3.0	5.3	2.3
Investment	1,890	1,578	1,584	1,463	1,584
Revenue	1,361	1,077	1,008	821	1,024
Expenditure					
Feed excluding roughage	453	326	270	230	301
Roughage cost	503	416	400	380	412
Other expenditures	59	44	48	50	49
Gross margin					
Excl. roughage cost	849	707	690	541	674
Incl. roughage cost	346	291	290	161	262
Fixed cost	348	289	291	266	290
Net margin					
Excl. roughage cost	501	418	399	275	384
Incl. roughage cost	-2	2	-1	-105	-28
Cash output-input ratio					
Excl. roughage cost	2.66	2.91	3.17	2.93	2.93
Incl. roughage cost	1.34	1.37	1.40	1.24	1.34

Widodo *et al.* (1994) also made a comparison of the milk price developments at farm gate and for the consumer from 1977 to 1990 (Table 4.10). Improvements in the ratio between the farm gate price and the consumer price in the early 1980s were decreasing rapidly during the latter years of the 1980s. Apparently the increase of consumer prices benefits the dairy industry and the cooperatives more than the dairy farmers.

Table 4.10. Comparison of milk prices (Rp) in East Java, Indonesia at farm-gate and for the consumer (1977-1990).

Year	General consumer price level 1980=100	Milk prices				Proportion farm-gate price/ consumer price (%)
		farm-gate price		consumer price		
		(Rp/l)	(1980=100)	(Rp/l)	(1980=100)	
1977	67	60	33	180	50	33
1980	100	180	100	360	100	50
1983	137	257	143	600	167	43
1987	184	360	200	1,125	313	32
1990	227	400	222	1,800	500	22

CONCLUSIONS

The Dutch experience with above dairy developments in Kenya, Tanzania, Sri Lanka, India and Indonesia suggests the following attention points for Asia and Africa:

1) A producer-friendly milk price climate is required for smallholder dairy development either through direct sales between producer and consumer or macro-policy measures (import regulation, pricing formulas) and/or through processing of milk in value-added products;

2) Most dairy projects have problems with low milk prices paid in rural areas (high cost of collection and transport) compared to more remunerative prices directly from consumers to producers close to town or in areas with little dairy production;

3) Surplus rural milk may benefit from small-scale processing to arrive at a better producer price, provided rural farmers organisations can afford trained people in processing and marketing;

4) Whereas imported dairy stock is costly and little productive in relation to their potential in temperate areas, crossbreeding of local stock with exotic semen seems more successful such as observed at the parastatal (commercial) heifer breeding units in Tanzania;

5) To correct the little internal generation of dairy stock, both at large-scale farms as well as at smallholder level, improved calf rearing and heifer raising should be encouraged either by a high price for in-calf heifers and/or small incentives to recover the cash cost of raising young stock along a targeted growth chart;

6) Integration of farmers training (within a mixed farming set-up to consider milk production as well as manure utilization), extension, veterinary services and dairy stock supply is essential for technical dairy development at smallholder level;

7) The organisation of dairy farmers and experience with cooperatives are quite different per country. The replication of the Indian Operation Flood model based on 4 tier cooperative dairy development and powerful leadership to defend producer interests against food aid, dumping of milk powder and multi-national dairy companies appears very difficult for other countries;

8) The Heifer-in-Trust scheme as shown in Tanzania reduces the high capital requirements for dairying and facilitates the access to cattle by the poorer sections of society (rural area, women);

9) Women participation in dairy development requires that extra attention is given to facilitate training (location and timing) and access to credit, fodder production and dairy revenues; and

10) Napier grass as the bulk forage supplier for zero-grazing in Kenya is also getting popular for farm grown fodder in Sri Lanka and Indonesia. The growing of leguminous fodder trees for supplementary feed in Indonesia, India and Sri Lanka has stimulated similar developments in Kenya and Tanzania.

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Appendix 4.1

FARM-LIQUIDITY-BUDGET DISTRICT:

FARMER: LOCATION: SUB-LOCATION:

FARM-SIZE (present situation) Full / Part — time farmer

Crops	no cr. p yr	acres	c.e.	Total	Livestock	no	c.e.	TOTAL
Tea, Coffee	1				Cows Pure bred			
Horticulture					Grade			
Subsistence crops					Cross			
					Local			
					Working Oxen			
Nat Pasture	1							
Napier/Bana	1				Sub-Total			
Total					→			
Homestead, Swamp, etc					TOTAL c.e. on farm			

LIVESTOCK AND ROUGHAGE PLAN (new situation) GRAZING-SYSTEM:

Livestock	No.	L.U.	TOTAL	Roughage	acre	DM per acre	Total DM/yr
Cows Pure/Grade		1		Napier/Bana		5500	
Heifers (over 12 m)		0.7		Improved Grazing		3500	
Calves (5-12 m)		0.4		Natural Pasture		2000	
Cows Cross		0.8					
Cows Local		0.6		Total Foddercrops			
Young-stock Cross/Local		0.4		Adjustment-factor ( )			
Donkeys		0.4		By products			
Working-oxen		0.8					
Mature sheep/goats		0.2					
Total L.U. on farm							
Total DM required		x 3600		← → Total DM available			

ADDITIONAL INVESTMENTS				FINANCING		MILK MARKETING
DESCRIPTION	Total Inv	Own input	Add Inv.	DESCRIPTION	KShs.	All milk sold
Cows				Own Cash		Morning Milk Sold
Building-mat						
Chaff-cutter						Milk price KSh/kg
				Project-grant		
				Loan (A F C)		
Total additional Investment				Total Amount		

ANNUAL COMMITMENTS		EXPECTED ANNUAL CASH FLOW SURPLUS		
DESCRIPTION	KSh.	DESCRIPTION	KSh.	
Loan (AFC)		Dairy-enterprise		New Situation
		Other Farm activities		
		c.e. x		
Salary Labourers				
Family expenses (KSh /m)				
Total Commitments per year		Total Surplus per year		

ADVICE

Date of visit Signature

Extension-officer:

Appendix 4.2

Farmer:..................................
Farmcode:................................
Farm-size:...............................
Full/Part*-time farmer.

MINISTRY OF LIVESTOCK DEVELOPMENT
DAIRY DEVELOPMENT PROJECT

DAIRY EVALUATION AND ADVISE FORM
PART I

Name extension officer:................................
Date of visit: ..../..../....

1. DAIRY COWS AND HEIFERS OVER 18 MONTHS.

Name of the animal	Breed (1)	Kept inside (Y/N)	Date of birth	HERD FERTILITY: Date of last: Calving	Heat	Service or ins.	Total number of services: A(2)	B(2)	Last P.D.: Date	Result (P/E)	RECOMMENDATIONS OR REMARKS	MINERALS: Supplied to the animal (Y/N)	UDDER CONDITION: Number of lost quarters	Number of times affected by mastitis(3)	MILK: Kg's milk per day	PRODUCTION AND CONCENTRATES: Concentrates: Fed/day (kg's)	Type of concentrate	Advised kg/day
1.																		
2.																		
3.																		
4.																		
5.																		
6.																		
7.																		
8.																		
9.																		
10.																		

2. DAIRY YOUNGSTOCK UNDER 18 MONTHS MALES + FEMALES AND BREEDING BULLS.

Name of the animal	Male or Female (M/F)	Date of birth	Kept inside (Y/N)	Properly housed (Y/N)	Has the animal access to: Minerals (Y/N)	Good Roughage (Y/N)	Fresh water (Y/N)	Liters of milk per day: Fed	Adv.	CONCENTRATES: Fed/day (kg's)	Type of concentrate	Advised (kg/day)	VACCINATIONS: Brucell. (Y/N)	Anthrax (Y/N)	Dehorned (Y/N)	Condition of the animal (E/G/F/P)(4)	RECOMMENDATIONS OR REMARKS
1.																	
2.																	
3.																	
4.																	
5.																	
6.																	
7.																	
8.																	
9.																	
10.																	

3. MILK MARKETING.

Milk sold locally ....L/day
Milk sold via Dairy Society/KCC ....L/day
Milk price: - Local sales KSh............/L
- Dairy Society/KCC KSh............/L

4. VETERINARY. DATE

Last deworming: - cows ..../..../....
- calves ..../..../....
Last F & M vaccination ..../..../....
Dipping/Spraying* frequency ..../week

5. MINERALS.

Is a mineral box or holder present? Yes/No*
Estimated use of amount of minerals per week .....kg/week
Type of minerals used ....

For notes see PART II of the form.

Farmer:..............................

Farmcode: ____________

Date of visit: ..../..../....

MINISTRY OF LIVESTOCK DEVELOPMENT
DAIRY DEVELOPMENT PROJECT

DAIRY EVALUATION AND ADVISE FORM
PART II

6. UNIT.

Type of unit	....
Number of cubicles	......
Number of calfpens	......
Number of cubicles which require maintenance	......
Maintenance of walking area required	Yes/No*
Maintenance of calfpen required	Yes/No*
General hygiene	Excellent/Good/Fair/Poor*
Drinking water available to all animals	Yes/No*
Number of dairy animals grazing outside	......

ADVISE ON UNIT: ____________

7. ROUGHAGE.

Total area planted with Napier	......acre
Area of Napier interplanted with Desmodium	......acre
Natural pasture	......acre
____________	......acre
____________	......acre
____________	......acre
Does the farmer use: Brewer's waste/Banana stems/Roadside grass*	
Has fodder from trees been used during the past half year	Yes/No*
Regular fodder purchases during the past half year	Yes/No*
Napier irrigated	Yes/No*
Plenty of good fodder present in feedtrough at the time of visit	Yes/No*

ADVISE ON ROUGHAGE FEEDING: ____________

8. NAPIER AND MANURE MANAGEMENT.

Present cutting length of the Napier (cm's)	(60 / 60-120 /)120*
Weeding of Napier	Excellent/Good/Fair/Poor*
Kg's of fertilizer used during the past growing season	......Kg
Type of fertilizer used	____________
Manure stored in proper pit	Yes/No*
Manure used within a week	Yes/No*
Amount of manure returned to Napier	All/Most/Half/Little/None*
Manure application	Superficial/Covered*
Urine taken to Napier	Yes/No*

ADVISE ON NAPIER MANAGEMENT: ____________

9. CATTLE CHANGES AS FROM .. - .. - .. ONWARDS (Including deaths and slaughter).

	Date	Name of the animal	Date of birth	Sex (M/F)[1]	TYPE OF CHANGE[5]: Purch.[2]	Sold for Breeding	Sold for Slaughter	Home cons.	Died	Value of the animal	REASON OF CHANGE
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											

NOTES:

(*) Delete which is not applicable.

(1) A:Ayrshire, F:Friesian, G:Guernsey, J:Jersey, S:Sahiwal and L:Local.

(2) A: A.I. and B:Bull Service.

(3) During current lactation for cows in milk and during the previous lactation in case the cow has been dried off.

(4) E:Excellent, G:Good, F:Fair and P:Poor.

(5) Tick as appropriate.

ADVISE ON CALFREARING: ____________

ADVISE ON MINERAL FEEDING: ____________

ADVISE ON VETERINARY ASPECTS: ____________

CONCLUDING REMARKS: ____________

Appendix 4.3.

Some key figures of the DEAF surveys 1988-1991 of the Kenya National Dairy Development Project (Van der Valk, 1992)

	1988	1989	1990	1991
Number of farms included				
- old districts	1,820	1,960	1,921	1,789
- new districts	-	320	540	782
Total number of farms	1,820	2,280	2,462	2,571
Coverage of farms				
- old districts	80%	76%	63%	53%
- new Districts	-	87%	73%	74%
Overall coverage	80%	77%	65%	58%
Farm size in acres:				
- average	5.8	5.7	6.3	6.5
- median	4.0	4.0	4.0	4.5
Cows per farm	2.1	2.0	1.9	1.9
Acres of Napier grass per cow	0.62	0.65	0.70	0.73
Napier grass (kg dm/LU/day				
- for all animals	7.4	7.7	8.2	8.7
- for animals kept inside	10.1	10.1	10.5	10.8
Average milk yield/lact.day (1)				
- old districts	8.0	7.5	7.3	7.6
- new districts	-	8.6	7.9	8.7
- overall	8.0	7.7	7.4	10.8
Lactating cows	83%	83%	85%	86%
Lact.cows receiving supplements	71%	67%	62%	64%
Kg concentrate per cow/day	2.2	2.2	1.9	2.0
Milk sold				
- through societies/KCC	61%	63%	61%	61%
- local sales	35%	35%	27%	24%
Milk price societies/KCC (KSh)	2.85	3.35	3.75	4.00
Local sale price (KSh)	4.35	5.05	5.85	6.55
Milk receipts/day/cow (KSh)	15.8	18.3	21.3	25.3
Home consumption (I/d)	5.4	4.8	4.8	4.8
Median lactation stage (d)	181	184	196	183
Cows with estimated C.I.	31%	33%	33%	31%
Median of the estimated C.I.	427	422	431	426
Farms using minerals	80%	78%	79%	89%
Minerals used in kg/LU/year	24	23	20	20
Farms fertilizing	33%	31%	31%	37%
Kg fertilizer/acre/season	44	51	42	46
Farms with half or more of the manure returned to Napier	67%	74%	68%	72%
Farms according to manure application				
- ideal	17%	22%	24%	25%
- covered	51%	62%	61%	50%

5. EXPERIENCES WITH HORIZONTALLY INTEGRATED LIVESTOCK DEVELOPMENT IN RURAL SOUTH AMERICA[1]

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GENERAL INTRODUCTION

Latin America is a heterogeneous region, with large differences within and among countries. Culture, natural environment and economic context vary substantially (Table 5.1) and the range of issues relevant to livestock production, consumption and trade is immense (Jarvis, 1986).

Table 5.1. Selected milk production systems of South America (adapted from Jarvis, 1986).

Milk production system	Extensive grazing	Mixed farms crops/pasture	Semi intensive grassland	Intensive irrigated	Specialized dairies with concentrate
Country	Bolivia	Paraguay	Brazil	Bolivia	Colombia
Area	San Javier			Santa Cruz	Sabana de Bogotá
Rainfall (mm)	800	600	1300	900	1000
Altitude (m a.s.l.)	300	150	600	650	2600
Mean annual temperature (°C)	24	25	20	25	15
Farm area (ha)	200	215	232	340	55
Pasture/Forage (ha)	200	40	226	312	55
Milk cows (head)	150	15	94	256	100
Milk/cow (kg/yr)	334	536	1.527	824	3.558
Milk/ha (kg/yr)	250	201	652	676	6.470
Annual gross income (US$)					
Dairy	8.750	957	41.349	33.869	68.200
Total farm	16.550	3.228	48.143	107.597	86.845
Purchased inputs (US$)	4.025	1.261	23.264	30.466	20.075
Labour units (family)	7 (1)	1.5 (1.5)	15 (1)	8 (0)	9 (0)
Paid labour (US$)	6.720	--	10.158	13.200	22.110
Annual net income (US$)	5.805	1.967	14.721	69.931	44.661
Gross income/person (US$)	2.364	2.152	3.210	13.450	9.649
Investment/farm (US$)	n.a.*	12.750	548.336	514.310	626.070

* n.a. = not available

Animal resources not only consist of the more conventional domesticated species (*e.g.* cattle, sheep and goats) but also of such indigenous species as the camelids (llama, alpaca and vicuña) and guinea pigs or cuyes.

Five major topographical/climatological subregions can be distinguished: Central America, the Caribbean, the South American subtropics, the Andes and the Temperate Southern Zone. Eco-systems, under which livestock is reared, vary strongly from tropical to temperate grasslands, through to semi-arid and desert scrubland, often interspersed with areas of improved pastures that depend on irrigation water from mountain rivers (IAEA, 1990).

[1] Case study of the Pasto Project, Nariño, Colombia, presented at the International Workshop "Livestock Production in Rural Development", Wageningen, January 23, 1992 (De Jong, 1992).

pastures that depend on irrigation water from mountain rivers (IAEA, 1990).

Livestock production systems range from commercial, large-scale ranches and dairy farms to small mixed farms with a few dairy cattle or sheep/goats. In South America cattle are bred and fattened almost exclusively on pastures and forages, and intensification of cattle production is focused on improved pasture. Dairy production is mainly from pastures (dual purpose cattle), sometimes hay/silage and concentrates near urban centres. In contrast pigs and poultry are produced mainly and increasingly on feed grain rations, thus stimulating pressure on imports or higher domestic production of feed grain. (Jarvis, 1986).

Beef is the principal meat consumed in Latin America, accounting on average for about 50% of the total (including fish at 13%) by weight. Annual meat consumption varies from 13 to 141 kg per capita among countries, reflecting substantial differences in income and agricultural resources. Milk consumption varies from 12 to 200 kg (average 100 kg) among countries.

The decline in peasant sector agriculture in Latin America today (Altieri and Yurjevic, 1991) is largely the result of inappropriate development policies that have equated national interests with an export strategy favouring large farmers, cattle ranchers, and logging and mining companies at the expense of peasant producers.

The aim of this paper is to analyze livestock development (various species) in its horizontal context with crops within the mixed small-scale farm context and its perspectives in sustainability of such developments, *i.e.* can improved technologies at smallholder level be introduced that can co-exist in the market with medium and large-scale farms. As an example to demonstrate what was involved in technology development and testing in agro-livestock, training of extension staff, credit provision, extension and communication methodology the Pasto project in Nariño, South Colombia has been selected.

THE CASE STUDY OF THE PASTO PROJECT, NARIÑO, SOUTH COLOMBIA

Various Dutch supported projects operated in the department of Nariño, one of which was the "Improvement of the standard of living of small farmers of Nariño with emphasis on milk production and processing" (1974-1978), later widened into "Agro-livestock development of small farmers of Nariño" (1978-1984) or popularly called the Pasto project. Objectives were to (i) improve the standard of living of the rural smallholder population emphasizing improvement of both crop and livestock production (horizontally integrated development), (ii) train the project participants, and (iii) develop a pilot model for future activities in Integrated Rural Development Projects.

INTRODUCTION

For Nariño, following a visit of Colombian scientists and trainers to a Dutch-Ecuador project (INIAP, Sta. Catalina project near Quito) oriented to milk production and processing in an environment similar to Nariño conditions, a Colombian-Dutch project was formulated in 1973 and started in 1974 to improve the dairy industry. The department, with over 1 million inhabitants, has a typical climate and a high potential for dairy at an altitude between 2,000 and 3,000 m with an average temperature of 10 °C (4-14), average rainfall of 700 mm (range 600 - 1,000), about 120,000 ha in pastures, low incidence of detrimental animal diseases, and an overproduction of raw milk, which was processed as white soft cheese. Access of the department to the Northern part of Colombia (milk-deficient) greatly improved in 1975 with the completion of the Panamerican highway. In 1981, about 80,000 litres milk per day (40% of the

Jong, 1982).

Period 1974-1976

In this period the project aimed at applied animal nutrition research and farm development, and focused on pasture and forage species, fertilizer application, a model medium-size (10 cows plus followers on 7.8 ha) grazing and a small (1 ha) zero-grazing farm unit at the regional research station "Obonuco" of the Institute of Colombian Agriculture (ICA), and organisation of on-station and on-farm field days. At the regional centre of the National Institute for Vocational Training (SENA), training in dairy production was strengthened for farmers' sons. Improvement of milk quality in production and processing focused on pilot units of Gouda cheese production at ICA-Obonuco and SENA-Lope in Pasto to demonstrate possible extended shelf life of surplus milk. Further work was concentrated on the establishment of a dairy cooperative to absorb a Dutch loan for a pasteurized milk processing facility in Pasto. Technical assistance personnel at that time comprised an animal nutritionist working at ICA, Obonuco, an animal husbandry lecturer working at SENA, and a dairy processing officer, who worked with ICA and SENA counterparts.

After extensive on-station work and demonstrations with general field days over the whole area, the evaluation by the end of 1975 recommended the following modifications: to reduce, for reasons of effectiveness, attention to medium and large-scale (absentee) landowners and focus more on smallholders, the project area was reduced from Nariño Department to Pasto district, and shifted from on-station farm development to smallholder pilot farms.

Period 1976-1978

The project selected 10 pilot farms (2 per village) that were developed according to a two year farm plan. Cash for farm development was provided in quarterly instalments using a small revolving development fund. Interest rate was set at 14% per annum, while pilot farmers had to open a saving account which gave 18% interest on year-basis to stimulate saving-behaviour and timely, complete repayment after two years.

A project tractor service was established for ploughing and harrowing of smallholder plots for pasture establishment. Furter, a veterinarian was added to the project team to survey the area for breeding diseases such as brucellosis and to develop a mobile veterinary clinic and an AI service.

Production of Gouda cheese at ICA and SENA was expanded to a few individual farms and to CECORA (centre of cooperatives after land reform) that had sizeable quantities of milk for cheese making and interest in realizing added value on milk produced. A dairy cooperative "COOPROLACTEOS de Nariño" was formed in May 1977 to absorb a possible Dutch development loan for starting a milk pasteurization plant in Pasto and a cheese factory at Guachucal.

The evaluation, by the end of 1977, focused the project more on both crop and livestock activities of mixed smallholder farms under the Integrated Rural Development Programme (called DRI, with some 13 Colombian organisations participating) including special smallholder credit from the agricultural bank (CAJA AGRARIA). Technical assistance personnel in the project had to be expanded by an horticulture specialist, an agronomist, and a socio-economist. The training component at SENA was to be changed from dairy to sociology, reason for SENA to leave the project. The dairy processing component was organized in a separate financial aid project with technical assistance of 2 dairy experts (one in Popayan at a strong sister dairy cooperative COLPURACÉ and an assistant for COOPROLACTEOS in Pasto).

Period 1978-1984

From 1978 to 1980 the pilot farm approach was extended to include agricultural/horticultural activities on the existing pilot farms, and to add a few more different farm types (a guinea pig/stem onion small farm, a horticulture/arable cropping farm without cattle, and an arable farm with broilers).

Development of arable farming and fruit trees

In arable farming attention was paid to potatoes, indigenous root crops such as "ulloco" and to the introduction of fruit trees to boost local fruit production to replace expensive imported apples and pears, combat erosion and accelerate income generation compared to wood production. Production of seed potatoes was encouraged in the higher parts to obtain virus-free material, that was distributed through the seed bank to various keen smallholders (only a few per village) for multiplication. Fruit trees were introduced in the form of local/well known species like the tree tomato and blackberries, acquirement of species from similar areas like plums, peaches and apples plus imported apple and pear varieties successful in Ecuador. Farmers were encouraged (at half price) to test the material in various micro-climates in the project area, simultaneous to introduction at the ICA-research station. Enthusiastic fruit growing farmers were further trained in nursery techniques to start their own nurseries for fruit materials that showed high potentials. In 1991 some 300 ha of fruit trees were in production.

Horticultural development

Studies were carried out on improved technology packages and on the economics of various crops (areas under cultivation, labour inputs and potential markets). Production of carrots, beets and even garden beans could be improved at relatively little cost. However, an increase in cultivated area would quickly lead to market saturation, but especially adoption of those crops with little demand on labour by large-scale farmers kept the project from pursuing these crops further.

The strategy was aiming at potential crops that large-scale farmers could not monopolize due to high labour demands (risks of strikes and increased wages). This led to focusing on stem-onions that required 1,000 labour days per ha per year, and a production that could increase from 35 to 70 tons per ha through improved manuring/fertilization and disease control. Also an attempt was made to grow garlic, which was possible, but management-intensive in sanitary control and crop rotation.

Livestock development

AI was developed as a daily service with monthly pregnancy diagnoses together with a mobile veterinary clinic for curative service and the sale of mineral salts. The clinic was operated by inseminators on motor bikes following fixed, daily routes along treatment stalls.

In addition, four-monthly foot and mouth disease vaccination campaigns were implemented and combined with S19 vaccination of young female calves, and deworming against nematodes and liver flukes.

Mineral supplementation, especially with a mixture of salt and phosphate with high biological value, although more expensive produced quick returns in extra milk, and also improved reproduction.

With motorised, highly motivated inseminators, which were evaluated on performance, and daily mineral feeding, insemination rates per conception were very good at between 1.3-1.4. Although these services were very much appreciated by smallholders, they turned out to be costly, and attempts were made to develop alternative approaches to arrive at economically viable services, which could then be transferred to the dairy cooperative. Farmer-inseminators were trained for new areas to serve in their own village, but the number of inseminations was low and variable. In Ipiales district, where COOPROLACTEOS was active, an inseminator was trained who served small and large farmers when notified through the milk lorry. Synchronisation of cattle in non-AI areas was also attempted. All village cattle were centrally examined for pregnancy twice, with a month interval. After the second check the non-pregnant ones were treated with hormones on day 1 and 11 and inseminated twice on day 14 and 15. Although many cows responded in showing good heat, the pregnancy rate was only 30-40%, and this practice was abandoned. Another idea of training the second person of the cooperative milk lorry to do mobile clinic work and AI during milk collection did not materialize, since COOPROLACTEOS was not yet active in the Pasto district.

Pasture development

Pasture development continued with demonstrations and trials of different rye grasses and fertilization rates. Between 1979 and 1984 some 1,100 peasant farmers had established 800 ha of improved pasture (ICA/CCH, 1985). An interesting phenomenon became apparent with smallholder pasture development. Farmers applied basic calcium and phosphate applications for establishment of pasture, but nitrogen was applied only once after establishment and not after every grazing. When improved pasture was running down in two years they preferred to plough the land again and use it for some 4 potato crops (2 years), taking advantage of the nitrogen build-up in the soil. Subsequently, pasture was again established, now benefitting from the phosphate applied to the potato crops.

Guinea pig development

Expansion of improved guinea pig keeping on the pilot guinea pig/horticultural farm, was after considerable struggle financed by the agricultural bank.

For smallholders without cattle, the only profitable livestock species turned out to be the guinea pig. Pig and poultry production in the rural area meant extra, costly transport of breeding stock and feeds, and of the finished product. The climate was colder and less favourable in rural areas than for the commercial urban Pasto and Cauca valley farmers close to the urban consumers of Pasto and Cali, respectively.

Rabbits and guinea pigs were other options, with guinea pigs (0.7-1.0 kg) selling at double the price of a rabbit (1-2 kg) being the most profitable. These animals were kept by all smallholder families under the sole responsibility of the wife (and some by the daughters).

Within the project, some applied research facilities were available, where Dutch students investigated effects of improved housing (different materials and separation of age and sex groups) and feeding (alfalfa as an improved forage, a local drought-resistant Indian cereal "Quinoa" as concentrate, and mineral supplementation), measuring reproduction, mortality and growth rates. The breeding policy was to crossbreed local females (collected from good farmers all over the Department) with purebred Peruvian males. Breeding stock and offspring were kept under "student" management.

This meant students learned all the ins and outs of guinea pig keeping on-the-job, and communicated their experiences to interested households who came to buy offspring breeding stock. At the time of sale, sold stock and the flock of the purchasing household were treated against external parasites. In this way mortality of improved stock was negligible compared to that from purebred stock (from a rural cooperative) introduced directly into household flocks.

It was a sales strategy to concentrate on a few households per village with high quality breeding stock that could serve other colleagues with breeding stock and the project could cover more ground in a shorter time. Applied research in nutrition and especially in guinea pig diseases was conducted with the University of Nariño and the ICA-Diagnostic Veterinary Centre in Pasto. Especially treatment of diseases proved difficult, since not many antibiotics can be used in guinea pigs without upsetting digestion, and the parenteral application causes easily anaphylactic shock (Okerman *et al.*, 1982). Main emphasis was therefore on hygiene, careful introduction of new stock and occasional treatments against external and internal parasites.

Applied on-station research

The medium-size dairy production unit used rotational grazing (15 paddocks) of cattle groups (young stock over 3 months, followed by cows in milk, and thereafter by dry cows and young stock older than 10 months). After each grazing cycle 30 kg N (65 kg urea) was applied, in total 180 kg N/ha/year. Calves, after three days colostrum feeding by the dam, were reared artificially with cow milk (270 litres in 84 days) and tethered on young, fresh grass. No concentrates were given to calves and cows, only some carrots during a month of severe drought. Milk production reached 5,109 litres per ha per year (Van Oers, 1977). The unit was closed in its third year of operation in 1978. The Kikuyu grass after years of urea application (soil acidification) was not productive any more, and it took a long time to regenerate the plot (liming, harrowing, etc).

The zero-grazing dairy unit, which had demonstrated to be able to maintain 7 dairy cows on 1 ha of fertilized alfalfa and Brazilian fodder grass, was modified. Economic performance of the unit was satisfactory, but technical parameters per cow (milk yields per cow and calving intervals) were not impressive. The model was not adopted by farmers for the amount of work needed, and the investment necessary for a farmer with only 1 ha.

The unit was transformed into 1 ha grazing land with Kikuyu/ryegrass pasture and 0.4 ha of crop land to demonstrate the possibilities of mixed farming on a small family farm. The objective in dairy farming was this time to demonstrate how much milk one could get from "improved" pasture under good smallholder management, such as moving the tethered cattle regularly to avoid overgrazing and compacting the grazing area. Pasture, after grazing, was weekly fertilized (0.25 ha) with calcium ammonium nitrate to avoid acidification with urea or ammonium sulphate. A management committee met weekly to discuss the feed situation to avoid overgrazing and other matters if required. Some details on milk production on 1 ha zero grazing (1974-78) and tethered grazing (1981-1983) are provided in Table 5.2.

Table 5.2. Milk production and other characteristics at the 1 ha demonstration farm at ICA-Obonuco, Pasto.

Characteristics in year	1	2	3	4
Zero-grazing				
Milk production per ha (litres)	7,995	8,695	8,615	8,295
Average number of cows	4	4	4.6	6
Tethered grazing				
Milk production per ha (litres)	10,720	11,666	7,726	
Average number of cows	3	3.3	3.5	
Fertilization in kg N per ha	661	579	512	
Mineral supplements (g/c/d)	102	159	128	

With tethered grazing in year 1 at all times, there was surplus grass which strengthened the belief in "it is better to set the stocking rate at the dry season production" to avoid any overgrazing and let animals at all times select/eat the top of the grass. In the second year, adjustments were introduced monthly in putting an additional cow or reducing the population with one cow to maximize milk production. In the third year this management gamble was overdone and production per ha suffered as usual under practical conditions. Milk yields per ha in the 1 ha unit with improved and heavily fertilized pasture exceeded that at the medium size farm with Kikuyu grass and white clover under less intensive N fertilization.

In arable farming 2,000 m^2 was cultivated permanently with stem onions and 2,000 m^2 with potatoes or red beets which were cultivated on land previously in grass. Yields on a ha basis were 25 tons for stem-onions, 25 tons for potatoes and 45 tons for red beets.

Labour studies revealed that 175 days per year were spend in arable farming, 160 in livestock and 15 in general activities. The farmer contributed 260 and his wife 90 days. Total gross margin was twice the minimum salary. After deductions for interest and depreciation the income available for clothing, health and recreation would be about two-thirds of the gross margin (Franco and Arcila, 1985)

Smallholder pilot farms and plots

It appeared impossible on pilot farms to improve all aspects of agriculture (crops, horticulture, cattle, small stock) at the same time and of sufficient quality for on-farm demonstrations. Moreover, the pilot farmers were reluctant to include all aspects in the technical and economic monitoring. Therefore, the pilot farm approach was changed to a pilot plot approach including monitoring. At the pilot farms that remained in the monitoring scheme, the following progress was noted from 1977-1979 over four 6-monthly periods for 7-8 farms per period (Table 5.3). Average annual labour income amounted to 156,940 pesos per farm or 2.68 times the minimum wage.

Table 5.3. Average farm size, labour income in Colombian pesos (1 Colombia peso = Dfl 0.05) per month and per ha/year from crops and dairy, and dairy characteristics on pilot farms, Pasto project, Colombia.

Period	1	2	3	4	1977-1979
Numbers of farm records	8	7	8	7	10
- Average farm size (ha)	7.1	5.6	6.9	7.5	8.8
Labour income/month					
- Crops	1,282	1,141	2,854	3,202	2,069
- Dairy	4,271	5,579	9,044	11,559	7,486
Labour income/ha/year					
- Crops	5,962	4,841	12,159	12,136	11,823
- Dairy	6,380	7,288	13,439	15,107	13,368
Dairy characteristics					
- Large animal units/ha	1.22	1.46	1.47	1.60	
- Milk/farm/year (litres)	6,706	8,892	9,656	13,639	
- Milk/ha/year (litres)	949	1,598	1,407	1,818	
- Milk/cow/year (litres)	1,277	1,622	1,644	1,989	
- Milk/cow/day (litres)	3.5	4.5	4.5	5.5	

* adapted from Venegas, 1982

Trends in production of individual crops and dairy from 1980-86 are shown in Figure 5.1 (Engel, 1990), differentiated into high impact domain (wheat and dairy) and low impact domain (beans and maize).

Milk collection by COOPROLACTEOS increased from 10,000 litres per day in 1980 to 35,000 in 1986 while the milk price was rising steadily, following more (1977-1981) or less (1982-1986) the consumer index from 1977-86.

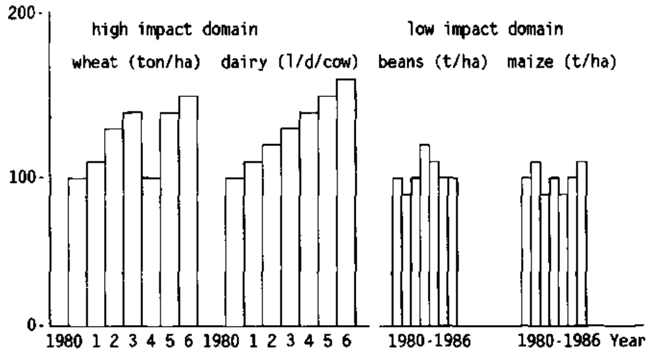

Fig. 5.1. *Relative productivity trends in Nariño, 1980-1986 (1980 = 100).*

Economics

In first instance, the technical and economic data collected during monitoring of the pilot farms was worked out. The difficulties in complete recording led to a distinction between farms that continued to be intensively supervised and those with partial recording of crops, horticulture, dairy and/or guinea pigs.

Secondly, because of the different views of the specialists in horticulture, agriculture and livestock who advocated all that their packages would be better for the smallholder, a study for three project subregions (differing in land size, climate and cropping system) was made into the various technical and economic parameters and actual on-farm data on yields, inputs, labour requirements, etc., to arrive at optimum farm plans with linear programming (Meindertsma, 1982). Relative gross margins per ha for milk and various crops are given in Table 5.4 (Koeslag, 1985) under different technologies: traditional, improved (at least improved seeds and fertilization) and pilot farm/plot experience (improved seeds, fertilization and sanitary control as per technical recommendations and supervised by technician). On smallholder farms not only land, but also labour and capital can be very limiting and relative gross margins per labour day and per 100 pesos costs (variable and costs of capital) of some major activities are included as well (Table 5.4) from Meindertsma (1982).

Table 5.4. Relative gross margin of traditional, improved and pilot farm/plot technology (traditional milk = 100) per ha, labour day and per 100 pesos costs in various smallholder activities, Pasto project, Colombia.

Relative gross margin	Traditional system			Improved system			Pilot farm/plot operations		
per activity	Per ha	labour day	100 pesos costs	Per ha	labour day	100 pesos costs	Per ha	labour day	100 pesos costs
Milk	100	100	100	190	143	50	410	187	50
Stem onion	1,410	102	459	2,650	112	394	4,420	124	448
Potatoes	20	47	22	160	80	31			
Garden beans	120			130			140		
Carrots	360	192	56	400	182	48			
Ulloco	330								
Maize/beans	130	83	155	270	104	133			
Barley	-20			-10			110		
Wheat	-50			-20			150		
Guinea pigs				1,323	213	100			

Linear programming was done for three areas with various farm sizes (0.5, 1, 3, 6, 12 ha), technology level (3) and labour (2 levels), resulting in 108 farm plans for the Atríz valley, 12 for

Catambuco and 12 for La Cocha. For the average farm size of 6 ha the optimum farm plan indicated 0.32 ha stem onions, 1.5 ha carrots, potatoes 0.08 ha, maize/beans 0.1 ha, pasture for guinea pigs 0.3 ha and for dairy cattle 3.0 ha with 1.0 ha unutilized due to labour constraints.

Credit system

Credits of pilot farmers under the revolving fund were repaid in time, often even earlier. Especially, in relation to Christmas and carnaval during the first week of January, farmers preferred to pay before the festival season to avoid that their saving accounts would be emptied for Christmas gifts and festival expenses and would not be replenished in time for loan repayment. The revolving fund was transferred to a seed/input bank for smallholders (purchase in bulk, repacking and retail sale mainly of improved pasture seeds, small equipment, fruit trees, seed potatoes). Later on, the seed/input bank exercise was handed over to the dairy cooperative, which established a number of shops for inputs and veterinary medicines. The old revolving project fund was used as a starting capital for CORFAS, a non-government organisation specializing in rural credit for women especially in guinea pig production.

Smallholder credit of pilot farms was re-oriented to the Agricultural Bank (larger amounts and ample repayment periods) to avoid unnecessary differences between pilot and ordinary DRI farmers. Cost price calculations were made to determine maximum loan amounts for crops and livestock activities. In practice the amounts taken out for crops were much lower and closely related to what farmers would be able to repay, *i.e.* a conservative yield times a moderate price. In the case of cattle, farmers who had cattle were prepared to borrow for additional cattle, knowing that they could pay annual instalments from the sales of calves (from present and borrowed cows) at the age of about 8 months. Farmers without cattle were reluctant to take out credit for a cow, fearing that there might not be a calf for sale every year to repay the loan.

Guinea pig credits did well also, 40 male farmers got a DRI/CAJA AGRARIA credit and women benefitted through the Financial Corporation in support of cooperatives/groups (CORFAS). In 1985, 236 women had obtained credit and in 1991 the number stood at well over 800.

Extension and rural communication

Within the project operated some 10 extensionists and 3 inseminators. Farmers were individually attended for DRI credit and the design of a farm plan. Mass extension was organised through the extensionist in keeping field days, talks with film and slide/sound series and extension leaflets made by the project.

In 1981, rural communication staff (one Colombian and one Dutch) joined the project. With assistance of ICA's Communication Department "Plans for Technology Transfer" were developed, spelling out objectives, target groups, content and sequence of these multi-media extension programmes (Engel, 1990). Leaflets were improved with the assistance of an anthropologist for text and picture improvement and colour print. At farm level a participatory diagnosis methodology was introduced to define extension priorities and possible ways in which farmers problems could be tackled and/or solved. The methodology was later applied in the smallholder area of Medellin, improved upon, and is now known as RAAKS (rapid appraisal of agricultural knowledge systems) and applied in many countries (Engel, 1995).

Approach to staff training

Staff tours were organized to North Colombia and Ecuador for fruit trees. For guinea pigs, instead of sending personnel to Peru to get acquainted with improved guinea pig keeping, two experts from Peru were invited to Nariño to train farmers, extension staff, researchers and officials.

Public relations

A film was made of the project bringing the various developed packages in crops (improved seed, fertilization, disease control) and dairy practices (establishment and maintenance of improved pasture, AI, vaccinations, deworming, mineral supplementation) and farm planning (crop-livestock based) as implemented on the pilot farms, to a broader audience of farmers and officials.

Internal weekly project staff meetings were complemented quarterly and preferably in Pasto to show actual developments, constraints and suggested solutions by:

a) project committee meetings with participants in Pasto (chiefs of ICA-DRI, ICA-Research. Obonuco and Planning Department, Nariño);
b) regional committee meetings with ICA-regional representatives; and
c) national committee meetings with ICA-headquarters, National Planning and the Netherlands Embassy.

Milk processing

The Dutch loan for milk processing did not materialize. The sister dairy cooperative COLPURACÉ in Cauca expanded by using cheap milk powder, while COOPROLACTEOS in Nariño and the dairy farmers in the Pasto and the Sibundoy area received milk prices dictated by COLPURACÉ and multinationals operating in Nariño and Sibundoy areas.

There were even attempts to concentrate on the strong sister cooperative COLPURACÉ, and to move away from the small and weak Nariño cooperative. However, knowing that most of the milk was produced in Nariño, the Pasto project insisted that it should be processed within Nariño to guarantee that smallholders and large farmers themselves would benefit from the added value.

After considerable discussions with Wageningen (IAC advisers), the Embassy and The Hague (desk officers) a pasteurizing unit on grant basis was negotiated for COOPROLACTEOS and installed in Guachucal to explore the market for pasteurized milk in urban centres (Pasto, Ipiales and Tumaco) and to test factory cheese production.

The pasteurization exercise turned out to be not very profitable and very risky in terms of market organisation. If transport from Guachucal to Pasto (both at high altitude) was delayed on the way in the valley (warm environment) the milk arrived or quickly turned sour at the shops in Pasto. Moreover, the entrepreneur contracted for selling the milk of COOPROLACTEOS (to avoid transport and marketing investments) had great difficulties in supplying many selling points with sufficient milk, collecting surplus milk, and returning sour milk to the factory.

The prospects of cheese production were financially much better, and a soft loan (no interest) was negotiated from the Netherlands Embassy for expanding cheese production, while the members contributed towards the enlargement of the building in Guachucal.

The dairy cooperative moved to expand into the Pasto area, acquired additional land from the town council, and established a collection centre and initial cooling facilities with Dutch funds. However, part of these investments, especially in remodelling of buildings had to come from the cooperative's profits or from a bank. Profits were small as result of struggles with longer established, stronger competitors. Sometimes profit only existed on paper when a client had not yet paid for delivered milk. The Colombian Livestock Bank (Banco Ganadero) and the Netherlands Embassy had become reluctant in the absence of large profits, sufficient liquidity and the dimmed prospective for a large dairy factory.

It was only in 1982 when COOPROLACTEOS was given DRI support for a development loan (justified on the basis that post-harvesting of the milk crop was essential also for smallholders) that the cooperative could expand on its own. It has been growing steadily since then, acquired the premises of their milk buyer in Cali, expanded cheese production and their cheese marketing channels and embarked on various other products such as yoghurts (see also Chapter 6).

DISCUSSION AND CONCLUSIONS

What lessons can be learned from this case study? Smallholders have a variety of resources like land, labour, crops and livestock species in varying combinations, according to their individual interests and skills. This means that a variety of technology packages are needed to meet the various demands, and that adoption of individual packages will be small and will vary considerably over time due to changing family labour conditions and price developments. Land can even be unutilized at times due to labour shortages (migration for schooling or work) or be left for labour-extensive grazing of livestock (young stock, fattening) or natural forest.

It is extremely difficult to find productive crops and livestock for smallholders that are not easily taken as an activity by large farmers with consequently high competition on the market. Horticulture crops such as carrots, red beets and garden beans could easily be produced at large scale. Stem onions, garlic and fruit trees (tree tomato, blackberry and to less extent apple, pear, plum and peach) required more labour, management attention and sanitary control that could profitably be done by smallholders.

Supervised smallholder credit is only taken up for part of the total crop cultivation costs to be sure that repayment can be effected from yields in excess of family needs times a moderate price. Cattle on credit is mainly taken up by farmers that have already cattle, to allow repayment from young stock born from existing and borrowed cows.

Short-term rotation (two years) of potatoes and pasture every two years, benefitting from cross-fertilization of N and P, and clean seed beds for pasture (eradication of Kikuyu and weeds) after potato cultivation was preferred above long-term improved pasture with regular N fertilization. In the PROMEGA project in Arequipa, Peru alfalfa for dairy cattle was rotated with potatoes or onions to obtain a clean seed bed for renewal of alfalfa fields and to use N and organic matter stored in the sandy soils for highly profitable cash cropping (Van der Kuip, 1982).

Concentration on typical, local livestock like guinea pigs in the case of Nariño can be attractive due to their very good prices. The fact that every household is keeping such species provides a chance to reach a large number of beneficiaries and especially women, since guinea pig production is an activity of women only. In Peru, livestock development in the PRODERM project around Cuzco concentrated since 1979 on better animals, through credit for cattle, sheep and camelids. These credits were very popular because of low interest rates compared to high inflation rates. Credit originated till 1987 from project funds while the Agricultural Bank took over these obligations per 1988/89 (Kaasschieter, 1990).

It is not easy to make technical support services such as a mobile veterinary clinic and AI cost-effective at smallholder level. Economic delivery of these services requires time and responsible farmers' groups to take them over.

Development of a dairy industry step-by-step from a cooling centre and small-scale processing plant to a fullfledged dairy cooperative is a long-term endeavour. Strong and long-term support in a competitive environment (multinationals, interest of other areas) is needed before a dairy cooperative is strong enough to stand on its own (see also Chapter 6).

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6. EXPERIENCES WITH VERTICALLY INTEGRATED DAIRY DEVELOPMENT APPROACHES IN SOUTH AMERICA

INTRODUCTION

Milk production in Latin America (South America and Caribbean countries) is based on a large variety of (cross)breeds, mainly kept on pasture in large farms or ranches and to a smaller extent at small mixed farms. Estimates are that 60-80% of the region's milk producers are small producers and that 25 to 30% of the milk comes from small farms in most countries, reaching almost 60% in the Andean zone (Barron del Castillo, 1989). Some specialized dairy farming occurs, but a large proportion of the milk comes from dual purpose cattle, *e.g.* 70% for Colombia, estimated by the Banco Ganadero (1991).

Strong dependence on rainfed pasture results in highly fluctuating milk supplies over the year. This results in milk marketing problems: too much milk in the rainy season and a shortage in the dry season, similar to the dairy situation in New Zealand, but there surpluses are used for production of butter and milk powder that are exported. Distances in South America are long between production in rural areas and very concentrated urban demand in metropolitan type of towns. Transport is costly, because of long routes over small, winding roads with many stops for small quantities of milk. Roads, especially in potential dairy areas as the Andes are difficult to travel in the rainy season due to falling stones, rocks and potholes.

The industry catering for the growing urban demand often relies on import of cheap milk powder while rural milk producers have to resort to the production of milk products such as white cheese and milk powder to cut on transport cost, and find markets for seasonal surpluses.

Also consumption patterns are important. Children are breast-fed or fed with fluid milk prepared from milk powder and later on continue taking some milk at school or at home. Young people and adults refrain from drinking milk. Some milk use is combined with coffee, or in milk shakes and ice-cream, but major consumption of milk products is in the form of cheese, mainly soft white cheese and occasionally hard, mature cheeses.

Dutch technical aid projects for the dairy sector began in 1966 with three projects: one in Sidi Thabet, Tunesia with imported cattle, management and training of stockmen in large-scale farms; one in Naivasha, Kenya with emphasis on research and imported Dutch cattle; and one in Sta. Catalina, Ecuador with training and research for medium-scale farms and the use of local cattle. For this last project, on purpose, cheap local heifers were acquired of such quality that better local farmers would not consider buying them. This project (1966-1972)has been followed up by a project in Arequipa, Peru (1973-1981) for training of small farmers and research on the role of alfalfa and dairy farming in the development of irrigation schemes in the desert and a project in Pasto, Colombia (Phase I: 1974-1978) and the FAO/WFP/Dutch assisted Model Project *for Integrated Dairy Development in Cañar, Ecuador* in the 1990s, where the emphasis was put on small farmers and the vertical integration between production, processing and marketing of milk. Also projects oriented to small mixed farmers were supported in Peru (first in Tarapoto and later PRODERM in Cusco) and the Pasto project (Phase II: 1978-1984). Dutch aided projects in the dairy sector in South America also comprised the import of calves (Chili, Colombia both unsuccessful) and of heifers in the South of Peru (successful in adaptation to the climate, but unnecessary for the increase of cows and milk yields in the region). Dutch financial aid was directed to the supply of the machinery for 5 dairy plants in Peru and 1 in Colombia in the early seventies.

Vertically integrated dairy development approaches aim at integration of four components of the "milk line", *i.e.* from (1) supply of inputs and services through (2) production and (3) processing to (4) marketing of milk, through organization of the producers, increasing milk production, improvement of milk processing and assistance to marketing of produce.

Objectives of this paper are to review experiences in vertically integrated dairy projects, assess their achievements and constraints and analyze perspectives of such integrated approaches for small milk producers.

MATERIALS AND METHODS

In 1989 milk production in South America was estimated at 38 million tons (8% of world production) from 36 million cows (16% of world population). Average annual production per cow was about 1,000 litres, *i.e.* close to 50% of the world average (2,109 litres) (Barron del Castillo, 1989)

Major importers of milk products are Mexico, Cuba, Venezuela and Brazil, while Argentina, Uruguay and Costa Rica are net exporters. The following dairy zones can be differentiated according to location and climate, total annual milk production and consumption of milk per capita:

- Southern cone with a temperate climate (Argentina, Uruguay, Chile);
- Andean region with temperate and sub-tropical climates (Bolivia, Peru, Ecuador, Colombia and Venezuela);
- Central America and the Caribbean with a tropical climate, with an important milk producing area in the highlands of Costa Rica; and
- Others like Brazil and Mexico are characterized by a variety of climates with prevailing sub-tropical characteristics. Paraguay also has sub-tropical conditions.

For the review of vertically integrated dairy development projects use has been made of own experiences, visits, reports and literature reviews of two Dutch supported projects:

1) Dairy Cooperatives in Cauca and Nariño regions of Colombia; and
2) FAO/WFP/Dutch assisted Model Project for Integrated Dairy Development in Ecuador.

REVIEW

6.1 Dutch support to dairy cooperatives in Cauca and Nariño regions of Colombia

Under the first phase of the Pasto project (1974-1978, see also Chapter 5) a dairy processing expert was included to improve the quality of milk production and processing (mainly for white cheese) of farmers in Nariño region. Milk production at small farms was not very hygienic and hygienic standards of milk processing at the homes of white cheese makers were low. The consequence was that the end product had a very short shelf life. To expand market opportunities for surplus milk in the Nariño region, production of more mature cheeses of the "Gouda" type was initiated. Demonstration cheese vats were installed at the regional research station ICA-Obonuco and at the regional training centre SENA-Lope, Pasto that had dairy cattle that were milked under reasonably high standards of hygiene. Also a few large-scale farmers and staff of CECORA (Centre of Cooperatives under Land Reform) were trained in Gouda cheese production. Cheese quality was appreciated by urban customers except at times that of CECORA, where large numbers of small producers supplied milk of variable hygienic standards that resulted in cheese with poor keeping quality.

Dutch loan offer

In the early 1970s, milk plant inventories on Dutch loans (DFO, Department of Finance for Developing Countries) were popular contributions of the Ministry of International Development Cooperation, *e.g.* 5 for Peru and 1 for Colombia. For Pasto, a pasteurized milk plant (40,000 l/d, Dfl 3 million) was earmarked to create a dairy industry in Nariño for more economic milk processing, improvement of public health through processed milk and of the position of small milk producers through a large outlet for their milk. The loan was offered to the National Plan Bureau of Pasto in 1975 that commissioned the feasibility study to CECORA. The CECORA study on a milk plant in Pasto for Nariño was commented upon by the National Plan Bureau, the Pasto Project, and the Corporación Financiero Popular (CFP), for canalizing the loan). The CECORA study was also analyzed in 1977 by experts from the Netherlands, while 25 milk producers established the dairy cooperative "COOPROLACTEOS of Nariño" in March 1977 in anticipation of the milk plant loan for Nariño (COOPROLACTEOS, 1980). In addition to inventory of the milk plant, about Dfl 1.7 million was needed for land, structures, working capital, water and electricity arrangements to be financed from members' capital and loans from local banks (DNP, 1977; Uitentuis, 1977).

Project studies and project plan

The analysis of Van den Berg (1977) led to modifications in the original project plan favouring the establishment of a joint dairy cooperative industrial project Cauca/Nariño with COLPURACÉ (dairy component Cooperativa Lácteos Puracé of the Cooperativa Agropecuaria del Cauca, in Popayan) and COOPROLACTEOS. The project envisaged to start with a cooling centre in Guachucal, expansion of the pasteurizing plant in Popayan, Cauca, establishment of a pasteurizing milk plant in Pasto, followed by a cheese and butter plant in Guachucal, and a cooling centre in Sibundoy, Putumayo (Map 6.1).

Holterman (1977) recommended to change to sterilized milk (in sachets) production in Guachucal to accommodate more milk consumption of the poor urban consumer and became teamleader in Popayan. Technical assistance for 1977-1981 (Dfl 1,200,000) to the cooperatives (COLPURACÉ and COOPROLACTEOS) was to be provided by three experts (management and milk processing stationed in Popayan, and milk collection/transport stationed in Pasto) and an associate expert to be shared by Popayan/Pasto. Financial assistance in the form of DFO loans was estimated at Dfl 2.7 million for Pasto and Dfl 2.4 million for Popayan (Holterman, 1979). It was hoped that COLPURACÉ, already established in 1971 and with a much sounder financial base would assist with the organization of the local funds.

DFO-loan

Problems arose in canalization of the loans. Cooperatives under Colombian law were earmarked as private enterprises, hence CFP could only grant foreign government loans on hard commercial terms, and insisted on a 50% contribution of the cooperative to project investment. Disagreement over interest rate (15% suggested by DFO against 20% commercially in Colombia), but most of all about repayment in foreign currency with the cooperative carrying the inflation risk, finally led to cancellations of the dairy industry loan offers. In fact, COOPROLACTEOS was constantly in financial crisis. Banks only provided small loans at a time, and only later on, through grants and revolving interest-free funds of the Netherlands Embassy, the cooperative could develop during 1978-1983. Subsequently, through support of the Rural Integrated Development Programme (DRI) and commercial bank loans COOPROLACTEOS could accelerate development and diversify its milk products.

Project development 1978-1981

COLPURACÉ with a 10,000litres per day operation (70% raw milk and 30% milk powder) expanded on the basis of own and locally borrowed funds, assisted by cheap skim milk powder operations. COOPROLACTEOS as a weak and starting partner was offered a 50-50 deal in the surplus of a cooled milk operation in Guachucal that consisted of milk collection, cooling and transport of Nariño milk by COLPURACÉ. COOPROLACTEOS financed, with members' capital, the land and buildings, COLPURACÉ provided the equipment on loan basis and actually ran the operation. COOPROLACTEOS hardly made any money on the deal nor gained management experience (Vreugdenhil, 1982). In February 1980, after two years of joint cooled milk operation the contract between the two cooperatives was not extended. COOPROLACTEOS, fortunately, obtained cooling equipment through an interest-free loan (Dfl 180,000) from the Netherlands Embassy and found at short notice a private customer "PROLACTEOS DE LA SABANA" with a collection centre in Cali and a factory in Bogota. COLPURACÉ started its own collection/cooling operation at 500 m distance from the Guachucal plant of COOPROLACTEOS. In the same year Dutch assistance to COLPURACÉ was withdrawn.

To assist COOPROLACTEOS in Nariño, where the major part of the milk in the Cauca/Nariño/Putumayo regions is produced, a request for Dfl 350,000from technical assistance funds for a pasteurizer was submitted to the Dutch Government. Objective of the pilot project was a small-scale operation of production and marketing of pasteurized milk in various towns (Pasto, Ipiales and Tumaco) in Nariño that up to that moment had been served by raw, water polluted milk. The results would also assist in determining the feasibility of the projected large scale pasteurized milk plant for Pasto. The money was granted during bilateral negotiations in 1979. The pasteurizer could also be used to pasteurize milk for cheese production. The market outlook for hard cheese was good (Cali, Bogota, Medellin used imported cheese). COOPROLACTEOS expanded with members' contributions its Guachucal plant with facilities for cheese production and ripening. Pasteurized milk sales from the Guachucal plant to other towns was not successful at this stage. In Ipiales and Pasto only 300, respectively 1,000 litres per day could be sold, as not enough people (outside supermarkets) were prepared to pay the same price for a lower quantity (750 cc) despite the better quality; the distributor hired to transport and market the milk had no experience in this business which resulted in milk getting sour; sour milk not returning in time to the plant; and no new supplies to selling points (Vreugdenhil, 1980).

Local government (still keen on pasteurized milk for Pasto) assisted COOPROLACTEOS further in 1982 with land in Pasto on which, with a small Dutch loan (Dfl 150,000) a cooling/collecting centre was built to collect milk from members around Pasto. The evaluation mission in 1981 noted that milk production had increased considerably, as well as the producer milk price in Nariño (from 8 in 1979 to 12 pesos in 1981), and milk money had become a very important source of farm income for small and large producers (Mision Evaluadora, 1981). Further, the mission emphasized the need for more attention to education of the members in cooperative procedures, obligation of the members to sell milk to the cooperative, differentiation of the milk price in lean and flush season, development of technical support services, introduction of capital formation on the basis of milk delivered to create working capital, and to strengthen administrative and financial procedures. It also recommended a milk market study at national level to match dairy policy and legislation with import policy and expected developments of regional milk production and consumption, seasonal milk and milk products, price relations between raw milk and processed products, and scope of a feeder balancing system (processing of excess milk in flush season into powder to supplement seasonal deficits).

Project period 1982-1983

Gouda cheese production turned out successful and was expanded to daily processing of 3,000 litres of milk. All cheese could be sold to one client in Cali. Bonification for butterfat content was introduced in August 1982 and butter production was started. Similarly for milk with a good reductase test a bonus was paid to stimulate delivery of milk with a better keeping quality for cheese production. Small-scale processing of milk in Pasto was developed over time to produce yoghurt, kumis (sweetened buttermilk) and pasteurized milk. Statutes were changed in 1983 to include a condition that members had to deliver 50% of their milk to COOPROLACTEOS. Retail shops for agro-veterinary products were established in Guachucal (end 1981), Pupiales (end 1982) and Pasto (April 1983). Two mini-collection/cooling centres were established in Pupiales (1982) and later in la Victoria, both areas with a large number of small producers. During this period there was an enormous discontinuity in personnel: 5 different cooperative managers, 3 plant managers in Pasto , 3 plant managers in Guachucal, 3 lab-assistants (Kloosterboer, 1984). The evaluation in 1984 indicated that milk production in Nariño had increased its share from 1 to 2.8% of national milk production form 1972-1982, and more than tripled from 1976 to 1982 (from 20 to 70 million litres), COOPROLACTEOS increased milk collection up to 9.5 million litres per year (1980-1983), a strong competition for milk existed, COOPROLACTEOS still experienced liquidity problems, the level of plant maintenance was low and market outlets were few (2 for cooled milk and 1 for cheese) (Oosterloo and De Vries, 1984).

Expansion period 1985-1992

Dutch technical assistance was prolonged through monthly visits of a marketing advisor during 1985-1988, COOPROLACTEOS expanded its markets to Bogotá, started pasteurizing milk in Pasto, and managed to take over a pasteurized milk plant in Cali. In Figure 6.1, average daily milk collection is presented for the period 1978-1992 (Vreugdenhil, 1978, 1979, 1980, 1981; Oosterloo and De Vries, 1984; and COOPROLACTEOS 1980; and 1986-1992).

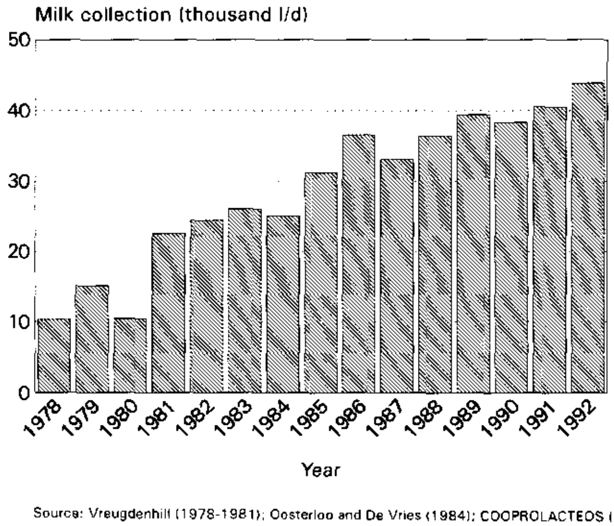
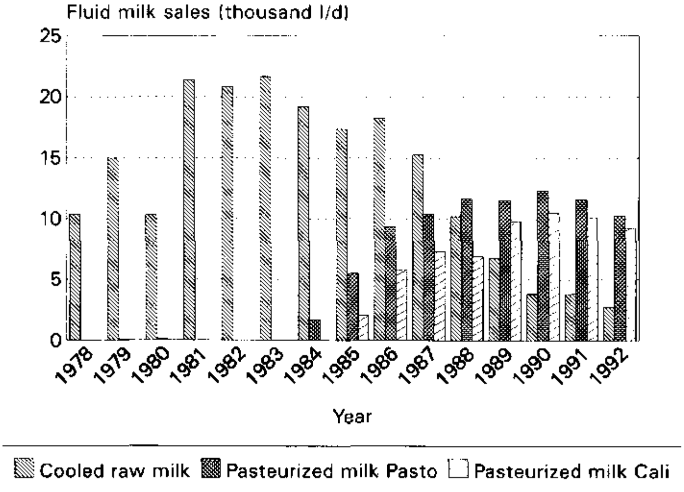


Fig. 6.1. *Milk collection of COOPROLACTEOS, 1978-1992.*

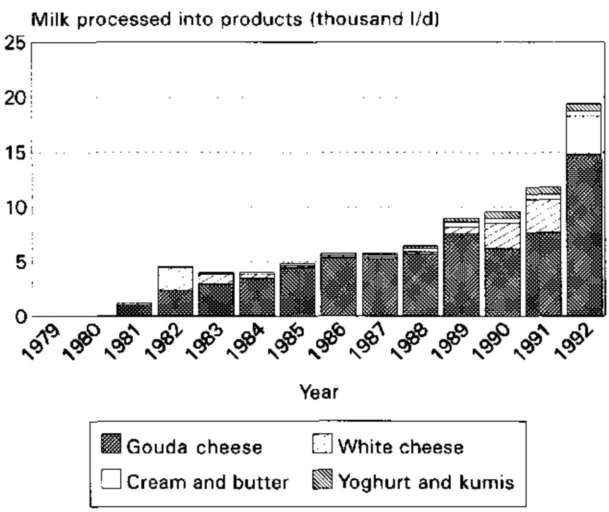
Similarly, average daily sales of cooled raw milk and pasteurized milk are presented in Figure 6.2a.



Source: Vreugdenhil (1978-1981); Oosterloo and De Vries (1984); COOPROLACTEOS (1980; 1986-1992)

Fig. 6.2a. *Daily sales of cooled raw milk to Cali and pasteurized milk to Pasto and Cali of COOPROLACTEOS, 1978-1992.*

Sales of processed milk in Gouda and white cheese, and milk products such as cream and butter, yoghurt and kumis are illustrated in Figure 6.2b. Conversion rates used for Gouda cheese are 10 litres per kg, and for white cheese 8 litres per kg.



Source: Vreugdenhil (1978-1981); Oosterloo and De Vries (1984); COOPROLACTEOS 1980; 1986-1992)

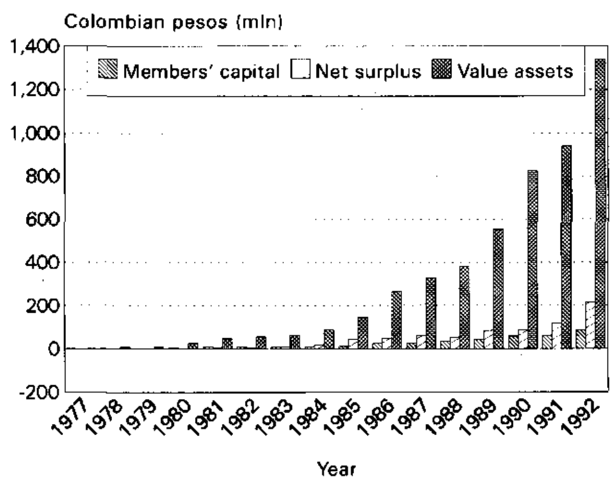
Fig. 6.2b. *Daily sales of processed milk into Gouda and white cheese, cream and butter, yoghurt and kumis of COOPROLACTEOS, 1979-1992.*

Other developments included organization of training sessions in technical matters and in cooperative affairs. Annually between 300 and 900 persons attended training, including 20-40 farmers in artificial insemination. Technical services were provided at the rate of 1,000 visits by 3 veterinarians in 1985 up to 4,000 visits by 4 veterinarians and one agronomist in 1992. Sales of inputs (mainly agro-veterinary products) increased steadily over time up to 20% of total sales (milk and inputs). Inputs were passed at a discount rate of 15-25% to the milk producer, because of cooperative bulk purchases. In the 1990s COOPROLACTEOS further increased its technical support to small producers by establishing intensive farming demonstration units at farms of less than 5 ha. Ten units were established in 1992. Also assistance to more marginal parts of Nariño was provided through encouragement to form cooperatives of small producers that could become members of COOPROLACTEOS (10 groups existed in 1992) and receive a bonus for milk collected by the group.

During a visit to the Guachucal plant in 1992 it was observed that strict hygienic measures were applied. All workers were wearing protective boots, clothes and caps and visitors were only allowed in exceptional cases and had to wear protective clothing as well. This regime of strict hygiene and the cold climate might explain the success of milk processing in Nariño, while for example hard cheese production operations in COLPURACÉ and the cooperative in Medéllin failed (Kuppens, member of COOPROLACTEOS and supervisor of building activities, pers. com., 1992). Nariño cheese (Gouda, white cheese, processed cheese) was now marketed in all large towns in Colombia.

COOPROLACTEOS, although it never collected more than 42,000 litres per day and still had to fight with competitors from outside (cooperatives and multinationals), proved an essential factor in dairy development in Nariño. Overall daily milk production increased from 80,000 litres in 1977 to 350,000 litres in 1991, not only due to training and technical assistance, first by the Pasto project and subsequently by COOPROLACTEOS staff, but also through cooperative efforts of developing a market (regional and national) for members' milk, never allowing a reduction in the milk price (as competitors did in times of seasonal surpluses) (COOPROLACTEOS, 1991).

Financial performance (1977-1992) of COOPROLACTEOS is presented in Figure 6.3 to illustrate the step by step approach.



Source: Annual reports COOPROLACTEOS de Narino

Fig. 6.3. *Financial performance of COOPROLACTEOS de Nariño (1977-1992).*

6.2 FAO/WFP/Dutch assisted Model Project for Integrated Dairy Development in Ecuador

As a follow-up to the recommendations of the FAO Expert Consultation on Dairy Development in Rome, 1984, FAO decided for a modular project approach and assigned missions on identification and formulation of Model Projects on Integrated Dairy Development to each region in 1985. For the Latin American and Caribbean region, Ecuador was selected (Tanzania for Africa, Syria for the Middle East and Indonesia for the South East Asian region). The Model Project approach aims at maximising the role of integrated dairying in rural development. It encourages full participation of small producers in decisions that influence their future, a firm commitment from the Government and active involvement of donors. Model Projects are focused on the training and development needs of small producers. They operate on a modular principle and comprise four basic components: small producer, milk production, milk processing and milk marketing. These components can be divided in 11 different sub-components or even 27 modules or activities (Appendix 6.1). Four modules refer to organizational and training needs of small producers, fifteen to milk production, while the remaining eight are dealing with processing and marketing of milk.

Ecuador was selected for the Latin American Model project because of: its potential for increased production; its milk deficit covered by imports (5,000 ton per year), under-utilized milk processing plants; a high proportion of the population living in rural areas (50%), a large number of small producers (25 percent of milk), a government committed to integrated rural development and to dairying according to two previous ISCDD (International Scheme for Coordination of Dairy Development) mission reports.

Objectives of the Model project in Ecuador are:

- Demonstrate the viability and benefits of an integrated concept to improve the living standards of small milk producers and to contribute to development of the rural area and the dairy industry:
- Improve dairy husbandry practices without significantly altering the cattle population;
- Improve milk collection, processing and marketing to cater for milk surpluses and contribute to the national dairy industry.

The project has the following targets:

- Improve the income of 4,000 families grouped in 30 farmers' organizations either existing or to be established with their own service units for inputs, technical services and milk handling;
- Improve milk productivity at farm level in the following way:
    - Change the composition of the herd by increasing the proportion of producing females, by reducing age at first calving and the number of male animals;
    - Reduce adult cattle mortality from 5 to 3 percent and calf mortality from 20 to 8 percent;
    - Increase the parturition rate from 60 to 75 percent, reducing the calving interval from 20 to 16 months (irrespective of culling rate);
    - Increase lactation yield from 720 litres (4 litres daily for 180 days) to 1920 litres (8 litres daily for 240 days).
- Increase area milk production from the current 4.25 to 14.1 million litres annually in the tenth year, with improved collection, processing and marketing of milk for the regional and the national dairy industry.

Total cost of the project was estimated at US$ 9 million (53% foreign funding) including contingencies or some US$ 1,500 per family over ten years. The project area was confined to the Cañar Canton (1,500-4,000m a.s.l.) and initially the higher plain and hilly parts (2,800-3,600 m a.s.l, 500-750 mm rainfall) and later also cattle keeping pockets in the lower zone (1,500-2,800 m a.s.l., 1,000-1,400 mm rainfall).

Implementation of the project by Ecuador started in March 1987 with limited funds and personnel of the Ministry of Agriculture and Livestock (MAG), the regional development organization (CREA) and the regional milk plant in Cuenca (PROLACEM). In 1988 the World Food Programme joined in with milk powder and butter oil estimated to generate US$ 1,690,000 to fund 17 modules. In 1990, the Dutch Government funded FAO international technical assistance with US$ 1,122,780 (1990-1994). FAO further supported with a number of start-up missions before 1990, and assisted in the monitoring and evaluation side of the project with a technical cooperation project of US$ 160,000 to set up a computerized data-base that was commissioned to Wisconsin University.

The project operates in 4 zones with teams each composed of a veterinarian, an assistant and two social workers (1 male, 1 female) and in addition a crop specialist (pasture, potatoes), a monitoring officer, a credit officer, a training/organisation officer, and a Director with a coordinating committee (ministry, regional development organization, WFP, FAO and four representatives of farmers' organisation).

Organization and training of small producers proceeds by making contact with the community/farmers group or area cooperative, followed by a seminar/workshop to introduce the project, formulate action plans and agree on coordination meetings between groups and the project. Action plans may contain visiting ongoing activities in other areas, implementation of technical and organizational training plans, group selection of a promotor farm to demonstrate recommended packages and group activities in input supply and milk handling. After sufficient confidence was built up, individual farm questionnaires are filled in to get baseline data on farm size, crops, livestock and income. In addition to technical monitoring of promotor farms (maximum 40, 10 per zone), reference farms (maximum 80, 20 per zone) are followed for progress on cattle productivity without intensive guidance as on promotor farms.

To increase milk production, problem analyses were carried out with farmers and technicians. These revealed that the cattle, tethered on small plots, obtained limited amounts of often very mature grass. Tethering also led to overgrazing (dry season) and trampling (wet season) of the sward around the sticks and erosion. Furthermore, calf mortality was as high as 20% from suckling insufficient quantities of milk and high incidence of internal parasites as a result of joint keeping of cow and calf. Technology packages developed consisted of using grass at a young stage, improved pasture mixtures (high productive annual and more persistent perennial ryegrasses, white clover for nitrogen fixation and drought-resistant cocksfoot), free grazing through electric fencing, slashing and manure distribution (to reduce parasite infection), followed by an application of fertilizer after each grazing. Calves were separated from the mother, housed in movable pens and fed 4 litres of milk per day up to the age of two months, concentrate and young grass. Cows were fed strategically up to 6 kg concentrate per day during the first two months of the lactation. Planting of trees (wind breaks) around the farm was encouraged, and cultivation of crops was only recommended in horizontal strips of 25 metres width between grass areas, following contour lines, to reduce erosion. Grassland renewal is encouraged through a system of shared cultivation of a cash crop with the project. Inputs for crops (generally potatoes or maize) for preparing new pasture land are provided by the project and farmers contribute land and labour. Proceeds are shared on a 50-50 basis, whereby the farmer's share is used for inputs in improved pasture establishment, and the project's share is used to maintain the crop sharing fund. A tractor lease service supports adequate land preparation. Repeated developments are financed by farmer funds or by bank loans. From 1994 on, farm developments (crops/pasture rotation, fencing, feeds, and by exception cattle) are financed by credits from a private bank in Cañar, upon technical approval by the project and client scrutiny by the bank. Overall loan amounts are guaranteed by WFP funds (90% for first borrowing, 80% for second).

To improve milk collection, cooling, processing and marketing, farmers' organizations can apply for establishment of a collection centre (expandable with input store or cheese making facilities), based on submission of a list of prospective producers and expected quantities of milk. Farmers' groups contribute land, local materials and non-skilled labour, while two to three persons have to be trained in the operation of such a centre. WFP contributes the cooling tank, building materials and qualified labour from outside, and milk cans (at 75% of the cost price) to participating farmers. The group signs a holding contract (becomes owner after 10 years of good management) and negotiates for a better price with various buyers (milk plants, cheese makers).

The milk industry is composed of 4 milk plants in the area: PROLACEM in Cuenca (joint venture between national and regional government with a small share for large farmers); two private enterprises of large farmers: SAN ANTONIO (trade name Nutrileche) in Chuichun and TIPAL (trade name Blanca Aurora) in Burqay, and DIANA PRISCILLA (private plant from shareholders of TONI YOGHUR in Guayaquil) between Chuichun and Cañar. In addition, numerous white cheese producers are found on farms, in small towns and along the Panamerican highway. PROLACEM and COMPROLACSA (a similar joint venture enterprise in Loja) received up to 1993 WFP milk powder and butter oil through the project. PROLACEM and TIPAL received assistance in yoghurt preparation and better use of sub-products. From 1994, WFP supplies have to be auctioned centrally to obtain the best price in the open market.

Average gross margin composition in three of the four zones from the baseline surveys during 1991-1993 from dairy (excluding livestock sales, purchases and change of inventory), crops, handicraft, other (shop, mason, carpenter, etc.) and from migration is shown in Figure 6.4.

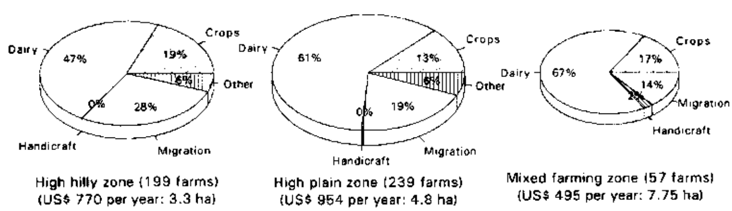


Fig. 6.4. *Composition of average annual family gross margin in 1991-1993 in three zones of Model Integrated Dairy Development Project, Cañar, Ecuador.*

Dairy is the most important contributor to total gross margin and increases with land size from 47% (3.3 ha) in the high hilly zone via 61% (4.8 ha) in the high plain zone to 67% (7.75 ha) in the mixed farming zone. Migration is most important in the high hilly zone with the lowest average land-size. In 1994, the project worked with 2,700 families: 2,400 in 34 communities in the high zone and 300 in cattle pockets of 12 communities in the lower zone. Most contacts are maintained through 4 regional Apex Farmers Cooperatives and through 13 active women community groups. Radio-contacts have been established in 18 communities, 14 have shops (consumer goods and some agro-veterinary products) and 7 have a distribution centre for molasses, minerals and concentrates. Collecting centres are functioning in 4 communities (3 more in progress) and 2 (2 more in progress) operate rural cheese plants. During 1989-1994 665 farmers were assisted through sharecropping (171 ha and 318 farmers) and pasture establishment (240 ha and 347 farmers). Credit during 4 months in 1994 reached 40 farmers with S/. 181.100.000 (US$ 90,000), distributed over chicken manure (44%), cattle (only 23.5%), crops and pasture (17.5%) and others (equipment, concentrate, fertilizer).

The milk collection component took a long time to materialize, and only in 1994 farmers managed to obtain a better price in the highly competitive market of milk plants and cheese makers. Problems encountered sofar are that distant farmers prefer the milk lorries above centrally located collection centres. Adulteration with (dirty) water is a large problem due to weather conditions while milking in the field (farmers do not have sheds), but also water additions are popular to increase the volume. Quality checks are only by lactodensimeter (water content) and alcohol test (sometimes reductase) for keeping quality.

Average results of promotor and reference farms at the start and in February/March 1994 are summarized in Table 6.1. Productivity expressed in milk per cow, per farm and per ha improved with 54, 68 and 63%, respectively, on promotor farms, against hardly any improvements on reference farms. Percentage of cows in milk went up over time and mortality of calves was considerably reduced on promotor farms. Also reference farms had a high percentage cows in milk, but mortality of calves was higher than on promotor farms.

Table 6.1. Average and range in cattle productivity on promotor and reference farms at the start and during February/March 1994 in 4 zones of the Model project, Ecuador.

	Promotor farms at the start Average	(Range)	Reference farms at the start Average	(Range)	Promotor farms In 1993/1994 Average	(Range)	Reference farms in 1993/94 Average	(Range)
Milk per cow per day (l)	6.8	(5- 7)	7.2	(5- 8)	10.5	(9- 11)	7.3	(7- 8)
Milk per farm per day (l)	45.4	(38-62)	25.0	(17-33)	76.1	(57-114)	25.4	(19-33)
Milk per ha per year (l)	2.419	(1,000-2,800)	2,007	(1,700-2,200)	3,939	(1,000-4,850)	2,036	(1,600-2,800)
Milk per lactation (l)	720				2,500			
Cows in milk (%)	60				74.8		72.3	
Mortality adult animals (%)	8				3.5		1.7	
Mortality calves (%)	20				5.3		13.7	

No data were available on age at first calving and growth performance of calves and liveweight estimates of cows. Chest girth measurements started in 1994 and prelimary data are shown for cows (Figure 6.5) and calves (Figure 6.6a and b). Cows at promotor farms are heavier and differences exist among zones. Preliminary chest girth data of calves indicate that female and male calves grow faster on promotor farms.

While preparing for a second phase of the project, milk production in the provinces of Azuay and Cañar was estimated to have increased from 10,000,000 litres in 1990 to 40 million litres per year in 1994 with a project farmers' contribution of about 20-25% (DHV, 1994).

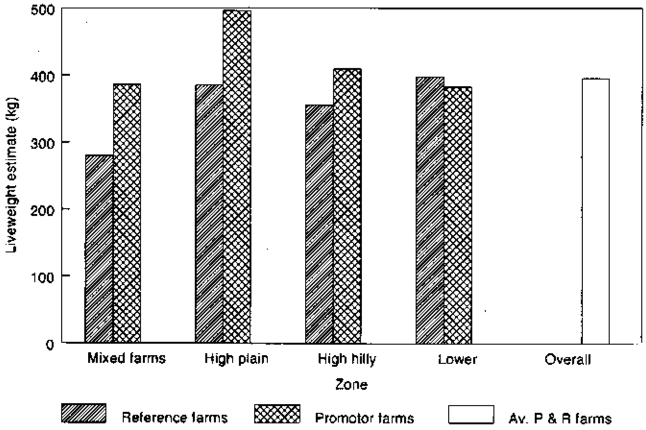


Fig. 6.5. *Liveweight estimates from chest girth measurements of cows on promotor and reference farms in the Model Project of Integrated Dairy Development Project, Cañar, Ecuador.*

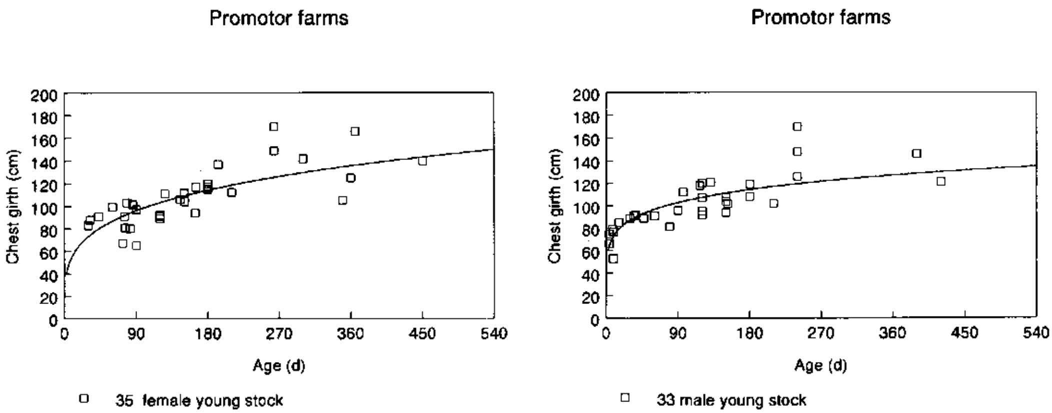


Fig. 6.6a. *Chest girth measurement of male and female young stock.*

In a second phase (1995-1998), decentralisation in milk collection and in input supply is planned to strengthen the community service units (milk handling centres/input stores). More attention will be directed to milk quality control and payments according to quality characteristics. Further, extension efforts should be intensified to transfer the favourable performance at the promotor farms to other farms in the zone.

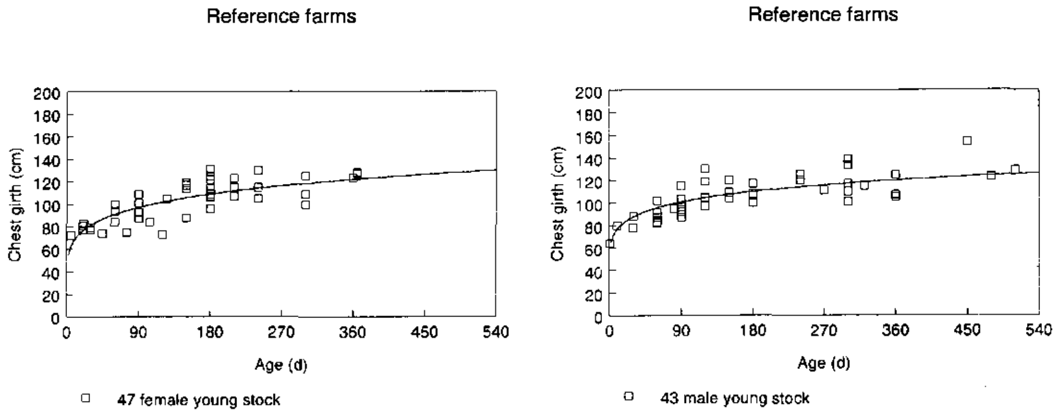


Fig. 6.6b. *Chest girth measurements of female and male young stock.*

In Ecuador milk production is increasing, especially after liberalization of the consumer price of milk in 1990 and setting a border price of US$ 2,500 per ton milk powder in 1993 (Table 6.2 from Guzman, 1994). Imports amounting to 6,470 tons of milk powder in 1985 decreased to 770 tons in 1993.

