Methodologies for prices and production costs in dairy farming

K.J. Poppe
J.A. Boone

March 1999

Rapport 99.09

Agricultural Economics Research Institute (LEI), The Hague

Methodologies for prices and production costs in dairy farming
Poppe, K.J., J.A. Boone
The Hague, Agricultural Economics Research Institute (LEI), 1999.

Contents

1. Introduction

This paper is written by K. J. Poppe and J.A. Boone [1] on request of Argentina's Milk Producers Association to provide information on the economics of dairy farming in the Netherlands and the European Union. Based on data from different sources and on a number of studies, the paper provides information on the structure of dairy farming and cost prices. The second part of the paper provides information on milk prices and market developments.

---

[1] Both authors are business economists at LEI, the Agricultural Economics Research Institute in The Hague. Krijn J. Poppe is deputy head of the Agriculture Division and is involved in the European Farm Accountancy Data Network. Koen Boone is researcher within the same division department. The authors are indebted to Ilona Langelaan and Walter van Everdingen for making available data and earlier published Dutch articles on dairy farming.

2. Dairy farming in Europe

1.1 Basic statistics [1]

EU production of cows' milk is over 121 million tons, including production in the newest member states. Biggest producers are Germany (24%), France (21%), United Kingdom (12%), the Netherlands (9.3%) and Italy (8.7%).

About 1 million farmers in the EU keep dairy cows, with on average 22 cows per holding. However, this figure is very misleading, as the distribution of dairy cows over holdings is very unequal. Fourty-one percent of the herds consist of less than 10 cows and contain 7% of the total number of dairy cows. The largest 2% of the herds are bigger than 100 cows and account for over 26% of the total herd. Small farms are often headed by older farmers. About 11% of the farmers is older than 65, another 25% older than 55.

About 75% of the milk is produced on specialist dairy farms, the other quarter on mixed farms. Mixed farms are especially important in the Mediterranean, but also French and Belgian farmers mix dairy farming with other agricultural activities, especially beef.

The average yield per dairy cow is 5,360 kg per cow per year. Yields vary considerably between member states, with high yields in the Netherlands, Denmark and Sweden (on average up to 7,000 kg), and low yields in Austria, Greece and Portugal. Fat content is on average just above 4% (Netherlands: 4.4%), protein content is between 3.1 (Spain) and 3.5% (Netherlands).

In total the EU had 84.5 million heads of cattle in 1995, of which 27% are dairy cows. The EU is the major player in the world dairy trade. Its market share in 1996 has been estimated at about 50%, with New Zealand and Australia as other important players that gained market share in the nineties (Rabobank, 1998).

2.2 Dairy farming systems

Dairy farms around the world use different production systems. Four farming systems can be identified (Rabobank, 1998):

- Grazing systems in Oceania, UK, Ireland and Argentina;
- Subtropical systems in south-west America and Northern Mexico;
- Tropical systems in southern Mexico, Brazil and India;
- Silage systems on the European continent, in parts of the USA and in Canada.

The difference between the farming systems has its effect on the milk yield, forage feeding, housing, seasonality pattern and the cost of production (table 2.1). The choice of the

[1] Based on statistics from Eurostat, as cited in Burell: *Economic aspects of milk production in the EU*, undated.

system depends on many factors, like regional climates, forage bases, farm structures and sizes, dairy policy and market conditions.

Table 2.1 *Farming systems*

	Grazing Systems	Silage Systems	Subtropic Systems	Tropical Systems
	New Zealand, Australia, Ireland, UK, Argentina	Europe Continent USA North East Canada	USA South West Mexico North	Brazil, India, Mexico South
Climate	temperate	temperate	subtropical, dry	tropical, humid
Herd size	50-500	10-250 a)	300-2,000	2-100
Milk yield (kg/cow/year)	4,000-6,000	6,000-9,000	9,000-10,000	1,000-2,000
Forage feeding -grazing -concentrates	own production -grass silage -corn silage -concentrates	own production -grass silage/hay -corn silage -concentrates	purchase feed -green chop concentrates	own production
Housing	none/very few none	yes	sun roof	
Risk that weather can influence production level	high	medium	low	high
Seasonality pattern	high	medium	low	
Ownership structure	family farming income oriented	family farming income oriented b)	commercial farming oriented on return on assets	family farming oriented on self-sufficiency
Costs (per kg Milk)	very low - low	medium - high	low	

a) Herd sizes: Eastern Europe and East Germany 20-2,000 cows/farm; b) Except co-operative type of farming in Eastern Europe.
Source: Hemme, Inter.

Within a farming system, like the silage system, there are also large differences based on the price of land, labour, capital and cereals on the one hand and the level of the milk price on the other hand. Figure 2.1 illustrates this point. For instance in the Netherlands, compared to Brittany, labour is expensive and compound feeds are cheap: for a Dutch dairy farmer the costs of 100 kg of compound feed equals the costs of 1.8 hours of labour. This figure is 2.6 for his competitor in Brittany, who will therefore buy less compound feeds and use more roughage from his own farm. Such a substitution of roughage for compound feed increases the value of land as a roughage producing asset, but due to technical relations (especially the natural available production capacity of a hectare) this effect is limited. The result is that a Dutch farmer needs less labour per 100 kg of milk and produces more milk per hectare (figure 2.2).

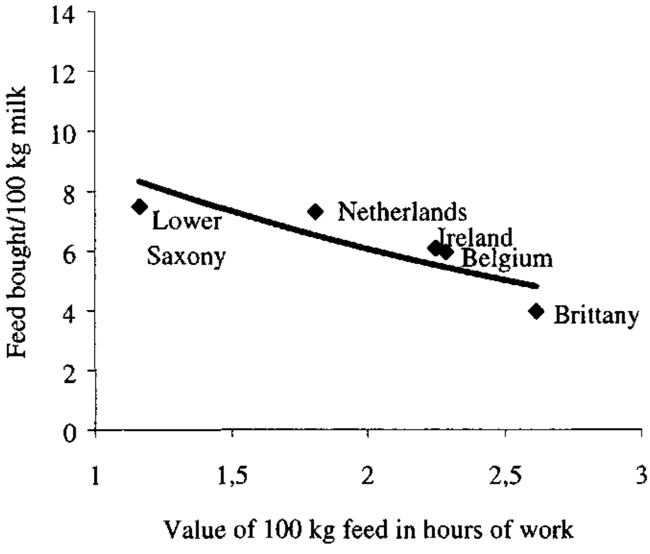

Figure 2.1 Relation between price of feed and labour and the producing of feed on the farm, 1994
Source: RICA and Eurostat.

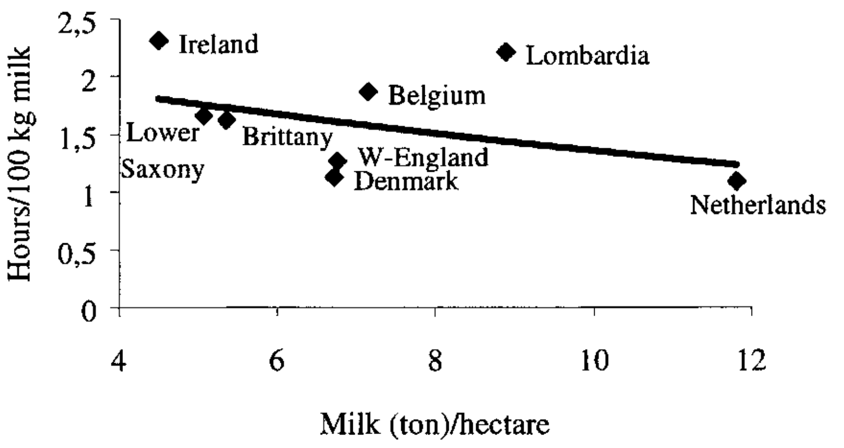

Figure 2.2 Relation between the price of labour and the production per hectare, 1994
Source: RICA.

