This is not a peer-reviewed article
Electronic-only *Sixth International Dairy Housing Conference Proceeding*
16-18 June 2007, (Minneapolis, Minnesota, USA)
Publication Date 16 June 2007.
ASABE Publication Number 701P0507e

Large Scale Dairy Farming in The Netherlands: Economic Evaluation and Environmental Impact

H. J. C. van Dooren and P. J. Galama

Animal Sciences Group of Wageningen University and Research Centre, Lelystad, The Netherlands.

Abstract. Increasing scale is an ongoing process in Dutch dairy farming. Average farm size in the Netherlands is about 70 cows. True benefits of scale however occur at sizes above 500 cows. A sudden growth to larger scale will bring the benefits of scale within reach in a couple of years. In the 'Cowmunity' project, three farmers developed five new concepts for a 1000 cow farm somewhere in the Netherlands. These new concepts were developed along two axes: grazing versus zero-grazing and technology versus labour. The Animal Sciences Group was asked to perform an assessment study on these concepts. Objective of this study was to evaluate the concept, list the possible bottlenecks and suggest solutions. This paper describes the differences between the concepts and the critical success factors focussing on economic results and environmental impact.

With average prices for rent, slurry removal and roughage, land in own property combined with grazing is economically the most favourable option. The landless concept has the highest result at low prices for roughage and slurry removal and high prices for rent. Zero-grazing with self sufficiency for roughage is only attractive compared to the landless option when rent is lower than € 400 per ha or when prices of slurry removal are higher than € 10 per m^3 slurry.

Environmental impact focuses on mineral balances for nitrogen and phosphate. Surplus of nitrogen and phosphate is highest in the concepts with grazing. General conclusions are that dairy farming on this scale doesn't necessarily lead to unacceptable impacts on the environment and grazing can, on this scale, lead to the highest net profit.

Keywords. Dairy farming, large scale, economic analysis, environmental impact, grazing, labor

Introduction

Increasing farm scale is an ongoing process in The Netherlands. Between 1980 and 2005 the number of farms decreased from 67,167 to 23,527. The number of milking cows decreased in the same period from 2.5 million to 1.5 million leading to an increasing farm size of 38 milking cows in 1980 to 64 in 2005 (CBS, 2007). These, often family run farms, develop in small steps towards a larger scale. True benefits of scale however occur at farm sizes above 500 cows. To reach this scale will take decades with the present growing rates. Besides this gradual development, a more sudden growth is possible. A larger scale is than reached in one step and benefits of scale are within reached in a couple of years. This idea was the starting point of three farmers who aimed to start a 1000 cow dairy farm somewhere in the Netherlands. In the project with the name 'Cowmunity' they developed five different concepts for this farm. Dairy facilities of this scale require new management skills to avoid expensive mistakes. To avoid these mistakes the Animal Science Group was asked to comment on these concepts on economic and environmental issues and give options for feeding and milking systems. This paper describes the results of this assessment.

Materials and Methods

Description of the concepts

The five concepts were developed along two axes: grazing versus zero-grazing and technology versus labour. This resulted in the following concepts:

A: Landless (only for farm buildings)
B: Grazing on 100 ha
C: Grazing on 450 ha

D: Zero-grazing with 480 ha (75% maize)

E: Zero-grazing with 450 ha (75% grass)

Concepts C, D and E are all self sufficient in terms of roughage production. In concepts A and B the necessary amounts of roughage are purchased. Concepts D and E differs in the amount of grass silage in the ration (25% and 75% respectively).

Figure 1 shows three possible options for the concepts without grazing (A, D and E). The options differ in milking system (Parlour or Automated Milking System(AMS)) and feeding system (self feeding, Total Mixed Ration(TMR) or automatic feeding).

Figure 2 shows two options for the concept with grazing that differ in milking system (milking parlour versus AMS). Because walking distances from the pasture is limited with automatic milking, the herd is divided over four locations.

Farm size of all concepts is 1152 total cows including 192 dry cows. Each year 344 yearlings in calf are purchased. After calving, 307 heifers are introduced into the herd. Each year, 1325 calves are born and sold after two weeks.

Maize and grass silage is stored in horizontal bunkers. Slurry is stored in concrete silos.