Table 6.2. Milk production, import and consumption in Ecuador.

Period	Production (million litres)	Import (million litres)	Total (million litres	Population ('000 inhabitants)	Consumption/caput (l/yr)
1976/79	551	40	591	7,352	80
1980/84	628	47	676	8,370	81
1985/89	750	26	776	9,656	80
1990/93	1,065	4	1,069	10,622	101

Milk price developments (Table 6.3) show that real prices for milk paid to the producer, charged to the consumer and the margin for the industry declined during the 1980s and only in the 1990s the margin for the industry improved, followed by higher producer and consumer prices (MAG, 1994).

With production increasing and demands being tempered by price increases, future attention should focus on quality of milk and milk products for the urban consumers and for *regional export* (Peru).

Table 6.3. Milk prices (producer and consumer) in sucres per litre in Ecuador and compared with the average price development of foods and drinks (1980=100).

Year	Milk price producer Nominal	Milk price producer Real	Milk price consumer Nominal	Milk price consumer Real	Margin for industry Real	Price development Foods/drinks(1980=100)
1980	5.8	5.8	11.4	11.4	5.7	100
1981	7.2	6.5	11.7	10.6	4.1	111
1982	8.4	6.4	12.3	9.5	3.0	130
1983	12.2	5.3	17.6	7.6	2.3	232
1984	15.2	4.8	24.3	7.7	2.9	317
1985	19.8	4.8	31.4	7.6	2.8	415
1986	25.7	5.0	39.3	7.7	2.7	511
1987	32.7	5.0	55.7	8.5	3.5	657
1988	50.9	4.7	80.4	7.4	2.7	1080
1989	95.6	4.7	149.6	7.4	2.7	2030
1990	141.6	4.7	222.6	7.4	2.7	2995
1991	205.6	4.6	333.4	7.5	2.9	4451
1992	329.4	4.8	555.3	8.1	3.3	6856
1993	493.6	5.1	795.1	8.2	3.1	9716

DISCUSSION AND CONCLUSIONS

Major problems for the development of vertically integrated dairy projects are at macro-level: imports of cheap (dumped) milk powder by the Government or its agent, Government influence on pricing of milk, and at micro-level: poor liquidity, weak management and organization of starting dairy groups/cooperatives.

Import of cheap milk powder

Colombia received annually about 20,000 ton of donated milk powder from USA through PL480 and from WFP over the period 1954-1973 (FAO, 1975). The Livestock Bank (Banco Ganadero) stated that annual imports reduced from 8,045 ton per year during 1966-1979 to 2,748 tons per year during 1980-1990 at an annual cost of 20 million US$ (1990 prices), and it was envisaged that from 1991 onwards there would be no more imports. Price of milk powder rose from US$ 600 in 1988 to US$ 2,000 in 1991 (Banco Ganadero, 1991). Annual milk consumption stood at 71 litres per person in 1970 (FAO, 1975) decreased to 51 litres per person in 1976 to increase steadily subsequently to 119 litres in 1989. This increase was to a large extend achieved by the cooperative sector organized in FEDECOLECHE (federation of dairy cooperatives), consisting of 13 dairy cooperatives with 8,500 members and having 41% of the pasteurized milk market in 1988 (COOPROLACTEOS, 1988). Private milk processors at times of cheap imports turned to recombination of milk and flooded the local market. This happened several times, resulting in stagnating local milk collection, "milk holidays" (no intake of milk) and producers returning to soft cheese production causing severe damages to cooperative efforts in collection, processing and marketing of local milk and milk products. Despite these constraints, efforts in Nariño achieved that from 1972 to 1982 milk production increased from 1% to 2.8% of national production.

In Ecuador, import of milk powder decreased from 6,470 tons (60% full cream and 40% skim milk powder) in 1985 to 770 tons in 1993. Imported milk powder to supplement seasonal deficits in the summer of 1992 and 1993 caused, in combination with favourable weather, difficulties for farmers to sell their milk and Model Project farmer groups broke up to find individual deals for their milk. Organized producers in AGSO (association of livestock farmers in the Sierra and Amazonian regions) convinced the Government in July 1993 to introduce a price adjustment and levy on imported milk powder fixing imported milk powder at a border price of US$ 2,500 per ton. In combination with liberalizing the consumer milk price, annual milk production increased from 750 million litres over the period 1985-1989to 1,065 million over the period 1990-1993.

Government and consumer milk price

Government's tendency to fix consumer prices for too long caused producer milk prices lagging behind inflation. In Nariño, Colombia the milk price between 1982 and 1986 only rose 87% against 117% for beer, 124% for lemonade and 162% for beef (COOPROLACTEOS, 1986). Squeezes on real milk price to farmers and margins to processors under the socialist government in Ecuador during the 1980s were clearly in favour of the consumers (Table 6.3). Even after liberalization of the consumer price in 1990 by the new government it took some time to increase producer price and processing margin, because of local political resistance.

Target group

Donor support to formation and extension of financial means to groups or cooperatives of farmers in South America depends among others on their perceptions with respect to the target group. In 1980 COOPROLACTEOS had among its 350 members 74 (20%) small producers with less than 10 ha land and less than 15 head of dairy cattle (Vreugdenhil, 1980). One of the reasons to stop Dutch assistance to COLPURACÉ in 1980 was the lack of evidence of sufficient involvement of small farmers in the cooperative set-up.

Van der Kuip (1982) mentions frictions between Dutch questions about reaching the correct target group in the Sta. Catalina dairy instruction project in Ecuador in the 1960s and in the CRICAS-PROMEGA project (1973-1980) in Peru and the national government's interest in producing local milk to substitute imports. During execution of the PROMEGA Project, milk intake of the largest milk factory, Gloria S.A., in the Arequipa area increased from 58.5 million kg in 1973 to 108.1 in 1980 or from 159,000 to 296,000 kg/d.

Dairy cooperatives

The type of dairy cooperative is an important factor determining possible development. In most developing countries cooperatives have both economic and social goals and fall under a government department for registration, settlement of disputes and audits. Dairy cooperatives in the Netherlands started only from the economic angle, and managed to attract capital for joint milk processing through unlimited liability and the obligation of farmers to deliver all their milk to their cooperative. Proceeds or surpluses of cooperative operation can be divided according to members' opinion. In practice, this is related to an objective distribution in terms of quality and quantity, because otherwise members might withdraw from the cooperative (NCR, 1986). Up to the end of 1983 the members of COOPROLACTEOS had no obligation to deliver all the milk to the cooperative and large farmers used several outlets for their milk. Only after heavy pressure from the Dutch adviser agreement was reached on 50% obligatory delivery of the milk to the cooperative (Kloosterboer, 1984).

Dutch financial assistance to the cooperative dairy sector in Cauca/Nariño failed. On the one hand the Dutch loan could not be canalized on soft terms, and on the other hand there was doubt on the Dutch government side whether small farmers would benefit among merely medium and large-scale members. Members were further reluctant to commit themselves to raising sufficient counterpart funding and to deliver all their milk to the cooperative. Without advance money for milk procurement of COOPROLACTEOS, milk collection was slow and irregular in competition with its sister cooperative COLPURACÉ and collection agents of other milk plants that used advance money to obtain guaranteed milk supplies. Only through partial use of technical assistance funds for cooling equipment, an infra-red pasteurizer, and later for cheese equipment, in addition to selective use of good milk of certain members for the production of Gouda cheese and a good sales outlet for cheese in Cali, COOPROLACTEOS managed to remain in operation. An additional constraint was the limited expertise of the management in processing and marketing, reason why the marketing of pasteurized milk failed in 1980. Frequent changes in management and personnel occurred in response to financial crises, mainly caused by late payments for the milk by the buying industry. Even management from outside Nariño was contracted once to extend experience in processing and marketing and it did put COOPROLACTEOS on the national scene, but it did not contribute to building the necessary trust between management and members (Kloosterboer, 1984). Dubach (1976) also mentioned several crises in the large service and producer cooperatives of Peru in relation to group management in the initial years of operating rural cheese plants.

In spite of the many problems initially, COOPROLACTEOS has developed step by step into a fullfledged industry, largely based on profits made out of Gouda cheese production. This contrasts strongly with the exercise of Dutch pasteurized milk plant inventories in Peru. Five factories had to be built by the Peruvian government, but national funds were insufficient and worst of all there was hardly any milk in the areas of the planned factories (Muller, 1981).

In Ecuador, most milk plants in the Model project area are owned by large-scale producers which, if they can expand their market, are willing to take milk from the smallholder sector. Small scale (8% shares) participation of large farmers in the milk processing sector did occur in PROLACEM a joint national/regional venture (now for >50% privatized), but management was not happy, since farmers only argued about a higher milk price. So far, private milk plants are not in favour of joint ventures with farmers' groups, while farmers' groups favour assistance for their own milk plant in terms of funds and management experience in processing and marketing. First experience with three (NGO) donated cheese plants in three of the four project zones shows one failure because of poor milk quality and high transport costs; the other two are working well and are presently being expanded with WFP funds for equipment, while the group contributes towards the expansion of the buildings.

Input supply and technical support services

Lack of input supply and technical services at farm level can be resolved through (cooperative) agro-veterinary input shops and technical project teams. Technical teams initially comprised of 4 persons (Model Project, Ecuador) per zone. However, due to the privatization moves of most government services in South America, financing has to be gradually taken over by the producers themselves. This means in practice reducted team size to cope with the financial consequences.

Cooperative agro-livestock input shops buy in bulk and pass on the goods to producers including discounts to members. Whereas farmers do pay for inputs through deduction of these costs from the milk cheque, they are not keen on paying for individual visits and services. Technical support services of COOPROLACTEOS are paid from the general proceeds of the cooperative and in the Model project in Ecuador still from project funds.

Dairy and rural sector plans

A constraint identified in all vertically organized dairy projects is the absence of a long-term plan for the dairy sector. Different ministers or cabinets may mean consumer milk price fixation or liberation, large-scale imports of milk powder to suit the consumer and processor or reduction of importations to assist the local producer.

In a seminar of the Model Project on Integrated Dairy Development in Ecuador in 1994, staff and beneficiaries of dairy projects in rural development of the governmental and non-governmental sector in Ecuador concluded as follows on rural development projects and sustainability of agro-livestock and social programmes (PMDLI-C, 1994):

- Milk production has increased on the basis of developed technology packages in conjunction with training, timely credit facilities and extension but falls still short of the country's needs;
- Generally, targets with respect to national contributions of funds, and number and skills of personnel have not been reached;
- There is still lack of real long-term policies for the agro-livestock sector and towards social development of the rural areas in terms of productive and social programmes;
- There is lack of consistency in institutional criteria for field work, which results in different commitments from and towards rural communities or groups;
- There are improvements in appreciation by men of women's role in production and socio-economic community affairs; but also set-backs were noted due to increased migration of men which causes less attendance by women to group meetings; and
- Organization and firmness of farmers' groups in product marketing is insufficient because of incomplete knowledge of the market forces and the play-out of groups by middlemen during periods of excess milk in relation to demand.

Participants in the above seminar formulated the following recommendations (PMDLI-C, 1994):

- More assistance to farmers' organizations is needed in training of their leaders both at primary and apex level in the use and marketing of their products to the benefit of their community or organization;
- Active participation of farmers' organisations in market studies at local and national level is required;
- Better coordination among institutions (governmental and non-governmental) and beneficiaries is needed to stimulate joint participatory diagnostic surveys, to unify criteria in implementation, monitoring and evaluation of projects and programmes, to create more jobs in the communities, and to ensure through intensive guidance during project implementation that in the end self management and sustainability is achieved;
- More training is required of producers as managers of their own development and training in management of services and crop-livestock production;
- More exchange is needed of experiences among communities at regional, national and international level.

Conditions for vertically integrated dairy development projects

After reviewing two Dutch supported integrated dairy development projects in South America I wish to conclude with the following essential conditions for sustainable vertical dairy development:

- Government commitment is important in deregulation of the consumer price to avoid the urban bias of favouring large numbers of voters/consumers against smaller numbers of voters/producers. Such urban bias is counter-productive to increased local milk production;
- Government should create a long-term favourable environment for local milk production by regulating the entrance of (subsidized) milk products to generate gainful employment and income for rural areas; it is essential that producer groups and processing sector participate in the formulation and implementation of such long-term dairy policy environments;
- Strong farmers' groups in organizing their input supply in bulk can obtain good discounts

that can assist in financing technical services (COOPROLACTEOS); and

- Diversification towards milk products with longer shelf life and more added value can assist farmers in getting a better price for their milk (cheese production by COOPROLACTEOS and in some small cheese plants in Ecuador), but much depends on climatic conditions, hygiene, quality control and marketing arrangements.

A step by step process approach is recommended in arrangements for type and scale of milk handling and funding of milk processing and marketing, especially where farmers' groups do not commit themselves to deliver all milk to their joint venture, because of strong competition from middlemen and existing milk plants. Starting off with joint milk collection and negotiating a better price for bulked quality milk will train the group in the technical, economic and organizational necessities of larger scale operations. Small-scale processing by trained persons of committed producer groups may follow with scaling up over time according to development of technical, organizational and marketing expertise.

In addition to vertical integration there are important dairy aspects for horizontal integration in mixed farms: dairy, crops and trees can complement each other in rotation (grass or lucerne with potatoes in the Andes), in providing feed for the dry season (fodder trees, although species for higher altitude are very limited), utilization of agricultural by-products (molasses, brans), and control of erosion.

Appendix 6.1

MODEL PROJECT FOR INTEGRATED DAIRY DEVELOPMENT

Components	Sub-components	Modules
Small producer	Organization	Organization process Management and administration of services Women's participation Training
Milk production	Cattle feeding	Pasture production and management Fodder conservation Use of feed supplements Calf feeding Training
	Genetic Improvement and Reproduction	Selection Artificial insemination Controlled breeding
	Management	Milking Milk recording Farm structures
	Animal Health	First aid animal health Field veterinary service Training
	Credits	Credits for cattle
	Milk collection/ input supply	Milk collection centres and distribution stores Transport
Milk processing	Processing plant	Pasteurization and milk products-technical aspects Pasteurization and milk products-organisational aspects Utilization of by-products
Milk marketing	*Transport of* finished products Manufacturing costs Market	*Transport, storage and* sale of products Fixing of processing and distribution costs Market study

Map 6.1


CARIBBEAN
SEA
Santa Marta
Barranquilla
ATLANTICO
Riohacha
GUAJIRA
Cartagena
MAGDALENA
PANAMA
SUCRE
CESAR
BOLIVAR
NORTE DE SANTANDER
VENEZUELA
CÓRDOBA
Cúcuta
Bucaramanga
Arauca
ANTIOQUIA
SANTANDER
ARAUCA
PACIFIC OCEAN
CHOCÓ
Medellín
Pore
Puerto
Quibdó
CASANARE
BOYACA
CUNDINAMARCA
VICHADA
Ibagué
Bogotá
Villavicencio
VALLE
TOLIMA
Cali
META
Neiva
CAUCA
Popayán
VAUPÉS
HUILA
NARIÑO
Florencia
Pasto
Mitú
CAQUETÁ
PUTUMAYO
ECUADOR
AMAZONAS
PERU
N
E
S
BRAZIL
Leticia

7. PERFORMANCE OF SMALL-SCALE LIVESTOCK/CROP DEMONSTRATION-CUM-TRAINING FARMS IN SRI LANKA[1]

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SUMMARY

Three livestock/crop demonstration-cum-training farms have been established on plots of 0.2, 0.4 and 0.8 ha, typical of the "Kandyan Forest Garden System". Vegetables, bananas, pepper, coffee, coconut and fruit trees are widely spaced, for intercropping with grass, and have been surrounded with live fences that also provide fodder for livestock to increase the family income. Each unit is operated by a selected employee and his family under a monthly incentive scheme based upon the gross margin. On these farms the technical parameters in dairying are better than elsewhere in the Mid-Country. Economic performance over 1985-1992showed that dairying contributed most to the total gross margin of the 0.2, 0.4 and 0.8 ha units, *i.e* respectively 31, 63 and 69%, respectively. Next came crops (29, 37 and 19%), poultry (22, 0 and 9%), and goats (18, 0 and 3%). In the three farms the cash income per Sri Lankan Rupee spent was 1.5, 4.6 and 2.1, respectively. The overall ratio was 3.2 for dairying, 1.1 for poultry, 4.5 for goats and 9.9 for crops. Actual family labour in the three farms was 548, 548 and 639 days, compared to the 270, 330 and 440 days anticipated in the initial feasibility study. The average incentive payments, which were 20% (0.2 ha), 61% (0.4 ha) and 133% (0.8 ha) of the parastatal salary of the employee, were only insufficient for the extra labour applied in the 0.2 ha unit. Dairying and goats proved to be attractive cash earners with a high labour productivity and a high capital requirement, while manure to improve soil fertility and biogas to replace domestic fuel were important benefits. Poultry did little to improve farm income.
(Key words: Livestock/Crop Integrated Farming, Performance, Economics, Sri Lanka)

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INTRODUCTION

The Mid-Country smallholder homestead gardens of Sri Lanka are mainly in the highlands, and are distinct from low-lying lands which are under paddy. The cropping pattern in these highland gardens is known as the "Kandyan Forest Garden System", and is a combination of tree crops, root crops and herbs stratified into layers of overhanging foliage canopies (MLDC, 1987). Livestock is kept on some 20% of the farms, usually in the form of cattle, sometimes as goats and poultry. The average farm size in the village sector of Kandy district is 0.6 ha; 52% of the farms are less than 0.4 ha, 23% are 0.4-0.8 ha, 11% are 0.8-1.2 ha and 14% are 1.2-8 ha (Westenbrink, 1986), and most dairy farmers keep one or two cows.

Three demonstration-cum-training farms have been set up at the Mid-Country Livestock Development Centre (MLDC), which is a training centre for smallholders and extensionists. MLDC is situated on the Mahaberiyatenna farm of the National Livestock Development Board (NLDB) in Digana, at an altitude of 600 m above sea level where rainfall is 1,200-1,500mm per year and falls during 100-112 rainy days as per MLDC rainfall data 1985-1992.

The aim is to demonstrate a technically and economically improved Kandyan Forest Garden System with a more open canopy to allow more intensive cash cropping of vegetables, bananas, and especially pepper (a money maker in the early eighties) and coffee under more widely spaced tree crops, *e.g.* coconut and fruit. In addition, livestock such as dairy, goats and poultry are intended to provide more gainful job opportunities for family labour on these small-scale farms, to benefit from more regular income (milk and eggs), to allow conversion of crop waste, and to provide the farmyard manure needed to enhance soil fertility, and biogas for cooking and lighting.

MATERIALS AND METHODS

Inventory of the three MLDC farm units

The three MLDC farms were established on bare farm land, with a house for the attendant and his family and a permanent water supply (valued at Sri Lankan Rupees or Rs 15,000), a biogas plant (Rs 3,823) and livestock sheds. More details on farm dimensions, crops planted and livestock units kept are given below.

The term livestock unit (LU) stands for a crossbred dairy cow of 300 kg or 6 goats of 40 kg or 240 layers, and assumes about 5 kg of manure dry matter is produced per day. The number of dairy cattle per unit depends on the farm size and the total livestock has to be sufficient to enable a family biogas unit of 6 m^3 to be operated to save on kerosene for lights and on labour for firewood collection. Therefore in the 0.2 ha farm, poultry and goats have been included. Improved grasses/legumes have been planted in the open spaces between the crops to produce basic forage for the dairy cattle. This is supplemented with leaves from fodder trees (Leucaena and Gliricidia) planted as live fences around the units or as supports (Gliricidia) to pepper vines and from a few Jackfruit trees (*Artocarpus heterophyllus*). On the 0.2 ha and 0.4 ha units a few rabbits are occasionally kept, mainly for demonstration purposes. At the end of 1989 some goats were added in the 0.8 ha unit (average 0.25 LU goats over 1985-1992).

The farms were planned and laid out in 1983/84 by the MLDC staff. In addition, labour studies were carried out to check on actual time spent on livestock, crop and household activities (Terwisscha, 1987; MLDC, 1990a,b,d,e). In all units the average value of biogas (6 m^3 plant) was estimated at Sri Lanka Rupees 1,200 (in average US$ 40 or 40 days of hired labour), equal to the money saved by not having to buy kerosene for lighting (0.25 litre per day) and to collect firewood (20 hours per month) for cooking. In the 0.2 ha unit part of the biogas value came from poultry (25%) and goats (25%). The average value of manure (biogas slurry) was set at Rs 1,200 per livestock unit, and charged to the crops and to the pasture plots as per actual rate of application.

Table 7.1. Inventory of the three MLDC demonstration-cum-training farms.

Farm inventory	0.2 ha farm	0.4 ha farm	0.8 ha farm
Buildings m^2	360	300	325
Vegetable plots m^2	597	780	650
Pasture with crops m^2	1,156	3,165	7,213*
Banana clumps	40	187	174
Pepper vines/Gliricidia	44	207	200
Coffee plants	8	52	101
Coconut palms	10	24	40
King Coconut palms	6	6	5
Fruit trees (Papaya, citrus)	19	13	31
Leucaena in metres of fence	50	190	273
Gliricidia in metres of fence	155	384	424
Cows	1	2	3
Calves/heifers	1	2	3
Female goats (+buck & offspring)	2 +	-	2 + **
Layers	120	-	60
Rabbits	***	-	***
Total Livestock Units	2.25	2.50	4.25

* with 4,086 m^2 improved pasture; ** entered late 1989 *** a few for demonstration

The MLDC training staff are responsible for the overall supervision of the units. Since 1984, the actual day-to-day management has been in the hands of a labourer employed by MLDC, assisted by his family (wife and 1 - 2 children). These families share in the profit and loss of the unit at the end of the month and receive a bonus or remain with a negative balance to be deducted from the next month's bonus. The employees, who are involved in supervising trainees and informing visitors as well as in the day-to-day management, receive their salaries to operate the units at the beginning of the month. At the end of the month MLDC staff draw up the monthly accounts in revenue, costs and gross margins, and discuss them with the staff and the unit families. The actual monthly incentive paid, is the gross margin minus recoveries for basic salary, transport of produce, for land rent at Rs 250 per ha and for the actual upkeep of the buildings (mainly "cadjans" or woven coconut leaves for roofing). The technical and economic data were collected over a period of 8 years (1985-1992).

Analysis of the data collected

This paper presents an assessment of the technical and economic performance of the three farm units, following a first report by De Jong *et al.* (1992) over the period 1985-1989 (MLDC, 1985-1990). The contributions from vegetables, bananas, pepper/ coffee, tree crops, dairying, goats and poultry (including a minute contribution from the demonstration rabbits) to the farm gross margin have been calculated in Sri Lankan Rupees (Rs: from 1985-1992 the exchange rate varied from 20 - 43 Sri Lankan Rupees per US$) and in % of the farm result. In addition, the returns in revenue and cash income per Rs spent in material costs have been calculated, and also the return to land (revenue minus material or direct costs minus labour costs) and to capital (revenue minus costs of materials, labour, land and depreciation on livestock sheds), and the labour productivity (revenue minus material costs per planned and actual manday worked). The results have also been scrutinized per livestock unit and per person labour input between farms, and per acre (0.4 ha), to check on the synergetic effects of integrated farming.

RESULTS AND DISCUSSION

Management

The management of the small-scale farm units by a selected MLDC employee and his family under guidance of the MLDC staff and the monthly participation in the gross margin have proved to work well. In 1986 the family in the 0.8 ha unit was changed, because not enough family labour was available to run the farm properly. In 1991 the family in the 0.2 ha unit opted to move to a newly established 0.8 ha dairying/goat/ sericulture farm which is expected to provide a higher income.

The parastatal annual salary of the employees rose from Rs 8,000 (US$ 400) in 1985 to Rs 23,575 (US$ 548) in 1992. The average incentive paid per annum over 1985-1992 to the 0.2, 0.4 and 0.8 ha farms was 20%, 61% and 133% (*i.e* an extra US$ 100, 307 and 669). Only in the 0.2 ha farm unit was the incentive payment of 20% above the parastatal salary not sufficient to reward in full the additional labour input of 0.5 household person. In the 0.4 ha and 0.8 ha units the additional 0.5 and 0.75 person household labour were fully recompensed. However, the tendency for incentives to decline over time indicated that rewards for family labour could not completely follow the trends in labour pay in the parastatal sector.

The very regular income from dairying under the incentive bonus scheme motivated the unit families well, and only in a few months was the deficit carried over to be recovered from the next month. This happened most when the poultry were making a monthly loss, either because pullets were being kept before the point of lay, or in months with low egg prices, and/or while the single cow in the 0.2 ha farm was dry.

Dairying

The comparative technical performance for the dairying component over 1985-1992per farm (MLDC, 1990c and 1993a-c is given in Table 7.2. Technical dairying parameters such as calving interval and milk yield per cow per annum were better in the 0.2 ha unit, which had a larger proportion of concentrates and minerals. Birth weights of calves and growth rates were also higher, while the restricted suckling practice employed during the early years in the 0.8 ha unit also showed good growth rates.

The economic performance in dairying is shown in Table 7.3 under revenue, costs and gross margin. The financial or cash components are indicated as cash income, cash expenses and cash flow.

The average milk sales of 1,457 litres per cow per year from 598 kg concentrates (coconut meal and rice bran) on the MLDC farms compared well with the results of surveys carried out (Linders, 1986, Meinderts, 1988, Houterman, 1989) in the Mid-Country. In average, the smallholders interviewed, kept more young stock and over longer periods than the MLDC farms resulting in larger amounts of concentrates per average cow.

The ratios of milk produced per kg concentrate fed on the MLDC farms imply that milk production could be increased when there was more intercropping of crops with grass, which was more feasible in the two larger units. The milk produced per m^2 of grass was highest in the 0.2 ha unit, but that farm unit relied partly on grass from outside.

Table 7.2. Average technical performance of the dairy component on the three MLDC farms (1985-1992).

MLDC farms	0.2 ha unit	0.4 ha unit	0.8 ha unit
Milk/cow/annum (l)	1,990	1,822	1,642
Concentrates/cow/annum (kg)	750	660	505
Minerals (kg/cow/year)	31	17	21
Milk per lactation* (l)	1,740(n=7)	1,792(n=8)	2,222(n=9)
Calving interval (days)	347	372	397
Milk/cow/day calving interval (l)	5.7	4.9	4.2
Milk per kg concentrate (l)	2.65	2.76	3.25
Milk per m^2 improved pasture (l)	1.7	1.2	1.2
Birth weight calves (kg)	27	25	23
Calf growth rate (g/d)	323	278	323**
Age of first calving (days)	871	885	928

* n gives the number of completed lactation records.
** most records were from the initial period when calves were on restricted suckling.

Table 7.3. Average economic dairy performance of the MLDC farms (1985-1992)

MLDC farm	0.2 ha unit		0.4 ha unit		0.8 ha unit	
Performance in	Kg	Rs	Kg	Rs	Kg	Rs
Milk sales	1,527	6,802	2,915	14,025	4,300	21,713
Milk (calf/home)	463	2,259	728	3,635	626	3,360
Stock sales		981		4,599		6,033*
Manure value		1,500		3,000		4,500
Biogas value		600		1,200		1,200
Total revenue (Rev)		12,142		26,459		36,807
Cash income (in % of Rev)		7,782(64)		18,624(70)		27,747(75)
Concentrates	750	2,403	1,319	4,112	1,515	4,938
Minerals	31	311	34	303	64	319
Artificial fertilizer	34	134	109	357	127	374
Milk to young stock	284	1,392	551	2,785	452	2,508
Other expenditure		1,086		1,132		2,016
Manure on pasture		1,000		1,000		1,200
Total direct cost (DC)		6,326		9,314		11,355
Cash expenditure (in % of DC)		3,878(61)		5,487(59)		7,647(67)
Gross margin (GM)		5,817		17,145		25,451
Cash flow (in % of GM)		3,905(62)		13,137(77)		20,099(80)
Gross margin/(LU dairy)		4,654(1.25)		6,858(2.5)		6,707(3.75)
Cash flow/(LU dairy)		3,124		5,254		5,360

* including Rs 52 grass sales.

The technical and economic parameters at MLDC also show good achievements by comparison with the results of studies of the cost of milk production in Kandy District of the Mid-Country (LPU, 1984 and 1987, SL-ADB, 1990), indicating what is possible under attentive and good farm management.

The gross margin and the cash flow per LU dairying at MLDC differed, favouring the larger units with more grass, which resulted in higher sales of older and therefore heavier young stock, and less expenses for concentrate feeding per cow.

Crops

The contribution from vegetables, banana, pepper/coffee and tree crops such as fruits and coconut is shown in Table 7.4. The gross margin of crops per ha was highest in the 0.2 and 0.4 ha units, which had large contributions from vegetables and bananas.

The productivity of the various crops as calculated per m^2 or plant was high on the 0.2 ha unit (2.25 LU) as a result of large applications of manure and compost. The larger units have relatively less manure available (the 0.4 ha farm has 2.5 LU and the 0.8 ha farm 4.25 LU) and/or find it more difficult to manure all plants properly. An exception is the category "coconuts" on the 0.8 ha unit, but on this farm one-quarter of the coconuts had been established long before the unit itself and was producing coconuts from the outset.

Table 7.4. Average composition of crop revenue (in Rs and %), total costs and gross margin per 0.4 ha crops in the three MLDC farms (1985-1992).

MLDC farm Crop contribution	0.2 ha unit Rs	 %	0.4 ha unit Rs	 %	0.8 ha unit Rs	 %
Vegetables	3,480	46	4,269	32	2,981	25
Banana	2,577	31	4,473	34	2,659	23
Pepper/coffee	786	10	3,505	26	3,440	29
Coconuts and fruits*	998	13	1,075	8	2,675	23
Total revenue of crops	7,841	100	13,321	100	11,754	100
Cost of animal manure	1,700		2,000		3,525	
Expenditure on crops	708		1,296		1,092	
Gross margin per 0.2 ha	10,868		10,025		3,569	

* Coconut palms and fruit trees were planted about a year later in the 0.2 ha unit. Some of the coconut trees in the 0.8 ha unit pre-date the establishment of the 0.8 ha unit.

The contribution in quantities (kg and nuts) and in Sri Lankan rupees of the crops over the years is given in Figure 7.1. showing the change from short-term via medium-term to tree crops over the years. The contribution of medium-term crops (pepper and coffee) has been relatively small. Initially, it took time to start bearing. Thereafter the unexpected fall in prices in the nineties resulted in low revenue and less attention. The production of tree crops is rising but not sufficiently to compensate for the drop in vegetable and banana production and the resulting gross margin.

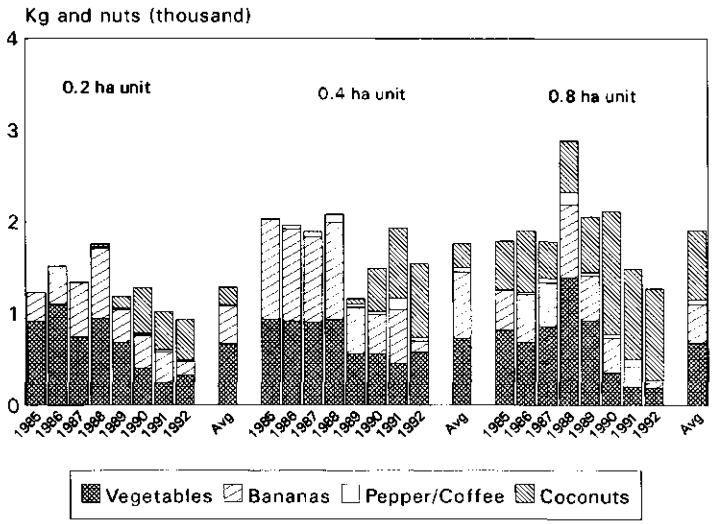

Fig. 7.1a *Crop yields in kg and nuts on the three MLDC units (1985-1992).*

Within crops, the physical and financial contribution from vegetables and bananas declined, particularly after the first four years. It seems that biogas slurry with annually decreasing gifts of artificial fertilizer (especially in the nineties, when fertilizer prices rose steeply), is not sufficient to maintain soil fertility. One way of avoiding the use of expensive artificial fertilizer would be to alternate the vegetable and banana plots with the pasture plots, and/or to step up compost making from grass-refuse and crop waste and use the compost on the crop plots.

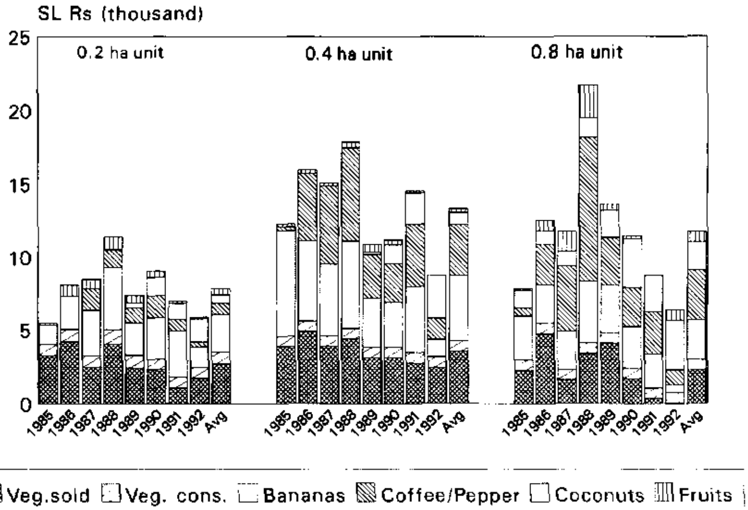

Fig. 7.1b *Crops yields in Sri Lankan Rupees in the three MLDC units (1985-1992).*

Farm economics

The economics for all farm activities are summarized in Table 7.5. The average gross margin generation in the farms increased with the acreage, but not linearly.

Table 7.5. Average economic performance per year, per ha and per person of the farm activities of the three MLDC farms (1985-1992).

MLDC farm	0.2 ha unit		0.4 ha unit		0.8 ha unit	
Economic parameters	Rs/year	Rs/ha	Rs/year	Rs/ha	Rs/year	Rs/ha
Total revenue	55,483	277,415	39,780	99,450	70,455	88,068
Total direct costs	36,937	184,685	12,611	31,527	33,401	41,750
Total gross margin	18,546	92,730	27,169	67,923	37,054	46,318
in % of 0.2 ha farm	100	100	147	73	200	50
Gross margin/(LU)	8,243 (2.25 LU)		10,868 (2.5 LU)		8,719 (4.25 LU)	
Gross margin/(person)	12,364 (1.5 p)		18,113 (1.5 p)		21,174 (1.75 p)	
in % of 0.2 ha farm	100		147		171	
Gross margin per Rs 1,000 investment	387		594		599	

The productivity per ha was higher for the smaller farms. Even if poultry keeping is excluded, since it requires hardly any land, the gross margin per ha of the 0.2 ha unit at Rs 74,162 (100%) compares favourably with the 0.4 ha unit at Rs 67,922 (92%) and especially with the 0.8 ha unit at Rs 42,152 (57%). The main reason for this is the higher productivity of crops in the 0.2 and 0.4 ha units. The gross margin per livestock unit was lowest in the 0.2 and

0.8 ha units, reflecting the small contribution from poultry.

The gross margin per actual person unit worked was larger in the 0.4 and 0.8 ha units. This proves that a family can produce a higher gross margin on larger plots.

The gross margin per Rs 1,000 invested was low in the 0.2 ha unit, because the investment in general farm premises was proportionally much larger.

The average ratios of revenue (Rev) over material or direct costs (DC) and cash income (Cinc) over cash expenditure (Cexp) are presented per farm activity in Table 7.6.

Table 7.6. Average ratio of revenue over direct costs (Rev/DC) and of cash income over expenditure (Cinc/Cexp) per farm activity of the three MLDC farms (1985-1992).

MLDC farm	0.2 ha unit		0.4 ha unit		0.8 ha unit		Overall	
Ratios	Rev/DC	CINC/CEXP	Rev/DC	CINC/CEXP	Rev/DC	CINC/CEXP	Rev/DC	CINC/CEXP
Dairying	2.0	2.0	3.0	3.4	3.4	3.6	2.8	3.2
Poultry	1.2	1.1	-	-	1.2	1.2	1.2	1.1
Goats	9.1	6.2	-	-	3.3	2.8	5.7	4.5
Crops	3.3	10.0	4.0	9.7	2.6	10.1	3.2	9.9
Overall	1.5	1.5	3.2	4.6	2.1	2.3	2.0	2.5

Goat keeping had high revenue/direct costs ratios, because goats are fed on farm grown Jack and Gliricidia leaves, and no separate charges for manure or fertilizer were assigned to goats. The ratio for dairying increased with the farm size, reflecting the value of grass for dairying. The high ratio of cash income over expenditure in crops is due to the large non-cash input of animal manure. Very low figures resulted for poultry; this demonstrates that given the prevailing prices for birds and eggs and the cost of poultry feed, poultry contributes little to improving smallholder income. On the other hand, poultry determine a large part of the costs and cash income of the farm. The result is low overall ratios for the poultry keeping in the 0.2 and 0.8 ha units. Figure 7.2 shows the contributions from dairying, crops, goats and poultry to revenue (Rev), material or direct costs (DC) and gross margin (GM).

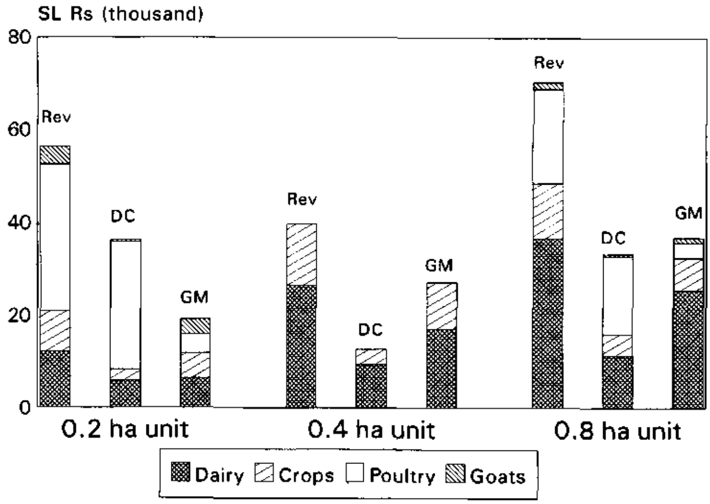

Fig. 7.2. *Average annual economic performance of three MLDC farms (1985-1992) in revenue (Rev), direct costs (DC) and gross margin (GM) for dairying, crops, goats and poultry.*

Dairy cattle contributed most to the gross margin in the three MLDC farms; respectively 31% (0.2 ha), 63% (0.4 ha) and 69% (0.8 ha), followed by crops (29%, 37% and 19%), poultry (22%, 0% and 9%) and finally goats (18%, 0% and 3%). But Figure 7.2 also clearly illustrates that crops and goats require relatively little money to generate a good gross margin, whereas dairying and poultry, particularly the latter, require more funds to generate a gross margin.

Labour assessment

Comparing the labour estimates of the feasibility study (De Silva, 1986) with actual labour observations and studies done on the units (Table 7.7) shows that in practice all units, especially the 0.2 and 0.4 ha ones, applied much more labour than originally envisaged.

Table 7.7. Outcome of estimates and studies of labour per year on the three MLDC farms.

Estimated	0.2 ha unit				0.4 ha unit			0.8 ha unit		
Labour input days	1)	2)	3)	4)	1)	2)	3)	1)	2)	3)
Dairying (+goats)	120	329	183	256	150	479	183	210	609	183
Poultry	60	140	91	110				40	65	46
Vegetables	50	102	171	130	60	167\		50	133	182
Perennial crops	40	44	103	52	120	95/	365	140	103	228
Subtotal	270	615	548	548	330	741	548	440	910	639
Household activities			182				182			182
Total days			730				730			821

1) De Silva (1986); 2) adapted from Terwisscha (1987); 3) MLDC (1990a,d,e); 4) MLDC (1990b)

Also the labour estimates used in the above feasibility study of 270 days in the 0.2 ha, 330 days in the 0.4 ha and 440 days in the 0.8 ha unit assumed some under-employment of family labour in the two smaller units and some need for contracted labour in the 0.8 ha unit. This was based on 260 man-days worked per farmer per year on average, augmented with family labour at a maximum contribution of 130 days by the wife.

The labour observations (Terwisscha, 1987) were additions of time schedules kept by the employee and his family with detailed descriptions of farm activities attended to during a month and extrapolated over the year. MLDC considered these additions of time spent on activities by these resident families as rather high, so per farm it estimated the hours the family members spent per enterprise over the day and the year (MLDC, 1990a,d,e).

The fourth study on the 0.2 ha unit was a compromise between the observations of the Terwisscha and MLDC studies (MLDC, 1990b). Whereas the units employed hardly any labour from outside, the actual labour studies indicated clearly that the employees' wives contributed substantially to the actual work on these small farms.

Although labour estimates were considered high by MLDC, they compared favourably with the 324, 219 and 411 man-days per year found for dairying in Kandy District in the studies on cost of milk production done in 1983, 1986 and 1990 (LPU, 1984 and 1987, and SL-ADB, 1990). Houterman (1989) interviewing 71 plantation workers in the tea estate sector of the Mid-Country found that dairy attendants spent per day 6 (wet season) to 10 hours (dry season) per day or 311 days per year on a one cow unit. Generally, in Kandy District and in the estate sector much more time is needed to collect roughage (outside the farm) and to transport and market the milk than at MLDC, where the milk is collected at the centre. Another advantage of the MLDC farms was the installation and proper functioning of the biogas plants, which produced enough domestic fuel for cooking and lighting, and saved on household labour for firewood collection.

The data from the feasibility study of De Silva (1986) and the MLDC studies (MLDC, 1990a,d,e) were used for the following analyses.

Actual performance versus feasibility study

Table 7.8 shows the projected economic versus actual performance for revenue and material costs with the resulting gross margin (excluding labour costs), cash flow and the return to land (including calculated labour). Also indicated is the net result of the farms in the actual situation of revenue minus the costs of materials, salary paid and incentive received, and the depreciation on the livestock sheds at 10% per annum. Whereas the costs of land rent and of marketing and of repairs to buildings have been deducted already under the final incentive payment, the net result is a measure of the return on capital. The difference between projected and actual investment is, besides the costs of the house, the initial wire fence, since this investment is not common in smallholder farms.

Only the 0.8 ha farm exceeded the projections in gross margin and return to land. This was because of inflation (see Table 7.9) and the addition of the goat enterprise. The 0.2 and 0.4 ha farms exceeded the gross margin projection because of inflation, but both farms fell below the projected returns to land because much more labour was actually applied than envisaged. The return to capital was low for all three farms, especially in the 0.2 ha unit, which had little income from poultry and a relatively high investment in general farm and poultry premises.

The 3-11% return to capital also indicates, that it will be difficult for smallholders to instigate instant improvements in the Kandyan Forest Garden System by means of dairying, goats and poultry, because commercial credit is currently available at interest rates of 16-19%. This becomes even more complicated in view of high increases in the price of breeding stock in recent years. A more gradual investment in phases of annual cash crops, medium-term crops, long-term tree crops and livestock seems more appropriate and is also more in line with the smallholder's way of farm improvement by taking small steps and avoiding high risks.

Table 7.8. Projected average (10 years) against average actual performance of the three MLDC farms (1985-1992) in Sri Lankan Rupees.

MLDC farm	0.2 ha unit		0.4 ha unit		0.8 ha unit	
Parameters	Projected	Actual	Projected	Actual	Projected	Actual
Investment	47,845	39,801*	45,765	31,068*	61,848	43,228*
Revenue	42,275	55,483	31,734	39,780	53,226	70,455
Material cost	24,480	36,937	8,900	12,611	25,906	33,401
Gross margin	17,795	18,546	22,834	27,169	27,320	37,054
Cash flow		15,737		24,442		34,448
Calculated labour**	8,100	16,440	9,720	16,440	13,020	19,170
Return to land	9,695	2,106	13,114	10,729	14,300	18,884
Return per 0.4 ha	19,390	4,212	13,114	10,729	7,150	9,442
in % of projection	100	22	100	82	100	132
Net farm result:						
Salary + incentive***		16,488		23,475		32,409
Depreciation on sheds		850		350		800
Return to capital		1,208		3,344		3,845
in % of actual investment		3.0		10.8		8.9

* investment in dairying, crops, goats, poultry, water system and biogas.

** at 30 Rs per man-day projected and at 30 Rs per man-day using the man-days found during the MLDC studies done in 1989/90.

*** actual salary + incentive (gross margin - land rent - marketing cost - repairs).

The low return to capital on the MLDC farms is also caused by the high initial investments. In the actual situation of the smallholder, the farm house, water source, boundary fence and buildings are already largely present and therefore the actual investment in the village will easily be about 20,000 Sri Lankan Rupees below the 47,000 to 62,000 Sri Lankan rupees budgeted for the demonstration-cum-training farms at MLDC (MLDC, 1988). Investments in livestock sheds in the Mid-Country are usually lower too. In Kandy District, the total investment in dairying was Rs 6,388 in 1983 (LPU, 1984), and Rs 7,918 in 1986 (LPU, 1987) and Rs 15,738 in 1990 (SL-ADB, 1990) compared to Rs 13,982-Rs 21,285 in 1985/86 for the MLDC farms. The main difference was costs of investment in buildings and equipment.

Projected data did not include inflation, assuming that prices of inputs and produce would rise at the same rate and hence so would the gross margin. As shown in Table 7.9 price levels of a number of items changed over the period 1985 to 1992 at different rates.

Salaries, the price of a dairy heifer/cow and the fertilizer price rose much faster than the exchange rate of the US dollar against the Sri Lanka Rupee, whereas crop prices increased slightly or even fell, especially in the case of coffee/pepper.

Table 7.9. Price developments in Sri Lankan Rupees over 1985-1992.

	Base level in 1985	Price level in 1992	Overall change (1985 = 100)
Value of 1 US Dollar	20	43	215
Parastatal salary per year	8,000	23,575	295
Milk price/litre	3.25	7.25	223
Concentrate price/kg	2.53	3.92	155
Dairy heifer/cow	3,000	11,000	367
Fertilizer price/kg	2.01	6.33	315
Vegetable price/kg	4.16	4.32	104
Banana price/kg	6.60	9.51	144
Coconut price per nut	2.29	3.37	148
Pepper/coffee per kg	91.7	35.0	38
Egg price per unit	1.28	2.25	176
Poultry mash per kg	4.84	7.98	165

Labour productivity (Table 7.10) in crops and poultry was lower than for dairying and goats, and therefore over the period studied dairying and goat keeping were more attractive options for generating regular, financially rewarding self-employment of rural families in the Kandyan Forest Garden System. The intensive cropping of vegetables, bananas, coffee, pepper and tree crops can absorb much family labour, but requires a good market and price. Moreover, a good mix of crops is essential, to compensate for the seasonality in harvests and for the fluctuations in price common in single crops. Elsewhere in the Mid-Country an extra risk is felt by farmers because of increasing abundance of wild boars, especially since the destruction of crops can only be prevented by expensive fencing or by guarding the crops on the farm.

In conclusion, good management and performance of small-scale demonstration-cum-training units proved very feasible from 1985-1992 at MLDC, thanks to selected employees and their families, attentive monitoring of MLDC staff and an incentive bonus system based on monthly gross margins. The intensive technical and economic data collection and evaluation clearly illustrate the requirements, role and scope of various crops, poultry, goats and dairying in the use of resources such as land, capital and labour, and the achievable technical output and economic returns. As such, the MLDC experience became an interesting intermediate between on-station and on-farm management for the demonstration and training of smallholders, staff and visitors, interested in improved, small-scale integrated livestock/crop farming. It would be worth further investigating more rotation between temporary crops and grass production and/or the use of more compost to maintain soil fertility for vegetables and bananas.

Table 7.10. Productivity of labour: planned (10 years) versus actual (1985-1992) gross margin in Rs/manday and mandays (md) in the three MLDC farms.

MLDC farm	0.2 ha unit				0.4 ha unit				0.8 ha unit			
Labour productivity	Planned		Actual		Planned		Actual		Planned		Actual	
	Rs/Md	Md	Rs/Md	Md	Rs/Md	Md	Rs/Md	Md	Rs/Md	Md	Rs/Md	Md
Dairying	58	90	43	137	59	150	94	183	63	210	150	170
Goats	45	30	72	46							84	13
Poultry	86	60	44	91					75	40	72	46
Crops	17	90	20	274	79	180	28	365	59	190	17	410
Overall	74	270	34	548	69	330	50	548	63	440	58	639
Ditto in US$	3.7		1.13		3.45		1.65		3.10		1.93	

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8. PERFORMANCE OF DAIRY FARMING ON ABANDONED MARGINAL TEA LANDS IN THE MID COUNTRY OF SRI LANKA[1]

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SUMMARY

In 1993, 76 farms that received an interest-free NLDB-NADSA single cattle loan between 1984 and 1990 and 19 neighbouring control farms were surveyed to evaluate financial, technical and economic performance, land use and gainful self-employment in small-scale farms, established on abandoned, marginal tea land. Five main areas were involved: Galaha (pilot area, 0.4 ha farms), Gampola (project expansion area, 0.4 ha farms), Nawalapitiya (idem, 0.4-0.8 ha farms), Red Cross Village in Rikilligaskada (established after a landslide with 0.4 ha farms) and Rajawelle Special Project in Menikhinna (peri-urban settlers on 0.2 ha). All control farms had obtained cattle between 1985 and 1993 through cash purchase or interest bearing loans. Project loan repayments in 36 fixed monthly reductions of the milk pay cheque, were satisfactory but could not be recovered in full from the project animal's lactations. Repayments in Gampola and especially Nawalapitiya area were slow with lower fractions of farms and cows producing milk in October 1993. Repayment in Rajawelle was 100%, but also off-farm income had been used; six out of seven loanees had stopped dairy farming due to further fragmentation of the small plots and more attractive urban jobs.

Dairy cattle was still found on 93% of project farms and of these 77% sold milk at a rate of 4.8 l/d, while all control farms had dairy cattle with 79% selling milk at 6.8 l/d. Home milk consumption was about 0.6 l/d per project family of 5.32 persons and 0.7 l/d for a control family of 4.74 persons. Calf production of the first project animal averaged 2.95 and 2 by control animals, but control farms started dairying later. Peak milk yields averaged around 7 l/d over lactations and average daily milk yield was 4.7 respectively 4 litres per cow in milk in October 1993. Overall long calving intervals of 507 days (n = 75) and mortality from tick borne diseases require more technical attention.

Milk, vegetables and perennial crops contributed 66, 15 and 18% respectively to monthly-NLDB-NADSA farm gross margin (SL Rs 769) and 32, 8, 9% to monthly family gross margin (SL Rs 1,582 with 51% for off-farm cash receipts). On control farms, these contributions were 81, 1 and 18% to farm (SL Rs 747) and 46, 0, 10% to family gross margin (SL Rs 1,331 with 44% for off-farm receipts). Only family gross margins were about equal to monthly cash flows over 1985-1992 at the 0.2 ha (1,311) but less than at the 0.4 ha (2,037) and 0.8 ha (SL Rs 2,807) farms of the MLDC where project beneficiaries were trained in crop-livestock farming. More, longer training periods increased project gross margins, while more, shorter periods reduced it in control farms. Highly, significant differences were found in monthly farm gross margin for main

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area with Red Cross Village farmers, followed by those in Galaha, generating more than those in Nawalapitiya and Gampola, in milk sales and negatively for number of male calves produced by the first animal. Monthly project family gross margin including off-farm cash showed similar differences for main area, milk sales and number of male calves. On control farms, milk sales only contributed significantly to farm gross margin and off-farm cash and milk sales to family gross margin. Impression of farmers and interviewers on crops, cattle shed and cattle condition was, in more than 50% of the farms, moderate to poor. Milk production proved attractive for farm and family gross margin, land improvement (mentioned by 64% of farmers), and livestock sales (SL Rs 1,000 per year), while crops so far contributed mainly to subsistence food and some money generation (vegetables and perennials). However, farmers still depended on Goverment food support to balance their average monthly family cash needs of 2,000 Sri Lanka Rupees (1 US$ = 47 SL Rs in 1993).

INTRODUCTION

The plantation sector in Sri Lanka was first developed with coffee and later with tea and rubber. At the time of national independence in 1948, tea and rubber estates occupied over 400,000 hectares. A Tea Commission was appointed by the Government in 1968 to review the effects of the tea replanting programme aiming at reversing declining yield and quality of tea in the late 1950s and early 1960s. The Commission concluded that of the existing 240,000 ha of tea land, 80,000 ha planted with high yielding clonal materials would be sufficient for home production and export demand. Diversification of 160,000ha of marginal tea lands to other crops was recommended in the Mid Country, since in this area yields and quality of tea were on average lower than elsewhere.

UNDP/FAO technical assistance was requested by the Government in the 1970s to develop a strategy for optimal land use of marginal tea land based on technical and economic feasibility studies of alternative crops. Thereafter, the Government formulated a diversification project for 1 hectare farmsteads for settlers with mostly perennial crops and introduction of a few dairy cows to some farmers. Settler blocks would be interchanged with tree areas for timber and fuelwood. To implement such a project, World Bank assistance was sought for two districts, Kandy and Kegalle. A five year project with a credit of 4.5 million US dollars from the International Development Association (IDA) of World Bank became operational in 1978, to be implemented by the National Agricultural Diversification and Settlement Authority (NADSA) set up for this purpose. Delays in implementation caused by reluctance of former estate labour to move out of the acquired estates, objections raised to the alienation policy of the Land Reform Commission by previous estate owners, and selection of qualifying settlers led to the withdrawal of IDA, but the Government continued the project with its own funds. Adaptations were introduced in the form of reduced farm allotments of 0.4 ha, grants for settlers to construct their own houses and a special development scheme providing SL Rs 3,600 (US$ 120) for farm development. To tide settlers over the period required for concentrating on development of their allotments, food aid was requested for a period of five years (FAO/WFP, 1988).

The introduction of the dairy component in settler farms was rather slow in the late 1970s and early 1980s through lack of cattle and because of high cost of dairy farm loans. Therefore, the Sri Lanka-Netherlands Livestock Development Programme (SL-NLDP) was requested in 1984 by the National Livestock Development Board (NLDB) to fund a pilot dairy project for 30 resource-poor settler families in the Galaha area of NADSA. SL-NLDP would finance the supply of one in-calf dairy heifer per settler from the calf salvaging farms of NLDB on the basis of an interest-free loan. Training in mixed farming of the settler family would be provided at the demonstration units of the Mid Country Livestock Development Centre (MLDC). The livestock development service of NLDB would assist with cattle shed and farm development. After a first technical review in 1986 (Ariyaratne, 1986; Nell, 1986) this pilot effort became part of the regular activities of the SL-NLDP's Small Holder Dairy Development Project (SHDDP) between 1986-1989, continued under the Small Farmer Dairy Project (SFDP) from 1990 to June 1991, and thereafter by the DPAs and their apex body the Mid Country Milk Producers Union (MIDCOMUL).

The objectives of this paper are 1) to review financial, technical and economic performance of a large sample of NLDB-NADSA settlers that received dairy cattle between 1984 and 1990, 2) to compare the technical results with earlier technical studies in 1986 (Ariyaratne, 1986) and 1987 (Odekerken, 1988), 3) to check upon the original NADSA strategy towards optimal land use on abandoned, marginal tea land and 4) to study if gainful self-employment has been obtained on small-scale farms with diversified crops and some dairy cattle. For this purpose, not only dairy, but also crops (vegetables and perennials) and off-farm resources will be surveyed. In addition, a number of neighbouring farms will be surveyed to compare results without dairy or with cattle obtained from cash or bank loans. Also farm and family gross margin (cash receipts minus expenses) will be compared with average monthly cash flows over 1985-1992 (De Jong *et al.*, 1994) of the three MLDC demonstration units on which farmers were trained before receiving the project animal.

MATERIALS AND METHODS

The Mid Country is located in the centre of Sri Lanka at an elevation of 600-1200m a.s.l., with monthly mean temperatures of 18.3-23.8 0C, 1,900-5,000mm rainfall and 55-75% relative humidity. Farms and areas mentioned in this paper are shown on Map 8.1.

The National Livestock Development Board (NLDB) operated an IDA funded Dairy Development Project from 1973 to 1981. The IDA credit was at concessional rates of interest for total farm development, including the provision of in-calf heifers, either imported or supplied locally from NLDB farms to smallholders. Training and extension to cattle recipients was provided through mobile training courses and a development service of Regional Livestock Development Officers (RLDOs) and Livestock Development Assistants (LDAs). From 1982 onwards the selection and follow-up of recipients continued through the RLDOs and LDAs in the Mid Country, supported by training of the Mid Country Livestock Development Centre (MLDC) through one day visits, one and two week residential courses and/or mobile training courses.

In 1984 a pilot project was initiated for the introduction of dairying for 30 resource-poor settlers on abandoned marginal tea lands in the Galaha area (Wariyagala and Gurukelle-Nillambe DPAs) in the Mid Country. Aspiring dairy farming settlers were invited for a one day visit to MLDC at Mahaberiatenne to become acquainted with integrated crop-dairy farming at the demonstration units of 0.2, 0.4 and 0.8 ha. Subsequently, a member of the interested settler family attended a one week resident course at MLDC to gain experience in farm development (grass establishment, planting of Glyricidia, pepper, vegetables and perennials, cattle shed lay-out). Upon return farm development was undertaken under guidance of the RLDOs and their LDAs. This included cattle shed development with 6 bags of cement, roofing materials and masonry, and plant materials (grass, seedlings of coconut, pepper and fruit trees, Glyricidia sticks, vegetable seeds and initial fertilizer), all free of charge. Upon completion, a family member was sent to MLDC for another one week course to learn all dairy activities before receiving the in-calf heifer. Also the functioning of the dairy producers associations (DPAs) was explained for dairy inputs and marketing of the milk.

The pilot project provided per settler one in-calf heifer insured for three years, interest-free on the basis of 36 capital instalments deducted from the DPA milk cheque during the months the cow produced sufficient milk to pay for inputs and loan repayment. Together with the animal the farmer received a bag of coconut meal and a packet of minerals to facilitate a good start before the animal would calve down. The NLDB livestock development staff supported the trainees further with extension on dairy management and monitoring of performance.

The pilot scheme was expanded over time to other DPAs in the NADSA areas, such as Kalugamuwa and New Gurukelle DPAs, Nawalapitiya DPA, and the Angammana, Kahawatta and Orayanwatte DPAs in the Gampola area. In addition, farmers in Rikilligaskada DPA that lost their land after a landslide and were settled in the Red Cross Village, and poor semi-urban families of Menikhinna DPA settled in the Rajawelle Special Project received assistance under the NLDB-NADSA interest-free cattle loan scheme.

From 1984 to 1990, in total 134 single cattle loans had been issued to NLDB-NADSA cattle loan beneficiaries in the various DPAs. The distribution and financial details per June 1991 are presented in Table 8.1 (NLDB/DDD, 1991). The proceeds of the capital repayments went into a NLDB-NADSA aspiring dairy farmers development fund to continue the scheme on a revolving fund basis once SL-NLDP would pull out.

In 1993, a survey format (Appendix 8.1) was developed for data collection on a large sample (about 50%) of these NLDB-NADSA farms and some control farms at the rate of 1 neighbour per 3 project farms along the same milk collection routes of the DPAs. General data included the farmer's family composition, home milk consumption, farm crops and livestock and the status of the loan. Farm details referred to plot size with the number and species of perennial bushes, vines, clusters and fruit trees, and the vegetable area in square meters.

Table 8.1. Distribution and financial details in Sri Lankan Rupees of NLDB-NADSA cattle loanees per main area per June 1991 (1 US $ = 30 Sri Lanka Rs).

Main Area	Number of NLDB-NADSA loans	Amount Issued	Amount Repaid	Balance Outstanding	Balance (%)
Galaha	48	151,491.05	118,602.00	32,889.05	22
Kalugamuwa DPA*	5	17,534.75	10,950.20	6,584.55	38
New Gurukelle DPA*	4	12,697.00	11,023.50	1,673.50	13
Nawalapitiya	21	84,943.60	12,520.00	72,423.60	85
Gampola	25	99,115.70	32,328.60	66,787.10	67
Red Cross Village	18	73,837.10	5,900.00	67,937.10	92
Rajawelle Special Project	13	50,861.20	36,795.80	14,065.40	28
Total	134	490,480.40	228,120.10	262,360.30	53
Average per loaner		3,660.30	1,702.39	1,957.91	

* because of small numbers these DPAs were left out in the 1993 survey (see Table 8.2)

Livestock information was gathered on the number and composition of livestock kept, and the fodder resources such as type of feeds and length of live fence (mainly Glyricidia trees). The farm history was recorded in terms of starting date, type and length of training in dairying received and by whom. The livestock history on the farm recalled the date of reception of the in-calf heifer, the breed, the supplying farm (Haragama, Rosita, Ambewela, MLDC or private farm) and the value of the issued in-calf heifer, the number and sex of the calves produced, and the fate of the animals. Milk productivity was characterized by the peak yield of the cow in litres per day (l/d), the length (months) of the milk production period per lactation, and the calving interval in days (d). Development of the dairy cattle activity was obtained by recording what happened with the first in-calf heifer and her calves in terms of either kept on the farm, shared, sold (price and age) or died and the cause of death.

Also farm cash receipts and expenditure per month were recorded and differentiated among vegetables, perennial crops and milk to derive at monthly farm gross margin. Source and amount of off-farm cash was obtained to calculate monthly family gross margin. Monthly family cash needs outside farm activities were collected as well. Based on price and age of sold offspring an estimate was made on annual stock sales.

In October 1993, final year students from the Agricultural School at Kundasale were instructed in the use of the questionnaire and surveyed 76 farmers with a NLDB-NADSA cattle loan and 19 control farmers.

The data were analyzed with DbStat (Brouwer, 1992). Least square methods were used to explain the variation in monthly farm gross margin (farm cash receipts minus expenses) in relation to the following factors: main area, who received the training (farmer, farmer's wife, or relative), farm of origin and period in which the first animal was received (for convenience of sizable numbers per group divided in 1984, 1985-1987, 1988, and 1989-1990). Covariables adjusted for their average were: family size (persons), training periods (1-4) and total training days (d), farm size (ha), vegetable area (m^2), number of tea bushes, number of trees (vines, clusters and fruit trees), number of dairy cattle (expressed in TLU, a tropical livestock unit of 300 kg with cows and bulls at 1 TLU, calves at 0.25 TLU, and young heifers and young bulls at 0.5 TLU), number of calves (male and female) produced by the first animal and litres of milk sold to the DPA during the last month (l/month). Similarly, by adding off-farm cash receipts, monthly family gross margin was analysed for the above factors and covariables.

RESULTS

In October 1993, 76 farms (57%) of 134 NLDB-NADSA cattle loanees were surveyed along the milk collection routes of the DPAs participating in the NLDB-NADSA cattle loan scheme. Of these farms 71 had dairy cattle and 55 sold milk. Number and financial details of loans of these 76 farmers are given in Table 8.2.

Table 8.2. Number of NLDB-NADSA loanees (total, with cattle, with milk sales) per main area and details on their average cattle loan situation in Sri Lanka Rupees in October 1993.

Main area	NLDB-NADSA Loanees Surveyed Total	With cattle	With milk	Average Loan 76 loanees	Av. Repaid 76 loanees	Av. Loan Balance 76 loanees	Balance (%) 76 loanees
Galaha	30	27	23	3,210.33	3,134.32	125.21	4
Nawalapitiya	16	15	8	3,505.79	1,677.15	1,828.64	52
Gampola	19	18	14	3,791.98	2,889.73	919.76	24
Red Cross village	10	10	9	3,901.97	3,425.97	476.00	12
Rajawelle	1*	1	1	4,000.00	4,000.00	0.00	0
Average	76	71	55	3,519.34	2,816.17	726.97	21

* in the visited area only one farmer out of 7 loanees was present and attending his farm

Financial details per main area and year of animal supply are illustrated in Figure 8.1. Over time the cattle loan increased from SL Rs 3,175 in 1984 to about SL Rs 4,000 in 1989/90 reflecting a small increase in cattle prices. Rajawelle farmers paid their loans in full, using in part off-farm income. Repayments in Galaha and Red Cross Village were almost completed but repayments in Gampola and Nawalapitiya were lagging behind

The 19 control farms surveyed, comprised 8 farms in the Galaha area, 8 in the Gampola area and only 3 could be covered in the Nawalapitiya area. In the Red Cross Village no control farmers were found since all farmers participated in the loan scheme. In the Rajawelle area other project farmers and control farmers had left farming due to further fragmentation of the small plots. All control farmers surveyed along the milk collection route had either obtained cattle through cash purchase or cattle loans from the People's Bank. Average purchase value of control cows amounted to SL Rs. 6,650 reflecting the higher purchase prices of dairy stock after 1989. All 19 farms had cattle and 15 (79%) sold milk at the time of the survey.

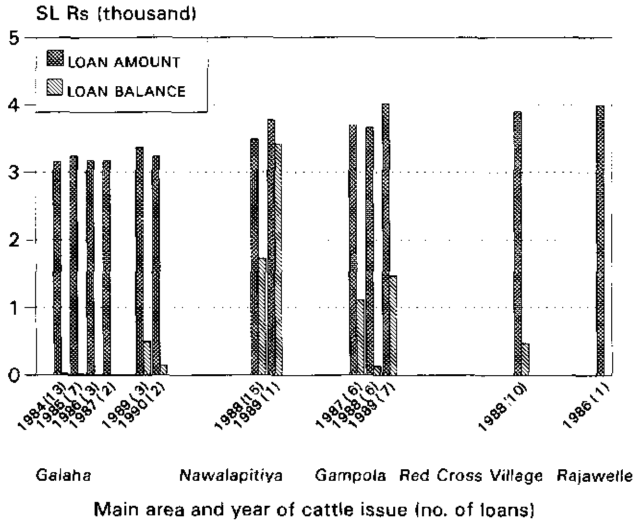

Fig. 8.1. *Average amount of 76 NLDB-NADSA cattle loans issued per main area per year (1984-1990) and outstanding loan balance in Sri Lanka Rupees in October 1993.*

Details per main area on family characteristics and farm details are presented in Table 8.3. Average family size of NLDB-NADSA families of 5.32 persons (range 3 to 10) was larger than at control farms (4.74 persons), mainly because of more children. Milk consumption at home averaged 0.6 litres per day in NLDB-NADSA farms, slightly lower than at control farms consuming 0.7 litres per day. The range was from 0 litres (10 project and 2 control farms) to 45-60 litres per month for a family (6-10 persons).

Average farm size was around 0.46 ha with larger farms (0.69 ha) in Nawalapitiya and a smaller farm in Rajawelle (0.20 ha). Remaining tea bushes on the land were more abundant in Gampola and especially in the Red Cross Village. Vegetable plots were largest in the Red Cross Village, followed by Nawalapitiya and very small plots in other areas and control farms. The composition in tree crops (vines, clusters and fruit trees) was quite different per area with very few trees in the Red Cross Village, Galaha and Rajawelle. The length of live fence was less in the Red Cross Village and Rajawelle, where fences were merely demarcation lines between farms, while fences in the other areas were in part demarcations between developed and non-developed areas.

In average 1.9 (s.d. 0.9) training periods, totalling 9.8 days (s.d. 5.6) were attended by project beneficiaries at MLDC and 0.9 (s.d. 1.1) periods by control farmers. The project farmer went to MLDC in the case of 53 (70%) loans, the farmer's wife attended the training for 5 (7%) loans, while both were trained for 11 (14%) loans and relatives for 7 (9%) loans. Of the control farms only 11 persons (7 male and 4 female) received some training at MLDC or directly by NADSA, averaging 6 days in 1.5 periods.

Table 8.3. Means and coefficients of variation (c.v. in %) of family composition, home milk consumption, training periods received, farm size with vegetable plot size, number of tea bushes, perennial tree crops, and length of live fences on 76 farms of NLDB-NADSA loanees surveyed per main area and 19 control farms in October 1993.

Main Area	Galaha	Nawala-pitiya	Gampola	Red Cross Village	Rajawelle	Total NLDB-NADSA Farms		Control Farms	
Number of farms surveyed	30	19	16	10	1	76		19	
Characteristics	Mean	Mean	Mean	Mean	Mean	Mean	c.v.	Mean	c.v.
Family size	4.80	5.63	5.42	6.00	7.00	5.32	31	4.74	34
adult male	1.37	1.31	1.00	1.20	1.00	1.24	63	1.21	44
adult female	1.47	1.25	0.95	1.00	1.00	1.22	41	1.26	52
boys	1.17	1.88	1.89	1.60	3.00	1.58	82	1.26	105
girls	0.80	1.19	1.58	2.20	2.00	1.28	88	1.00	100
Milk consumed (l/month)	18.00	18.94	16.79	22.50	0.00	18.25	64	21.79	74
Training periods (number)	1.4	2.7	2.1	1.8	3.0	1.9	47	0.9	122
Farm size (ha)	0.40	0.69	0.40	0.39	0.20	0.46	30	0.47	32
Vegetable plot (m^2)	14.40	166.88	28.00	552.00	0.00	120.45	298	67.58	335
No. of tea bushes	189.00	189.31	337.37	1050.00	0.00	336.96	146	169.47	111
No. of coconut trees	6.30	2.56	11.79	2.10	20.00	6.51	109	6.32	162
of clove trees	20.30	8.81	6.47	0.40	0.00	11.54	130	8.32	94
of pepper vines	79.93	245.94	224.95	0.20	15.00	139.79	99	136.68	160
of jack trees	4.37	14.56	6.26	8.60	8.00	7.59	108	9.26	124
of bread trees	0.77	1.00	0.68	0.10	0.00	0.70	114	0.84	91
of mango trees	0.70	7.63	4.05	1.40	1.00	3.09	123	4.58	242
of avocado trees	1.73	6.50	11.63	4.80	8.00	5.50	144	4.68	72
of banana clusters	14.76	63.06	70.26	24.00	75.00	40.78	169	23.32	142
of coffee trees	5.93	258.44	142.89	13.10	6.00	94.28	137	80.53	146
Total tree crops	134.70	608.50	479.00	54.70	133.00	309.97	87	274.53	91
Live fence (m)	326.83	260.63	234.84	137.00	180.00	262.99	96	275.26	90

The average dairy cattle population per main area surveyed, is detailed in Table 8.4. Furthermore, the dairy cattle composition per farmer that had cattle at the time of the survey is given for 4 groups of farms in relation to the period (1984, 1985-1987, 1988 and 1989-1990) of receiving the first in-calf heifer.

Table 8.4. Means and coefficients of variation (c.v. in %) of the dairy cattle population (number per farm) on 71 NLDB-NADSA farms with cattle per main area and per period of receiving the first animal and on 19 control farms, surveyed in October 1993.

Main Area/Period	Galaha	Nawala-pitiya	Gam-pola	Red Cross Village	Raja-welle	-Period Reception 1st Animal- 1984	1985-1987	1988	1989-1990	NLDB-NADSA w/cattle		Control farms	
Number of farms	27	15	18	10	1	12	17	31	11	71		19	
Dairy herd composition	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	c.v.	Mean	c.v.
Cows in milk	1.11	0.60	0.83	0.90	1.00	1.25	0.94	0.74	0.91	0.90	67	1.37	92
Dry cows	0.33	0.33	0.33	0.20	0.00	0.25	0.35	0.32	0.27	0.31	167	0.21	200
Heifers	0.41	0.27	0.33	0.20	1.00	0.50	0.59	0.23	0.09	0.34	167	0.68	163
Heifer calves	0.22	0.60	0.22	0.70	0.00	0.17	0.24	0.58	0.18	0.37	125	0.37	134
Bull calves	0.37	0.13	0.06	0.30	0.00	0.50	0.12	0.16	0.27	0.23	250	0.26	216
Young bulls	0.11	0.27	0.17	0.00	0.00	0.25	0.00	0.19	0.09	0.14	400	0.21	255
Bulls	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	458
Total cattle	2.55	2.20	1.94	2.30	2.00	2.92	2.24	2.22	1.81	2.27	48	3.11	76
Total in TLU	1.85	1.38	1.45	1.45	1.50	2.04	1.68	1.46	1.39	1.60	48	2.24	76

Control farms had more dairy cattle (3.11 animals, 2.24 TLU) compared with the-NLDB-NADSA farms (2.27 animals, 1.60 TLU), mainly because of more cows in milk and heifers. According to the period of reception of the first animal, the older NLDB-NADSA farms kept more cows in milk and heifers than farms that received initial stock more recently. Only 6 NLDB-NADSA farms kept goats (18 in total), and poultry was kept on 5 farms (1 with 800 birds and the other four had in all 18 birds).

Cattle productivity up to October 1993 as obtained by recall method from the farmers or their household members is presented in Table 8.5. The number of records recalled, are indicated in brackets. The number of offspring produced showed a large variation (2.88-4 calves) per area and between project (2.95 calves) and control animals (2 calves), but control farmers started 1-3 years later with dairying. Also the sex ratio varied greatly with a large percentage of male calves in Galaha and Red Cross Village. The number of records on calving intervals was much less than on peak yield and lactation length. Calving intervals were very long in all areas with an average of 507 days, based upon a total of 75 NLDB-NADSA records. Registration of calving dates on control farms was very limited.

Table 8.5. Means and coefficients of variation (c.v. in %) of the average cattle productivity (based on recalled records) on 76 NLDB-NADSA farms and 19 control farms surveyed in October 1993.

Main Area	Galaha	Nawala-pitiya	Gampola	Red Cross Village	Rajawelle	Total NLDB-NADSA farms		Control Farms	
Number of farms surveyed	30	19	16	10	1	76		19	
Cattle productivity	Mean	Mean	Mean	Mean	Mean	Mean	c.v.	Mean	c.v.
Number of calves produced	3.23	2.88	2.47	3.00	4.00	2.95	47	2.00	84
male calves	2.17	1.56	0.79	1.80	3.00	1.66	83	0.68	161
female calves	1.07	1.31	1.68	1.20	1.00	1.29	78	1.32	105
Peak milk yield (l/d)									
1st lactation (records)	6.7 (27)	5.6 (16)	6.1 (16)	7.2 (10)	5.0 (1)	6.4 (70)	43	6.6 (14)	35
2nd lactation (records)	8.1 (24)	5.9 (14)	7.2 (12)	7.4 (9)	5.0 (1)	7.3 (60)	33	7.7 (9)	30
3rd lactation (records)	8.0 (19)	5.5 (10)	6.9 (9)	7.5 (6)	5.0 (1)	7.1 (45)	35	7.8 (6)	34
4th lactation (records)	7.3 (12)	5.0 (5)	7.3 (4)	8.3 (3)	5.0 (1)	6.9 (24)	35	10.0 (2)	28
5th lactation (records)	7.3 (7)	6.0 (1)	6.0 (1)	7.5 (2)		7.1 (11)	34	10.0 (2)	28
6th lactation (records)	4.0 (1)		5.0 (1)			4.5 (2)	16	12.0 (1)	
Lactation period (months)									
1st lactation (records)	7.5 (26)	9.9 (16)	9.9 (16)	8.6 (10)	8.0 (1)	8.8 (69)	28	7.7 (13)	33
2nd lactation (records)	7.5 (23)	11.0 (14)	10.6 (12)	7.8 (8)	8.0 (1)	9.0 (58)	25	8.9 (9)	27
3rd lactation (records)	7.1 (18)	9.8 (10)	9.4 (7)	8.8 (5)	8.0 (1)	8.4 (41)	31	8.7 (6)	24
4th lactation (records)	7.0 (11)	10.0 (4)	10.7 (3)	8.5 (2)		8.3 (20)	22	8.0 (3)	18
5th lactation (records)	7.2 (6)		11.0 (2)	9.0 (1)		8.2 (9)	22	7.5 (2)	9
6th lactation (records)	7.00(1)					7.0 (1)		7.0 (1)	
Calving interval (d)									
First (records)	460 (9)	527 (10)	490 (8)	613 (5)		512 (32)	23	493 (1)	
Second (records)	481 (6)	652 (8)	492 (7)	433 (3)		535 (24)	28	367 (1)	
Third (records)	630 (4)	462 (3)	377 (4)	393 (2)		477 (13)	37	526 (1)	
Fourth (records)	548 (2)	396 (1)	411 (1)	346 (2)		432 (6)	32	395 (1)	

The fate of the 76 NLDB-NADSA in-calf heifers per October 1993 is shown in Table 8.6.

Table 8.6. Fate of 76 NLDB-NADSA in-calf heifers (supplied between 1984-1990) up to October 1993.

Fate/Year of animal supply	1984	1985	1986	1987	1988	1989	1990	Total	In %
Number supplied	13	7	4	8	31	11	2	76	
Number up to October 1993									
- present on farm			1	2	13	3	1	20	26.3
- died	1	2		1	4	1		9	11.8
- culled (to trader/butcher)	2	1	1	1	1			6	7.9
- sold (to other farmer)	9	3	2	4	14	5		37	48.7
- shared	1			1			1	3	4.0
- exchanged					1			1	1.3

Calving rate and fate of calves produced by these 76 NLDB-NADSA animals (Table 8.7) and those of the first cow at 19 control farms (Table 8.8) are given in numbers and in percentages. Calving rates over time of project cows are higher than in control animals suggesting a more rapid movement in control farms, while loanees depend much more on their first animal to repay the loan.

The average price and age of sold offspring of 76 NLDB-NADSA animals could be recalled by the loanees for 87 (79%) of the 110 animals and are presented in Table 8.9. Prices increased considerably after 1989 together with a general upward price trend for parastatal cattle. Average price and selling age for 24 female offspring was SL Rs 3,265 at 18.8 months and for 63 males SL Rs 1,512 at 10.5 months. Most sales occurred in 1989 (n=21), 1990 (n=16) and 1991 (n=17) in conjunction with rising average returns in SL Rs per month of age.

Table 8.7. Calving rate and fate of calves of 76 NLDB-NADSA project animals.

Project animal's calf number	1	2	3	4	5	6	Total	In %
Female calves	34	26	19	13	6	0	98	
- on farm	12	12	10	9	5	-	48	49.0
- died	7	3	3	2	-	-	15	15.3
- sold	14	10	5	2	1	-	32	32.7
- shared	-	1	1	-	-	-	2	2.0
- left at Haragama farm	1	-	-	-	-	-	1	1.0
Male calves	40	37	29	14	5	1	126	
- on farm	1	1	1	3	2	-	8	6.3
- died	12	8	8	2	2	-	32	25.4
- sold	24	28	18	7	1	1	78	61.9
- shared	1	1	1	-	-	-	3	2.4
- unknown destiny	2	1	1	1	-	-	5	4.0
Total calves	74*	63	48	26	12	1	224	
Calving rate in % of the 76 animals	97*	83	63	34	16	1	295	

* two heifers did not produce a live calf

Table 8.8. Calving rate and fate of calves of the first dairy cow on the 19 control farms.

First dairy cow's calf number	1	2	3	4	5	6	Total	In %
Female calves	11	5	3	4	1	1	25	
- in farm	5	2	1	1	-	1	10	40.0
- died	1	1	-	-	-	-	2	8.0
- sold	2	1	-	1	-	-	4	16.0
- shared	1	-	-	1	-	-	2	8.0
- unknown destiny	2	1	2	1	1	-	7	28.0
Male calves	6	3	2	1	0	1	13	
- in farm	3	1	-	-	-	-	4	30.8
- died	-	-	-	-	-	-	0	0.0
- sold	1	1	2	1	-	1	6	46.2
- shared	1	-	-	-	-	-	1	7.7
- unknown destiny	2	-	-	-	-	-	2	15.3
Total calves	17*	8	5	5	1	2	38	
Calving rate in % of the 19 animals	89*	42	26	26	5	12	200	

* from two farms no information on calves was available.

Based on these 87 known sales at a total price of SL Rs 173,600 out of 110 animals sold during 454 NLDB-NADSA farm/years (farms times years between reception and 1993), annual average offspring sales were calculated at SL Rs 483 per farm. Including the value of project animals culled or sold at an average rest value of SL Rs 5,000 per head and an estimated few sales of offspring of farm-born animals, average monthly cash from livestock sales was estimated at about 125 Rs per farm on average. This represents about 25% on top of the gross margin for milk (SL Rs 507) on the surveyed farms (Table 8.10). Recalled information on price and age of animals sold was very limited on control farms.

The composition of average monthly farm gross margin (cash received minus expenditure) per main area is given in Table 8.10, with details for milk, vegetables and perennial crops.

Estimated average livestock sales (125 SL Rs per farm) are not included. Off-farm cash receipts are added to derive at average family gross margin. In addition, average monthly cash needs for the family, outside those for farm activities, are given, as indicated by the interviewees.

Table 8.9. Details of prices in Sri Lanka Rupees (Rs) for the sales of 63 male and 24 female NLDB-NADSA offspring related to calf numbers (n), age and year of sale as per recalled record in October 1993.