The costs of feed produced on the on the own farm is not only influenced by the costs of labour but also by the land price. In the Netherlands the prices of land are relatively high in comparison with Brittany: in Brittany the value of hundred hours of work buys a hectare of land, against nearly 1,100 hours in the Netherlands. These relatively high land prices force individual farmers to have a land intensive farming system, otherwise they are not able to meet the resulting financial obligations. Environmental regulations on for example the maximum amount of milk cows per hectare, limits the possibilities for this strategy however.

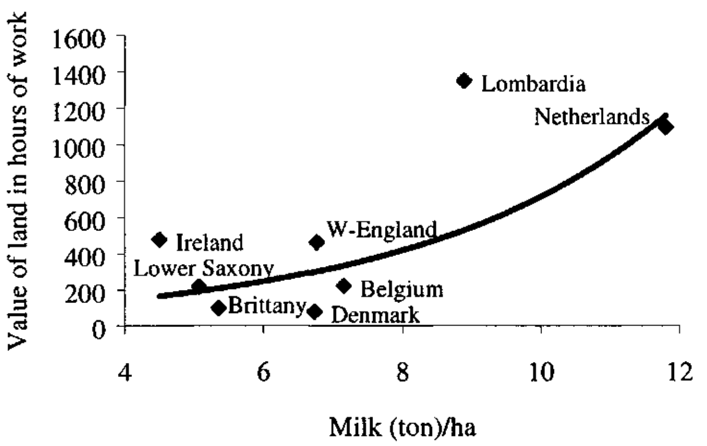

Figure 2.3 Relation between the price of land and the production per hectare, 1994
Source: RICA.

2.3 The quota system

It will be well known that the EU protects its dairy farmers rather well from the influences of the world market. The main policy instrument, since 1984, has been the milk quota regime. Farmers who produce more than a historical reference (their quota) pay a huge fine (more than 100% of the price per litre). Since 1988 the milk quotas are essentially butterfat quotas. There are differences between the EU member states in the management regimes of the quota system and trade cross the member states borders is impossible. In some member states quotas cannot be exchanged between farmers, whereas in others like the Netherlands and the UK the quota can be traded and leased. There are also countries that operate a quota management system somewhere between the liberal trading solution and no exchange at all. This includes arrangements in which a part of the traded quota is skimmed and falls to the government to be distributed to privileged groups like young starters or less favoured rural areas.

The quota system has reduced budget costs greatly: from 9,000 million ecu in 1979 to 2,000 in 1995. The share of dairy policy in the EU's market organization costs has fallen from 41% in 1976 to 12% in 1995 (Burell, undated).

Although the quota system has originally been greeted with much scepticism by farmers, the system has been very beneficial for the farmer's income (compared to a liberal free market scenario) as well as for the environment. One of the effects has been that farmers' attention has been drawn from intensification of land use towards reducing costs and inputs like nitrogen and concentrates. This has however partly been offset by the decrease in the EU's cereal prices that have been lowered towards world market levels.

As quotas are a much scarcer factor than land, the economic rent has been transferred into quota values. Table 2.2 gives some prices for buying and leasing milk quota in the Netherlands. Farms with high incomes and over capacity in labour, land and buildings (in 1984 the reference quotas were set at a lower level than the actual production) are willing to enlarge their milk operation and are able to pay a high price for a marginal increase in farm size. It has to be taken into account that costs of leasing and buying (depreciation in 8 years) can be deducted from income tax (that has high marginal rates of 50 or 60%).

Table 2.2 Quota prices and lease prices in Dutch guilders per kg (1 USD = NLG 1.90)

	Purchase price (NLG/kg)	Lease price (NLG/100 kg)
1986/87	2,25	.
1987/88	2,65	.
1988/89	3,30	.
1989/90	4,10	40,90
1990/91	4,30	40,30
1991/92	3,60	35,45
1992/93	4,00	38,60
1993/94	3,95	40,15
1994/95	3,85	38,10
1995/96	3,70	36,85
1996/97	3,45	38,35

The volume of trade in quota has been high. Every year around 8% of the farms are buying quota. Farmers that sell quota or lease them out are often older (or disabled) farmers that want to scale back their operation temporarily, often without selling the land. But also some young farmers that inherited a small farm are interested in leasing out.

The trade in quota has lead to a large investment in property rights (intangible assets) that benefited especially out-goers. Many villages have seen the building of nice villas for retired dairy farmers. It should be noted however that intra-generational transfers in the same family are often done free of charge (a transfer price of zero). There is much debate on the extent in which the investment in intangibles is weakening the competitive position of Dutch dairy farming: the costs of quota are now equivalent to 10% of the milk price.

As this value is more or less a rent that would otherwise fall to the land value, the problem is, from a theoretical point of view, manageable. An abolishment of the system, with a drop in milk price, in a short period, would nevertheless lead to large problems as farmers have financing obligations on the loans they took to invest in quota.

2.4 Some key prices

Farm systems are shaped by natural conditions and economics, especially price levels. Table 2.3 provides data on some key prices in Dutch dairy farming.

Table 2.3 Key prices in Dutch dairy farming, 1997

Product	Unit	Price in NLG	Price in USD
Calf	Head	254	135
Dairy cow	Head	1,595	848
Cull cow	Head	1410	750
Diesel oil	Litter	0.59	0.31
Fertiliser - nitrogen	Kg	1.12	0.60
Concentrate (standard)	100 kg	32.80	17.45
Hay	Ton	410	218
Silage maize	Ton	105	56
Grassland	Hectare	45,800	24,360
Labour costs (gross)	hour	38.20	20.30

Prices in USD based on an exchange rate of 1 USD = NLG 1.88

It should be noted that it is difficult to compare the data between countries, especially between for instance the Netherlands and Argentina. Quality of products can vary enormously. However, it is clear that the high land prices and high labour costs create important economic incentives to develop a very intensive production system with high stocking rates. The labour intensive activity of roughage production is in a certain sense outsourced to growers of tapioca and soya in Thailand, Brazil and the US by the substitution for concentrates. As a result more cows can be kept per man and per hectare, leading to high land prices. These land prices force other farmers in the same direction and the high labour productivity keeps dairy farming attractive compared to other (non-farming) businesses.

3. Cost prices

3.1 Methodology

The competitiveness of the products of a country is influenced by many factors. The more homogenous the products, the more important the role of pricing competition and thus the costs of production (Porter, 1990). Although some endproducts of milk (like desserts) are rather heterogeneous, the product itself is still largely homogenous. So the cost of production is still one of the most important factors in determining competitiveness in the international marketplace.

The importance of the costs of production has triggered the publication of numerous articles in newspapers and periodicals on this subject; and greatly differing results have been obtained because different methods and sources are used. This section is about the methodological and practical problems encountered when comparing the costs of production at farm level.

Different costs for different purposes

Estimates of production costs are used for many different purposes. One of their first applications was in decision-making at farm level. Information about the profitability of the individual products can be important in the planning of future production. Besides that, comparisons between firms ('benchmarking') could lead to greater efficiency in the production process of individual farms. Later on, policy purposes became more important. Governments used the estimates, for example, to determine a fair price level. It is important to note that in this report the production costs are calculated for the aim of comparing competitiveness between countries. Calculations for other purposes could lead to different results ('different costs for different purposes').

Approaches

There are two widely used approaches for comparing production costs between countries. The first one, the engineering approach, starts with technical coefficients for the average farm in a given region and multiplies the technical results by prices (used by the USDA before 1980, for example).

In the Netherlands the average farm has x dairy cows. X dairy cows need a kilos of feed and b hours of labour a year. One dairycow produces z kilos of milk a year.