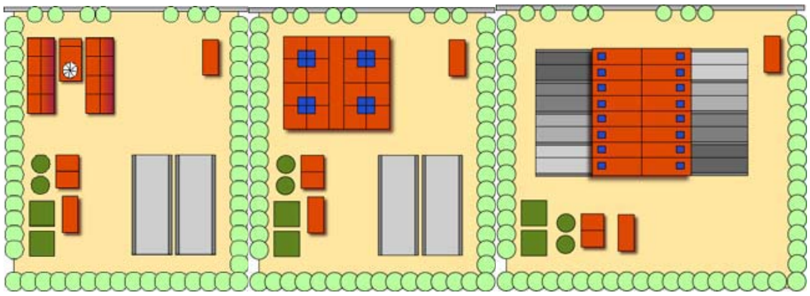

Figure 1: Three possible option for concepts A, D or E with automatic milking (middle and right) and self feeding (right)

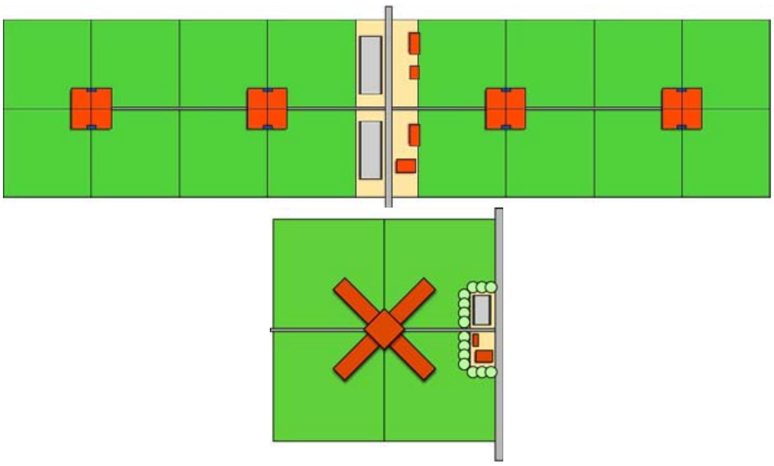

Figure 2: Two options for concepts B and C with automatic milking (above) or a milking parlour (bottom).

Economic evaluation

The economic net results of the concepts depend strongly on the price level of the main production factors. Table 1 gives an overview of the chosen prices.

Table 1: Prize of different production factors at three levels

	Low	Average	High
Land Rent (€/ha)	400	650	900
Slurry removal (€/m^3)	3	6	15
Maize Price (€/ton FW[1])	25	35	45
Grass Price(€/ton FW[1])	25	40	55

[1] FW = Fresh weight

Table 2 gives the net economic results of the concepts in 9 different price scenarios.

Table 2: Net result of concept in different price scenarios (€/100 kg milk)

Nr	Price level	Landless	Grazing		Zero-grazing	
			100 ha	450 ha	75% maize	75% grass
1	Average prices	7.4	7.5	8.3	5.8	6.3
2	Low prices for maize and grass	9.4	9	8.4	5.8	6.3
3	Low prices for land rent	7.4	7.8	9.4	7	7.4
4	High prices for land rent	7.4	7.3	7.3	4.7	5.2
5	Low prices for slurry removal	8.3	8.2	8.3	6.2	6.5
6	High prices for slurry removal	4.7	5.4	7.8	4.7	5.8
7	Optimal for landless	10.3	9.5	7.5	5	5.4
8	Optimal for landowners	4.7	5.6	8.9	5.9	6.9
9	EU-subsidy maximized at € 870/ha	3.7	4.5	8.3	5.8	6.3

Based on the results of the economic evaluation the following conclusion can be drawn. With average prices concept B (Grazing on 450 ha) is most favourable when cow walking distances are less than 1000 meters, the milk production levels do not decrease and the grazing does not cause damage to the pasture. Extra investments in grazing equipment such as selection gates are not included in these calculations.

The landless concept has the highest profit at low prices for forage and slurry removal and high prices for rent.

Zero-grazing is only attractive compared to concept A when rent for land is lower than € 400 per ha or when prices of slurry removal are higher than € 10 per m^3 slurry.