Year of sale	1985	1986	1987	1988	1989	1990	1991	1992	1993	Average
Female number										
1 - price (n)	2,000(2)			1,500(1)	3,275(4)	4,125(2)			8,000(1)	3,485(10)
- age (month)	15			7	24.3	17.5			63	23.2
2 - price (n)		3,000(1)			3,000(1)		5,667(3)	3.933(3)		4.350 (8)
- age (month)		15			7		20	27.7		20.6
3 - price (n)				1,800(1)		1,500(1)			500(1)	1,267 (3)
- age (month)				15		3			2	7.2
4 - price (n)					1,550(2)					1.550 (2)
- age (month)					10.5					10.5
5 - price (n)							1,800(1)			1.800 (1)
- age (month)							12			12
Overall price/ month of age (Rs)	133	200		150	153	257	261	142	131	174
Male number										
1 - price (n)	1,000(1)	700(1)			1,390(10)	1,450(6)	3.300(2)			1,545(20)
- age (month)	12	8			10.3	10	27			11.9
2 - price (n)			750(7)		2,200(1)	1,320(5)	2,100(8)	1,000(1)		1,448(22)
- age (month)			10.1		12	7.2	10.3	8		9.5
3 - price (n)				1,500(4)	600(2)		2.750(1)	1,683(6)	2.000(1)	1.575(14)
- age (month)				14.8	8		7	9.8	6	10.5
4 - price (n)					1,200(1)	1,000(1)	750(1)		2,250(2)	1,490 (5)
- age (month)					8	8	5		12	9
5 - price (n)							1,800(1)			1,800 (1)
- age (month)							12			12
6 - price (n)						1,200(1)				1,200 (1)
- age (month)						12				12
Overall price/ month of age (Rs)	83	88	75	101	133	149	179	166	217	144
Known sales/year	5000(3)	3700(2)	5250(7)	9300(6)	37700(21)	27250(16)	47500(17)	22900(10)	15000(5)	173600(87)

The 5 NLDB-NADSA farms without cattle had a monthly farm gross margin of SL Rs 180 derived from perennial crops only. Monthly family gross margin was SL Rs 730 through off-farms receipts of SL Rs 550.

Dairy expenditure on feeds and minerals amounted to 42% of the receipts from milk on project farms with cattle and lower than the 51% found on control farms. Average farm gross margin of NLDB-NADSA farms (SL Rs 769) differed considerably per main area (from 525 in Rajawelle to 1,446 in the Red Cross Village) and for farms with cattle (810) and those with cattle in milk (1,010) but not with control farms (SL Rs 774). Dairying contributed 66% to monthly gross margin of the farm and 32% of the family on the surveyed NLDB-NADSA farms and 81 respectively 46% on control farms. Off-farm income contributed around 50% except for the Red Cross Village where income from vegetable production contributed 41% to farm gross margin and 35% to family gross margin.

In Figure 8.2, average family gross margin per main area is given, differentiating farmers with cows in milk, those without lactating cattle, and those without cattle.

The majority of farmers indicated that the productivity of abandoned tea land had improved through the application of cattle dung and urine (64%), others (36%) mentioned the beneficial use or combination of compost, mulching and artificial fertilizers, soil conservation and farm management.

Table 8.10. Mean composition and coefficient of variation (c.v. in %) of monthly farm and family gross margin, and expressed monthly family cash needs of NLDB-NADSA cattle loanees (all farmers, farmers with cattle in milk, and farmers with cattle) per main area and of 19 control farmers interviewed in October 1993.

Main Area	Galaha	Nawala-pitiya	Gampola	Red Cross Village	Rajawelle	---NLDB-NADSA Loanees--- All Farmers		1)	2)	Control Farmers	
Number of farms	30	19	16	10	1	76		55	71	19	
Economics per month	Mean	Mean	Mean	Mean	Mean	Mean	c.v.	Mean	Mean	Mean	c.v.
Sale of milk (litres)	142.1	75.9	113.2	121.8	100.0	117.7	81	162.7	126.0	164.5	83
Milk receipts (Rs)	1,021	662	784	950	800	874	85	1,207	935	1,248	97
Expenses on dairy (Rs)	443	228	366	364	350	367	90	507	393	642	120
Vegetables receipts (Rs)	90	113	12	1,010	0	195	328	244	209	4	436
Expenses on vegetables (Rs)	28	35	3	415	0	74	441	94	79	0	
Perennials receipts (Rs)	138	82	237	295	75	171	122	185	170	145	242
Expenses on perennials (Rs)	10	43	51	30	0	30	355	26	32	8	436
Farm gross margin (Rs)*	767	550	612	1,446	525	769	87	1,010	810	747	70
Off-farm cash receipts (Rs)	992	773	855	265	750	813	141	822	831	584	126
Family gross margin (Rs)*	1,759	1,323	1,468	1,711	1,275	1,582	77	1,831	1,641	1,331	68
Expressed cash needs for the family	2,026	1,706	2,045	2,175	1,550	1,977	62	2,136	2,060	2,196	57

1) NLDB-NADSA loanees with cattle in milk. 2) NLDB-NADSA loanees with cattle
* excluding average livestock sales estimated at SL Rs 125 per farm.

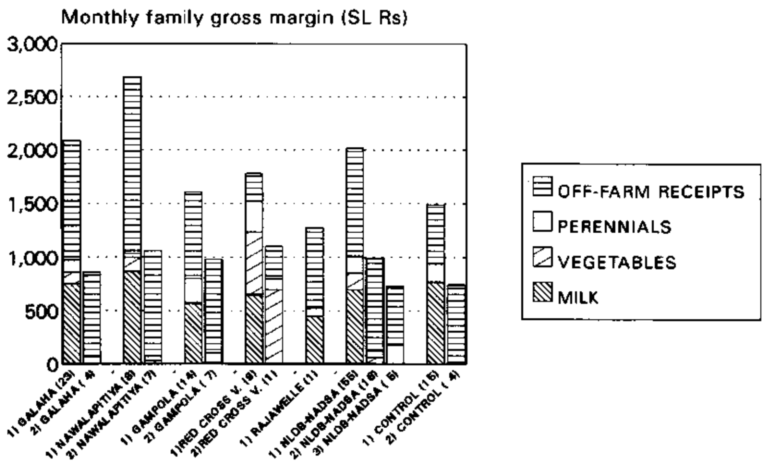

Fig. 8.2. *Average gross margin for farm activities and off-farm cash receipts per main area and number of farms on 76 NLDB-NADSA and 19 control farms for farmers 1) with cows in milk, 2) without lactating cattle and 3) without cattle in October 1993.*

In Figure 8.3, average family gross margin of project and control farms is detailed per main area and compared with the average monthly farm cash flow (receipts minus expenses) over 1985-1992 of the 3 MLDC farms on which farmers were trained.

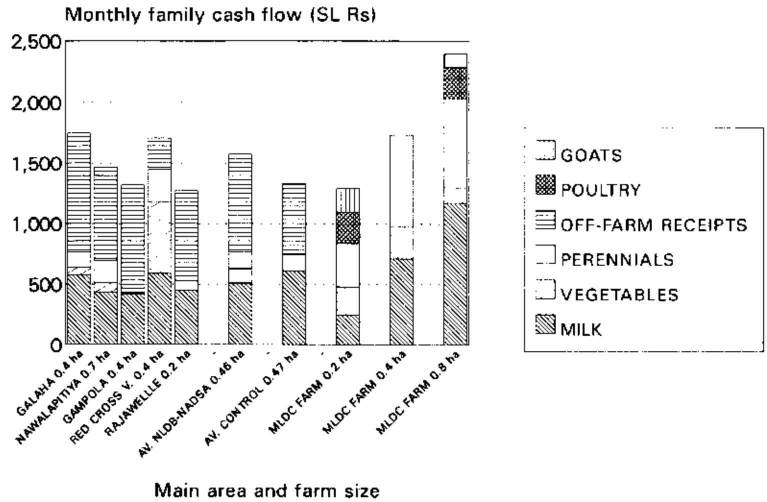

Fig. 8.3. *Average monthly cash flow for farm activities and off-farm cash receipts per main area on 76 NLDB-NADSA farms and 19 control farms in October 1993 compared with average monthly cash flow from 1985-1992of demonstration farms (0.2, 0.4 and 0.8 ha) at MLDC where farmers were trained.*

The impression of farmer and interviewer on the status of the farm in general (stand of the crops including vegetables), the cattle shed and the condition of the cattle is averaged in % excellent, good, moderate and poor in Table 8.11. Generally, farmers considered their crops, cattle shed and cattle condition slightly better than the interviewers. The total score in the categories excellent and good was only 48.8% for crops, 35.3% for cattle shed and 53.4% for cattle condition on project farms, against even lower scores on control farms for crops (36.4%) and cattle shed (22.8%), but a higher score for cattle condition (73.7%).

Table 8.11. Impression of farmer and interviewer on general status of the farm/crops, cattle shed and condition of the cattle in 76 NLDB-NADSA farms and 19 control farms in October 1993.

Impression in %	Excellent		Good		Moderate		Poor	
by	Farmer	Interviewer	Farmer	Interviewer	Farmer	Interviewer	Farmer	Interviewer
Project farms								
Status of farm/crops	6.8	6.8	45.4	38.6	43.2	43.2	4.6	11.4
Cattle shed	4.5	2.3	27.3	36.4	43.2	36.3	25.0	25.0
Cattle condition	6.8	2.3	47.7	50.0	29.6	25.0	15.9	22.7
Control farms								
Status of farm/crops	9.1		27.3	36.4	63.6	63.6		
Cattle shed			36.4	9.1	27.3	63.6	36.4	27.3
Cattle condition	9.1		72.7	63.6	9.1	27.3	9.1	9.1

In Table 8.12 and 8.13 the results are given of step-wise regression of total monthly farm gross margin of project and control farms on the characteristics of family size, farm size, crops, livestock and training.

Table 8.12. Least square (l.s.) mean and regression coefficients of characteristics after step-wise regression on monthly farm gross margin of 76 NLDB-NADSA farms surveyed in October 1993 (SL Rs).

Characteristics	l.s. Mean1)	s.e.2)	Regr. Coefficients	s.e.2)
Overall monthly farm gross margin	861	82		
Main area				
Galaha	852a	88		
Nawalapitiya	522b	130		
Gampola	456b	103		
Red Cross Village	1,487c	148		
Rajawelle	988abc	371		
Milk sales to DPA (l/month)			5.32****	0.53
Male calves produced by first animal			-121 **	37
Training periods (number)			114	62
Vegetable area (m^2)			0.23	0.14
Vines, clusters and fruit trees (n)			0.45	0.26
R^2 model = 75% 3)				

1) l.s. Means with different superscripts are statistically significantly different (P>0.01); 2) Standard error; 3) Coefficient of determination. ** P<0.01; **** P<0.0001

NLDB-NADSA farmers in the Red Cross Village earned statistically significantly more farm gross margin, followed by Galaha, than the ones in Nawalapitiya and Gampola. In addition, more than average milk sales (117.7 litres per month) improved and number of male calves produced by the first animal (1.7) decreased statistically significantly monthly farm gross margin by SL Rs 5.32 per extra litre and SL Rs 121 per extra male calf. More than average vegetable area (120 m^2), *training periods (1.9) and trees (310) contributed with* SL Rs 0.23 *per extra* m^2, 114 *per* extra period and 0.45 per extra tree, but these effects were not statistically significant (P > 0.05). This model explained 75% of the variation in farm gross margin.

Table 8.13. Least square (l.s.) mean and regression coefficients of characteristics after step-wise regression on monthly farm gross margin of 19 control farms surveyed in October 1993 (SL Rs).

Characteristics	l.s. Mean	s.e.1)	Regr. Coefficients	s.e.1)
Monthly farm gross margin	747	66		
Milk sales to DPA (l/month)			4.21****	0.43
Training periods (number)			-108	55
Year of reception of first cow			42	31
R^2 model = 87% 2)				

1) Standard error; 2) Coefficient of determination. **** P<0.0001.

Variation in control farmers' farm gross margin was explained for 87% by differences in the sale of milk, year of reception of the first cow and number of training periods. More than average milk sales (164.5 litres per month) improved monthly farm gross margin significantly by SL Rs 4.21 per extra litre. More than average training periods (0.9) reduced it by SL Rs 108 per period and first cows received after 1989 improved it with SL Rs 42 per year, but these two effects were not statistically significant (P > 0.05).

When off-farm cash receipts of NLDB-NADSA farmers were included in the step-wise regression, 93% of the variation in monthly family gross margin could be explained (Table 8.14). Area differences followed the same pattern as under farm gross margin. In addition, more than average off-farm cash receipts (SL Rs 822), milk sales (117.7 litres per month) and number of training periods (1.9) contributed positively and number of male calves (1.7) negatively to family gross margin (SL Rs 1,582) statistically significantly by 0.91 per SL Rs off-farm cash, 5.28 per litre, 151 per training period and minus SL Rs 111 per male calf. More than average vegetable area (120 m^2), and number of trees (337) increased average monthly family gross margin with 0.26 per m^2, and SL Rs 0.41 per tree, but effects were not significant (P > 0.05).

Step-wise regression of monthly family gross margin of control farmers (Table 8.15) showed that 95% of the variation could be explained, positively by more than average off-farm income (Sl Rs 584) and milk sales (164.5 litres per month) at the rate of SL Rs 1.07 per extra SL Rs off-farm cash and SL Rs 4.25 per extra litre. Extra training periods (average 0.9) reduced it by SL Rs 172 per period and a first cow received after 1989 improved it by SL Rs 42 per year, but these effects were statistically not significant (P > 0.05).

Table 8.14. Least square (l.s.) mean and regression coefficients of characteristics after step-wise regression on monthly family gross margin of 76 NLDB-NADSA farms in October 1993 (SL Rs).

Characteristics	l.s. Mean1)	s.e.2)	Regr. Coefficients	s.e.2)
Monthly family gross margin	1,666	79		
Main area				
Galaha	1,688a	86		
Nawalapitiya	1,311b	126		
Gampola	1,283b	100		
Red Cross Village	2,237c	146		
Rajawelle	1,809abc	359		
Off-farm cash receipts (SL Rs)			0.91****	0.04
Milk sales to DPA (l/month)			5.28****	0.48
Male calves produced by first cow (n)			-111 **	37
Training periods (number)			151 *	62
Vegetable area (m^2)			0.26	0.14
Trees (vines, clusters, fruit trees) (n)			0.41	0.26
R^2 model = 93% 3)				

1) l.s. Means with different superscripts are statistically significantly different (P>0.01);
2) Standard error; 3) coefficient of determination. * P<0.05; ** P<0.01; **** P<0.0001

Table 8.15. Least square (l.s.) mean and regression coefficients of characteristics after step-wise regression on the monthly family gross margin of 19 control farmers in the NADSA areas (SL Rs).

Characteristics	l.s. Mean	s.e.1)	Regr. Coefficients	s.e.1)
Monthly family gross margin	1,331	53		
Off-farm income			1.07****	0.07
Milk sales to DPA (l/month)			4.25****	0.43
Training periods (number)			-108	55
Year of reception of first cow			42	31
R^2 model = 95% 2)				

1) Standard error; 2) coefficient of determination. **** P<0.0001.

DISCUSSION

The outcome of the survey was disappointing in the sense that very few farmers without cattle were found to compare dairy farming with non-dairy farming on small-scale farms on abandoned tea land. All neighbouring control farms had cattle, although they started dairying 1-3 years later than NLDB-NADSA loanees. The five project farmers (only two had not repaid the loan in full) that were found without cattle, showed no gainful alternative for dairy farming: they had a low average family gross margin of SL Rs 730, composed of perennial crops and off-farm cash receipts only. Repayment in the Rajawelle Special Project had been completed early, for which also off-farm cash receipts were used. According to the Menikhinna DPA's secretary in that area, 6 (86%) of the 7 loanees had stopped farming mainly due to further fragmentation of the small plots (0.2 ha) in the semi-urban area and low returns from dairy compared to urban off-farm jobs.

NLDB-NADSA single cattle loan repayments in 36 fixed amounts, varied from 85 per month for 1984 beneficiaries to 125 Sri Lanka Rupees for loanees that started in the late 1980s. This amount equalled about 18 litres per month or 0.6 litres per day (13% of daily milk yield). This is much lower than the amount farmers in Indonesia paid for imported cattle at 3 litres per day (30% of daily milk yield) over a seven year period (Ibrahim *et al.*, 1991). Based on an average lactation length of about 8.5 months (Table 8.5), repayment required over 4 lactations. With an average production of 2.95 calves, and subsequently 2.95 lactations, farmers could not complete payment from the lactations of the original animal. Some used other sources of funds, but most farmers used part of the milk of the offspring of their first animal to settle their loans completely. Overall repayment by these resource-poor farmers was satisfactory, although farmers in Gampola and especially Nawalapitiya were behind schedule (Figure 8.1), associated with low fractions (74 respectively 50%) of farms producing milk or low ratios of cows in milk (72 respectively 65%) at the time of the survey (Table 8.2 and 4).

Cattle productivity of the first animal up to October 1993, compared with earlier studies in the Galaha area covering the period from November 1984 to January 1986 (Ariyaratne, 1986) and from November 1984 to July 1987 (Odekerken, 1988) is illustrated in Table 8.16. After high initial death rates in 1984/85, mainly caused by tick fever and worms due to stock grazing outside, the situation improved in 1987 (Ariyaratne, 1989). Mortality rates up to October 1993 are slightly higher, but cover a much longer period.

In October 1993, calf production of 2.95 calves per supplied animal for NLDB-NADSA farmers was composed of 2.82 calves from 56 animals that left the farms (either dead, culled or sold) and 3.22 calves so far of 20 original animals (26%) still present in the farms. First cows of control farmers produced up to October 1993 on average 2 calves, but these farmers had 14 animals (74%) still in the farms.

Over time, daily milk sale figures improved from 1986 to 1987, due to more productive second and third calvers in 1987. No further improvement was seen in October 1993, except in control farms, that had more cattle and cows in milk (Table 8.4). Average production per cow in milk was low in 1993 due to very high concentrate prices which hit control farmers with more cattle even harder. Odekerken (1988) found that farmers were feeding 2 kg concentrates per cow per day, while in the 1993 survey, estimated from the level of dairy expenses of SL Rs 542, project farmers fed in average about 1.5 kg per cow per day.

Calving intervals were long on project farms in particular between first and second lactation (512 days) and between second and third lactation (535 days). Causes were initially the late introduction of bulls but also farmers' reluctance to early breeding because of noted drops in milk production in pregnant cows. Resource- poor farmers depended heavily on milk for income and loan repayment, and that would assist in explaining that generally peak milk yields are lower and lactation lengths longer in project animals (Table 8.5). Average peak milk yields also tended to be slightly higher within NLDB-NADSA farms (Table 8.5) in areas with a high percentage of male calves (Galaha, Red Cross Village). The latter may be due to smallholder practices of allowing male calves less milk suckling than female calves. Adjusted l.s. gross margins for male calf effects were therefore considerably higher than actual in Galaha, Red Cross Village and Rajawelle (Table 8.12 and 14). Lactation periods were longer within NLDB-NADSA animals for areas with a higher percentage of female calves.

Overall average long calving interval of 507 days (75 records) in NLDB-NADSA farms equalled those of the study of Nholope *et al.* (1993), who calculated an average calving interval of 511 days for 925 cows that calved between 31st March 1992 and 1st April 1993 in the Kagera Smallholder Dairy Extension Project in Tanzania. Average lactation lengths of 8-9 months, as recalled by the farmers during the survey, are short in view of these long intervals. Odekerken (1988) found at one DPA that 34 farmers had delivered milk during 7,630 farm-milk delivery days (in average 82%) out of 9 months' milk collection data. In October 1993, 55 (77%) out of 71 NLDB-NADSA farmers with cattle produced milk and 15 (79%) of control farmers, suggesting an average lactation length of about 12.8 months per average overall calving interval of 507 days in project animals.

Table 8.16. Comparative cattle productivity of the first animal in the surveyed farms per January 1986, July 1987 and October 1993 in the NLDB-NADSA areas.

Main area	Galaha	Galaha	Galaha, Gampola, Nawalapitiya Red Cross Village and Rajawelle	Galaha, Gampola Nawalapitiya
Farms	NLDB-NADSA	NLDB-NADSA	NLDB-NADSA	CONTROL
Characteristics/survey report	January 1986	July 1987	October 1993	October 1993
First animal received during	1984/85	1984/86	1984/90	1985/93
Farms surveyed (n)	48	53	76	19
Animals issued (n)	55	58	77	
Mortality original animals (%)	12.5	8.6	11.8	7.9
Number of calves produced	42	99	224	38
Mortality calves (% of calves born)	28.6	19.2	21.0	5.3
bull calves (%)	47.6	30.0	25.4	
heifer calves (%)	9.5	8.2	15.3	8.0
Sale of heifer calves (%)		9.3	32.7	16.0
Sale of bull calves (%)		30.0	61.9	46.2
Unknown destiny (%)			4.0	23.7
Farms surveyed with milk records*	42	34	71	19
Milk production per cow in milk (l/d)	4.3	5.2	4.7	4.0
Milk sales per farm (l/d)	3.8	4.3	4.2	6.8
Home consumption per family (l/d)	0.5		0.6	0.7
First calving interval (d) (records)	482 (15)	521 (40)	512 (32)	493 (1)
Second calving interval (d)		392	535 (24)	367 (1)

* period of analysis: November 1984-January 1986; November 1986-July 1987; and September/October 1993, respectively.

On control farms more cattle and cows in milk were kept than on the NLDB-NADSA farms, but monthly gross margin from milk differed only by 64 SL Rs, due to less milk per cow in milk and higher concentrate expenses. Widodo *et al.* (1994b) found a similar trend of reduced gross margins per cow between one cow dairy farms and larger units (2, 3, 4 and more cows) in small mixed dairy/crop farms in East Java.

Livestock other than cattle, *i.e.*, goats and poultry was limited to a few farmers only. This is not surprising for poultry in the light of large negative poultry gross margins in 1992 on the MLDC farms (De Jong *et al.*, 1994), but goat keeping deserves more attention for income generation as shown at the 0.2 and 0.8 ha MLDC farms (Figure 8.3). On the other hand there is limited supply of breeding goats versus high demands of rural and urban projects going for high prices of goat milk (about double the price of cow milk).

NLDB-NADSA farms and control farms showed a large variation in vegetable area size, number of remaining tea bushes, number and type of trees (vines, clusters and fruit trees) planted between and within areas. Apart from home consumption not much gross margin was generated from crops (Table 8.10). The exception was from vegetables and perennial crops in the Red Cross Village area with farmer settlers from Rikilligaskada, that have grown vegetables traditionally and that still do a lot of tea picking.

On NLDB-NADSA farms, milk, vegetables and perennial crops contributed 66, 15 and 18% respectively to average monthly farm gross margin (SL Rs 769) and 32, 8, 9% to average monthly family gross margin (SL Rs 1,582 or US$ 34 with 51% from off-farm cash receipts). On control farms, these contributions were 81, 1 and 18% to farm (SL Rs 747) and 46, 0, 10% to family gross margin (SL Rs 1,331 or US$ 28 with 44% from off-farm receipts). These gross margins on abandoned, tea land were considerably lower than average family gross margin (equivalent to US$ 63 per month) found by Widodo *et al.* (1994a) in 1989/90 on small-scale dairy farms on more fertile land in East Java in three farming systems (cassava, horticulture and sugar cane dominated). In East Java, average family size was smaller (4.5 versus 5.3 and 4.7 persons), farm size larger (0.58 versus 0.46 and 0.47 ha), and farmers kept more TLU in dairy cattle (3.31 versus 1.60 and 2.24) than in NLDB-NADSA and control farms. Average contributions to family gross margin of 42% from dairy, 29% from crops and 29% from off-farm revenue indicated that dairy-crop farming yielded more gross margin in absolute and relative terms in East Java than obtained so far on abandoned tea land under rehabilitation.

Gross margins of project and control farms were also different from the monthly gross margins achieved monthly over 1985-1992 from farm activities (no off-farm employment was allowed) at the demonstration farms at the MLDC, where farmers were trained: SL Rs 1,311 (US$ 41) in the 0.2 ha; SL Rs 2,037 (US$ 65) in the 0.4 ha; and SL Rs 2,807 (US$ 89) in the 0.8 ha farm. Level and composition of farm and family gross margin between surveyed farms and farm cash flow on MLDC demonstration farms (Figure 8.3) showed that farmers in Galaha (0.4 ha), Nawalapitiya (0.7 ha), Gampola (0.4 ha) and Rajawelle (0.2 ha), only through off-farm cash receipts surpassed the 0.2 ha farm, but obtained less than at the 0.4 ha and especially the 0.8 ha farm. Farm size in MLDC farms was important for farm gross margin, but at field level differences were not marked. Intensity of farming was higher at MLDC farms, so original NADSA's objectives of gainfull employment and improved land use as shown at MLDC, have only in part been realized at NLDB-NADSA farms, but farmers' problems were higher due to shortage of water and wild boars attacking vegetables and food crops (Ariyaratne, 1989).

Regression analysis showed statistically highly significant contributions of milk sales to farm and family gross margin of project and control farmers (Table 8.12 and 8.14). In Figure 8.4 the wide variation in milk sales per day is illustrated for surveyed farmers in 1986, 1987 and 1993.

Over time there was a tendency that more farmers reached higher milk sales per day, although in 1993 also a good number were in the category of no milk sales, since records were based on one month only compared to an average picture over 14 months in 1986 and 9 months in 1986/87.

In addition, off-farm cash receipts contributed statistically significantly to family gross margin (Table 8.13 and 8.15). Area differences and number of male calves produced by the first project animal were important, significant factor and covariable respectively. Size of vegetable area and number of trees supported gross margin but this was not statistically significant ($P > 0.05$). When number of male and female calves were taken out of the step-wise regression, farm of origin of the first animal became statistically significant with SL Rs 200 more for ex-Haragama animals compared to ex-Rosita animals. De Jong and Ariyaratne (1995) found that ex-Haragama stock farmers obtained 59 female and 54 male calves from 40 in-calf heifers, while 33 of Rosita produced 64 male and 37 female calves. The very different sex ratio caused a delay in expanding dairying and generating more gross margin from milk (Table 8.4 and 8.10). Expansion of the dairy enterprise was slow also since more first female calves were sold than kept on the farm (Table 8.7). Thereafter, the ratio kept on farm vs sold female calves increased rapidly, resulting in more heifers and cows on the older dairy farms (Table 8.4).

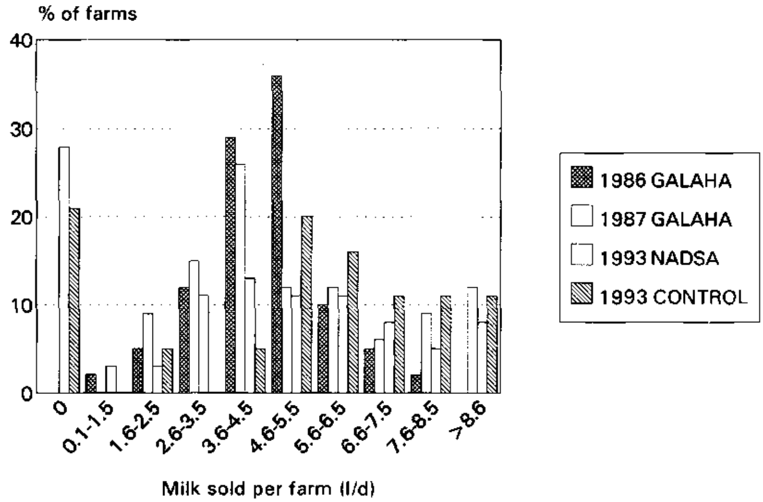

Fig. 8.4. *Daily milk sales in the NADSA areas as encountered during surveys in 1986, 1987 and 1993.*

Length of dairy farming (period/year of animal reception, number of calves born), after step-wise regression, did not contribute positively to gross margin. In fact, more bull calves produced over time reduced monthly farm and family gross margin with farm gross margin with SL Rs 121 and family gross margin with SL Rs 111 per bull calf above average (1.7).

MLDC training periods (average 1.9, totalling 8.9 days) of project farmers in mixed dairy/crop farming contributed positively to farm gross margin and even significantly to family gross margin (Table 8.12 and 8.14). Less and shorter training periods (average 1.5 totalling 6 days for 11 persons) by MLDC or NADSA for control farmers had a negative contribution to gross margin (Table 8.13 and 8.15).

Gross margins from tree crops (an important contributor to gross margin on the MLDC demonstration farms, Figure 8.3) have not yet fully materialized on these poor tea soils. Coconut trees in this respect had just started bearing in the visited NADSA areas.

The general impression on the status of the farm crops, the cattle shed and the cattle condition was in the majority of farms moderate to poor. Lack of funds for intensification and maintenance of farms, and shortage of interested family labour in small-scale farming seemed to impede more intensive farming in NADSA farms.

Off-farm work, mainly as casual labourers, was the most important source of family gross margin of the surveyed farmers except in the Red Cross Village area where dairying and crop farming (vegetables and perennials, especially tea picking) dominated and on control farms where dairying and perennial crops together was higher than off-farm cash receipts (Table 8.10). Almost all farmers indicated that the cash needs of the family (SL Rs 1,977 for project farmers and SL Rs 2,195 for control farmers) were higher than the money obtained from off-farm work and farm activities, and only through food supporting programmes by the Government families managed to survive.

The large dependence on off-farm cash receipts so far, defeated the original 5 year NADSA concept that farmers would find gainful self employment on small-scale farms with diversified crops and some dairy farming on abandoned, marginal tea land. Neither, generated farm nor family gross margin turned out to be sufficient to cover their cash needs for purchasing cereals, salt, clothes, schooling and medical services. Also, due to the small size of the dairy herds, milk yields do fluctuate much during the year. In spite of these fluctuations, NLDB-NADSA loan scheme farmers were more enthusiastic than the economic outcome justified (Ariyaratne, 1986) and there is great demand for more cattle in the NADSA areas. Also, breeding female stock becoming available from NLDB-NADSA farms allowed more farmers to start dairying.

At the end of 1994 close to 200 resource-poor farmers (in average 20 annually from 1984-1994) had received a NLDB-NADSA loan and also other farmers started dairy farming through cash purchases and bank loans as could be observed on the control farms. In view of rising cattle prices from 1990, the NLDB-NADSA revolving fund that does not charge interest to resource-poor settlers can in future serve less new farmers per year. The fund handed over by SFDP mid 1991 amounted to almost SL Rs 500,000 and if repayment rates are kept up some 10 resource-poor farmers can annually benefit from the scheme at the 1993 price of in-calf heifers (10-12,000 SL Rs).

CONCLUSIONS

Financially, overall loan repayment of resource-poor NLDB-NADSA *farmers that obtained* an interest- free single cattle loan was satisfactory, although slow in Gampola and Nawalapitiya. Repayment in 36 monthly instalments could not be completed from the average 2.95 lactations of the first animal. Peak milk yields during lactation averaged around 7 litres per cow per day with average daily milk production of 4.7 litres (project farms) and 4 litres (control farms) per cow in milk and milk sales of 4.2 respectively 6.8 litres per farm in October 1993. Long calving intervals of 507 days based on 75 records and mortalities from tick borne diseases indicated that sufficient technical attention should be given to arrive at higher potential contributions of dairying. Off-farm income (mainly casual labour) contributed 51% (project farms) and 44% (control farms) to family gross margin defeating the original NADSA concept of gainful self employment on small-scale farms. Only Red Cross Village farmers obtained major family gross margins from farming: dairy (34%), vegetables (35%) and perennial crops (15%) and had, followed by pilot farmers in Galaha, significantly higher monthly farm and family gross margins, than those in Nawalapitiya and Gampola. Milk sales ($P > 0.0001$), area differences ($P < 0.01$) and number of training periods explained positively, and number of male calves of the first animal ($P < 0.01$) negatively, 75% of variations in monthly farm and togther with off-farm cash ($P < 0.0001$) 95% in family gross margin. On control farms, milk sales only ($P < 0.0001$) explained *significantly 87% of variation in farm gross margin, while similarly off-farm cash receipts* ($P < 0.0001$) and milk sales ($P < 0.0001$) explained 95% of the variation in family gross margin. Short term activities such as vegetable growing and long term tree cropping have sofar contributed mainly to subsistence food and relatively little to income generation on project farms and even less on control farms. Although farm gross margins were less than those at MLDC demonstration farms on which farmers were trained, more than average, longer training periods (1.9) contributed positively to project farmers' gross margins, while more than average, short training periods (0.9) were associated with reduced gross margins in control farms. Dairy farming proved a potentially, attractive cash earner next to off-farm cash receipts for settlers on abandoned, marginal tea lands, essential for land improvement and able to generate additional livestock sales estimated at Sl Rs 1,000 per year. NADSA's objectives of gainfull employment and improved land-use have only in part been achieved, while settlers still depended on food support of the Government to survive between expressed monthly cash needs of about SL Rs 2,000 and family gross margins of SL 1,582 (project farms) and SL Rs 1,331 (control farms).

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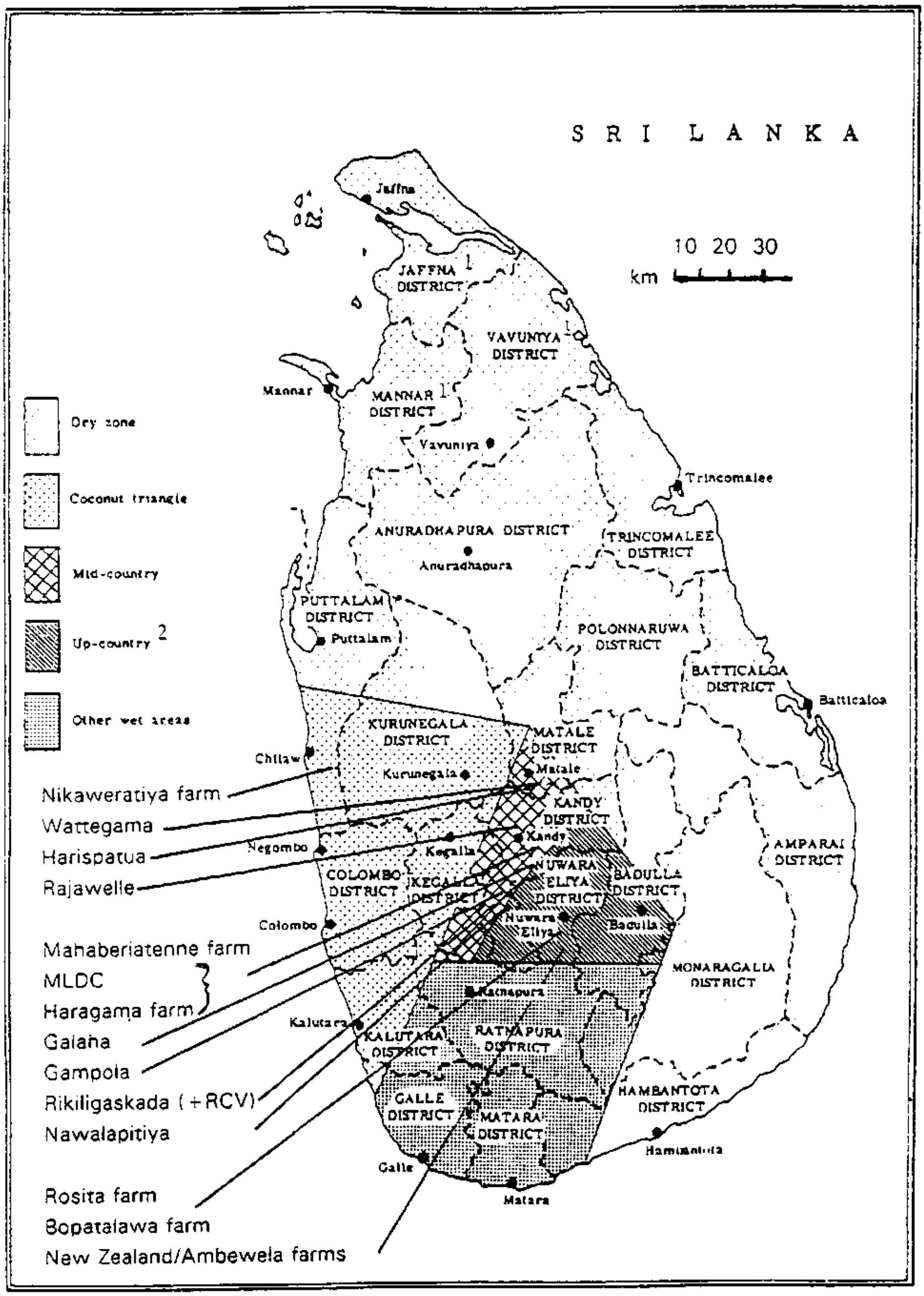
Map 8.1

Agro-Ecological Zones in Sri Lanka



1 A new district - Mullaitivu - was created in January 1979 from parts of Jaffna, Mannar and Vavuniya districts.

2 The Up country area is also referred to as Hill country.

Appendix 8.1

QUESTIONNAIRE FOR NADSA SURVEY (CROP/STOCK ON ABANDONED TEALANDS)

1. **Name and address of farmer**...

   DPA:.......................Supply number:.........Member number........
   Family size: total persons:.........
   Number of adults:...male...female...;no of children:... boys... girls...
   Home consumption of milk per month:........litres

2. **Farm**: size...... acres. How many crops and livestock do you have?

   Coconut trees:... Cloves:....Pepper vines:..... Tea bushes........
   Jack trees:..... Bread fruit trees:.......Mango:.....Avocado:.....
   Bananas:.....Coffee:.....Other:......................................

   Vegetable plot size in square meters:.... type of vegetables:..........

   Fence type (species)............................ length in metres....

   Number of cattle: total....: cows in milk.....dry cows....heifers......

   heifer calves....bull calves.... young bulls....bull....

   Other livestock numbers: goats......poultry......Other.................

   Fodder resources: grazing...how many hours per day....own grass plot...
   What type of grasses are being stall fed:.............................
   Which tree leaves:..

3. **Farm history**

   When did you start this farm................(month/year)

Any training received: periods	where trained	who went
First time..................	....	....
Second time.................	....	....
Third time..................	....	....

4. **Livestock history**

   When did you receive your cow:.......... (month & year) Cow no..........

   Breed?...........Value Rs.........and from which farm(er)..............

   Loan received from IDA Rs......... Paid Rs......... Balance left Rs.....

4a. Information from the Milk Co-operative
   Total loan received from IDA...DPA....NADSA.... - Rs...............
   Paid by the farmer - Rs...............
   Balance to be recovered - Rs...............

4b. How many calves did she produce in total:... how many male.. female..

4c. What happened with your first animal (tick) and give the date/reason:
died...date........:cause:..
sold...date........:to whom?farmer in area..other farmer..other:.....
shared...period.............:reason..............................

4d. How much milk did she give in lactation:

	1	2	3	4	5	6
At peak production?: in liters/day	.....	.....	....	....	....	....
How long was she in milk:tot. months	.....	.....	....	....	....	....

5. Cattle progress

What happened with the calves? Please give the details for each calf

	Cow no	Birthdate of calf	Sex F/M	Left in farm	Sold date (age +price)	Died date + reason
Calf 1:	.....	....	...	....	....	....
Calf 2:	.....	....	...	....	....	....
Calf 3:	.....	....	...	....	....	....
Calf 4:	.....	....	...	....	....	....

6. Progress of the farm

Is the land now more fertile?........: why.........................

PLease indicate income & cost of the following activities <u>per month!</u>

Milk (.....liters/month): Rs .... cost: Rs.......items:.....

Income from vegetables: Rs. .... cost: Rs.......items:.....

Income from bushes/trees: Rs. .... cost: Rs.......items:.....

Income from off-farm work:Rs .... type of work:............

How much do you spend outside the farm per month for your family? Rs........
Is the income of your farm enough for your monthly expenditure? Y/N.........

7. Observations of the interviewer and opinion of the farmer

a. Interviewer:
Farm in general: excellent...good...medium...poor...
Cattle shed: excellent...good...medium...poor...
Livestock condition: excellent...good...medium...poor...

b. Farmer:
Farm in general: excellent...good...medium...poor...
Cattle shed: excellent...good...medium...poor...
Livestock condition: excellent...good...medium...poor...

Date of interview...................
Reporter's name...........................Signature...................

9. PERFORMANCE AND PROGRESS OF DAIRY STOCK DEVELOPMENT IN SRI LANKA[1]

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SUMMARY

Various efforts to increase the number and quality of dairy stock in Sri Lanka have been evaluated in the (para)statal sector and in calf rearing schemes and projects at smallholder level. In the (para)statal sector a) multiplication of dairy stock over 1981-1993 allowed about 7% or 2000 head of male and female stock off-take per year for smallholders, b) imported dairy stock did not do well in the production of milk and stock numbers due to poor milk/feed price ratios, heat and humidity stress, and management standards easily resulting in late ages at first calving, long calving intervals and low fractions of cows in milk, and c) special calf salvaging operations at two parastatal farms turned out only 231 female breeding stock per year from 1980-1988 with late ages of first calving. At inspected small-scale dairy farms in 1993 73 of these in-calf heifers, introduced between 1984-1990, produced 214 calves, had a peak milk yield of 6.86 litres per cow per day (n = 202), a lactation length of 8.7 months (n = 188) and a high calving interval of 523 days (n = 69).

At smallholder level calf rearing schemes and projects up to calving showed low mortalities of 2-8%, good growth rates of around 300 gram per day and ages at first calving of around 29 months. The registration of calves was slow and far below the targets set for the schemes (contract heifer breeding, calf health care, AI heifer calf rearing) operated through the veterinary ranges. However, through associated Dairy Producers Associations, the MIDCOMUL Heifer Calf Target Growth Project registered 1850 female calves against 1400 planned in 6 months. Further the experiences at Dutch funded calf rearing extension and incentive projects indicated that attention to calf rearing with incentives such as periodical bonuses for target chest girth reached can improve rearing standards, although there are large differences between the 25% poor and 25% best performers. Chest girth measurements put along a target curve by extension workers worked well. Mobile training for assessment of the calf's chest girth by farmers themselves with tailor bands and growth charts did equally well, and was more cost effective and participatory. The MIDCOMUL young project cows performed well in relation to their dams: 95.5% for chest girth at the age of 1034 days, and a peak milk yield of 75.4%, while fed on 94.1% of the dam's concentrate allocation during peak milk production. Step-wise regression on the MIDCOMUL field data showed the positive effects of suckling (one teat and around milking) and the concentrate level at two years on the age of first calving: 888 days for project young cows and 1084 days for control young cows. The chest girth (153.5 cm) at inspection after calving corresponded positively with the dam's chest girth, the concentrate level at one year and the peak milk yield of the project young cow, and negatively with a low

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availability of fodder expressed by the number of dry months and the total livestock units on the farm. The peak milk yield of 7.7 litres per day related well with the dam's peak milk yield, the concentrate level during the young cow's peak milk yield and the chest girth of the young cow. A higher than average age at first calving had a positive effect on milk yield of project cows but a negative one in the case of the control cows that calved on average 196 days later.

Import of cattle is expensive, even at US$ 1,000-2,000per head. Multiplication of stock required a subsidy of US$ 140-280per animal issued and rearing of salvaged stock costed US$ 200-250against subsidized sales at US$ 100. The AI heifer calf rearing scheme with feed in kind and at 50% subsidy is also costly at US$ 170 per heifer enrolled. Incentive or bonus schemes based on payments at chest girth targets reached, costed at smallholder level up to US$ 100 per in-calf heifer produced, and are recommended for implementation through farmers organizations to raise larger numbers of dairy stock by smallholders with good technical results and at a much lower cost than feasible by the parastatal sector or through import.

INTRODUCTION

While a number of developed countries have surplus production of milk and dairy stock, in many developing countries in the tropics local production of milk and dairy stock cannot meet the demand. The gaps are filled by low cost imports of milk powder and butter oil. National dairy development programmes with strategies to become more self sufficient in milk production and to save on foreign exchange vary considerable among countries. Turnkey projects importing cattle, farm structures, machinery and often management and concentrates are common in Middle East countries and New Income Countries. Exotic stock was imported at smallholder level at large scale in Indonesia and at smaller scale in other Asian countries.

Sri Lanka has a long history of importing foreign dairy stock. During colonial times cattle from temperate zones were imported to supply milk to the estate sector, and Indian zebu types for urban milk production. Since 1936, the government has opened farms in various parts of the country, introduced imported cattle and buffaloes for crossbreeding and upgrading of local stock for draught and milk, and initiated multiplication of stock for the smallholder sector to increase milk production island-wide (M/RID, GTZ, 1985). More recent imports included some 900 Dutch heifers in 1978/79 at Mahaberiatenne and Haragama farm in the Mid Country and New Zealand farm in the Hill Country, some 100 Sahiwal cattle in December 1989 and some 200 Nili Ravi buffaloes in 1990 at Nikaweratiya farm in the Coconut Triangle, and a hundred Australian Friesians in December 1993 at Bopatalawa farm in the Hill Country.

Sri Lanka's bill for the import of dairy products rose from 34 in 1973 to 76 million US$ in 1993 associated with the import of 24,000 to 36,000 tons of milk powder, respectively, the equivalent of 192 to 288 million litres of milk. Local milk production in 1993 is estimated at 327 million litres, of which 82 million is collected by the two main processors MILCO and Nestlé (Daniel, 1994).

The island's number of large ruminants has been quite stable over the last 20 years with about 1.7 million head of cattle and 0.9 million buffaloes. The main development from 1973 - 1993 has been that the proportion of dairy cows doubled from 20 to 40% at the expense of a reduction of non-dairy cows from 35 to 20%, bulls from 20 to 17% and calves from 25 to 23%. In buffaloes the number of dairy cows rose from 13 to 32% with reductions in non-dairy cows from 32 to 24%, bulls from 30 to 21% and calves from 24 to 23%. The increased emphasis on dairy has not led to a higher fraction of calves essential for replacement stock and in-calf heifers for the many aspiring dairy farmers.

Various ways are tried in Sri Lanka to increase the number and quality of dairy stock in the country. On (para)statal farms the approach includes a) multiplication of breeding stock, b) import of foundation stock in the form of young or in-calf dairy heifers, and c) salvaging and raising operations of neglected smallholder calves. In the smallholder sector, after failing performances with imported cattle in the seventies and early eighties, experiences have been gained since 1985/86 with calf rearing schemes such as d) contract heifer breeding and raising and e) calf health care, followed by f) AI heifer calf rearing scheme "Kerala" since 1992. The Sri Lanka-Netherlands Livestock Development Programme (SL-NLDP), in operation from 1982 to June 1991, supported the National Livestock Development Board (NLDB) in the Small Holder Dairy Development Project (SHDDP 1985-1989) with various pilot calf rearing extension and incentive projects at Dairy Producers Associations (DPAs) in the Mid Country: 1) at Rikilligaskada, 2) at Rikilligaskada and Galaha, 3) calf competitions in large DPAs, and 4) at Matale DPA. The Matale pilot project was succeeded for all DPAs by 5) the Mid Country Milk Producers Union (MIDCOMUL) heifer calf rearing target growth project in 1990 under the SL-NLDP Small Farmer Dairy Project (SFDP).

During three visits in 1993 and one in 1994, information on the various dairy stock development, calf rearing schemes and projects in Sri Lanka was collected, while on sabbatical leave at the Post Graduate Institute of Agriculture (PGIA). At field level records were taken of chest girth, milk production during the first and second lactation and calf rearing practices. Preliminary results were discussed in Sri Lanka during two seminars and fed back through brief visit reports. In this paper a comprehensive analysis is given of the results and a discussion of the important technical, economic and organizational factors involved in approaches to stock development.

MATERIALS AND METHODS

Sri Lanka, an island in the Indian Ocean, is located between 6 - 10 °N and 80 - 82 °E, and measures 65,610 km². Administratively it is organized in 9 provinces comprising 25 districts. The climate is influenced by two monsoons: the northeast monsoon in December-January with rain to the Northern and Eastern dry region and the southwest monsoon during May-July with main rainfall for the Central Hilly, Southern and Western regions. Average annual temperatures range from 27 °C at the coast, and from 18.3 to 23.8 °C in the Mid Country (305-914 m a.s.l.) to 16 °C in Nuwara Eliya (1,890 m a.s.l.) in the Hill Country. Rainfall varies from 1,900-5,000 mm in the Mid Country and from 2,160-3,175 mm in the Hill Country.

The government livestock farms are dispersed in various agro-ecological zones: the Coconut Triangle, Low Country Wet and Intermediate Zone in the West and South of the island, the Dry Zone in the North and East, and the Mid Country and the Hill or Up Country in the Centre. Appendix 9.1 shows agro-ecological zones, farms and places mentioned in this paper. Most farms are operated by the National Livestock Development Board (NLDB), established in 1973, some were run by the Department of Animal Production and Health (DAPH) from 1978 to 1991, when they were handed over to NLDB, and 6 farms are managed by the Mahaweli Authority of Sri Lanka (MASL).

Dairying in Sri Lanka is mainly a small-scale, complementary labour and income generating activity with a low milk price of about 0.20 US$ per litre with a standard content of 4.3% butterfat and 8.4% solid non fat (SNF) and concentrates at variable, high prices between 0.15 to 0.25 US$ per kg coconut meal (poonac) or commercial mixtures.

In the Mid Country or Central Province, the main smallholder area of this study, dairying is characterised by a few crossbred cattle per farm both in the "higher" located tea estates and the "lower" located surrounding villages. Most dairy cows are stallfed with grasses and weeds from roadsides, ravines, crop fields and forest gardens. Some grazing occurs in villages of mainly dry cows and young stock on abandoned, marginal tea lands. Disease incidence, apart from occasional outbreaks of Brucellosis, Foot and Mouth Disease, and Haemorrhagic Septicaemia, is limited to gastro-intestinal infections. Ticks, if not controlled, transmit Anaplasmosis and Babesiosis in the lower and warmer parts, while leeches attack grazing stock in the high and wet areas.

Progress on dairy stock development was studied on the basis of data gathered and monitored under the SL-NLDP up to 1991 (De Jong and Meinderts, 1992), and through field work and desk research in 1993 and 1994 as follows:

(PARA)STATAL LIVESTOCK DEVELOPMENT

a) Multiplication of dairy stock

- reports of the Livestock Planning Division (LPD) of the Ministry in charge of livestock development and milk production and of the Sri Lanka-Netherlands Livestock Development Programme (SL-NLDP) were studied.

- livestock statistics of NLDB farms were collected for the period 1981-1993 from the NLDB monitoring office in Colombo to get insight in animal numbers born, died, culled and sold or issued as breeding stock.

b) Import of dairy stock

- dairy performance records were studied for the NLDB farms at Mahaberiatenne and New Zealand farm that received imported Dutch Friesian stock in 1978/79.

- at New Zealand farm Friesian annual calf growth performance lines for the late eighties and early nineties were updated.

- Nikaweratiya farm of NLDB in the Coconut Triangle was visited to review performance of the 97 Sahiwal and 197 Nili-Ravi buffalo heifers, imported from Pakistan in December 1989 and 1990, respectively.

c) Calf salvaging and raising operation

- the concept of calf salvaging operations was introduced in 1978. The National Livestock Development Board bought neglected or excess heifer calves from smallholders to rear them at two special farms, to breed them and to sell them back to the previous owners or to other interested farmers. In addition some excess stock from NLDB farms was reared as well.

- information on the calf salvaging operation at Haragama farm in the Mid Country and at Rosita farm in the Hill Country, was obtained from farm managers' reports and from 1993 surveys in the National Agricultural Diversification and Settlement Authority (NADSA) programme area on the production and reproduction of ex-Haragama and ex-Rosita in-calf heifers, introduced to aspiring dairy farmers during 1984-1990.

CALF REARING SCHEMES AT SMALLHOLDER LEVEL

d) Contract heifer breeding and raising scheme

- a pilot scheme for contract heifer breeding and raising was introduced in 1985/86 (Anonymous, 1986a) along lines of the New Zealand model of contracting farmers for the production of crossbred Sahiwal-Friesian or Sahiwal-Jersey heifers (Kopalasuntharam, 1987).

Interested farmers qualified to raise good excess stock and prospective farmers in need of dairy stock could apply for registration at the veterinary surgeon's office. Farmers received the market price for their heifer at 1 year or 2 years of age plus a subsidy for the difference between direct rearing costs and the market price (Table 9.1).

Table 9.1. Sale price and subsidy of heifers at one or two years of age under the contract heifer breeding and raising scheme (1985-1991).

Contract heifer prices (received by farmer)	Temperate breed (pure/crossbred)	Dairy Zebu/buffalo (pure/crossbred)
Market price at 1 year old	Rs 1,200	Rs 800
Subsidy	Rs 1,700	Rs 600
Total for 1 year old	Rs 2,900	Rs 1,400
Price at 2 year old, pregnant	Rs 3,500	Rs 3,300
Subsidy	Rs 3,200	Rs 1,500
Total for 2 year old	Rs 6,700 (US$ 248)	Rs 4,800 (US$ 178)

- veterinary office staff took monthly chest girth measurements, gave advice, and recommended on the instalments to be paid at birth, at the age of 4 months, 1 year, 1.5 years and 2 years or when pregnant and ready to be sold.

- initially, the scheme was envisaged for three districts, Nuwara Eliya, Kurunegala and Jaffna with 250 females each at an estimated cost of Rs 700,000 per district. Finances would come from respectively the Dutch funded Nuwara Eliya Integrated Rural Development Project (IRDP), Nestlé Dairy Development Services in North Western province and the Asian Development Bank (ADB) in Northern province. The scheme was introduced island-wide in 1987 with ministerial funding out of a levy on imported milk products, and decentralized with a price and subsidy adjustment to the provincial councils in 1991.

- initial achievements of the contract heifer breeding scheme were evaluated by a random survey in 1986 in the three districts. Van Eekeren (1989) evaluated the scheme in three areas of Nuwara Eliya district in 1988 based on recorded chest girth, the number targeted, registered, withdrawn, dead, or sold, the average age of calving and on scoring the physical condition. A second evaluation of the performance in Kurunegala was collected from the 1992 records of DAPH, North Western Province.

- overall progress including budget versus actual costs from 1986 to 1991 was studied from the records of the Ministry of Livestock Development and Milk Production and the Department of Animal Production and Health.

- since the scheme was decentralized in 1991 to the provinces, a questionnaire pertaining to results over 1992/93 was prepared and sent to the respective provincial headquarters.

e) Calf health care scheme

- an island-wide calf health care scheme, prepared in 1985/86 (Anonymous, 1986b), aimed at the follow-up of 3 annual batches of 16,800 calves born to artificial insemination (AI) and an equal number out of natural mating. Farmers received a package of preventive medicine (pre-immunisation against tick fever, and vaccinations against Haemorrhagic Septicaemia, Brucellosis or Foot and Mouth Disease depending on the area), anthelmintic, acaricide and minerals free of charge representing Rs 428 for a female calf (in 4 kits over 2 years) and Rs 243 for a male calf (in 2 kits over the first year only). Total costs of the scheme amounted to Rs 33,688,800.

- veterinary staff visited farmers monthly to check the chest girth of the calf and to give technical advice. Farmers were expected to follow recommended feeding practices of calves at the rate of 160 kg of milk and 28 kg of hay (first 3 months) and 555 kg of concentrates (31 kg calf starter up to 4 months, 160 kg of calf meal up to 1 year and 364 kg dairy meal in the second year). It was anticipated that calf mortality could be reduced from 20 to 10%, that higher growth rates would increase male weight from 75 to 100 kg at 1 year of age, and that non-pregnant females would now fetch Rs 2,500 instead of Rs 2,000 at the age of 2 years.

- *achievements of the scheme in Nuwara Eliya were taken from Van Eekeren (1989) and* island-wide from ministerial records as under the contract heifer breeding scheme.

f) AI heifer calf rearing scheme "Kerala"

- this scheme was prepared in 1991 (Anonymous, 1991) as a follow-up of the contract heifer breeding and raising scheme aiming at the rearing of part of the annual crop of 25,000 AI female calves at smallholder farms with subsidized feed, and provided in kind at the farm. This scheme was based on good experiences with subsidizing calf feeds in Kerala, India. Initially, the scheme was earmarked for three districts Kandy, Matale in the Mid Country and Gampaha in Western province for three annual batches. The target was to raise 3,600 calves in the first year and 110% of that number in each subsequent year. Its cost was estimated at Rs 56.8 million (1.2 million US$) for 11,916 calves in the period 1992-1996. The aims were to reduce calf mortality to 5% or less, and to reduce the age at first conception at field level from 38 to 23 months. The scheme provides calf feeds in kind in the form of 31 kg calf starter for 4 months, 1041 kg of dairy meal and 27 kg minerals with a 50% subsidy. The scheme also pays 50% of the insurance premium for the animal for a period of 32 months, and gives free vaccination, deworming and technical assistance. Staff of the veterinary ranges monitors the calves monthly for chest girth development and growth rate, and records the number of deaths, sales, drop-outs and the reproduction status up to calving (Anonymous, 1993).

- for the study of the AI heifer calf rearing scheme island-wide growth rate data per May 1993 were obtained from DAPH. For Central Province the following data up to December 1994 were collected from the recording office in Peradeniya: name of the veterinary range (23 in total) and the corresponding district (Kandy, Matale and Nuwara Eliya), birth date and breed of the calf, monthly weights (derived from the relation between chest girth and live weight presented in Appendix 9.2), and information relating to calf mortality, sales, transfers, drop-outs (animals not having calved at 32 months) and details of reproduction such as dates of breeding and calving.

PILOT CALF REARING EXTENSION AND INCENTIVE PROJECTS

First pilot calf rearing project (Rikilligaskada DPA)

- in 1985, the Small Holder Dairy Development Project of the SL-NLDP with the National Livestock Development Board started surveys of calf rearing at smallholder level and initiated the first pilot calf rearing project in the Rikilligaskada Dairy Producers Association (DPA), providing only extension to 15 farmers who had a female calf below one month of age (Linders, 1986).

Second pilot calf rearing project (Rikilligaskada and Galaha DPAs)

- the second pilot calf rearing project followed in October 1986 for motivated farmers selected by the milk collection secretaries in the Rikilligaskada DPA and was extended to Galaha DPA in February 1987. The project provided per group of 10 selected farmers with a new-born calf a one-day training programme at the Mid Country Livestock Development Centre on calf rearing, discussing feeding, housing and health aspects. The SHDDP further assisted with a Rs 200 incentive for cement and planks to improve individual calf housing, and gave monthly free packets of minerals and free deworming at 1, 3 and 6 months of age (Linders, 1986). Technical assistance was given by a part-time project officer, two livestock development assistants, while 6 milk collection secretaries recorded weekly the chest girth of the calves on a calf growth chart at the farm. Control female and male calves and their dams, taken from the cow freshening records at the DPA, were measured monthly between August 1987 and March 1988 to check on differences in growth rate, weight loss during lactation and calf rearing practices (Van Doren, 1988).

Third pilot calf competition project (large DPAs)

- after a visit to India, the Mid Country I Regional Livestock Development Officer started in October 1986 the third pilot project in the form of calf competitions (or rallies as they are called in India) in the larger DPAs. Farmers had to pay Rs 5 for admission and obtained a free packet for worm treatment. During the annual show day of the DPA the owners of the best calves could obtain prices such as a milk bucket, milk can or a bag of concentrates. Registered competition calves were visited three times in 1987/88 to measure chest girth development below the age of 18 months (Van Doren, 1988).

Fourth pilot calf rearing target growth project (Matale DPA)

- the fourth pilot project started in November 1987 as the Matale calf rearing target growth project for 25 farmers. This project assumed that farmers know how to rear calves, but don't pay sufficient attention to calves since calf rearing only costs money with no rewards in the short term. Also extension efforts of monthly or weekly visits are very expensive and this money, if paid directly to farmers, would finance large parts of their investments in calf rearing.

Table 9.2. Chest girth, corresponding weight targets and possible bonuses of the Matale target growth project.

Age of the calf (month)	0	2	4	6	10	18	
Targets for calves of dams < 325 kg							
Chest girth (cm)		74	86	96	112	133	
Corresponding liveweight (kg)		44	62	82	125	200	
Targets for calves of dams > 325 kg							
Chest girth (cm)		81	91	102	117	140	
Corresponding liveweight (kg)		52	72	94	141	230	
Bonus payments (SL Rs)	100	300	300	200	100		(max. SL Rs 1,000 in total)

- to avoid that only certain categories of farmers would participate, farmers with a newborn calf were attracted by a registration incentive of Rs 100 (Van Doren, 1988). Farmers received a one day mobile training in calf rearing and were provided with a measuring tape to check the chest girth of their calf against targeted development (Table 9.2).

- calves were followed during the target ages up to 10 months and measured again around 24 months of age. As a control group calves below 1 year of age were measured once in 1987 in the nearby Harispatua and Wattegama areas of Matale district followed by a second measurement in 1988.

- during 1993, 9 out of the original 25 Matale project farmers, as random sample, were interviewed to get information on reproduction and production of their project animals, the calves produced and the whereabouts of the animals.

Fifth pilot heifer calf rearing target growth project (MIDCOMUL, all DPAs)

- the succeeding fifth project, the MIDCOMUL heifer calf rearing target growth project was formulated in 1990 under the SL-NLDP Small Dairy Farm Project to extend the Matale calf target growth project approach to all DPAs of MIDCOMUL up to calving and if possible after calving for first lactation details. The details of the targeted chest girths in cm, the corresponding liveweight estimates in kg as indicated in Appendix 9.2, and the respective bonuses are given in Table 9.3 (SL-NLDP, SFDP, 1991).

- the philosophy of this MIDCOMUL project was to assist the local farmers in raising their calves well and on their own farm. Only farmers delivering milk to their DPA could participate. In this way the scheme would strengthen the cooperative set-up as well. The incentives of Rs 300 each (under a low milk price regime) were paid on targets reached and were meant to compensate the farmer in part for the investment in the calf to grow out to a good future cow.

The premium of Rs 500 for pregnancy below the age of 21 months that aimed at assisting the farmer up to calving and that of Rs 500 for calving below the age of 30 months was provided with the objective of allowing the farmer to purchase additional feed, so that the young cow could continue to grow to her proper mature size, conceive quickly again while making a good first lactation record, and it would allow also for extra feed for the newborn calf.

Table 9.3. Details of the MIDCOMUL heifer calf target growth project.

Age of the calf (month)	3	6	9	12	15	18	<21 pregnant	< 30 calved
Chest girth (cm)	80	95	105	114	119	125	(132)*	(150)*
Estimated liveweight (kg)	50	79	103	130	146	170	(198)*	(272)*
Bonus (SL Rs)	300	300	300	300	300	300	500	500
Target (% of registered stock)	100	100	80	80	70	70	60	60
Cost in '000 SL Rs	420	420	336	336	294	294	420	420

* the parameters in brackets were replaced for calving below 30 months at SL Rs 1,000.

- the cost of the programme was estimated for 1400 calves at Rs 2,800 per heifer that would qualify for all targets, and at an overall cost of the scheme of Rs 3,250,000 including 310,000 for contingencies (SL-NLDP, SFDP, 1991). All DPAs would receive a mobile training, from the Mid Country Livestock Development Centre and staff of MIDCOMUL, on proper calf rearing and the operation of the project. Farmers could register a female calf with the DPA calf rearing committee and received a measuring tape and calf target growth chart. Quarterly claims of the farmers for the bonus at their DPAs would be checked by one of the 12 Union field officers before payment.

- data collection and analyses during the field studies in 1993 and 1994. DPAs were consulted on the number of calves registered, the quarterly recorded chest girth measurements up to 18 months of age and the bonuses paid. Also, information on the number of calves that had died, were sold or shared during rearing was obtained. Further, details on the heifers that calved (and then became young cows), and where possible service data of the heifers that had not yet calved, were collected.

- farm inspections were made by the authors and/or MIDCOMUL field officers to first calvings reported in the various DPAs, measuring the chest girth of the young cow and her calf, and if still available on the farm the cow's dam and her most recent calf for comparative developments of chest girth and growth rates.

- in addition, data were gathered on the young cow's breed, differentiated in Friesian or black type of crossbred, Ayrshire or red type of crossbred and Jersey or small type of crossbred, the location of the farm either in the estate or in the village sector, and the mating arrangements for the project heifer either by AI or bull, the length of the dry period in months on the particular farm, and the dairy herd composition. The size of the dairy herd was expressed in tropical livestock units (TLU) of 300 kg liveweight, using 1 TLU for cows, young cows and bulls, 0.7 for pregnant heifers, 0.5 for young heifers and young bulls, and 0.25 for heifer and bull calves.

- to get a good picture of the milk production potential, farmers were asked about the peak milk production of the young cow and of her dam in litres per day, the associated level and type of concentrate feeding in kg per day, and the past calf rearing practices of the young cow.

- questions referring to calf rearing were related to the method of milk feeding, whether by bucket, allowance of one teat suckling and/or suckling before and after milking, and the length of the period of milk feeding in months. The level of concentrate feeding during calf rearing was expressed in the type and amount of concentrates fed at the age of one and two years in kg per heifer calf per day.

- during the young cow inspections in 1993 also young cows after calving that did not belong to the MIDCOMUL project were examined for comparison with the performance of the project animals. Also a number of pregnant project heifers, when encountered close to a farm with a reported calving, was inspected for chest girth measurement and detailed questions on the rearing practices of these animals.

The data were analyzed with DbStat (Brouwer, 1992). Least square methods were used to explain variations in age at first calving, chest girth of the young cow during inspection and peak milk yield of the young cow in relation to differences in calf rearing practices, farm and production characteristics of the young cow and her dam. The following regression models were tested:

1) age at first calving (d):

$$Y_{ijc} = C + LOC_i + BREED_j + b_1x_{1c} + b_2x_{2c} + b_3x_{3c} + b_4x_{4c} + b_5x_{5c} + b_6x_{6c} + b_7x_{7c} + b_8x_{8c} + b_9x_{9c} + b_{10}x_{10c} + b_{11}x_{11c} + b_{12}x_{12c} + E_{1c}$$

2) chest girth of the young cow (cm):

$$Y_{ijg} = G + LOC_i + BREED_j + b_1x_{1g} + b_2x_{2g} + b_3x_{3g} + b_4x_{4g} + b_5x_{5g} + b_6x_{6g} + b_7x_{7g} + b_8x_{8g} + b_9x_{9g} + b_{10}x_{10g} + b_{11}x_{11g} + b_{13}x_{13g} + E_{2g}$$

3) peak milk yield of the young cow (l/d):

$$Y_{ijm} = M + LOC_i + BREED_j + b_1x_{1m} + b_2x_{2m} + b_3x_{3m} + b_4x_{4m} + b_5x_{5m} + b_6x_{6m} + b_7x_{7m} + b_8x_{8m} + b_9x_{9m} + b_{10}x_{10m} + b_{12}x_{12m} + b_{13}x_{13m} + E_{3m}$$

The following factors and covariables were adjusted for their average:

Factors:

LOC_i	= location with	i = 1, 2 (Estate; Village)
$BREED_j$	= crossbreed with	j = 1, 2, 3 (Ayrshire; Friesian; Jersey)

Covariables:

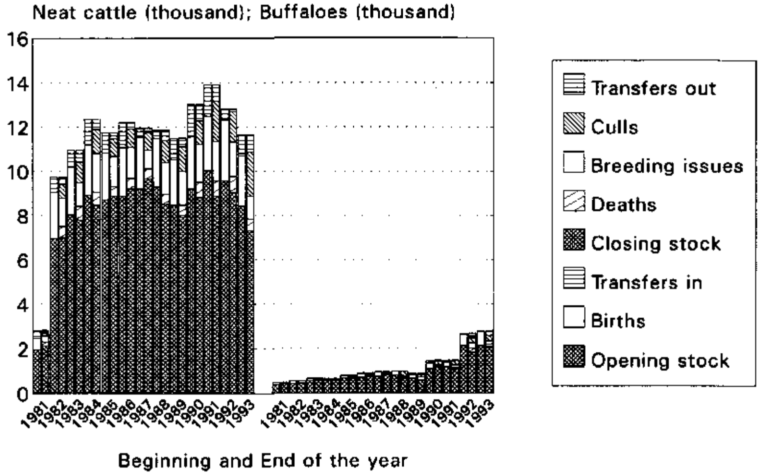
$x_{1c.g.m}$	= number of months given one teat to suckle (n)
$x_{2c.g.m}$	= number of months of suckling before and after milking (n)
$x_{3c.g.m}$	= concentrate fed at one year of age (kg/d)
$x_{4c.g.m}$	= concentrate fed at two years of age (kg/d)
$x_{5c.g.m}$	= concentrate fed at peak milk yield of young cow (kg/d)
$x_{6c.g.m}$	= chest girth of the dam (cm)
$x_{7c.g.m}$	= peak milk production in litres per day of the dam (l/d)
$x_{8c.g.m}$	= concentrate fed at peak milk yield of dam (kg/d)
$x_{9c.g.m}$	= total dairy herd in livestock units (TLU)
$x_{10c.g.m}$	= number of dry months in the farm (n)
$x_{11c.g}$	= peak milk yield of young cow (l/d)
$x_{12c.m}$	= chest girth of young cow (cm)
$x_{13g.m}$	= age at first calving (d)
$b_{1.2..13}$	= regression coefficients
C, G, M	= overall average
$E_{1..3}$	= residual term

RESULTS

(PARA)STATAL LIVESTOCK DEVELOPMENT

a) Multiplication of dairy stock

Some 50 state and parastatal farms, including 30 for large ruminants by DAPH, NLDB and MASL, keep nucleus breeding stock, mainly neat cattle (*Bos Taurus* and *Bos Indicus*) and some buffaloes (Figure 9.1). Excess breeding material produced is distributed to other parastatal farms and to smallholders. Smallholder demand is mainly for in-calf heifers, which from 1980 to 1989 have been supplied at highly subsidized prices. Actual average subsidies per head of cattle (male, female, young and old) disposed between 1983 and 1988 by 11 DAPH and 13 NLDB farms amounted to Rs 10,089 and Rs 4,847, respectively (Anonymous, 1989). In addition, dairy development schemes have concentrated on obtaining and distributing bull calves and young bulls of these parastatal farms to serve as studbulls to improve the local dairy animals through crossbreeding.



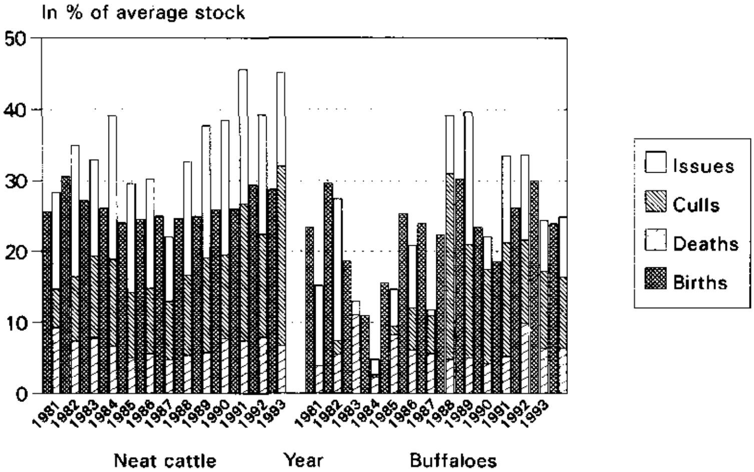
Source: NLDB livestock statistics (1994)

Fig. 9.1 *Livestock statistics of neat cattle and buffaloes on NLDB farms (1981-1993).*

The livestock statistics of the NLDB farms over 1981-1993are detailed per year for cattle and buffaloes in Figure 9.1. Annually, the opening stock, births and transfers into the farm are shown against the closing stock, the deaths, the culled animals, the animals transferred out to other NLDB farms and the animals issued for breeding. The low numbers in the early eighties are due to the fact that not all farms participated in the computerized monitoring. The higher numbers during 1990-1992are caused by the take-over of all DAPH farms by the NLDB during 1990/91.

Over the period 1983-1985 11 DAPH farms and 14 NLDB farms with an average total stock of 18,086 neat cattle and 4,030 buffaloes, supplied annually 1178 female cattle for breeding to smallholders or 8.7% of average total stock on the farms and 134 females or 4.4% in the case of buffaloes (Wolf, 1986). Data on the output of the 5 relatively recent MASL farms have not been published.

In an analysis of disposals over the period 1980-1988,the task force for the rehabilitation of government livestock farms arrived at a total of 2,170 animals (1,130 males and 1,040 females) per year issued for breeding to individual farmers from all DAPH and NLDB farms (LPD/Task Force, 1989). The variation in births, deaths, culled animals and issues for breeding expressed as percentage of the average of the opening and closing stock in each year (Figure 9.2) is considerable over the years.



Source: NLDB livestock statistics (1994)

Fig. 9.2. *Births, deaths, culled stock and issues for breeding in percentage of average annual total stock in neat cattle and buffaloes on NLDB farms (1981-1993).*

Averages calculated over a 13 year period in percentage of average stock for neat cattle (8,132) and buffaloes (918) are presented in Table 9.4. From the average percentages it can be concluded, that the births were sufficient to compensate for deaths and culled animals, leaving only 7% for breeding stock issues for cattle and 7.5% for buffaloes. The higher, actual issues for breeding indicate that the farms especially with neat cattle are being destocked. The sex ratio of the animals issued to farmers could not be derived directly from the computer data of NLDB, but data for the period 1983-1985 and data from the cattle registers of 20 NLDB farms from 1980-1988 indicated that slightly more females than males were issued (Wolf, 1986; LPD/Task Force, 1989).

Table 9.4. Average number of births, deaths, issues for breeding and culled neat cattle and buffaloes expressed as percentage of the average stock kept at NLDB farms over the period 1981-1993.

	Neat cattle	Buffaloes
Births (%)	26.3	23.9
Deaths (%)	6.6	6.4
Culled animals (%)	12.7	10.0
Sub-total deaths and culled (%)	19.3	16.4
	-----	-----
Left for breeding issues (%)	7.0	7.5
Actual average issues for breeding (male and female) (%)	16.1	8.5

Agrawal et al. (1987) assessed the impact of cattle distribution from government livestock farms on smallholders as positive, though still far below the full potential. Constraints, mentioned by more than 160 farmers and landless estate labourers, surveyed in the Coconut Triangle (CT), Dry Zone (DZ), Mid Country (MC) and Up Country (UC), were the unfavourable returns from dairy, low prices of milk in relation to high prices of feed, lack of money/credit for expanding the dairy enterprise, lack of feed and the right type of animals in all regions, and lack of land and labour in MC and UC.

b) Import of dairy stock

Import of foundation dairy stock, from 1965 to 1984, amounted to 6659 head of 11 breeds, of which the majority went to state and parastatal farms (Nell, 1986).

Pregnant heifers (860) from Australia in the seventies under Dairy Development I (1973-1978), that went directly to smallholders and some larger farms to increase the number of dairy farms did not perform very well. A large number of heifers (late pregnant) aborted, died within the first 6 months after arrival (30% of imported stock and 50% of calves born) or produced much less than expected at high initial cost and high feed cost in relation to a low milk price (Nell, 1986).

The import of some 900 young dairy heifers of the Friesian and the Maas-Rhine-IJssel (MRY) breeds from the Netherlands in 1978/79 for raising them on 2 parastatal farms and supplying them in-calf to smallholders was no success either. Over a period of 7 years (1979-1985) only 115 imported pregnant heifers/cows were supplied to smallholders, while the ones remaining on the NLDB farms produced on average 1,836 litres of milk per day and a total of 1,890 calves only. From these calves only 107 females (5.7%) and 155 males (8.2%) went to *smallholders. Major causes of the poor performance were shortage in quantity and quality of* feed, and a low fertility because of heat stress and claw problems (Nell, 1986).

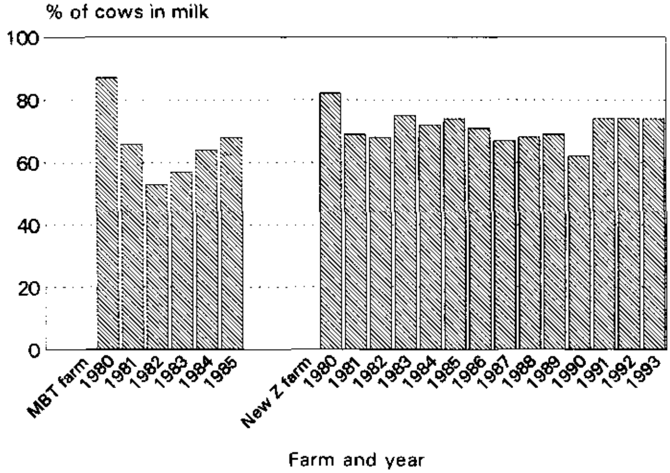
An overview of the fluctuating dairy performance is presented over time at Mahaberiatenne farm (1979-1985) in the Mid Country and New Zealand farm (1979-1993) in the Hill country for % of cows in milk (Figure 9.3), average milk production per cow per day (Figure 9.4), age at first calving (Figure 9.5) and calving interval (Figure 9.6).

Average milk production per cow in milk per day (Figure 9.4) is low in spite of high amounts of concentrates. The ratio of litres of milk produced over kg concentrates fed is close to 1.

Average age at first calving ranged annually from 28 to 48 months. Average calving intervals varied annually between 400 and 560 days (Figure 9.6). The overall performance over 1980-1985 at Mahaberiatenne farm is poorer than over the same period at New Zealand farm due to more heat and humidity stress.

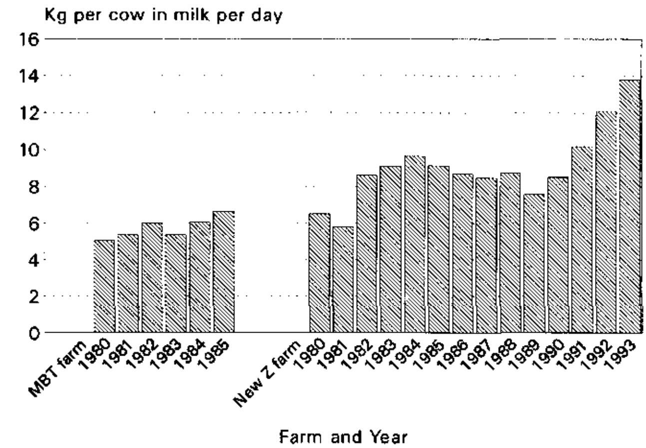
Annual fluctuations in total number of cows, cows in milk, number of births and total milk production at New Zealand farm (1979-1993) is given in Figure 9.7.

Feeding problems in calf rearing, especially acquiring good quality concentrate in the absence of good quality hay or grass, had a lot of influence on growth patterns. Those of Friesian calves born at New Zealand farm for the periods 1983-1987 and 1990-1994 are presented in Figure 9.8 to illustrate the large variation in growth performance over years (Tennekoon, 1987; Madurasinghe, farm manager NZ farm, pers. com. 1993; Melchizedech, monitoring officer NLDB, pers. com. 1994). Over the period 1983-1987 the use of broiler mash and maize feeding resulted in favourable growth rates, while restricted feeding of rice bran/copra cake mixtures led to much lower growth rates. The low growth rates during 1990 and 1991 resulted from a management drive to economize on farm costs which hit the calf rearing operation hard, while from 1992 to 1994 this trend has been reversed by new management keen on good calf rearing (Madurasinghe, pers. com. 1993).



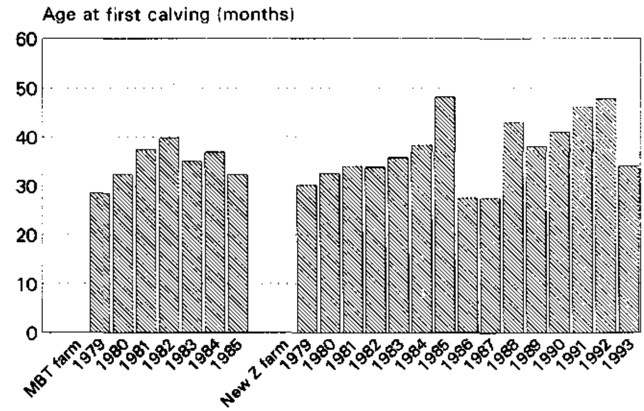
Source: Nell (1986) and New Zealand farm data

Fig. 9.3. *Percentage of cows in milk of imported Dutch Friesian cattle and their offspring at Mahaberiatenne and New Zealand farms.*



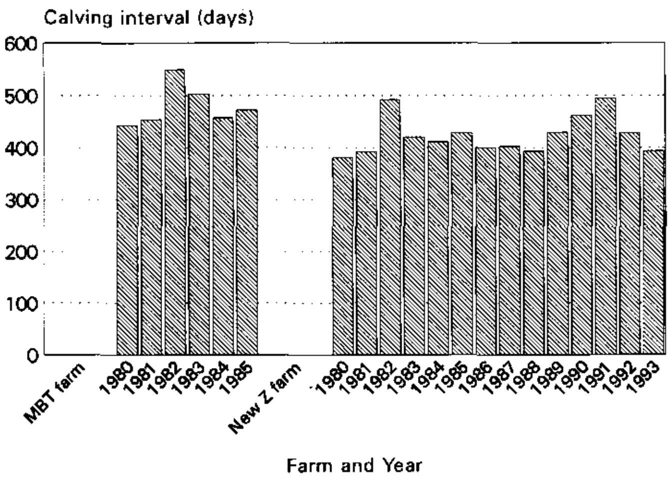
Source: Nell (1986) and New Zealand farm data

Fig. 9.4. *Daily milk yield per cow of imported Dutch Friesian cattle and their offspring at Mahaberiatenne and New Zealand farms.*



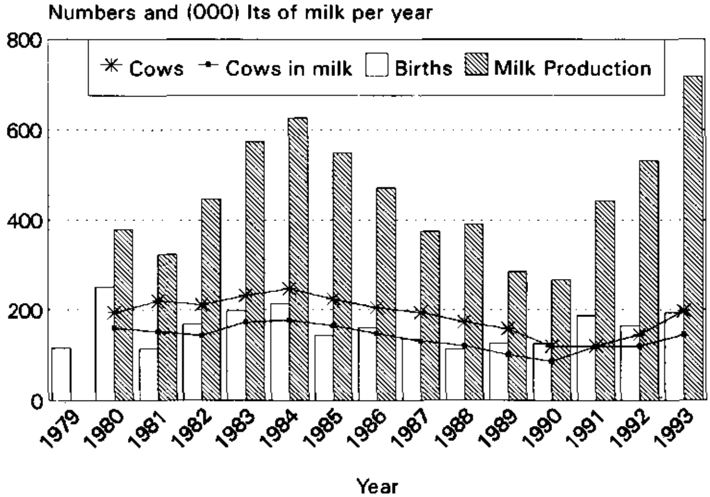
Source: Nell (1986) and New Zealand farm data

Fig. 9.5. *Age at first calving of imported Dutch Friesian cattle and their offspring at Mahaberiatenne and New Zealand farms.*



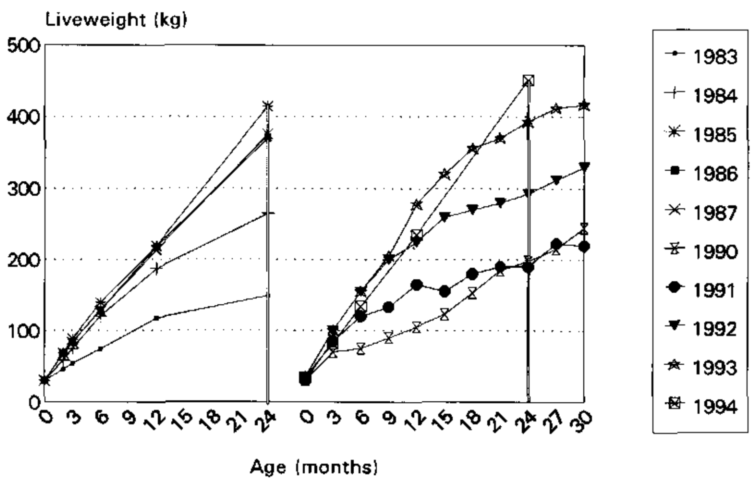
Source: Nell (1986) and New Zealand farm data

Fig. 9.6. *Calving interval of imported Dutch Friesian cattle and their offspring at Mahaberiatenne and New Zealand farms.*



Source: Nell (1986) and New Zealand farm data

Fig. 9.7. *Total cows, cows in milk, calf births and milk production (in '000 litres) of imported Dutch Friesian heifers and their offspring at New Zealand farm (1980-1993) in the Hill Country of Sri Lanka.*



Source: Tennekoon (1987); Madurasinghe (1993); Melchizedech (1994)

Fig. 9.8. *Growth patterns of Friesian young stock at New Zealand farm over the years 1983-87 and 1990-1994.*

Sahiwal cattle and Nili Ravi buffaloes imported from Pakistan to Nikaweratiya farm in December 1989 and December 1990 showed the following characteristics over the years 1992 and 1993, and are compared with the breed performance in Pakistan in Table 9.5.