The costs of one litre milk are: $(a * P_a + b * P_b) / (z * X)$.

The advantage of this method is that you only need to know the development in the technical coefficients and prices to calculate the development in production costs. This calculation is, however, only possible for a short period of time because in the long run structural changes will happen. The biggest drawback is that the production costs calculated in this way are not necessarily representative for the country as a whole. The average farm does not necessarily have average production costs. Mostly, not an average farm is chosen, but a 'modern farm'. The term 'modern' is not easily harmonized between countries, though. The lack of information about the distribution of the production costs between the farms is another drawback to this method.

The second approach, the survey approach, is based on accounting information gathered from a sample of farms. Every farm in the sample is representative for a group of farms (with more or less the same characteristics), so that all the sample farms together are representative for (nearly) all the farms in the region. Calculations of the production costs based on this data do not have the disadvantages mentioned above (unrepresentative and lack of information about distribution). But this method also brings with it the problem of harmonization of data between the countries. Each country uses its own rules to calculate income and production costs and compiles different variables. In the Farm Accountancy Data Network (FADN), however, all the countries in the European Union organize the harmonized compilation of accounting information from a sample of farms in their own country (in total more than 50,000 farms) [1]. The data have been compiled and combined in one database by the European Commission in Brussels.

Production costs and current cost accounting

The methods for the calculation of income and production costs in the Farm Accountancy Data Network are based on the ideas of current cost accounting. The foundations of this type accounting were laid by Schmidt and (in the Netherlands) Limperg. Horring (1948) used the work of these authors to develop the Dutch version of the FADN. The European version, which was developed years later, was (in part) based on the Dutch version. Originally the main purpose of the Dutch network was to calculate the production costs of the most important products so that the government could make a fair valuation of agricultural prices. Horring said that the cost of fixed assets should be based on the replacement value instead of the historical expenditure. If the profit of a company during times of high inflation is based on the historical expenditure and the profit is used up for paying tax and private expenses, the company would not have enough resources to buy the same fixed asset again because inflation would make it more expensive. The company would then not have the money to continue its business. If the profit is calculated on a current cost base, the company would have just enough resources to buy the new asset again. Another advantage of current cost accounting is that it is well suited to inter-business comparisons. The cost of two companies who have exactly the same asset (of the same age), but that did not buy the asset at the same time (one farmer bought it second hand), and hence with different historical expenditures , will be calculated

[1] Many other countries (for example, the USA, Canada, Australia, New Zealand) also compile farm accountancy data from a sample of farms. Their methods are however not harmonized with EU methods, which makes comparisons of the results extremely difficult (Morisset, 1994).

in the same way. The original price they paid for the asset is irrelevant for comparing the production costs of the farms at this moment.

Although from a theoretical viewpoint the current cost accounting has important advantages, the practical implications can be rather complicated. Each year a replacement value has to be calculated for every fixed asset. This is especially complicated for assets, which change hands only seldom or never. This could be the case for old assets, but also for assets for which there has been a technical breakthrough. For these assets, and often for efficiency reasons also for other assets, rules of thumb are used to calculate the replacement value. These calculated replacement values can be very different from the real replacement values. Apart from that, each country may use different rules of thumb, a process, which distorts the comparisons between countries and introduces a subjective element into the calculations.

Current cost accounting also makes the calculations of income and cost of production much more complicated. This may lead to mistakes in the calculations of the indicators and misinterpretations of the users of the data.

Mixed farms

Although agricultural products are increasingly being produced on specialized farms (Poppe, 1997), the main part of total production is still produced on farms which produce more than one product. Some of the products are even necessarily produced together (joint products like cow milk & beef and cereals & straw). Some of the costs of those mixed farms are logically connected to one product. For other costs this is not possible. Labour, capital, machines etc. can be used for different products. For an individual farm it is possible to allocate these costs to the products using Activity Based Costing (Schoorlemmer et al., 1997). This method starts by attributing all costs to activities. The costs of the activities are attributed to the products depending on the amount of activities that are needed to produce that product. Because this method requires a lot of information (for example, about the hours of labour and machines used for the different activities) which is not collected in the FADN, this method is not possible using this network. Of course it is also possible to use the ABC philosophy for some of the costs for which information is available on the activities used for the different products. The USDA/ERS, for example, allocates machine costs based on the hours used for the different products, but allocates other fixed costs using non-ABC methods (Ahearn et al., 1992).

Butault and Cyncynatus (1991) and Moxey and Tiffen (1994) have investigated the possibility of calculating the production costs through econometric analysis based on linear programming, regression analysis and Bayesian theory. These methods are only possible if the results many farms can be used, as is the case with the FADN. The first problem with these methods is that they do not have any (economic) theoretical foundation. Besides that, they can only be used to find an average relation between costs and output for a group of farms. There is no information about the distribution of the costs between the farms. Although the Bayesian approach has some advantages above the other methods (Moxey et al., 1994), the empirical results of all 3 methods are not always very promising. This is partly to do with multicollinearity and heteroscedasticity in the data (Butault et al., 1991). Other reasons that these econometric methods do not give the desired results are the possible variance in production methods (using labour, machines or contract work) and the influence of factors which are normally not brought into accountancy surveys (like weather, soil quality, etc.).

At the Agricultural Economics Research Institute (LEI) in The Hague two simple methods are used which have some economic theoretical foundation. The first method assumes that in the long run every product has the same profitability (expressed as revenues/costs) because otherwise the farmer would change his product composition. The costs that cannot be directly allocated to a single product are allocated in such a way that every product has the same profitability. For an individual year this method is not correct, but as stated later, production costs should be based on several years and in that case it may be a reasonable approximation. The method is only possible for fairly specialized farms. If a farm has many products, the approximation would be too rough. The USDA/ERS (Ahearn et al., 1992) uses a variant of this method where costs are attributed to a product on the share of gross value of a product in the farm's total gross value. This variant, however, can lead to the relatively low profitability of products with relatively high (variable) costs already allocated. If the gross value of two products is equal, both products are allocated half of the (fixed) costs. This will lead to low profitability of the product with high variable costs [1].

The second method can be used for products that are necessarily produced together (like cow milk and beef). The method supposes that the by-product is only produced because of the main product. The revenues of the by-product are supposed to be the same as the costs of it. The remaining costs are allocated to the main product. This approximation is also only possible when the by-product forms only a small part of the total production. Another drawback of this method is that in situations where the total costs of the farm (including opportunity costs) are higher than the total revenues, which is the case for most farms in Western European countries, the by-product is the most profitable product.

Another method that is sometimes used in practice to overcome the allocation problem, is calculating the cost of 100% specialized farms and using the level of those costs to divide the costs of the mixed farms over the products. This method is of course only possible if there are enough 100% specialized farms for the different products produced in a mixed farming system. Besides that, the cost per product of the 100% specialized farms can be different from the cost of that same product on the mixed farms, because of economics of scale, for example. Consequently, the results will only be rough approximations.

Because of the difficulties of allocating costs to individual products, production cost analysis is mostly based on more or less specialized farms. Depending on the level of specialization, this can result in different costs per unit. Only by coincidence will the cost for the specialized farms be the same as the cost for all the farms. Significant distortions can occur especially when the degree of specialization differs between the countries or when only a small percentage of the total number of farms are specialized and these farms have different characteristics than the average farm. Comparing the characteristics of the average farm with those of the specialized farms and sensitivity analysis for selecting different degrees of specialisation are essential in examining whether the analysis is still representative for the average in different regions. From a practical viewpoint, the choice of the degree of specialization of the

[1] An example of this situation is a farm with both cereals and pigs. The cereals have relatively low variable costs and the pigs relatively high variable costs. The USDA method would lead to the relatively low profitability of pig production.

chosen sample of farms will be a trade-off between distortions due to an incorrect allocation of costs to the product on the one hand, and the representativeness of the sample on the other hand. The chosen degree of specialization of the sample farms should differ depending on the degree of specialization for the product in the different regions and the differences in characteristics between the specialized farms and the mixed farms.

In some situations, however, the main interest lies in the costs of the group of specialized farms. In some countries only the products of (some of the large and modern) specialized farms are exported. These are the farms that are competing on the international markets. The cost of these specialized farms, which sometimes produce 'a different product' (in terms of quality, for example) than the other farms, can be of more interest than the average of a region. But even in this situation, the average production cost is of interest because if prices in their own region are high (because of the high costs of most of the farms), the exporting farms will also be able to sell their products on their own markets.

Calculated costs

Total costs can be divided in three different categories depending on the period analysed. All costs that lead to a cash outflow in the same period can be treated as the short-term production costs. When receipts are smaller than these costs, this will always lead to a cash outflow for the farm and therefore also to a reduction in liquidity and/or liquidity problems. When depreciation is added to the short-term costs, this gives us the medium-term production costs. When receipts are equal to the medium-term cost, there is just enough money for the (future) investments needed to replace the current assets. However, no income is retained for the farmer and his family. When calculated cost for the equity and unpaid labour are added to the medium-term cost, this gives us the long-term costs. Non-paid labour and capital are valuable because when it is not used for the farm, they can be used for other purposes (opportunity costs). In the long run, capital and labour will only stay in the business if the receipts are greater than or equal to the long term costs. A shortfall in the receipts compared to the long term costs can, however, result in an income that is sufficient for the expenditures of the farmer and his family.

3.2 Netherlands

Table 3.1 presents the cost price for milk in the Netherlands for five-year averages, and for 1996/97, based on the Farm Accountancy Data Network and the methodology presented in the previous section. The cost price includes an imputed value for the capital/net worth and the labour of the farm family. The revenues of the by-product are supposed to be the same as the costs of it.

For this reason cost prices are higher than the actual market price for milk: the remuneration of labour on a family farm is lower than the cost of labour, if this would have to be paid to contracted workers. In a certain sense this flexibility of family labour and the willingness to work 2,500 hours a year including in weekends at a low remuneration is the strength of the family farm.

Variable costs are about 15 dollar cents per kg of milk. Most of the costs are fixed costs, of which the labour component is the highest (nearly 20 dollar cents). Also land, buildings and quota rights (depreciated in this calculation in 14 years) are important items.

Table 3.1 Cost prices for milk in the Netherlands (in NLG)

Years	1981-1985	1986-1990	1991-1995	1996
Number of sample farms329	316	289	258	
Number of farms represented	25,991	23,211	19,323	18,788
Production (tons)	322.5	334.0	374.9	408.2
Dairy cows (number)	58.3	52.4	54.46	55.4
Cows per hectare		2.21	1.81	1.71
1.63				
Milk yield per cow	5,528	6,376	6,880	7,370
Data per 100 kg milk				
Feed costs	28.60	19.05	16.63	17.58
Fertiliser	4.75	4.05	2.85	3.07
Other direct costs	3.56	5.07	5.74	5.99
Total variable costs dairy	36.92	28.17	25.22	26.65
Other variable non-dairy 1.49	1.20	1.01	0.95	
Labour costs (incl. imputed)	31.59	33.23	35.95	34.62
Machinery costs (incl. interest)	10.17	12.54	13.22	12.64
Contractors	2.27	3.01	3.57	3.69
Land and buildings (rental base)	11.01	15.02	17.36	16.80
Total quota costs (incl. interest)	0.01	1.84	6.89	8.38
Other fixed costs	8.34	8.74	9.28	8.37
Total costs	101.80	103.74	112.49	112.08
Milk price	74.31	78.63	77.53	72.36
Other output	15.35	16.86	16.68	12.43
Total output	89.65	95.49	94.21	84.80
Cost price of milk	86.46	86.88	95.81	99.65
Net-margin	-12.15	-8.25	-18.28	-27.28
Specification quota costs:				
Depreciation	0.01	0.84	3.17	4.51
Interest	0.01	0.72	2.04	1.92
Lease	0.00	0.27	1.68	1.95

As explained the net margin is negative: minus 15 dollar cents. Matched with the labour costs this means that the cost price of milk excluding the family labour costs is about 40 dollar cents. It also implies that the remuneration for the family labour input is about 4 dollar cents.

Especially in the nineties the cost price of milk has increased due to the higher costs for production rights (quota), and in recent years, the lower value of the by-product meat/calves.

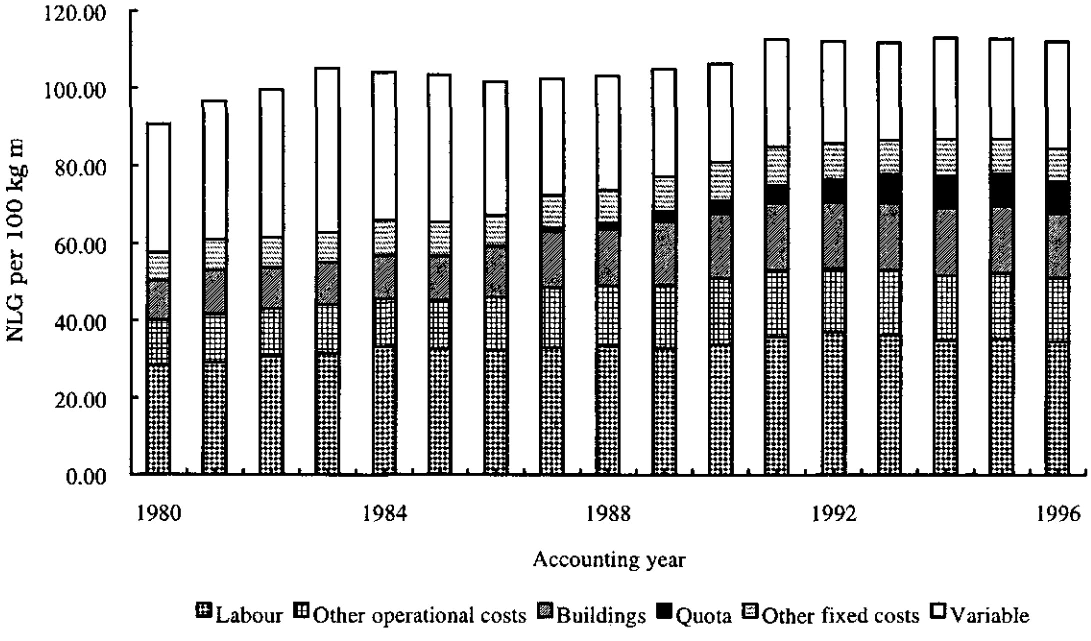

Figure 3.1 Development and details of the costs per 100 kg milk
Source: FADN, LEI.

3.3 FADN

RICA (or Farm Accountancy Data Network, FADN) is a database with accountancy results of more than 50,000 European Farms. These farms are representative for more than 3 million European Union farms. Nearly all the commercial farms are represented with the exception of some of the very large farms. Also the very small, non-commercial farms are not represented. Because the farms in RICA are representative for nearly all farms in a country and they are assembled in a harmonized way, it is very well suited for international comparisons of costs. Because of the international harmonization of accountancy rules however, the costs of production in this paragraph may differ from the results in paragraph 3.2.

Table 3.2 gives a calculation of the cost of production of milk. Total costs (including calculated costs for family labour and net worth) have been allocated to milk and other output (mainly beef) as a percentage of output, assuming an equal 'profitability' for milk and beef.