The performance in Sri Lanka is poor for the fraction of cows in milk and milk production per kg concentrate. Calf mortality is high which could be due to the system of artificial calf rearing that has been introduced since 1992/3.

Table 9.5. Some production and reproductive parameters of imported Sahiwals and Nili Ravi buffaloes compared to their performance in Pakistan.

Reproduction parameters	at Nikaweratiya (SL)		in Pakistan			
	Sahiwals	Nili Ravi	Sahiwals[1)] Gov. farms	Field[3)]	Nili Ravi[2)] Gov. Farms	Field[3)]
Period of study/survey	1992/93	1992/93	1962/72	1985	1962/71	1985
Age at first calving (months)	33	51.5	37.9	37.5	44.8	51.8
Calving interval (d)	408.5	460.5	491	405.0	524.0	531.5
Birth weight calf (kg)	23	35	23.5		37.1	
Growth rate calf first year (g/d)	395	506.8	390		602	
Heifer growth rate (g/day)	402.5	494	430		542	
Average number of cows	112	118				
Average % of cows in milk	50	54		64		57
Average milk per cow (l/d)	5.3	6.9	6.2[4)]	8.5	8.4[4)]	7.8
Average concentrate (kg/cow/d)	4.0	5.0				
Mortality rate adult stock (%)	2.5	8	)		)	)
Mortality rate calves (%)	11	21	)5	7.4	)5-10	)7.75

[1)] taken from PARC (1985) and Chandrasiri (1991) [2)] as reported by Ishaq (1972), Ishaq and Shah (1985) in PARC (1991)
[3)] Shah and Mir (1985) in PARC (1991) and Shaw (1990)
[4)] Average daily milk yield on Government livestock farms as reported by Wahab (1971) in PARC (1991)

c) *Calf salvaging and rearing operation*

The annual transfer of salvaged excess neat cattle in the Mid and Hill Country during 1980-1988 to smallholders was only 19 males and 100 females for Rosita farm and 34 males and 131 females from Haragama (calculated from LPD/Task Force, 1989) in spite of large numbers of neglected calves and high demands for in-calf heifers of credit schemes in the area.

Average growth rates of 246 calves during the first year at Rosita farm have been grouped in Figure 9.9 according to monthly weight gain (3-4; 4-6; 6-8; 8-10; and 10-12 kg) based on data of the farm manager (Dharmapala, 1985). Calves received 1.5 kg of rice bran and 56 gram minerals per calf per day on top of stallfed Guinea and Napier grass.

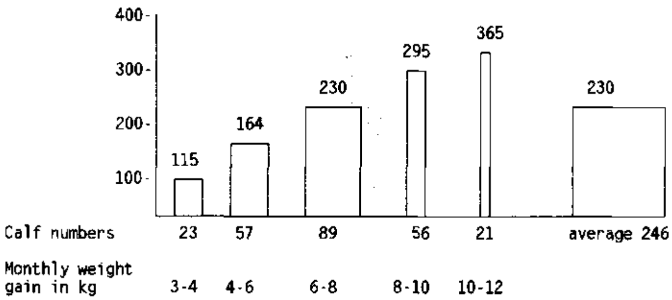


Fig. 9.9. *Growth rate of salvaged heifer calves grouped according to monthly weight gains during their first year at Rosita farm.*

The quality of the salvaged calves has been rather low because farmers and farm managers sold only their poor, neglected calves. Growth rates varied with quite a number of calves growing little following the poor start. The reliance on stall feeding with quite mature grass (costs less in labour for grass cutting), and on type and amount of concentrates, minerals, further contributed to the large variation in growth. The age at first calving of Rosita stock varied from 3 to 3.5 years and the cost to rear them up to 3 months pregnant amounted to SL Rs 6,000 or US$ 250 in 1985.

Performance (peak milk production, lactation length and calving interval) of 33 ex-Rosita stock that produced 101 calves (64 male, 37 female) and 40 ex-Haragama stock that produced 113 calves (54 female, 59 male), and that had been selected by the SL-NLDP management for aspirant dairy farmers is given in Table 9.6, as recorded during surveys in 1993 at 76 farms in the NADSA area.

Table 9.6. Performance of cattle issued from the Haragama and Rosita farms for the production of calves, the means (M) and coefficients of variation (c.v. in %) of peak milk production, lactation length and calving intervals as surveyed in 1993 in the NADSA aspirant dairy farmers project.

Lactation number	1		2		3		4		5		6	Overall
	M	c.v.	M	c.v.	M	c.v.	M	c.v.	M	c.v.	M	Mean
Rosita farm:												
Peak milk production (l/c/d)	6.5	46	8.0	32	7.9	35	7.0	33	7.3	39	4.0	7.27
Number of records	30		24		21		14		7		1	97
Lactation length (months)	8.8	31	8.9	27	8.1	31	8.1	23	7.9	24	7.0	8.48
Number of records	29		23		20		12		7		1	92
Calving interval (d)			500	24	570	31	462	25	961	37		552
Number of records			10		8		5		2			25
Haragama farm:												
Peak milk production (l/c/d)	6.3	40	6.7	33	6.3	31	6.8	40	6.8	22	5.0	6.49
Number of records	36		32		22		10		4		1	105
Lactation length in months	8.9	26	9.1	26	8.7	31	8.6	23	9.5	7		8.91
Number of records	36		31		19		8		2			96
Calving interval in days			537		467		503		377			498
Number of records			18		12		7		3			40

Costs of rearing salvaged calves up to in-calf heifers at Haragama farm came to about US$ 200 (De Jong, 1985). Having to sell them at about US$ 100 each meant that these farms were running at a loss. Due to a government move to maintain only potentially profit making (para)statal farms, the purely calf salvaging farms have been fased out since 1990 (NLDB, 1990).

d) Contract heifer breeding and raising scheme

The first performance check in the Jaffna, Kurunegala and Nuwara Eliya districts was carried out in 1986 by the Ministry of Rural Industries. The results (Table 9.7) indicated the highest growth rates for Jersey type calves, the majority from Jaffna district, followed by the Friesian type, but standard deviations are high.

Table 9.7. First evaluation of performance per breed type (mean liveweight, age, growth rate and standard deviation) in the contract heifer breeding and raising scheme in Jaffna, Kurunegala and Nuwara Eliya districts in 1986.

Type	Number of calves	Average liveweight (kg)		Average age (d)		Growth rate (g/d)	
		Mean	s.d.	Mean	s.d.	Mean	s.d.
Ayrshire	7	113	49	328	97	270	115
Friesian	16	169	73	425	94	310	120
Jersey	38	135	54	308	109	360	120

The second evaluation was carried out in Nuwara Eliya district, where DAPH obtained IRDP funds for a maximum number of 150 heifer breeding and raising contracts in 1985 and for the remaining 100 in 1987. Three areas were inspected: Talawakelle, Punduloya and Nuwara Eliya with in total 78 contracts: 42 of the 1985 and 36 of the 1987 batches. Out of these 42 farmers were visited: 19 with animals that calved of the 1985 batch and 23 held by 1987 participants (Van Eekeren, 1989). The results are presented in Table 9.8.

Table 9.8a. Performance in animal numbers of the contract heifer breeding and raising scheme in three areas of Nuwara Eliya district (1985-1988).

Evaluation of animal numbers	Targeted	Registered	(% of target)	Evaluated numbers (in %)		
Contracted animals in batch of 1985	150	113	(75)	42		
Contracted animals in batch of 1987	100	77	(77)			36
Animals withdrawn				6		2
Animals rejected				2		-
Animals died				5	(11.9)	-
Animals moved to other place				1		-
Animals issued				25	(60)	-
Animals still remaining at initial farm				3		34
Age at first calving of 24 animals issued (d)				899		

Table 9.8b. Liveweight development in the contract heifer breeding and raising scheme in three areas of Nuwara Eliya district (1985-1988).

Age (months)	6	12	18	24
1985 batch liveweight (kg)			219	271
1987 batch liveweight (kg)	83	150		
Number of records	30	12	21	19

Visits to N'Eliya farmers that received 19 pregnant animals of the 1985 batch, revealed that one animal (4%) was returned to the owner, one (4%) was resold to another farmer and three (12%) had died. Condition scores of 23 animals visited of the 1987 batch indicated 16 (70%) animals in good, 2 (8%) in moderate and 5 (22%) in poor condition.

A performance check in North Western province from 1985-1990 showed the following rate of implementation: for 1985, 100 contracts targeted and actually 56 heifers registered; for 1986 100 targeted and 45 registered; for 1987 100 targeted and 35 registered; for 1988 100 targeted and 29 registered; for 1989 112 targeted and 100 registered; for 1990 150 registered and 92 registered or in total 662 targeted and 357 (54%) registered. Weight gains of 100-150 animals inspected monthly during August 1991-May 1992 indicated average growth rates varying per month between 188 and 211 g/d against 300 g/d targeted. These relatively low growth rates are an indication of the high percentage of Zebu blood in this province. Other achievements in this area are indicated in Table 9.9 under North Western province.

Overall performance from 1985 to 1991 as derived from the information of the Ministry of Livestock Development and Milk Production is given in Table 9.9.

Unfortunately, no overview of performance data after the decentralization of the scheme in 1991 could be obtained from the provincial authorities.

The subsidy element at SL Rs 4,430 per heifer sold so far is lower than the difference between the cost of producing heifers at Government farms and the price paid by farmers for breeding stock. The difference averaged Rs 5,000 and 10,000 per head from 1980-1988 at NLDB and DAPH farms, respectively (Anonymous, 1989).

Table 9.9. Summary of the island-wide progress of the contract heifer breeding and raising scheme.

Province	Reporting Period	Targeted	Number of Calves: Registered (% of target)	Deaths	Withdrawn	Rejects	Number of Heifers: Sold	Balance	Project Costs in (000) SLRs
				-------(% of registered calves)-------					
North Western	1985/1992	698	357 (51)	25 (7)	48 (13)	24 (7)	76 (21)	184 (52)	293
Northern	1985/1991	360	260 (72)	41 (16)	32 (12)	54 (21)	76 (29)	56 (22)	287
Central	1985/1991	1128	652 (58)	46 (7)	30 (5)	29 (4)	238 (56)	309 (28)	1,130
Southern	1987/1991	250	192 (77)	15 (8)	4 (2)	41 (21)	1 (1)	131 (68)	143
Western	1987/1991	240	199 (83)	10 (5)	12 (6)	1 (1)	24 (12)	152 (76)	79
Uva	1987/1991	120	187(156)	9 (5)	35 (19)	15 (8)	100 (53)	28 (15)	301
Sabaragumuwa	1987/1991	165	79 (48)	7 (9)	5 (6)	18 (23)	5 (6)	44 (56)	70
TOTAL animals		2961	1926 (65)	153 (8)	166 (9)	183 (10)	520 (27)	904 (47)	2,303
in % of target		100	65	5	6	6	18	31	

e) *Calf health care scheme*

The results over the period 1986-1991 of the island-wide scheme as collected from the records of the Ministry of Livestock Development and Milk Production are presented in Table 9.10. The start of the scheme was delayed in many areas, because of a limited availability of minerals and veterinary kits. The registration into male and female calves, that could only be traced in part, amounted to 65% females and 35% males.

Table 9.10. Summary of the island-wide progress of the calf health care scheme (1985-1991).

Area/Province	Reporting Period	Targeted	Number of Calves: Registered (% of target)		Sold/Left	Deaths	Balance	Project Costs in (000) SL Rs
					-----(% of registered calves)----			
Galaha	7/86-12/88	525	129 (25)		48 (37)	28 (22)	53 (41)	24
Nuwara Eliya	6/87-12/88	700	665 (95)		31 (5)	20 (3)	614 (92)	98
Central province	- 6/91	1251	949 (76)	242*	71 (7)	38 (4)	840 (89)	77
Kegalle	1990- 6/91	860	537 (62)	244*	39 (7)	21 (4)	477 (89)	5
Galle	1990-12/90	25	40 (160)		0		40 (100)	
Western province	12/89- 6/91	475**	443 (98)	190*	17 (4)	9 (2)	417 (94)	58
Total animals		3836	2763 (72)		206 (7)	116 (4)	2441 (88)	262
in % of target		100	72		5	3	64	

* specified number of male calves; ** estimated at 25 per month.

The subsidy per remaining calf in the scheme amounted sofar to SL Rs 107.53. Performance data after decentralization of the scheme in 1991 could not be obtained from the provinces.

In November 1988, the calf health care scheme in three areas of Nuwara Eliya district was evaluated by Van Eekeren (1989) with 110 calves of the 1987 (500 calves) and 1988 (200 calves) batches (Table 9.11). From the condition score of the two batches in 1988 it can be concluded that the condition deteriorates in the second year of the scheme, most likely for economic reasons, because farmers require to invest much more in feeding than in health care costs. The performance of calves not participating in either of the two calf rearing schemes in the three areas of Nuwara Eliya district is indicated in Table 9.12.

Regression analysis utilizing all individual weight data indicated an average growth rate of 328 gram per calf per day for contract breeding up to 30 months of age versus 304 gram per calf per day for non-scheme calves, while health care calves gained 309 gram per day against 300 gram for non-scheme calves during the first 13 months (Van Eekeren, 1989).

Average liveweight development for the heifer breeding and raising scheme calves, health care scheme calves and control calves in the three areas of Nuwara Eliya district is presented in Figure 9.10.

Table 9.11a. Performance in animal numbers and condition score of animals visited in the calf health care scheme in three areas of Nuwara Eliya district (Van Eekeren, 1989).

Performance		1987 batch male	1987 batch female	total (%)	1988 batch female (%)	Total calves	(%)
Calves targeted				110	70	180	
Calves registered		19	91	110	71	181	
Calves rejected (males)				3		3	
Calves withdrawn				2		2	
Calves died (%)				17 (15.5)	3 (4.2)	20	(11.1)
Calves sold				6		6	
Calves remaining (%)				82 (74.6)	68 (95.8)	150	(82.9)
Condition score	good (%)			8 (23.5)	12 (46.1)	20	(33.3)
(60 calves)	moderate (%)			11 (32.4)	8 (30.8)	19	(31.7)
	bad (%)			15 (44.1)	6 (23.1)	21	(35.0)

Table 9.11b. Liveweight development in the calf health care scheme in three areas of Nuwara Eliya district (Van Eekeren, 1989).

Age (months)	1	3	6	9	12
Average liveweight (kg)	31.2	56.8	87.8	112.8	139.7
Number of records	110	78	40	12	6

Table 9.12. Performance of a few non-scheme calves in three areas of Nuwara Eliya district (Van Eekeren, 1989).

Age (months)	1	3	6	9	12	16	18	24	30
Average liveweight (kg)	38	54	77	105	112	153	223	271	235
Number of records	4	2	6	1	2	2	4	5	3

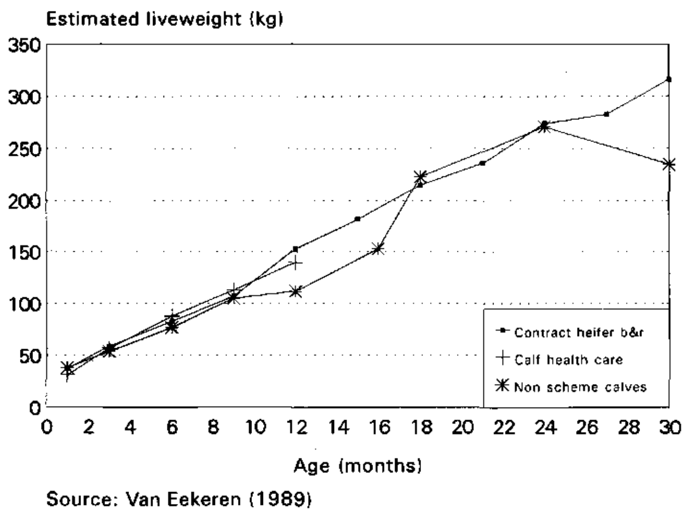


Fig. 9.10. *Liveweight development of calves in the contract heifer breeding and raising scheme, calf health care scheme and non-scheme calves raised in the Talawakella, Punduloya and Nuwara Eliya areas of Nuwara Eliya district of the Hill Country.*

Differences are small up to 10 months of age. Subsequently, the health care calves up to 12 months and a few control calves up to 18 months show less development. A few other control calves and the contract heifers show equal liveweight development between 18-24 months of age.

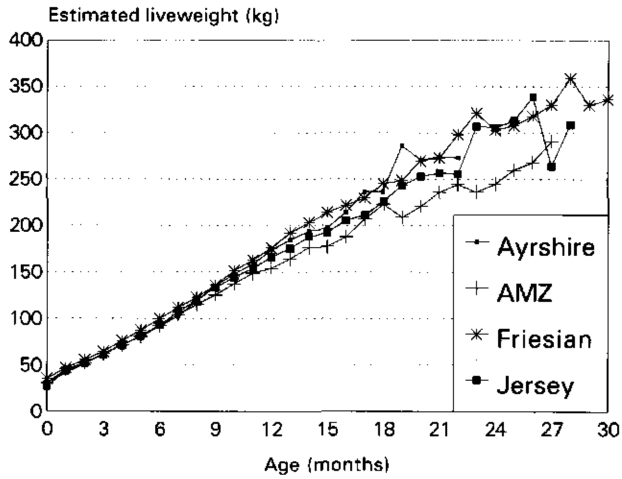
f) AI heifer calf rearing scheme "Kerala"

In the island-wide AI heifer calf rearing scheme up to May 1993, 1242 calves enrolled,including 593 from Central province. The performance is summarized in Table 9.13.

Table 9.13. Performance of the AI heifer calf rearing scheme "Kerala" per May 1993 (adapted from Anonymous, 1993).

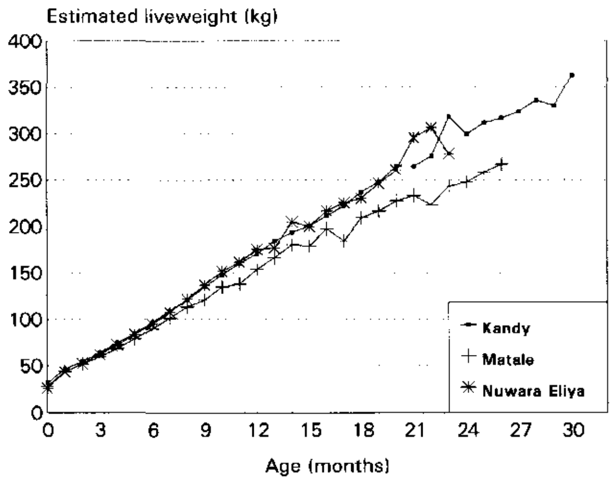
Breed	AMZ	Jersey cross	Jersey	Friesian cross	Friesian	All Breeds
Number of enrolled calves	200	274	390	171	207	1,242
Average liveweight (kg)	147	152	113	104	117	126.5
Average age (months)	9.9	9.1	7.8	6.7	7.5	8.2
Estimated birth weight (kg)	17	17	22	31	30	22.7
Growth rate (g/d)	430	486	383	357	380	415

At the end of 1994 the data of the scheme recorded for Central Province included 1500 registered calves. Liveweight data have been averaged and are presented in Figure 9.11 per district (Kandy, Nuwara Eliya and Matale) and in Figure 9.12 per breed, differentiating Friesian, Ayrshire, Australian Milking Zebu (AMZ) and Jersey AI bred calves. Friesian calves had the highest growth rates followed by Ayrshire, Jersey and AMZ in that order. Kandy district although at a lower altitude than Nuwara Eliya district did equally well, while Matale district at low altitude and with more zebu blood had the lowest growth rates.



Source: AI heifer calf rearing scheme records

Fig. 9.11. *Liveweight development of AI heifer calf rearing scheme calves over 1992/94per breed based on average monthly liveweight estimates.*



Source: AI heifer calf rearing scheme records

Fig. 9.12. *Liveweight development of AI heifer calf rearing scheme calves over 1992/94 per district based on average monthly liveweight estimates.*

Further, preliminary progress data of the scheme in Central province indicated an average age at first service of 17 months (139 heifers) and at first calving of 25.5 months (50 heifers), 54 calves had died (3.6%), 41 calves had been sold, and 34 had been removed, rejected or transferred.

THE PILOT CALF REARING EXTENSION AND INCENTIVE PROJECTS

1) Pilot calf rearing project in Rikilligaskada DPA

The first pilot project was carried out in 1985/86 with 15 farmers with a calf below 1 month of age that only obtained technical advice in better calf rearing. Farmers' interest was low for advice only, and growth rates of the calves remained very low, ranging from 20 to 145 gram per day (Linders, 1986 and 1989).

2) Pilot calf rearing project in Rikilligaskada and Galaha DPAs

This second pilot project attracted 57 interested farmers with 69 female calves spread over the village (40) and estate sector (29) in Rikilligaskada and Galaha DPAs in the Mid Country. From August 1987 onwards, 61 control calves (34 female and 27 males; 32 in the village sector and 29 in the estate sector) were monthly visited and monitored for weight by measuring tape. Of all participating calves the breed of the mothers was recorded as well and their chest girths to check on weight development of calf and dam after calving.

In Table 9.14, the characteristics of the pilot project in Rikilligaskada and Galaha are presented for project calves and control calves in total and per estate and village sector (Van Doren, 1988).

Table 9.14. Mean and standard deviation (s.d.) of characteristics of the second pilot calf rearing project in the estate and the village sector of Rikilligaskada and Galaha DPAs for project and control calves in numbers and growth rates, weight of the dam and the following calving interval (d) of the dam.

Characteristics of project and control calves	Overall Mean	s.d.	Estate Mean	Village Mean	Male Mean	Female Mean
Project calves						
Number of female calves	69		29	40		69
Growth rate (g/d)	278	200	275	300		278
Age at weaning (d)	172	103	149	193		172
Liveweight of the dam (kg)	304	50	322	291		304
Following C.I. of dam (d)	445	61	431	451		445
Control Calves						
Number of calves	61		29	42	27	34
Growth rate (g/d)	131	140	138	123	94	151
Liveweight of the dam (kg)	295	54	308	284	285	310

Growth rates differed significantly between project and control female calves ($P<0.05$), for factors such as sex, calf housing, dam breed/ type and location and for the covariable of the dam's weight. In the control group, female calves did grow faster at 151 g/d compared to male calves at 94 g/d ($P<0.05$). Calves constantly raised indoors gained 267 g/d, which was significantly ($P<0.05$) better than those reared outdoors with 177 g/d. Growth rates of project calves of Friesian type dams averaged 297 g/d and those of Ayrshire type dams 336 g/d, which were significantly different ($P<0.05$) from calves of Jersey type dams with 248 g/d. The dam's weight significantly ($P<0.05$) affected the calf's growth rate with an additional 0.7 g/day per extra kg of the dam's weight. Between estates, after correction for breed, growth rates varied from 93.2 g/d in Galaha to 231 in Rikilligaskada. Between villages average growth rate varied from 199.7 to 266.3 g/d in Rikilligaskada against 310.2 g/d in Galaha. In a statistical model, however, the factors sex, breed and location only explained 8% of the variance in growth rates.

From October 1986 - April 1988 (19 months) only three (4%) out of the 69 female project calves died. In the control group over a period of 7 months, from August 1987 to March 1988, 5 male calves (19%) out of 27 and 3 female calves (9%) out of 34 died. On an annual basis, the mortality of project calves was 2.82%, and 45.6% and 15.4% for male and female control calves. Additional data collected in the period 1988/89 are presented in Table 9.15 (Meinderts, 1990). Growth rates of female calves were analyzed and classified according to performance in 25% poor, 50% moderate and 25% best growers in the periods of 0-6 months, 6-12 months and 12-24 months of age. For the control female calves only data up to 8 months are given, since subsequently all calves had been sold and could not be traced.

Table 9.15. Average growth rate (g/d) of female calves sub-divided in poor, moderate and best growers and in growth periods of the second calf rearing project in the Rikilligaskada and Galaha DPAs.

Selected Calf groups	All Calves		Calves Sub-divided by Growth Level					
			25% Poor		50% Moderate		25% Best	
Growth Periods	No. of Calves	Growth rate	No. of Calves	Growth rate	No. of Calves	Growth rate	No. of Calves	Growth rate
Project calves								
0- 6 months	66	322	17	188	32	313	17	473
7-12 months	52	297	13	129	26	293	13	472
13-24 months	31	214	8	88	15	201	8	365
Control calves								
0- 8 months	22	223	6	127	10	211	6	340

Also the number of project calves with recorded data reduced over time but not as drastic as in the case of the control group. After 2.5 years of monitoring 22 project calves were still present, 10 calves had been transferred to another farm for sharing and 34 had been sold. From the project calves that still could be monitored the first 16 calved at an average age of 29 months (range 24-35 months).

Differences in growth rate were considerable among performance groups both for project and control calves. The differences among periods indicated that growth over the first six months was highest, decreasing somewhat during the second half year, and declining considerably during the second year, when calves were completely weaned and farmers found it difficult to feed their heifers properly, i.e. with enough high quality fodder and/or concentrate supplements.

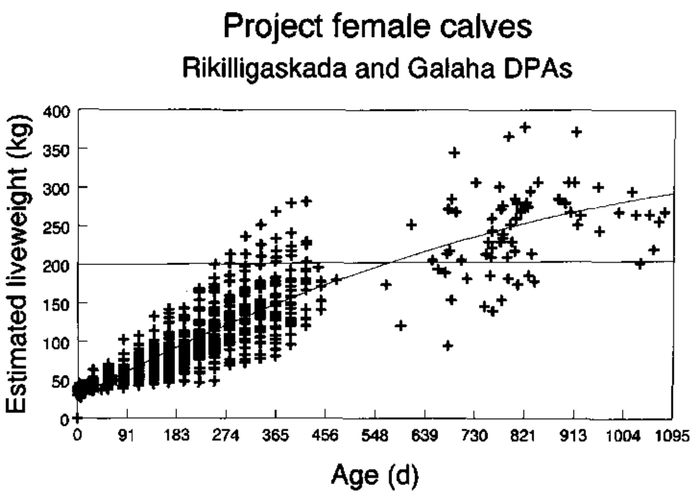


Fig. 9.13. *Liveweight development based on chest girth measurements of 69 project calves in the Rikilligaskada and Galaha DPAs.*

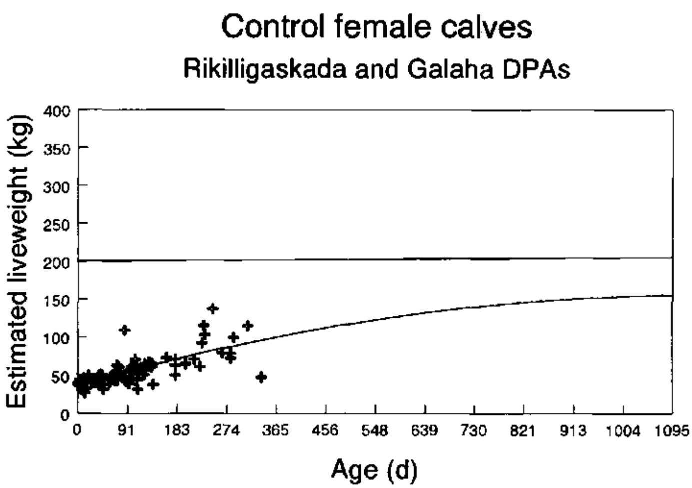


Fig. 9.14. *Liveweight development based on chest girth measurements of 34 control female calves in the Rikilligaskada and Galaha DPAs.*

To illustrate the large variation in calf weights during rearing in more detail, all weights are plotted individually in Figure 9.13. Also an average growth curve (best fitting quadratic function of time) are shown. Similar data for 34 control female calves are given in Figure 9.14.

3) Calf competition project at large DPAs

Out of 53 calves registered, 48 could be measured between 0-6 months of age, 27 between 6-12 months and 34 between 12-18 months of age. In Table 9.16 average weights and ages of the calves during three field rounds are presented. Average weight of those dams that were present at the farms during the second round, is also given and growth rates have been calculated by assuming an average birth weight of 30 kg.

Table 9.16. Mean and standard deviation (s.d.) of liveweight, corresponding age and growth rate of calves of the calf competition project during three field rounds.

Characteristics	Registered No. of	Liveweight Development from Chest Girth Measurement							
		0-6 months		6-12 months		12-18 months		Dams	
	Calves	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Number of records	53	48		27		34		20	
Liveweight (kg)		67.4	17.5	114.7	44.5	168.4	54.5	297.3	43.0
Age (d)		131.5	26.0	255.1	33.7	481.1	31.5		
Growth rate per period (g/d)		284		383		238			
Overall growth rate (g/d)		284		332		288			

Unfortunately no details were available on mortality, calves shared or sold, but the number measured during the third round indicated that 64% of the calves was still present at the participating farms around the age of 18 months. The low number of dams present suggested a large movement to sharing or sale. The growth rate of calves under this scheme was also highest in the first year and declined subsequently. No follow-up has been made under this scheme for reproduction and production parameters.

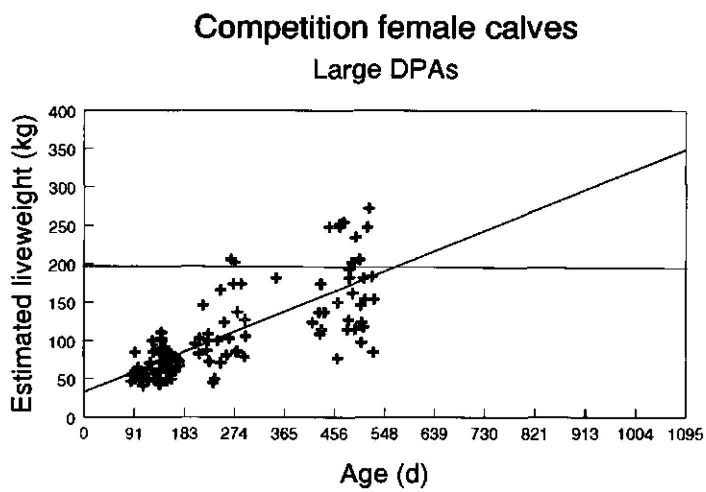


Fig. 9.15. *Liveweight development with linear regression lines of calves of the competition project measured during three field rounds in the Rikilligaskada and Galaha DPAs.*

The estimated liveweights during the three field rounds are plotted together with those of female and control calves in the Rikilligaskada and Galaha DPAs in Figure 9.15.

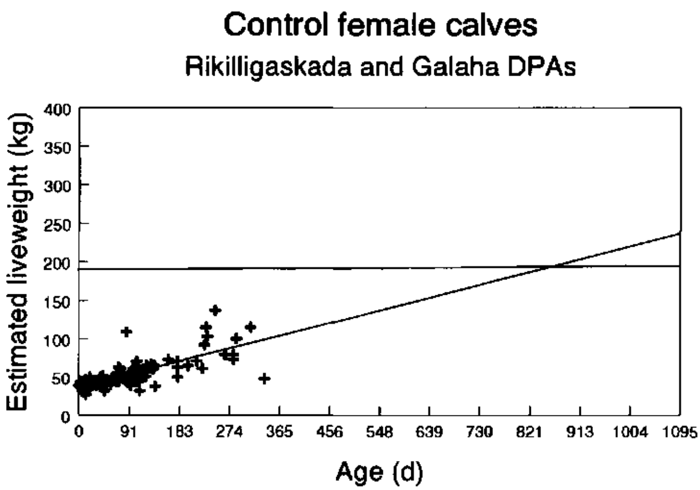


Fig. 9.16. *Liveweight development with linear regression lines of female control calves in the Rikilligaskada and Galaha DPAs.*

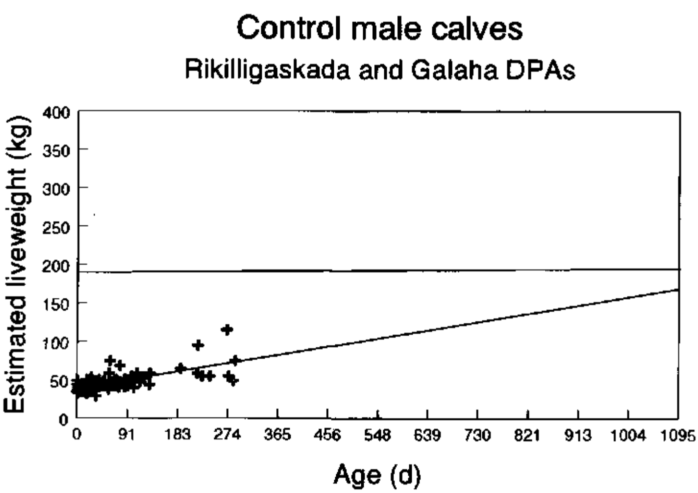


Fig. 9.17. *Liveweight development with linear regression lines of male control calves in the Rikilligaskada and Galaha DPAs.*

A chest girth measurement survey of calves between 0-2 years was undertaken in March 1988 in Harispatua and Wattegama areas in Matale district to gain insight into growth rates in the absence of an incentive project. During November/December 1988 25 farmers registered each a female calf under the target project in Matale DPA.

In Table 9.17 the characteristics are given for the first 10 months of the calf rearing target growth project in Matale and those of the control calf survey in Harispatua that were between 0-12 months old (Van Doren, 1988).

At 10 months of age 7 (30%) out of 23 calves (1 was sold and 1 died) had an overall growth rate over 300 g/d.

Table 9.17. Mean and standard deviation (s.d.) of the growth rate of calves, the liveweight of the dam, and the number of bonuses received in the Matale target growth project and the average growth rate of calves in Harispatua area of Matale district.

Project/Control Calves	Matale Target Growth Project			Harispatua Control Survey	
	Female calves Mean	s.d.	Bonus Received Number	Female calves Average*	Male calves Average*
Number of calves	25			30	25
Growth rate (g/d)					
0- 2 months	220	115	15		
2- 4 months	196	81	7		
4- 6 months	281	175	11		
6-10 months	274	99	5		
Overall 0-10 months	247	139		177	149
Liveweight of dam (kg)	269	41		289 ± 56	

* growth rate obtained through linear regression.

Towards the end of 1989 the Matale project calves were measured again and classified per age group into their performance in growth rates (25% poor, 50% moderate and 25% best). In Table 9.18 (Meinderts, 1990) these growth rates are presented for 6 monthly periods in the first year and for 12 months in the second year. In addition, growth rates were calculated assuming an average birthweight of 30 kg and compared with those of female control calves in the Harispatua and Wattegama areas of Matale district, that were split in age groups (those between 150-200, 200-400, and 400-700 days old), and for those weighed twice (W2 in 1989 - W1 in 1988).

Table 9.18. Average growth rates (g/d) of female calves per age period, subdivided in poor, moderate and best growers of the calf rearing target growth project in Matale DPA and control calves in the Harispatua/Wattegama areas.

Selected Calf groups	All Calves		Calves Subdivided by Growth Level					
			25% Poor		50% Moderate		25% Best	
Growth Periods	No. of Calves	Growth rate	No. of Calves	Growth rate	No. of Calves	Growth rate	No. of Calves	Growth rate
Project calves								
1- 6 months	24	241	6	154	12	244	6	320
7-12 months	23	274	6	140	11	290	6	379
13-24 months	22	203	6	87	10	216	6	299
with assumed birth weight (30 kg)								
0- 6 months	24	242	6	156	12	250	6	312
0-10 months	23	256	6	180	11	258	6	330
0-24 months	22	226	6	136	10	243	6	289
Control Calves								
0- 6 months	22	242	6	128	10	229	6	378
0-10 months	32	239	8	125	16	233	8	367
0-24 months	21	177	6	136	10	185	5	210
W2-W1	31	176	8	122	15	168	8	244

In Figure 9.18 the individual calf weights of the Matale calves are plotted over time together with the average growth curve (best fitting quadratic function over time). In Figure 9.19 the average growth curve is presented together with the individual liveweights of the control calves surveyed in Harispatua and Wattegama in 1988, including the second weight obtained from 31 calves in 1989.

Differences among growth periods in the Matale calves show that calf growth between 7-12 months of age improves, and decreases considerably in the second year. This pattern can be explained by the fact that calves compete with the sale of milk during the first 6 months after calving. Subsequently, farmers in this area milk their cows less frequently or not at all, while the calves continue suckling their dams. Growth in the second year growth is much less, as most farmers don't feed any concentrates to their weaned calves, and the quantity and quality of available roughage is low. This effect is less pronounced with project farmers, especially those with 'moderate' and 'best' performance. The category '25% poor' shows not much difference between project and control calves in the second year. This suggest that the rearing of young stock needs continuous attention both in the first and the second year, and that a bonus or incentive project should preferably cover the whole calf rearing and heifer raising period.

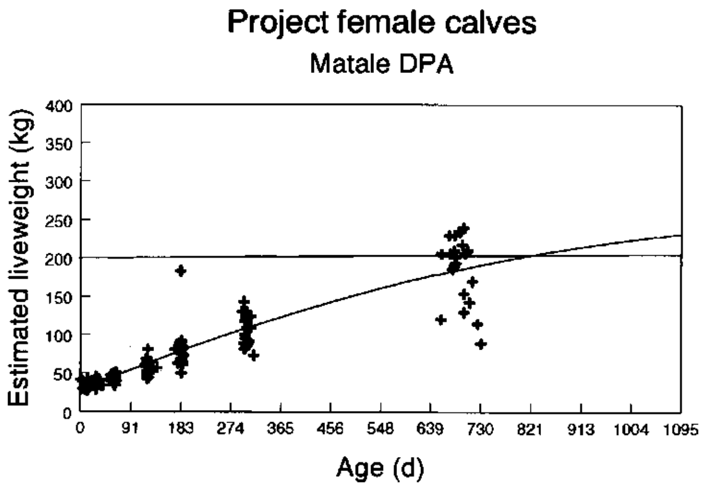


Fig. 9.18. *Liveweight development based on chest girth measurements of 25 female calves of the Matale calf rearing target growth project.*

In October 1993, a random sample of 9 out of 25 farmers of the Matale project were revisited for collection of information on production and reproduction (Table 9.19). Their animals had attained an average weight of 115.6 kg at the age of 10 months, and three of them had qualified for all bonus payments. Sofar the 9 animals had produced 19 calves (10 male and 9 female) on the farms. The age at first calving was rather high at 44.8 months (range 33.4 - 70.7). Four animals were present during inspection and had an average estimated liveweight of 262.8 kg, indicative of the high percentage of Zebu blood in cattle of the Matale area. From the other five animals one had been shared out, 1 had died and 3 had been sold for reasons of low production, breeding problems and warts, respectively. Of the 10 male calves produced 1 was present with the dam, 6 had been sold, 2 were shared out and 1 had died. Of the 9 female calves, 3 were present with the dam, 1 had died, 1 went back to the cow owner (sharing arrangement), 3 were shared out and 1 was present at the farm as replacement stock.

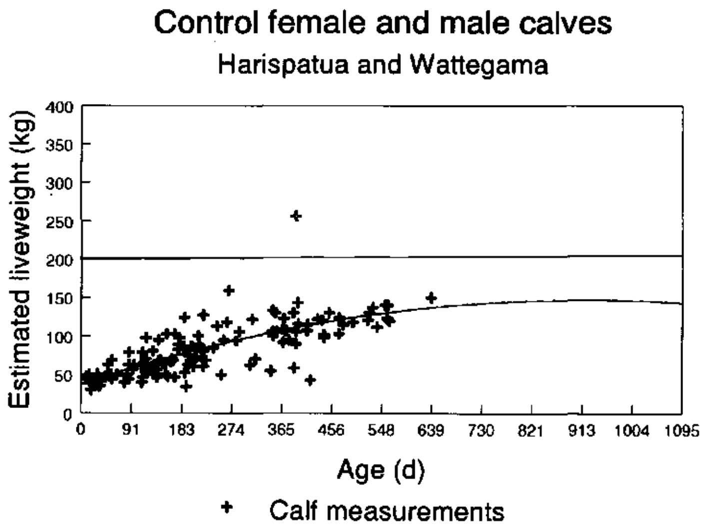


Fig. 9.19. *Liveweight development based on chest girth measurements of control calves in the Harispatua and Wattegama areas of Matale district.*

Table 9.19. Mean and standard deviation (s.d.) of milk production and reproduction characteristics of project cows and their dams of 9 farmers of the Matale target growth project (1989-1993).

Lactation number of project animal:	1 Mean	s.d.	2 Mean	s.d.	3 Mean	s.d.	4 Mean	s.d.	Dam's Best Lactation Mean	s.d.
Peak milk production (l/d)	6.17	2.42	7.08	1.28	7.50	2.50			7.00	2.65
Number of records	9		6		3				9	
Peak concentrate feed (kg/d)	1.29	0.82	1.60	0.41	1.37	0.40			1.23	0.82
Number of records	9		6		3				9	
Lactation period (months)	10.50	1.41	9.33	1.16						
Number of records	8		3							
Calving interval (d)			534	164	359	33	365			
Number of records			6		3		1			

Average peak milk yields during first, second and third lactation of the project animals were 88%, 101% and 107% of those of the dams and were well in accordance with the concentrate given. Lactation periods were long and the calving interval after first calving high.

5) MIDCOMUL heifer calf rearing target growth project

The total number of calves registered under this project amounted to 1850 or 132% of the 1400 envisaged during a period of 6 months (November 1990-May 1991). At the age of 18-20 months 36 calves or 2% had died, 40 or 2.2% had been sold, and 7 calves were disqualified for bonus payment because they were not present at the farm during inspection due to sharing out.

No bonus claim was received for 630 calves or 34%, indicating that the calf was no longer present at the farm or that it had not reached the target weight at 18-20 months. For 172 calves (9.3%) the premium was not paid because the calf was found to be underweight during inspection, and for 47 calves or 2.5% no payment was effected because the farmer did not deliver milk any more to his DPA. The chest girth check planned at 18 months took actually place at 18-20 months of age due to shortage of field staff at MIDCOMUL. In Table 9.20 the overall performance of the project up to December 1994 is detailed.

During 1993 and 1994 MIDCOMUL received from the DPAs 603 reports on calvings, and in total 390 calvings have been checked through questionnaires and field visits. Characteristics of young cows are given in Table 9.21: a) with a complete set of quarterly chest girth data (528 animals), b) with complete field inspection data (321 animals), c) with complete data of their dams during inspection (164 animals), and d) non-project animals (39).

Table 9.20. Performance of the MIDCOMUL heifer calf target growth project in number of calves and the number of heifers with a reported calving.

Age (months)	3	6	9	12	15	18-20	Heifers with Calving Report (December 1994)
Number of calves (cumulative)							
Calves that had died	6	15	24	33	34	36	
Calves that were sold	5	17	22	28	32	40	2
Calves that were shared out	1	4	5	6	6	7	1
Calves of farms without milk supply to DPA	20	15	25	34	43	47	7
Calves for which no claim was received	70	237	301	410	473	630	85
Calves with claim but no payment	76	78	111	96	151	172	52
Calves that received bonus	1672	1484	1361	1242	1109	916	456
Number of bonuses							
In % of registration	90	80	74	67	60	50	
Envisaged % (as per project document)	100	100	80	80	70	70	
Liveweight development							
Average chest girth (cm)	84.5	97.8	107.6	116.3	123.7	133.9	
Estimated liveweight (kg)	58.0	84.6	110.8	134.9	164.8	205.6	
Growth rate from birth (g/d)	306	298	294	287	295	303	
Number of records	1736	1539	1388	1159	869	1157	603
Average age at first calving (months)							29.4

Differentiation of characteristics according to location and breed is given in Table 9.22 for the 321 project young cows and in Table 9.23 for 39 non-project young cows.

Table 9.21. Means and coefficients of variation (in %) for selected characteristics of project and non-project young cows collected after calving in the MIDCOMUL heifer calf target growth project.

	MIDCOMUL HEIFER CALF TARGET GROWTH PROJECT								NON-PROJECT	
Characteristics	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.
Number of records	603[1]		528[2]		321[3]		164[4]		39	
Age at first calving (d)	897	12	895	12	888	11	888	10	1084	26
Project calf history:										
Number of bonuses received			5.9	7	5.9	7				
Chest girth at 3 months (cm)			86.5	7	86.0	6				
Chest girth at 18-20 months (cm)			136.6	6	136.3	6				
Calf rearing practices										
One teat suckling (months)					2.50	56	2.45	64	2.35	68
Total suckling (months)					4.90	34	4.86	34	5.03	32
Concentrate at one year (kg/d)					0.64	54	0.67	54	0.66	65
Concentrate at 2 years (kg/d)					1.15	48	1.18	44	1.31	66
Data collection at field visit										
Dairy cattle at the farm (TLU)					3.04	64	3.98	56	2.89	70
Chest girth of young cow (cm)					153.3	6	153.5	6	156.5	8
Peak milk yield young cow (l/d)					7.62	33	7.72	36	8.32	31
Peak concentrate feed (kg/d)					2.09	39	2.23	42	2.08	48
Chest girth of the dam (cm)							160.7	5	162.9*	
Peak milk yield of dam (l/d)							10.24	34	10.46**	
Peak concentrate feed dam (kg/d)							2.37	46	2.43**	

[1] 603 calving reports [2] 528 calvings with 3 and 18 months chest girth records [3] 321 calvings checked in the field with complete records [4] 164 calvings with complete set of records on young cow and her dam.
* only 14 dams were still at the farm ** only of 24 non-project dams information was obtained.

The costs of the project at 18-20 months amounted to SL Rs 2,335,200 or Rs 2,018 per remaining heifer in the project. With 391 (21% of registered calves) reported calvings below 30 months of age and a bonus of Rs 1,000 total expenditure rose to SL Rs 2,726,200 or Rs 4,521 per heifer with a reported calving under the project.

Average peak milk yield of project young cows and corresponding concentrate levels are higher in the estate sector than in the village sector. Friesian types had the highest peak milk production followed by Ayrshire and Jersey types in accordance with breed expectations. In the village sector the total suckling period was longer than in the estate sector, while Jersey calves had the longest periods of one teat suckling. As farmers indicated during the field visits, to reach the target chest girth they had to feed either more milk or concentrates to the Jersey calves than they used to do. The dry period in the estates was a little shorter than in the village due to the difference in altitude. Ayrshire keepers in the estates had the largest number of TLU.

Data for non-project young cows were somewhat conflicting to the trends indicated above, but the numbers in the breed/location categories for Ayrshire both in the estate and village sector and those for estate Friesians are very small, while no data for estate Jersey type were found during field inspections.

Table 9.22a. Means and coefficients of variation (c.v. in %) for selected characteristics of 321 project young cows in the MIDCOMUL heifer calf target growth project.

Crossbreed and location Characteristics	Ayrshire		Friesian		Jersey		Overall	
	Estate Mean	Village Mean	Estate Mean	Village Mean	Estate Mean	Village Mean	Mean	c.v.
Number of records	43	68	56	101	13	40	321	
Age at first calving (d)	884	892	895	886	857	894	888	11
No. of quarterly bonuses up to 18 months	5.9	5.9	5.9	5.9	5.8	5.9	5.9	7
Estimated birth weight (kg)	30	30	32.5	32.5	25	25	30.4	
Chest girth at 3 months (cm)	85.2	86.0	86.4	86.4	83.8	85.9	86.0	6
Estimated liveweight (kg)	59.4	61.0	61.8	61.8	56.8	60.8	61.0	
Calculated growth rate (g/d)	321	339	320	320	348	391	334	
Chest girth at 18-20 months (cm)	137.0	134.8	138.8	136.0	135.4	135.4	136.5	6
Estimated liveweight (kg)	218.0	209.2	225.2	214.0	211.6	211.6	216.0	
Calculated growth rate (g/d)	324	309	333	313	322	322	320	

Table 9.22b. Means and coefficients of variation (c.v. in %) for selected characteristics of 321 project young cows in the MIDCOMUL heifer calf target growth project.

Crossbreed and location Characteristics	Ayrshire		Friesian		Jersey		Overall	
	Estate Mean	Village Mean	Estate Mean	Village Mean	Estate Mean	Village Mean	Mean	c.v.
Number of records	43	68	56	101	13	40	321	
Age at inspection (d)	1055	1019	1038	1015	1034	1008	1025	9
Chest girth at inspection (cm)	152.5	151.0	157.2	154.1	154.7	150.4	153.3	6
Estimated liveweight (kg)	282.5	276.0	308.2	290.2	293.5	273.6	286.5	
Calculated growth rate (g/d)	239	241	265	254	260	247	250	
Peak milk production (l/c/d)	8.41	6.93	9.02	7.54	7.15	6.35	7.62	33
Peak concentrate feed (kg/c/d)	2.34	1.84	2.23	2.05	2.35	2.03	2.09	39
One teat suckling (months)	1.84	2.50	2.63	2.54	3.15	2.70	2.50	56
Suckling period (months)	4.36	4.99	4.62	5.01	4.62	5.58	4.90	34
Concentrate at 1 year of age (kg/d)	0.73	0.59	0.61	0.62	0.73	0.72	0.64	54
Concentrate at 2 years of age (kg/d)	1.32	1.06	1.17	1.06	1.35	1.24	1.15	48
Dry period in the farm (months)	4.00	4.22	3.81	4.25	4.08	4.17	4.12	23
Total Livestock Units (TLU)	3.59	2.86	3.09	3.05	2.69	2.79	3.04	64

Age at first calving, number of bonuses received and chest girth development of project animals, contrary to age at first calving of non-project young cows, showed little variation among breeds and locations, suggesting that setting chest girth targets assisted to unify performance. Differences in average peak milk yields, corresponding concentrate levels, and calf rearing practices are more pronounced among breed/location categories, but high coefficients of variation prohibited statistical significance.

The growth rates of 320 g/d found in project animals up to an average age of 19 months (Table 9.22) are higher than the growth rates in the earlier pilot projects: 278 g/d in Rikilligaskada/Galaha (Table 9.14) and 288 g/d in the calf competition project (Table 9.16), where emphasis had been on the first year of calf rearing. Growth rates from birth up to inspection after calving are in average higher for project young cows with 250 g/d (Table 9.22) than for non-project young cows with 221 g/d (Table 9.23).

Table 9.23. Means and coefficients of variation (c.v. in %) for selected characteristics of 39 young cows inspected outside the MIDCOMUL heifer calf target growth project.

Crossbreed and	Ayrshire		Friesian		Jersey		Overall	
Location Characteristics	Estate Mean	Village Mean	Estate Mean	Village Mean	Estate Mean	Village Mean	Mean	c.v.
No. of young cows	5	2	8	18	0	6	39	
Age at first calving (d)	1041	1173	945	1093		1251	1084	26
Age at inspection (d)	1144	1366	1141	1238		1398	1237	26
Estimated birthweight (kg)	30	30	32.5	32.5		25	30.9	
Chest girth at inspection (cm)	153.0	145.5	160.4	157.9		153.8	156.5	8
Estimated liveweight (kg)	285.0	254.0	327.4	312.4		289.0	304.0	
Calculated growth (g/day)	223	164	259	226		190	221	
Peak milk production (l/c/d)	6.30	9.50	8.00	9.17		7.50	8.32	31
Concentrate fed at milk peak (kg/c/d)	1.80	1.50	2.69	1.97		2.00	2.08	48
One teat suckling (months)	2.40	3.00	2.63	2.25		2.00	2.35	68
Suckling period (months)	4.00	5.50	5.13	4.89		6.00	5.03	32
Concentrate at 1 year of age (kg/d)	0.60	0.50	0.73	0.69		0.57	0.66	66
Concentrate at 2 years of age (kg/d)	1.10	1.00	1.63	1.35		1.07	1.31	66
Total Livestock Units (TLU)	3.25	6.63	2.00	2.76		3.25	2.89	76

Comparison between locations, breeds and forms of breeding shows very little differences in age at first calving of young project cows, suggesting that going for target girth measurements or uniform liveweight estimates assists in achieving uniform and early ages of calving.

Details on calves of the project young cows are given in Table 9.24. For the growth rate calculations estimated birthweight for Ayrshire types is taken at 30 kg, for Friesian types at 32.5 kg and for Jersey types at 25 kg. For calves of first calvers or young cows 90% of these birth weights have been used with a further differentiation for male and female calves.

The average growth rate of 236 gram per day at the average age of 140 days of the calves of the young project cows that were inspected in 1993/94is much lower than the average growth rate of 298 gram per day for the project calves in 1991, suggesting a positive impact on growth rate of a target growth project.

Table 9.24. Means and coefficients of variation (c.v. in %) of liveweight development of 305 calves of 321 young cows in the MIDCOMUL heifer calf target growth project during inspection at the farms.

Crossbreed and Location Characteristics	Ayrshire Estate Mean	Ayrshire Village Mean	Friesian Estate Mean	Friesian Village Mean	Jersey Estate Mean	Jersey Village Mean	Overall Mean	Overall c.v.
Number of calves	39	64	56	97	12	37	305	
Estimated birthweight (kg)	27	27	30	30	23	23	27.9	
Chest girth calves at inspection (cm)	87.3	88.5	83.5	86.5	89.1	82.5	85.9	17
Estimated liveweight (kg)	66.0	56.0	63.6	62.0	67.2	54.0	60.8	
Age inspected calves (d)	181.0	128.7	145.9	135.8	173.8	107.0	139.2	65
Calculated growth (g/d)	216	225	230	236	254	290	236	
Number of female calves	28	37	34	48	8	29	184	
Chest girth female calves (cm)	86.1	82.4	86.4	87.3	92.9	81.5	85.3	
Estimated liveweight (kg)	61.2	53.8	61.8	63.6	74.8	52.0	59.6	
Estimated birthweight (kg)	26	26	28	28	22	22	26.1	
Age female calves (d)	182.3	113.7	133.1	147.1	177.6	96.4	136.5	
Calculated growth rate (g/d)	193	245	254	242	297	311	245	
Number of male calves	11	27	22	49	4	8	121	
Chest girth male calves (cm)	94.6	85.0	88.6	85.7	81.5	86.0	86.8	
Estimated liveweight (kg)	78.2	59.0	66.2	60.4	52.0	61.0	62.6	
Estimated birthweight (kg)	28	28	32	32	24	24	30.0	
Age male calves (d)	177.5	149.3	155.4	124.7	166.3	145.4	143.3	
Calculated growth rate (g/d)	283	208	220	228	168	255	228	

Table 9.25. Actual performance per location, breed and form of breeding service of 164 young cows and comparative performance in % of their respective dams in the MIDCOMUL heifer calf target growth project.

Characteristics young cows and in % of their dams	Location Estate	Location Village	Breed Ayrshire	Breed Friesian	Breed Jersey	Form of Service AI	Form of Service Bull	Overall
Number of young cows	61	103	73	71	20	49	115	164
Age of first calving (d)	900	882	895	882	889	874	894	888
(months)	29.5	28.9	29.3	28.4	29.1	28.7	29.3	29.1
Chest girth at inspection (cm)	154.6	152.9	152.2	155.3	151.9	153.2	153.6	153.5
Estimated liveweight (kg)	293	284.5	281	296.8	279.6	286	288	287.5
Age at inspection (months)	34.7	33.5	34.3	33.8	33.1	33.8	34.0	33.9
Chest girth of their dams (cm)	162.2	159.8	159.9	162.0	159.1	160.4	160.8	160.7
Peak milk yield young cow (l/d)	8.33	7.35	7.45	8.15	7.13	7.01	8.02	7.72
Concentrate fed at peak (kg/d)	2.40	2.13	2.18	2.32	2.05	2.11	2.28	2.23
Litres of milk per kg concentrates at peak	3.47	3.45	3.42	3.51	3.48	3.32	3.52	3.46
Performance in % of their dams								
Chest girth young cow	95.3	95.7	95.2	95.9	95.4	95.5	95.5	95.5
Peak milk yield	75.9	75.0	75.4	74.0	81.5	74.5	75.7	75.4
Concentrate fed at peak	96.8	92.2	94.8	95.9	83.7	88.7	96.2	94.1
Litres of milk/kg concentrate	78	81	80	77	97	84	79	80

A comparison of relative development of chest girth, relative performance of peak milk production and corresponding levels of concentrate fed during peak milk production between the young cows and their respective dams is shown in Table 9.25.

The achievement of the young cows in reaching already 95.5% of the dam's chest girth at the age of 1034 days (33.9 months) compares very well with 87% (520 kg at 34 months versus 600 kg adult liveweight) for Friesians in the Netherlands (Scheper, 1995). The relative peak milk yield of 75.4% of the dam's best peak milk yield for the young cows calving in average at 29 months of age is close to the standard of 79% calculated from Dutch correction data for age and those indicated by Schmidt and Van Vleck (1974) for Ayrshire, Friesian and Jersey. It is also interesting to note, that the ratio milk produced per kg concentrate at peak production is almost equal for factors as location, breed and form of service, indicating that farmers feed in relation to production.

The first 33 project animals, with reported second calvings in 1994, had an average age at first and at second calving of respectively 835 and 1226 days or 27 and 40 months. On 8 out of 16 farms visited (with second calvers) a daughter/dam comparison showed a chest girth ratio of 100% (155.7 cm or 300 kg liveweight), peak milk yields of 8 (65%) and 10.56 (85%) litres for respectively the first and second lactation of the project heifer compared with a peak milk yield of 12.38 litres (100%) in the best lactation of the dam.

Regression analysis of the MIDCOMUL heifer calf target growth project data

For the first calvers a step-wise regression was carried out for age at first calving, chest girth during inspection after calving and peak milk production of the young cow. The analysis was applied to the 164 young project cows with complete data of the young cow, her dam and her calf rearing characteristics. The main contributing covariables and factors to the tested models, as selected by the DbStat programme, are presented in Tables 9.26a, 9.27a and 9.28a. The same procedure was followed for 39 non-project young cows (Tables 9.26b, 9.27b and 9.28b), but without data of their dams because of limited availability.

The results of this step-wise regression in the MIDCOMUL project showed, that a lower than average age at first calving was significantly associated with a longer than average period of one teat suckling ($P<0.01$), total suckling period ($P<0.01$), a higher than average concentrate level fed to the calf at two years ($P<0.1$), peak milk production of the dam and level of concentrate feeding at peak milk yield of the young cow ($P<0.1$). A higher than average peak milk production of the young cow was associated with a higher age at first calving ($P<0.05$). The model explained 17% of the variation.

Table 9.26a. Least squares (l.s.) mean and regression coefficients for various calf rearing and production characteristics with age at first calving of 164 heifers and their respective dams in the MIDCOMUL heifer calf target growth project.

Characteristics	l.s. Mean	s.e.[1]	Regr. coefficients	s.e.[1]
Overall age at first calving (d)	888.4	6.7		
One teat suckling (months)			-10.88*	4.72
Period of suckling around milking (months)			-13.09**	4.61
Concentrate fed at two years of age (kg/calf/d)			-24.15	14.43
Peak milk production of young cow (l/d)			7.22*	3.65
Peak milk production of the dam (l/d)			- 4.11	3.01
Concentrate fed at peak milk of young cow (kg/d)			-13.54	7.38
R^2 model[2] = 17%				

[1] Standard error. [2] Coefficient of determination. * P<0.05; ** P<0.01.

Table 9.26b. Least squares (l.s.) mean and regression coefficients for various calf rearing and production characteristics with the age at first calving of 39 non-project young cows in the MIDCOMUL area.

Characteristics	l.s. Mean	s.e.[1]	Regr. coefficients	s.e.[1]
Overall age at first calving (d)	1084.2	6.7		
One teat suckling (months)			-51.96*	25.28
Concentrate fed at two years (kg/calf/d)			-65.86	48.67
Number of livestock units at farm (TLU)			48.45*	20.84
R^2 model[2] = 30%				

[1] Standard error [2] Coefficient of determination. * P<0.05.

For the 39 non-project young cows in the MIDCOMUL area, without data of the dams being available, the average age at first calving of 1084 days or 35.5 months was explained for 30% by: total number of livestock in TLU (P<0.05), delaying it with 45 days per extra TLU; number of months given one teat to suckle (P<0.05) and the concentrate level fed at 2 years old, which would reduce the calving age by 52 days per additional month of one teat suckling, respectively by 65 days per extra kg concentrate per day at two years.

The variation around average chest girth of 153.5 cm of young project cows at inspection after calving was for 47% significantly and positively influenced by chest girth of the dam (P<0.001), concentrate feed level at one year of age (P<0.001), the peak milk yield (P<0.01) and the concentrate feed level during peak milk production of the young cow, while a more than average concentrate feed level at two years of age (P<0.05) and that during the dam's peak milk production (P<0.05), number of dry months (P<0.05) and total number of livestock in TLU had a negative influence.

Table 9.27a. Least squares (l.s.) mean and regression coefficients for various calf rearing and production characteristics including information on the dams with chest girth (cm) during farm visits of 164 young cows after calving in the MIDCOMUL heifer calf target growth project.

Characteristics	l.s. Mean	s.e.[1]	Regr. coefficients	s.e.[1]
Overall chest girth of young cow (cm)	153.51	0.55		
Chest girth of the dam (cm)			0.64***	0.07
Concentrate fed at one year of age (kg/calf/d)			7.87***	2.23
Peak milk production of the young cow (l/d)			0.76**	0.23
Number of dry months at the farm			- 1.33*	0.63
Concentrate fed at milk peak of the dam (kg/d)			- 0.86*	0.90
Concentrate fed at two years of age (kg/calf/d)			- 3.41*	1.64
Number of livestock units at farm (TLU)			- 0.39	0.25
Concentrate fed during milk peak of young cow (kg/d)			1.43	1.08
R^2 model[2] = 47%				

[1] Standard error [2] Coefficient of determination. * P<0.05; ** P<0.01; *** P<0.001

The variation around average chest girth of 39 non-project young cows of 156.5 cm could be explained positively for 23% by a more than average age at first calving (P<0.1), peak milk yield of the young cow (P<0.05) and corresponding concentrate feed level (P<0.1).

Table 9.27b. Least squares (l.s.) mean and regression coefficients for various calf rearing and production characteristics with chest girth (cm) during farm visits after calving of 39 non-project young cows in the MIDCOMUL area.

Characteristics	l.s. Mean	s.e.[1]	Regr. coefficients	s.e.[1]
Overall chest girth of young cow (cm)	156.54	1.77		
Peak milk production of young cow (l/d)			1.51*	0.74
Concentrate fed at milk peak of young cow (kg/d)			3.68	1.95
Age at first calving of young cow (d)			0.01	0.007
R^2 model[2] = 23%				

[1] Standard error [2] Coefficient of determination. * P<0.05.

The variation in peak milk yield of the young project cows was for 64% explained by the following covariables: positively by a more than average peak milk yield of the dam (P<0.001), concentrate feed level during peak milk production of the young cow (P<0.05), age at first calving P<0.05), number of months suckling during rearing and chest girth of the young cow, and negatively by concentrate feed level during peak milk yield of the dam, concentrate feed level at one year (P<0.05) and total number of livestock units in TLU.

The variation in peak milk yield of non-project young cows could be explained for 35% by location ($P<0.01$) in favour of the village sector, a higher than average chest girth ($P<0.01$) that increased peak milk yield and a higher than average age at first calving ($P<0.01$) that reduced it.

Table 9.28a. Least squares (l.s.) mean and regression coefficients for various calf rearing characteristics and farm conditions including information on the dams with the peak milk production (l/d) of 164 young cows in the MIDCOMUL heifer calf target growth project.

Characteristics	l.s. Mean	s.e.[1]	Regr. coefficients	s.e.[1]
Overall peak milk production young cow (l/d)	7.72	0.13		
Peak milk production of the dam (l/d)			0.55***	0.04
Concentrate fed at milk peak young cow (kg/d)			1.22***	0.25
Concentrate fed at milk peak of the dam (kg/d)			-0.61**	0.22
Age at first calving of young cow (d)			0.003*	0.002
Total livestock units at the farm (TLU)			-0.11	0.06
Chest girth of young cow during farm visit (cm)			0.02	0.02
R^2 model[2] = 64%				

[1] Standard error [2] Coefficient of determination. * P<0.05; ** P<0.01; *** P<0.001

Table 9.28b. Least squares (l.s.) mean and regression coefficients for various calf rearing characteristics and farm conditions with the peak milk production (l/d) of 39 non-project young cows in the MIDCOMUL area.

Characteristics	l.s. Mean	s.e.[1]	Regr. coefficients	s.e.[1]
Overall peak milk production young cow (l/d)	7.96	0.37		
Location				
- estate	6.89a	0.62		
- village	9.03b	0.43		
Chest girth of young cow (cm)			0.09**	0.03
Age at first calving of young cow (d)			-0.004*	0.001
R^2 model[2] = 35%				

[1] Standard error. [2] Coefficient of determination.
l.s. Means with different superscripts are statistically significantly different (P<0.05); * P<0.05; ** P<0.01.

DISCUSSION

Proper calf rearing as a basis for a good productive cow of to-morrow is important to improve milk production. Many tropical countries want to increase dairy production to become less dependant on imports from temperate countries, and list more and better dairy stock as their highest priority. To initiate the lactation in cattle, heifers are bred according to weight generally at 60-70% of their adult liveweight. However, liveweight development over time can be quite different between temperate and humid tropical areas and between breeds/types, as illustrated in Figure 9.20. Average liveweight development over age is shown of Friesian stock in the Netherlands (from 0-51 months of age, including 3 calvings), as measured at "De Marke" a farm for applied research in the Netherlands (Schepers, 1995), of Friesian cattle (average over 1984-1994) at New Zealand farm in Sri Lanka and of the average liveweight estimates per month of crossbreeds measured sofar under the "Kerala" scheme and the MIDCOMUL project.

In practice, reproduction and calf rearing in the tropics can be rather poor with high calf mortalities, resulting in very limited internal production of good dairy stock.

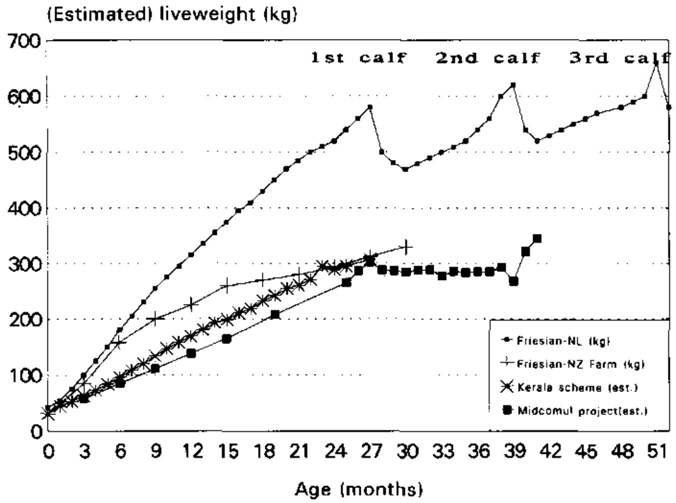


Fig. 9.20. *Liveweight development in relation to age of Friesians in the Netherlands, ex-Dutch Friesians at New Zealand farm and crossbreeds at smallholder farms measured under the AI heifer calf rearing scheme "Kerala" and the MIDCOMUL Project.*

State and/or parastatal farms in the tropics, run on annual money allocations, prove a difficult pathway to produce large numbers of excess breeding stock at set low prices. Potential off-take of excess breeding stock at (para)statal farms in Sri Lanka of about 7% of average total stock, after deducting the culled and dead animals from the percentage born, is no exception. It compares, however, well with results on specialized parastatal heifer crossbreeding units in Tanzania. The Mruazi ranch in the Tanga region of Tanzania annually sold 200-250 F1 (Friesian X Boran) in-calf heifers (5-6.25%) during the 1980-1986 period from an average 2,000 breeding cows out of a total ranch stock of 4,000 animals (Mtenga et al., 1987). The Kikulula heifer breeding unit in the Kagera region produced in average 210 F1 heifers (4.9%) for sale per year from 1978-1987 from in average 2,044 breeding cows out of a total ranch stock of 4,320 animals (Chande et al., 1989). Disease problems are, however, more severe in Tanzania than in Sri Lanka especially tick borne diseases and trypanosomiasis.

Rearing of salvaged stock from the smallholder sector and some excess stock from the (para)statal sector, such as at Haragama and Rosita farm, requires appropriate selection of calves and the implementation of correct rearing practices. The transition of calves from suckling at small farms to artificial rearing may prove difficult. Also rearing of small, weaned calves on mature roughage and rice bran of variable quality is not easy. This may result in high mortality, but certainly results in poor growth at the start leading to delayed first calving (Dharmapala, 1985). The overall performance of 73 selected in-calf heifers from the two farms issued to aspirant dairy farmers in the NADSA area, as indicated by available records and farmers' verbal information, showed a large variation around the average production of 3 calves per in-calf heifer issued (214 for 73 in-calf heifers), average peak milk yield of 6.86 litres per cow per day (202 records), a lactation period of 8.7 months (188 records) and a calving interval of 523 days (65 records). Mainly Friesian stock from Rosita farm performed slightly better for total number of calves and peak milk production, but had a slightly shorter lactation period and a longer calving interval than the Ayrshire and Friesian crossbred stock from Haragama farm. The sex ratio of the calves produced was more favourable for ex-Haragama farm animals, but the survival rate was more favourable for ex-Rosita stock (Table 9.6). In an economic analysis ex-Haragama stock farmers produced Rs 200 more in monthly farm gross margin than ex-Rosita stock farmers because of a better female/male calf ratio which facilitated expansion of the dairy.

Import of dairy stock from abroad is costly at prices per head varying from US$ 1,000 (transport of donated stock), US$ 2,000 (stock from the region plus transport) up to US$ 5,000 (purchased and flown in from Europe). Imported stock from Australia and the Netherlands turned out rather disappointing in terms of production of milk and number of offspring. Even import of Sahiwals and Nili Ravi buffaloes from Pakistan has as yet not produced much cows in milk (97 Sahiwal heifers imported in December 1989 led to only 56 cows in milk in 1992/93 and 197 Nili Ravi buffalo heifers of December 1990 led to only 64 cows in milk in 1992/93). The respective average milk yields of 5.3 and 6.9 litres per cow per day required also large amounts of concentrate (Table 9.5). Performance of ex-Pakistan stock in Sri Lanka appeared poorer in mortality and growth rate, especially in Nili Ravi possibly due to the introduction of artificial calf rearing. Comparative lower milk production and much lower milk sales after the calves have been fed in Sri Lanka are not promising either for inter-regional trade of Bos indicus and buffalo stock into Sri Lanka for milk and stock development.

Internal generation of stock requires livestock breeders who enjoy calf rearing and can afford long-term investment in young stock. Smallholders in Sri Lanka lack pasture land and capital, as well as incentives of a favourable milk price to buy concentrates, to rear their calves into young and well developed in-calf heifers in sufficient numbers for replacement and sale. However, effective attention by government and donors to calf rearing incentives at small farms seems to contribute to lower ages at first calving, at least in 3 of the 4 large schemes (Table 9.30).

The calf health care scheme provided insufficient incentives to grow good replacement stock in the second year, when physical conditions of the calves became moderate (32%) or poor (35%). The animals in the contract heifer breeding and raising scheme and the MIDCOMUL heifer calf target growth project showed a better physical condition (authors' own observation), and farmers were keen on having the well-grown heifers calving on the farm. For that reason the contract breeding scheme became unpopular, as farmers were reluctant to depart from their good looking heifer, and this scheme was replaced by the AI calf rearing scheme "Kerala", that has no obligations to sell the product (Kopalasuntharan, pers. com., 1993). The MIDCOMUL project showed a high drop-out rate compared to the DAPH schemes. However, during field inspections it turned out that even though calves had not qualified for one or more bonus payments, most farmers were still keeping their project animal, but did not supply milk to the cooperative, had an animal with a high proportion of local blood (Matale area) or had sold them when pregnant.

In the "Kerala" scheme in 1993 many calves started cycling at 8-10 months of age. Farmers wanted to have them inseminated, but the AI technicians judged that the development of the reproductive organs was still insufficient and refused to inseminate them at such an early age (Ranawana, research officer Veterinary Research Institute, pers.com., 1993). During the 1993 field inspection the 10-14 months old "Kerala" calves looked rather fat. Therefore in 1994, the recommended type and amount of concentrates in the scheme was reduced from 1-2.5 kg calf feed (crumbles) to 1 kg dairy meal per day from the 4th to the 12th month.

Though in the MIDCOMUL project higher levels of concentrate feeding at 1 year of age appeared not conducive to an early age at first calving and high peak milk yields, it would be interesting to follow up the heifers that have calved in the "Kerala" scheme. The present thinking in Sri Lanka is to start milk recording of both the "Kerala" scheme cows and their dams (Amarasekera, officer DAPH, pers. com., 1994).

Table 9.30. Technical and economic performance of 4 large calf rearing schemes at smallholder level in Sri Lanka.

	Contract Heifer Breeding & Raising Scheme	Calf Health Care Scheme	Heifer Calf Target Growth Project MIDCOMUL	A.I. Heifer Calf Rearing Scheme "Kerala" Island wide	Central Province
Original target					
Number of calves	750	100,800	open	11,916	
Period/area/batch	3 areas	3 years	1 year	3 batches	
Total cost (Rs)	2.1 mln	33.7 mln	open	56.8 mln	
Cost/heifer (Rs)	1,5-3,200	428	2,800	5,000	
Cost/male (Rs)		243			
Adjusted target					
Number of calves	2,961	3,836	1,400	3,185 (1992/93)	3,035
Total cost (Rs)	8 mln		3.25 mln	7.17 mln	
Results over period	1985/91	1986/91	1990/94	1992/93	1991/94
Registered calves	1,926	2,763	1,850	1,242	1,500
in % of target	65	72	132	39	49
Mortality (%)	8	4	2	0.7	3.6
Drop out rate (%)	19	8	43 (18-20 months)	1.6	5
Growth rate (g/d)	337[1)] 328	309[2)]	303	415[3)]	
Number of calves	61 78	110	1157	1242	
Age (months)	0-12 0-30	0-12	0-19	av. 8.2	
Resulting stock	520 (27%) sold	2,441 (88%) remaining	603 (33%) calvings	n/a	50(3%) calvings
Calving age (months)	29	n/a	29.4	n/a	25.5
Actual spending (Rs)	2.3 mln	0.26 mln	2,73 mln	n/a	8 mln
Cost/animal (Rs)	4,430 (per heifer sold)	108 (per balance calf)	4,521 (per reported calving)		(est) 8,000 (per scheme heifer)

1) first evaluation in 1986 island wide (Table 9.7) and second evaluation in Nuwara Eliya district in 1988
2) evaluation in Nuwara Eliya district
3) estimated birth weight varied from 17 - 31 kg against 30 kg in other schemes
n/a means not available with the authors

The peak milk yields (Table 9.24) of the 164 MIDCOMUL young cows of 7.72 litres per day, although slightly lower than those of the 39 older control young cows of 8.32 litres per day compared favourably with those (Table 9.6) of the salvaged in-calf heifers of Haragama farm at 6.3 litres per day, those of Rosita farm of 6.5 litres per day and the ones (Table 9.19) from the Matale calf rearing target growth project of 6.17 litres per day. Moreover, the milk yields of MIDCOMUL young cows compared favourably on a per kg concentrate basis (Table 9.25) at 3.5 litres compared to 2 litres of milk per kg concentrate in the (para)statal sector. In addition, at smallholder farms the majority of calves suckle their dams, while in the (para)statal sector calves are bucket-fed. The latter practice reduces the amount of saleable milk to less than 2 litres per kg concentrate.

Not all smallholders are skilled in calf rearing and/or keen or able to raise young stock adequately. Considerable differences were observed between the 25% poor and the 25% best growers as shown in the second pilot calf rearing project in Rikilligaskada and Galaha and the third pilot target growth project in Matale (Table 9.15 and 9.18). The control group also comprised farmers skilled in calf rearing as demonstrated by the liveweight development of control animals outside the contract breeding and calf health care schemes in Nuwara Eliya district (Figure 9.7). If farmers decide to raise a calf for replacement stock on their farm or for sale, good performance can be achieved.

Monitoring of the 1,850 MIDCOMUL project animals was done on a part-time basis by the 12 MIDCOMUL field officers under the guidance of the Regional Livestock Development Officer of NLDB at MIDCOMUL. Unfortunately, when the number of field officers was reduced from 12 to 4 in 1992, the chest girth measurements at 18 months were delayed for some animals up to 20 months, pregnancy diagnosis was impossible for the 21 months pregnancy bonus, and also inspections after calving were delayed for months. The objective of the premium at calving, to feed the heifer to attain a good peak yield and early reproduction and to avail some money for rearing the new calf properly, was not met because the combined premium for pregnancy and calving was only paid after November 1993.

Economics

Prices of recent imported stock are of the order of US$ 1,000 (transport costs per donated animal) to 2,000 (for purchase and transport) for animals from within the Asian/Australian region. Multiplication of breeding stock and sale to smallholders had a cost for the state and parastatal farms of respectively Rs 5,000 and Rs 10,000 or US$ 140-280, i.e. the difference between the rearing costs and the price paid by smallholders in the period 1980-1988. Also the high cost of rearing salvaged stock at US$ 200-250 was not compensated by the prevailing subsidized selling prices of US$ 100 in the 1980s.

The actual cost for the Government per in-calf heifer produced, was about US$ 100 in the contract heifer breeding scheme and the MIDCOMUL project. The "Kerala" scheme was more expensive at about US$ 170, an amount that heavily depended on the price of concentrates. The cost of the pilot calf rearing project in Rikilligaskada/Galaha amounted to Rs 97,800 or Rs 6,113 (US$ 165) per recorded heifer that calved, excluding the salary and transport costs of the project officer. The calf competition project costed an estimated Rs. 10,000 (Rs 294 per heifer present at 18 months) and the pilot target growth project in Matale spent Rs 11,800 (Rs 513 per remaining calf at 10 months) in bonuses, but for the latter two projects no follow up has been made to arrive at a comparative cost per in-calf heifer.

In economic terms, an additional growth rate of 150 gram per day (e.g. 300 instead of 150 gram per day), from 30 kg at birth up to 200 kg at service, means a reduction in the age at first service of some 566 days or 1.5 years, which at 10 Rs per day (Dharmapala, 1985) amounts to Rs 5,600, i.e. higher than the level of subsidy/bonus in the Sri Lankan schemes/projects, except for the AI heifer calf rearing scheme "Kerala". During field inspection in 1993 of the MIDCOMUL animals farmers indicated that the cost of producing heifers was between Rs 8,000-12,000 (US$ 170-255), depending mainly on the prevailing price of coconut meal. This compares favourably with the cost of rearing in-calf heifers at parastatal farms, which was estimated at an average cost of Rs 1,000 per month or Rs 24,000 - Rs 30,000 (US$ 510-640) for an early age at first calving of 24-30 months on New Zealand farm in 1993 (Madurasinghe, pers. com., 1993).

As it is the aim of the Sri Lanka government to bridge the gap between milk consumption and production over a 10 year period (1993-2002), large numbers of additional and good quality dairy stock are needed. These animals could be raised by smallholders if large schemes or projects could be organized and monitored by enthusiastic and capable livestock field officers. Sofar, the schemes aiming at AI calves only and operating through the veterinary ranges had a slow registration of calves, and actual numbers fell far short of anticipated targets (Table 9.30). The MIDCOMUL project showed that large numbers can be registered in a short time through Dairy Producers Associations. Farmers' participation has been high through adequate initial mobile training on calf rearing and explanation of the calf rearing project; calf registration and follow up on quarterly chest girth measurements was in the hands of their own DPA calf rearing committee. Quarterly monitoring by professional MIDCOMUL staff to check on DPA reported quarterly targets of the calves (up to 18 months of age) seems sufficient and is far less labour-intensive than the AI heifer calf rearing scheme, in which chest girth monitoring and provision of feeds to the farms is done monthly by staff of the veterinary ranges involved.