Table 3.2 Cost of production (ecu) of 100 kg milk in several EU -regions, 1994

	Lower Saxony	Brittany	Lombardia	Belgium	Nether-Lands	Denmark	Ireland	West England
Specific costs	13.75	9.97	14.76	10.09	12.34	15.77	12.83	12.83
of which feeding costs	7.48	3.98	11.94	5.95	7.30	10.00	6.09	7.24
Overhead	10.62	10.12	4.21	5.18	7.89	8.29	6.78	6.57
Depreciation	6.29	4.29	6.48	5.91	6.73	4.50	2.81	3.23
External factors	6.32	3.03	1.81	4.72	5.94	10.51	3.88	6.49
Total paid costs	36.99	27.41	27.27	25.89	32.9	39.07	26.30	29.13
Calculated costs	24.93	16.33	32.18	23.17	16.54	16.31	28.43	14.05
Total costs	61.92	43.74	59.45	49.06	49.44	55.37	54.73	43.18
Output milk	30.97	29.74	40.14	30.21	33.75	34.12	27.53	29.15
Other output	11.76	9.14	5.49	9.06	9.49	10.20	11.58	8.27
% Milk of total output	72.5	76.5	88.0	76.9	78.1	77.0	70.4	77.9
Costs/100 kg milk	44.65	33.66	51.70	37.36	38.43	42.61	38.38	33.60

Table 3.3 Farm structure and results for specialist dairy farms in EU -regions (1994, ecu)

	Lower Saxony	Brittany	Lombardia	Belgium	Netherlands	Denmark	Ireland	West England
Field of survey (1.000)	15.2	12.5	5.7	6.8	26.7	10.3	31.6	9.7
Agricultural Area (hectare)	46	34	31	34	32	45	34	66
% forage crops	92	86	97	95	97	70	99	91
% rented	53	73	64	77	33	22	12	35
Labour input	1.7	1.4	2.7	1.6	1.7	1.7	1.6	2.3
% family labour	82	98	92	95	93	72	85	60
Dairy cows	37	31	48	45	54	48	33	78
Total milk production (1.000 kg)	228	182	275	243	378	303	153	447
Milk per cow (1.000 kg)	6.2	5.9	5.7	5.4	7.0	6.3	4.6	5.7
Cows per labour unit	22	23	18	28	33	29	20	34
Net value added per abour unit (1.000)	21.6	21.8	21.0	30.9	38.6	32.8	17.1	30.5
Family farm income per family labour unit (1.000)	14.6	18.5	20.9	23.2	26.0	19.4	16.3	30.3
Assets	368.8	146.8	721.0	285.5	792.0	370.9	272.3	671.8

Total costs are the lowest in Brittany and in West England. The British farms have low cost because of scale effects. They have by far the biggest farms (78 dairy cows). The low costs of the farms in Brittany is mainly caused by their low use of capital. The Dutch farms use 3 times the amount of capital per cow that is used in Brittany. This is mainly caused by the high price of land in the Netherlands. The Dutch farmers can still produce for relatively low cost per kg milk because they have the best technical results (7,000 kg milk per cow).

3.4 International Farm Comparison Network (IFCN)

In the IFCN farms form all over the world are compared. The biggest drawback of this network is that the farms are not representative for their regions/countries. 'Typical farms' are compared but although these typical farms are common modern farms for that region, their

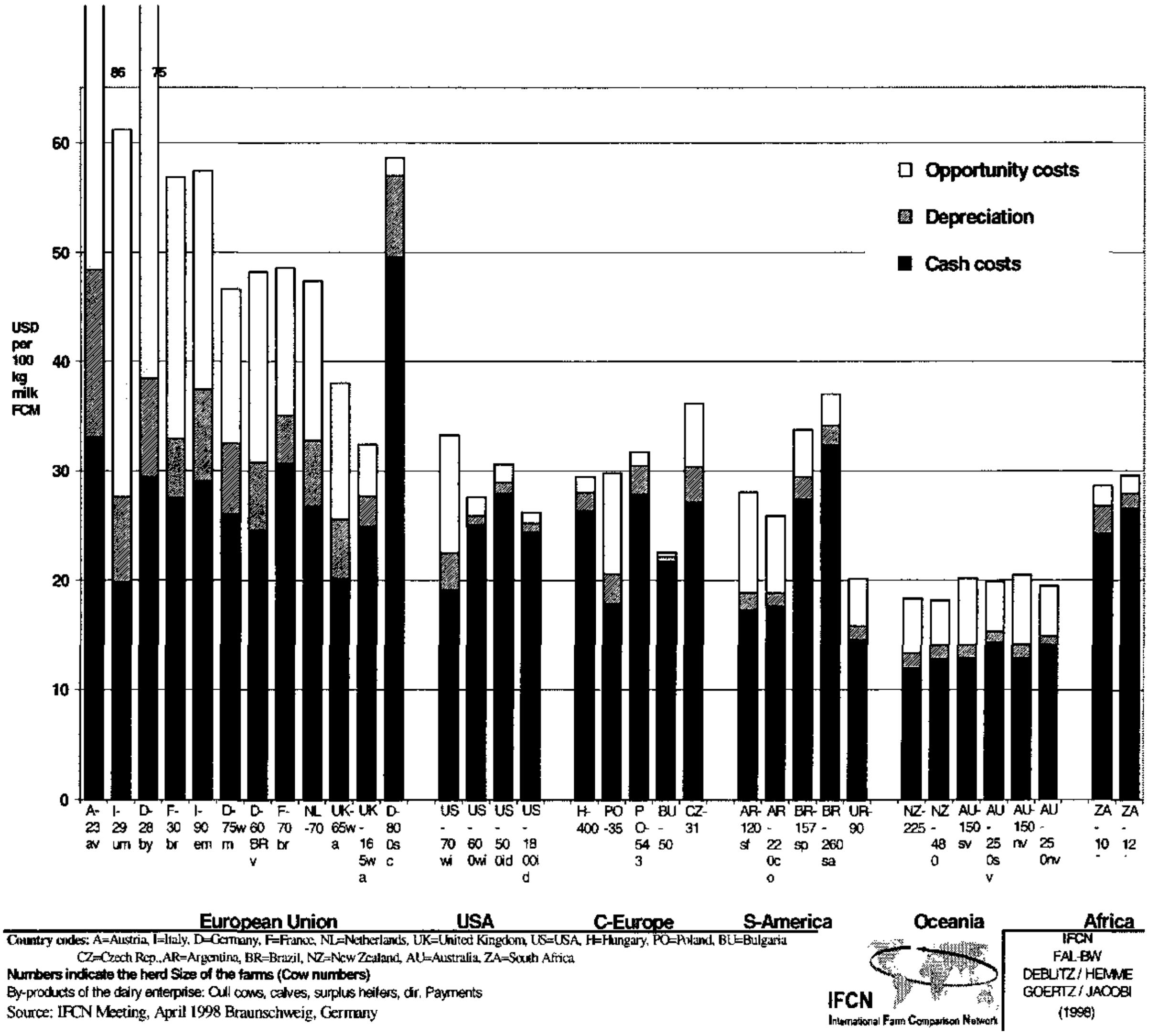

Figure 3.2 Costs of milk and by-products at typical dairy farms in 1996/97, IFCN

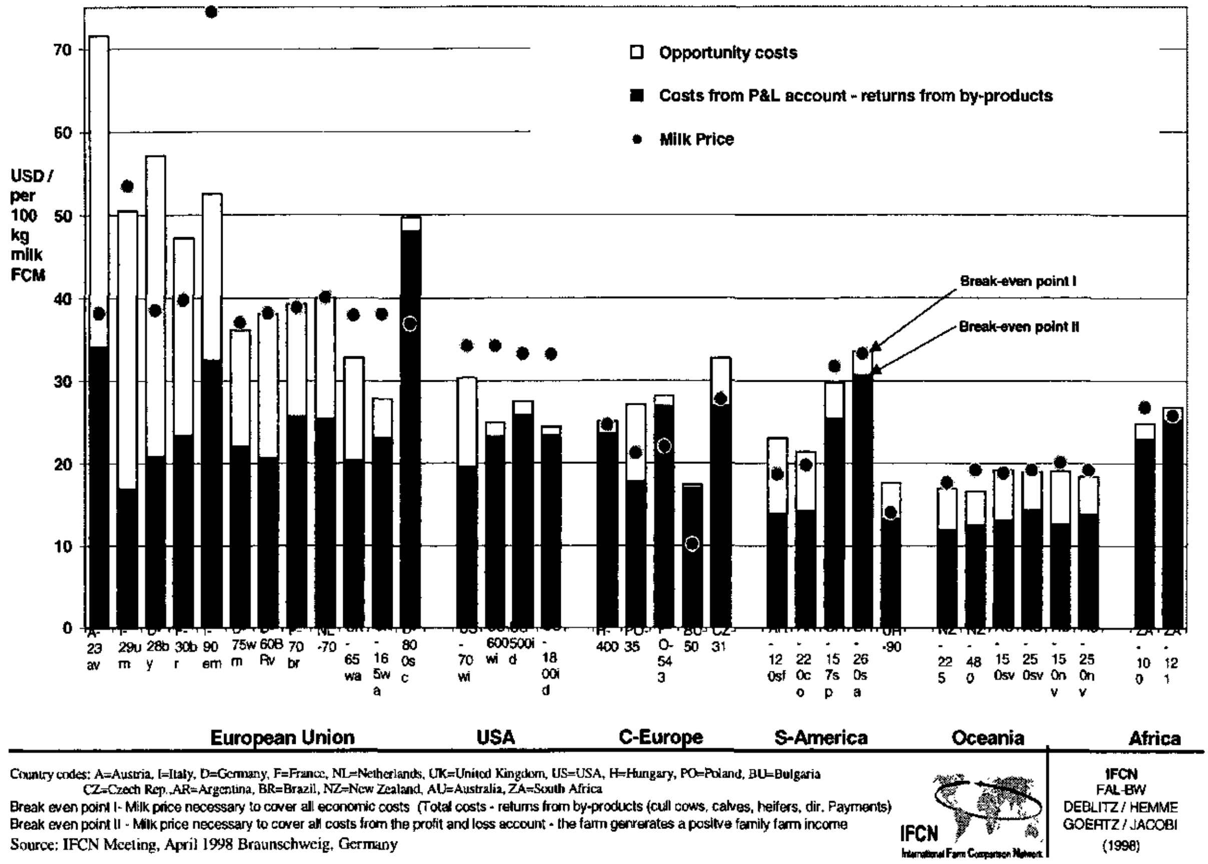

Figure 3.3 Milk prices and break even points at typical dairy farms 1996/97, IFCN

costs may be quite different from the average costs of all farms. As already stated in paragraph 3.1 the term typical farm is not easily harmonized between the countries. The typical Dutch farm in the IFCN for example has 70 cows but the average of all specialized Dutch dairy farms is only 55. Because the IFCN is as far as we know the only network that makes world-wide comparison, it is nevertheless interesting to analyze their results.

Because the IFCN uses different rules for their calculations of the cost of production, the results can not be compared with the results in the paragraphs before. Costs are not split between milk and other output in the IFCN and they use for example the same interest rate for all countries, where in RICA the amounts of interest that are really paid are used.

Figure 3.2 shows that the farms in Oceania and Uruguay have the lowest costs. The farms in the EU have by far the highest costs. This is mainly caused by the small scale of the European Union farms and their high labour costs. High costs in Europe are compensated (and partly due to) the market organization (figure 3.3).

4. Economies of scale

4.1 The effect of size

The cost price for milk on specialized Dutch dairy farms is lower on large farms than on small farms (figure 4.1). This is especially the case for the cost price including labour costs. On small farms there is too much labour available from the family, that is used inefficiently. Even on farms with a production of 700,000 kg the cost price is (marginally) lower than on a farm with e.g. 500,000 kg.

If labour costs are seen as fixed, or estimated with a very low opportunity costs (assuming that the farm family has not much alternatives for the use of their labour, and can make a living from the farm by foregoing necessary investments and accepting a relative decline of the farms capital), and excluded from the costs, the cost price is much less influenced by farm size.

This graph explains how the best medium sized farms, with good technical results and high incomes, are able to invest in the enlargement of their operation and obtain a lower cost price and a higher income level. Small and less profitable medium sized farms do not have this possibility. They often can have a level of welfare that is not alarming, but at the moment the farmer retires, the necessary enlargement has not taken place, and the next generation has to choose for other employment opportunities and closes down the farm by selling land and production rights.

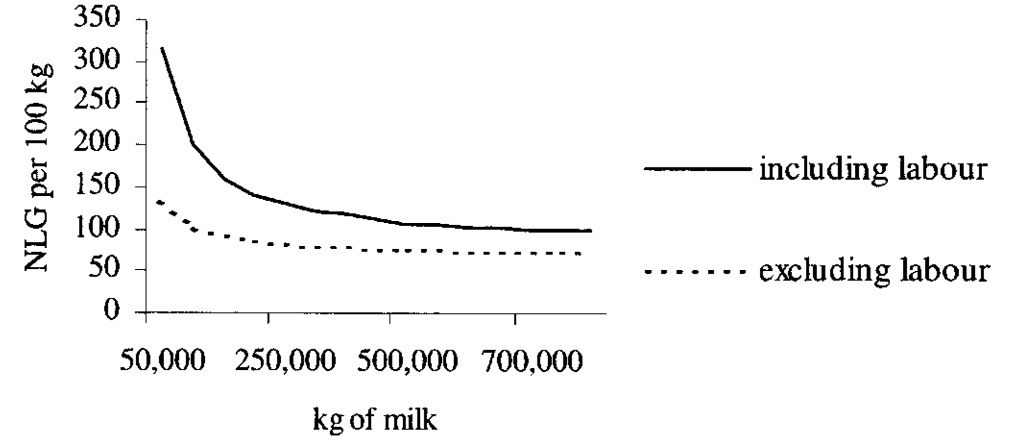

Figure 4.1 Cost of production and farm size

4.2 Structural change

The process of technological change leads to the need to enlarge dairy farms. Every year about 1,000 dairy farms (3%) in the Netherlands are going out of business and are not transferred to the next generation. It are especially small farms that disappear and sell their production rights to others. Table 4.1 also shows that the number of intensive farms drops more quickly than those of extensive farms. This is partly an effect of the environmental concerns (see below) and partly an effect of the quota system as such: as the yield per cow increases, the number of cows, and hence the stocking rate, decrease given the fixed quota. Buying or leasing extra quota without land is possible, but not attractive for environmental reasons.

Table 4.1 *Number of specialized dairy farms in the Dutch census*

	Small and extensive	Small and intensive	Large and extensive	Large and intensive	Total
1990	9,008	9,465	4,104	12,505	35,082
1991	8,489	8,650	4,104	12,612	33,855
1992	9,528	8,163	4,673	11,558	33,922
1993	9,070	7,466	4,947	11,671	33,154
1994	8,705	6,859	5,279	11,104	31,947
1995	7,985	6,347	5,215	11,712	31,259
1996	7,777	5,995	5,632	10,920	30,324
1997	8,283	5,200	6,375	9,450	29,308

4.3 Technological change: robots on the farm?

Technological change, and hence the structural change in the dairy industry is here to stay. It will still take many years before the current technological opportunities are fully adopted and utilised. In the mean time new changes are introduced. One which is currently getting much attention is the introduction of milking robots. It is estimated that at the moment there are about 350 robots from four companies installed. Canada and Japan are installing the first models (Dunn, 1998). Farmers using the systems report advantages like improved udder health, more milk per cow and quieter cows through a more 'nature-like' milking approach. A more relaxed family life is also reported as an attractive aspect of this robotization. High labour costs are a clear incentive to introduce this technology. Costs of a milking robot are about 125,000 ecu (USD 110,000) for a herd size of 60 - 80 cows.