CONCLUSIONS

In Sri Lanka, the production of in-calf heifers either by multiplication or salvaging operations by the (para)statal sector was uneconomic at prevailing prices, and numbers have been limited. Performance of expensive imported stock has been disappointing both at (para)statal farms and at smallholder level in terms of milk production and offspring. However, smallholders in Sri Lanka seem receptive to apply better rearing practices for their calves when given some calf rearing/heifer raising support from birth to in-calf heifers. Moreover, such support at the rate of 100 US$ per in-calf heifer could result in the local production of 20 well adapted dairy animals in Sri Lanka at a cost similar to importing one unadapted heifer from abroad. Large numbers of calves can be enrolled through farmers DPAs, and would benefit farmers using AI close to the Veterinary ranges as well as those using natural service further away but within reach of the dairy cooperative through the milk collection points. High farmers' participation and quarterly monitoring of the chest girth up to 18 months followed by bonus payments only for qualifying calves, resulted in a low overall calf mortality of 2% and growth rates of about 300 grams per day with early ages at first calving of around 29 months, irrespective of crossbreed type and location. Relative estimated liveweight was high with a reasonable peak milk yield during first lactation compared to the performance of their dams.

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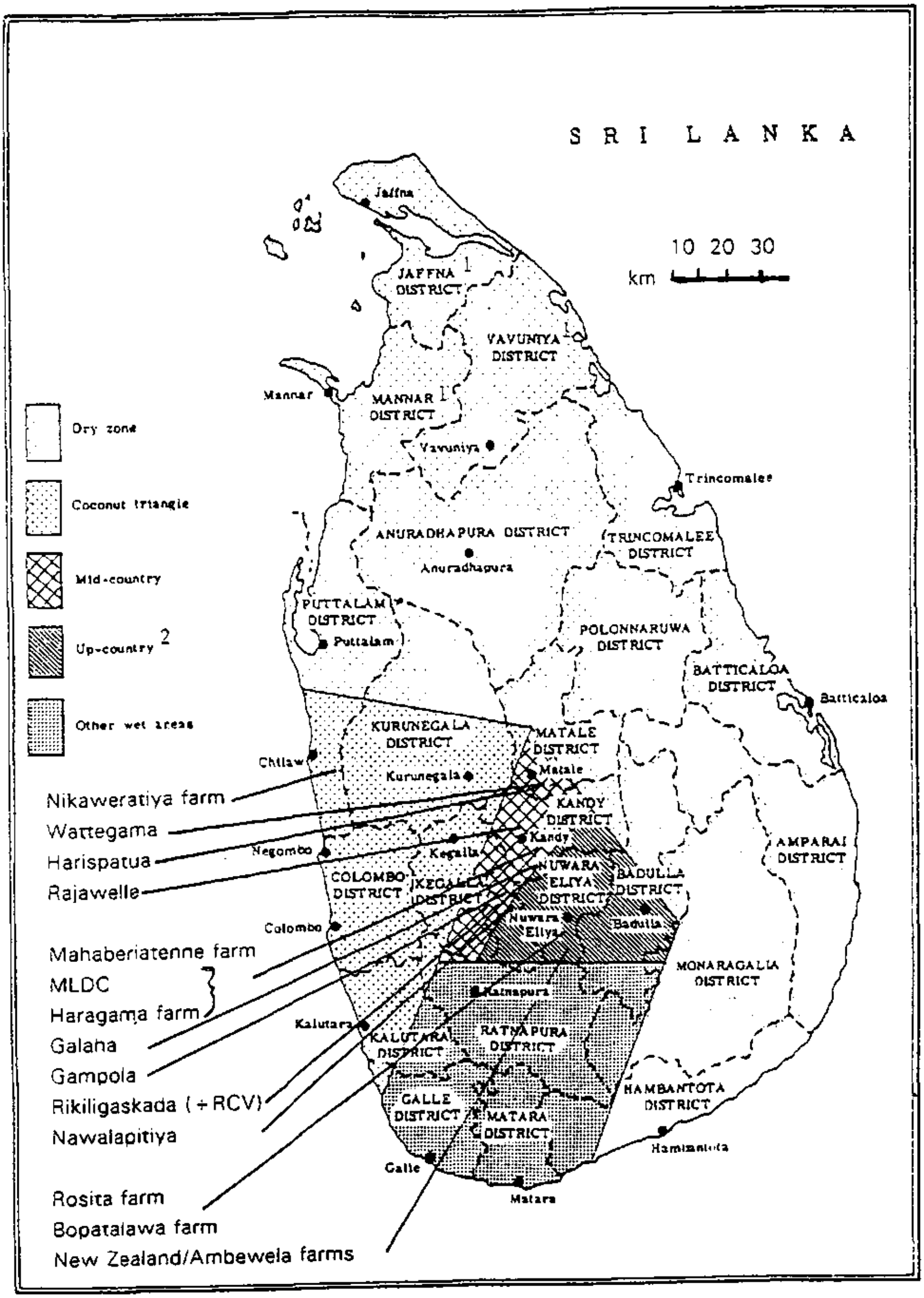
Appendix 9.1

Agro-Ecological Zones in Sri Lanka



1 A new district - Mullaitivu - was created in January 1979 from parts of Jaffna, Mannar and Vavuniya districts.

2 The Up country area is also referred to as Hill country.

Appendix 9.2

Live weight of cattle in relation to girth size (adopted from the Report "Health Care Scheme For Calves" of the Sub-Committee on Dairy Development, Sri Lanka)

GIRTH SIZE cm	LIVE WEIGHT kg	GIRTH SIZE cm	LIVE WEIGHT kg	GIRTH SIZE cm	LIVE WEIGHT kg
63	33	106	106	149	268
64	34	107	109	150	272
65	35	108	112	151	276
66	36	109	115	152	280
67	37	110	118	153	285
68	38	111	121	154	290
69	39	112	124	155	295
70	40	113	127	156	301
71	41	114	130	157	307
72	42	115	134	158	313
73	43	116	137	159	319
74	44	117	140	160	325
75	45	118	143	161	331
76	46	119	146	162	337
77	47	120	150	163	345
78	48	121	154	164	353
79	49	122	158	165	360
80	50	123	162	166	366
81	51	124	166	167	372
82	53	125	170	168	378
83	55	126	174	169	385
84	57	127	178	170	392
85	59	128	182	171	399
86	61	129	186	172	406
87	63	130	190	173	413
88	65	131	194	174	420
89	67	132	198	175	427
90	69	133	202	176	435
91	71	134	206	177	443
92	73	135	210	178	451
93	75	136	214	179	459
94	77	137	218	180	467
95	79	138	222	181	475
96	81	139	226	182	483
97	83	140	230	183	491
98	85	141	235	184	499
99	87	142	240	185	508
100	89	143	244	186	516
101	92	144	248	187	525
102	95	145	252	188	534
103	98	146	256	189	543
104	100	147	260	190	552
105	103	148	264	191	561

10. RECENT OVERVIEW OF DAIRY DEVELOPMENT IN SELECTED COUNTRIES

INTRODUCTION

Dairy development in a country has organizational, technical, socio-economic and cultural aspects, as well as implications in the areas of nutrition and equity. Organizational aspects refer to macro-policies of prices, taxes, trade and exchange rates, infra-structural development of roads, communication and marketing channels, land ownership and use, support services of input supplies, credit and veterinary support, training, research and extension programmes, farmers' knowledge and organization. Technically, the number of dairy cows times the milk yield per cow leads to total milk production. Nutritionally, total milk production divided by the population size provides theoretically the available milk per capita. Actual availability depends on purchasing power and cultural and traditional consumption patterns. Economic dairy farming aspects comprise investments in animals, buildings, equipment and land, recurrent costs of feeding, breeding, disease control labour, management and upkeep of land, buildings and equipment, fixed costs of depreciation and interest, and revenues of milk production, sales of animals, manure and draught rental for cultivation and transport. However, many transactions in dairy farming do not involve cash transfers, making it difficult to arrive, for instance, at a real cost price for assessing the comparative advantage of a country, farming system or farmer in dairying. Examples of costs, that are often not expressed in cash terms, are physical infrastructure, cost of water and government supported training, research, extension and veterinary services and quality control.

Quantitative information on these various aspects of dairying is only partially available and varies in type and completeness per country. Dairy development projects have tried to collect technical and sometimes economic data that allow more detailed study of progress to identify successful policies, strategies and activities.

For this overview use has been made of (1) FAO statistics over the period 1980-1993for selected countries per geographical area; latest progress reports and evaluations of (2) Dutch supported smallholder dairy development projects, (3) dairy food aid supported projects, (4) Swiss aid supported projects in rural cheese making, (5) a FAO/UNDP supported integrated dairy project that has incorporated the private sector (feed, fertilizer, milk) to arrive at a sustainable dairy development programme in the Dominican Republic, and (6) FAO efforts in supporting out-reach dairy development training units in Latin America.

10.1 Dairy productivity in selected countries per geographical area

Dairy productivity expressed in dairy cow numbers, milk yield per cow and the consequent total milk production, as well as the available local milk (cow and buffalo) per capita for a number of countries, mentioned earlier on in this thesis, between 1980and 1993are presented in Tables 10.1 (Africa), 10.2 (Asia), 10.3 (Latin America) and 10.4 (Oceania and Europe). The order of country selection starts from the one with the largest number of dairy cattle to show the relative importance of countries in dairying.

In Africa, *i.e.* Kenya and Tanzania, increases in milk production were mainly based on more animals that entered the dairy sector through herd growth and crossbreeding. In Egypt increased production came mainly from imports of dairy cattle, while in Tunisia -although cattle numbers increased somewhat- the major contribution came from increased production per cow through imported cattle and concentrates. Zimbabwe, a potential exporter of milk from surplus in the commercial sector when world market prices are attractive, showed a slight reduction in stock numbers. In Zambia, a traditional importer of milk products, cattle numbers increased parallel with the human population increase. Milk production per cow in Eastern and Southern Africa remained low, because of the large number of local cattle of the Zebu type that are milked and classified as dairy cattle by the respective governments.

Table 10.1. Development of dairy cow numbers, milk yield and annual changes between 1980 (av. 1979-1981) and 1993 (av. 1992-1994) and associated annual changes in total milk production and in available local cow and buffalo milk (c+b) per capita in selected countries of Africa.

Selected Countries	Dairy cows numbers (000) 1980	1993	Annual change %	Milk yield (kg/cow/year) 1980	1993	Annual change %	Total milk Ann. change (%) cow	buffalo	Available milk per capita (kg/yr) 1980(c+b)	1993(c+b)
Eastern Africa										
Tanzania	2,337	3,121	2.25	160	166	0.28	2.55		20	19
Kenya	2,083	3,895	4.93	460	491	0.50	5.46		58	72
Southern Africa										
Zimbabwe	1,057	1,003	-0.40	431	438	0.12	-0.27		64	41
Zambia	201	288	2.81	300	300	0.00	2.80		10	10
Northern Africa										
Egypt	962	1,468	3.31	674	674	0.00	3.31	1.52	44(15+29)	41(16+25)
Tunisia	247	260	0.40	878	1,683	5.13	5.58		34	51

Source: FAO Production Yearbook (1994).

In India, improved milk yields per cow contributed considerably more to production increase than increased cow numbers. Extensive crossbreeding of non-descript stock and increased use of concentrates under programmes as Operation Flood started showing results. Milk yields in buffaloes rose fastest in Pakistan followed by India and China. Thailand, followed by the People's Republic of China had the largest annual increase in numbers based on imports, and a large-scale crossbreeding programme. In Thailand, milk yield per cow decreased with the influx of crossbred stock compared to earlier introduced exotic stock from India, Germany and Denmark. In Sri Lanka, more animals joined the dairy sector, but average milk yield per cow decreased. In Indonesia (on small farms) milk production increased through large imports of Holstein Friesian stock but the genetic potential of these animals was only partly exploited (Ibrahim *et al.*, 1991). In South Korea, imports of Holstein Friesian (up to 1985, with the majority kept on commercial farms with > 15 cows) resulted in much higher milk yields, that coincided with a liberal import policy of concentrates.

Table 10.2. Development of dairy cow numbers, milk yield per cow and annual changes between 1980 (av. 1979-1981) and 1993 (av. 1992-1994) and associated annual changes in total milk production and in available local cow and buffalo milk (c+b) per capita in selected countries of Asia.

Selected Countries	Dairy cows numbers (000) 1980	1993	Annual change %	Milk yield (kg/cow/year) 1980	1993	Annual change %	Total milk ann. change (%) cow	buffalo	Available milk per capita (kg/yr) 1980(c+b)	1993(c+b)
India	25,333	30,833	1.52	530	973	4.78	6.33	4.28	45(19+26)	67(33+34)
Turkey	5,952	6,079	0.16	1,300	1,457	0.88	1.04		174	149
Pakistan	2,534	4,414	4.36	864	893	0.25	4.62	5.08	101(26+75)	121(30+91)
China	634	3,468	13.96	1,802	1,545	-1.14	12.66	3.08	2(1+ 1)	6(4+ 2)
Sri Lanka	406	629	3.43	448	332	-2.29	1.08		12	12
Saudi Arabia	150	49	-8.20	443	6,749	23.31	13.50		7	19
Indonesia	103	341	9.65	762	1,174	3.38	13.30		1	2
Israel	103	116	0.90	6,817	9,234	2.36	3.28		180	203
South Korea	93	282	8.91	4,864	6,692	2.48	11.68		12	43
Thailand	10	121	21.17	1,950	1,613	-1.45	19.65		0	3

Source: FAO Production Yearbook (1994).

Milk production per cow in Israel increased considerably through breeding, cubicle housing and mixed feed (concentrates and improved fodder) preparations (Berman and Wolfenson, 1988). Saudi Arabia went away from local stock, focusing now on exotic stock with high milk yields of imported Holstein Friesians on large-scale turnkey projects, including imported farm structures, machinery and management.

In Ecuador and Costa Rica in Latin America, milk production increased more from milk yields per cow than from increased numbers, while the rise in milk production in Colombia was almost completely from increased numbers. Peru, Dominican Republic and Nicaragua showed decreases in animal numbers and lower productions per cow (except Peru). In Bolivia and Guyana increases came from more dairy animals (Table 10.3).

Table 10.3. Development of dairy cow numbers, milk yield per cow and annual changes between 1980 (av. 1979-1981) and 1993 (av. 1992-1994) and associated annual changes in total milk production and in available local cow milk per capita in selected countries of Latin America.

Selected Countries	Dairy cows numbers (000) 1980	1993	Annual change %	Milk yield (kg/cow/year) 1980	1993	Annual change %	Total milk ann. change (%) cow	Available milk per capita (kg/yr) 1980	1993
Brazil	15,968	19,833	1.68	712	794	0.84	2.53	94	101
Mexico	5,420	6,477	1.38	1,284	1,153	-0.82	0.56	104	83
Argentina	3,046	2,954	-0.24	1,746	2,523	2.87	2.65	189	221
Colombia	2,267	4,540	5.49	965	978	0.10	5.60	82	131
Chile	711	870	1.56	1,561	1,884	1.46	3.04	100	119
Cuba	664	497	-2.21	1,579	1,510	-0.34	-2.50	108	69
Ecuador	640	765	1.38	1,446	2,185	3.23	4.67	116	152
Peru	614	553	-0.80	1,298	1,448	0.84	0.04	46	35
Uruguay	569	657	1.12	1,442	1,756	1.53	2.75	278	367
Costa Rica	298	320	0.56	1,067	1,480	2.55	3.12	139	145
Nicaragua	283	272	-0.30	814	669	-1.49	-1.90	84	44
Dominican Republic	245	222	-0.76	1,742	1,698	-0.20	-0.95	75	50
Bolivia	51	93	4.76	1,396	1,446	0.27	5.05	13	19
Guyana	16	29	4.77	832	920	0.77	5.78	17	33

Source: FAO Production Yearbook (1994).

Table 10.4. Development of dairy cow numbers, milk yield and annual changes between 1980 (av. 1979-1981) and 1993 (av. 1992-1994) and associated annual changes in total milk production and in available local cow and buffalo milk (c+b) per capita in selected countries of Oceania, North America and Europe.

Selected Countries	Dairy cows numbers (000) 1980	1993	Annual change %	Milk yield (kg/cow/year) 1980	1993	Annual change %	Total milk ann. change (%) cow milk	Available milk per capita (kg/y) 1980(c+b)	1993(c+b)
Oceania									
New Zealand	2,189	2,791	1.89	3,016	2,977	-0.10	1.81	2,116	2,386
Australia	1,870	1,704	-0.71	2,994	4,459	3.11	2.39	384	432
North America									
USA	10,180	9,706	-0.37	5,377	7,090	2.15	1.30	255	267
Canada	1,778	1,276	-2.52	4,137	5,967	2.86	0.26	299	267
Europe									
Germany	7,592	5,405	-2.58	4,178	5,201	1.70	-0.93	405	347
France	7,308	4,846	-3.11	3,707	5,230	2.68	-0.51	503	441
Poland	5,847	4,077	-2.74	2,778	3,114	0.88	-1.90	457	329
United Kingdom	3,348	2,717	-1.59	4,755	5,458	1.07	-0.54	282	255
Italy	3,032	2,684	-0.93	3,478	3,912	0.91	-0.03	188(187+1)	186(184+2)
Netherlands	2,354	1,732	-2.33	5,025	6,278	1.73	-0.65	837	711
Ireland	1,488	1,468	-0.11	3,178	3,685	1.15	1.04	1,390	1,520
Denmark	1,042	710	-2.91	4,920	6,230	1.83	-1.11	1,001	855
Switzerland	871	776	-0.89	4,194	5,028	1.40	0.50	578	553
Finland	708	421	-3.92	4,572	5,903	1.98	-2.02	677	490
Sweden	657	520	-0.93	5,257	6,274	1.37	-0.44	415	374

Source: FAO Production Yearbook (1994).

Dairy cattle numbers in Oceania (except New Zealand), North and Central America and Europe decreased, while production per cow increased, especially in Australia, Canada and France (Table 10.4).

In conclusion, milk production in most European countries declined through large decreases in numbers partly offset through improved production per cow. In selected developing countries the tendency is more towards increasing numbers (Kenya, Tanzania, Egypt, Thailand, China, Indonesia, Korea Republic, Pakistan, Colombia, Bolivia, Guyana) and only few (Tunisia, Saudi Arabia, India, Ecuador, Argentina, Costa Rica) showed increasing milk yields per cow from 1980 to 1993.

10.2 Overview of Dutch supported smallholder dairy development projects

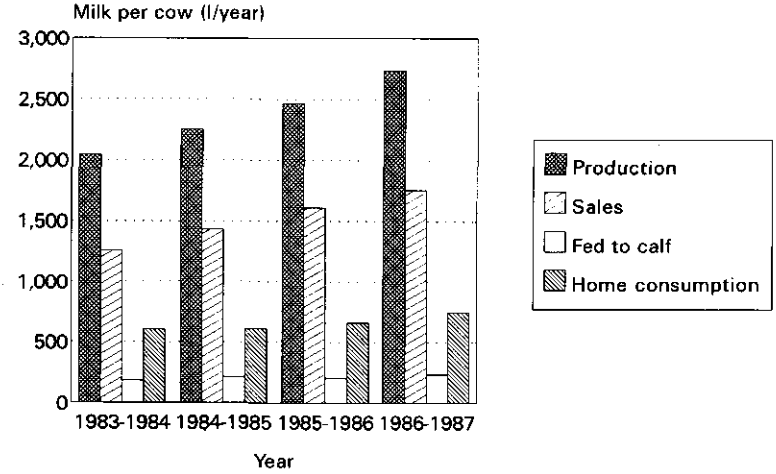
In this section a closer look is given to selected Dutch supported smallholder dairy development projects, mentioned earlier in Chapters 4 to 9. For Africa, data have been used of the Kenya Dairy Development Project, the Kagera Livestock Development Programme and the Tanga Smallholder Dairy Development Programme in Tanzania, and of the Livestock Development Programme in Western Province of Zambia. For Asia, data of the Sri Lanka-Netherlands Livestock Development Programme have been used as well as some studies of smallholder dairying in East Java, Indonesia. For South America, project data of the smallholder project in Nariño, Colombia and of the Integrated Dairy Development Project in Cañar, Ecuador have been used. As far as possible, an identical set of technical (Table 10.5) and economic (Table 10.6) characteristics was collected.

Technical characteristics

All projects in Kenya, Tanzania, Sri Lanka, Indonesia, Colombia and Ecuador recorded average daily milk yields per cow, which increased over time in all projects. Increasing productions per ha were recorded in Colombia and Ecuador. Milk yield per ha was highest in Indonesia, based on concentrates and off-farm forage in addition to home grown fodder. Daily milk production per farm was recorded in most projects. Lowest farm yields were recorded in Sri Lanka from just over one crossbreed cow in villages and estates to the highest in promotor farms in Ecuador with an average of 7 cows. The percentage of cows in milk increased from 60% (estimated initially in Ecuador) and 70% (Kenya) to 75% (Ecuador) and 86% (Kenya). Figures for Tanzania, Sri Lanka and East Java did not increase much, but remained between 70 and 80%.

Records and progress information on age at first calving were scarce (except for Kagera region in Tanzania and Sri Lanka) in spite of attention to calf rearing in extension activities of all projects. Calculated calving intervals in Kenya, Tanzania and for imported cattle in East Java were all very long. Conception rates after first insemination varied from a low 35.6% for imported cattle in East Java to a good 63% in Kenya. Adult mortality rates have generally been reduced, but especially calf mortalities from between 20-30% down to 3-9%. Home consumptions of milk were only reported for Kenya and Sri Lanka. Mentioned amounts were indicative for the high importance of milk for family consumption in Kenya and the low milk consumption habits in Sri Lanka.

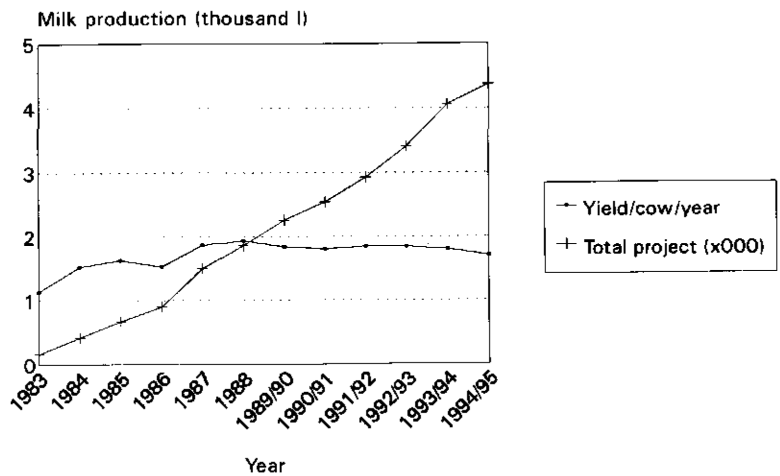
In Kenya, milk yield per cow over the period 1983-1987 increased from 2,043 to 2,736 litres and milk sales from 1,256 to 1,755 litres per year, while milk fed to the calf and home consumption increased also over the period (Figure 10.1; Van der Valk, 1985a and b, and 1987).



Source: NDDP, Kenya (Van der Valk, 1987)

Fig. 10.1. *Milk production and use per cow in Kenya Dairy Development Project (1983-1987).*

In Kagera region of Tanzania, milk yields per cow also increased, but remained below levels achieved in Kenya because of lower exotic blood levels (KALIDEP, 1993 and 1995). Total milk production in the project rose fast and was mainly from newcomers to the industry (Figure 10.2). Decline in milk yield from 1993-1995occurred because input prices increased faster than milk prices (KALIDEP, 1995) reducing also the gross margin per farm and per cow in 1993/94 (Figure 10.4).



Source: KALIDEP (1993) and (1995)

Fig. 10.2. *Annual milk yield per cow and total milk production in Kagera Livestock Dev. Programme (1983-1995).*

Table 10.5. Comparison of selected characteristics and progress (->) in dairy development projects/programmes.

Country	Period	Farmers reached	Milk production (l/c/d)*	Milk production (l/ha)	Milk production (l/farm/d)	Cows in milk (%)	Age 1st calving(month)	Calving Interval(d)	Conception rate/ 1st service (%)	Mortality rate adult(%)	Mortality rate calves(%)	Home milk consumption (l/d)
Kenya	1980-1992	6,200	6.4-> 7.9		->12.9	70->86		432->465	63	5.4->7.3	20 ->8-9	4.3
Tanzania												
- Kagera	1982-1992	1,435	3.1-> 5.1		-> 7.8	72->75	33	467	59-84 (town) 75-52 (rural)	11.3->2.7	28.6-> 8.1	
- Tanga	1984-1992	1,108	-> 7.1		-> 6.1					3.8->2.0	-> 2.8	
										4.8->2.7	-> 3.2	
Sri Lanka	1985-1991	MC** 1,833 Est	4.9-> 5.2		5.9-> 5.8	83->86	37-->30	423 (1989)				0.8
(survey 1985 & 1988)		MC 4,511 Vil	2.2-> 3.9		3.4-> 4.1	71->72	-->30					0.5
		MC control	2.8			85						0.5
		CT**	3.1			79						
		Control	1.9			87						
Indonesia												
- East Java (study 1980-1990)		16,700->84,100	6.3-> 7.8			74		521	35.6 (imported)	5.0 (imported)		
								404 (all)	52-55 (all)			
(survey 1980&1990)			7.7->10.7	10397	->16.5	80						
Colombia	1974-1984	5,000										
- Nariño		7-8 pilot farms	3.5-> 5.5	949->1818	18->37							
Ecuador	1990-1994	2,700										
- Cañar		20 promotor f.	6.8->10.5	2419->3938	45->76	60->75				5 ->3.5	20 -> 5.3	
		47 reference f.	7.2-> 7.3	2007->2036	25->25.4	60->72				5 ->1.7	20 ->13.7	

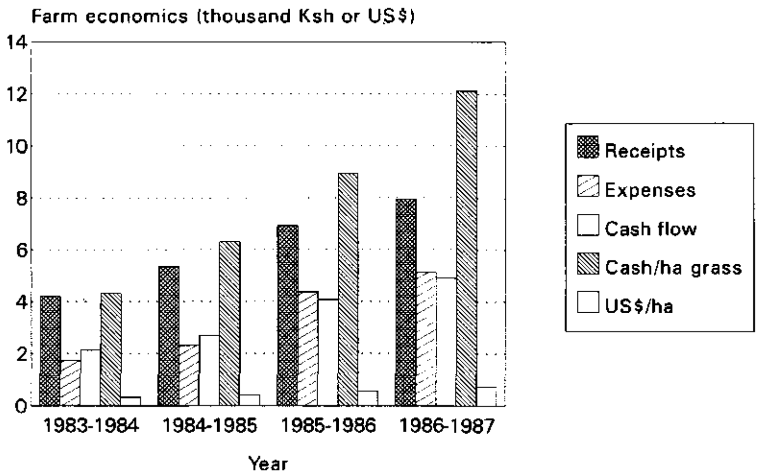
* in Kenya, East Java and on pilot farms (Colombia) and promotor farms (Ecuador) artificial calf rearing is used.
** MC = Mid Country and CT = Coconut Triangle;
Kenya data: Nkanata *et al.*, 1983; Van der Valk, 1985a, 1985b, 1987, 1990 and 1992; Metz, 1994.
Tanzania data: Sudi *et al.*, 1991; TSDDP, 1992; Rugambwa *et al.*, 1994;
Sri Lanka data: Linders, 1986; Meinderts, 1988; Houterman, 1989;
Indonesia study: Ibrahim *et al.*, 1991; surveys: Widodo *et al.*, 1980; 1994a and 1994b;
Colombia data: Chapter 5; Ecuador data: Chapter 6.

Economic characteristics

Table 10.6 shows the large variation in the proportion of income coming from livestock, crops, other farm or off-farm activities in the total annual income per farm in different projects. In Kenya with mainly full-time farmers the proportion from dairying in 1982/3 varied from 94% in Kakamega to 37% in Kiambu district. In 1987 the dairy contribution to farm cash income had changed for most districts, except Kiambu and varied from 33% in Meru up to 109% in Taita, where dairy was subsidizing crops. Total cash income varied from US$ 272 in Kericho with low milk prices to US$ 2,032 in Kiambu with higher milk prices and a large contribution from cash crops (coffee, horticulture).

From 1983/84 to 1986/87 average cash income almost doubled from US$ 696 to US$ 1,343, both through increasing milk yields per cow (Figure 10.1) and milk price increases higher than cost developments (Figure 10.3).

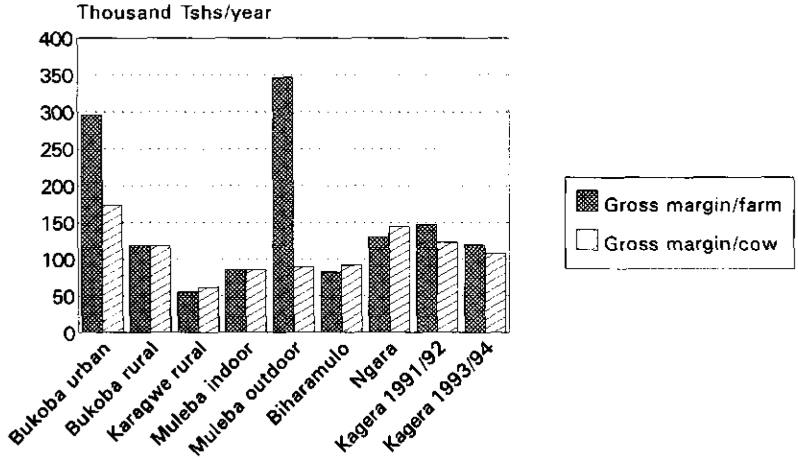
Receipts from milk and livestock sales per cow increased from Ksh 4,212 to 7,951. Expenses rose at a lower rate, resulting in an increase of the net cash flow per cow from Ksh 2,136 to 4,913. Net cash flow per ha forage increased, both in nominal terms, and in US$ from 313 to 716.



Source: NDDP, Kenya (Van der Valk, 1987)

Fig. 10.3. *Farm economics in the Kenya Dairy Development Project (1983-1987).*

For Kagera region in Tanzania, Rugambwa *et al.* (1994) recorded annual gross margins in 1991/92 from dairying, varying from US$ 188 in distant rural Karagwe to US$ 1,008 in Bukoba town with high milk prices. Muleba farmers with outdoor grazing earned US$ 1,180, but had more cattle on the farm and a larger contribution from livestock sales. Per cow outdoor gross margin was about equal because of lower milk yields The breakdown of total costs among casual labour (present on 65% of the farms), feed and veterinary services was 38, 31 and 31% for Karagwe, 27, 52 and 21% for Bukoba urban, and 29, 8 and 63% for the Muleba outdoor farmers with an overall average of 45, 34 and 21% for Kagera region. These figures illustrate the high feed costs in the urban area, and the high costs for veterinary services in outdoor farming (tick-control).



Source: Rugambwa et al. (1994) and KALIDEP (1995)

Fig. 10.4. *Gross margins 1991/92 and 1993/94 in Kagera region.*

In Zambia (Baars *et al.*, submitted) found an average annual cash income equivalent to US$ 411 per kraal for traditional livestock keeping in 1987 in a survey of 56 kraal keeping families (Figure 10.5).

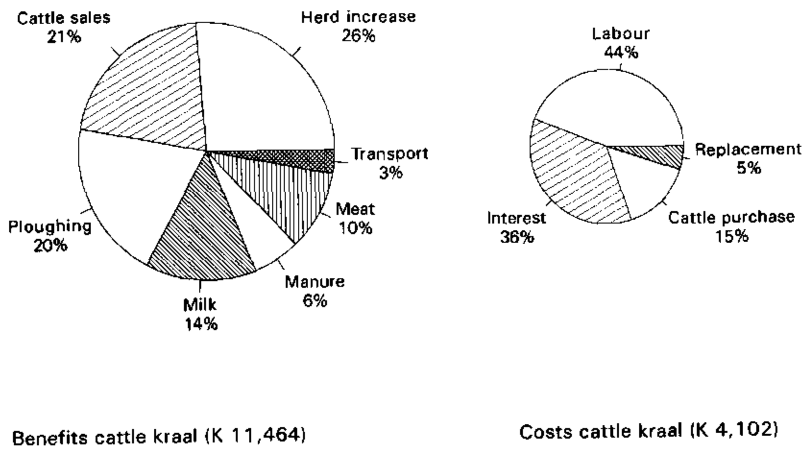


Fig. 10.5. *Cattle kraal benefits (K 11464) and costs (K 4102) in 1987 in Western Province, Zambia.*

Table 10.6. Relative contribution (%) of cattle, crops, other farm and off-farm activities to farmers' gross margin or cash income of smallholders in different countries, farming systems and farms.

Country & Farming system	Cattle	Crops	Other farm activities	Off-farm income	Total/yr in local currency	Total* in US$	Source
Kenya DDP: Cash income 1982/3	(1987)						Nkanata *et al.*, 1983
- Kakamega: coffee/tea/cane	94 (46)	6			7,389 Ksh	617	& Van der Valk, 1987
- Kericho: tea/pyrethrum	74 (46)	26			3,262 Ksh	272	
- Kiambu: coffee/horticulture	37 (37)	63			24,333 Ksh	2,032	
- Kilifi: coconut/cashew	81 (87)	19			12,347 Ksh	1,031	
- Meru: horticulture/coffee	42 (33)	58			12,171 Ksh	1,016	
- South Nyanza: sugar cane	77	23			9,161 Ksh	765	
- Taita: horticulture/coffee	86(109)	14			8,458 Ksh	706	
Kenya Dairy Development Project							
- 63 recorded farms 1983/84	56	44			9,605 Ksh	696	Van der Valk, 1985a
- 96 recorded farms 1984/85	54	46			12,687 Ksh	831	Van der Valk, 1985b
- 88 recorded farms 1985/86	61	49			16,579 Ksh	1,020	Van der Valk, 1987
- 70 recorded farms 1986/87	56	44			21,845 Ksh	1,343	Van der Valk, 1987
Tanzania: gross margin dairy 91/92							Rugambwa *et al.*, 1994
- Bukoba urban					295,609 Tsh	1,008	
- Karagwe rural					55,100 Tsh	188	
- Muleba outdoor farmers					346,058 Tsh	1,180	
- Kagera region					147,301 Tsh	502	
- Kagera region in 1993/94					119,343 Tsh	266	KALIDEP (1995)
Zambia (1987)							Baars *et al.*, subm.
- traditional livestock							
keepers - benefits	54	29	5**	12	8,847 Kw	1,000	
- cash income	36	22	13**	29	3,638 Kw	411	
East Java: gross margin (1990)							Widodo *et al.*, 1994a
- Sugar cane/dairying	29	41		30	1,185,000 Ind.Rp	642	
- Cassava/dairying	58	16		26	1,391,000 Ind.Rp	754	
- Horticulture/dairying	39	31		31	1,664,000 Ind.Rp	902	
Sri Lanka: gross margin							
- MLDC demo farms (1985/92)							De Jong *et al.*, 1994
- half acre	31	29	40***		18,546 SL Rs	556	
- one acre	63	37	0		27,169 SL Rs	815	
- two acre	69	19	12***		37,054 SL Rs	1,112	
- NLDB-NADSA loanees survey (1993)							De Jong & Ariyaratne,
- with no cattle any more		25		75	9,360 SL Rs	197	1995
- with cattle	38	17		45	19,692 SL Rs	414	
- with cattle producing milk	33	16		51	21,972 SL Rs	461	
- cattle with vegetables	34	50		15	20,532 SL Rs	431	
- Estate dairy survey (1989)	23			77	32,624 SL Rs	1,087	Houterman, 1989
Colombia: gross margin							
- 7-8 pilot farms (1977-1979)	78	22			156,940 C peso	3,924	De Jong, 1992
Ecuador (Integr.Dairy Dev.Proj. 1991/93)							PMDLI, 1994
- 199 high alt. hilly mixed farms	48	20	4	28	1,519,083 E suc	1,016	
- 239 high alt. plain farms	61	13	7	19	1,908,341 E suc	1,277	
- 57 medium-high alt.mixed farms	67	17	2	14	989,228 E suc	662	

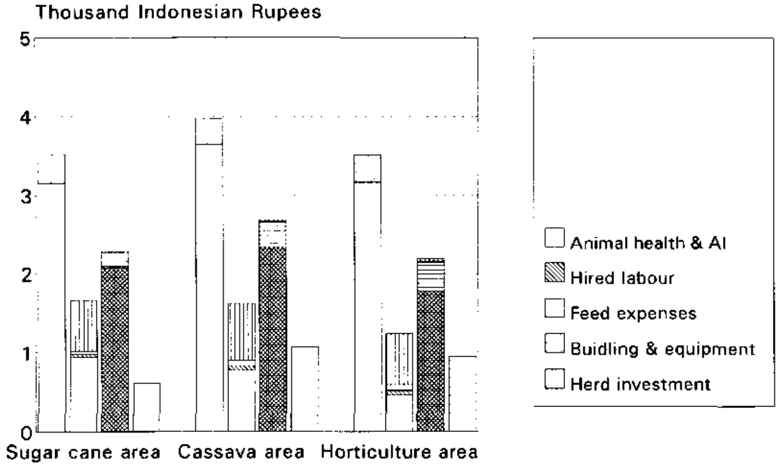
* exchange rates as indicated in FAO Yearbook Trade (1993); ** poultry, handicraft, beer brewing;*** goats and poultry.

Increase in herd size (births minus deaths), cattle sales, ploughing by oxen, and milk were the most important benefits. Benefits from meat (local, emergency slaughter), manure and draught power for transport played minor roles. Major costs were those for labour and capital and minor ones those for cattle purchase and replacements of equipment. The kraal keeper's household, owning 60% of the kraal herd, accrued 64% (ranging from 54 to 85%, depending on type of benefit) from the total kraal benefits, but incurred 73% of the total costs (ranging from 60 to 100% per type of cost).

The kraal keeper's household enjoyed 61% of the net benefit. Average benefits from cattle (Table 10.6) were 54%, but in cash income only 36%, because of important cash contributions from crops (22%), sales of other farm produce and handicraft (13%), and off-farm income (29%). Total costs, which mainly consisted of labour and opportunity costs of capital (44 and 36% respectively), were about a third of the benefits.

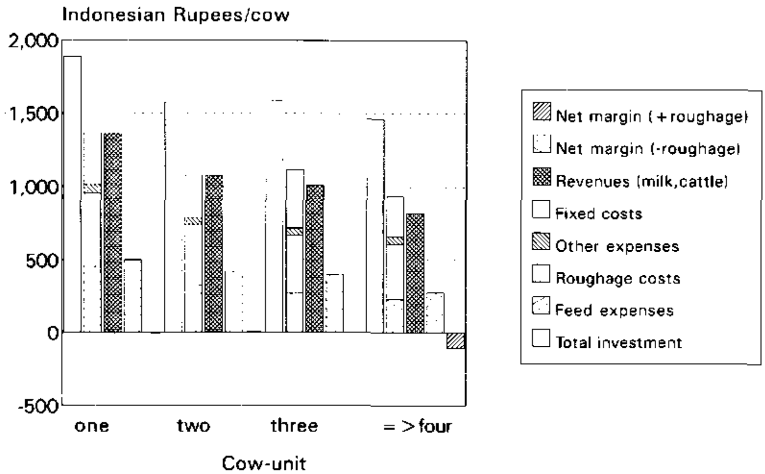
In East Java, Widodo *et al.* (1994a) found on 274 dairy farms, surveyed in 1990 in three agro-ecological zones, an average annual income (gross margin) equivalent to US$ 782. Dairy contributed 42%, crops 29% and off-farm revenue 29%.

Dairy income was highest in the cassava area, where it compensated for the low crop income, and lowest in the sugar cane area with contract sugar cane cultivation (Figure 10.6). Farm area and average daily milk yield per cow correlated positively with farmer's income, whereas crop income increased significantly with farm area and number of cows. Government officials and professionals engaged in dairying had a significantly higher income than those with their main occupation in dairying, cropping or working as farm labourers.



Source: East Java survey, Widodo et al. (1994a)

Fig. 10.6. *Farm economics on dairy farms in three agro-ecological zones of East Java.*



Source: East Java survey, Widodo et al. (1994b)

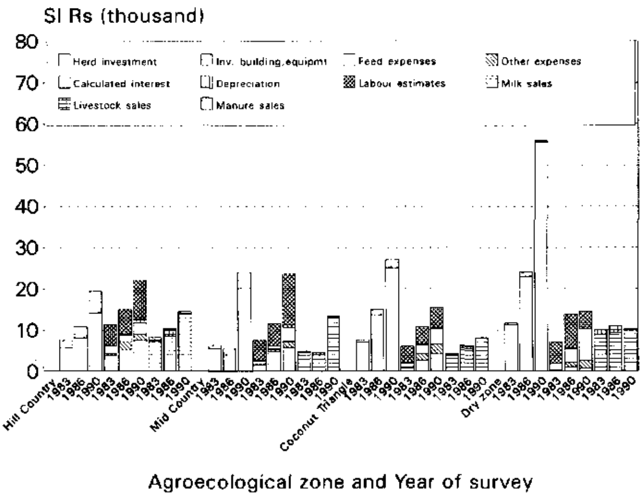
Fig. 10.7. *Economics per cow in different size cow-units in East Java.*

However, production levels per cow were lower in larger cow-units, because of less feed being offered per cow (especially concentrates). Net margins (return to family labour) per cow became even negative when labour costs of roughage collection were charged (Figure 10.7).

Further expansion of dairying in the area might only be expected when producer milk prices would be increased substantially above the rate of increase in feed price. Or, alternatively through expansion into new areas with sufficient wasteland and family labour resources. Experience learned that such introduction had high initial costs of training, extension, veterinary services, input and marketing arrangements (Widodo *et al.*, 1994b).

De Jong *et al.* (1994) showed that in Sri Lanka intensive integrated farming in training cum demonstration farms (without off-farm activities), resulted in smallholder families earning annually average farm gross margins (1985-1992) varying from US$ 556 on the 0.2 ha farm to US$ 1,112 on the 0.8 ha. Annual gross margins of settlers' families on 0.2 - 0.8 ha plots of abandoned, marginal tea lands and cultivating vegetables and tree crops, after introduction of a dairy cow between 1984-1990, varied in 1993 from US$ 197 (no cattle left) to US$ 461 (cattle producing milk), but included large contributions (75 and 51%, respectively) from off-farm income. Where vegetable gardening and dairying was taken up intensively, little off-farm work was performed, leading to an average gross margin of US$ 431 per year (Chapter 9).

Economic data from surveys in December 1983, July 1986 and August 1990 carried out by the Livestock Planning Unit in Sri Lanka for four zones (Hill Country, Mid Country, Coconut Triangle where the Dutch supported Smallholder Dairy Development Project was active, and the Dry Zone) are presented in Figure 10.8 (LPU, 1984, 1986 and 1990).



Source: LPU (1984, 1986, 1990)

Fig. 10.8. *Development of investment, costs and revenues in four agro-ecological zones in Sri Lanka.*

Investments increased considerably over time mainly due to increases in cattle values, and also feed costs rose rapidly, while returns from milk sales lagged behind, due to late and small increases in the producer milk prices. Returns to family labour were below the minimum wage, except for extensive livestock keeping in the Dry Zone in 1983.

Farm gross margins in Colombia (Chapter 5) on pilot farms of full-time farmers averaged US$ 3,924 per year over 1977-1979 with 78% coming from dairy. In Ecuador (Chapter 6) annual gross margins in the initial project period varied from US$ 662 on smaller, medium altitude mixed farms to US$ 1,277 on larger, high altitude farms in the plains. Relative contributions varied among farming areas, dairy (48-67%) contributed most, followed by off-farm income (14-28%) from migration and crop cultivation least (13-20%).

In conclusion, Dutch supported dairy development projects in Kenya, Tanzania, Sri Lanka, Colombia and Ecuador managed to improve technical characteristics of milk production such as milk yield per cow and per farm and mortalities in adult cattle and calves. Calving intervals were generally long although the percentage of cows in milk was close to a theoretical maximum of 76%, excluding freshening heifers. Economic performance showed a large variation among farming systems (relative contributions of crops and dairy) and among countries. Off-farm income contributed an important part to income on small dairy farms in East Java, Sri Lanka and Ecuador. Economic evaluations over time such as in Kenya, Colombia and Sri Lanka are scarce or missing in other projects, but should receive more attention to follow profitability of dairy farming and to play a role in national policy development (prices of inputs and outputs) to improve returns to farmers. In Sri Lanka, economic survey data showed a deteriorating picture for small-scale farming with poor remuneration in view of increasing investments and recurrent costs.

10.3 Overview of selected dairy food aid supported dairy development projects

Dairy food aid can be used in four ways: (i) for emergency relief in the case of natural disasters, (ii) for the medium and long term alleviation of hunger, *e.g.* in programmes for vulnerable groups, (iii) in food for work programmes and (iv) for monetization that will finance investment in the production, processing and marketing of food, thus contributing to the alleviation of future needs of such aid. Most food aid have gone for alleviation of hunger and too little has been used as investment (Kurien, 1992).

A first evaluation of some WFP dairy aid projects (Bolivia, Cuba, China and Tanzania) and the development of dairy production in developing countries was carried out by the department of Tropical Animal Production of the Wageningen Agricultural University in 1987 (De Boer *et al.*, 1987). Main conclusions were that (i) local milk production in Bolivia had increased but also imports, because producer prices were kept low, (ii) local milk production in China increased fast with adequate support from the government and dairying was a profitable enterprise with a favourable price ratio between milk and concentrates. In Cuba, expectations were high in view of high producer prices that supported dairy development, and (iii) in Tanzania milk collection had not increased due to a low official producer price and lack of foreign exchange for improvement of the milk collection (collection equipment and transport means) and packaging of processed milk (renewal of packaging machines).

During a WFP sponsored seminar on dairy development in June 1994 in Managua, Nicaragua participants from Cuba, Bolivia, Nicaragua and Ecuador discussed experiences, constraints and future prospects (Crespo, 1994). All countries were in the grip of structural adjustment programmes affecting vulnerable groups in society most. Dairy development projects were considered important means of job and income generation for the rural poor. A major discussion developed on the target group of these projects. Details on variation in farm size, herd size, monthly income and major crops cultivated of WFP beneficiaries are shown in Table 10.6.

Table 10.6. Variation in farm size, herd size, monthly income and major crops grown by beneficiaries in WFP supported projects in Cuba, Bolivia, Nicaragua and Ecuador.

Characteristics	Bolivia	Cuba	Ecuador	Nicaragua
Farm size (ha)	0.25 - 5	1 - 60	1 - 10	1 - 80 (70%) 80 - 160 (30%)
Total cattle (head)	1 - 8	10 - 40	1 - 15	8 - 29
Monthly income (US$)	3 - 11		30 - 90	8 - 14
Major crops	Potatoes, Quinoa, Maize, Yucca, Sugar cane	Pasture, Horticulture	Pasture, Potatoes, Maize, Garden beans	Maize/beans, Bananas, Sugar cane

Constraints identified were the rather short-term duration of WFP assistance in relation to long-term needs of support expressed by national governments; lack of law enforcement to ban illegal raw milk sales to consumers; and the lack of funding for the arable farming part of the generally mixed farms of beneficiaries. Discussion of gender issues indicated that participation of women in dairy projects was still limited. Women were always present, but generally in a silent and hidden form, managing the family resources including financial matters, while men always maintained contacts with the outside world. Generally, neither sufficient local personnel was assigned to projects nor was methodology available to execute studies of project impact at farm and community level.

Credit forms varied from pass-on credits in kind (Bolivia) to State bank credits (Cuba), and recently private bank credits with project guarantees (Ecuador). Initially, all projects were to apply the FAO formula of pricing donated milk products at price levels of local milk arriving at the plant, but in the course of development variation developed in application of the formula. In some cases prices were adjusted late (Bolivia), in other cases, where in open economies considerable competition exists from low-priced (dumped) milk products, donated products have to be auctioned to determine the price (Ecuador).

Recommendations of the meeting urged for technical assistance that should include also social, organizational and management aspects, more contacts with the academic world (universities, research centres) to improve technology packages, extension at field level and impact measurements.

Dairy development modules in Bolivia

WFP dairy projects in Bolivia consisted of "Development of the dairy industry" (US$ 0.8 million), "Milk reconstitution in La Paz" (US$ 6.1 million for five years, actually utilized between 1971 and 1981), "Assistance to dairy development in three areas" (US$ 1.4 million for 2.5 years, actually utilized between 1977 and 1982) and "Promotion of dairy development modules for small producers" (US$ 7.8 million for four years, and extended in 1990 with US$ 4.6 million for another 5 years).

Project activities were part of the implementation of a 20 year Dairy Development Plan (1971-1991)of the Bolivian government to substitute milk imports through local milk production. However, imports increased from 30,000 tons of milk equivalents annually in the early 1970s to 70,000 ton in 1981 (WFP/CFA, 1982a) and only in 1995 imports were no longer considered necessary in view in increased local milk collection (WFP/CFA, 1995). Producer prices were static in the 1970s with a large increase in 1982, subsidized by the government, while consumer prices remained unchanged. The dairy industry could survive through low prices set for WFP donated commodities, *i.e.* far below prices indicated by the FAO formula to avoid competition with rurally produced milk delivered at the milk plants (WFP/CFA, 1982b).

Dairy development modules for small producers were initiated since 1979 as temporary associations (consisting of 50 farmers each) under the national dairy development organization CBF (Bolivia Development Corporation), that delegated the daily execution to the dairy industry EIL (Empresa de Industria Lechera) with its five milk plants. EIL provided finance, training, inputs and services, while farmers contributed land and labour to enter dairying. Technical support was provided by one veterinarian and one agronomist per 4 modules and was linked through a trained producer-extension agent called "promotor" at each module. The association operated the milk collecting centre with input store and AI-facilities. WFP provided financial support for development costs of 27 modules with 1,400 farmers nation-wide over 4 years, while the milk plants belonging to Regional Development Corporations assisted with marketing of the milk. Associations were expected to stand on their own feet after 4 years. Baron del Castillo (1989) reported that milk supply from modules to the Cochabamba milk plant increased from 270,000 litres in 1984 to 1,800,000 in 1987. Eight modules with 458 members were in operation in the Cochabamba valley. Each dairy farmer had 3 to 4 cows on 1 to 3 ha of land, mainly planted with legumes and grasses. Crossbred Friesian cattle produced 2,236 litres during a lactation period of 290 days. Calving rate was 80% with 75-80% of the cows in milk during the year.

WFP/CFA (1995) indicated that the total number of beneficiaries had increased from 2,500 producers in the early nineties to 4,177 in 1994 spread over 77 milk units with 130 milk collection centres. Planting of improved pasture had reached a total of 4,997 ha. Milk production became the main source of income for small producers, and in some cases freed them from seeking off-farm employment in the agricultural estates.

In the next phase (1996-1998), WFP assistance is envisaged in financial form (sales of wheat under food commodity aid), and has been redirected to (1) strengthening of project follow-up and evaluation by the National Directorate, (2) greater emphasis on training and technical assistance to improve production, milk yield per cow and to permit consolidation of autonomous, self-managed units including participation in the purchase of dairy plants and take-over of project services, and (3) incorporation of a gender perspective for higher remuneration of women's work, more training and technology transfer oriented to women, who were in more than 70% of the farms in charge of milking, cleaning, feeding and milk deliveries, and support to creation of women operated modules (WFP/CFA, 1995).

In conclusion, long-term WFP dairy assistance has helped to increase local production of small producers in Bolivia, although another phase of financial assistance is needed during the planned privatization of the dairy industry and the take-over of services sofar provided by the Milk Promotion Programme to ensure future sustainability.

Dairy development in Cuba

Consumption of milk and milk products received high priority in Cuba's food and nutrition policies over the period 1959-1984, and resulted in little variation in per capita intake levels because of the flat income distribution (WFP/CFA, 1984). Pasteurized, condensed and evaporated milk were sold at subsidized prices in rations of 0.95 l/d to children (up to 6 years of age, in addition to a breast feeding programme), elderly people (over 65) and invalids. Overall per capita consumption of milk products was 150 kg in 1984 (one third imported) against a national target of 219 kg.

Milk production more than doubled from 446,000 tons in 1970 to 964,000 in 1982, while milk collection more than trebled from 214,000 to 730,000 tons. High collection rates of up to 75% are typical for dairying based on large-scale state farms. The dairy industry paid a higher milk price to producers than it charged to consumers for fluid milk. Financial losses in the liquid milk sector were compensated with high make-ups in the milk product sector and with government subsidies. However, the pace of dairy development slowed down in the 1980s, partly due to adverse weather conditions and partly to the economic recession. Foreign exchange constraints also resulted in reduced availability of imported inputs, such as fertilizers and concentrates that had to be rationed (WFP/CFA, 1984).

Cuba obtained WFP dairy aid support for supplementary feeding of school children and for (i) Dairy development in the Jimaguayu basin (US$ 43.9 million from 1985-1988 and extended with US$ 23.5 million up to 1992) and for (ii) Dairy development in Las Tunas Province (US$ 23.6 million for four years from 1992-1995). Over time (WFP/CFA, 1987a and b), the nature of support by WFP changed from investments in the state sector (86% in the Jimaguayu basin) to those in agricultural producer cooperatives (CAP) and credit and service cooperatives (CCS) (79% in Las Tunas Province). Furthermore, the government contributed even more investment funds than WFP to total project costs.

Project objectives were providing support in the more marginal areas of Cuba for production units (pasture development, fencing, wells, improved cows from other areas, milking facilities, sheds for milking, calf rearing and heifer raising) to increase milk production, create employment opportunities through additional jobs for men, women and other family members, training of members of the cooperative, support in the transformation of CCSs to CAPs, and to increase salaries of workers, members of the cooperative and increment family income.

For the Las Tunas project, use was made of surveys carried out by the Ministry of Agriculture with full involvement of the Federation of Cuban Women and the National Small Farmers' Association to investigate the response of potential project beneficiaries (especially women) towards the credit element in promotion of dairy activities.

Annual milk production in the country stagnated in the 1980s. Milk production in 1989 was only 930 million litres compared to 964 million in 1982. FAO even estimated that from 1980 to 1993, *total production dropped from 664 to 470 million litres* (FAO Yearbook 1994), *and* availability of local milk dropped from 109 to 69 kg per capita (Table 10.3). Annual imports of milk powder between 1991-1993 averaged 38,000 tons (US$ 63 million) against 54,000 tons annually between 1978-1982 (FAO Trade Yearbook, 1993 and WFP/CFA, 1984).

However, following the investments by WFP and the Government, most physical and income targets were met in the Jimaguayu Basin project. Farmers received a remunerative producer milk price of 0.32 pesos (US$ 0.43), while the consumer price for pasteurized milk was kept at 0.25 pesos per litre (WFP/CFA, 1991). Differences between consumer and producer prices were partly recovered from sales of dairy products and partly from government funds for social welfare ("standard feeding" programme for children, the elderly and pregnant women, and the "social feeding" programme in workplaces, primary and secondary schools and in hospitals). To reduce dependence on imported concentrates, the government is a strong supporter of the use of a mixture of sugar cane and other locally available by-products. Improved pastures of Rhodes and Guinea grass have been introduced under rainfed conditions. Sugar cane and plots of irrigated King grass have been established for dry season feeding and silage preparation.

In conclusion, a remunerative producer milk price and strong government support for farm investment (credit at low interest rate) resulted in increased milk production in marginal areas, although the strategy was not effective for the whole country, because of insufficient government funds and scarcity of foreign exchange (investment, concentrates).

Dairy development in India (Operation Flood)

In the late sixties "Operation Flood" (OF) was formulated by the National Dairy Development Board (NDDB), a dairy development organization set up as a cooperative society in 1965 in response to the Prime Minister's call to "transplant the spirit of Anand (place of the successful Kaira District Cooperative Milk Producers Union, also called AMUL = Anand Milk Union Ltd, established in 1946 in Gujarat State) in many other places to produce a flood of rural milk in India's villages". Foreign food donations would be monetized by reconstitution in the four large metropolitan cities of India (Delhi, Bombay, Madras and Calcutta) and proceeds would be used for local dairy development. The Indian Dairy Corporation (IDC) was established in 1970 under the Companies Act to handle the generated funds. Later, in 1988, NDDB and IDC were merged by an Act of Parliament into one corporate body bearing the old name NDDB, and became an institution of national importance (Patel, 1992).

Organization of milk producers is following the "Anand Pattern" of cooperatives, *i.e.* village-based milk cooperative societies (VMCSs, the first tier), united in District Milk Cooperative Unions (second tier) with milk plant(s) operating a milk collection and input and services supplying network. Unions are federated into a State Milk Cooperative Federation (third tier), that is responsible for milk marketing towards urban centres. Federations are member of the National Cooperative Dairy Federation of India (fourth tier) for coordination of general issues and policies in dairy development (Kurien, 1987).

In OF's operational strategy, dairy development requires first of all a large, growing, but unsatisfied demand for milk, that existed in the Indian metropolitan cities. In potential dairy areas, spearhead teams of NDDB, composed of professionals in dairying (engineer, veterinarian, extensionist, marketing manager) and cooperatives (organization and accounts) investigated present and potential numbers of dairy stock, milk production and sale patterns. They then offered potentially viable dairy communities the OF alternative in milk procurement (guaranteed market, quality control and twice daily payment) to traditional milk collection by middlemen and traders, that don't pay according to quality and enforce low milk prices and milk rejections in the flush season compared to better pay and collection in the lean season. Village communities have to agree to a cooperative set-up for joint milk delivery of all saleable milk exclusively to the cooperative district milk Union. Sufficient quantities of milk (usually over 100 litres per day) over a sufficiently long period of time (usually 6-9 months including the lean season), establishment of a management committee and hiring their own collection staff are prerequisites for becoming a registered VMCS. Participating communities will receive weekly veterinary visits (free of charge), have access to emergency veterinary services at a minimum charge, may obtain a (10-14 day) revolving fund for (twice) daily milk payments, a milk society operated AI service and feed store.

India received dairy food aid during three phases: OF I with EC commodities through WFP (1971-1975, actually extended to 1981), and OF II (1978-1985, actually used from 1981-1985) and OF III (1985-1990, actually from 1987-1994) directly through the EC. World Bank/IDA funded OF in three States (Karnataka, Rajasthan and Madhya Pradesh). Quantities and values of dairy food aid in the funding of OF are presented in Table 10.7, and various physical and organizational achievements in Table 10.8. Objectives of OF I were to improve marketing and organization of the dairy sector to establish a commanding share in the four metropolitan towns (Delhi, Calcutta, Madras and Bombay) by procurement and production of milk from rural areas. Action lines were a major increase in milk plant capacity and throughput; resettlement of urban cattle and buffaloes in rural areas; development of basic transport (insulated rail and road tankers) for supply of pasteurized milk to the cities; competitive transfer of milk from traditional suppliers (Village Milk Cooperative Societies) to the urban markets.

Table 10.7. Selected characteristics of food aid and achievements under Operation Flood.

Characteristics Period	OF I 1971 - 1981	OF II 1981 - 1985	OF III 1987 - 1994
Skim milk powder (tons)	126,000	186,000	75,000
Butter oil (tons)	42,000	76,000	25,000
Value in Rs (mln)	1,160	2,460	2,227
Value in ECU (mln)	135	350	119
Total project outlay in Rs (mln)	1,160	4,855	9,150
-(equivalent in mln US$)	40	500	678
-World Bank/IDA finance (mln US$)		150	360
Development expenditure in Rs (mln)	1,164	2,772	4,116 (1985-90)

Source: Dairy India (1983; 1985; 1987 and 1992).

Table 10.8. Achievements in infra-structural developments, milk collection and milk yield development in India under Operation Flood (1971-1990) and projected for 1994.

	1971	1981	1985	1987	1990	projected 1994
Milksheds	5	27	136	168	174	194
Processing capacity:						
-Rural dairies (000 l/d)	680	3,590	8,780	12,200	14,030	20,000
-Metropolitan dairies (000 l/d)	1,000	2,900	3,500	3,700	3,790	
-Milk drying capacity (tons/d)		261	507.5		663	1,000
Milk collection (000 l/d)	520	2,560	5,780		9,810	15,000
-Peak milk procurement (000 l/d)		3,400	7,900		12,000	20,000
Peak liquid milk marketing (000 l/d)		2,800	5,000		7,260	12,000
Milk powder prod. (000 tons/y)	22.4	76.5	102		165	
Balanced feed capacity (tons/d)		1,700	3,300		4,405	
Molasses-urea block cap. (tons/y)					72	205
Yield per breedable cow	270	371	434	470	522	605
Yield per cow in milk	600	762	885	955	1,060	1,190
Milk/cow/year in cattle		181		345		640
Milk/cow/year in buffaloes		438		692		1,020

The evaluation of the first phase of Operation Flood indicated that some 1.5 million producer members had been organized in more than 10,000 VMCSs that sold on average 1.5 to 2 litres of milk per day and had benefitted from the project in receiving 50-100% more milk income. Total milk production in India increased from 21 million tons in 1970 to 32 million tons in 1981, but annual milk yields per dairy cow or buffalo hardly changed. Concurrently, the amount of crop residues and by-products over the period 1977-1982 increased with 40,5 and 42%, respectively over quantities produced in the period 1961-1966.

Objectives of Operation Flood II were to include 10 million rural dairy families by 1985, to breed a national dairy herd of 14 million crossbred cows and upgraded buffaloes during the 1980s, to build a national milk grid linking rural producers with major urban centres (150 million people), to increase milk availability to 180 gram per capita for a population of 750 million, and to build the necessary infrastructure. Individual district and state plans for dairy development were envisaged through the State Dairy Cooperative Federations, acceptable to the State authorities (with transfer of state-owned dairy facilities), technically approved by the National Dairy Development Board (NDDB) and financially by the Indian Development Corporation (IDC). The planning process was started in 1978, actual implementation of OF II started in 1981.

The Jha commission (GOI, 1984) stated in the evaluation of Operation Flood II that it saw the persuasion of rural producers to use modern inputs, rather than increasing the number of cows, as the most effective way of increasing milk production in India. It noted the paucity of bench mark surveys and reliable data in the livestock and dairy sector. All states had started off with OF dairy development, but delays were observed in states with little experience in cooperative affairs. Given the sheer size of India -and some of its problems- the government had no choice but to embark on a certain number of "nation-building" projects. OF was clearly one of them, and perhaps one of the most important, because it aimed at integrating marginal farmers and even landless labourers into the national economy - and the nation.

Objectives of Operation Flood III were to increase the number of VMCSs to 70,000 with 8 million producer members, average milk procurement to 13.7 million litres per day (peak 18.3) with 10.3 million litres marketed as liquid milk and the remainder in products. Major emphasis was on consolidation of achievements during the earlier phases by improving productivity and efficiency of the cooperative dairy sector and its institutional base for long-term sustainability (Dairy India, 1992).

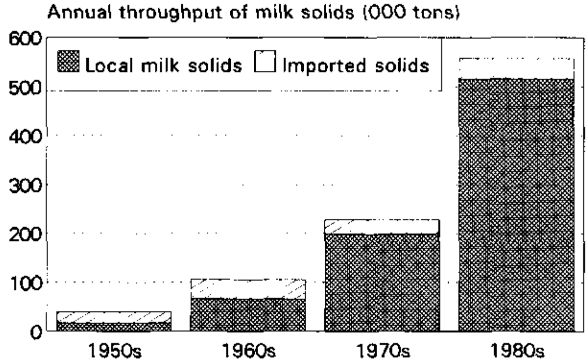
Various constraints have been identified and criticism has been voiced on this large and ambitious project (CEC, 1986 and see also Chapter 4). Constraints were related to the size of India, social barriers, competition with state dairy development projects and political opposition. Rural India is vast and varied with limited means of transport and communications, in which OF tried to mobilize people from a diversity of backgrounds, many of them poor and illiterate. Social barriers, based on caste, occupation, custom and tradition had to be taken in organizing village cooperatives in a bottom-up approach. Veterinary services and artificial insemination -often free of charge- were extended by the animal husbandry departments of the different States, through their own dairy development programmes such as Key Village Schemes (studbull distribution) and Integrated Dairy Development Programmes (studbull and AI services within a milk collection scheme). Political opposition was experienced from the various State bureaucracies holding on to their own milk schemes and dairy plants, from local politicians that were in favour of middlemen and private traders, and from local authorities that were reluctant to increase milk prices (especially in Delhi and Calcutta, consumer milk prices were kept low). All these constraints caused delays and unevenness in implementation of a producer-based dairy industry. Critical notes came from within India and from outside, and were formulated in the form of the following questions (CEC, 1986).

- Operation Flood has increased India's dependency on imports?
- Food aid has depressed Indian milk production and producer prices?
- Operation Flood is bad for the urban poor and good for the rural rich?
- Milk, milk everywhere, and not a drop to spare?
- Too much hardware, too little milk yield increase?

Before and during OF I and II, imported milk powder was used to reconstitute milk in urban dairies, but commercial imports were banned from 1976 and requirements were met from food aid and locally produced powder, all handled by IDC.

Total imported milk solids did not increase in real terms, but in proportion to local milk solids its share reduced from 46% in the 1950s to 8% in the 1980s (Figure 10.8; Dairy India, 1992). In the 1990s the nominal amounts decreased further and in 1993/94 India even exported milk powder.

Producer prices of VMCSs in the flush season improved from 40-50% to 80-90% of the lean season price (GOI, 1984). Producer prices varied considerably among regions. In the Western region with a daily milk production of 30 million litres in 1990, producers received the highest milk price, followed by those in the Eastern (18 million l/d), Northern (62 million l/d) and Southern (31 million l/d) regions (Figure 10.10). A remunerative price policy has to be pursued bearing in mind, that it was only when support prices began to be fixed for food grain that India witnessed a green revolution (GOI, 1984).

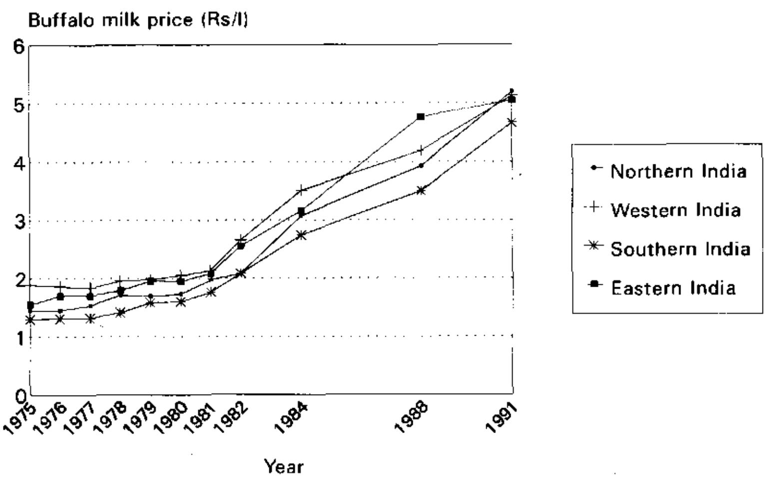


	1950s	1960s	1970s	1980s
Imported solids	22.87	38.99	29.03	42.18
Local milk solids	16.97	65.81	198.89	515.57

Period

Source: Dairy India (1992)

Fig. 10.9. *Average annual throughput of solids of local milk and imported milk products in India during the 1960s before OF and during OF I (1970s) and II (1980s).*



Source: Indian Dairy Corporation in: Dairy India (1983); Dairy India (1992)

Fig. 10.10. *OF producer prices of buffalo milk (1976-1991).*

Price developments of milk and concentrates and costs of production during the 1980s almost followed the exchange rate of the Rs against the US$ (Figure 10.11). Operating surplus per litre milk (milk price minus costs of production, assuming a 60% share for feed costs and 40% for other items) improved under OF II, and stabilized subsequently.

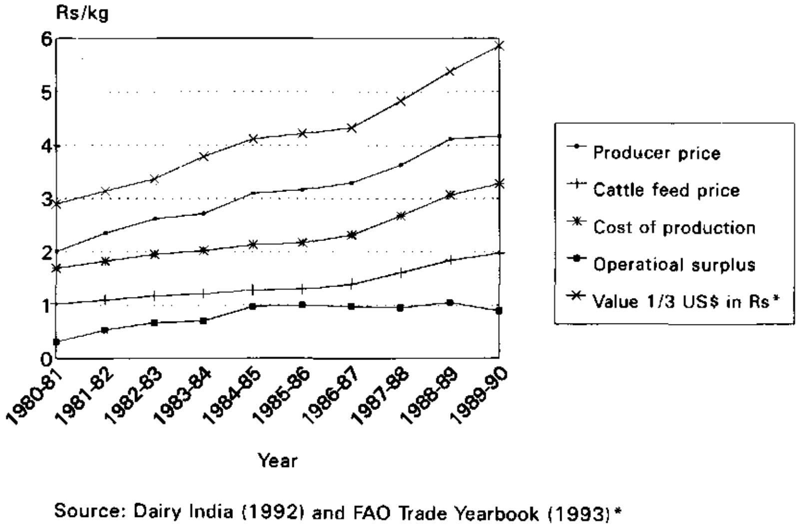


Fig. 10.11. *Price development of milk, concentrates, costs of production and operational surplus development per kg milk and the exchange rate in Indian Rupees against the US$.*

The issue of diverting milk from rural to urban areas and particularly depriving rural children of milk they need, was not considered valid. Milk from poorer producers in India has always been primarily a source of income and less an article for home consumption (GOI, 1984).

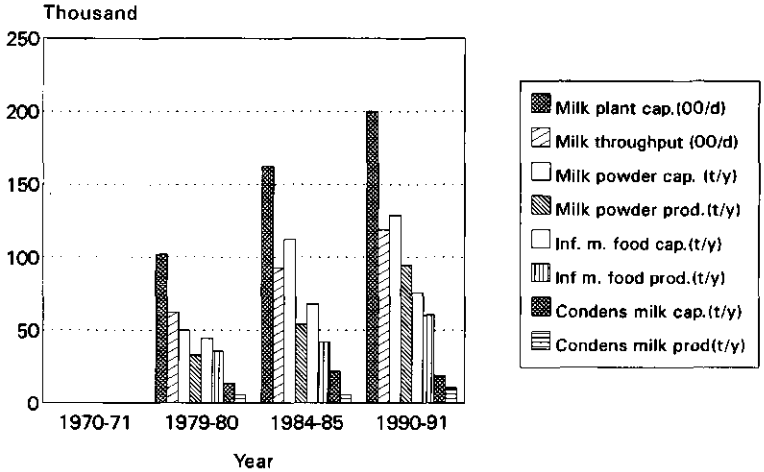
Low utilization of plant capacity was claimed under OF I especially of new dairy plants and mini-dairies at 42.50% (Dairy India, 1983) and of milk powder plants and cattle feed plants under OF II (GOI, 1984).

Considerable development over time of capacity of plants as well as throughput for liquid milk processing, milk powder, infant milk powder and evaporated milk has been undertaken under OF (Figure 10.12). Differences between capacity and average throughput are indicative of seasonal milk production. In the late 1980s and early 1990s "milk holidays" have been experienced in the flush season. Shortage of flush season capacity silenced the over-capacity discussion in the milk industry.

After stagnant milk production levels during the 1950s and 1960s and consequently a decreasing availability of local milk per capita, milk production increased in the 1970s and 1980s and even milk availability levels increased considerably (Figure 10.13).

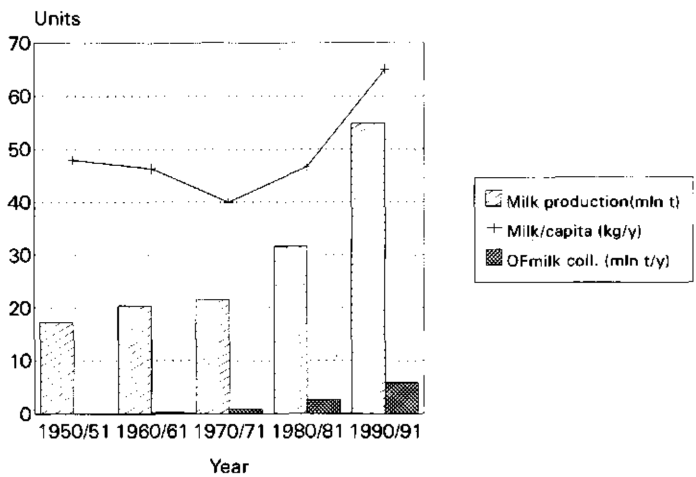
Milk collection under Operation Flood developed from 0.5 million litres per day in 1970/71 up to 10 million litres per day in 1990/91. However, the percentage of milk collected from total milk production represented only an increase from 1 to 10%, leaving major use of India's milk by the informal sector, calves and home consumption.

The question how vulnerable groups without purchasing power for milk can benefit from increased availability of milk is a general one for the government. This can be resolved either by creating more equity in the country's incomes or social welfare programmes that should be borne by the government and not by the milk producers. Vulnerability estimates in India for the year 2000 are some 25% of the population (Dairy India, 1987).



Source: Dairy India (1992)

Fig. 10.12. *Plant capacity and average throughput of OF milk plants.*

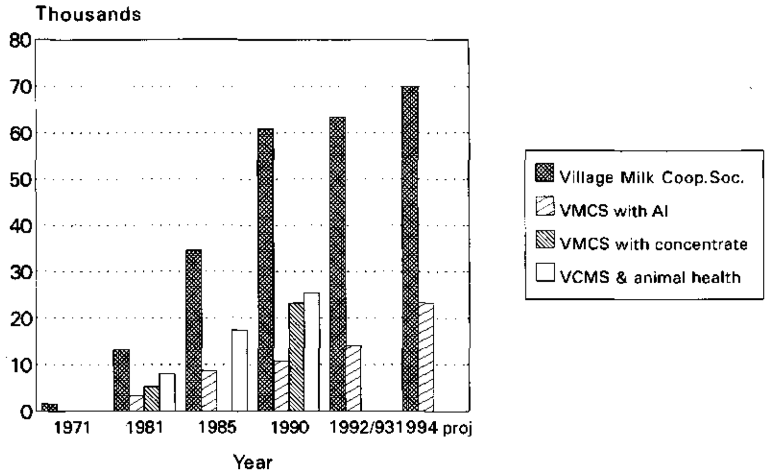


Source: Dairy India (1992)

Fig. 10.13. *Overall milk production, milk availability per capita and milk collection by OF (1950/51-1990/91).*

Development of the milk producers organization in VMCSs for milk collection, selling feed, having AI and animal health services is presented in Figure 10.14.

After evaluation of OF II by the Jha commission, further separate development of AI and animal health services by OF has been discouraged. Under OF III, their services had to be combined with the services of the State Animal Husbandry Departments.



Source: Dairy India (1983, 1985, 1987, 1992); NDDB (1992/93)

Fig. 10.14. *Organization of VMCSs (for milk collection) and those that have AI services, concentrate sales and animal health cover (1971-1992/93 and projected for 1994).*

India has 90 million farmers holding 140 million ha of cropped land (average cropping intensity 1.3) and the distribution of farmers, land, dairy animals and milk production is given in Table 10.9 (Aneja, 1994).

Table 10.9. India's land and milk production pattern.

Class of farmers	% of farmers	% of land owned	% of dairy animals	% of milk production
Landless farmers	26	-	22.5	22.6
Small and marginal farmers	49.3	27	41.8	41.9
Medium and large farmers	24.7	73	35.7	35.5

Source: National Council of Applied Economic Research 1991. In: Aneja (1994)

A committee TMDD (Technology Mission on Dairy Development) was formed in 1989. TMDD aims to apply modern technology to improve animal productivity and to optimize the use of available infra-structural facilities for dairy development such as breeding farms, bull mother farms, semen freezing and artificial insemination facilities, veterinary hospitals, etc. TMDD also intends to have included another 80,000 VMCSs from outside the present OF areas by the year 1995 to reach 150,000 VMCSs (180,000 by the year 2000) with an average milk procurement of 20 million litres per day in 1995 (25 million in 2000) (Chatterjee and Achariya, 1992).

Next to technology development there is a Cooperative Initiative Panel formed to put cooperation back on the national agenda. In a "free market" economy, cooperation is the only way in which the vast majority of farmers, artisans, fishermen, etc. can avoid return to economic colonialism. Four main items are pursued: first, new legislation, *i.e.* adoption of the Model Cooperatives Act by GOI, each state and union territory and amendments of the Companies Act to allow the entrance and benefits of cooperative companies, second to rescue cooperatives, from nominated boards and management by deputationists, third to extricate cooperatives from labour laws that often strangle a cooperative attention, and fourth to rationalise the tax structure for cooperatives to facilitate capital formation (NDDB 1992/93). Under Operation Flood III, more attention is also paid to training of the rural leadership of the cooperatives.

In conclusion, dairy food aid supported the creation of a large rural producer-based cooperative dairy industry, collecting increasing amounts of surplus rural milk for urban consumption of liquid milk and milk products and increasing availability of local milk per capita. From an importing country of milk products for a long time India started recently also exporting milk powder and milk products. Major attributes to these achievements are better producer milk pricing, organized marketing and appropriate farmers' organization.

Dairy development in Tanzania

WFP dairy aid dates back to 1976 and projects included "Dairy development to Zanzibar" (US$ 2.1 million for 1977-1982) and "Dairy development in Tanzania" (± US$ 10 million over the period 1976-1983 and US$ 13.4 million for 1984-1993). Initially, the support was for the large scale farms in the (para)statal sector, but results were disappointing due to low official milk prices, that resulted in high financial losses. The number of dairy cattle in the parastatal sector increased from 1,256 in 1976 to 2,822 in 1982, including the import of 1,039 heifers on 11 of the large scale farms, but milk production only doubled (WFP/CFA, 1983).

Smallholder dairy development, that received more attention since 1983, took off slowly due to lack of improved stock for the sector. The national AI services supported by Cuba and Sweden suffered from lack of liquid nitrogen and transport facilities, resulting in only 15,000 cows inseminated or 50% of the target. The number of grade dairy cattle in Tanzania increased from 96,000 (census 1978) to 144,000 (census 1984) and is estimated to have reached 256,900 by 1993. Heifer breeding at 5 units showed a turn-out of 433 heifers in 1977 and 1,070 in 1981. In 1993, 16 Livestock Multiplication Units arrived at a production of about 2,000 heifers per year, but this was still insufficient to meet the estimated demand of 8,000 in-calf heifers per year (Massae, 1994).

In conclusion, low official pricing of milk and dairy stock resulted in financial losses in the large scale dairy sector and in Livestock Multiplication Units.

Dairy development in China

In pastoral areas of North and West China, a 5,000 year old history in dairying exists in minority nationalities. In and around several coastal cities, a number of dairy farms and small processing plants was established, based on import of mainly Black and White, a few Red and White, Simmental and Brown Swiss cattle to produce fresh milk, initially for foreign residents and later for babies, sick people and a few privileged Chinese (Pronk, 1992).

From 1949, the foundation of New China, to 1988, the classified dairy cattle population (Chinese Black and White, exotics and crossbreeds) increased from 0.12 to 2.22 million and goats from 0.17 to 3.22 million head (7.8% per year). Total production of cow and goat milk increased from 0.217 to 4,189 million tons (7.9%). From 1979 to 1985 the most rapid cattle population growth was observed (19.1%). From the 2.22 million dairy cattle, 1.36 million belong to the China Black and White (China-CEC, 1989). The dairy cow population increased from 268,000 head in 1969 to 1,715,000 head in 1993 with total milk production of 561,000 and 4,978,075 tons, respectively. Together with milk produced in pockets of the country from 5-10,000 milked buffaloes out of 22.5 million head, from 106 million goats and a few million yaks, total milk production was estimated at 5,624,900 tons (China Yearbook, 1994). Overall availability of cow milk was only 1.29 kg per capita in 1981, although higher in the 6 large cities/municipalities (varying from 3.5 in the municipality of Nanjing to 13.8 kg in Beijing), and increased to 5 kg per capita in 1993 from 3.45 million dairy cattle and is expected to reach 8 kg in 2000. Improved livestock feed supplies in 1993 consisted of 40 million tons of compound feed, 59 million tons of silage and 11.7 million tons of ammoniated crop stalks, but a major constraint in the liberalised market was that feed prices were rising faster than animal product prices (China Yearbook, 1994).

Milk consumption patterns, mainly oriented to pasteurized milk and rationed to babies, children, sick people and some special groups, are changing with economic development, particularly in the coastal areas. In 1988, milk utilization in the 20 main cities was 17.5% in the form of milk powder, 15% in milk products such as yoghurt, condensed milk, ice-cream and milk drinks, and 67.5% as pasteurized milk. Dairy factories are all but three state-owned. Lack of investment funds and technical know-how in the dairy industry are for some factories solved by joint ventures that concentrate on more profitable milk products, while others remain behind in the pasteurized milk sector (Bonnier, 1995). School milk was introduced during 1983/84 and reached 458,000 children (6-12 years) in 673 schools in December 1985, but because of distribution problems and costs, some cities reduced the size of the scheme (WFP/CFA, 1986).

The (peri)urban milk production system is intensive, relying heavily on concentrates to produce relatively high milk yields of over 5,000 litres per cow. Most farms practise milking and feeding three times a day. Cereal straws and maize silage, mainly from stover, is used for dry season feeding, but amount and quality are at the most covering maintenance requirement. Depending on farm type and location of the city 0.06-0.26 ha farm land per cow is dedicated to green fodder production. In addition, individuals harvest herbage from roadsides and other waste areas and deliver it to the dairy farmers and some collect manure in return for their vegetable plots (Gartner and Krostitz, 1984).

Constraints in dairy husbandry are mastitis, endometritis, and feet and claw problems in stall-fed cattle, because of time spent on concrete and in muddy exercise yards. Also low butterfat content and SNF occur, where forage supply was insufficient. On some farms inadequate nutrition and feeding practices caused low conception rates at first insemination (as low as 30-35%) and high incidence of retained placenta (up to 20%). Calf rearing on State farms, mostly by women, was usually excellent with calf mortalities below 5% (Gartner and Krostitz, 1984).