It is clear that the introduction of a milking robot has important influences on the dairy farm. It requires special skills of the farm manager: scientific management, based on data from computers to be transferred into management decisions, overtakes the farmer with 'green fingers'.

The robot also influences the country site and the image of the industry with the consumer (and tax payer). It is therefore important to look to the long term trends in the dairy industry. A recent study carried out in our institute sees room for three types of dairy farming in 2025 (Van der Ploeg et al., 1997):

- industrial dairy farms;
- nature-oriented dairy farms;
- part-time dairy farms.

These three future farm systems differ in scale, intensity of land use and products. Industrial dairy farms compete on the world market (liberalised from current state intervention), are extremely specialized with a separation between farms with roughage production and others with milk production (and thus a zero grazing system). Robots will find their place in such farms. Nature-oriented farms not only produce milk, but they also get paid for the maintenance of nature (wetlands, bird areas in meadows) and the landscape in a very crowded country. Cost prices are high due to high labour costs (nature maintenance, imperfect allotment of parcels to conserve the country side) but this is compensated by payments for these services, be it by the market (products of regional origin, organic production, service payments from the tourist industry), be it by the government. On the part time farms the economic sustainability of the farm is searched in income from non-farm activities in the rural area (close to cities).

These three extreme farm systems are models for the potential trends in the Dutch dairy industry. The most likely development will be a mix of less extremes.

5. Milk prices and the quota system

The milk price is on average about USD 38 per 100 kg (table 5.1). Most of the milk in the Netherlands is delivered to a farmers co-operative, Friesland Coberco and Campina Melkunie being the biggest of them. Milk prices are based on fat and protein content as well as other quality aspects. There is an important differentiation between lower prices in summer time and higher ones in wintertime.

Table 5.1 Milk price in the Netherlands

	Price in NLG	Price in USD a)
Milk price (4.44% fat, 3.49% protein)	72.25	38.00
Value of 1% of fat per kg	7.80	4.10
Value of 1% of protein	10.55	5.55

a) 1 USD = NLG 1.90.

Compared to the world market, the internal EU price level is high. The high price level is maintained through a quota system (see above). Officially this quota regime has to be renewed in the coming years, and some member states are now in favour for abolishment of the system. It has to be seen if this so-called decision blocking minority of member states will keep its ranks closed, but it shows nevertheless that there is a chance that a reform of the system will be carried through in the next 5 to 10 years.

An abolishment of the system will make the current quota, and the investments in them, worthless. This could leave some farmers with less assets as a security for their loans. As most finance is not based on assets but on the cash flow of the business, this is not problematic as such. The most important question is the effect of an abolishment on the milk price. If this decreases sharply, not only quota values and land values will drop, but also cash flows to service current debt levels. The effects of the European Commission's Agenda 2000 proposals illustrate this.

6. Agenda 2000

The European Commission has made proposals to adjust the Common Agricultural Policy (CAP). The main trigger for this is that an enlargement of the European Union toward Central and Eastern European Countries makes an adjustment of the CAP necessary. Guarantees at CAP level to Eastern European farmers would be much too costly. Farmers in Western Europe however complain that Eastern Europe should change to be able to join the Union and not the other way around. Besides the issue of enlargement, also the next WTO-round will make a change in the CAP attractive.

The positive experiences of the EU with the 1992 CAP reform has lead to an extended version of such a reform, labelled Agenda 2000.

For the dairy sector it is proposed to lower milk and beef prices, and to compensate them with payments per hectare or per cow. This system is already existent for the beef and arable sector (including silage maize), and is now extended to the milk sector. As the proposed lowering of the milk price (15%) is not large enough to bring the milk price in line with the world market price, the quota system can not be abolished under the Agenda 2000 scenario.

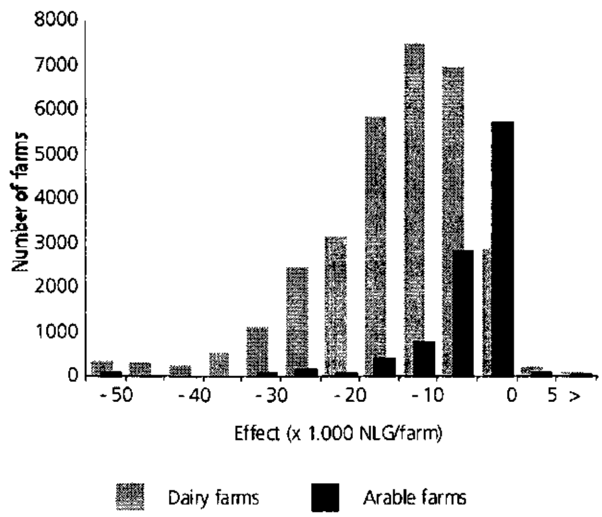

Figure 6.1 Effect of Agenda 2000 on Dutch dairy and arable farms

For Dutch dairy farms the net-effect of the proposals is negative. The proposed cut in the milk price leads to a lower output of about USD 6 per 100 kg milk. The lower beef price lowers output with USD 1.75. This is compensated by a premium per cow of about USD 250.-, equivalent to USD 4.30. Thus the direct payment per cow is too low to compensate the decline in milk price. The proposal for the cereal sector could lead to 5% lower feed costs. The total effect of Agenda 2000 on the income of the Dutch dairy farmer is minus NLG 15,000,- (USD

8,000.-), or 20%.

The total effect per farm is mainly dependent on the size of the farm, but also the share of beef in the output of the farm and the stocking rate play a role. About 2,500 farms will see their income decline with more than NLG 30,000.- (USD 16,000.-). These are mainly bigger farms.

Table 6.1 Effect of the Agenda 2000 proposals for Dutch dairy farm per size class (in NLG 1000 per farm, 1USD = NLG 1.90)

	Total	Small farms (<45 cows)	Large farms (>45 cows)
Number of farms	31,470	13,830	17,640
Hectare	30.4	19.4	39.1
Number of dairy cows	50.8	29.0	67.9
Price decline	-45.7	-25.4	-61.6
Of which milk	-36.3	-19.6	-49.4
beef	-11.7	-7.1	-15.4
feed	+2.4	+1.3	+3.2
Extra compensation	30.2	16.8	40.6
Total effect	-15.5	-8.6	-21.0
Coverage (%)	66	66	66

In the Agenda 2000 proposal the level of direct income support is limited to a maximum level. Farmers that are entitled to premiums higher than ecu100,000 (USD 115,000), get 20% less on their payments above this level. Above ecu F200,000 the reduction will be 25%. In the current situation there are no farmers that will see their income influenced by this proposal.

7. Environmental issues

Dutch dairy farmers are not only influenced by the government through price, and market regulations. The environment is a major concern to policy makers. Linking direct income payments to services on the environment or landscape (the so called cross compliance) is an issue that is much debated, also as a method to secure the prolongation of direct income payments in the future.

For the moment the environmental policy focuses, in line with the polluter pays principal, on levies. At the EU level the Nitrate directive is an important regulation. It obliges member states to run an environmental policy that guarantees the quality of ground water in terms of the maximum content of Nitrate. This includes a maximum production of manure per hectare.

In the Netherlands the implementation of the Nitrate directive is at the moment of less importance than the national environmental policy that focuses on phosphate. Farmers are obliged to keep mineral accounts, and will face a levy if the mineral surplus (the difference between the intake of minerals in the form of e.g. feed and fertiliser and the output of minerals in the form of beef and milk) is above a certain level. All farms with more than 2.5 livestock units per hectare are obliged to keep such mineral accounts; this includes more than 50% of all Dutch dairy farms. Figure 7.1 provides a distribution of Dutch dairy farms on the livestock density per hectare.