WFP support was negotiated in the form of 45,000 tons of skim milk powder and 13,300 tons of butter oil, amounting to US$ 64.7 million out of total project costs of US$ 214.6 million for five years (1984-1988) to support dairy development in and around 6 cities (Beijing, Shanghai, Tianjin, Wuhan, Nanjing and Xian) with some 22 million inhabitants (WFP/CFA, 1983; 1984). In 1987, a EC Mission recommended further support for another 14 large cities (45,000 tons of skim milk powder and 16,700 tons of butter oil valued at 105 million ECU or 377 million Yuan), and the preparation of a dairy strategy plan up to the year 2000. In 1992, China submitted to the EC a request for another 60,000 tons of skim milk powder and 20,000 tons of butter oil, but the EC is only considering some financial and technical assistance for 1995-1998 of some 80 million ECU, while China is expected to contribute 97 million ECU to a third phase (CEC, 1993).

Proposals for a second phase of EC support for 6 years up to the year 2000 (24 project areas throughout China covering 30 prefectures, 150 counties and 3,000 townships) are aiming at improved enterprise productivity by a full set of equipment and transport for an advisory and back-up service to dairy farmers, full equipment packages and drugs to enable the veterinary services to provide a complete animal health service to the dairy industry, backed up by an improved laboratory service (veterinary diagnostic lab equipment and some nutritional labs) and an artificial insemination set-up at county level with mobile inseminators and straw insemination equipment to replace the current ampoules. Planned interventions at national level planned are: attention to cattle and buffalo breeding (4 national semen production units) and goat breeding (import of new Saanen blood from Europe), further expansion of the milk collection, processing and marketing network; focus in training will be on education of local trainers that can train farmers at county and township level. Technical assistance is considered for the training programme and in extension (video productions). Institutional arrangements are envisaged in combining of the staff of the regional dairy offices (planning) with those of the regional bureaus of the Department of Agriculture and Animal Husbandry (implementation). The latter operate at four levels: province, county, township and village. There are 3,200 county-level veterinary stations with 100,000 employees and 59.600 township veterinary stations with 310,000 employees, but personnel with dairy training and experience is in short supply. In terms of disease control, control of tuberculosis and brucellosis is carried out in and around the city dairies.

In late 1995, EC support has been approved for 35 million ECU for 4 years for 10 regions, including 6 of the ongoing cities and four new regions. Support will only be in financial terms for investments and technical assistance for production, commercialization and project coordination.

The cost/price ratio for milk production associated with good management and high-yielding animals has made dairying a profitable activity in the 1980s. Producer milk prices ranged between 0.48 - 0.50 Yuan per litre delivered to the factory at a cost of milk production of 0.28-0.38 Yuan per litre (including labour). Feed prices per kg ranged from 0.10 Yuan for wheat bran via 0.21 Yuan for compound feed to 1 Yuan for fish meal. Annual net profits per cow varied from 400 to 800 Yuan and per person from 900-1,800 Yuan in the state sector, from 600 to 2,200 Yuan in collective farms and from 1,300 to 3,800 Yuan on private farms (Gartner and Krostitz, 1984; 1 Yuan = 0.50 US$). WFP funds were invested in interest-free loans to collective and private farmers (39%) and capital investment for equipment (61%). Later on, interest on dairy farm loans was charged but at low rates (<7%).

Milk production was further promoted and supported by the Central Government's policy, that included dairy development in the "Vegetable Basket Project". Low interest loans could be obtained, some tax reductions were granted and various subsidies and other incentives were given. The application of subsidized feed prices under a system called "feed for milk" related to the milk delivered to the dairy plants (varying from 1 kg grain for every 4 kg of milk to 1 kg crop by-product for every 2.5 kg of milk) has been the most important incentive for milk production. However, feed prices went up considerably in 1988-1989 and subsidies have largely been abandoned in 1992. Results were aggressive culling of stock in 1988-1989 and again in 1993, especially in collective and private farms. Credit facilities and investment subsidies have become limited. The milk price is lagging far behind the increases in cereal, meat and concentrate prices.

In the future, improved feeding efficiency and concentrate costs saving measures are needed to reduce the rapidly increasing costs, because compensatory producer price corrections are lagging behind. Milk quality problems in adulteration of milk and high levels of penicillin have to be corrected. Expansion of urban dairy production is becoming progressively more difficult because of limited availability of land (competition with other town enterprises) and pollution problems (waste water and manure) of large farms. State farms are forced to move outside the town area, but lack the necessary investment funds, resulting in sale of urban premises and animals. Private farmers have been reluctant to enter the dairy business in view of the low profitability and some farmers even quit (Bonnier, 1995). In the National Dairy Strategy (1990-2000) prepared in 1989 jointly by experts from China and a Dutch consortium (China-CEC, 1989), dairy development funding was projected at 11.6 billion Yuan, 70% in the form of own resources of collective and private farms and 30% in loans and grants. In view of the decreasing economic returns in dairying in 1988-1989, it was proposed to move out to the rural areas (10 dairy cattle milk production bases or belts) that are principal producers of corn, soybean, wheat and cotton with large numbers of improved cattle and abundant feed resources.

A brief summary of cumulative achievements (all above the set targets, except for local milk powder production) in the infrastructure of the dairy industry in the 6 cities (1981-1993) and the 14 cities (1988-1993) is presented in Table 10.10.

Dairy cattle and cow numbers in the six cities increased steadily, but slacks have been noted in 1989, 1990 and 1993 due to unfavourable milk/feed price ratios. Milk production and milk intake by the dairy plants showed a similar pattern of development (Figure 10.15). Milk prices in 1995 have reached 1.6 Yuan and 1.8 Yuan per litre in the 6 and 14 cities, respectively, but are still considered insufficient to compensate for the disappearance of concentrate subsidies.

Table 10.10. Cumulative infrastructural developments, milk powder production and milk price development in China's dairy industry in the 6 (1981-1993) and the 14 cities (1988-1993).

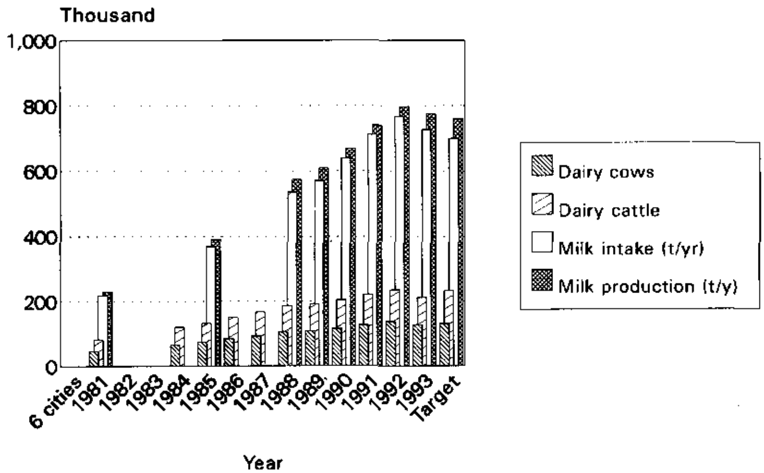
	6 Cities			Target	14 Cities		Target
Infrastructure	1981	1988	1993	1993	1988	1993	1993
New dairy plants \	9	17	25	25	12	37	13
Expanded dairy plants /	14	10	19	13	11	24	17
Milk processing cap.(tons/d)	375	2,223	2,966	2,554	1,723	2,316	1,997
Retail shops	155	438	505	488	157	835	393
Collection stations	61	90	135	98	44	140	111
Breeding centres		4	6	5	3	7	5
Service centres		43	71	48	18	170	63
Training centres		5	6	5	1	11	10
Test centres		3	5	4	2	7	3
Milk tank lorries		113	156	86	29	106	74
Milk vans		341	517	137	95	263	147
Feed mills		3	6	8	6	21	7
Local milk powder prod.(tons)		13,919	11,998	13,140	19,474	16,404	18,566
Milk price (Yuan/l)		0.49	0.69	1.07		0.76	1.17

Source: China-EC project statistics (1994).

Development of animal numbers and milk production in the 14 cities is not different from that in the 6 cities (Figures 10.15 and 10.16).

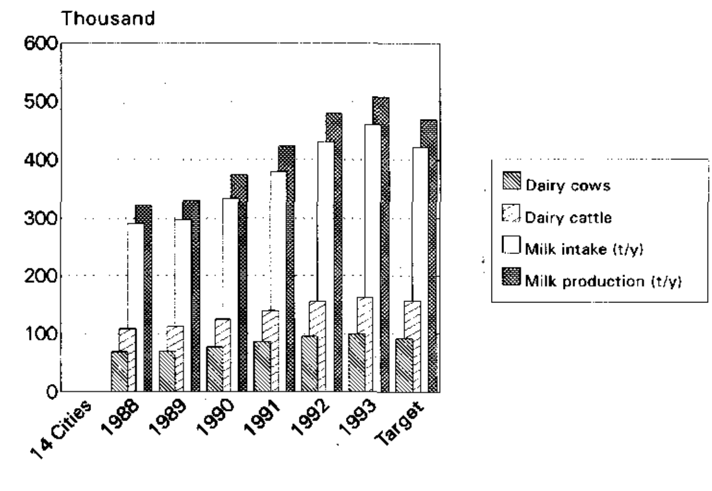
The distribution of dairy cattle and cows changed towards private farms, especially in the 14 cities, where they represented more than half of the total cattle population (Figure 10.17).

Annual milk yield per cow increased both in the 6 and in the 14 cities and reached levels close to the initial targets (Figure 10.18).



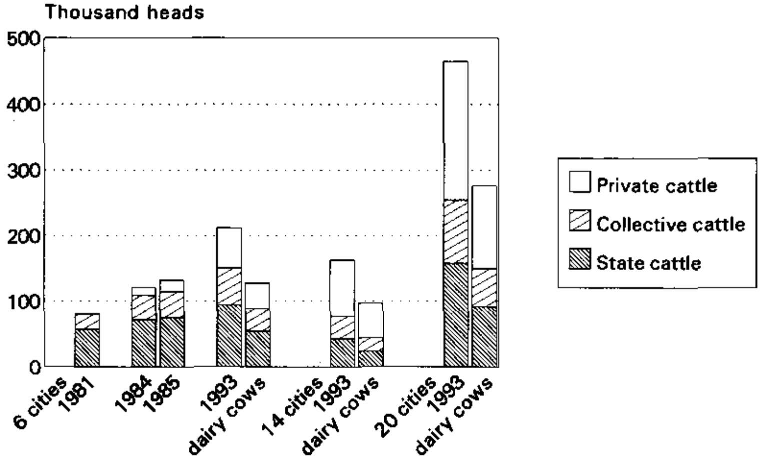
Source: WFP/CFA (1983) and China-EC statistics (1994)

Fig. 10.15. *Development of dairy cattle and cow numbers, milk production and intake in the 6 cities (1981-1993).*



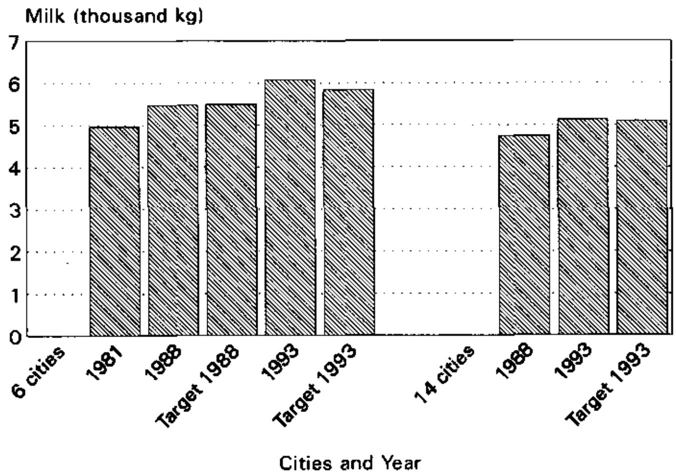
Source: China-EC project statistics (1994)

Fig. 10.16. *Development of dairy cattle and cow numbers, milk production in the 14 cities (1981-1993) and milk intake by the dairy plants.*



Source: China-EC project statistics (1994)

Fig. 10.17. *Development of number of dairy cattle and cows kept in state, collective and private farms in the 6 and the 14 cities.*



Source: WFP/CFA (1983) and China-EC statistics (1994)

Fig. 10.18. *Average milk yield per cow in the 6 (1981-1993) and in the 14 cities (1988-1993).*

In addition to the progress in cow numbers and in milk yields per cow in the urban sector, two important agricultural laws are worth noting that were promulgated in 1993 to strengthen the rural economy (China Yearbook, 1994): the "agricultural law" and the "law of popularization of agricultural techniques". The two laws contain the following principles: (1) protect, strengthen and develop agriculture. Agriculture is an industry with high social benefits but low economic results. It can not compete with other industries in attracting funds, materials and techniques in the process of industrialisation and modernization and is easily thrown into recession; (2) consolidate and develop the achievements in rural reform and promote the development of the socialist market economy; and (3) fully implement the initiatives of farmers, agricultural scientists and technicians as well as related departments in all quarters of society.

The total rural labour force in China comprises 420 million people with employment for about 200 million in agriculture at most. Township enterprises absorbed 20 million rural labour in 1978 up to some 100 million in 1992, either through regional transfers or by "leaving the land but not the homes". In rural areas monthly earnings amount to several hundreds of Yuan against 2-3,000 in towns. Investment in agriculture increased fast at 17% per annum between 1984-1990. However, in 1991 and 1992, prospects for agriculture became less favourable, annual capital investments in agriculture diminished and peasant households opted for secondary and tertiary activities. Support funds, initiated during 1985-1990for building commodity grain bases (belts), establishing quality cotton, grain production and "lean-meat pork" production bases, and for carrying out the "good harvest" programme and the "vegetable basket" project increased local development funds in agriculture. Protective prices for agricultural products and subsidies for agricultural production are further contemplated to reduce costs, improve economic efficiency and increase the capacity of agriculture to accumulate funds (China Yearbook, 1994).

In conclusion: active government support in the project cities/municipalities with subsidized concentrates and loans at no interest (WFP period) or low interest rates (vegetable basket project) has resulted in a rapid expansion of milk production, both through increased numbers and increased yields per cow. Liquid milk is regarded a health commodity that requires controlled consumer prices. Milk product prices are not controlled, which allows for higher industrial margins and prices to compensate for low and controlled prices for pasteurized milk. Reduced ratios of milk/concentrate prices call for a different type of dairy development that is more oriented to the rural areas, and will require considerably more effort in the provision of training, extension, veterinary services, input supply and marketing of milk.

10.4 Swiss Technical Corporation assistance to rural cheese plants in the Andean region (Peru and Ecuador)

Peru and Switzerland signed in 1964 a project agreement for improvement of the dairy sector (crossbreeding with Brown Swiss, improved fodder and pasture, milk collection/cooling and transport) in small and distant villages in the Sheque valley of the Sierra near Lima and training of its participants. Five zootechnicians in turn tried to improve milk production, but with little more success than a few dozen crossbred bulls. Only in 1969 when a cheese maker joined the project and moved the research cheese unit into the village, the project took off. Villagers became more involved in the project, milk quality was much better due to shorter distances between cows and cheese plant, and the site was characterised by excellent water quality and an ideal climate for cheese ripening. In 1971, evaluation of the first three cheese plants resulted in initiation at national scale for distant villages in the Sierra mountains (2,000-4,000 m a.s.l., 12-15 °C) to reduce migration of rural people to the towns. Three types of cheese are produced:

Andino (2 weeks of ripening), Tilsiter (4 weeks) and Danbo (6 weeks) because customers prefer an unripe, mild, and white cheese. At the same time, the government introduced import levies on butter and cheese to protect the large-scale farmers that had produced Swiss type of cheeses since decennia. From 1969-1976 35 small cheese plants were established, processing each in 1976 in average 270 litres (range 40-1,000) of milk per day and a total daily cheese production of 1,500 kg (Dubach, 1976). These cheese plants are located in 13 service cooperatives, 12 producer cooperatives, 3 village operations, 2 in government farms and 5 in private farms.

Most constraints on variation in quality, management changes and variation in profitability occurred in the larger organisations. Some 300 cheese makers were trained during one month of practical training in the field and several dozens have been employed as cheese production manager and assistant cheese makers. In 1974 a school was established in Chuquibambila, Puno with a nine months' programme and the project was pushing for a quality control programme, more uniformity in product presentation, and coordination of marketing (Dubach, 1976). Milk yields were decreasing due to deterioration of lucerne fields by the encroachment of Kikuyu grass. A tractor service for farmers was requested and honoured by Swiss Technical Cooperation (STC) with smallholders paying for the services from milk proceeds. In total, STC supported establishment of 60 cheese factories. Such a rural cheese factory costed US$ 2,000 in locally made equipment, 1,000 for furbishing the buildings and 1,000 for working capital (Baron del Castillo, 1989).

Swiss Technical Cooperation was similarly active in Ecuador from 1978. By 1989, 11 cheese factories had been installed with 423 members and a daily intake of 6,000 litres (Baron del Castillo, 1989). In 1994, the number of participating groups had increased to 28. Ecuadorian counterparts of the Swiss project have been incorporated in the large Dairy Farmers Association of the Sierra and Eastern Region (AGSO), and are preparing plans for standardization of cheese processing and quality control assistance to these cooperatives to guarantee market expansion for their joint outlet in Quito. Cheese cooperatives were formed in areas that were not reached by middlemen for milk collection, and where farmers could collect, within a 3 km radius, at least a daily amount of 300 litres of milk and were prepared to deliver quality milk and supervise the employed cheese maker to guarantee a high quality end product suitable for the urban market (Torres, cheese making expert in AGSO, pers. com. 1994).

In conclusion, small-scale rural cheese factories are attractive for marketing excess milk in isolated areas, simple technology is available in manuals produced locally by the STC projects, and can be learned by intensive practical training of committed cheese makers. Group management, quality control of milk and products and organization of marketing are essential to achieve a guaranteed added value for milk.

10.5 FAO/UNDP assisted Integrated Dairy Development in the Eastern region of the Dominican Republic (PRODELESTE)

This dairy development project (1989-1995)is governed by semi-annual project meetings of the Ministry of Agriculture and Livestock, the private sector (feed company, fertilizer company, milk plants and cheese plant), the producers (presidents of the dairy associations and their apex organization FEDAGARE), United Nation Development Programme (UNDP) and FAO (Prodeleste, 1989).

In 1989, annual milk production in the Dominican Republic was estimated at 300 million litres (90 million in the Eastern region of which only 40 was collected by the dairy industry). Consumption per capita stood at 75 litres per year (considered 50% of the requirement). Half of the consumption was based on imports with a price rise from US$ 800 to 2,400 per ton in 1989, leading to annual costs of US$ 35-40 million.

Objectives of Prodeleste were: a higher production and better quality of milk, more regular supply over the seasons; technical, economic and human improvement of participants; demonstrate that improvements in the field can be made with support of the private sector; less dependence on the international milk market and savings of foreign currency; and higher consumption of milk products (Prodeleste, 1989). The project operates along three action lines: (i) technical assistance (field teams), (ii) credit facilities (hardly developed due to lack of funds) and (iii) assistance in marketing of milk (collection centres). Targets are to reach about 6,000 farms (average 36 cows per farm) through 36 teams, to increase the number of farms that are milking from 45% to 80%, proportion of cows in milk from 50 to 68% and daily milk yield per cow in milk from 2.5 to 5 litres. Consequently, annual milk production is expected to increase from 48 to 232 million litres.

Field teams (initially composed of 2 agronomists-later reduced to 1- and 1 livestock/veterinary officer) attending 150-180 farmer families each, are equipped with small pick-ups (project pays mileage and technician pays 48 monthly instalments to become owner) and cameras to facilitate visual and group communication. Active farmer participation is stimulated by summarizing conclusions and recommendations at the end of group meetings, demonstration and field days, and distribution of these summaries in writing. A project magazine is published, with articles written by the group, on price/policy developments, technical matters with pictures on group activities, and distributed free of charge to project farmers and other interested parties.

In April 1992 Prodeleste operated with 16 field teams (3 composed of women) and three zonal coordinators involving a total of 2,400 project farmers. Headquarters staff consisted of five technical staff (national director, specialists in nutrition, pastures, economics/credit and the FAO adviser/international director). Milk prices in the "milk line" were as follows: 2.50 pesos per litre by middlemen, 3.47 at the cheese factory, 3.60 at the milk collection centres, 3.80 at the milk plants and 4.86 at the consumer's doorstep (12.5 pesos = 1 US$). In one participating area visited balanced feed was prepared by a cooperative at a cost of 89.50 pesos per 50 kg (pilot scale production of multi-nutritional blocks costed 62.63 pesos per 50 kg), with a milk collection of 45,000 l/d with a total input of 30 tonnes of concentrates (De Jong and Preston, 1992).

Impact monitoring, consisting of annual surveys carried out by staff and producers, showed that milk production increased with 7% from 1989 to 1990, 15% from 1990 to 1991, and 35% from 1991 to 1992. The number of cows reached 86,000 (35.8 cows per farm) on 376,740 ha in 2,400 farms in 1991, indicating more medium-sized farms than in Nariño, Colombia and Cañar, Ecuador. The proportion of cows in milk improved from 40 to 46% in dual purpose herds and from 63 to 65% in dairy herds from 1990 to 1991. Average daily milk yield per cow in milk increased from 3.6 to 4.2 litres in dual purpose cattle and from 8.9 to 9.6 in dairy cattle (De Jong and Preston, 1992).

After 5 years, the milk production in Eastern region had almost doubled and in total four regional federations are now in operation in the country (Prodeleste, 1994). Important technical recommendations from the project are: more pasture produces more money; plant sugar cane as a safeguard against the dry season; molasses-urea blocks at 500 g/d in the dry season could produce an additional 0.7 litres of milk in a profitable manner; and plant live fences for cattle feed (Prodeleste, 1995).

FEDAGARE has a department of inputs and services and is responsible for collecting the quotas of the gradual transfer of the cost of the field teams per association (20% in year 1, increasing to 100% in year 5). In addition, the private sector contributes monthly to a project fund (to sustain central project management and general expenditures), the magnitude based on a percentage of the milk collected and inputs sold in the area. Most associations opt for payment of field teams from the proceeds of their input stores. The reduction in team size from 3 to 2 (triggered off by 100% inflation in 1990) facilitated also introduction of salary scales (average 400 US$/month) operating along lines of promotion based upon reaching set targets per area.

10.6 FAO supported Outreach Dairy Development Training Units

FAO, through its Regional Dairy Development and Training Teams supported by the Danish International Development Agency (DANIDA) in Africa, Asia and Latin America, educated trainers and extensionists in dairy development. The "Outreach Dairy Development Training Unit" (DDTU) concept was developed to reach the small producer. First, the term "out-reach" refers to the need to consolidate the efforts of the past by the institutional support and to maintain a viable relation between the DDTU at producer level and the Dairy Training Centre, training institution or extension service. Secondly, the DDTU concept is based on involving the small-scale milk producers in organizing dairy development in a planned, integrated and logical fashion to respond to their needs, aspirations and management. In Appendix 10.1 information is given on basic types of DDTUs. DDTUs have a two-fold purpose. They serve as focal points of training and organizing the producer and as vital components of integrated dairy development. In 1989, some 9 DDTUs were planned or just in operation in Panama, Dominican Republic, Colombia, Guatemala and Ecuador (Barron del Castillo, 1989). Main technologies promoted, are improved grassland management, manufacture of molasses-urea blocks and some DDTUs will be provided with simple cheese making equipment.

DISCUSSION AND CONCLUSIONS

FAO's general statistics, based on the information Governments provide on annual questionnaires, show large differences in milk production among geographical regions (Table 10.1-5). In Europe and North America milk yields per cow are increasing and dairy cattle numbers are declining. In Africa, local milk availability generally declined, with the exception of Kenya and Tunisia where it increased through increased dairy cattle numbers and milk yields, respectively. In Asia, local milk availability per capita increased in a large number of countries through imports of cattle (Thailand, Indonesia, South Korea, Saudi Arabia), increased local dairy cattle numbers (Pakistan, China) and/or improved milk yields (Israel, South Korea, Indonesia and India). In Latin America, milk availability per capita increased through increased milk yields (Argentina, Ecuador, Costa Rica), dairy cattle numbers (Colombia, Bolivia and Guyana) or both (Chili, Uruguay, Brazil), while in a number of other countries (Mexico, Cuba, Nicaragua, Peru and Dominican Republic) local availability decreased. The latter are all large importers of milk products.

Smallholder dairy development projects in Kenya, Tanzania, Sri Lanka, Indonesia, Colombia and Ecuador recorded improved milk yields over time, a high percentage of cows in milk, reduced adult mortality and especially calf mortalities. Calving intervals were long in all projects, pointing to problems in early lactation nutrition and subsequently delays in ovarian activity. Poor heat detection, difficulty in timely arrangements for mating and little follow up in the form of pregnancy tests, as well as farmers' fear for reduced milk yields after breeding all contributed to long intervals.

Farm cash income or gross margin varied considerably among farming systems in Kenya (US$ 272 -2,032 in 1982/83), Tanzania (US$ 188 - 1,180 in 1992), East Java (US$ 642 - 902 in 1990), Sri Lanka (US$ 197 - 461 in 1993) and Ecuador (US$ 662 - 1,217 in 1991/93) with a contribution from dairying ranging from 29-94%. Major factors that influenced the share of dairying, were profitability of crops close to the urban market, price paid for the milk by direct sales or the parastatal collection network (Kenya), or milk price in urban and rural areas (Kagera, Tanzania), the importance of off-farm income (migration in Ecuador) and farm size (demonstration farms in Sri Lanka). Income over time improved in Kenya (1983-1987), decreased in Kagera, Tanzania (1992-1994) and deteriorated in Sri Lanka (1983-1990).

WFP supported dairy development projects, formulated generally as a follow-up of an International Scheme for Coordination of Dairy Development (ISCDD) mission into the country, required in some countries more time to be implemented than originally envisaged (Bolivia, India, Tanzania). In others with high priority and funds of the national governments (Cuba, China) the targets of development were met in time. Delays in the periodic application of the FAO formula for price setting of the donated milk products to avoid competition with locally produced milk occurred in most countries to facilitate the financing capacity of the dairy plant and/or to delay the politically sensitive upward adjustment of consumer prices. The WFP seminar in March 1994 in Beijing, which assessed 30 years of WFP experience in "food aid for development", further indicated that projects supported by food aid were successful if properly focused and targeted, their implementation well monitored: and when located in regions where poverty, unemployment, food insecurity and infra-structural needs prevailed (WFP/CFA, 1994).

In India, the targets set initially for Operation Flood II of reaching 10 million rural producers by 1985 had to be adjusted to 8 million by the end of OF III in 1994. Milk procurement of 18.3 million litres per day set for the end of OF II was not reached either. The target of a national milch herd of 14 million improved dairy cows and buffaloes (Dairy India, 1983) was reduced to 10 million (Dairy India, 1985). Also, incorporation of feed stores, AI facilities and animal health cover in VMCSs required considerable more time than organizing producers and milk collection (Figure 10.14). These services under OF I and II provided as grants or on a 70% loan and 30% grant basis had, for reasons of cost recovery, been scaled down, affecting of course especially the VMCSs in less potential areas that were included in the later stages.

In China, substantial dairy development has been undertaken in (peri)urban areas but further expansion is limited by scarcity of land for fodder and reduction of subsidies on concentrates. The big challenge for the coming years will be to incorporate the rural sector in the dairy scene.

Stimulating dairy development in the rural areas has basically two options: either along lines of Operation Flood of an extended network of collection, cooling centres and feeder-balancer dairies to supply the urban plants oriented to the majority of milk consumers and purchasing power. Or, very locally, through small-scale milk processing into marketable products with longer shelf lives and higher margins that allow long distance transport and distribution to more prospective buyers. Swiss technical corporation supported a number of rural cheese production projects to provide a more remunerative outlet for rural milk. The Netherlands has supported cheese making in parastatal farms (Tanzania and Sri Lanka) and at cooperative level (Colombia) to produce a value-added product or to extend the shelf life of surplus milk. FAO through its regional training programmes has trained large numbers of technicians, but the biggest challenge is in quality control and marketing of processed milk.

Organization of inputs, services, training and extension aimed at small-scale dairy farmers is generally costly in terms of salaries and transport. Moreover, it requires personnel with sufficient knowledge and experience in the complex sector of the dairy industry. Transfer of these inputs and services to the producers on a cost recovery basis has been initiated in the various dairy development projects. Most successful attempts were observed in the area of inputs by producer cooperatives (COOPROLACTEOS in Nariño, Colombia and FEDAGARE in the Dominican Republic, the Federation, Union and Village Dairy Cooperatives in India, Dairy Cooperatives in Indonesia and Sri Lanka and in a number of producer associations in the Tanga and Kagera regions in Tanzania). Most of the technical services are still being financed by the Government, although larger cooperatives increasingly recruit technicians for AI, first aid and sometimes veterinarians and agronomists besides administrative and commercial staff. Under the structural adjustment programmes, most governments are forced to integrate crop and livestock in training and extension into general agriculture to attend to the mixed farming community. Attention to dairy matters is increasingly removed from local teams and left towards sector specialists at district level. The latter position depends further on the relative importance of crops and livestock in the area.

In conclusion, long-term projects in dairy development have been successful in terms of numbers of dairy cattle and dairy farmers as well as increased milk yields, if supported by conducive government attention to producers and their organizations, opportune credit for dairy stock and farm development, training, extension and veterinary services. Long-term donor support stimulated technology generation and implementation such as the zero-grazing package, grass-crop rotation and small scale milk processing, and strengthened producers' organizations. In most projects, further strengthening of farmers' organizations is still needed to arrive at more sustainable dairy development with small producers.

Appendix 10.1

BASIC TYPES OF DAIRY DEVELOPMENT TRAINING UNITS (DDTU)

Components	Modules
DDTU-1 Milk production	*Producer organization, management and administration of producer services, participation of women.* Pasture production and management, fodder conservation, use of feed supplements, calf rearing and feeding. Cattle selection, artificial insemination and controlled breeding. Improved milking techniques, milk recording, basic farm structures, labour, time and energy saving methods, dairy farm sanitation, animal health first-aid.
DDTU-2 Milk collection and Producer services	Central collection of milk, milk testing, payment for milk, milk cooling, cooled milk transport to processing plant. Supply centre for service inputs to producer, *e.g.* mineral supplements, concentrates, veterinary products, cleaning and sterilizing supplies, basic milking equipment. Central contact point for provision of services, *e.g.* animal health first-aid, A.I., veterinary care.
DDTU-3 Village milk processing	In conjunction with milk collection/cooling facilities provision is made for processing cheese, ghee, fermented products and fluid milk for: a) Local markets, particularly where transport facilities are inadequate. b) Urban markets.
DDTU-4 Rural dairy plant	As milk production increases and demand for dairy products other than liquid milk grows, the rural dairy plant, which itself developed from DDTU-2 to a DDTU-3 becomes a needed and viable integrated entity. Products such as cheese, ghee, etc., are produced chiefly for urban markets.
DDTU-5 Urban dairy plant	Major population centres are served by urban dairy plants whose primary function is to receive cooled milk from DDTU-2s and process, package and distribute fluid milk. These plants also serve as distributors of the dairy products (cheese, ghee, etc.), produced in the DDTU-2 and the rural dairy plants.
DDTU-6 Milk marketing	Integrated dairy development is market and demand oriented. This requires regular analysis of operation and product cost structures and an accurate assessment of present and future supply and demand trends. To secure adequate incentive prices for milk production profitable margins for processed products, suitable product mix combinations and prices ensuring lowest possible fluid milk price to consumers, good marketing intelligence is needed.
DDTU-7 Appropriate technology and applied research	The technology that is used throughout the integrated development project must be appropriate to the situation. Basic uncomplicated equipment, preferably of national manufacture and capable of being serviced locally is a prerequisite. Maximum use should be made of innovative sources of alternative energy, *e.g.* wind and water power, solar energy, biogas, etc.
DDTU-8 Information systems	All components are inter-related on a modular basis into an integrated entity which depends for its strength on the inter-locked building block concept. This, in turn, requires an adequate information collection, and transfer network analysis and transfer network for proper evaluation, decision-making and action.

11. GENERAL DISCUSSION AND CONCLUSIONS

Dairy development in the preceding chapters was reviewed in terms of changes in the production of dairy stock and milk as part of agricultural and rural development, focusing on three main aspects: (1) technical, economic and organisational progress of producers in dairy development, (2) options for smallholders in dairy farming based on more self-reliance and less dependence on foreign aid, and (3) possibilities of smallholders in rearing and raising sufficient dairy stock on their farms for replacement and supply to aspirant farmers.

Global developments in population and agriculture

Assessments were done for geographical regions, whereby the totals for Africa, Asia, South and Central America also include Japan, South Africa and Israel that have been mentioned separately in earlier literature of FAO as other developed countries. World population over the period reviewed in this thesis-(1980-1994) increased with 1.7% per year (ranging from 0.32 in Europe to 2.88% in Africa), lower than the peak rate of 2.1% recorded in 1965-1970 (FAO, 1995). Land use from 1980 (average over 1979-1981 to correct for annual fluctuations) to 1993 (average 1992-1994) increased less than population. Arable and permanent cropping land increased with 0.13% per year (ranging from -0.28 in Europe to 0.50% in Africa), permanent pasture land with 0.31% (ranging from -0.54% in Europe and 1.08% in Asia). The area of forest/woodlands changed with -0.22% per year (ranging from -0.39 in South America to 1.43% in Oceania) and other lands (roads, towns, barren land) with -0.01% (ranging from -1.46 in North America to 0.68% in the former USSR).

Production of food crops and total crops worldwide from 1980 to 1994 increased with 30.3 and 29.6%, respectively, both higher than population with 27% and livestock production with 26.6%. The smaller growth in the livestock sector was caused by negative growth of the wool sector and low growth in the dairy sector. Over the period 1989-1994 meat production increased with 2.53% per year, egg production even with 2.76%, while wool decreased with 2.46% and milk production with 0.34%, because of reductions in Europe and the former USSR. Increases in agricultural production below population increases were found in Europe, Oceania, Central America and Africa, while in North America, South America and especially Asia, production increased faster than population. FAO (1995) recorded for 93 developing countries from 1970-1990 (and projected for 1989-2010) annual meat production increases from poultry of 7.0% (5.1), pigs of 6.1 (4.0), sheep and goats of 2.8 (3.1) and cattle and buffaloes of 2.2 (2.7).

On a per capita basis, world food production increased with 0.31% (ranging from -0.38% in Africa to 1.86% in Asia), total crops with 0.21% (ranging from -0.37% in Africa to 1.09% in Asia) and livestock production with 0.21% (ranging from -0.67% in Africa and 3.82% in Asia) as shown in Chapter 1.1.

Agricultural production increases were associated with increased fertilizer use in developing countries from 22.6 million tons in 1980 to 36.8 in 1989 (ranging from 11 kg in sub-Saharan Africa to 89 kg per ha in Near East/North Africa). Use of cereals for livestock feed grew at 5.6% in the 1970s and 3.6% in the 1980s reaching some 160 million tons in 1989 (17% of total production) and is expected to increase up to 2010 at 3.7% per year compared to 1.9% increase in cereal production for food use. Oilseed proteins (converting oilseeds and their meals/cakes to 100% crude protein equivalents) grew at 1.2% from 5 to 14 million tons from 1970 to 1989 and are expected to grow with 1.3% annually up to 2010. The use of fishmeal for livestock stood at 1.2 million tons in 1989 (FAO, 1995). In 1989 grains fed per kg livestock unit per year was 25 kg in sub-Saharan Africa, 100 in Latin America, 110 in South-East Asia and 260 kg in Middle East/North Africa (De Haan, 1992).

Worldwide development of milk production and processing

The first objective of this thesis was to examine the technical, economic and organizational progress in dairy farming. This was illustrated over time for the Netherlands (1930-1993/4), compared for 1992 with some industrialized dairy countries in Europe, Oceania and the USA, and for geographical regions and selected countries of Africa, Asia, Central and South America over the period 1980-1993 (Chapters 1 and 10).

Industrialized countries

Over the period 1980-1993,in the industrialized countries cattle numbers decreased from 408 to 363 million, dairy cows from 107 to 92 millions and total milk production from 343 to 339 million tons, but milk yields increased from 3,145 to 3,623 kg per cow (Table 11.3). Milk production per ha increased in North America and Oceania, and decreased in Europe and the former USSR (Table 11.2). Per person involved in agriculture (Table 11.3), the number of dairy cows is increasing as well as the amount of permanent pasture and arable land. The number of dairy farms declined, substituting labour for capital to benefit from economies of scale and to limit the cost price of milk for consumers and export. The other side of the coin is a growing concern in Europe and the USA about environmental pollution of the large-scale intensive units, high culling rates for reproduction aspects and rising animal health costs of highly productive cows, compared to low culling rates in grass-based milk production in Oceania (Table 2.7).

Table 11.1. Total land, population, numbers of cattle and dairy cows, and total milk production (cattle, buffalo, sheep and goats) in the world, and the distribution per geographical region and for the Netherlands, in 1980 (av. 1979-1981) and 1993 (1992-1994). Source: FAO Production Yearbook (1994).

	Land (mln ha)	Population (mln)		Cattle (mln)		Dairy cows (mln)		Total milk (mln tons)	
		1980	1994	1980	1993	1980	1993	1980	1993
World	13,082	4,444	5,630	1,218	1,283	213	226	463	526
Proportional (in%)									
a. Africa	22.7	10.7	12.6	14.1	14.8	12.0	14.9	3.4	3.8
b. Asia	20.5	58.2	59.2	28.8	31.4	22.0	26.2	15.1	23.1
c. Central America	2.3	2.7	2.8	3.9	3.7	3.9	4.2	2.3	1.9
d. South America	13.4	5.4	5.6	19.7	21.8	11.8	14.0	5.2	6.7
sub total (a-d)	58.9	77.0	80.3	66.5	71.7	49.7	59.3	26.0	35.5
e. North America	14.4	5.7	5.1	10.2	8.8	5.9	4.8	14.1	14.7
f. Europe	3.6	10.9	9.0	11.0	8.6	22.2	16.2	37.5	30.2
g. Oceania	6.5	0.5	0.5	2.9	2.6	1.9	2.0	2.6	3.0
h. Former USSR	16.7	6.0	5.1	9.4	8.3	20.2	17.8	19.7	16.5
sub total (e-h)	41.1	23.0	19.7	33.5	28.3	50.3	40.7	74.0	64.4
The Netherlands	0.26	0.32	0.27	0.42	0.37	1.11	0.77	2.56	2.07

Africa, Asia, Central and South America

In 1980, Africa, Asia, Central and South America, representing 59% of the land area and 77% of the world population, had two-thirds of the world cattle population, but only 50% of the dairy cows and produced only 20% of the total cow milk. In 1993, the population of these regions amounted to 80% of the world, with 72% of the cattle, 59% of the dairy cows and 27% of the cow milk. Their share in total milk production including milk from buffaloes, sheep and goats (Table 11.1) increased from 26 to 35.5%, i.e. from 120 to 187 million tons or 3.43% per year. The increase came both from increased numbers of dairy cows from 105.8 to 134 million head (1.8%/yr), buffaloes from 121 million to 148 million head (1.55%/yr), sheep from 437 to 569 million head (0.5%/yr) and goats from 437 to 569 million head (2.05%/yr) and from increased milk yields from 782 to 942 kg per dairy cow, i.e. from 102 to 137 kg per head of cattle and from 229 to 319 kg per head of buffalo. The largest increases were recorded for Asia in dairy cow numbers (1.80%) and heads of buffaloes (1.48%) and for milk yields (2.82% in both) (Table 1.13). For 93 developing countries FAO (1995) indicated a growth in milk consumption for 1970-1990 of 3.7% and estimated a further increase of 2.5% up to 2010. Production increased with 3.5% and trade with 5.8% per year over 1970-1990, and is expected to increase with 2.5 and 2.2%, respectively till 2010.

Milk processing

Processed milk over this period showed increased annual cheese production from 11.5 to 14.8 million kg (1.95), whey powder from 1.1 to 1.7 million kg (3.67), whole milk powder from 1.7 to 2.2 million kg (2.11) and decreased for skim milk powder from 4.2 to 3.4 million kg (1.49), evaporated milk from 4.6 to 4.4 million kg (0.21), and butter and ghee from 6.9 to 6.8 million kg (0.04). In milk equivalents, processed milk products increased from 185 to 296 million tons or from 40 to 56% of world milk production (ranging from 80-95% in industrialized countries and between 10 and 40% in developing countries).

Production per ha

Per ha of total land area, annual world production of milk and meat increased from 35 and 10 kg in 1980 to 40 and 14 kg in 1993, and milk yield per dairy cow from 1,970 to 2,035 kg (Table 11.2). As only part of the land is used for dairying, milk production has also been calculated per ha permanent pasture, and per ha arable land (crop and plantation agriculture) plus permanent pasture to consider the production of milk based on forage, crop residues and crop by-products.

Per ha permanent pasture, total milk and meat production increased from 144 in 1980 to 157 kg in 1993, and per ha arable plus pasture land from 100 to 110 kg, respectively. Milk and meat production per ha is lowest in Africa with large areas unaccessible to livestock because of tsetse infestation, and limited amounts of crop by-products part of which are still exported (Walshe *et al.*, 1991), followed by Oceania and South America, both with limited supplies of crop by-products. Africa, Oceania and South America have only about 6% of the land dedicated to arable cropping (Table 1.1, Chapter 1) against about 10% in the former USSR, over 12% in North and Central America and about 30% in Europe and 25% in the Netherlands.

The milk and meat production figures in the Netherlands are illustrative for the intensive farming conditions that included imported feed supplements of 14.5 million tons in 1980 and 16 million tons in 1992 (LEI/CBS, 1994). Imported supplements are equivalent to about four million ha at 4,000 kg produce per ha or double the Dutch area under crops and pasture. The per ha figures for milk and meat are important characteristics for the scope, mode and costs of milk collection and beef cattle transport to the urban sector. Milk and meat densities in Europe, and especially the Netherlands are much higher than in other geographical regions. Low milk densities outside Europe complicate rural milk collection unless milk production is area-wise concentrated in large-scale farms, villages or along viable milk routes in milksheds, where sufficient milk can be collected over reasonable distances and time (about 3 hours from milking to cooling in the tropics).

Table 11.2. Average annual milk (cow, buffalo, sheep and goat) and meat (bovine, ovine, caprine, equine and poultry) production per ha of total land, and annual milk production per ha permanent pasture land and per ha arable plus pasture land, and milk yield per dairy cow (+ index) in the world, per geographical region and in the Netherlands, in 1980 (av. 1979-1981) and 1993 (av. 1992-1994).

	Milk/ha land		Meat/ha land		Milk/ha pasture		Milk/ha arable+pasture		Milk yield/cow		Index
	1980	1993	1980	1993	1980	1993	1980	1993	1980	1993	1980=100
World	35	40	10	14	144	157	100	110	1,970	2,035	103
a. Africa	5	7	2	3	19	23	16	19	452	445	98
b. Asia	26	45	11	23	103	152	62	96	786	1,121	143
c. Central America	36	34	12	16	116	106	83	75	1,232	1,052	85
d. South America	14	20	7	9	52	71	43	59	960	1,101	115
weighted av.(a-d)	16	24	7	12	54	83	42	61	782	942	120
e. North America	35	41	14	18	249	290	131	155	5,203	7,137	137
f. Europe	367	336	83	89	2,006	1,991	760	737	3,569	4,216	118
g. Oceania	14	19	5	5	27	37	25	33	2,982	3,508	118
h. Former USSR	42	40	7	7	284	268	165	156	2,097	2,150	103
weighted av.(e-h)	64	63	16	18	311	309	193	194	3,145	3,623	115
The Netherlands	3,485	3,206	567	832	9,604	10,350	5,783	5,478	5,025	6,278	125

Source: FAO Production Yearbook (1994).

Table 11.3. Availability of total land, permanent pasture, arable land (ha) and dairy cows per person in agriculture and milk (cattle, buffaloes, sheep and goats), meat and hen eggs (kg/person) in the world, per geographical region and in the Netherlands, in 1980 (av. 1979-1981) and 1993 (av. 1992-1994).

Availability/	Per inhabitant		Per person involved in agriculture						Per capita of local production					
geographical region	Ha total land		Perm.pasture		Arable land		Dairy cattle		Milk		Meat		Eggs	
	1980	1993	1980	1993	1980	1993	1980	1993	1980	1993	1980	1993	1980	1993
World	2.9	2.3	1.5	1.4	0.6	0.6	0.10	0.09	104	94	30	34	6	7
a. Africa	6.2	4.2	2.7	2.1	0.6	0.5	0.08	0.08	34	28	14	13	2	2
b. Asia	1.0	0.8	0.4	0.4	0.3	0.3	0.03	0.03	27	37	11	19	3	5
c. Central America	2.5	1.9	2.0	2.0	0.8	0.8	0.19	0.20	90	63	31	30	8	12
d. South America	7.3	5.6	6.7	7.4	1.4	1.5	0.36	0.47	101	112	48	52	7	8
weighted av. (a-d)	2.3	1.7	1.0	0.9	0.4	0.3	0.05	0.06	35	41	15	19	3	5
e. North America	7.5	6.5	25.9	40.3	23.2	35.2	1.24	1.64	260	267	106	119	18	16
f. Europe	1.0	0.9	1.4	2.2	2.3	3.7	0.78	1.00	359	315	81	83	15	13
g. Oceania	37.3	30.1	101.7	96.6	10.7	11.6	0.68	1.03	540	569	175	165	12	8
h. Former USSR	8.3	7.6	6.1	8.7	4.4	6.2	0.82	1.07	343	302	58	51	14	12
weighted av. (e-h)	5.3	4.9	8.7	12.9	5.1	7.7	0.84	1.08	334	305	83	87	15	13
The Netherlands	0.2	0.2	1.6	2.2	1.0	2.0	3.01	3.48	837	707	139	183	38	40

Source: FAO Production Yearbook (1994).

Production per person

Overall availability of total land per person declined from 2.9 ha in 1980 to 2.3 in 1993. Availability of arable plus pasture land per person involved in agriculture declined in Africa and Oceania, and remained stable in Asia and Central America. In South America, North America, Europe and the former USSR it increased from 1980 to 1993, implying relatively high outflows of people from agriculture and area expansion of agricultural farms for those remaining (Table 11.3).

Local milk (cow, buffalo, sheep, goat) availability per inhabitant decreased from 104 kg in 1980 to 94 kg in 1993 in the world, because of higher increases in human population than in milk production in Africa and Central America, reduced milk production in Europe and the former USSR, and in spite of higher production increases than population growth in North America and Oceania, South America and especially Asia. In contrast, availability of local meat (bovine, ovine, caprine, equine, pigs and poultry) increased from 30 to 34 kg per inhabitant with declining availability in Africa, Central America and the former USSR. Production of hen eggs increased from 6 to 7 kg per inhabitant with fast rising availability in Asia, South America and especially Central America, but declined in industrialized countries (Table 11.3) in view of decreasing local demand and low effective demand in the world market. The Netherlands with the lowest land area per inhabitant, has the highest number of dairy cattle per person involved in agriculture and the highest local availability of milk, meat and eggs per capita, making the country also very dependent on export possibilities. The Dutch per capita consumption in 1992 was 126.4 kg milk and cream, 14.2 kg cheese, 81.2 kg meat and 10 kg eggs (LEI/CBS, 1994).

World production of milk amounted to 355 million tons of milk equivalents in 1962 and FAO projections for 1975 came to 447 million tons (growth 1.8%/yr). Actual production increased less than projected and reached 463 million tons in 1980 (1.5%/yr) and 526 (1.3%/yr) in 1993. This excludes an estimated 7-8 million tons of milk of camels. Buffalo milk production showed the highest increase in %/yr (4.18) followed by sheep/goat milk (1.63) and dairy cow milk (0.70). Milk yield increases per animal were respectively 2.65, 0.89 and 0.25% per year. Increases in milk yield per cow were highest in Asia (2.82%, followed by South America (1.09%), while increased milk production in Africa and Central America was based on increased numbers only.

World trade in milk products

In 1962 (av. 1961-1963) developing countries imported some 3.5 million tons of milk equivalents (ME) i.e. about 20% of local milk production (PZL, 1969). Thirty years later, imports had increased to 17 million tons representing about 10% of local production. World trade in milk products (excluding inter-EU trade) amounted to 28 million tons of milk equivalents (calculated by using international standards mentioned by Mors, 1990). Imports were comprised of 0.725 million tons of butter/butter oil (1.1 ME/kg), 2 million tons of milk powder (50% skim milk powder at 10.87 ME/kg and 50% full cream milk powder at 8.26 ME/kg), 0.9 million tons of cheese (8.33 ME/kg) and 0.4 million tons of evaporated milk (2.1 ME/kg) according to PZ/FAO data quoted in Rabobank (1995). Annual net imports by developing countries increased from 16 (average 1977-1979) to 20 (1987-1989), and are expected to rise further to 23 million tons in 2000 (Phelan, 1993). For 2010 FAO (1995) expects it to rise slowly to 26 million tons in view of low effective demand in the Near East/North Africa, limited stimuli for increased milk consumption in view of dietary habits in East Asia, an area with rapid economic growth, and production constraints in regions where milk is a staple food for large parts of the poor population, e.g. the pastoral societies of sub-Saharan Africa, and to a lesser extent, South Asia.

Nutritional aspects and dairy food aid.

After world war II, the United Nations Children's Fund (UNICEF) was active in stimulating the erection of milk plants in developing countries and delivery of dairy food aid. These milk plants usually had the obligation to deliver 125% or more of the value of UNICEF support in free milk for vulnerable groups (PZL, 1969). UNICEF donations of skim milk powder decreased from 44,100 tons in 1961 to 5,200 in 1966, handing over the responsibility of food aid increasingly to the World Food Programme established in 1963 (PZL, 1969).

In 1967, a global comparison of animal protein consumption was carried out by an advisory committee of the President of the USA. Average consumption of animal protein amounted to 63 grams in North America, 61 in Oceania, 42 in Europe, 28 in Latin America, 18 in Near East Asia, 12 in Africa and 8 in Far East Asia, compared to 22 grams per capita per day as considered appropriate for an animal protein containing diet (PZL, 1969). The proportion of the population belonging to vulnerable groups, i.e. children, pregnant and nursing women, and poorest sections of the society in developing countries varied in 1965 from 46% both in Latin America and Asia, to 53% in Africa. Chronic malnutrition in developing countries has decreased from 36% in 1970 to 20% in 1989 (from 941 to 781 million) with further downward projections to 11% (637 million) in 2010 with sub-Saharan Africa (32%) and South Asia (12%) above the average (FAO, 1995).

FAO projected for 1975 that vulnerable groups would comprise 876 million people (against 409 million existing in 1962), and estimated a annual requirement of 20 million tons milk equivalents to bridge the "nutritional gap". In addition, a "commercial gap" of 20.5 million tons was estimated in view of limited purchasing power between unsatisfied demand of 26 million tons and a commercial import of about 5.5 tons (PZL, 1969).

Annual needs during calamities were estimated to range between 200,000-800,000tons milk equivalents (PZL, 1969). In an FAO study "Milk products as food aid" in 1968 (PZL, 1969), some-60,000-80,000tons of butter oil and 242,000-327,000tons of skim milk powder were projected annually for direct use in existing channels such as the local dairy industry for balancing seasonal fluctuations (16%), in food for development work projects (33%) and for supply to vulnerable groups (51%).

Actual dairy food aid shipments to developing countries amounted initially to 76,600tons per year (1963-1968), increased to a maximal annual average of 445,000tons (1984-1986) and decreased to 137,000tons in 1990-1992, while Eastern Europe and the former USSR received annually 55,000 tons in 1990-1992 (PZL, 1969; Phelan, 1993). Major reasons were fewer surplus milk products, increase in world market prices in the 1990s, and a change in the outlook upon dairy food aid.

Food aid concepts changed from food provision to the hungry from surplus to deficit countries in the 1950s to a more structural presence of food aid in the 1960s and 1970s followed by increasing awareness of negative effects of food aid on local production.

Also, nutritional concepts changed from a "protein gap" to "energy density gap" as the important factor causing malnutrition in weaned children. Liquid milk with an energy density of 0.64 kcal/ml falls short of the required value for weaning foods of 1 kcal/ml. A balanced diet for optimal growth, maximum physical performance and good health requires per kg body weight daily 120 kcal and 2 g protein for an infant, decreasing to 100 kcal and 1.2 g protein at the age of 12 months, and further to 50 kcal and 0.75 g protein for adults (medium work). Infants in the weaning period (6-30 months) require soft, liquid food supplements of high energy and protein content. Pregnant women, particularly in the last trimester, nursing mothers, convalescent patients and malnourished children have a greater need of energy, protein, minerals and vitamins (Anon., 1991). Advantages of animal milk (although relatively short in iron and vitamin D) are in the high biological availability of protein, a more complete mixture of essential amino acids (especially lysine) to balance cereals, and a high content of minerals especially soluble calcium, important for young children, expectant and lactating mothers, sick and elderly people (Van den Berg, 1988). The increase in lactose-malabsorption rates for animal milk after breast feeding, which should not be mistaken for milk intolerance, favours the intake of smaller quantities of milk and the use of processed milk products with no (mature cheese, ghee) or less lactose (60-85%) like sour milk, butter milk, yoghurt and fresh cheese (Van den Berg, 1988).

For economic reasons, feeding of vulnerable groups is now directed to balancing local foods such as cereals with pulses (Anon., 1991), although pulses may not be available throughout the year for the poor as was the case in Kagera region in Tanzania (Ricardo, 1986). Milk products still eligible for food aid are infant milk powder on medical prescription, full cream milk powder and vitamin-A enriched skim milk powder plus butteroil for hospital use of rehabilitation of malnourished children and convalescent patients, in take-home rations only for populations traditionally dependent on milk and for feeding programmes of pre-school children as a protein-rich component (up to 10% milk powder) of blended foods (Anon., 1991).

The earlier attention to urban milk conservation schemes for the distribution of safe pasteurized milk to children in the 1960s to provide a good part of the daily 1 g of protein per kg body weight from milk was replaced by attention to dairy food aid for local dairy development to increase rural income (Krostitz, 1991).

In spite of the nutritional views that milk no longer is an absolute must (Van den Berg, 1990; Kuiper, 1992), many countries still use recommendations from their national nutritional institutes, although variable per country, for essential levels of milk availability per capita/year, e.g. Ecuador 125 kg, Dominican Republic 150 kg, Algeria 40 kg and Cuba 209 kg. India mentions an average of 73 kg for vulnerable groups and 109.5 kg for children between 1-3 years old (Iya, 1987). Van den Berg (1990) states that a milk intake of 350 ml/d (or 128 kg/yr) would satisfy children's essential protein needs.

Traditionally, use of animal milk and dairy products is limited in tropical countries to pastoralists of the savannas and highlands in West and East Africa and farmers in the Northern part of the Indian subcontinent. Production and consumption of milk in the Andes region started more recently. At present, use of milk is geographically widespread throughout the tropics as a prestigious food, appreciated for its taste, however expensive and almost exclusively restricted to urban higher income classes (Anon., 1991).

Berg (1987) analyzing human nutrition aspects in World Bank projects in Colombia, Brazil, Indonesia and India and/or nutrition components in other projects (rural and agriculture, urban and health) concluded that, although malnutrition was closely linked to a country's economic development, improvements in nutrition need not wait the achievement of high economic growth. Gains can come in particular from careful targeting of food subsidies, food supplementation programmes, and nutrition education to those groups most at risk, especially poor women and children.

More targeted attention to vulnerable groups could reduce the cost of government expenditure and is preferred to general consumer subsidies often applied by governments. Such policy would avoid the negative effects on low pricing of agricultural products, including milk, on local production.

Dairy development reviews

The reviews of development of dairy stock and milk production in Chapters 2, 3, 4, 5, 9 and 10 presented several complications. Paucity of baseline data is a common feature in dairy projects, even in large ones as Operation Flood (GOI, 1984). Obtaining the correct information on land size (farmers may have several plots, including land options, shared cropping, rented land), livestock (several species and sharing arrangements) and details on income for proper evaluation of impact, require personnel and development funds, and time for building up good relations for reliable answers. Smallholders often fear that information will be used by the government for taxation (lands, cattle), reductions in food subsidy programmes (e.g. in Sri Lanka) and increased cost recovery of services and inputs.

Moreover, strong fluctuations in production occur in the course of the year and among years, because of climatic factors. Information on technical progress of some intensively guided and monitored farms is available, but information on effects on other farms that adopt only part of the improved messages is seldom available for assessment (Laurent and Centres, 1990; Maarse, 1995).

Effects of livestock development projects can only be assessed in the long term and are complex in nature which requires intensive monitoring of technical and economic productivity. Although foreign supported projects have in many cases included expatriate assistance, local personnel is scarce and often not incorporated in the ministerial structure at project and field level. Also, the identification of which items are to be monitored can be a problem, as was expressed by participants in WFP projects in Latin America (Crespo, 1994) and researchers in the FAO/France supported Dairy Development Programme in Arusha and Kilimanjaro regions (Laurent and Centres, 1990). The question is often, should monitoring be restricted to implemented versus planned activities as demanded by desk officers or should also progress be investigated (demands of evaluators) on technical, economic, social and organizational matters, which takes considerable more time, manpower and development funds. Matters related to economic progress and to development of farmers' organizations often meet resistance from livestock staff that refers these matters to economists and cooperative personnel that may not be part of the same project or belong to the same ministry.

Identification of proper evaluation criteria in smallholder dairy development schemes, projects and programmes is another difficulty. Improvement of the standard of living of smallholders is a general overall long-term objective, but data on productivity of labour, land and capital and especially aspects as division of work, nutritional status and decision-making within the family, at the start and the end of a project on the same farms are scarce. In the absence of base line data, impact studies at smallholder level tend to be more qualitative than quantitative, e.g. Maarse (1995) found in an impact study of NDDP, Kenya that through the introduction of zero grazing (i) the amount of milk for home consumption had increased according to both female and male respondents (92%) resulting in better family health (42%), (ii) two third indicated an increase in income and (iii) the majority (85%) stated that their financial status and family welfare had improved. Moreover, for proper judgement, objective comparison with control groups would be required for which data generally are not collected within the project. A desk study by PANAFCON (1994) in the National Dairy development Project of Kenya found from scanty data of 160 project cows and 248 control cows that project farmers, compared to non-implementers, registered an increase of between 900 and 1,500 kg per lactation. The use of reference farms as in Ecuador to compare developments without direct project support in the area with those involving actions (share cropping, intensive guidance) on promotor farms has problems also, since data collection is facilitated with small gifts of mineral salts that may improve parameters in control farms and hide real differences between project and control farms (Table 10.5).

Detailed collection of data from agricultural crops and livestock activities on smallholder mixed farms is limited. For the projects treated in this thesis, such details were only available for the demonstration farms in the Pasto project (Chapter 5), the small-scale training-cum-demonstration farms at the Mid Country Livestock Development Centre of Sri Lanka (Chapter 7) and to some extent the smallholder farms on marginal, abandoned tea lands in Sri Lanka (Chapter 8). Rough indications of crop income (receipts minus expenses) were taken from DEAF surveys in Kenya, kraal keeper interviews in Zambia (Baars *et al.*, submitted), dairy farm surveys in East Java (Widodo *et al.*, 1994a and b) and interviews with farmers in the different zones of the model project in Ecuador (PMDLI, 1994).

The type and number of smallholders reached by dairy development projects are difficult to assess, because visiting staff and farmers from outside the project area rarely report back in number and impact of replication. The annual report of 1992 of the National Dairy Development Project in Kenya indicated 6,215 participating farmers, 520 dormant farmers and another 9,550 interested farmers (PANAFCON, 1994). Also in view of the total number of smallholder dairy farmers in 1993, estimated at 400,000 families by Bartilol (1994) the country-wide participation is limited, although the project covers 21 potential districts. Most projects that introduce zero grazing and require improved cattle, have waiting lists of interested farmers such as in Kagera, Tanga but also in the NADSA areas of Sri Lanka and depend on availability of improved stock.

Information on progress in calf rearing requires long-term assessment from birth to age at first calving, and preferably longer to include lactation details and overall inputs during the whole period (at least five years) to make a sensible comparison between common and improved practices. Investigations in calf rearing practices were mainly done through student thesis work of the Agricultural University in Wageningen, e.g. in India (Luttikhuis and Van der Wilt, 1988), Zambia (De Kroes, 1989), Sri Lanka (Van Eekeren, 1989; Van Doren, 1988) and Kenya (Van Noort, 1985; Romkema, 1992). Information on age at first calving followed by milk production details could only be analyzed for a few schemes in Sri Lanka (Chapter 9). Student thesis work was also used to look into the effects of gastrointestinal infections and possible control in cattle in Sri Lanka and Kenya (De Rond, 1987; Van Doren, 1988 and Romkema, 1992).

Analyzing the long-term effects of development policies on technical and economic progress in smallholder dairy farming in developing countries is rather difficult. Generally, these policies are short-term and change due to elections, cabinet reshuffling and economic outlook. Milk price developments, when reported in progress reports, are rarely related to inflation rates or price changes of other consumables. Long-term price developments could only be collected for East Java, Indonesia, India, China and Ecuador, and still hide large differences among areas such as for urban-distant rural and agroecological zones.

Production data collected by projects are often limited to a number of technical parameters such as milk yield, deaths and calvings that gave, if calculated/reported over time, mortality rate and reproduction data. (Table 10.5). Milk yields per cow per day and the proportion of cows in milk were the most commonly monitored parameters, although milk yield comparisons are complicated by the way calves are reared (artificially versus suckling without exact data on milk consumed. The frequency of milk data collection, such as monthly checks in projects in Tanzania, Colombia and Ecuador gave more accuracy on lactation milk yields than the estimates from periodic surveys in Kenya (DEAF) and in Sri Lanka (NADSA-NLDB loanees). On the other hand, comparative chest girth measurements, data obtained from recollection such as lactation number, peak milk yield and peak amounts of concentrates fed at peak production of first calvers and their respective dams gave a good insight in the relative development of body weight, milk production and concentrate feeding on smallholder dairy farms in Sri Lanka. Absolute data on liveweight development are difficult to obtain in the absence of portable weighing scales and the possibility to periodic weights at the same time to avoid confusion with rumen fill. Several measure tapes exist to transform cm chestgirth in kg for light, medium and heavy cattle, that may further deviate per breed and condition. While there is inaccuracy in growth rates due to weight differences for gut fill, there are also measurement differences between persons measuring the same animal. Another method to indicate performance in calf rearing is condition scoring that was used in calf rearing studies and in dairy projects. Also, here experience and differences between persons complicate exactness of the results. For smallholders with a few animals all of different ages and/or in different phases of lactation, condition scoring is of little help. To avoid a lengthy discussion on the exactness of measurements, comparative measurements were taken of young cows and their dams by the same person and used for relative chest girth developments. The same methodology was used in recalling information on peak milk yields and concentrate levels fed during peak milk production. Concentrate levels were also compared with monthly purchases of bags of poonac at the DPA to compare the accuracy of data mentioned by the farmer. In view of differences in persistency of the lactation curve, peak milk yield may not be conclusive for the whole lactation. On the other hand, Mchau (1993) found in 227 first lactation records of Ayrshire-Boran crossbreds at smallholder farms in the Southern Highlands of Tanzania, an average 100-day yield of 617 kg milk at an average persistency of 1.61 (305-day yield over 100-day yield). Differentation in high (H) and low (L) 100-day milk yield and high (h) and low (l) persistency showed a 305-day production of 2,455 kg (Hh), 1,862 kg (Hl), 1,261 kg (Lh) and 1,058 kg (Ll), indicating the relevance of high production in the first part of the lactation on total 305-day milk yield.

Gender issues in livestock projects

Gender aspects became apparent over time in development policy and were also included in the various Dutch supported livestock projects. In the Pasto project, Colombia, attention was focused on guinea pigs, an enterprise almost exclusively operated by the female population, that received support in training, extension and credit for improved stock and housing. In most projects consultancies were used to analyze gender aspects (De Moor, 1989 in Sri Lanka; Price Waterhouse, 1990 in Kenya; Tibaijuka, 1990 in Kagera; Njido and Njema, 1990 in Tanga; Majorca, 1993 in Ecuador; and Aquilar and Rodriquez in Costa Rica in: Galina and De Jong, 1994). In Kagera region, a woman coordinator was incorporated in KALIDEP to assist women groups in acquiring land for zero-grazing and with dairy cattle introduction for individuals and groups. In NDDP of Kenya and the Model integrated dairy development project of Ecuador staff obtained training in the 1990s in gender sensitivity in extension messages and attitudes to attending smallholder families. In NDDP, Kenya, a gender desk was installed in 1992 under Phase V for planning a gender-differentiated study into zero grazing and the use of in-depth interviews and observation techniques (Maarse, 1995). Further in 1993, a technical supplement on dairy development was prepared with a comprehensive supplement, developed within the framework of the Social and Gender Analysis Training Programme of FAO/UNDP/World Bank to take account of social and gender aspects of dairy development (Dieckmann, 1994).

Most studies in gender issues in dairy projects indicate the important role of women in daily work, responsibility and decision making, and stress the need for more recognition of their roles by extensionists and trainers. Generally, it has been difficult to recruit and maintain qualified female extension personnel to work in dairy development in rural areas to attend to the "hidden" women that do most of the work in the dairy enterprise. In training, most women requested more adequate timing and location of courses so that they can attend the sessions.

Dairy production systems

Worldwide, systems of milk production and dairy stock raising are very diverse. In industrialized, western countries, milk production is mainly on family farms that are characterized by heavy mechanization (milking, feeding and manure disposal), and are either based on pasture and concentrates (Europe, West and North USA, Canada) or on pasture (New Zealand, Australia) without concentrates except for those dairy farms that produce year-round for the towns. Farms are passed on through inheritance or are purchased after share milker arrangements. Corral or feedlot-type of dairy farming on irrigated fodder, purchased roughage and concentrate is common in West and South USA, Middle East countries and to some extent in Japan, South Korea and China. Calf rearing in these systems is characterized by artificial rearing with milk or milk replacers and early weaning facilitated by legume hay and special calf feeds.

In developing countries, milk production and consumption by pastoralists in Africa and Asia is based on large family herds with seasonal surpluses of milk or milk products, sold to towns or exchanged for grain with arable farmers. In Latin America, large, dual purpose

Zebu/Criollo ranch herds are seasonally milked, mainly for supply to milk powder factories. Landless labourers (in Asia) and smallholders produce milk from small herds as a supplementary activity to off-farm labour and arable cropping for consumption in the area or for collection by regional milk plants. Calf rearing in these systems is mainly based on restricted suckling with none or very little feed supplements.

Small and medium-scale commercial dairies are found in towns and peri-urban areas. In addition, large-scale farms (mainly private in Latin America) or (para)statal farms (in Africa, Asia, former USSR and Eastern Europe) are located around urban centres to supply milk to the towns.

Capital intensity of milk production in industrialized countries is much higher than in developing countries, because of mechanization in milking, fertilization, winter feed conservation and feed milling, and costs of housing and feed storage. On the other hand, simple milking methods and equipment as well as cheap labour make some of the developing countries most competitive milk producers for future supplies to satisfy ever increasing demands (Uotila, 1995).

The large variation in production systems calls for a more detailed analysis in technical and economic productivity, the organization of the sector in relation to dairy policies and the economic environment, government support and the involvement of farmers and their organizations in input supply, services, training, extension and reserach in milk production, processing and marketing.

Technical productivity

Technical productivity was reviewed in terms of changes in milk yield per cow, per ha and per manday. Increase in milk yield per cow has the advantage that a lower proportion of the feed is used for maintenance that favour a more profitable milk production from crossbreeds over indigenous cattle and buffaloes on station and in rural farms in India (Singh, 1987), and from cattle over buffaloes in Pakistan (Hanjra *et al.*, 1987). More milk per ha is indicative for feeding more people from the same unit of land. This is important in view of population pressure for land and encroachment into marginal land. Milk per manday indicates the improvement of labour productivity, an important criterion in industrialized countries, and/or the rate of employment that is more important in developing countries.

Milk yield per cow

Annual milk production per cow (Chapter 2) ranged from a few hundred litres milk off-take per cow in pastoral and dual purpose herds, via a few thousand litres in tropical dairy breeds (cows and buffaloes), up to 8,000 litres in intensively managed Holstein Friesian herds.

In the Netherlands, milk production per cow increased from 3,250 kg in 1930 to about 7,000 in 1993/94, while the amount of concentrates fed increased from 400 to 2,200 kg. On the basis of 1 kg of concentrates for 2 kg of milk, increased milk yield can be explained largely by the increased use of concentrates. Dommerhold (1995) concluded for herdbook cows in the Netherlands that increased milk yields over the last five years (up to 7,576 kg for Black and Whites and 6,634 kg for Red and Whites in 1994/95) were realised with reducing amounts of concentrates by a combination of a sound confirmation score with emphasis on udders, legs and claws, and good management. A large variation further existed among farms with, e.g. milk production in 20 highly productive Dutch farms of about 10,800 kg per cow with an average use of 3,000 kg of concentrates against average milk production of 6,440 kg milk per cow on 1,314 kg concentrates on a sample of 87 farms on sandy soils in Friesland. Within the Friesland samples milk yields associated with different farming styles ranged from 5,640 kg on 1,200 kg concentrates for dairy farmers that pioneered in trying out alternative enterprises as well, to 7,456 kg on 1,515 kg concentrates for the typical dairy cow caring farmers (Table 1.9), indicating that not only feed, but also time and individual attention given to cows by (wo)men are important for high milk yields.

Milk yield differences in 1992 (Table 1.10) for New Zealand (3,550), Australia (4,568), Europe (range 4,800-6,600), and USA (6,447 kg) were largely related to the level of concentrate feeding with small influences of the genetic characteristics of the breed. In the international FAO Black and White strain comparison executed in Poland between 1974 and 1984 differences among country strains showed no outright winner for all dairy characteristics. Average first lactation milk yield of F1s under intensive feeding on the large-scale state farms was 4,970 kg and 3,615 kg in the field test (FAO, 1982). Definite merit in milk yield, cow size and growth capacity was found for Holstein Friesians from the USA, Canada and Israel. Friesians of New Zealand, the Netherlands and Poland showed the highest fat and protein content in the milk, the British strain was best for carcass dressing percentage and the Swedish was highest in lean meat content in the carcass (Jasiorowski *et al.*, 1987). However, such large-scale performance tests have not been carried out under tropical conditions in developing countries, where heat tolerance and disease resistance are important qualifications. For Holstein Friesians kept on commercial farms, McDowell (1989) showed that performances (milk yields, days open, dam and calf weights, calving interval and survival rates) decreased considerably with latitude, going from a cold New York state climate in the USA towards more tropical situations closer to the equator (North Carolina state, Mexico, Puerto Rico, Colombia). Higher altitudes with lower daily temperatures are more conducive for the proportion of cows in milk and daily milk yields, a lower age at first calving and shorter calving intervals as shown, e.g. for Friesians in Sri Lanka on Mahaberiatenne farm in the Mid Country and New Zealand farm in the Hill Country (Figures 9.3, 9.4, 9.5 and 9.6), and for milk yields per cow in production systems in South America (Table 5.1). A similar altitude effect was found by the monitoring unit of CAPLE in the San Carlos area, Costa Rica for the low, medium and high zones (Galina and De Jong, 1994).

Variations in milk yields per cow are not only attributable to individual cows or breeds, but show a large dependence on the amount of concentrates fed, while a cooler climate in latitude and altitude facilitates the expression of high milk yield potential, when cows are well-fed and managed.

Milk production per ha

In industrialized dairy countries, milk production per ha in 1992 ranged from a low 1,934 kg in the USA (large farms with a high proportion of grass-fed followers) via 8,170 kg in New Zealand (pasture-based, high stocking rates) to 11,220 kg per ha grassland in the Netherlands (based on forage plus concentrates) (Chapter 1). Milk production per ha in dairy regions in the Netherlands ranged from about 12,800 kg on dual-purpose cattle farms in the Achterhoek to 16,500 on 20 highly productive Dutch dairy farms, but the latter fed more concentrates.

Among farming systems in Kenya in 1983, milk production per ha ranged from 185 kg from Zebus grazing permanent pasture to 6,667 kg from grade cattle under zero grazing. In Sri Lanka, milk production per ha ranged from 846 litres for Indian x local crossbreeds grazing under coconuts to 10,969 litres for Jersey crossbreeds under intensive zero grazing on tree fodder, straw, stover and crop by-products. In South America in the early 1980s milk production ranged from 250 kg per ha under extensive grazing to 6,470 kg on specialized dairy farms with silage and concentrate feeding.

Milk production on demonstration-cum-training units at the MLDC in Sri Lanka (1985-1992) with crossbred cows varied from 9,950 kg/ha/yr (3,750 kg concentrates) in the 0.2 ha unit to 6,160 (1,895 kg concentrates) in the 0.8 ha unit (Table 7.2). At the ICA research station in Obonuco, Pasto in Colombia, annual milk production per ha with local Friesians purchased at the market ranged from 5,109 kg per ha rotational grazing of Kikuyu grass with 180 kg N via 8,400 kg per ha zero-grazing of alfalfa and Brazilian fodder grass to 7,726-10,037 kg per ha tethered grazing (moving them thrice a day) and 512-661 kg N/ha/yr, all without concentrates. An intensive milk production model (4.4 ha) operated from 1977-1983 at the Turrialba research station, Costa Rica (humid tropical with 2,647 mm rainfall) with Jersey-Criollo cows and followers (6.4 Livestock Units of 350 kg) with strip grazing on *Cynodon nlemfuensis* pastures fertilized with ammonium nitrate (205 kg N/ha/yr) showed an annual milk production variation from 8,033 to 12,742 kg, reflecting managerial success and subsequent returns for the operator were 5.35 and 4.48 times the minimum wage prevailing in the country (De Alba, 1985). An extension project for settlers (colonies or modules) in Rio Frio and Zona Fluca de San Carlos, Costa Rica on 10 ha farms (4 ha pastures, 1.3 ha crops and 4.7 ha mountain area) managed to intensify dairy production through credit for pasture management and crossbred cattle, and came close to the Turrialba performance in increasing milk production per ha pasture from 600 to 9,400 kg milk (Villegas, 1992).

The large variation in milk production per ha depends not only on type of pasture and climate, but more so on fertilization levels, stocking rates, type of cattle and number of followers kept, and especially, supplementary feeding in the form of off-farm feeds that can be concentrates, but also in small farms the amount of off-farm roughage collected.

Milk production per manday

Milk produced per manday in the early 1980s varied in Kenya from 6 kg under grazing conditions to 34 kg under zero-grazing and in Sri Lanka from 4 kg with grazing under coconut palms to 21 kg in intensive zero-grazing. In South America, it varied from 18 to 132 kg, the latter with some mechanization in the form of machine milking and silage preparation. In the Netherlands from 1940 to 1994 milk production per manday increased through mechanization from about 40 to 1,500 kg. In New Zealand milk produced per manday amounted to about 900 kg in 1985.

In the Pasto project, Colombia annually 37 mandays per cow were required under the traditional tethering system and 32 under the recommended rotational or strip grazing. Milk production per manday increased, because of more intensive pasture management (fertilization) from 32 kg (tethering) via 59 kg (rotational) to 79 kg (strip grazing) (Meindertsma, 1981).

In Sri Lanka at the MLDC units with grass grown between crops, milk production per manday varied from 11 (1 cow-unit) to 27 kg (3 cow-unit), showing a positive effect of larger units on labour productivity on self-contained farms. Houterman (1989) found in tea estates in the Mid Country with off-farm fodder resources a daily labour requirement of about 6 hours per cow in the wet season that increased to about 10 hours in the dry season mainly due to additional time in roughage cutting and transport and some in water fetching. Milk production per manday came to about 5 kg. In East Java, milk produced per manday that included in part off-farm roughage collection, was 12.3 litres in the sugar cane area, 12.8 in the cassava area and 15.8 in the vegetable area for average cow-units of 2.15, 2.52 and 2.26, respectively.

In Kenya in the late seventies labour requirements were estimated at 725, 666 and 607 hours per cow or in total 1.1, 1.5 and 1.8 man equivalents for 2, 3 and 4 cow-units. In 1982 and 1983 in average 3.1 man equivalents were found on NDDP demonstration farms with an average labour requirement of 685 hours per cow (Nkanata *et al.*, 1983; PANAFCON, 1994). Reductions of labour in zero grazing have been attended to in Tanga (light plastic wheel barrows) and in Kenya (donkey transport) but no quantitative labour savings were reported. Maarse (1995) indicated from a NDDP survey with 604 respondents that zero grazing meant less work (12% for male and 3% for female farmers) and more leisure time (28% for males and 16% for females) and more work (18% for males and 26% for females) and less leisure time (18% for males and 16% for females).

Milk production per manday is low on smallholder farms, because of relative high labour inputs in tethering, herding small numbers, and especially zero grazing with (off-farm) feed and water collection. Improvement was possible through more intensive grassland management in Pasto, Nariño, but in other projects little quantitative information was available on effects of labour-saving methods and/or higher increases in milk production compared to labour requirements. Hardly any appropriate mechanization has been developed in view of relatively high costs for a few cows on smallholder farms.

Economic productivity

Milk produced per US$ 1,000 investment varied considerably among countries in different geographical regions and among farming systems, e.g. in Kenya (488-2,730 kg), Sri Lanka (1,007-9,125 kg) and South America (260-631 kg) during the early 1980s (Chapter 1.4). The lower values in South America are associated with a higher degree of mechanization. In the Netherlands, investment costs per cow of Dfl 11,500 (in case of farm expansion) to 30,000 (a new farm, including land and milk quota) and average milk yields of 7,000 kg indicate about 1,000 and 230 kg milk per US$ 1,000 investment, respectively.

Economics of milk production (including fixed costs) showed higher cost prices for milk than the actual producer milk price received in the Netherlands. Family farms survive by accepting lower remuneration for their labour compared to other sectors in the economy. Gross margins varied strongly among dairy regions and farming styles in more or less homogeneous dairy regions of the Netherlands. Large standard deviations or ranges within a farming style indicate even more differences due to individual dairy farm management.

In Sri Lanka, return to labour was below the minimum wage in most dairy systems during the 1980s, when fixed costs were taken into account, except where milk was marketed directly between producers and consumers. In East Java, average returns to labour in 1990 at about 1 US$ per day for dairying were equal to those of unskilled labour, which is low for an complicated and risky enterprise (Widodo *et al.*, 1994b).

Returns to labour in dairy projects in Kenya, Tanzania, Colombia and Ecuador were higher than the minimum wage, but most data refer to gross margins that did not include fixed costs in the absence of systematic collection of investment details (except for Colombia). On the other hand, the more regular income from dairy compared to crops makes it attractive to smallholders, especially for those that can invest in a dairy cow or are supplied with one through support schemes. Also in areas with high risks of crop failure and fluctuating prices, cattle will still produce milk providing a guaranteed and more regular income.

The high requirements in investment and labour in dairy farming and the low financial returns limit the number of cows kept per smallholder, but favours expansion to smallholders that have sufficient fodder resources and family labour and are able to arrange for the necessary simple buildings and a few dairy cattle.

Producer milk prices

Producer milk prices in the world in 1990 showed large differences among countries, ranging from US$ 0.15 per litre in New Zealand and Uruguay, both pasture-based systems on low-cost land to US$ 0.75 in Switzerland with an over-valued Swiss franc, and where most milk is being converted into luxury milk products in small processing plants. Within countries large price differences were observed for seasonal rural, distant surplus milk (low prices), milk delivered to collection centres, and milk delivered directly to urban consumers (high prices). In addition, there are special prices for consumption milk, e.g. winter milk prices in the Netherlands, town supply milk prices in Oceania, and premiums in the USA that increase with the distance from Wisconsin the oldest dairy region in the USA. Long-term milk price development for producers and consumers are combined in Table 11.4 for Indonesia, Sri Lanka (Chapter 4) and Ecuador (Chapter 6).

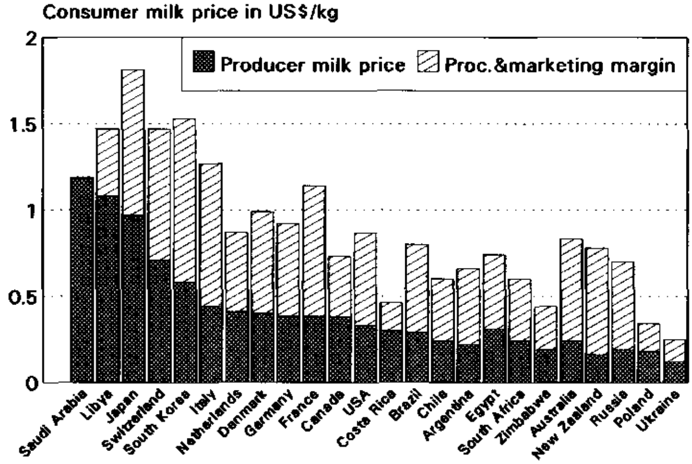
In Indonesia, government raised the producer milk price considerably in 1980 when it wanted to increase employment and income in the rural area through milk production from imported cows. The cooperative movement was strengthened and tripartite price negotiations (government, producer cooperatives, and private milk processing sector) were held twice a year with a favourable outcome for the producer in the 1980s. The consumer price increased faster in that period in favour of the private processing sector and resulted in a reducing share of the producer in the consumer price in the absence of a strong cooperative milk processing sector. In Sri Lanka the new government in 1978 increased the producer price drastically from 1.60 to 2.21 Rs/l, but subsequent increases lagged behind the general consumer price index. Privatization of the milk industry in the 1980s did not result in a higher producer share in the consumer price. In Ecuador, the producer and consumer price for milk increased much less than the consumer price index for foods and drinks. The producer price increased faster than the consumer price through allowances of milk powder imports and keeping the margins tight for the processing industry.

Table 11.4. Development of price levels (1980=100) and the proportion of the farm-gate price of the consumer price of pasteurized milk in Indonesia, Sri Lanka and Ecuador.

Country/ year	General consumer price level 1980=100	Milk prices farm-gate price 1980=100	Milk prices consumer price 1980=100	Proportion farm-gate price/ consumer price (%)
Indonesia				
1977	67	33	50	33
1980	100	100	100	50
1983	137	143	167	43
1987	184	200	313	32
1990	227	222	500	22
Sri Lanka				
1978	71	100	70	79
1980	100	100	100	55
1983	149	145	149	55
1987	205	195	208	52
1990	315	300	315	53
Ecuador				
1980	100	100	100	51
1983	232	210	154	69
1987	657	564	489	59
1990	2,995	2,441	1,953	64
1993	9,716	8,510	6,975	62

In 1995, producer milk prices and consumer prices for whole milk in different countries were collected by Dutch Agricultural Councillors for the Dutch Dairy Commodity Board (PZ, 1996). Details for some selected countries are presented in Figure 11.1.

In Saudi Arabia, large-scale dairy complexes have the highest producer milk price since production, processing and marketing are in one hand. Japan has the highest consumer milk prices, based on large private sector milk processing companies and the absence of a sizeable cooperative dairy industry. In Europe, Dutch producers with a large cooperative milk industry receive the largest proportion of the consumer price. In the USA with mainly private sector milk processing, the producer share is less. In South America producers receive less than half of the consumer price, except in Costa Rica with a large, strong cooperative dairy industry and low consumer prices for whole milk. New Zealand and Australian milk producers receive on average the lowest share of the consumer price, since most milk is exported and only a small portion is consumed for which town milk producers receive a higher milk price. The low producer and consumer prices in the former USSR are caused by the low US$ value of their currencies.



Source: PZ (1996)

Fig. 11.1. *Producer milk prices (3.7% fat), margins for processing/distribution, and consumer prices for whole milk in selected countries as reported by Dutch Agricultural Counsellors in 1995.*

(Peri)urban versus rural milk production

The high price received by (peri)urban farmers in direct milk sales to urban consumers stimulates urban and peri-urban dairy systems. Access to inputs and veterinary services is generally easier and at lower costs, although roughage supply may be costly. Generally, these systems are managed by producers that possess sufficient economic resources and are motivated to increase their income. To some extent also poor households are managing such units to find additional means of income for survival (Langelaar, 1995) and/or benefit from employment opportunities.

From a dairy husbandry point of view, (peri)urban dairying often purchases good dairy stock from rural areas and concentrates on milking with little attention for reproduction and calf rearing. In India, this leads to high losses of scarce high potential dairy stock (Banerjee, 1994). In Tanzania, the majority of scarce crossbred in-calf heifers are purchased by urban people, except where foreign-supported projects manage to negotiate with government that most in-calf heifers will be taken up for local dairy development first. Mulangi *et al.* (1995) evaluated the performance of dairy cattle in Tanga and Dar es Salaam in Tanzania over 5 years (1989-1993) and found a moderate calf mortality of 9.9%, possibly because of high scarcity of dairy stock in both rural and urban areas. Land holdings averaged 6 ha, herd average was 5.3 dairy cattle and family-size 10.8 persons. The proportion of farmers that hired labour was 64% for milking and 69% for dung removal.

Debates circle also on pollution dangers of urine and manure disposal, as well as on the health risks of distributing unprocessed and unchecked milk directly to consumers. Customary boiling of the milk after reception will kill most of the pathogenic bacteria such as coli and salmonella, but transmission of zoonoses such as tuberculosis and brucellosis still remains a problem when milk is not properly processed. Legally, most countries insist on milk processing for consumers but in practice little or no control is exercised.

In rural areas, dispersed dairy cattle keeping can also result in a good milk price from local demand, but it is costly in extension and veterinary services, supply of inputs and veterinary medicines. Effective local demand in Arusha and Kilimanjaro regions caused that increased milk production was kept in the areas, and that the project objective, to increase milk supply to towns, was not met (Laurent and Centres, 1990).

A rural cluster approach in introduction dairy cattle and guidance of aspiring dairy producers may reduce the cost of extension, input supplies and veterinary services but it easily runs into marketing problems that may require small-scale processing to reduce the transport cost and to reach a more remunerative market.

Whereas most donors favour to attend the poorer section of the society, where prospects for dairying per km^2 are less favourable, problems may occur in the allocation of scarce counterpart personnel and funds. Considerably more technical and financial support will be required for investment in cattle, input supply and services for milk production, processing and marketing with smallholders in the rural area than for (peri) urban dairying. On the other hand producer milk prices in (peri) urban area are indicative for the level required in rural areas to trigger off a more entrepreneur type of smallholder dairy farming.

Economic environment and dairy policies

Detailed information on how different countries have organized their dairy development, what it costs and who pays for it, is difficult to come by in literature and hardly or not accessible for exchange among developing countries. The Organization for Economic and Community Development (OECD) reported (in: FAO, 1995) nominal assistance rates in agricultural support to producers in 1988 and 1993 (provisional) for Japan (3.10 and 2.93 times the border price), EC-12 (1.84 and 1.93), USA (1.29 and 1.29), Canada (1.51 and 1.40) Australia (1.08 and 1.10) and New Zealand (1.07 and 1.03). Total OECD producer support over the period increased from US$ 130.2 to 139.3 billion, and the consumer subsidy equivalent increased from US$ 99.9 to 106.6 billion. Important reforms in agriculture, in combination with the Uruguay Round Agreement on Agriculture, point to reduced direct market support in favour of alternative means of supporting farm and rural incomes, mainly payments per ha. In fact, real producer prices for milk (1988 = 100) have already decreased in 1993 to 82 in the EC-12, 87 in the USA, 92 in New Zealand, 93 in Japan and 96 in Canada, but remained at 100 in Australia.

Governments in developing countries soliciting aid or loans are provided with planners and economists that advocate structural adjustments programmes and liberalized markets of inputs and outputs, even in agriculture, although most of them are coming from countries with high protection rates of food production and agricultural exports. Dairy development assistance is, more often than not, requested and provided in technical assistance terms to improve local milk production through increased yields at reduced costs. However, such endeavour oriented to economies of scale requires considerable investments in farm lay-out, livestock, mechanization or employed labour inputs (both very expensive in foreign exchange or risky through labour strikes) for which generally no remunerative price environment exists except in rich countries, where producer protection and/or investment facilities are granted.

Over time, producers in developed countries have managed, through civil leaders interested in agriculture and farmers organizations, to obtain support for the sector in terms of agricultural education, research and extension to improve agricultural productivity per hectare and per person. Cost price calculations for agricultural products were used to arrive at price agreements such as guaranteed producer orientation prices, set minimum consumer prices, a set of intervention prices to prevent cheap imports or import quota, and support for export of surplus agricultural products in a low priced world market, etc.

On the other hand, producers in developing countries are more at the mercy of governments that prefer to keep prices down for agricultural products to suit consumers in the urban and industrial sectors, and farmers organizations are generally weak and hardly represented or attended at national level.

In Latin America, producers and especially the large-scale ones organized in livestock associations appear better able to put more producer influence on government policy. This was the case with FEDECOLECHE in Colombia in the 1980s and especially with AGSO in Ecuador in the 1990s, that convinced the government to abolish fixation of consumer prices and to introduce a border price of US$ 2,500 per ton imported milk powder, which proved to stimulate local milk production (Chapter 6). Another promotion of the producer's role in dairy development occurred in Argentina through the enactment of the law on dairying by establishing a Commission on Coordination of Dairy Policy, which will fix a minimum milk price, advice on dairy policy, and manage the Fund for Promotion of Dairy Activity (administering private funds for dairy export promotion) (Zavalia, 1991). Kenya freed the official consumer prices in 1992 and installed a flexible levy regime to avoid that subsidized world market dairy products would harm local production (Bartilol, 1994).

In contrast, small producer cooperatives in Sri Lanka, although willingly received by the Minister for Milk Production and Livestock Development to attend to their justifiable cries for a more remunerative producer milk price, were unable to negotiate price improvements at government level in the early nineties. As a result of insufficient upliftment of the producer milk price, Dutch support to the Small Farmer Dairy project was withdrawn by mid 1991 after a project review (Soree and Zijderveld, 1991). Ironically, Sri Lanka has increased per January 1996 the producer milk price with a subsidy of 6 Rs (from 12 to 18 Rs or 0.25 to 0.38 US$) per litre milk of 4.5% butter fat at the collection/chilling centre as an accompanying move to privatize the 33 farms of the National Livestock Development Board in joint ventures with foreign investors.

Dairy producer cooperatives in Kenya, e.g. Meru and Kitinda managed to obtain donated "Elecster" milk plants and initial technical assistance in milk collection, transport, processing and marketing, but throughput has hardly increased after the initial FINNIDA support (Bartilol, 1994).

Dairy producer cooperatives in India received long-term food aid assistance under Operation Flood for setting up a cooperative dairy industry including technical services and input supplies. Through the applied funding scheme (70% loan and 30% grant) large parts of monetized food aid are still revolving for investment in the cooperative sector. Dairy producer cooperatives in Indonesia benefitted from producer-friendly bi-annual tripartite producer milk price reviews in the 1980s, and from subsidized wheat pollard in producing concentrates, but are also overburdened in recovering long-term loans from imported cattle.

Centrally planned economies paid incentive producer prices to state farms (Cuba, China) or export price support (former USSR and Eastern European countries) and subsidized consumers through social welfare programmes.

Subsidies versus other incentives

A hot issue in the discussion on dairy development is that on subsidies and other incentives. Generally, in industrialized dairy countries research, education and extension in agriculture were government funded as incentives to produce milk at lower cost. Credit is generally supplied at real terms, but a lot on-farm investment is governed by tax-facilities such as fast depreciation rates before tax, and investment subsidies to encourage energy saving, nature conservation and less environmental pollution, and incentive premiums for diverting from dairying into nursing cows for beef production or ewes for mutton production. Veterinary services include private practises and government funded animal health programmes of national importance (control of notifiable diseases, veterinary public health, meat inspection). Farmers pay for vaccine costs and general animal health control.

To match supply with effective demand, export restitutions in the EU are given for sale of livestock products outside the EU. In the USA there is no mention of subsidies but for export of milk products a Dairy Incentive Export Programme exists whereby the difference between the costs and what the market can pay, can be negotiated for compensation. In both the EU and the USA, discussions are ongoing to reduce the level of market price support to producers in exchange for income support per ha.

Generally, extension and veterinary services in developing dairy countries have been provided free of charge and as such contributed to increased production during the time that sufficient funds were available. At present, under the Structural Adjustment Programmes, governments are forced to reduce staff and try to encourage the private sector. Current staff is allowed to retire with one-time high costs of retirement benefits, while for younger staff arrangements are encouraged to be paid gradually by the agricultural sector itself.

(Para)statal production units such as heifer breeding and livestock multiplication units, vaccine units, distribution of veterinary and agro-chemicals supplies, and even research and training institutes and farms are increasingly privatized to reduce government spending and losses to free funds for new investments and running costs of essential government tasks.

However, without incentives it is very difficult to produce show pieces in technology and economy in dairying. Many (para) statal farms have therefore little to show that is technically or economically better than what can be done on private farms. Usually, visitors will only see the technical breakdowns due to reduced funds for investment and operating costs. In contrast, at the MLDC, Sri Lanka incentives based on monthly gross margin, paid to the unit manager, produced a good integrated performance of crop-livestock activities with yields above those of the rural smallholder. These incentives were sufficient to pay for the family labour contribution in the 0.4 and 0.8 ha farm, but not completely for the 0.2 ha farm that had the most intensive combination of vegetables, bananas and tree crops with cattle, goats, poultry and rabbits. Training and demonstration units in other projects, operating on government salaries only, find it much more difficult to operate such demonstrations and achieving technical performances worth showing to smallholders.

Supply of inputs and veterinary services

Governments are increasingly pressing for full cost recovery of inputs and privatization of services. Medium and large-scale dairy farm operators are increasingly prepared to do so, as shown in the case of PRODELESTE in the Dominican Republic where FEDEGARE operated the input supply shops and deducted the cost of the technical extension teams (20% in year 1 up to 100% in year 5) from the margin obtained from input sales. The technical extension teams of ICA in the Pasto project in Colombia were transferred to local government (municipalities) and the input shops and services went to COOPROLACTEOS, which increased its number of technicians over time and paid them from the general proceeds of the cooperative.

In the Model integrated dairy development project in Ecuador, farmers paid for inputs and veterinary medicines, but sharing in the cost of personnel and transport still has to materialize.

For large farmers, the government has negotiated agreements with AGSO for a number of veterinary officers that gradually will be paid for by AGSO, and AGSO has started charging farmers for its services.

In Indonesia, dairy cooperatives increasingly employ their own technical staff from funds deducted from the milk price. In Sri Lanka, dairy cooperatives set up under the Dairy Development Project of the National Livestock Development Board were supposed to take over the technical staff (livestock development officer with livestock development assistants) gradually over a period of 5 years (1989-1993). In practise they opted for cheaper staff, from the cooperative areas, but uncertainty of permanent employment (the provincial department of cooperatives refused the young cooperatives permanent cadre for fear of high labour costs later on) made that most of them went to "greener pastures" in the Middle East.

In Kagera region, following the recommendations of the 1993 joint Tanzania-Netherlands evaluation mission (Zijderveld *et al.*, 1993) extension activities will remain with the government and the more commercial activities (heifer breeding, HIT scheme, input supply, AI, milk and meat processing and marketing) will be transferred gradually to livestock associations and cooperatives that are capable of doing so (KALIDEP, 1995).

Similarly in Tanga region, producer associations are increasingly taking over production and distribution activities of the Tanga Smallholder Dairy Development Programme (Sudi *et al.*, 1991).

Effective government support

Examples of government support that triggered dairy development in developing countries are Cuba and China which availed investment funds for dairying (first mainly on state farms, later on also on collective and private farms), but above all a remunerative producer price based on cost calculations and allowing a profit margin. Consumers were assisted through social welfare programmes in Cuba providing children, workers, elderly people, expectant and nursing mothers with rations of subsidized milk. In China, dairy farming from 1980-1992 was made attractive through investment support and concentrate subsidies, while children, expectant and nursing mothers and special service groups received cheap rations of milk.

In India, some states created more remunerative rural producers' milk prices, especially for cattle milk in Maharasthra and Kerala, than prevailed in the rest of India. As a result Maharasthra, previously being a milk-deficit state, produced surpluses. The government, committed at the same time to make milk available to urban consumers, particularly the weaker sections at a price they could afford, subsidized this group (Fera, 1986). In Kerala, a large-scale cattle crossbreeding programme could flourish from 1963 to 1990 from crossbreds that produced earlier and more economically than nondescript cattle at favourable cow milk prices (Nair, 1981; Schneider, 1990) and per capita milk availability increased from 30 in 1963 to 140 g/d in 1988. Kenya started a government funded school milk programme in 1980, that created an additional market for milk, and conducted regular price reviews to suit dairy farming.

In Ecuador, the government in the early 1990s liberalized the consumer price and installed a border price for imported milk powder at US$ 2,500 per ton in 1993. Subsequently, milk production increased rapidly thereafter, allowing for the first time a rise in milk availability from 80 to 101 kg per capita, and a sharp reduction in imports.

Major improvements in local dairy production were stimulated more by producer-friendly policies of price and investment support, than from economizing on costs through technology developments as often solicited by most governments. Cost effectiveness and long-term sustainability of government support are questioned both in industrialized and developing countries as well as centrally planned economies, and the outcome will depend on how important *societies view, how rural communities will perform in future.*

Successful attempts in privatization of input supply and services were observed in the area of inputs by producer cooperatives (COOPROLACTEOS in Nariño, Colombia and FEDAGARE in the Dominican Republic, the Federation, Union and Village Dairy Cooperatives in India, Dairy Cooperatives in Indonesia and Sri Lanka and in an increasing number of producer associations in the Tanga and Kagera regions in Tanzania).

For transfer of technical services, especially smaller groups will need more time and support in technical, economic and organizational terms to benefit in the long run from more economies of scale.

Poverty alleviation

The second objective of this thesis was to answer the question "what can be done for smallholders to transform them from subsistence farming or agricultural labour to dairy farming entrepreneurs". Agricultural credit has been used or earmarked to initiate and/or stimulate dairy farming. Credits at interest rates lower than the annual inflation rate have been popular in Latin America and large sums were taken up by large farmers with often poor repayments, causing the bankruptcy of many rural agricultural credit systems (De Haan, 1992). Special credit lines were negotiated for smallholders using selection criteria as maximum landownership (< 10 ha) and a major share of income out of agriculture (> 70%) under the integrated rural development programmes (DRI) in smallholder areas with technical extension support of the Ministry of Agriculture (Colombia), and repayment rates varied between 90-100%. WFP support in Latin America also facilitated credit components to smallholder dairy development (Bolivia, Nicaragua, Cuba, Guyana and Colombia). In Kenya, only 7% of 202 farmer families surveyed in 1994 in the NDDP had received a formal AFC (Agricultural Finance Corporation) loan for starting zero-grazing against 'use of savings' and 'sale of assets' as the most frequently used sources of funding. Another 20% had access to funds of 'NGO/Minister/Project' or self-help groups (Maarse, 1995). In smallholder dairy projects in Tanzania hardly any bank credit was used because of high interest rates and lack of dairy stock. In Kagera and Tanga, main supply of stock is through heifers in trust. The Swiss supported Smallholder programme for Mbeya/Iringa also has shifted to HIT supplies to reach poorer farmers.

The Integrated Rural Development Programme (IRDP) in India is the single largest antipoverty programme under way in all the 5,011 community development blocks in India. The milk animal programme (up to 50% subsidies on loans for milk animal procurement) is a major component, employing the cluster approach for selecting villages, the antyidaya (the poorest of the poor) approach for selection of beneficiaries, e.g. small and marginal farmers, agricultural and non-agricultural labourers, rural artisans and craftsmen, including scheduled castes and tribes families who are below the poverty line (CEC/WB, 1986).

Heifer-in-Trust schemes funded by Heifer Project International and by WFP funds support the supply of in-calf heifers to groups of poor people, eliminating interest and capital repayment in cash under conditions that first female offsprings are passed on when diagnosed in-calf to the next beneficiary. Although these revolving livestock schemes can support very much the poor sections of society (rural farmers, women), since no collateral is required, it requires initial funds and a strict follow-up in selection of beneficiaries, training, extension, input supply and supervision on passing on the gift. Pass-on rates reviewed in Tanzania indicated a 62.5% pass-on in 4 years in KALIDEP. At this rate, it required 8 years to double the number of participating farmers. Pelant (1992) quoting from HPI experience worldwide indicated an actual pass-on rate of 40% in two years, 60-65% in 40 months, and a 75-80% in 6.5 to 7 years from the original distribution.

Dairy experiences of lending agencies and international organizations

Experiences of lending agencies and international programmes (Chapter 3) in dairy development indicated that capital investments (farm structures, cattle purchases, especially imported exotic stock, and milk plants) in the (para)statal sector were little successful, except in central planned economies of Eastern Europe, China and Cuba with well-disciplined management and as long as government supported in investment and price policies. In other countries, parastatal farm management was poor and/or government interference not supportive in creating a remunerative producer price environment. Smallholder dairy projects did better when milk was sold direct to the consumer without expensive processing and distribution. Extensive dairy food aid programmes in India and China have shown what was possible when generated funds from food aid were used intelligently for local dairy development.

Dutch supported dairy development programmes

Dutch supported dairy development programmes and projects (Chapters 4-9) are generally aimed at training, extension and technical issues (housing, feeding, breeding, disease control, applied research) and sometimes milk collection, processing and marketing. Support is limited to specific locations (area, district, province) or target groups such as (para)statals, smallholders or pastoralists. Introduction of more productive dairy farming takes time in preparing better animal housing (cubicles in Africa, stalls in Sri Lanka and Indonesia) and feed (Napier grass, grass/legumes, fodder trees) and obtaining a better animal to benefit from farm improvements. Training and guidance of smallholders has been intensive in farmer and farm development to arrive at lower animal mortalities and higher milk yields. Expansion of these schemes has been slow because of small numbers of improved stock being available from parastatal heifer-breeding units, private farms and within the smallholder sector to start zero grazing for increased marketable production of milk.

Horizontally integrated dairy development

Horizontal integration of dairy farming in small mixed farms in the highlands of South America (Chapter 5) required a team approach of animal and crop husbandry staff, economist and communicator to investigate the possibilities of improved arable farming and livestock keeping. For the crop sector in Nariño, Colombia, difficulties were experienced in finding attractive cash crops for smallholders, which can not easily be taken over by large-scale farmers. Dairy cattle on improved grassland in rotation with cash crops such as potatoes proved attractive in terms of mutual savings on fertilization. Crops benefit from the nitrogen build-up in grass, while grass after potatoes benefits from residual effects of basic fertilization of calcium and phosphorus. The introduction of fruit trees as a short-term alternative to long-term wood/timber trees for income generation and combating soil erosion was practised on-station and on-farm to find quickly suitable niches for local and exotic fruit shrubs and trees. Looking into other livestock species than dairy resulted in attention to guinea pigs that were a profitable undertaking for smallholders' wives and daughters, while more commercial production of pigs, poultry and rabbits in rural areas was not attractive.

In the model project for integrated dairy development (Cañar, Ecuador, Chapter 6) milk production on smallholder mixed farms was increased through improved cow and grassland management. Grasslands were improved through establishment of a mixture of improved grass-legume species (differentiating early and late producing, drought and frost resistant species) on well-prepared seedbeds. However, this introduction had to be done after share-cropping of cash crops (mainly potatoes) between the project (providing the external inputs) and beneficiaries (providing land and labour) in order to gain smallholders' trust in new technology. No arable cropping was supported on steep hill slopes, while arable crops in moderately undulating terrains were only encouraged in 25 m wide strips between grass areas, following the contour lines, to prevent erosion.

In Sri Lanka crop-livestock integration was studied on the basis of an intensive technical and economic data collection in three training cum demonstration farms (Chapter 7) on abandoned, marginal land. Dairy cows and goats proved to be attractive cash earners with a high labour productivity but also a high capital requirement, while manure to improve soil fertility and biogas to replace domestic fuel were important side benefits. Poultry did little to improve farm income, because of large fluctuations in product prices. Intensive cropping of vegetables, bananas, coffee, pepper and tree crops absorbed much family labour, but required a good market and price, enough water, and protection from wild boars. In a 1993 field study of 76 settlers on marginal tea lands that received in the period 1984-1990an in-calf heifer on interest-free loans, as well as building materials for the cattle shed, and planting materials for integrated crop/livestock farming, revealed that milk production proved attractive for farm and family gross margin, land improvement (mentioned by 64% of the farmers) and livestock sales, while crops so far contributed mainly to subsistence food and some money generation (vegetables and perennials). In addition to farm gross margin (US$ 16) and off-farm income (US$ 17), farmers still depended on Government food support to balance their average monthly needs of about 40 US$. Significant differences in farm gross margin were found among areas, favouring the beneficiaries of the pilot area and the ones with tradition in vegetable growing. Milk sales determined largely farm gross margin, while farmers that obtained more female offspring from the supplied animal had more possibilities to expand or to select from offspring, that resulted in a higher farm gross margin than those with more male offspring.

Horizontal integration of farming (livestock, crops, horticulture, trees) in rural development requires the participation of many disciplines and actors to analyze the constraints and opportunities of the farming system (soil, water, climate, production systems and family conditions) and off-farm activities, and to develop various packages suitable for varied rural farming and family conditions.

Vertically integrated dairy development

Vertical integration, comprising milk production, collection, processing and marketing (Chapter 6) in the surplus milk production area itself (Nariño in South Colombia and Cañar in Ecuador) showed the problems associated with starting a cooperative or producer groups with strong competition from other economically more powerful buyers.

In Colombia, a step-by-step approach was followed for COOPROLACTEOS in financing such a venture, after a Dutch financial loan was impossible to canalize in the absence of 50% equity by the cooperative and that missed favourable terms, because of the obligation of repayment in foreign exchange. Self-help contributions in the form of land and buildings, complemented with firstly donated equipment, followed by small interest-free loans of the Dutch government resulted in the slow but certain build-up of technical and financial management qualities and equity funds to attract commercial loans. Market outlets to regional towns and especially metropolitan towns outside the milk-surplus region for cooled raw milk, cheese and pasteurized milk had to be conquered. Joint cooperative battles at national level succeeded slowly by slowly to achieve a producers' say in milk pricing and regulation of import of low-priced milk powder.

Vertically integrated collection, processing and marketing of milk by producer groups in Cañar, Ecuador is still little developed amidst the many private milk plants owned by large-scale producers and companies. In 1994 two communities operated local cheese plants and seven communities operated collection/chilling centres (all under a holding contract with the project), that supported them in negotiating a higher milk price. Rural cheese plants in Peru and Ecuador, supported by the Swiss Technical Cooperation, supported distant rural producers in obtaining a market for their milk. In Bolivia, dairy development modules, i.e. farmers organizations that operated milk collection centres and input stores, are expected to take over the parastatal dairy industry in the near future.

In Kenya, the Dutch supported NDDP assisted the production side, while FINNIDA under the Rural Development Project, supported the Meru Central Farmers' Cooperative Union from 1982-1985, provided a "Elecster" milk sterilization plant (cap. 20,000 l/d), bulk coolers, lorries and technical assistance personnel and the Union modified the dairy buildings (FINNAGRO, 1985). During the first two years the Meru plant processed 4 million litres (about 5,500 l/d). Constraints during this first phase were lack of counterparts and middle cadre staff, and selling cooled milk on their own by dairy societies, and the dairy plant had to operate on fluctuating surplus milk. Marketing for the Kenya School Milk Programme did not start in the initial years, causing that part of the milk had to be supplied to the nearest KCC centre. A similar project was launched in the early 1980s in Kitinda Dairy Farmers Cooperative Society (established in 1957) also with support of FINNIDA (Tribe, 1989). Actual processing in 1992 amounted to 4 million litres in the Meru plant and 3 million litres in the Kitinda plant (Bartilol, 1994). Major reasons, that cooperatives had not gone into processing in Kenya included (i) lack of liquidity, (ii) weak management, (iii) small size of cooperatives and (iv) strong KCC competition in milk producing zones and lucrative urban markets (Bartilol, 1994).

In Tanzania, KALIDEP supports milk processing in farmers groups in distant rural areas with cheese making, and marketing of surplus liquid milk in and around Bukoba town towards Mwanza by boat. Surplus milk produced in Tanga region is sent by road with project support to Dar es Salaam, and efforts are made to take over viable parts of the Tanga milk plant by the dairy producer associations.

In Sri Lanka, support of small-scale processing (yoghurt) and marketing to schools was supported in large DPAs and in the Mid Country Milk Producers Union under the Small Holder Dairy Development Project (1985-1989). More intensive try-outs were contemplated under the Small Farmer Dairy Project for MIDCOMUL and the Coconut Triangle Milk Producers Union (CTMU), but Dutch support came to a halt with the closure of the project in mid 1991. Milk processing and marketing in MIDCOMUL remained a very small operation, because an earlier promise of handing over a chilling centre to the union did not materialize. CTMU that operated a chilling centre since 1979 and started small-scale processing in 1982, collected in August 1993 7,500 litres of milk per day and processed daily around 2,500 litres (500 litres buffalo milk into curd, 1,000 litres into flavoured yoghurt, 1,000 litres into vanilla and chocolate milk, and some ghee and milk toffees) for marketing through a large number of small selling points/shops all over the Coconut Triangle. A smaller-mini-dairy is operated by a dairy producers cooperative of newly settled farmers in system C of the Mahaweli project, and processes about 1,000 litres per day of the same produce mix, that is marketed locally with surpluses going to Kandy.

In India, large-scale support of food aid from WFP and EC (worth about 600 million ECU) under powerful technical leadership of the National Dairy Development Board and financial leadership of the India Dairy Corporation, managed to install a large, producer-based cooperative network of VMPCs, Unions and Federations with milk plants, feed plants, molasses-urea-mineral block producing units, veterinary supplies and a large network of milk transport and communication to supply rural milk of some 8 million producers to rural and urban consumers.

Vertical integration of dairy farming (input supply, milk production, processing and marketing) in rural development requires strong commitment of producers in milk quantity and *quality, high quality technical, commercial and administrative management and leadership to organize funding, technology and marketing. A step-by-step approach to test producers and management attitudes is recommended with long-term advise and support in technical, economic and organizational matters.*

Dairy stock development

A third objective of this thesis was to examine "can smallholders be motivated to raise their own calves and heifers to generate sufficient stock for replacement and supply to other farmers".

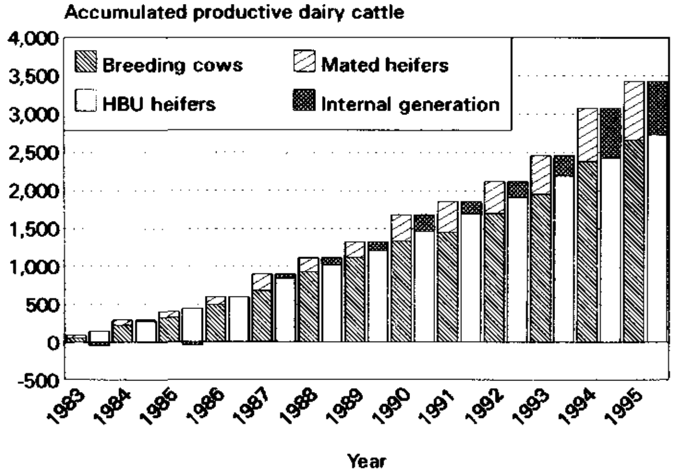
In temperate areas, farmers tended to go for the larger animals (Holstein Friesians), better calf rearing and raising of heifers, both resulting in higher liveweight and lower age at first calving, followed by higher first lactation and lifetime milk yields (Chapter 2).

In developing countries crossbreeding is used to reduce the age at first calving and to increase milk yields. Calf mortalities, in the tropics between 10-45%, are much higher than the 7-16% in temperate areas, leaving less room for selection of replacement stock. Imported exotic stock did not even produce sufficient offspring in the tropics to replace their dams, while locally born pure dairy breeds just managed to produce an in-calf heifer for replacing the dam.

Approaches to dairy stock development (Chapters 2 and 9) showed a poor record for import of exotic stock in developing countries in the tropics with insufficient funds for feed and management arrangements. In other tropical countries with sufficient capital and work funds (oil countries, Japan, South Korea), imported cattle, feeds, machinery and management, performances were comparable to achievements in warm environments (South USA, Israel) in industrialized countries. The major question related to imported exotic cattle is therefore either matching farming standards (capital, land, personnel, feed, mechanization and especially management and operating facilities) that fit imported cattle under difficult circumstances (Van Velzen, 1988) or matching cattle to existing resources (Preston, 1986). Various authors (Menzi *et al.*, 1982; Khan, 1990; Ibrahim *et al.*, 1991) noted that the genetic potential of pure exotic stock is not physically expressed to its full extent under the tropical conditions. This indicated the existence of genotype/environment interactions. Even keeping the import stress to a minimum by timing early pregnancy and shipment of animals in the most favourable season did not eliminate the requirement for a long-term adaptation process. Adaptation is a two-way process: animals become slowly adapted to the new environment, but the environment (management) also has to be adapted to the new animals (Menzi *et al.*, 1982).

Multiplication of breeding stock at (para)statal farms can be disappointing with low calving rates, high calf mortality and high ages at first calving, which increases the need for own herd replacements. In Sri Lanka the production of breeding stock (both male and female) for sale over 1980-1993 came to annually 7% for cattle and 7.5% for buffaloes of average stock present or about 10% heifers per neat cow and 8.5% per buffalo cow. The turn-out of large-scale heifer breeding units may also be constrained by low conception rates of AI or exotic bulls on indigenous cows and high calf mortality as shown for Tanzania, resulting in about 100-125 saleable pregnant F1s per 1,000 breeding cows per year or 10-12.5% per cow. In order to keep the indigenous herd up to strength (some 1,700-2,000 Boran cows) annually about 100 head of additional indigenous breeding stock had to be brought in (Chande *et al.*, 1989) reducing effective in-calf heifer output to 5-6% per cow. Shaw and Hoste (1987) calculated on the basis of production parameters collected in Central and West Africa possible herd growth rates of trypanotolerant cattle (Ndama and Small West African Shorthorn) in village herds and in ranch/station herds. They arrived at potential surplus heifer production per breeding cow (%) in village cattle of 0.62 for the low set, 1.95 for the medium and 4.52 for the high set of production parameters (calving rate, mortality and age at first calving) and for ranch/station herds these figures amounted to 3.4, 5.1 and 11.1, respectively.

Production of dairy stock by smallholders requires high cattle prices to become an attractive investment. For KALIDEP, Tanzania this is illustrated in Figure 11.2.



Source: Chande et al. (1989) and KALIDEP (1995)

Fig. 11.2. *Development of numbers of productive stock (cows and mated heifers) by supply from the Kikulula heifer breeding unit and internal generation in the Kagera Livestock Development Programme (1983-1995).*

Internal generation of dairy stock amounted to 21 in-calf heifers per year (4% per cow) in addition to an annual input of 186 in-calf heifers from the Kikulula heifer breeding unit in the first 6.5 years (1983-1989) when heifer prices were kept low. Over the next 6 years (1989-1995), when heifer prices were gradually increased to commercial market prices, annually 100 in-calf heifers (5.2% per cow) were internally generated, on top of an annual supply of 234 in-calf heifers from Kikulula. Especially in 1994 and 1995 internal generation was increasing rapidly, facilitated by some incentive prices to local livestock associations and cooperatives for offering surplus breedable cattle to KALIDEP (KALIDEP, 1995).

Generally at smallholder level, calves and young stock are left to suck the dam before and after milking and receive little or no supplements. Pasture or fodder is often insufficient to grow them out properly and the ones that survive disease attacks (internal and external parasites) are small heifers with a high age at first calving. De Kroes (1988) found in Western province, Zambia for Barotse cattle a calf mortality of 19% in 1986 and 25% in 1987 when the dry season was longer. Growth in chest girth of calves in 1986 averaged 0.07 cm/d for 0-1 year olds and 0.05 cm/d in 1-2 year olds, with only 0.014 cm/d for 0-1 year olds in 1987. Luttikhuis and Van der Wilt (1989) surveyed calf rearing performance and feeding practices in South Gujarat, India and found growth effects for season (220 g/d in the dry season and 269 g/d in the wet season), sex (269 for females and 220 for males with crossbred and buffalo males being neglected) and farm (285 in small farms that fed more green fodder and 203 in large farms that offered large amounts of dry fodder). Romkema (1992) found in Kenya high incidences of gastrointestinal infections on irrigated calf paddocks on-station as well as on small farms that reduced growth rates especially after weaning. Growth checks could be improved by grazing on mown pasture (on-station) and by deworming (on-farm) but other factors, nutrition in particular, had to be studied in more detail to quantify long-term effects on growth and frequency and economics of control.

Moreover, for a smallholder it is difficult to keep track of his calf's performance. Growth changes are very difficult to observe compared to changes e.g. in daily milk yield of the dam. Training based only on how to feed and keep a calf (as in the first pilot project in Rikillagaskada) did not show results. Chest girth measurements as an indicator of growth recorded on growth curve charts proved much more effective as observed in the subsequent calf rearing target growth projects in Sri Lanka (Chapter 9).

Such "growth velocity" measures are not unfamiliar for people. It proved valuable in educating parents, for it increases their awareness of the nutritional needs of very young children and provides an easily understood signal that a faltering child needs special attention (Berg, 1987)

Milk or calves

Throughout pastoral Africa, calves and people compete for milk from lactating cows. Finding ways to supplement the nutrition of young calves is of utmost importance if the productivity of pastoral production systems is to be improved (Brumby, 1986). Some supplementation strategies have been tested during the calf's first year, but differences in weaning weight had disappeared at the age of three years on the fluctuating feed supply in the semi-arid region of Ethiopia (Coppock, 1989).

Most calves have little value at birth in the absence of markets for veal production such as in the Netherlands. Milk replacers, cheaper than cow milk, are hardly prepared in developing countries and imported products are relatively expensive and risky, if not properly reconstituted with clean, hot water. Most smallholders in developing countries use restricted suckling of calves with no special arrangements for supplementary feeds. Low-cost grazing on high quality pasture with low incidence of internal parasites, e.g. regrowth after mowing, as popular in summer time in the Netherlands, is hardly practised either. Therefore, smallholder calves are often exposed to poor quality forage and internal parasites after a period of limited milk supplies with little or no access to supplementary feeds after weaning, resulting in high death rates of 20-45%, slow growth and high ages at first calving.

In the FAO/France supported dairy development programme in the Arusha and Kilimanjaro regions of Tanzania, farm surveys indicated an average calf mortality of only 12%, but slow calf growth rate of 200 g/d with an average milk intake of only 200 kg of milk per calf without any supplementary concentrates before and after weaning at 5-8 months of age. A high age of 3 years at first calving and a long calving interval of 18 months caused an overall low supply of dairy heifers and a large call for import of additional stock to respond to demand for dairy stock (Laurent and Centres, 1990). Van der Valk (1992) mentioned that more attention to calf rearing in NDDP, Kenya was required, because 20% of the calves were found in poor to fair condition and only 17% received supplementary feed below the age of 6 months. Metz (1994) found in the same project from DEAF records in 1991 and 1992 that rearing inside with access to good quality fodder and water resulted in significantly higher condition scores than for calves reared outside or those with little access to good fodder and water. Most calves received less milk and concentrates compared to the recommended calf rearing practices in the project.

The age at first calving under the MIDCOMUL target growth scheme in Sri Lanka was statistically significantly lower in animals that had a longer than average period of one teat suckling and a longer than average period of suckling around milking (Chapter 9), indicating the importance of adequate milk feeding during the early life of the calf, especially when they receive little or no concentrates.

Cattle pricing and production of stock

Local cattle prices in developing countries are kept low by selling animals of state and parastatal farms at low rates often equal to beef prices to facilitate access by new dairy farmers on cash or credit basis. The result is that farmers that could produce excess dairy stock have little incentive to do so. Calves reared or shared out are easily sold at any time to the private meat trade.

In Sri Lanka, production of in-calf heifers either by multiplication (US$ 140-280 per head) or salvaging operations (US$ 200-250) by the (para)statal sector was uneconomic when it had to compete with prevailing subsidized prices of US$ 100 in the 1980s, and the numbers sold were limited (Chapter 9).

In Tanzania, production of in-calf heifers was not economic either at prices of US$ 200 per head in the livestock multiplication units in the 1990s, and the 2,000 head produced per year at heifer breeding and livestock multiplication units was far below actual demand of 8,000 head (Massae, 1994).

Calf rearing schemes

Smallholder schemes in Sri Lanka with attention to calf rearing and heifer raising showed that smallholders can rear their own stock with calf mortality rates as low as 2-8% (Chapter 9). Moreover, good growth rates could be obtained, leading to low ages at first calving between 2 to 3 years, when schemes were implemented up to the time heifers were confirmed in calf. Farmers lost interest in subsidized health care schemes in the second year, because of high feeding costs that were not subsidized. In the contract heifer breeding and raising scheme, farmers were reluctant to depart from their healthy, good looking animals. A new AI heifer calf rearing scheme with subsidized feed at 50% of the price, up to calving or 32 months of age and without obligation to sell, replaced the earlier health care and contract breeding schemes. This scheme was more attractive to farmers, since it was their own animal and future stock that was benefitting from the scheme. However, the monthly chest girth monitoring and delivery of supplies at the farmers' doorstep made the scheme expensive in personnel and transport.

Under the Dutch supported MIDCOMUL heifer calf target growth scheme, heifer calves both from AI and natural service could obtain quarterly, up to 18 months, a small bonus if target chest girth was reached, followed by another bonus at pregnancy below 21 months and calving below the age of 30 months, all in case these targets were met on their own farm. At the age of 18-20 months 1,137 heifers (61%) out of 1,850 registered calves were still present and of 603 heifers (33%) a report on first calving (average age 29.4 months) was received. Comparative studies of 164 first calvers and their respective dams showed that at the average age of 33.9 months (4.8 months after calving) project young cows had reached 95.5% of the chest girth, 75.4% of the peak milk yield while fed at 94.1% of the peak concentrate level of their dams. The age at first calving of project (29.1 months) and control (35.5 months) young cows was positively related to the suckling period (both for period of provision of one teat, and for period of suckling around milking), and the concentrate level fed at the age of two years. Peak milk yield of 7.7 kg per cow per day was positively related to peak milk yield of the dam, and peak concentrate level and chest girth of the young cow. The chest girth (153.5 cm) of project young cows corresponded positively with chest girth of the dam, peak milk yield of the young cow and concentrate level fed at the age of one year, while more than the average number of dry months and total livestock units on the farm affected chest girth negatively.

Data on the 33 first project cows under the MIDCOMUL scheme with a second calving, indicated a calving interval of 13 months, and in 8 farm visits daughter/dam comparison showed 100% for chest girth, peak milk yields of 65% for the first lactation and 85% for the second lactation.

Regular chest girth measurements along a targeted growth curve with small incentives paid upon quarterly target realization, resulted in a large number of farmers rearing and raising their own calves into well-developed heifers that calved below 30 months of age with good first lactation peak milk yields. Through chest girth measurements, farmers easily became aware of the performance of their calves, and many reported during field inspections, that they corrected the calf's performance with more milk and/or supplementary feed. The importance of more milk and supplementary feeding during calf rearing resulted also in statistically significant lower ages at first calving, larger chest girths and higher peak milk yields. The large numbers of calves both from AI and natural services that could be reached through mobile training, and calf rearing committees in dairy producer associations compared favourably to other programmes served by veterinary office personnel, and warrants wider application of such a target growth scheme in developing countries. The costs of supporting such programmes at smallholder level at about US$ 100 per qualifying animal are much lower than the production of such animals either by salvaging schemes, multiplication units, crossbreeding units and especially compared to those that are imported. Furthermore, the smallholder stock is more adapted to feeding and management practices in the area than stock coming from further-away large-scale units and imports .

Funding of dairy development

Annual imports of developing countries of 17 million tons of milk products in 1992 valued at US$ 45,000 million (Lambert, 1994) represents a large drain on foreign exchange. On the other hand, in some developing countries, e.g. Sri lanka, milk is being considered a strategic commodity that falls outside restrictive measures of foreign exchange, thus facilitating imports, and providing generally good business for the private and government sector, that put a considerable margin on the subsidized world market products before they reach the consumer.

Large-scale loans or investments in imported stock to bridge the gap between local supply and demand for milk, without providing high quality feed and management, resulted in animals producing far below their potential. Long adaptation periods in reproduction and high mortality rates caused that the strength of the imported batch could not be maintained from their own offspring. Large-scale crossbreeding at smallholder level with long-term support of Sweden (Kenya) and Switzerland (Kerala, India) and BAIF (India) created a large number of crossbreeds entering the dairy sector. In the Pasto project in Nariño, Colombia and PROMEGA in Peru (Van der Kuip, 1982), AI at smallholder level was not sustainable in view of the limited number of inseminations. The genetic potential of local Friesians was not the limiting factor in South America, but nutrition, as was proven by research and demonstration in Sta. Catalina and Obonuco where poor looking Friesian cattle bought in the local market produced well when fed properly.

Production costs of in-calf heifers at (para)statal farms in Sri Lanka rose from US$ 240-380 in the 1980s to US$ 510-640 in 1993, while smallholders estimated the costs of producing an in-calf heifer at US$ 170-255 in 1993. Incentive schemes to produce in-calf heifers at smallholders farms amounted to US$ 100 in the MIDCOMUL target growth scheme to US$ 170 in the AI heifer calf rearing scheme with a 50% feed subsidy. Such producer incentives for in-calf heifers, adapted to the local environment compare very favourably to the costs of imported stock at US$ 2,000 per in-calf heifer from the Asian-Australian region. For the same investment about 16-20 in-calf heifers could be produced locally, that provide at the same time more gainful employment to the rural area, and would avoid loss of potential stock through insufficient feeds before and especially after weaning.

Also funds raised from import tariffs on dairy products could be used for such investments in the local dairy sector, although this requires tough bargaining with the Ministry of Finance and Planning. Dairy food aid, although future availability may be limited, has its attractive features of balancing lean season requirements in the urban market, but its use should preferably by canalized by the producers' sector to avoid competition with local milk production.

Future perspectives

In a world full of hungry people, despite there being enough food produced currently, the illogical fact remains that many of the poorest and hungriest are small-scale producers (Elswick, 1992). Crees (1993) mentioned that policy makers in Tanzania have realized that most Tanzanians are rural people and that most of them belong to the households of producers and that the non-producing urban and civil servant classes are numerically so small that they can be discounted.

Prospects for enhanced food security and nutrition and improved sustainability of agricultural and rural development have been discussed at the Den Bosch conference on Sustainable Agriculture and Rural development in 1991, the United Nations conference on Environment and Development in Rio de Janeiro and FAO/WHO International Conference on Nutrition in Rome in December 1992, and have been further elaborated in a recent FAO study on "World Agriculture Towards 2010" (FAO, 1995). Policy reforms towards a more market-oriented international agricultural trade system have been negotiated in the completed Uruguay Round of Multilateral Trade Negotiations in 1993, and will hopefully encourage the producers of the South to increase local production of milk and dairy stock on their own feed resources to replenish soil fertility (often exported to the North in the form of crop-byproducts as oil cakes).

Non Governmental Organizations (NGOs) indicated important principles of an alternative approach to the industrial model of conventional agriculture in their preparatory meetings around the above-mentioned conferences, whereby sustainable agriculture (i) is a model of social and economic organization based on an equitable and participatory vision of development that recognizes the environment and natural resources as the foundation of economic activity, (ii) uses locally available, renewable resources, appropriate and affordable technologies, and minimizes the use of external and purchased inputs, thereby increasing local independence and self-sufficiency and ensuring a source of stable income for peasants, family and small farmers and rural communities, and (iii) respects the ecological principles of diversity and interdependence and uses the insights of modern science to improve rather than displace the traditional wisdom accumulated over centuries by innumerable farmers around the world (Elswick, 1992).

In line of the above principles, development of milk production and dairy stock with smallholders on their own farms might assist in increasing this local independence, with increased self-sufficiency, rural employment and stable income if the economic environment and dairy policies would guarantee a long-term outlook for a remunerative price for their labour and care, and farmers' organizations would be allowed to organize themselves for more empowerment in the vertical milk column. Further, chest girth measurements of young and lactating livestock by smallholders, extensionists and researchers might assist in reducing serious bottlenecks in dairy development such as young stock mortality, high ages at first calving and long calving intervals, which in turn would stimulate early and more milk production from smallholder farms.

SUMMARY

My work in technical development cooperation and missions in developing countries, touched often upon worldwide dairy development, and stimulated my interest in comparative analysis of technical and economic progress in the sector. This did not only deal with milk production, but increasingly in the course of time with the development of dairy stock as the basis for enhanced and/or expanded milk production. Dairy production, generally performed on more specialized farms in industrialized countries, is mainly taking place in small-scale mixed farming in most developing countries, apart from milk production in pastoral societies. This inspired me to look into details of the horizontal mix of agriculture, horticulture, trees and livestock species, including off-farm activities of the smallholder family. Coming from a dairy farm in a country where dairy farming developed in a reasonably stable policy environment that was focused on producer prices and investment incentives, I was also interested in the organization of the sector in other countries. To what extend was it supported by the triangular network of agricultural education, extension and research? How strong was the vertical column of input supplies, services, production, processing and marketing and was it handled by farmers' organizations themselves? Progress reporting in project work and the push to publish in the academic world brought me to write this thesis on development of dairy stock and milk production with smallholders with the following objectives:

1) to study technical, economic and organizational changes in dairy farming/development, i.e. has the production of milk per cow, ha and person increased and/or has the number of dairy cattle and farmers increased;
2) to consider the options for dairy development with smallholders aimed at more self-reliance and less dependence on foreign aid; and
3) to examine whether smallholders can be motivated to rear their calves and heifers on their own farms to generate sufficient stock for replacement and supply to aspirant dairy farmers.

In *Chapter 1*, global developments over 1980-1994 indicate that the world population increased at an annual rate of 1.7%, which is lower than the highest rate of 2.1% recorded in 1965-1970. The number of people involved in agriculture still increased from 2.2 to 2.4 billion, although its proportion decreased from 49.4 to 43.4% of the world population. Land use increased annually with 0.13% in arable lands, 0.31% in permanent pasture against a loss of 0.22% in forest/woodlands and 0.01% for other land (towns, roads, barren lands). From 1980-1994 total food production increased with 30.3%, crop production with 29.6 and livestock production with 26.6%, compared to a population increase of 27%. Per capita, the availability of food increased with 0.31% and of livestock products with 0.21% per year. Surplus production of milk over effective demand characterizes the industrialized countries, while unsatisfied demand and limited foreign exchange is typical for developing countries.

Dairy development in the Netherlands from 1930-1993/4 showed that annual milk yields increased from 3,250 to 6,970 kg per cow and concentrate use from 400 to 2,200 kg per cow. Fertilizer application reached 315 kg N per ha in 1984, a year before the introduction of milk quota, and decreased to 280 kg per ha in 1993/4. Annual labour input per cow in dairy farming declined from 340 in 1940 to 40 hours in the 1990s. Average milk production per ha increased to 10,085 kg in 1984 and per farm to 266,500 kg in 1993/4, while the number of dairy farms decreased from 185,000 in 1960 to 40,500 in 1993/4. Economically, dairy farm results are negative as milk and stock incomes do not fully compensate total calculated costs of land rent,

capital and farm family labour. Farmers remaining in the sector manage to survive through low expenses for family consumption, and the use of savings and depreciation to invest in their farms. Large variation exists in performance among regions, farming styles within a region, but even more as a result of differences in individual farm family conditions and management.

The contribution of the dairy sector in 1992 to the agricultural GNP in the Netherlands, Germany, France and Denmark was around 25%, compared to about 10% in New Zealand, Australia and the USA. Of these countries, the Netherlands, with the smallest farm size, has the highest milk yield per cow, per ha forage and per manday. New Zealand has the highest stocking rate of 2.3 cows per ha forage with the lowest feed and fixed costs (low costs of land, housing and forage management) and the lowest producer milk price. In the USA, dairy farming varies considerably per region, with family farms in the North Central and North East and large commercial farms in the West and South West. Large shifts occurred from dairy to beef production using young grass-fed dairy and beef animals for fattening in feedlots. Special milk prices for consumption milk are in use such as the Dutch winter milk price, the town milk price in Oceania, and the premium in the USA that increases with the distance from Wisconsin.

Dairy production in (sub)tropical areas showed a very wide variation in milk yields, from an off-take of a few hundred litres per cow per year in indigenous cattle herds up to 6-9,000 kg per cow on imported commercial dairy complexes in oil countries (Saudi Arabia, Libya). Technical and economic characteristics of dairy farming systems in developing countries, varying from extensive pasture grazing of local stock to zero grazing with grade cattle, were illustrated for South America, Kenya, Sri Lanka and Colombia in the early eighties. Milk production per cow (170-3,500 kg/year), per ha (200-11,000 kg) and per manday (2-132 kg) varied considerably as did gross margins in US$ per manday (0.35-66), per ha of forage (50-1200) and per US$ 1,000 investment (45-1,150).

In *Chapter 2* characteristics of dairy production systems were differentiated in subsistence-commercial type of production, seasonality of production and non-productive periods (dry period, calf rearing and heifer raising), and related to the role of supply and demand locally and in the world market with the respective producer prices for milk and dairy stock. Milk production characteristics, i.e. age at first calving, lactation length and yield, and calving interval were reviewed for buffaloes and cattle in the tropics. Age at first calving is much higher than the 24-30 months of cattle in temperate areas, e.g. for milk buffaloes (38-47 months), nondescript buffaloes (up to 57 months), Indian dairy breeds (40-58 months), nondescript cattle (up to 54 months), crossbreeds (30-46 months) and exotic dairy cattle (27-36 months). Calving intervals, varying from 381-638 days are much longer than the recommended 365 days, in combination with the high age at first calving, limit the annual number of calves produced in a herd. Calf mortalities in the tropics of 20-45% are much higher than the 7-16% found in temperate areas. Major causes are high disease incidences, low feeding levels and low prices of calves for meat or future stock. Competition with men in milk use like payment of stockmen in milk, family milk consumption in pastoral societies and milk sales for income may limit the use of milk during calf rearing. This, together with lack of supplementary feeding before and especially after weaning results in slow growth and makes calves more vulnerable to diseases. Low values for young stock are associated with low meat prices for cattle in Hindu and Buddhist society and low world market prices. The value of male animals for draught may provoke a more intense rearing and raising. Price controls of government to supply breeding stock cheaply may further result in little interest in raising of young stock.

In contrast, calves in the Netherlands have a ready market at remunerative prices, with males going for specialized white, pink and red meat production, and female calves being reared for replacement, export or meat production as well. Attention to calf rearing in research and extension, large scale introduction of more Holstein Friesian blood, more milk feeding to calves after introduction of the milk quota, stimulated improved calf rearing and heifer raising that resulted in high liveweights of 420-550 kg and early ages at first calving, and more milk. In the tropics, birthweights and growth rates of cattle are lower leading to liveweights at first calving of 200-300 kg in local breeds, 300-400 kg in crossbreeds and 350-450 kg of exotic breeds, especially at lower latitude and altitude.

Lifetime production of milk and calves is intensive but short in the Netherlands. Cows produce on average three lactations and are culled at about five years. In the tropics lifetime is much longer, but total number of calves ranges between 3-5, with some up to 6-10 in village herds in India and Nepal, that hardly practice culling or slaughtering. With a requirement of about three calves to replace the dam by an in-calf heifer in the tropics, little scope exists for selection in the offspring, and genetic improvements have to come through selection in the male line.

After the successful introduction of exotic dairy cattle in the tropics in the early twentieth century by European settlers, army men and missionaries, many developing countries after independence in the 1940s to 1960s imported dairy cattle in attempts to satisfy quickly the increasing urban demand for milk. Severe intolerance to tropical heat and humidity and susceptibility to vector-borne diseases resulted in deaths, abortions and low production of milk and stock, especially at smallholder level. At (para)statal farms, introduction and comparison of exotic breeds under better feed and health management continued, and some countries changed to crossbreeding towards synthetic breeds with more or less fixed characteristics such as the Jamaica Hope, Siboney in Cuba, Chinese Black and White, Sunandini, Karan Swiss and Karan Fries in India, Friesian Sahiwal and Australian Milking Zebu in Australia.

A number of countries started large-scale, donor-supported AI schemes at farm level in the 1960s with successes in Kerala after long-term support by Swiss Technical Cooperation, and in Kenya with support from Sweden. In other countries, e.g. Ethiopia and Tanzania, crossbreeding was done in parastatal farms using exotic semen and bulls on ranch cattle (Boran, Small East African Zebu) to produce F1s for smallholders. Imports of dairy cattle continued in the Middle East/North Africa, utilizing oil money and private capital to achieve self-sufficiency in milk through investment in large dairy complexes, with imported housing facilities, machinery, feeds and even foreign management, except in Tunisia where local management was trained. Large numbers of exotic dairy cattle have been imported in Indonesia, mainly for smallholders supported by cheap long-term credit, but milk production is far below their genetic potential and internal generation of stock is very limited.

In *Chapter 3*, experiences from lending agencies and international organizations with dairy development as well as those presented at international workshops and seminars were reviewed, and also taking account of changing approaches to rural development. Main factors determining success or failure in livestock development identified by the banks, were adequacy of producer incentives and supporting services, appropriateness of technologies used and the planning and implementation capacity of responsible institutions. Failures were attributed to wrong economic policies, e.g. overvalued exchange rates favouring imported products and technology, price controls protecting the politically more active and clamorous consumers, and weak parastatal management of milk processing and marketing. Promising developments were noted in (peri)urban dairy farming in West and East Africa, in smallholder schemes with local sales of milk, and in Indian dairy projects that developed an effective multi-tier cooperative system with a broad range of services to millions of farmers and collecting, processing and marketing of millions of litres daily. Appropriate technologies emphasized matching breeds with climatic conditions and feed resources, manual operations to benefit from the use of cheap family/rural labour and commercial dairy production only, if price ratios of milk/concentrate exceed 1.5. Institutional issues associated with successes included projects suggested by beneficiaries and motivated by their needs, and planned per commodity and area by the country itself prior to project assistance. Success in implementation required experienced staff motivated by institutionalized incentives, and farmers that were trained and organized by strong and motivated managers. Other essentials included adequate feed resources, effective animal health services and well-organized collection, processing and marketing facilities, absence of market distortion from imports, and opportune credit to facilitate remunerative production.

The Food and Agriculture Organization (FAO) shifted its focus from technical support in milk processing plants of urban milk conservation schemes (1950s and 1960s), to training programmes by regional dairy development training teams (RDDTT, supported by DANIDA from 1960-1990) and technical missions under the international scheme for coordination of dairy development (ISCDD, supported by FINNIDA from 1972-1990),that in most cases were followed up by WFP assistance. After a dairy expert conference in 1984, FAO opted for a modular approach in four regional model projects for integrated dairy development, supporting milk production, processing and marketing of milk at smallholder level, with satisfactory experiences sofar in Tanzania and Ecuador. FAO further supports introduction of molasses-urea-multinutrient blocks to improve local dairy feed supplies and village level processing of indigenous dairy products.

The World Food Programme supports, through monetization of dairy food aid, development of the dairy industry only as a viable economic activity. Fluid milk at lower prices can be brought within reach of a larger public by cross-subsidizing pasteurized milk from higher margins on other dairy products. The emphasis is on supporting smallholders to stimulate economic growth and reduce poverty in rural areas through labour-intensive milk production that contributes to income and employment generation. Dairy development through food aid, further requires an effective package of technical and management assistance, support in dairy policy analysis and support with foreign exchange from other sources, if local currencies are not convertible.

The international seminar in Anand, India (1989) noted in Asia promising increases in milk production through strengthening of producer cooperatives in India, Thailand and Indonesia, through high producer milk prices in Japan, Taiwan, South Korea, and on state and private farms in China. In Africa, large regional differences existed in availability of local milk and imports. Most organizations involved in dairy development were closely linked to the state, with low local milk intakes by the parastatal dairy industry in view of higher dealers' prices for rural milk. In South America, regional differences in milk availability were also striking, with promising dairy development approaches in rural cheese plants (Peru, Ecuador), dairy development modules of producers in Bolivia, and the model integrated dairy development project in Ecuador.

The dairy congress in Wageningen, the Netherlands (1991) illustrated the large variations in milk consumption due to different degrees of malabsorption of lactose and income levels with a typical threshold income of 500 US$ per capita before consumption of livestock products starts to increase rapidly. Also, the variation over time in protection rates in developed countries was given in relation to the milk producer price, as well as the trends in milk production increases in Western countries at 1-1.5% per year compared to 4% in developing countries.

The international workshop in Wageningen, the Netherlands (1992) for policy makers of livestock development involved in rural development, emphasized the multifunctional role of livestock and the needs for stimulating local production for food security, employment, income generation and equity. It was recommended to reverse the urban bias in adjusting price, trade, credit, land use and tenure policies to support the producer. Technically, development of the feed situation and feeding regimes for pastoral, mixed, intensive and ranching systems was the main prerequisite for improved local livestock production.

Dairy development in the Caribbean region, discussed in Jamaica (1992), focused on the high bill of imports for livestock products and feeds for livestock, which could be reversed by changing economic policies in favour of employment and income from local small-scale dairy farming, making use of local crop-byproducts and underutilised grazing resources.

The international seminar in Harare, Zimbabwe (1993) on dairy development policy and implementation and sharing of experiences between Africa and Asia, recommended the formulation of clear, long-term dairy development policies, minimizing direct government involvement, stimulating more technical cooperation among developing countries, and creating regional networks of relevant training institutions. It was concluded that technology development was required for fresh milk preservation, processing, cheaper packaging and marketing. Project implementation was recommended through a modular approach with emphasis on development of strong support services, bull-oriented breeding, and training aiming at improved productivity of smallholder dairying and intensified fodder and crop residue utilization. Linkages of rural producers with urban consumers should be developed with full participation of farmers organizations.

Over time, approaches to rural development shifted from increased agricultural production and area expansion, through large-scale farming operations to produce enough food locally and also for export, to more attention to food crops and small-scale farming with modern input technology (green revolution). Community development, to improve the wellbeing of rural people, supported local institutional development, and incorporated later more attention to power relations (land distribution) and socioeconomic inequalities in rural societies (poverty alleviation) in integrated rural development projects. Subsequently, also environmental aspects and the position of women were added to development projects that focused on specific areas (districts and watersheds). The area approach, embedded in local horizontal structures, often conflicts with dairy development programmes that are organized vertically by the Ministry of Agriculture.

Bank and donor financing for large dairy farm development has been reduced over time in view of low or negative farm profitability, when looking at comparative advantages with subsidized world market milk, and/or low price ratios for milk/concentrates resulting from government set producer milk prices and encouragement of feed export. Support of a dairy component within small-scale farming, based on family or low cost rural labour, use of improved local feed for feeding a crossbred cow and milk sales directly to the consumer appeared the best option to develop local milk production.

Experiences of Netherlands development cooperation in dairy development in Africa (Kenya, Tanzania) and Asia (Sri Lanka, India and Indonesia) were reviewed in *Chapter 4* and those in South America in *Chapters 5 and 6*. Lessons derived from early experiences in support of livestock development were formulated by the Operation review unit in 1987, and used as a basis for formulation of new policy guidelines, published in 1992.

Neither the supply of Dutch cattle in the seventies nor support to large-scale dairy farming were successes. Matching exotic cattle to local feed and management environments, especially in hot and humid conditions appeared problematic. Mechanized large-scale dairy farming could not be maintained through lack of foreign exchange for spares and replacements. Attention to small-scale farming in the 1970s and 1980s required pilot phases or projects to prove that improved feeding of local Friesian cattle (South America) and zero grazing of improved cows (Africa and Asia) was a feasible and profitable practice for small-scale farmers. Most programmes consisted of essential combinations of training, applied research, extension and veterinary services with access to cattle resources as a prerequisite for increasing the number of participating farmers and/or a processing component. Monitoring of technical and economic parameters was included in most projects after some time to streamline data collection, processing and progress reporting, and to focus the project on solutions for identified constraints.

The Pasto project, Colombia included in its second phase (1978-1984) horizontal integration of dairy cattle with crops, horticulture, trees and other livestock species (*Chapter 5*). The large variety in smallholder resources of land, labour, crops and livestock species required a variety of technological packages with adoptions rates, depending much on family conditions and price developments. Cash crops with low labour inputs were easily taken over by large farms which blocked the market for smallholders. Labour and/or management intensive cash crops as stem onion, garlic and fruits were more appropriate for smallholders. Guinea pigs, kept by women, require a fairly constant management of feeds and feeding that was difficult to realize with labour in large farms, and proved an attractive income earner through a high price per kg, compared to other small stock species (pigs, poultry, rabbits). Supervised credit with the farm as collateral was only taken up to the extent that it could be repaid from guaranteed yields and prices in the poorest season or, in the case of dairy, from young stock sales from calves born to borrowed and existing cows. Improved grassland was established in a two-year rotation with potatoes to benefit from cross-fertilization of P on potatoes and N on grass, similar to potato/onion rotations in combination with lucerne in Peru.

Vertical integration of milk production, processing and marketing, reviewed in *Chapter 6* refers to support to the cooperative dairy industry in Nariño, Colombia and the prospects of vertical integration in the model integrated dairy development project in Cañar, Ecuador. Major constraints at macro-level were imports of cheap (dumped) milk powder by the government or its agent and government influence on milk prices, and at micro-level poor liquidity, weak management and organization of starting groups/cooperatives. Grass-based milk production is very seasonal and requires processing of the surplus into products with an extended-shelf-life such as milk powder that can be used to balance shortages in the lean season and/or into products with added value, such as cheese for the more affluent sector in society. Poorly timed imports of milk powder may induce "milk holidays" (no intake of milk), and controlled flat-level producer milk prices don't stimulate milk production in the lean season. Small farmers with surplus milk for sale without having their own organized collection/cooling centres are easily manipulated by the milk collector whose interest it is to serve its customers, either the consumer or the receiving milk industry at low prices with enough margins for himself. Even if donor support for collection/cooling and/or processing equipment is provided, it takes time and a lot of technical/organizational support to attract suitable management, develop appropriate processing technology and market strategies, and especially to organize operating funds, install milk quality and quantity rules to arrive at a successful group effort. The step-by-step approach, committing both the group and the donor/banks into small expansions of the COOPROLACTEOS project, proved worthwhile, and resulted slowly in a full-fledged, strong dairy farmers cooperative, that set the milk price in the area, based on profitable, high quality, hygienic cheese production.

A similar step-by-step philosophy is applied in the model integrated dairy development project in Cañar, Ecuador through rural milk collection/cooling centres/cheese plants provided in trust to individual communities that still need to grow from experience gained into a larger organization to negotiate or acquire through processing and marketing a more remunerative producer milk price.

In smallholder dairy development projects, improved cows were generally in short supply (except in South America). Introduction of improvements in dairy farming would generally start off with better-off people that could afford the risk of investment in improved cattle, housing and feed. To encourage also poorer farmers, favourable financial schemes were used. A low-interest project revolving fund, followed by special smallholder credit (for farmers with < 10 ha and > 70% of income from farming) was applied in Colombia. In Ecuador, farmers are encouraged to establish improved pasture through a cash crop sharing arrangement with the project. The grant scheme in Kenya subsidized investments in zero grazing dependant on farm income, milk price and once or twice milk collection. An interest-free single cattle loan assisted poor settlers on abandoned, marginal tea land to start crop-livestock farming. Heifer-in-trust schemes applied by Heifer Project International (HPI) in various countries to improve the lives of poor people, are applied by dairy development projects in Tanzania to encourage poor rural families and women to start zero grazing. Improved feed production and feeding management for smallholder dairying focused on Napier grass (Kenya), Guatemala grass (Kagera, Tanga), Guinea grass, Gliricidia and rice straw (Sri Lanka), followed by inclusions of legumes, fodder trees and treatment of roughages. Exchange visits among projects in different geographical regions, often disliked by donors but highly appreciated by professionals, resulted in cultivation of a wider range of forages to produce a more complete roughage diet over the year.

In *Chapter 7* the performance over 1985-1992 of integrated crop-livestock systems on small demonstration-cum-training farms at the Mid Country Livestock Development Centre (MLDC) in Sri Lanka was analyzed. Poor abandoned, barren land was used to rebuild the "Kandyan forest garden system" on 0.2, 0.4 and 0.8 ha, typical sizes of holdings of Mid Country smallholders. Crops were widely spaced to allow intercropping with grass and were surrounded with live fences for fodder production to accommodate 1, 2 and 3 cow-units aiming at milk income, manure for biogas and slurry for soil fertility. Each unit was operated by a selected MLDC employee and his family using his salary to operate the unit. He was entitled to the farm income after deductions for land rent, capital and marketing costs. Design and supervision was the responsibility of MLDC staff as well as monitoring of all technical and economic data for all crops (vegetables, bananas, pepper, coffee, coconut and fruit trees) and livestock (local dairy cows, goats, commercial layers and broilers). Dairying and goats proved attractive cash earners with a high labour productivity, while manure for biogas to replace domestic fuel and slurry to improve soil fertility were important benefits, however with a high capital requirement. Commercial poultry did not improve farm income overall, due to fluctuating prices over the years. Within crops the yields and financial contribution of vegetables and bananas declined, particularly after 4 years, which stressed the need for rotation including pasture plots or to step up compost making from grass refusals and crop wastes for incorporation in the crop areas. Crop production per m^2 was highest in the 0.2 ha unit with the highest concentration of livestock units per ha. Comparing actual performance with the predicted one in the feasibility study showed that, especially actual labour days were higher and return to capital lower than estimated and even below prevailing interest rates. A more gradual investment in smallholder farms in phases of annual cash crops, medium-term crops, long-term tree crops and livestock seemed more appropriate and is also more in line with the smallholder's way of farm improvement by taking small steps and avoiding high risks.

In *Chapter 8* the financial, technical and economic performance of dairy farming introduced on abandoned, marginal tea lands was analyzed on the basis of a survey in 1993 of 76 settler farms (and 19 neighbouring control farms), that received an interest-free single cattle loan between 1984 and 1990, to stimulate crop-livestock farming for gainful self employment.

Project loan repayments, recoverable from 36 fixed monthly deductions of the milk pay cheque were satisfactory, but with on average 2.95 lactations per project animal, balance payment had also to come from milk of the offspring or from off-farm income. Dairy cattle were still present on 93% of the project farms with 77% selling milk. Average home consumption was 0.6 l/d for a family of 5.32 persons. Milk production proved attractive for farm gross margins of both project (66%) and control (81%) farmers and contributed significantly to family gross margins by 32 and 46%, respectively. Land improvement by livestock was mentioned as a benefit by 64% of the farmers. Crops contributed mainly to subsistence and only marginally to income (vegetables and perennials). In addition, farmers still depended on off-farm income and government food support to meet their family needs.

In *Chapter 9*, performance and progress of dairy stock development in Sri Lanka was analyzed in both the (para)statal and the smallholder sector. Multiplication of breeding stock (pure and crossbreeds) on (para)statal farms amounted to 10% female stock per cow in cattle and 8.5% in buffaloes (1981-1993)as breeding issues to others. In comparison, heifer breeding units in the Kagera and Tanga regions of Tanzania produced on average between 200-250 in-calf F1 heifers from on average 2,000 breeding cows. The output of 10-12.5% F1 animals per cow in Tanzania, however, could only be maintained with additional purchases of about 100 Boran heifers (5% of breeding cows) per year to maintain the original Boran cow herd.

Calf salvaging operations at two parastatal farms to rear otherwise neglected smallholder calves proved difficult in acquiring large numbers of good quality, transferring them successfully from suckling to artificial rearing and raising them properly on low feed inputs. The output averaged 100 and 131 in calf-heifers per year (1980-1988). In contrast, the MIDCOMUL scheme created an additional stock of 164 milk producing animals per 390 cows on smallholder farms over a period of 33.9 months. On an annual basis this meant 15% per cow, which was much higher than breeding issues from parastatal farms of Sri Lanka and cross-breeding ranches of Tanzania.

Seven calf rearing schemes at smallholder level in Sri Lanka were studied that applied incentives in the form of (i) a calf health care package (CHCS), (ii) price support in contract heifer breeding and raising for sale to others (CHBRS), (iii) 50% subsidy on calf feeds supplied at the farm (Kerala), (iv) material for calf housing, deworming and minerals (PPRG), (v) gifts after winning in calf competitions of Dairy Producers Associations, and (vi) bonus payments upon chest girth targets met up to 10 months (Matale) or (vii) until calving (MIDCOMUL). Calf mortalities were low between 2-8%, improved growth rates around 300 g/d were achieved as well as low ages at first calving around 30 months compared to 36-48 months in other smallholder and parastatal farms. Most control calves had in fact disappeared from the farms and could not be traced any more in the area by the age of 6 months. Not all project farmers were successful in good calf rearing. Large differences in growth rate were found in the field between the worst 25% (growth rates below 200 g/d) and the best 25% (300 g/d and above) performers. Growth rates were considerably lower in the second year without sufficient incentives such as only health kits in the CHCS and none in the Matale scheme. Schemes should therefore cover the whole rearing period up to calving to obtain well-grown heifers that calve at an early age.

In the MIDCOMUL bonus until calving scheme, 164 first calvers with complete records on quarterly chest girth measurements, age at first calving, breed type (Friesian, Ayrshire or small crossbreed with Jersey/Australian Milking Zebu), farm location (estate-Tamil managed or village-Singhalese managed) and calf rearing history (months of one teat suckling, months of suckling before and after milking, concentrates fed at one year and at two years old) could be compared with their dams in chest girth, peak milk yield and peak concentrate level during a farm visit. First calvers, inspected at the average age of 33.9 months, had reached already 95.5% of the dam's chest girth (well above the standard of 87% in the Netherlands), 75.4% of the dam's best peak milk yield (close to the standard 79%) at 94.1% of the dam's peak concentrate level.

Step-wise regression showed that a lower than average age at first calving of 29.1 months was statistically significantly associated with a longer than average period of one teat suckling (2.45 months) and total suckling period (4.86 months). In 39 non-project first calvers, the age at first calving of 35.5 months was also statistically significantly lower at a higher than average period of one teat suckling (2.35 months) and higher at a more than average number of livestock units kept (2.89 TLU).

Similarly, average chest girth of young project cows (153.5 cm, i.e. about 286 kg) at inspection after calving (at the average age of 33.9 months) was positively associated with a more than average chest girth of the dam (160.7 cm), concentrate level fed at 1 year of age (0.67 kg/d) and peak milk yield of the young cow (7.72 kg/d), and negatively with more than the average number of dry months on the farm (4.12 months) and the concentrate level fed at two years of age (1.18 kg/d). The chest girth of non-project young cows was only positively associated with a higher than average peak milk yield of the young cow.

Step-wise regression of average peak milk yield (7.72 kg/d) of young project cows showed statistically significantly associations, positively with the dam's peak milk yield, concentrate level fed at the young cow's milk peak and age at first calving, and negatively with concentrate level fed at the dam's milk peak.

The importance of these incentives is that (i) enough milk during the rearing period in smallholder farms contributes to reducing the age at first calving, (ii) supplementary feeding up to one year of age, especially to correct for dry months and high stocking rates stimulates chest girth development, that subsequently allows for higher peak milk yields and possibly higher first lactation milk yields. Differences among breed types in age at first calving of project animals were very small and much smaller than in control animals that showed the expected pattern of lowest ages at first calving for Friesians, followed by Ayrshire and Jersey/AMZ, and lower ages in estates with Tamil managed cattle than in villages with Singhalese managed cattle. Chest girth measurements and peak milk yields did show superiority for breed and location that were statistically significant associated with the dam's girth size and peak milk level of the dam. The average ratio of produced milk/concentrates fed at peak level was 3.46 with little or no differences among breed types and locations.

Comparison of the various calf rearing schemes further brought to light that schemes operating from the veterinary ranges/units such as CHCS, CHBRS and Kerala registered about 300-600 calves per year in various regions in Sri Lanka, while the MIDCOMUL scheme could register 1,850 calves in 6 months time in its associated dairy producers' associations (DPA) in the Mid Country. Awareness through mobile MLDC training offered at milk collection points, inclusion of both calves from AI and natural service, and establishment of calf rearing committees in the participating DPAs encouraged a high farmer's participation.

The MIDCOMUL target growth scheme also proved that many farmers in measuring their own calves along a growth chart, with quarterly checks of the Union's field officers and a bonus upon targets reached, were quite keen to raise their own young stock on their own farms. Many indicated during the field inspection that they adjusted their management by allocating more milk or supplement to the calf to reach the target. Even heifers that had not qualified for all bonus payments, were still kept or had been sold when pregnant.

Measurements of calves from project young cows showed average growth rates of 245 g/d up to 4.5 months old in 184 female calves and 228 g/d up to 4.7 months old in 121 male calves. This was lower than under the bonus system with an average growth of 334 g/d up to

3 months and 320 g/d from birth up to 19 months of age, suggesting positive impact of the incentives under the MIDCOMUL target growth scheme.

The average daily peak milk yield in the first lactation of 7.7 kg for 164 MIDCOMUL scheme young cows was also higher than the 6.4 kg of 66 young cows (mainly Friesian and Ayrshire crossbreeds) from salvaging farms, and the 6.2 kg of 9 young cows (Jersey/AMZ crossbreeds) in the Matale target growth scheme.

In terms of costs, the incentives under the calf rearing schemes amounted to US$ 100 per sold contract heifer, US$ 100 per reported calving in the MIDCOMUL scheme and US$ 170 per participating AI heifer calf up to calving in the Kerala scheme. These incentives compared favourably with the required subsidy of US$ 140-280 per breeding issue from 33 (para)statal farms and US$ 100-150 from two salvaging (para)statal farms, and more so if compared to imported Friesians from Australia at US$ 2,000 each. Compared to on-farm schemes (MIDCOMUL, KERALA), other breeding stock is usually sold when 3 months pregnant requiring another 6 months upkeep (costing about US$ 20 per month in parastatals in 1993).

Other forms of generation of dairy stock were analyzed in the Kagera Livestock Development Programme, Tanzania. After correction for annual inputs of pregnant crossbred heifers from Kikurula heifer breeding unit, the growing productive dairy population (cows and mated heifers) of smallholders showed an internal generation of 17 heifers per year or 1.14% of total average stock from 1983-1989 when heifer prices were kept low up to 90 heifers per year (1.71%) in 1989-1995 when commercial heifer prices prevailed and incentives to deliver surplus breeding stock to the project were introduced.

In *Chapter 10* dairy development achievements in selected countries and projects supported by the Dutch, WFP, the Swiss and FAO/UNDP/private sector were reviewed.

From 1980-1993 milk yields per cow increased and dairy cattle numbers and farms decreased in Europe and North America. In Africa, local milk availability per capita declined with the exception of Kenya and Tunisia, where it increased through increased dairy cattle numbers and milk yields, respectively. In Asia, local milk availability increased in many countries through imports of cattle (Thailand, Indonesia, South Korea, Saudi Arabia), higher numbers of local dairy cattle (Pakistan, China) and/or improved yields (Israel, South Korea, Indonesia, India). In Latin America, milk per capita increased through higher yields (Argentina, Ecuador, Costa Rica), dairy cattle numbers (Colombia, Bolivia, Guyana) or both (Chili, Uruguay, Brazil) with lower local milk availability per capita in major milk importing countries (Mexico, Cuba, Nicaragua, Peru and the Dominican Republic).

Smallholder dairy development projects in Kenya, Tanzania, Sri Lanka, Indonesia, Colombia and Ecuador recorded improved milk yields over time, a high percentage of cows in milk, reduced adult mortality and especially calf mortalities. Calving intervals were long in all projects, pointing to problems in early lactation nutrition and consequently delays in ovarian activity. Poor heat detection, difficulty in timely arrangements for mating and little follow up in the form of pregnancy tests, as well as farmers' fear for reduced milk yields after breeding all contributed to long intervals. Farm cash income or gross margins varied considerably among countries and farming systems with a contribution from dairying ranging from 29-94%. Major factors that influenced the share of dairying were profitability of crops (higher close to the urban market), producer milk prices (higher in local sales than at collection centres in Kenya, higher in urban than in distant rural areas in Kagera and Tanga regions in Tanzania), and the importance of off-farm income (higher through migration in Ecuador) and farm size (higher in larger units, e.g. demonstration farms in Sri Lanka, and ecological zones in Ecuador). Real dairy income improved in Kenya (1983-1987) through regular and effective milk price reviews, decreased in Kagera, Tanzania (1992-1994) because costs of inputs increased faster than returns from milk, and deteriorated in Sri Lanka (1983-1990) where milk prices lagged behind cost increases and inflation.

World Food Programme supported dairy development projects, formulated generally as a follow-up of missions under the International Scheme for Coordination in Dairy Development, in some countries (Bolivia, India, Tanzania) required more time to be implemented than originally envisaged. In others with high priority and large, additional funding of national governments (Cuba, China), the targets of development were met. Periodic applications of the FAO formula, i.e. price setting of the donated milk products to avoid competition with locally produced milk, were delayed in most countries, to facilitate the financing capacity of the dairy plant and/or to delay the politically sensitive adjustment of consumer prices.

Stimulating dairy development in rural areas has basically two options: either along lines of Operation Flood, i.e. an extended network of collection, cooling centres and feeder-balancer dairies to supply the urban milk plants oriented to the majority of milk consumers and purchasing power. Or, very locally, through-small-scale milk processing into marketable products with longer shelf lives and higher margins that allow long distance transport and distribution to more prospective buyers. Swiss technical cooperation supported a number of rural cheese production projects that provided a remunerative outlet for rural milk. The Netherlands has supported cheese making in parastatal farms (Tanzania and Sri Lanka) and at cooperative level (Colombia) to produce a value-added product or to extend the shelf life of surplus milk. FAO, through its regional training programmes has trained large numbers of technicians, but the biggest challenge remains in organization of quality control of raw milk and cheap packaging and marketing of processed milk.

Organization of inputs, services, training and extension, aimed at small-scale dairy farmers is generally costly in terms of salaries and transport. Moreover, it requires personnel with sufficient knowledge and experience in the complex sector of the dairy industry. Transfer of these inputs and services to the producers on a cost recovery basis has been initiated in various dairy development projects. Most successful attempts were observed in the area of inputs by producer cooperatives (COOPROLACTEOS in Nariño, Colombia and FEDEGARE in the Dominican Republic, the Federation, Union and Village Dairy Cooperatives in India, Dairy Cooperatives in Indonesia and Sri Lanka and a number of producer associations in the Tanga and Kagera regions in Tanzania). Most of the technical services are still being financed by the Government, although larger cooperatives increasingly recruit technicians for AI, first aid and sometimes veterinarians and agronomists in addition to administrative and commercial staff. Smaller ones still require technical, economic and organizational support to benefit from economies of scale.

Under the structural adjustment programmes, most governments are forced to integrate crops and livestock in training and extension into general agriculture to attend to the mixed farming community. Attention to dairy matters is increasingly transferred from local teams towards sector specialists at district and regional level, and calls for more field training of general extensionists to attend to dairy matters in rural areas.

In *Chapter 11*, global developments in population and agriculture are discussed with special attention to worldwide developments in milk production, processing, trade and food aid, and nutritional and gender aspects of dairy development. Further, technical, economic and organizational matters in dairy development are linked with effective government and donor support in price policies, subsidies and other incentives for producers, poverty alleviation programmes and possibilities for dairy stock development by smallholders.

World production of milk, amounting to 364 million tons in 1962, increased to 463 in

1980 (at 1.5% per year) and to 526 in 1993 (at 1.3% per year). Imports of milk products by developing countries increased from 3.5 million tons of milk equivalents in 1962 to 17 million in 1992.

The share of Africa, Asia, Central America and South America with 59% of the world land area, increased from 1980 to 1993 in world population (from 77 to 80%), cattle numbers (from 66.5 to 71.7%), dairy cow numbers (from 50 to 59%), and in total milk from cows, buffaloes, sheep and goats (from 26 to 35.5%).