Due to the quota system the stocking rate has already decreased from 3.14 livestock units per hectare (1983) to 2.46 at the moment (1997). This decrease in the stocking rate however is not equivalent to the decrease in the production per hectare. Production per cow is now much higher (7,300 kg, +34%) and production per hectare is now 9% lower than in 1983.

Farms with a higher stocking rate have a higher surplus on their mineral balance (table 7.1). This is due to a higher intake of concentrates. As losses of minerals are more important in roughage production the efficiency of mineral use is higher on such farms. Research on differences in mineral surpluses between farms has learned that management practices have a large influence on these differences.

The maximum surplus of minerals that are allowed without having to pay levies are 300 kg of nitrogen per hectare and 40 kg of phosphate. On average dairy farms have a surplus of 380 kg of nitrogen and 62 kg of phosphate (data 1996/97). This implies that 83% of dairy farms exceed the nitrogen norm and 75% the phosphate norm. Extensification is one method to reduce a mineral surplus. Another, and perhaps more attractive one, is to use the mineral accounts as a management tool.

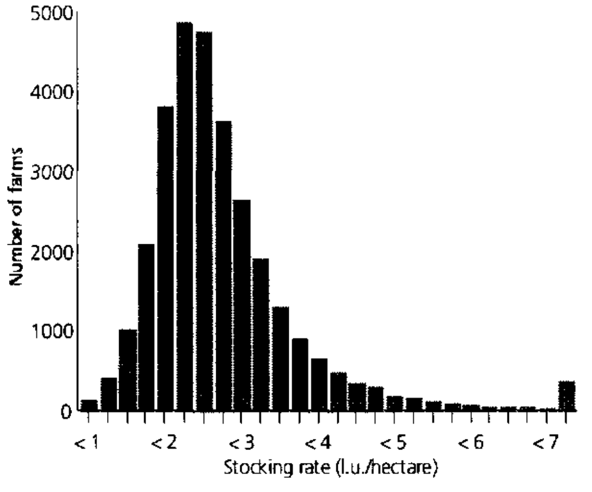

Figure 7.1 Distribution (number of dairy farms) in terms of the stocking rate per hectare

Table 7.1 Mineral balances of dairy farms, according to livestock density in livestock units per hectare (1996/97)

l.u./ hectare	Nitrogen			Phosphate		
	in-take (kg)	surplus kg	surplus % of intake	in-take (kg)	surplus kg	surplus % of intake
< 1,75	355	283	80	78	46	5
1,75 - 2,0	422	336	80	90	53	59
2,0 - 2,25	461	378	82	101	64	63
2,25 - 2,50	507	399	79	108	60	56
2,50 - 2,75	539	417	77	124	71	57
2,75 - 3,0	579	423	73	133	64	48
3,0 - 3,25	638	439	69	163	76	47
> 3,25	672	448	67	173	76	44
Total	494	382	77	110	62	56

The environmental issue also influences the image of Dutch dairy farming. Consumer concerns in the Netherlands are an important trigger for farmers organizations to reflect on the future developments in the sector. This has lead to a policy document in which farmers organization propose to direct policy instruments towards a farm system that does not have an industrial image, but in which cows are grazing outside and landscape and the environment are respected.

8. Chain management and co-operatives

Consumer concerns and consumer awareness have also lead to a more market oriented organisation of the dairy chain. Projects are carried out to improve quality systems and tracing and tracking systems. The BSE-crisis has also stressed the need for such systems. The market share of organic production is - at least in the Netherlands- very small.

Large super market chains have gained much market power in the last 10 years. Co-operatives have been forced to merge, to create brands and to develop new products in order to keep market power. These developments ask for large investments and hence a need to attract capital. That is not an important strength of a co-operative. The rate of return on such investments can not always made clear to the members of the co-operatives. Old farmers without a successor and young farmers who need the capital in their own farm are often not in favour to invest more in their co-operative. Some farmers with a good performance have more promising investment options in their own farm.

Dairy co-operatives have been looking for solutions for this problem of raising capital, and have found different solutions. In Ireland there has been a trend to turn dairy co-operatives in to public stock companies. That benefited farmers who are going to leave the sector, but doesn't seem to be an attractive solution for the milk price. In the Netherlands Friesland Dairy Foods has created a co-operative with shares that can only be traded between farmer-members. The milk price is based on a benchmark of prices paid out by other European dairies and a resulting profit (or loss) is paid out per share in stead of per kg milk. Other co-operatives have raised capital by shares or participation's that are coupled with the milk delivery.

Advocated, but not much installed, is the suggestion to make a distinction between first stage and second stage activities in a co-operative. The first stage is the classical function of the dairy co-operative to collect milk and process it into standard, bulk products (like Gouda cheese, butter, and milk powder for intervention). The second stage includes the development of branded products, novel dairy food products, foreign investments and new, untraditional outlets for milk like industrial use. Business units that carry out such activities do not need to be organised as a co-operative and can be run like a normal limited company and clear performance criteria for its management (return on investment), with the co-operative having a majority interest.

9. Conclusion

This paper described a number of trends in the dairy sector that will influence the future shape of the farming systems, their cost price and the economic performance of the dairy farms. The future is hard to predict, especially in a time that technology and political developments seem to be in discontinuity with yesterday's trends. For European dairy farming, and agriculture in general, two trends however seem to be certain: more orientation towards science and society. Scientific developments lead to more know how on the processes in dairy farming, that will be supported by e.g. computers and robotics, and makes farmers less dependent on 'green guesswork'. Demands from the society on production methods (industrial farming, bio technology) makes it more important that farmers choose their farm system in line with these consumer concerns.

It are these mega trends that will shape the future of the European dairy industry.

References

Ahearn, M.C. and U. Vasavada, *Costs and returns for agricultural commodities, advances in concepts and measurement.* Westview Press, Oxford, 1992.

Burell, A., *Economic aspects of milk production in the EU.* Eurostat, (undated).

Butault J.P. and M. Cyncynatus, *Les couts de production des principaux produits agricoles de la communaute Europeenne en 1984-85-86.* INRA/INSEE, Paris, 1991.

Dunn, N., 'Milking robots: the revolution rolls on'. In: *Agrifuture.* november '98, pp. 30-33, 1998.

Eck, W. van, B. van der Ploeg et al., *Koeien en Koersen: ruimtelijke kwaliteit van melkveehouderijsystemen in 2025.* Wageningen, 1996.

FAL, *International cost comparisons IFCN.* (http://www.fal.de/english/institutes/bw/ifcn/html/ifcnhome.html).

Horring, J., *Methode van kostprijsberekening in de landbouw.* Emmen, 1948.

Morisset, M., 'Cost of production surveys'. In: *Bulletin of the International Dairy Federation,* 46 (1994) 296, pp. 19-33.

Moxey, A.P. and J.R. Tiffen, *Estimating linear production coefficients from sample farm data: A Bayesian approach.* University of Newcastle upon Tyne, Research paper, 1994.

Poppe, K.J., *Competitiveness at farm level: Milk production costs and quota.* Den Haag, LEI-DLO, Research Paper, 1993.

Poppe, K.J., 'Specialisatiegraad binnen EU neemt toe'. In: *Agri-monitor,* (1997) 1, pp. 9-10.

Porter, M.E., 'The competitive advantage of nations'. In: *Harvard Business Review,* (1990) March - April, pp. 73-93.

Rabobank, *The world dairy market.* 1998.

Schoorlemmer, H.B., J.P.P.J. Welten and A.T. Krikke, *Geagrificeerd ABC, een methodiek voor het toerekenen van vaste kosten aan gewassen.* Proefstation voor de Akkerbouw en de Vollegrondsgroente (PAV), Lelystad, 1997.