Annual milk production increased from 1980 to 1993 through more animals and higher yields in buffaloes (1.53 and 2.65%), followed by sheep and goats (0.74 and 0.89%) and dairy cows (0.45 and 0.25%). Regionally, Asia showed the highest annual increase in production of milk from cows (4.62%), buffaloes (4.30%) and sheep and goats (2.92%), followed for cow milk by South America (2.88%), Oceania (2.07%), Africa (2.02%), and North America (1.29%), and reductions in milk production in the former USSR (0.35%), Central America (0.35%) and Europe (0.71%). Local milk availability per capita increased in Asia from 27 to 37 kg, in South America from 101 to 112 kg, but decreased from 34 to 28 kg in Africa and from 90 to 63 kg in Central America.

Chronic undernutrition in 93 developing countries decreased from 941 million in 1970 (36% of the population) via 843 million in 1980 (26%) to 781 million (20%) in 1989 and is projected to decrease to 637 million in 2010 (11%). Insights in human nutrition changed from emphasis on the "protein gap" to "energy density" in feeding vulnerable groups, i.e. children, pregnant and nursing mothers, sick and elderly people. Food aid and also dairy aid was provided in the 1950s and 1960s from surplus to deficit countries by the USA (under Public Law PL480) and the World Food Programme to reduce hunger in the world, but quantities were reduced sharply in the late 1980s in view of reduced surpluses through the introduction of milk quota, and the negative effects of food aid on local production.

Gender issues appeared in development policy, and were increasingly incorporated in dairy development projects. Consultancy missions were often followed by training to sensitize project staff towards attendance for the whole farm family. Incorporation of more female staff to improve access of women to training, extension and opportunities in dairy farming was stimulated, but in practice it was difficult to recruit and maintain qualified female personnel to work in rural areas. Local mobile training with well-timed programmes of short training sessions would encourage attendance by women.

In developing countries, demand for milk is still increasing through urbanization and rising urban incomes, together with more propaganda for milk and a large variety of milk products.

Detailed analysis of development of milk production and dairy stock was complicated by paucity of baseline data in projects, because it requires time to get smallholder's confidence to provide the correct information on land use (several plots and utilization patterns), livestock (various species and sharing arrangements), labour (many activities) and income (many sources). Record keeping requires introduction and intensive follow-up, timely calculation of parameters and informative feedback to make it a useful management tool for smallholders and extensionists. Milk production fluctuates in the course of the year and among years and production of dairy stock is a long-term affair. Technical and economic monitoring is therefore very labour-intensive, while counterpart personnel for this work is often lacking at field level. On the other hand, if extensionists would be more keen on data collection and analysis, their services could be more focused on problem-solving during farm visits. Chest girth measurements by farmers and extensionists and putting these on growth cards would reveal young stock performance at a glance, while it is very difficult to judge it through daily looks or condition scores. Similarly, such measurements applied to cows, would reveal the weight and condition losses in cows after calving, that if timely corrected, could shorten the calving intervals at smallholder farms.

Variations in milk yield were not only attributable to differences among breeds, individual cows and/or lactation number, but were strongly related with concentrate supply, while a cooler climate associated with differences in latitude and altitude, facilitated the expression of high milk yield potential, when cows were-well-fed and managed. The large variation in milk production per ha could not only be explained by differences in climate and pasture type, but were also related to fertilization levels, stocking rates, number of followers kept, and especially supplementary feeding in the form of off-farm feed, both in the form of concentrates, and also in small farms the amount of off-farm roughage collected. Milk production per manday is low on smallholder farms, because of lack of mechanization and relatively high labour inputs in tethering, herding small numbers and/or (off-farm) feed and water collection. Improvements may be possible through introduction of more productive varieties and intensive grassland management, but little recent, quantitative information was available on labour-savings. High requirements in investment and labour in dairy farming and the low financial returns limited the number of dairy cows per farm, and favoured smallholders with sufficient family labour that were able to arrange for simple buildings and a few dairy cattle. Large differences in producer milk prices exist that are more based on the supporting economic environment than on technical possibilities of climate, soils, plants, animals and farmers. Comparative advantages of production of milk and dairy stock are therefore more manmade and depend more on societal desires and financial sacrifices it is prepared to avail for either supporting the working producer or the enjoying consumer. A cashflow from city-have's to the rural have-nots is essential to reduce the population outflow from the rural areas to the city or even abroad. The discussion on subsidies or other incentives is complex, because many economists believe that liberalizing the agricultural world market would put order in demand and supply at the correct price, while farmers and technicians feel, that a more stable, thus regulated economic environment, that allows viable producers margins between revenues and costs, and that directs target-oriented development through production incentives is more attractive for food security, employment, income and wellbeing of both consumers and producers.

I hope that the importance of a long-term remunerative producer price for milk and dairy stock has sufficiently been illustrated in this thesis on development of milk and dairy stock with smallholders.

Long-term efforts in dairy development in developing countries has increased the numbers of dairy cattle and dairy farmers. Also milk yields could be increased, where conducive government policies were directed to producers and their organizations, with opportune credit for dairy stock and farm development, training, extension and veterinary services. Long-term donor support stimulated technology generation and implementation such as the zero-grazing package, forage-crop rotations and small-scale milk processing, and strengthened producers' organizations. In most projects, further strengthening of farmers' organizations is still needed to arrive at more sustainable dairy development with small producers.

Crossbreeding with exotic sires and using the maternal characteristics of heat and disease resistance proved a better road to raise dairy cattle numbers. The organization of AI at field level was critical in supply of semen and liquid nitrogen and timing of service (many indigenous cows show only heat during the night and should be bred the same day. AI schemes have been successful where enough recipient cows of farmers participated and a higher genetic potential could be realized, e.g. in large-scale farms (South America), state farms (India, China, Cuba), parastatal farms (Kenya, Tanzania, Zambia, Zimbabwe). In smallholder areas in Kenya support of Swedish aid was initially quite successful with volkswagen routes but later the almost free service was little sustainable. In South America, Dutch aided AI in PROMEGA, Arequipa and in the Pasto project, Colombia found that participation of smallholders was to low to justify the costs of insemination routes by motor bikes. AIs done by the Veterinary ranges reached only those close the vet's office. Doorstep AI in five states in India by BAIF and in Kerala with support of Swiss Technical Cooperation, was much more successful, but here dairy animals are more confined in villages and more accessible than where farmers have to walk a long distance to bring their animals to a road stall for service.

SAMENVATTING

Tijdens mijn werk in projecten en missies in ontwikkelingslanden heb ik veelvuldig te maken gehad met ontwikkelingen in de melkveehouderij op wereldschaal. Dit wekte mijn interesse in vergelijkende studies van de technische en economische vooruitgang in de sector. Hierbij werd niet alleen gekeken naar de melkproduktie, maar in toenemende mate ook naar de produktie van jongvee, dat de basis vormt voor mogelijke verhoging en uitbreiding van de melkproduktie in ontwikkelingslanden. Melkveehouderij vindt in de geïndustrialiseerde landen doorgaans plaats op gespecialiseerde bedrijven, maar in ontwikkelingslanden, afgezien van in de nomadische veehouderij, voornamelijk op kleinschalige gemengde bedrijven. Dit laatste vormde de aanleiding om de horizontale integratie te onderzoeken van landbouw, tuinbouw, boomteelt en veehouderij en eventueel werk en inkomen uit nevenwerkzaamheden van het boerengezin. Omdat ik zelf afkomstig ben uit de georganiseerde Nederlandse melkveehouderij, die zich kon ontwikkelen onder een politiek redelijk stabiel klimaat voor de producent, met aandacht voor prijzen en investeringsfaciliteiten, was ik ook geïnteresseerd in de organisatie van de melksector in andere landen. Hoeveel ondersteuning levert het drieluik van landbouwonderwijs, -voorlichting en -onderzoek in ontwikkelingslanden. Hoe sterk is de organisatie in de verticale kolom van toelevering, dienstverlening, melkproduktie, -verwerking en -vermarkting en in hoeverre is die in handen van boerenorganisaties.

Het maken van voortgangsrapporten en missieverslagen van projecten en de druk vanuit de academische wereld om te publiceren, hebben mij er toe toegebracht om dit proefschrift te schrijven met als onderwerp "de ontwikkeling van melkproduktie en jongveehouderij met kleine boeren" rondom de volgende vragen:

1) hoe staat het met de technische, economische en organisatorische vooruitgang in de melkveehouderij. Is de melkplas toegenomen door hogere melkprodukties per koe, per ha en per persoon en/of door grotere aantallen melkkoeien en/of melkveehouders;
2) welke mogelijkheden bestaan er voor kleine boeren om melkveehouderij te bedrijven, die leiden tot een hogere nationale graad van zelfvoorziening en minder afhankelijkheid van het buitenland; en
3) op welke manier kan de kleine boer gemotiveerd worden om kalveren en jongvee op het eigen bedrijf op te fokken ter verbetering van de eigen melkveestapel en voor toelevering van dieren naar beginnende melkveehouders.

In *hoofdstuk 1*, dat de mondiale ontwikkelingen over de periode 1980-1994 behandelt, wordt een gemiddelde bevolkingsgroei getoond van 1,7% per jaar, lager dan de hoogste van 2,1% gemeten over de periode 1965-1970. Het aantal mensen dat werkzaam was in de landbouw nam over de periode 1980-1994 nog toe van 2,2 naar 2,4 miljard, hoewel het als aandeel van de wereldbevolking daalde van 49,4 naar 43,4%. Het landgebruik veranderde mee, met een groei van het gewasareaal van 0,13% per jaar en van permanent grasland van 0,31%, ten koste van een afname met 0,22% van het bosareaal en 0,01% van overig landgebruik land (steden, wegen, braakliggend land).

Tussen 1980 en 1994 nam de totale voedselproduktie toe met 30,3% en de produktie van alle gewassen met 29,6%, terwijl de bevolking groeide met 27% en de produktie van veehouderijprodukten met 26,6%. Op jaarbasis steeg de voedselbeschikbaarheid per hoofd van de bevolking met 0,31% aan gewasprodukten en 0,21% aan veehouderijprodukten. De melkveehouderij in de geïndustrialiseerde landen kampt met overproduktie door een dalende effectieve vraag naar melk, terwijl ontwikkelingslanden zitten met een niet gedekte vraag en beperkte buitenlandse valuta voor de import van melk.

In Nederland nam tussen 1930 en 1993/94 de jaarlijkse melkproduktie per koe toe van 3250 naar 6970 kg, terwijl het krachtvoergebruik steeg van 400 tot 2200 kg per koe per jaar. Het kunstmestgebruik op grasland bereikte in 1984, net voor de invoering van het melkquotum, haar hoogtepunt met 315 kg N per ha, waarna het daalde tot 280 kg in 1993/94. Het aantal arbeidsuren per koe is afgenomen van 340 in 1940 tot 40 in de jaren negentig. De gemiddelde melkproduktie steeg tot 10.085 kg per ha in 1984 en tot 266.500 kg per bedrijf in 1993/94, terwijl het aantal melkveebedrijven daalde van 185.000tot 40.500in de periode 1960-1993/94. Het netto bedrijfsresultaat in de melkveehouderij is negatief, omdat melksaldo en omzet en aanwas de totaal berekende kosten van pacht, kapitaal en gezinsarbeid niet volledig dekken. De overgebleven melkveehouders weten het hoofd boven water te houden door lage gezinsuitgaven, terwijl afschrijvingen en spaargelden worden gebruikt voor vervanging en investeringen in het bedrijf. Er bestaan grote verschillen in resultaten tussen verschillende regio's en tussen verschillende bedrijfsstijlen per regio, maar de grootste spreiding wordt veroorzaakt door verschillen in individuele gezinssituatie en bedrijfsvoering.

In 1992 bedroeg het aandeel van de melksector in het agrarisch bruto nationaal produkt ongeveer 25% in Nederland, Duitsland, Frankrijk en Denemarken, tegen slechts 10% in Nieuw Zeeland, Australië en Amerika. Van deze landen heeft Nederland de kleinste bedrijfsomvang met de hoogste melkopbrengst per koe, per ha en per mandag. Nieuw Zeeland heeft de hoogste veebezetting met 2,3 koe per ha, de laagste voeruitgaven en vaste kosten voor land, stallen en groenvoerwinning per liter melk, en de laagste melkprijs voor de producent. In de Verenigde Staten bestaan grote regionale verschillen in de melkveehouderij met gezinsbedrijven in het noordelijke, centrale en oostelijke deel en grote commerciële bedrijven in het westen en het zuiden. Er hebben zich hier grote verschuivingen voorgedaan van melkvee naar vleesvee, dat na een weideperiode wordt afgemest op grote gespecialiseerde bedrijven (feedlots) op basis van aangekocht ruw- en krachtvoer.

De melkveehouderij kent premies voor de produktie van consumptiemelk, zoals de wintermelktoeslag in Nederland, de stadsmelktoeslag in Oceanië en de A-melkprijs in de VS, die hoger is naarmate de afstand tot Wisconsin, traditioneel het centrum van melkproduktie, groter is.

De melkveehouderij in (sub)tropische gebieden vertoont zeer grote verschillen in melkopbrengst per koe, variërend van enkele honderden liters bij nomaden en voor inheems vee tot 6.000-9.000kg voor geïmporteerde zwartbonte koeien op commerciële melkveebedrijven in olieproducerende landen (Saudi Arabië, Libië). De technische en economische kenmerken van melkveehouderijbedrijfssystemen in ontwikkelingslanden aan het begin van de tachtiger jaren, variërend van extensieve beweiding met lokaal vee tot zomerstalvoedering met gekruist vee, zijn verzameld voor Kenya, Sri Lanka, Colombia en een aantal produktiesystemen in Zuid-Amerika. De jaarlijkse melkproduktie per koe (170-3500kg), per ha (200-11000kg) en per mandag (2-132 kg) varieerde sterk. De bedrijfssaldo's in US$ per jaar varieerden per mandag (0,35-66), per ha (50-1200) en per 1000 US$ aan investeringen (45-1150).

In *hoofdstuk 2* wordt nader ingegaan op de kenmerken van melkveehouderijsystemen, zoals produktie voor eigen gebruik en/of verkoop, de seizoensgebondenheid en de niet-produktieve perioden (droge tijd, droogstand, opfokperiode van kalveren en jongvee), en de rol van vraag en aanbod op de lokale en de wereldmarkt met de bijbehorende prijzen voor melk en vee. Technische karakteristieken van de melkveehouderij, zoals de leeftijd bij eerste afkalven, lactatieperiode en melkproduktie en tussenkalfleeftijd, zijn geanalyseerd voor buffels en rundvee in de tropen.

De leeftijd bij eerste afkalven is in warme streken hoger dan de 24 tot 30 maanden in de gematigde streken, zoals bij melkbuffels (38-47 maanden), inheemse buffels (tot 57 maanden), Indische melkveerassen (40-58 maanden), inheems vee (tot 54 maanden), kruisingsvee (30-46 maanden) en exotisch melkvee (27-36 maanden). Tussenkalftijden, variërend van 381 tot 638 dagen zijn veel langer dan de aanbevolen 365 dagen. Dit, samen met de hoge leeftijd bij eerste keer afkalven, beperkt het jaarlijks aantal geboren kalveren in een kudde. Kalversterfte in de tropen varieert van 10 tot 45% en is veel hoger dan de 7 tot 16% in de gematigde streken. Hoofdoorzaken zijn de hoge ziektedruk, de lage voerniveau's en de lage kalverprijzen voor vlees en/of de fokkerij.

Vaarskalveren van melkrassen en stierkalveren van trekkrachtrassen krijgen over het algemeen de beste behandeling bij de opfok. Concurrentie voor melkconsumptie door het kalf treedt op als herders worden betaald in melk, als de voedselvoorziening van het gezin is gebaseerd op melk, zoals bij nomaden, en als het inkomen afhankelijk is van de verkoop van melk. Dit beperkt het melkgebruik voor kalveropfok, en in combinatie met weinig of geen extra voer voor en speciaal na het spenen, resulteert dat in trage groei, wat leidt tot verhoogde gevoeligheid voor ziektes. Lage kalverprijzen zijn bijv. het gevolg van geen of een geringe consumptie van rundvlees door Hindoes en Boeddhisten en/of de lage lokale en wereldmarktprijzen voor vlees. De wens van de overheid in veel ontwikkelingslanden om de prijs voor vrouwelijk fokvee laag te houden, zodat meer mensen met melkveehouderij kunnen beginnen, drukt de animo voor een goede opfok van vrouwelijk jongvee door kleine boeren, en beperkt de produktie van extra fokmateriaal boven hetgeen nodig is voor vervanging op grote bedrijven.

In Nederland daarentegen bestaat een ruime markt voor jongvee met goede prijzen. Stierkalveren hebben waarde voor de produktie van wit, roze en rood vlees, terwijl vaarskalveren boven het vervangingspercentage worden opgefokt voor export of verkocht voor vleesproduktie. De gestegen aandacht voor kalveropfok in onderzoek en voorlichting, naast de grootschalige introductie van Noord Amerikaans bloed en het verstrekken van meer volle melk tijdens de opfok na de introductie van het melkquotum, hebben geresulteerd in een betere kalveropfok leidend tot een hoger gewicht, een lagere leeftijd bij eerste keer afkalven en een hogere melkproduktie.

In de tropen zijn, afhankelijk van breedtegraad en hoogteligging en de ziektedruk, de geboortegewichten lager dan in de gematigde streken. Het inheemse vee weegt tussen de 200-300 kg bij het eerste afkalven. Exotisch melkvee kalft voor de eerste maal af bij een gewicht van 350-450 kg en kruisingen op een gewicht van 300-400 kg.

In Nederland is de produktieve levensduur kort, met gemiddeld drie lactaties en een opruimleeftijd van 5 jaar. In de tropen is de levensduur veel langer, maar het aantal kalveren is beperkt tot 3-5 met uitzondering van 6 tot 10 kalveren in dorpskuddes in India en Nepal, waar nauwelijks opgeruimd noch geslacht wordt. Omdat in de tropen ongeveer 3 kalveren nodig zijn om een klamvaars te produceren ter vervanging van de moederkoe, bestaat er dus weinig armslag voor selectie binnen het vrouwelijk jongvee, en moeten genetische verbeteringen vooral uit de mannelijke lijn komen.

Na de succesvolle introductie van exotisch melkvee in de tropen aan het begin van de twintigste eeuw door Europese boeren, militairen en missionarissen, begonnen veel ontwikkelingslanden na hun onafhankelijkheid in de jaren 1940-1960, met de import van melkvee om te voldoen aan de snel groeiende vraag naar melk in de steden. Deze dieren waren niet aangepast aan de combinatie van tropische hitte en hoge vochtigheidsgraad en bleken zeer gevoelig voor ziekten. Dit resulteerde in hoge sterfte en veel gevallen van abortus met als gevolg een lage produktie van melk en jongvee, vooral bij de kleine boer.

Op de (semi)staatsbedrijven werd verder gewerkt aan de introductie en het vergelijken van exotische rassen onder betere voedings- en gezondheidsomstandigheden. In een aantal landen ging men over tot kruisen met lokaal vee, wat leidde tot een aantal synthetische rassen met min of meer vaste eigenschappen, zoals de Jamaica Hope, Siboney in Cuba, Chinese Black and White, Sunandini, Karan Swiss en Karan Fries in India, Friesian Sahiwal en Australian Milking Zebu in Australië.

Een aantal landen begon in de zestiger jaren met door donoren gesponsorde KI op bedrijfsniveau. Successen werden geboekt in Kerala na een lange projectondersteuning door Swiss Technical Cooperation, en in Kenya met hulp uit Zweden. In andere landen, bijv. Ethiopië en Tanzania, kruiste men lokaal vee (Boran, Small East African Zebu) op semi-overheidsbedrijven met exotisch sperma en/of stieren voor de produktie van F1's voor de kleine boer. Import van melkvee werd voortgezet in het Midden-Oosten en Noord Afrika, gebruik makend van "oliegeld" en privékapitaal om zelfvoorzienend te worden in melk. Grote melkveebedrijven werden opgezet met geïmporteerd vee, huisvesting, machines, krachtvoer en zelfs buitenlands management (met uitzondering van Tunesië, waar lokaal management werd opgeleid).

Grote aantallen exotisch melkvee zijn ook geïmporteerd in Indonesië, hoofdzakelijk voor kleine boeren, ondersteund door goedkope, langlopende kredieten. De melkproduktie is echter ver onder de genetische potentie van de dieren gebleven en de interne generatie van vee is zeer beperkt.

In *hoofdstuk 3* worden de ervaringen van kredietverlenende instanties en internationale organisaties met melkveehouderijontwikkeling weergegeven. Hierbij zijn ook meegenomen de ervaringen die zijn uitgewisseld op internationale workshops en seminars, en de veranderende kijk op plattelandsontwikkeling. Ontwikkelingsbanken noemen de volgende factoren bepalend voor succes in veehouderijontwikkeling: adequate stimulansen en ondersteunende dienstverlening voor de producent, het gebruik van aangepaste technologie en de institutionele capaciteit in planning en implementatie. Falen van projecten wordt toegeschreven aan verkeerd economisch beleid, bijv. overgewaardeerde ruilvoeten die geïmporteerde produkten en technologie aantrekken, gecontroleerde prijzen die de politiek actieve en veeleisende consument beschermen, en zwak management van melkverwerking en vermarkting door semi-overheidsbedrijven. Veelbelovend zijn de ontwikkeling van de (peri)urbane melkveehouderij in West en Oost Afrika, projecten met lokale melkverkoop door kleine boeren direct aan de consument, en de zuivelprojecten in India die een efficiënt, gelaagd coöperatiesysteem hebben ontwikkeld met een brede reeks van diensten voor miljoenen boeren, dat miljoenen liters melk per dag verzamelt, verwerkt en vermarkt. Aangepaste technologie betekent een goede onderlinge afstemming van ras, klimaat en beschikbare voerbronnen, en handmatige werkzaamheden om te profiteren van goedkope gezinsarbeid en rurale arbeidskrachten. Commerciële melkveehouderij slaagt alleen daar, waar de melk-krachtvoer prijsverhouding hoger ligt dan 1,5. Institutionele successen zijn geboekt in projecten, die geïnitieerd zijn door de doelgroepen en aansluiten op hun behoeften, en zijn toegesneden op het specifieke produkt en gebied door het land zelf, voordat projectassistentie werd aangevraagd. Successen in de uitvoering vragen om ervaren personeel met geïnstitutionaliseerde vergoedingen, en getrainde, goed georganiseerde boeren onder leiding van gemotiveerd projectmanagement. Essentieel daarbij zijn een adequate voervoorziening, een effectieve diergezondheidszorg en een goed georganiseerd netwerk van melkophaal, -verwerking en -vermarkting, zonder verstoringen door importen, en een kredietvoorziening die een winstgevende produktie mogelijk maakt.

De Voedsel- en Landbouworganisatie (FAO) verlegde haar aandacht van technische ondersteuning voor urbane melkfabrieken (vijftiger en zestiger jaren), naar trainingsprogramma's door regionale zuivelontwikkelingsteams (gesteund door DANIDA van 1960 tot 1990) en technische missies onder het internationale programma voor de coördinatie van zuivelontwikkeling (gesteund door FINNIDA van 1972 tot 1990), die meestal werden gevolgd door projecten met assistentie van het Wereldvoedselprogramma (WFP). Na overleg met internationale zuiveldeskundigen in 1984, besloot de FAO tot het opzetten van model zuivelprojecten voor geïntegreerde ontwikkeling van produktie, verwerking en vermarkting (opgesplitst in modules) met kleine boeren in vier verschillende regio's. De eerste ervaringen in Tanzania en Ecuador zijn redelijk positief. De FAO ondersteunt voorts de lokale fabricage van "molasses-ureum-multinutrient" blokken om de lokale voervoorziening voor melkvee te verbeteren, en assisteert bij de kwaliteitsverbetering bij melkverwerking tot inheemse melkprodukten op dorpsniveau.

Het WFP ondersteunt, door middel van lokale verkoop van geschonken melkprodukten, de ontwikkeling van een economisch levensvatbare lokale zuivelsector. Consumptiemelk kan tegen lagere prijzen binnen bereik van een groter publiek worden gebracht d.m.v. het subsidiëren van gepasteuriseerde melk, met middelen verkregen uit de hogere marges op andere melkprodukten. De nadruk ligt op het stimuleren van economische groei bij kleine boeren en het terugdringen van armoede op het platteland, door arbeidsintensieve melkveehouderij, die inkomen en werkgelegenheid creëert. Ontwikkeling van de melkveehouderij door middel van zuivelhulp dient voorts gepaard te gaan met ondersteuning op technisch en management gebied, analyse van het zuivelbeleid en buitenlandse valuta, indien lokale fondsen niet vrij converteerbaar zijn.

Het internationale congres in Anand, India (1989) constateerde een snelle melkproduktietoename in Azië door versterking van producentencoöperaties in India, Thailand and Indonesië, hoge producenten prijzen in Japan, Taiwan en Zuid Korea, en een snelle toename van melkvee op staats- en vooral op privé melkbedrijven in China. In Afrika werden grote regionale verschillen geconstateerd in beschikbaarheid van lokale melk en melkimporten. De meeste organisaties die zich in Afrika met melkveehouderijontwikkeling bezig hielden, waren sterk gelieerd aan de staat, met een lage melkophaal door de (semi)overheids melkfabrieken, terwijl op het platteland hogere melkprijzen werden betaald door tussenhandel en/of consument. In Zuid Amerika waren de regionale verschillen ook zeer groot met veelbelovende ontwikkelingsmogelijkheden voor rurale kaasfabriekjes in Peru en Ecuador, melkproducenten-coöperaties in Bolivia en het model zuivelproject in Ecuador.

Het zuivelcongres in Wageningen, Nederland (1991) illustreerde de grote variatie in melkconsumptie in de wereld als gevolg van het voorkomen van lactose-malabsorptie en het kritische inkomensniveau van US$ 500 dat noodzakelijk is, wil het aandeel van veehouderijprodukten in het dieet sterk toenemen. Voorts werd de bescherming van de melkproducenten getoond in de tachtiger jaren in de verschillende melkproducerende blokken, alsmede de trends in melkproduktie met 1-1,5% toename per jaar in de geïndustrialiseerde landen en 4% in ontwikkelingslanden.

De internationale workshop in Wageningen, Nederland (1992) voor beleidmakers in de veehouderij benadrukte de veelzijdige functies van vee en de behoefte om de lokale produktie te stimuleren om redenen van voedselzekerheid, werkgelegenheid, inkomensvorming en een gelijkere verdeling daarvan. Dit betekent een beleidsverandering in ontwikkelingslanden, weg van de huidige focus op consumenten, maar richting kleine producenten op het platteland met de nodige aanpassingen in prijzen, handel, krediet, landgebruik en gebruiksrechten. Op technologische vlak lag de grootste uitdaging in de ontwikkeling van lokale voerbronnen en verbeterde voersystemen in de nomadische, gemengde en intensieve veehouderij en op ranches.

De discussie in de regionale workshop in Jamaica (1992) over zuivelontwikkeling in het Caraïbisch gebied benadrukte de hoge kosten van import van veehouderijprodukten en veevoer die teruggebracht zouden kunnen worden door een ander economisch beleid ten gunste van meer werkgelegenheid en inkomen uit kleinschalige melkveehouderij, gebruik makend van lokale gewasresten en onderbenut grasland.

Het internationale congres in Harare, Zimbabwe (1993) over beleid en praktijk in zuivelontwikkeling en uitwisseling van ervaringen op dit gebied tussen Afrika en Azië, kwam met de volgende aanbevelingen: een duidelijk lange termijn zuivelbeleid, een minimum aan directe overheidsbemoeienis in de sector, meer technische samenwerking tussen ontwikkelingslanden en de oprichting van een regionaal netwerk van relevante trainingsinstituten. Er bleek behoefte aan technologieontwikkeling op het gebied van de houdbaarheid van verse melk en goedkopere verwerking, verpakking en distributie van melk. Aanbevolen werd om zuivelprojecten in modules op te splitsen en nadruk te leggen op de ontwikkeling van ondersteunende dienstverlening, stiergerichte fokkerij en trainingen gericht op verbeterde produktiviteit van kleine veehouderijbedrijven door intensiever gebruik te maken van groenvoer en gewasbijprodukten. De organisatie van de melklijn tussen producenten en consumenten vereist de volledige inschakeling van de boerenorganisaties.

De nadruk bij plattelandsontwikkeling veranderde van produktieverhoging via grootschalige bedrijven voor produktie van voldoende voedsel en een surplus voor export, naar meer aandacht voor voedselgewassen op kleine bedrijven met moderne inputs (groene revolutie). Gemeenschapsontwikkeling om het welzijn van de plattelandsbevolking te verhogen, ondersteunde de opbouw van lokale organisaties. In de loop van de tijd werd meer aandacht besteed aan machtsverhoudingen (landverdeling) en sociaal-economische ongelijkheden (vermindering van armoede) in geïntegreerde regionale ontwikkelingsprojecten. Vervolgens werden ook milieuaspecten, de positie van de vrouw en de planningscapaciteit op lokaal niveau ingebracht in streekontwikkeling (district, stroomgebied). Voor de melkveehouderijsector die vaak verticaal is georganiseerd binnen het ministerie van landbouw, betekent streekontwikkeling gebaseerd op lokale horizontale lijnen vaak conflicten in de personele bezetting en uitvoering.

Bank- en donorfinanciering van grootschalige melkveehouderijbedrijven verminderde sterk in de loop van de tijd als gevolg van tegenvallende resultaten. De kostprijs van melk was veel hoger dan de prijzen voor (gedumpte) melkprodukten. De prijsverhouding tussen melk en krachtvoer was vaak ongunstig als gevolg van overheidspolitiek om de melkprijs laag te houden, met aan de andere kant hoge voerprijzen door stimulering van de export. Kleinschalige melkveehouderij op basis van goedkope gezins- en rurale arbeid, met gebruik van lokaal verbeterd voer voor een kruisingskoe en melkverkoop direct aan de consument lijkt de beste optie voor verbetering van de lokale melkproduktie.

Nederlandse ervaringen met ontwikkelingssamenwerking in de melkveehouderij in Afrika (Kenya, Tanzania) en Azië (Sri Lanka, India and Indonesië) werden besproken in *hoofdstuk 4* en die in Zuid Amerika in *hoofdstuk 5 en 6*. Lessen getrokken uit de ondersteuning van rundveehouderijprojecten over de periode 1974-1984 werden in 1987 opgetekend door de Inspectie te Velde en gebruikt voor formulering van nieuw beleid (gepubliceerd in 1992). Noch de Nederlandse veeëxporten, noch de steun aan grootschalige melkveehouderijbedrijven in de zeventiger jaren bleken successen. De aanpassing van exotisch vee aan lokale condities van voer en management was problematisch in de warme, vochtige tropen. Gemechaniseerde grootschalige melkveehouderij was ten dode opgeschreven door gebrek aan buitenlandse valuta voor onderdelen en vervanging van machines.

Ondersteuning van kleinschalige melkveehouderij vereiste proefperiodes of -projecten, om te bewijzen dat verbeterde voeding van lokaal zwartbont vee (Zuid Amerika) en stalvoedering van gekruist vee (Afrika en Azië) winstgevend kon worden uitgevoerd door kleine boeren. De meeste projecten bestonden uit een combinatie van training, voorlichting en toegepast onderzoek met een kredietcomponent en hadden waar mogelijk een bron voor de produktie van verbeterd vee, en een melkverwerkingscomponent in regio's met een melkoverschot. Monitoring van technische en economische parameters werd in de meeste projecten na enige tijd toegevoegd om de gegevensverzameling te stroomlijnen, de gegevens sneller te analyseren en te benutten voor voortgangsrapportage, sturing van project en formulering van advies op bedrijfsniveau.

Het Pasto project in Colombia richtte haar aandacht in de tweede fase (1978-1984) op de horizontale integratie van melkvee met akkerbouw, tuinbouw, boomteelt en andere diersoorten (*hoofdstuk 5*). De grote verscheidenheid aan combinaties van land, arbeid, verschillende gewassen en diersoorten bij de kleine boeren vereiste een gevarieerd assortiment aan mogelijke verbeteringen, terwijl de mate van adoptie van deze pakketten door de kleine boer sterk samenhing met zijn gezinsomstandigheden en prijsveranderingen. Verbeteringen in marktgewassen met lage arbeidsbehoeften werden vaak snel door grote bedrijven overgenomen, terwijl de kleine boer uit de markt werd geprijsd. Arbeids- en/of managementintensieve marktgewassen zoals stengelui en knoflook boden meer mogelijkheden voor kleine boeren. De caviahouderij die in handen was van vrouwen, was moeilijk te kopiëren door grote bedrijven omdat de dieren constant voer en aandacht vereisen. Bovendien werden de kosten van verbeteringen in de caviahouderij snel goedgemaakt door de hoge prijs voor cavia's, dit in tegenstelling tot de minieme of negatieve marges op investeringen in de konijnen-, varkens- en pluimveehouderij op het platteland. Begeleid krediet met het bedrijf als onderpand werd gebruikt voor gewassen, maar de geldopname was vaak gelijk aan wat het gewas minimaal opbrengt in slechte jaren. Bij de opname van melkveehouderijkrediet werd rekening gehouden met een gegarandeerde produktie van kalveren uit bestaand en geleend vee. Graslandverbetering vond plaats in een tweejarige rotatie met marktgewassen om te profiteren van achtergebleven fosfaat op aardappelland en van stikstofnalevering na grasland.

Verticale integratie van melkproduktie, -verwerking en -vermarkting is geanalyseerd in *hoofdstuk 6*. Het betrof de steun aan de coöperatieve zuivelindustrie in Nariño, Colombia en die aan het model zuivelproject in Cañar, Ecuador. Grote struikelblokken op macro-niveau vormden de importen van goedkoop (gedumpt) melkpoeder door of namens de regering en de prijsregulering ten gunste van de consument. Op micro-niveau waren het de geringe liquiditeit en de zwakheden in management en organisatie van beginnende groepen/coöperaties. De op gras gebaseerde melkproduktie is sterk seizoensgebonden, met de noodzaak tot verwerking van het overschot in de regentijd tot produkten als melkpoeder om tekorten te compenseren in de droge tijd en/of tot produkten met toegevoegde waarde zoals kaas met afzet naar de meer koopkrachtige consument. Slecht geplande importen veroorzaakten "melk vakanties" met geen of gedeeltelijke melkophaal, terwijl gelijkblijvende melkprijzen in de droge en natte tijd niet bevorderlijk zijn voor produktieverschuiving naar het seizoen met te weinig melk. Kleine boeren met een melkoverschot die geen eigen ophaal/koeling of verwerkingscapaciteit hebben, worden vaak uitgespeeld door de tussenhandel die er belang bij heeft afnemers, consumenten of de particuliere industrie, goedkope melk te leveren met voldoende eigen marge. Zelfs wanneer donors voorzien in ophaal/koeling- of verwerkingscapaciteit, kost het nog veel tijd en technische en organisatorische ondersteuning om een goed functionerende groep of coöperatie op te zetten, zelfs wanneer er naast kleine boeren ook grote en middelgrote boeren bij betrokken zijn, zoals bij COOPROLACTEOS in Colombia. Het vinden van adequaat management, het ontwikkelen van aangepaste verwerkingstechnologie en op tijd betalende, aantrekkelijke vermarktingskanalen en met name het creëren van voldoende operationele fondsen, het invoeren van kwaliteitsbepalingen en kwantiteitsafspraken vergden veel tijd en technische assistentie. Een stap-voor-stap benadering in de uitbreiding van het project, waarbij zowel COOPROLACTEOS als de donor/bank zich committeerde, bleek uiteindelijk de moeite waard, en resulteerde in een brede, sterke producentenorganisatie, die de melkprijs in de regio bepaalde op basis van met name de hygiënische geproduceerde kaas van hoge kwaliteit.

Een soortgelijke stap voor stap benadering wordt toegepast in het model zuivelproject in Cañar, Ecuador. Participerende boerengroepen krijgen een melkophaal/koelingcentrum of melkophaal/kaasfabriekje in bruikleen van het project om door verzameling, koeling en/of verwerking van hun melk een hogere melkprijs te kunnen bedingen. Bovendien vergemakkelijkt een additionele ruimte bij het centrum de groepsaankoop van inputs. Groepen kunnen op deze manier onderhandelingservaring opdoen, hetgeen hopelijk leidt tot een sterke overkoepelende organisatie van kleine boeren die een vuist zou kunnen maken in onderhandelingen over de melkprijs en bij de eventuele oprichting of overname van een melkfabriek.

Tekort aan verbeterd vee was, behalve in Zuid-Amerika, vaak een beperkende factor In melkveehouderijprojecten met kleine boeren. In het begin werden verbeteringen vaak geïntroduceerd bij de betere ondernemers die het risico van investeringen in verbeterd vee, huisvesting en voervoorziening wel aandurfden. Om ook armere boeren te laten participeren, werden er financieel aantrekkelijke mogelijkheden gecreëerd. Een projectkredietfonds met lage rente, later gevolgd door een speciaal kredietprogramma voor kleine boeren (bedrijven met minder dan 10 ha en meer dan 70% van het inkomen uit het landbouwbedrijf) werd gebruikt in het Pasto project in Colombia. In Ecuador werden projectboeren geholpen bij de aanleg van nieuw grasland door eerst op gezamenlijke rekening met het project een handelsgewas te telen. Het subsidie (grant) programma in Kenya gaf meer assistentie naarmate het totale bedrijfsinkomen en de melkprijs lager waren, en meer bij eenmaal dan bij tweemaal melkophaal per dag. In Sri Lanka maakte een rentevrije lening voor een klamvaars het mogelijk dat arme boeren op verlaten, marginale gronden met vee konden beginnen op hun landbouwbedrijfje. In verschillende landen worden vaarzen in bruikleen gegeven door Heifer Project International (HPI) aan arme mensen om ze aan een inkomen te helpen, onder de verplichting dat ze een eerste drachtige afstammeling doorgeven aan de volgende in de groep. Dit gebeurt ook in de melkveehouderijprojecten in Tanzania, om arme vrouwen en rurale gezinnen te helpen met de introductie van melkvee op basis van stalvoedering.

Voerontwikkeling richtte zich aanvankelijk op Napier gras (Kenya), Guatemala gras (Kagera, Tanga), Guinea gras, Gliricidia en rijstestro (Sri Lanka), en later ook op vlinderbloemigen, voederbomen en de ontsluiting van laagwaardig ruwvoer. Uitwisselingsbezoeken tussen projecten, hoewel de Nederlandse overheid dat niet altijd nuttig vond, dit in tegenstelling tot het projectpersoneel, resulteerden in de introductie van een breder scala aan voeders en/of een meer compleet ruwvoerrantsoen gedurende het jaar.

In *hoofdstuk 7* zijn de resultaten over 1985-1992van geïntegreerde akkerbouw-veeteelt op drie kleine demonstratie en training bedrijfjes van het Mid Country Livestock Development Centre (MLDC) in Sri Lanka vergeleken met de prognoses in de haalbaarheidsstudie. Op een stuk verwaarloosd, verlaten land werd het Kandyan Forest Garden System nagebouwd in 0,2, 0,4 en 0,8 ha demonstratie-eenheden, representatief voor de bedrijfsoppervlakte van boeren in de Mid Country. De gewassen werden verbouwd met een tussenbeplanting van gras, dat samen met bladvoer van de omheining het ruwvoer produceerde voor 1, 2 of 3 koeien en hun jongvee. Het vee voorzag in een regelmatig inkomen uit melk, in mest voor biogasproduktie en vloeibare mest om de bodemvruchtbaarheid te verbeteren. Elk bedrijfje werd gerund door een geselecteerde MLDC arbeider en zijn gezin, die van zijn salaris de lopende kosten betaalde, en elke maand de opbrengst kreeg na aftrek van pacht, vermarktings- en investeringskosten. Aanleg en supervisie was de verantwoordelijkheid van de MLDC staf, die ook de monitoring van alle technische en economische details verzorgde van zowel de gewassen (groenten, bananen, peper, koffie, kokosnoot en citrus), als het vee (lokale koeien, geiten en commerciële leghennen en slachtkuikens). Melkvee en geiten bleken aantrekkelijk uit economisch oogpunt met een hoge arbeidsproduktiviteit, maar ook een hoge kapitaalbehoefte. Belangrijke nevenopbrengsten waren het biogas, dat voldoende was om te voorzien in de behoeften van het huishouden, en de vloeibare mest voor grondverbetering. Commerciële pluimveehouderij leverde gemiddeld weinig op, door de sterk fluctuerende jaar- en seizoensprijzen. De opbrengsten van groenten en bananen namen af na het vierde jaar, hetgeen rotatie met gras en/of een hogere compostproduktie en -aanwending nodig maakte. De gewasopbrengst per m^2 was het hoogst op het kleinste bedrijf, dat de hoogste veebezetting had. Vergelijking met de haalbaarheidsstudie toonde aan dat de arbeidsinzet hoger was dan gepland, en de kapitaalvergoeding was lager dan het heersende rentepercentage. Een gefaseerde investering via éénjarige gewassen, aangevuld met meerjarige gewassen en gevolgd door de introductie van vee lijkt in dergelijke gevallen beter en ook meer in lijn met de aanpak van de kleine boer om stap voor stap zijn bedrijf te verbeteren en grote risico's te vermijden.

In *hoofdstuk 8* zijn de financiële, technische en economische resultaten van de introductie van melkvee op verlaten, marginale theegrond (0,2 tot 0,8 ha) geanalyseerd. In 1993 is een enquête uitgevoerd onder 76 projectboeren (en 19 controleboeren) die tussen 1984 en 1990 een rentevrije lening voor een koe hadden ontvangen om voldoende en regelmatig inkomen te genereren uit hun bedrijfjes. De afbetaling van de lening in 36 maandelijkse termijnen vanuit de melkopbrensten verliep goed, maar met gemiddeld 2,95 lactaties per projectkoe vond een deel van de afbetaling plaats via melk van de afstammelingen en/of via inkomsten van buiten het bedrijf. Op 93% van de projectbedrijven was nog melkvee aanwezig terwijl 77% in de maand van de enquête melk had verkocht. Per gezin werd dagelijks 0,6 kg melk gebruikt voor huishoudelijke consumptie. De verkoop van melk bepaalde voor 66% het bedrijfsinkomen voor projectboeren en voor 81% van controleboeren, terwijl de bijdrage aan het gezinsinkomen respectievelijk 32 en 46% bedroeg. Mest van melkvee werd door 64% van de boeren als belangrijkste factor genoemd voor de verbetering van de bodemvruchtbaarheid van hun grond. De gewassen waren voornamelijk voor zelfvoorziening en droegen slechts in geringe mate bij aan het inkomen (groenten en meerjarige gewassen). De boeren waren nog wel afhankelijk van inkomsten van buiten het bedrijf en van voedselbonnen van de regering om in hun levensonderhoud te kunnen voorzien.

In *hoofdstuk 9* zijn de resultaten van een reeks jongveeprogramma's in Sri Lanka onderzocht. Vermenigvuldiging van fokmateriaal (puur en gekruist vee) op (semi)-overheidsbedrijven (1981-1993) resulteerde per jaar in een verkoopbare produktie van mannelijk en vrouwelijk fokvee van 7% per gemiddeld aanwezig stuks rundvee en van 7,5% voor buffels. Per gemiddeld aanwezige fokkoe betekende dat een verkoopbare jaarproduktie van 10% vaarzen bij rundvee en 8,5% bij buffels. Ter vergelijking, de produktie van kruisingsvaarzen op basis van *Bos taurus* sperma en *Bos indicus* koeien op ranches in Tanzania bedroeg 10-12,5% per aanwezige fokkoe, maar jaarlijks moesten er ongeveer 100 stuks *Bos indicus* per 1700-2000 fokkoeien worden bijgekocht om de oorspronkelijke kudde op peil te houden.

Opfok van surplus kalveren van kleine boeren en semi-overheidsbedrijven die plaats vond op twee semi-overheidsbedrijven werd bemoeilijkt door de lage kwaliteit van de aangeboden kalveren, de omschakeling van zuigen bij de koe naar kunstmatige opfok en door de verplichte afzet tegen prijzen die de opfokkosten niet dekten. De produktie bedroeg gemiddeld 100 en 131 drachtige vaarzen per bedrijf per jaar (1980-1988). Daartegenover bleek het kalveropfokprogramma van MIDCOMUL (Mid Country Milk Producers Union, Ltd) bij kleine boeren veel produktiever. Bij inspectie van 321 melkvaarzen van het project op een gemiddelde leeftijd van 33,9 maanden bleken er nog 164 moederdieren op het bedrijf aanwezig te zijn. Over de periode van 33,9 maanden betekende dat een extra produktie van melkgevende vaarzen boven vervanging van 18% per koe per jaar, veel hoger dan de produktie aan surplus fokmateriaal in (semi)overheidsbedrijven in Sri Lanka en ranches in Tanzania.

Zeven kalveropfokprogramma's bij kleine boeren in Sri Lanka zijn geanalyseerd waarin de volgende stimulansen werden geboden: (i) een diergezondheidspakket in het "calf health care scheme" (CHCS), (ii) prijssteun voor het verschil in kosten en opbrengsten bij verplichte verkoop aan andere boeren in het "contract heifer breeding and raising scheme" (CHBRS), (iii) 50% subsidie op kalvervoer maandelijks afgeleverd op het bedrijf tot aan het afkalven of tot 32 maanden (Kerala), (iv) gratis constructiemateriaal voor een kalverhok en gratis ontwormen en mineralen in het voorbeeldproject in Rikilligaskada en Galaha (PPRG), (v) prijzen in kalveropfokwedstrijden georganiseerd door de grotere melkproducentenassociaties (DPA's), en (vi) bonus betalingen bij het bereiken van streefmaten voor de borstomvang op 2, 4, 6 en 10 maanden (Matale) of (vii) driemaandelijks tot 18 maanden met een extra bonus voor afkalven onder de 30 maanden op het eigen bedrijf (MIDCOMUL). De kalversterfte was laag tussen de 2 en 8%, de groei bedroeg gemiddeld 300 g/d en de leeftijd bij eerste afkalven lag rond de 30 maanden, vergeleken met gemiddelden tussen de 36-48 maanden op semi-overheidsbedrijven. De meeste controle kalveren hadden op een leeftijd van 6 maanden het boerenbedrijf reeds verlaten en konden zelfs in het gebied niet meer getraceerd worden.

Niet alle projectboeren bleken even goede kalveropfokkers. Grote groeiverschillen werden gevonden tussen de 25% dieren met de hoogste (meer dan 300 g/d) en de 25% met de laagste groeisnelheid (minder dan 200 g/d). De groei in het tweede jaar was aanzienlijk lager, met name in programma's met onvoldoende steun zoals alleen het gezondheidspakket in het CHCS en geen vergoeding meer in Matale. Programma's moeten daarom de gehele opfokperiode ondersteunen om te resulteren in goed ontwikkelde vaarzen die op jeugdige leeftijd afkalven.

In het MIDCOMUL programma konden 164 vaarzen met complete gegevens van de per kwartaal gemeten borstomvang, leeftijd bij afkalven, rastype, bedrijfslokatie en de gegevens over de gevolgde kalveropfok worden vergeleken met hun moeders in borstomvang tijdens een bedrijfsinspectie, en met gegevens over de piek melkproduktie en bijbehorende krachtvoergift. De vaarzen hadden op een gemiddelde leeftijd van 33,9 maanden bij inspectie reeds 95,5% van de borstomvang (standaard in Nederland is 87%) en 75,4% van de piek melkproduktie (standaard 79%) bij 94,1% van de maximale krachtvoergift van de moeders.

Stapsgewijze regressie toonde aan dat een lagere dan de gemiddelde leeftijd van 29,1 maanden bij eerste keer afkalven statistisch significant geassocieerd was met een langer dan gemiddelde zoogperiode aan één kwartier (2,45 maanden) en een totale zoogperiode (4,86 maanden). Bij 39 controlevaarzen was de gemiddelde leeftijd bij eerste keer afkalven (35,5 maanden) statistisch significant lager bij een langere dan gemiddelde periode van zogen aan één kwartier (2,35 maanden) en hoger bij een hogere dan gemiddelde veebezetting (2,89 tropische vee-eenheden).

De gemiddelde borstomvang van melkvaarzen uit het project (153 cm, corresponderend met een gewicht van ongeveer 286 kg) was positief geassocieerd met de borstomvang van de moeder (gem. 160,7 cm), het krachtvoerniveau op éénjarige leeftijd (gem. 0,67 kg/d) en de piek melkgift van de vaars (gem. 7,72 kg/d), en negatief met het aantal droge maanden op het bedrijf (gem. 4,12 maanden) en het krachtvoerniveau op tweejarige leeftijd (gem. 1,18 kg/d). De borstomvang van vaarzen op controle bedrijven was alleen positief geassocieerd met de piek melkgift van de vaars.

Stapsgewijze regressie van de gemiddelde piek melkgift (7,72 kg/d) toonde statistisch significante positieve relaties met de piek melkgift van de moeder, het krachtvoerniveau bij het bereiken van de piek melkgift van de vaars en de leeftijd bij eerste keer afkalven.

De uitkomsten van het MIDCOMUL programma geven aan dat (i) voldoende melk tijdens de kalveropfokperiode op kleine boerenbedrijven kan leiden tot lagere leeftijden bij eerste keer afkalven en (ii) bijvoeren tot een jaar met name ter compensatie van geringe voederbeschikbaarheid als gevolg van droogteperiodes en een hoge veebezetting, een grotere borstomvang bevordert, met mogelijk een hogere piek melkgift en meer melk in de eerste lactatie.

Verschillen in rastypes voor de leeftijd bij eerste keer afkalven waren zeer klein, in tegenstelling tot die bij controledieren. Daar heerste het gangbare patroon van de laagste afkalfleeftijden (i) voor kruisingen met zwartbonten, gevolgd door Ayrshire en tenslotte de Jersey/Australian Milking Zebu, en (ii) voor plantagevee van de Tamils, gevolgd door dorpsvee van de Singhalezen. Borstomvang en piek melkgift van project melkvaarzen verschilden wel per rastype en locatie, en waren statistisch significant gerelateerd aan de borstomvang en piek melkgift van de moeder. De gemiddelde piek produktie bedroeg 3,46 kg melk per kg krachtvoer met nauwelijks verschillen tussen ras en locatie.

Vergelijking van de kalveropfokprogramma's bracht aan het licht dat programma's die uitgevoerd werden vanuit de diergezondheidsposten zoals CHCS, CHBRS en Kerala slechts 300-600 kalveren per jaar registreerden in de verschillende delen van het land, tegen 1850 kalveren in 6 maanden tijd via de aangesloten producentencoöperaties in het MIDCOMUL programma. Attendering op en uitleg van het programma via mobiele MLDC cursussen op de melkophaalcentra, het inschrijven van kalveren afkomstig van zowel KI als natuurlijke dekking, en de oprichting van kalveropfokcomités in de DPA's, resulteerden in een hoge graad van boerenparticipatie.

Het MIDCOMUL programma toonde ook aan dat veel boeren, door het meten van hun kalveren en het vergelijken met streefmaten op een groeikaart, kwartaalinspectie door de technische staf van MIDCOMUL en een bonus na het behalen van de bereikte maten, zeer ingenomen waren met de kalveropfok op hun eigen bedrijf. Veel boeren gaven aan tijdens de inspecties dat ze hun management hadden bijgesteld -door meer melk of bijvoer te verstrekken- om de gestelde doelen te bereiken. Bovendien bleek ook tijdens het veldonderzoek dat ook dieren die zich niet voor alle bonusbetalingen hadden geclassificeerd, toch nog op het bedrijf werden aangehouden of waren verkocht als drachtige vaars.

De geschatte groei van kalveren van projectvaarzen bedroeg gemiddeld 245 g/d voor 184 vaarskalveren op een gemiddelde leeftijd van 4,5 maand en 228 g/d voor 121 stierkalveren gemiddeld 4,7 maanden oud. Dit was veel lager dan in het MIDCOMUL bonusprogramma, waar de gemiddelde groei 334 g/d bedroeg over de eerste drie levensmaanden en 320 g/d over de eerste 18 maanden, hetgeen het positieve effect van groeibonussen nogmaals onderstreept.

De gemiddelde piek melkgift van 7,7 kg/d van 164 MIDCOMUL vaarzen was ook hoger dan de 6,4 kg/d van 66 vaarzen (voornamelijk geselecteerde zwartbonte en Ayrshire kruisingen) afkomstig van de twee semi-overheidsopfokbedrijven, en de 6,2 kg/d van 9 vaarzen (Jersey/AMZ kruisingen met lokaal vee) uit het Matale programma.

De kosten van de opfokprogramma's bedroegen US$ 100 per verkochte, gecontracteerde vaars (CHBRS), US$ 100 per gerapporteerde, afgekalfde vaars (MIDCOMUL) en US$ 170 per geregistreerd KI vaarskalf (Kerala). De stimuleringskosten bij deze kleine boerenprogramma's staken gunstig af bij de benodigde subsidies van US$ 140-280 per vaars geleverd door 33 (semi)staatsbedrijven en van de US$ 100-150 per drachtige vaars van de 2 kalveropfokbedrijven, en zeker ook bij de US$ 2000 per geïmporteerde zwartbonte uit Australië. Vergeleken met programma's op het eigen bedrijf (MIDCOMUL, Kerala), wordt ander fokmateriaal bovendien verkocht wanneer het zo'n 3 maanden drachtig is, hetgeen nog eens 6 maanden opfokkosten met zich meebrengt (tegen ongeveer US$ 20 per maand op (semi)overheidsbedrijven in 1993).

Andere vormen om melkvee te produceren werden geanalyseerd in het Kagera Livestock Development Programme, Tanzania. Na correctie voor de jaarlijkse aanschaf van drachtige kruisingsvaarzen uit de Kikurula ranch, bleek dat de toename van produktieve dieren (koeien en drachtige vaarzen) bij kleine boeren bestond uit 21 drachtige vaarzen per jaar (4% per koe) in de periode 1983-1989 bij lage veeprijzen, oplopend tot 100 drachtige vaarzen per jaar (5,2% per koe) in de periode 1989-1995 bij meer commerciële veeprijzen, plus een bonus aan de boerenorganisatie voor aanlevering van fokmateriaal aan het project.

In *hoofdstuk 10* is de ontwikkeling van de zuivelsector over de periode 1980 (gem. over 1979-1981) tot 1993 (gem. over 1992-1994) nader geanalyseerd voor geselecteerde landen en in projecten die gesteund werden door Nederland, WFP, Zwitserland en FAO/UNDP/bedrijfsleven.

In Europa en Noord Amerika nam de melkgift per koe toe, en daalde het aantal melkkoeien en melkveehouderijbedrijven. In Afrika daalde de beschikbaarheid van lokale melk per hoofd van de bevolking, met uitzondering van Kenya en Tunesië, waar deze toenam door respectievelijk, meer melkkoeien en een hogere melkgift per koe. In Azië nam de lokale beschikbaarheid van melk in veel landen toe door de import van vee (Thailand, Indonesië, Zuid Korea, Saudi Arabië), door grotere aantallen lokaal melkvee (Pakistan, China) en/of door een verhoogde melkgift per koe (Israël, Zuid Korea, Indonesië, India). In Latijns Amerika, steeg de lokale beschikbaarheid door verhoogde produktie per koe (Argentinië, Ecuador, Costa Rica), toename in aantal melkkoeien (Colombia, Bolivia, Guyana) of beide (Chili, Uruguay, Brazilië). De lokale beschikbaarheid nam af in belangrijke melkimporterende landen (Mexico, Cuba, Nicaragua, Peru, Dominicaanse Republiek).

Door Nederland gesteunde melkveehouderijprojecten gericht op kleine boeren in Kenya, Tanzania, Sri Lanka, Colombia en Ecuador resulteerden in meer melkveehouders, hogere melkgiften per koe, een hoog percentage lacterende koeien en een lage sterfte bij volwassen dieren en met name bij kalveren. Tussenkalftijden waren in alle projecten lang, hetgeen wijst op onvoldoende voeding in het begin van de lactatie, met als gevolg het traag op gang komen van de ovariële activiteit. Slechte bronstdetectie, problemen bij het tijdig laten dekken of insemineren en geen of laat drachtigheidsonderzoek maar ook de angst van boeren voor een lage melkproduktie na het drachtig worden, droegen alle bij aan de lange tussenkalftijden. De netto geldopbrengst of het arbeidsinkomen van de bedrijven verschilde aanzienlijk tussen landen en bedrijfssystemen met een bijdrage uit de melkveehouderij die varieerde van 29-94%. Belangrijke factoren die van invloed waren op de hoogte van de melkveehouderij bijdrage waren de winstgevendheid van gewassen (die hoger was dichtbij de stad), de producenten melkprijs (hoger bij directe lokale verkoop dan via de officiële melkophaalorganisatie in Kenya; hoger in de stad dan op het afgelegen platteland in Tanzania); de hoogte van het inkomen van buiten het bedrijf (bijv. door migratie in Ecuador) en de bedrijfsgrootte (hoger bij grotere gemengde bedrijven in Sri Lanka en Ecuador). Het reële inkomen in de melkveehouderij nam toe in Kenya (1983-1987) door regelmatige prijsbijstelling; daalde in Kagera, Tanzania (1992-1994) doordat de kosten sneller stegen dan de opbrengsten; en verslechterde in Sri Lanka (1983-1990) omdat de melkprijs achterbleef bij de kostenstijging en de inflatie.

Melkveehouderijprojecten ondersteund door het Wereldvoedselprogramma hadden in sommige landen (Bolivia, India, Tanzania) meer tijd nodig om de gestelde doelen te bereiken dan aanvankelijk gepland, terwijl in landen met hoge bijdragen van de nationale regeringen (Cuba en China) de doelstellingen op tijd werden gehaald. De periodieke bijstelling van de melkpoeder- en boterolieprijs via de FAO formule om concurrentie met lokale melk te vermijden, werd meestal vertraagd om de financiële situatie van de ontvangende zuivelindustrie te ontzien en/of de politiek gevoelig liggende bijstelling van de consumentenprijs.

Stimuleren van de melkveehouderij op het platteland kan op verschillende manieren: (i) via het Operatie Vloed model met een uitgebreid netwerk van ophaalpunten, koelcentra en rurale melkfabrieken die de melkfabrieken in de stad bevoorraden en het melkoverschot in de regentijd omzetten in melkpoeder om de lage aanvoer in de droge tijd aan te vullen en/of in produkten met een hoge toegevoegde waarde of (ii) via meer streekgebonden, kleinschalige verwerking van melk tot produkten met hoge toegevoegde waarde en een langere bewaartijd die vervoer over grotere afstand toestaan naar een meer koopkrachtige klantenkring.

De Zwitsers ondersteunden een groot aantal kleine kaasfabrieken op het platteland hetgeen resulteerde in een betere afzet en een hogere melkprijs voor de boer. Nederland ondersteunde het kaasmaken op (semi)overheidsbedrijven (Tanzania en Sri Lanka) en op coöperatieniveau (Colombia) om via een hogere toegevoegde waarde een hogere melkprijs voor de producent te realiseren.

FAO heeft via haar regionale trainingsprogramma's een groot aantal lokale trainers en technici getraind. De grootste uitdaging blijft echter de lokale organisatie van de kwaliteitscontrole van verse melk, goedkope verwerking, verpakking en distributie van melk en melkprodukten.

De organisatie van inputs, diensten, training en voorlichting voor kleine boeren is over het algemeen duur aan salaris- en transportkosten. Bovendien vraagt het personeel met voldoende kennis en ervaring in de melksector. In verschillende melkveehouderijprojecten is een begin gemaakt met de overdracht naar particuliere diensten van inputvoorziening en dienstverlening tegen kostprijzen. Het meest succesvol waren de overdracht van de inputvoorziening via producentenorganisaties (COOPROLACTEOS in Nariño, Colombia en FEDAGARE in de Dominicaanse Republiek, melkproducentencoöperaties op dorps-, districts- en federatief-regionale niveaus in India, melkveehouderscoöperaties in Indonesië en Sri Lanka en een groeiend aantal producentenassociaties in de Tanga en Kagera regio's in Tanzania. De technische dienstverlening wordt nog door de regering betaald, alhoewel de grotere coöperaties steeds meer personeel zoals inseminatoren, eerste-hulp veterinaire assistenten en soms dierenartsen en landbouwkundigen zelf in dienst nemen. Kleinere producentengroepen behoeven echter nog technische, economische en organisatorische ondersteuning om door te groeien naar een voldoend grote, economisch zelfstandige onderneming.

Onder de structurele aanpassingsprogramma's worden veel regeringen gedwongen akkerbouw en veehouderij te integreren in training en voorlichting om zo met minder personeel de gemengde bedrijven te kunnen blijven assisteren. Melkveehouderijvoorlichting wordt in toenemende mate overgeheveld naar meer algemene landbouwkundigen met op afstand assistentie van specialisten (dierenarts, veeteler) vanuit districts- of regionaal niveau. Deze verschuivingen vragen een intensieve training van plaatselijke voorlichters om de rurale melkveehouders adequaat te kunnen adviseren.

Hoofdstuk 11 bevat een discussie van de globale ontwikkelingen in bevolkingstoename en de landbouw met speciale aandacht voor de ontwikkelingen in melkproduktie en -verwerking, de handel in melkprodukten en zuivelhulp, voedings- en genderaspecten in melkveehouderij-ontwikkeling. Voorts worden de technische, economische en organisatorische veranderingen in de melkveehouderij gerelateerd aan de effectiviteit van overheid- en donorbeleid ten aanzien van prijspolitiek, producentenstimulansen, programma's voor armoedebestrijding en programma's voor de produktie van melkvee met kleine boeren.

De wereldmelkproduktie van 364 miljoen ton in 1962 steeg via 463 in 1980 (toename van

1,5% per jaar) tot 526 in 1993 (1,3% per jaar). De import van melkprodukten door ontwikkelingslanden steeg van 3,5 in 1962 tot 17 miljoen ton melkequivalenten in 1992. Afrika, Azië, Centraal en Zuid Amerika, die 59% van het aardoppervlak beslaan, lieten over de periode 1980-1993 een toename zien in hun aandeel van 77 tot 80% van de wereldbevolking, van 50 naar 59% van het rundvee, van 65,5 tot 71,7% van de melkkoeien en van 26 tot 35,5% in de totale melkproduktie van rundvee, buffels, schapen en geiten.

De jaarlijkse melkproduktie steeg over 1980-1993 door meer dieren en hogere melkgiften; het meest bij de buffel (respectievelijk 1,53 en 2,65%) gevolgd door schapen en geiten (0,74 en 0,89%) en melkkoeien (0,45 and 0,25%). Regionaal vertoonde Azië de hoogste toename in melkproduktie van melkkoeien (4,62%), buffels (4,30%) en schapen en geiten (2,92%), gevolgd door koemelk in Zuid Amerika (2,88%), Oceanië (2,07%), Afrika (2,02%) en Noord Amerika (1,29%), terwijl de melkproduktie daalde in de voormalige USSR (0,35%), Centraal Amerika (0,35%) en Europa (0,71%). Lokale beschikbaarheid van melk per capita steeg in Azië van 27 naar 37 kg, in Zuid Amerika van 101 naar 112 kg, maar daalde van 34 naar 28 kg in Afrika en van 90 naar 63 kg in Centraal Amerika.

Chronische ondervoeding in 93 ontwikkelingslanden daalde van 941 miljoen personen in 1970 (36% van de bevolking) via 843 miljoen in 1980 (26%) tot 781 miljoen (20%) in 1989 en verwacht wordt dat het verder daalt tot 637 miljoen in 2010 (11%). Inzichten in de humane voeding veranderden van een nadruk op een eiwittekort naar een energiedichtheidstekort voor kwetsbare groepen, i.e. kinderen, zwangere en zogende vrouwen, zieken en bejaarden. Voedselhulp en ook zuivelhulp werd in de vijftiger en zestiger jaren verstrekt door landen met een overschot aan landen met een tekort en met name door de Verenigde Staten en later ook door het Wereldvoedselprogramma om de honger in de wereld terug te dringen. De zuivelhulp nam sterk af aan het eind van de tachtiger jaren door afname van de overschotten ten gevolge van het instellen van melkproduktiequota en door de negatieve effecten van voedselhulp op de lokale voedselproduktie.

Genderaspecten werden geïntroduceerd in het ontwikkelingssamenwerkingsbeleid, en werden ook in toenemende mate geïntegreerd in melkveehouderijprojecten. Consultancies werden doorgaans gevolgd door trainingen om projectpersoneel te leren om het hele boerengezin te betrekken in de projectactiviteiten. Het recruteren van vrouwelijk projectpersoneel werd gestimuleerd om de toegang van vrouwen tot training, voorlichting en mogelijkheden in de melkveehouderij te vergroten; in de praktijk blijkt het echter moeilijk om gekwalificeerd vrouwelijk personeel aan te trekken en te houden voor projectwerk op het platteland. De toegang tot training kan worden verhoogd door het inzetten van mobiele teams die ter plaatse series korte cursussen verzorgen.

In ontwikkelingslanden stijgt de vraag naar melk nog steeds door urbanisatie en inkomensstijging, samen met meer propaganda voor melk en een groter assortiment aan melkprodukten.

Gedetailleerde analyse van de ontwikkelingen in de produktie van melk en melkvee werd bemoeilijkt door het gebrek aan base-line data. Er is veel tijd nodig om het vertrouwen van de boer te winnen nodig voor het verkrijgen van correcte basisgegevens over bijv. landgebruik (aantal percelen en gebruiksvormen), veestapel (verschillende soorten en eigendomsverhoudingen), arbeid (veel kleine en verschillende activiteiten) en inkomen (meerdere kleine bronnen). Het bijhouden van gegevens vergt intensieve begeleiding, tijdige berekeningen van relevante karakteristieken en terugkoppeling naar boer en voorlichter om invloed op het bedrijfsbeheer te kunnen uitoefenen. De melkproduktie varieert sterk in de loop van het jaar en tussen jaren. De ontwikkeling van kalf tot melkvee is een zaak van de lange termijn. Technische en economische monitoring zijn daardoor zeer arbeidsintensief, terwijl lokale collega's vaak ontbreken op veldniveau. Anderzijds zouden voorlichters, die vooral gericht zijn op de verzameling en interpretatie van gegevens, veel meer probleemoplossend kunnen functioneren tijdens bedrijfsbezoeken. Het meten en registreren van de borstomvang op groeikaarten door boeren en voorlichters geeft een direct beeld van de ontwikkeling van jongvee tijdens de opfok en is veel eenvoudiger dan de visuele bepaling van groei en/of een conditiescore. Op dezelfde wijze kunnen borstomvangmetingen bij koeien aanwijzingen opleveren voor gewichtsverliezen in de periode na afkalven en na tijdige correctie helpen bij het verkorten van de tussenkalftijd op kleine boerenbedrijven.

Verschillen in melkgift bleken naast ras- en koeverschillen met name afhankelijk van de krachtvoergift, terwijl een koeler klimaat geassocieerd met de breedtegraad en hoogteligging helpt om het dier op haar genetisch potentieel te laten produceren, mits goed gevoed en behandeld. De grote verschillen in melkproduktie per ha hingen niet samen met grassoort en klimaat, maar werden mede bepaald door bemestingsniveau, veebezetting, het aantal stuks jongvee per koe, en door de beschikbaarheid van aanvullend voer in de vorm van krachtvoer en bij kleine boeren en landlozen het ruwvoer verzameld buiten het eigen bedrijf. Melkproduktie per mandag is laag op kleine boerenbedrijven, enerzijds door een lage mechanisatiegraad en anderzijds door het toepassen van arbeidsintensieve handelingen zoals veeverplaatsing of het hoeden van kleine aantallen vee en/of het verzamelen van voer en water buiten het bedrijf. Verbeteringen in de arbeidsproduktiviteit bleken mogelijk door de introductie van produktievere grassoorten en intensiever graslandbeheer, maar over het algemeen was er weinig recente, kwantitatieve informatie beschikbaar op het gebied van arbeidsbesparingen. Hoge investerings- en arbeidsbehoeften in de melkveehouderij en de lage financiële opbrengsten bij grootschalige bedrijven in ontwikkelingslanden beperken het aantal koeien per bedrijf. Dit werkt gunstig uit voor kleine boeren die over voldoende gezinsarbeid beschikken en in staat zijn eenvoudige stallen te bouwen en een paar koeien aan te schaffen. Er bestaan grote verschillen in melkprijzen die meer bepaald worden door de economische omgeving dan door de technische mogelijkheden van klimaat, grond, vegetatie, veestapel en boeren.

Comparatieve voordelen in de produktie van melk en melkvee hangen sterk samen met de maatschappelijke wensen en met de bereidheid tot financiële offers ter ondersteuning van ofwel de werkende producent ofwel de verzorging van de meer welgestelde consument. Een geldstroom van de rijke stedelijke consument naar de arme producent op het platteland is noodzakelijk om de uitstroom van het platteland naar de stad tegen te gaan. De discussie over subsidies of andere stimulansen is gecompliceerd, omdat veel economen geloven dat liberalisering van de agrarische wereldmarkt orde op zaken zal stellen tussen vraag en aanbod met als uitvloeisel correcte prijzen, terwijl veel boeren en technici waarde hechten aan een meer stabiele economische omgeving op lange termijn. Dit laatste houdt in dat er voor de producent voldoende marge zit tussen opbrengsten en kosten en dat noodzakelijk geachte wijzigingen in de produktiewijze worden doorgevoerd door gerichte stimulering van de producenten, hetgeen de voedselzekerheid, werkgelegenheid, inkomen en welzijn van zowel consumenten als producenten ten goede komt.

Langlopende projecten in de melkveehouderij met kleine boeren hebben geresulteerd in meer melkvee en meer melkveehouders, terwijl ook de melkgift per koe toenam daar waar regeringen rekening hielden met de belangen van producenten en hun organisaties, adequate voorzieningen voor melkvee en bedrijfsontwikkeling, en integratie van training, voorlichting, onderzoek en de gezondheidsdienst. Meer aandacht voor en investeringen in de opfok van jongvee kan de melkproduktie aanzienlijk vervroegen én verhogen op kleine boerenbedrijven, terwijl de investeringen veel lager zijn dan die voor geimporteerd vee of voor vermenigvuldiging van vee op grootschalige bedrijven. De extra produktie van melkvee kan aankomende melkveehouders helpen aan werkgelegenheid en inkomen, naast mogelijke verbeteringen van de bodemvruchtbaarheid door het vervoederen van gewasbijprodukten.

Langdurige donorondersteuning heeft technologieontwikkeling en introductie in het veld gestimuleerd, zoals het stalvoederingspakket, voer-gewas rotaties en kleinschalige melkverwerking en het stichten van boerenorganisaties. In de meeste projecten is een verdere versterking van boerenorganisaties, met name van de kleine, nog steeds nodig om te komen tot een duurzame melkveehouderij met kleine producenten.

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CURRICULUM VITAE

Rijk de Jong werd geboren op 3 mei 1941 in Diemen op een melkveehouderijbedrijf onder de rook van Amsterdam. Na het behalen van het HBS-B diploma, begon hij in 1959 met zijn studie aan de Landbouwhogeschool te Wageningen. Hij studeerde af met als hoofdvak veevoeding, aangevuld met de vakken fysiologie van landbouwhuisdieren, gezondheids- en ziekteleer en agrarische bedrijfseconomie en introducties in tropische veehouderij en grasland. De praktijktijd voerde hem naar de voorlichtingsdienst voor het gemengde bedrijf in Zeeland en naar melkveehouderijbedrijven en een veevoederfabriek in Californië. Een studiereis leidde hem voorts langs allerlei landbouwkundige projecten in Noord Afrika en het Midden Oosten. Tijdens zijn studie was hij docent veevoeding en grasland aan de Christelijke Hogere Landbouwschool in Ede en deed bij het Proefstation voor Akker- en Weidebouw onderzoek naar zomerstalvoedering en drinkgedrag van kalveren aan een drinkautomaat.

Na het ingenieursdiploma in 1969 volgde een 6-weekse stage bij de Veterinaire Faculteit te Utrecht en een 15-jarig dienstverband bij het Directoraat Generaal voor Internationale Samenwerking (DGIS). In Kenya was hij docent veehouderij op het Egerton College (1969-1974), voorts melkveehouderijmedewerker bij de Tanzania Rural Development Bank (1975-1978), teamleider van het Pasto project voor plattelandsontwikkeling in Colombia (1978-1982). Na terugkeer in Nederland besteedde hij zijn studieverlof bij de Vakgroep Tropische Veehouderij, en deed missies naar projecten in de melkveehouderij in Kenya en Sao Tomé, rurale ontwikkeling in India en veehouderij in de voedselproduktie en voedingsstrategie van Sri Lanka (1982-1984).

Van 1984 tot 1995 werkte hij als wetenschappelijk projectmedewerker bij de Vakgroep Tropische Veehouderij van de Landbouwuniversiteit. Hij begeleidde DGIS projecten en CEC onderzoeksprojecten in Sri Lanka, India en Indonesië en voerde diverse soorten missies uit voor DGIS, IAEA, INFIC en NUFFIC in Afrika, Zuid Amerika en Azië. Daarnaast gaf hij onderwijs en begeleidde studentenstages en -onderzoek in de tropen. Zijn sabbatsjaar in 1993 besteedde hij aan onderzoek naar de kalveropfok en het gemengde kleine boerenbedrijf in Sri Lanka. In 1994 werkte hij als plaatselijk technisch adviseur voor de FAO in het modelproject melkveehouderij in Ecuador.

Sinds februari 1996 werkt hij in dienst van het Koninklijk Instituut voor de Tropen als onderzoeker in het technische samenwerkingsprogramma voor de veehouderij bij het Kenya Agricultural Research Institute in Kenya.

CURRICULUM VITAE

Rijk de Jong was born on May 3, 1941 on a family dairy farm near Amsterdam. He studied at Wageningen Agricultural University and obtained a Master of Science degree in Animal Production in 1969. His main subject was Animal Nutrition combined with Animal Physiology, Health and Diseases and Agricultural Farm Economics. His practical training brought him to the extension service for mixed farms in the South Western part of Holland, and to various dairy farms, a dairy plant and a feed factory in California, USA. Before graduation, he also visited a large number of agricultural projects in North Africa and the Middle East, lectured part-time at an Agricultural College and did part-time research at the Research Centre for Crops and Pasture in Wageningen.

After a 6-weeks practical training in tropical diseases at the Veterinary Faculty of Utrecht, he worked for 15 years for the Directorate General of International Cooperation (DGIS). From 1969-1974 he was lecturer in Animal Science at Egerton College, Njoro in Kenya. From 1975-1978 he worked as dairy project officer of the Tanzania Rural Development Bank, and from 1978-1982 he was project manager of the Pasto project in Colombia focused on improved crop-livestock farming in rural development. After returning to the Netherlands he spent his study leave at the Department of Tropical Animal Production in Wageningen and carried out missions to Kenya, Sao Tomé, India and Sri Lanka (1982-1984).

From 1984-1995 he worked as a scientific project officer at Wageningen Agricultural University, supporting Dutch funded livestock development projects and CEC sponsored research projects in Sri Lanka, India and Indonesia, as well as teaching and guiding student research and participating in missions for DGIS, IAEA, INFIC and NUFFIC in Africa, Asia and Latin America. During this period, he also spent his sabbatical leave in Sri Lanka on research in calf rearing schemes and crop-livestock integration and worked for FAO as Chief Technical Advisor in the Model Integrated Dairy Development Project in Ecuador. Since February 1996 he is employed by the Royal Tropical Institute, Amsterdam as a technical cooperation scientist in livestock research of the Kenya Agricultural Research Institute.

ABBREVIATIONS and ACRONYMS

ACP	African, Caribbean and Pacific
ADB	Asian Development Bank
AFC	Agricultural Finance Corporation, Kenya
AGSO	Asociación de Ganaderos de la Sierra y Oriente, Ecuador
AI	Artificial insemination
AMUL	Anand Milk producers Union, Ltd, India
BAIF	Bharatiya Agro-Industries Foundations, India
Boerderij	Farmers' magazine of the Netherlands
CAP	Cooperativa Agricola de Producción (Agricultural Producers Cooperative)
CAPLE	Centro de Análisis de Producción Lechera, San Carlos, Costa Rica
CARDI	Central American Research and Development Institute
CBS	Centraal Bureau voor de Statistiek
CCS	Cooperativa Comunitaria de Servicios (Service Cooperative)
CEC	Commission of European Community
CECORA	Centro de Cooperativas de Reforma Agraria, Colombia
CFA	Committee for Food Aid, WFP
CHBRS	Contract Heifer Breeding and Raising Scheme
CHCS	Calf Health Care Scheme
COOPROLACTEOS	Cooperativa de los Productos Lácteos, Nariño, Colombia
CORFAS	Corporación Financiera de Asociados
CTA	Technical Centre for Agricultural and Rural Cooperation
DAC	Development Assistance Committee
DANIDA	Danish National Institute for Development Aid
DAPH	Department of Animal Production and Health, Sri Lanka
DDD	Dairy Development Division
DEAF	Dairy Extension and Advice Form
DGIS	Directorate General of International Cooperation of the Ministry of Foreign Affairs in the Netherlands
DHIA	Dairy Herd Improvement Association
DHV	Dutch consultancy firm
DLO	Dienst Landbouwkundig Onderzoek
DPA	Dairy Producers Association
DRI	Desarrollo Rural Integral (Integrated Rural Development)
DZ	Dry Zone, Sri Lanka
EEC	European Economic Community
ECU	European Currency Unit
ERR	Economic Rate of Return
EU	European Union of Communities
FAO	Food and Agriculture Organization of the United Nations
FCM	Fat Corrected Milk
FEC	Farmers Extension Centre
FEDAGARE	Federación de Asociaciones de Ganaderos (Federation of producers associations)
FEDECOLECHE	Federación de Cooperativas Lecheras, Colombia
FINNIDA	Finnish National Institute for Development Assistance

GNP	Gross National Product
GOI	Government of India
GON	Government of the Netherlands
GTZ	Gesellschaft für Technische Zusammenarbeit
HBU	Heifer Breeding Unit
HF	Holstein Friesian
HIT	Heifer in Trust
HPI	Heifer Project International
HVA	Dutch consultancy firm
IAC	International Agricultural Centre, Wageningen, the Netherlands
IAEA	International Atomic Energy Agency
IBRD	International Bank for Reconstruction and Development
ICA	Instituto Colombiano Agropecuario
IDA	International Development Association of World Bank
IDC	Indian Development Corporation
IDDP	International Dairy Development Programme
IDF	International Dairy Federation
ILCA	International Livestock Centre for Africa
ILO	International Labour Organization
INFIC	International Network of Feed Information Centres
IOV	Inspectie Ontwikkelingssamenwerking te Velde (Field inspection of DGIS)
IRDP	Integrated Rural Development Project
IRR	Internal Rate of Return
ISCDD	International Scheme for Coordination of Dairy Development
ISS	Institute of Social Studies, the Netherlands
KALIDEP	Kagera Livestock Development Programme
KARI	Kenya Agricultural Research Institute
KCC	Kenya Cooperative Creameries
KIT	Koninklijk Instituut voor de Tropen (Royal Tropical Institute)
LDA	Livestock Development Assistant
LEI	Landbouw Economisch Instituut
LMU	Livestock Multiplication Unit
LPD	Livestock Planning Division
LPU	Livestock Planning Unit
LT	Landbouwkundig Tijdschrift
M/RID	Ministry of Rural and Industrial Development
MADR	Ministry of Agricultural Development and Research, Sri Lanka
MASL	Mahaweli Authority of Sri Lanka
MIDCOMUL	Mid Country Milk producers Union, Ltd
MLDC	Mid Country Livestock Development Centre
MRY	Meuse, Rhine and Yssel cattle
N.E.C.T.A.R.	Netherlands Centres for Training and Animal Resource Management
NADSA	National Agricultural Diversification and Settlement Authority
NAHRC	National Animal Husbandry Research Centre, Kenya
NCR	Nationale Cooperatieve Raad (National Cooperative Council for Agriculture and Horticulture)
NDDB	National Dairy Development Board, India

NDDP	National Dairy Development Project, Kenya
NDRI	National Dairy Research Institute, India
NGO	Non Government Organization
NLDB	National Livestock Development Board
NRLO	Nationale Raad voor Landbouwkundig Onderzoek
NRS	Nederlands Rundvee Syndicaat
NUFFIC	Netherlands Organization for International Cooperation in Higher Education
NZ farm	New Zealand farm, Sri Lanka
O.T.D.	Office de Terres Dominiales
OECD	Organization for Economic Cooperation and Development
OF	Operation Flood, India
PGIA	Post Graduate Institute of Agriculture
PMDLI	Proyecto Modelo de Desarrollo Lechero Integral (Model project for integrated dairy development), Ecuador
PR	Proefstation voor de Rundvee-, Schapen- en Paardenhouderij (Research station for cattle, sheep and horse husbandry)
PRODELESTE	Proyecto de Desarrollo Lechero de la Región Este (Dairy development project in the eastern region of the Dominican Republic)
PRODERM	Proyecto de Desarrollo Rural en Microregiones, Cuzco, Peru
PROMEGA	Proyecto de Mejoramiento Ganadero, Arequipa, Peru
PVV	Produktschap voor Vee en Vlees (Commodity board for animals and meat)
RAAKS	Rapid Appraisal of Agricultural Knowledge Systems
RDDTT	Regional Dairy Development Training Teams
RLDO	Regional Livestock Development Officer
RRC	Regional Research Centre
SFDP	Small Farmer Dairy Project
SHDDP	Small Holder Dairy Development Project
SL-NLDP	Sri Lanka-Netherlands Livestock Development Programme
SNF	Solid Non Fat
STC	Swiss Technical Cooperation/Corporation
TCP	Technical Cooperation Project
TLU	Tropical Livestock Unit of 300 kg liveweight
TMDD	Technology Mission on Dairy Development, India
TSDDP	Tanga Smallholder's Dairy Development Programme, Tanzania
UNDP	United Nations Development Programme
UNICEF	United Nations Children Fund
VEEPRO	Information centre for Dutch cattle
VMCS	Village Milk producers Cooperative Society, India
WANA	West Asia and North Africa
WFP	World Food Programme of the United Nations