Environmental impact

Environmental effects included are surplus of nitrogen and phosphate, emissions of ammonia and greenhouse gasses and leaching of nitrate to the groundwater. Calculations are done for clay soils, only nitrate leaching is calculated on sand soil. Only grazing concepts were included in emission calculations. Emissions of methane and nitrous oxide are expressed in kg CO_2 equivalents. The convertion rate is 21 for methane and 310 for nitrous oxide. Animal slurry is applied to grassland and arable land using emission reducing techniques with reduction rate of 98%. Results are summarized in table 3.

Table 3: Overview of environmental impact

	Landless	Grazing		Zero grazing	
		100 ha	450 ha	75% maize	75% grass
Surplus of nitrogen (kg N per ha)	0	150	170	50	160
Surplus of phosphate (kg P_2O_5 per ha)	0	30	15	20	10
Emission of ammonia (kg NH_3/ha)	30	30	44		
Emission of N_2O (kg CO_2/ton milk)	10	50	160		
Emission of CH_4 (kg CO_2/ton milk)	440	420	440		
N fertilizer gift (kg N/ha):					
Dry sand soil		269	293		

Normal sand soil		294	325
Nitrate leaching (mg NO_3^- /l groundwater):			
Dry sand soil		113	65
Normal sand soil		84	51

Based on the results of the environmental evaluation the following conclusion can be drawn.

In the landless concept, the surplus of nitrogen is nil because all minerals in feed and fertilizer are transported from the farm in milk, meat and slurry.

The nitrogen surplus of concept D is low with 50 kg per ha. This is caused by a low artificial fertilizer supply and the majority of the slurry is transported from the farm (mainly to arable farmers in the region). The high number of hectares diluted the surplus also compared to concept E. With maize in ration more hectares are needed to become self sufficient in forage.

Housing and slurry storage are the major sources of ammonia and methane emissions. The emission of nitrous oxide is strongly related to the number of hectares.

Housing and slurry storage contributes in concept A to 100%, in concept B for 82% and for concept C for 58% of the total ammonia emission. The remaining emissions occur during application.

To remove the total amount of almost 33,000 m^3 slurry, 890 ha of arable land (e.g.in maize) is needed calculating with the maximum amount of 170 kg nitrogen from animal slurry per ha. When the slurry is transported to grassland (with a maximum of 250 kg nitrogen from animal slurry per ha) 605 hectares are needed.

The total emission of ammonia from housing, storage and application in concept A (including the emission on *arable* land) is 30 kg per ha. In concept C it is 44 kg ammonia per hectare.

Methane emission is higher in terms of CO_2 equivalents than the emission of nitrous oxide. Concept A has no N_2O emissions. The emission of N_2O in concept C is 28% of the total greenhouse gas emission.

In concept B the 1152 cows can graze 140 days a year, 5 hours a day. Grass intake is 3 kg dry matter per cow per day and maize intake is 10 kg dry matter. In concept C the grass intake is 6 kg dry matter per cow per day and grazing period is 166 days and 8 hours a day.

Nitrate leaching can be reduced by decreasing the grazing intensity or to decrease fertilizer gift with 100 kg N per ha.

Milking equipment

The choice for milking equipment depends on the yearly costs for investments and labour. Different milking systems are compared including automatic milking. Labour costs are calculated for twice of three time milking per day. Yearly equipment costs consist of maintenance (5%), interest (4%) and depreciation (10%).

Table 4: Overview costs of different options for milking equipment (€).

Parlour	Investment	Yearly Equipment Cost	Labour		Total	
			2x	3x		
2*14 side-by-side	100	20	405	-	425	-
2*14 side-by-side (2x)	200	39	331	497	371	536
2*28 side-by-side	180	37	364	546	401	583
Swing-over 2*24	88	18	355	533	373	551
Swing-over 2*48	160	33	318	476	351	509
Rotary (inner) 28	200	39	341	-	380	-
Rotary (outside) 48	300	59	305	458	364	517
Rotary (outside) 60	350	70	305	458	375	527
16 AMS 1-box systems	1.500	287	145		432	
8 AMS 3-box systems	1.200	232	145		377	
12 Herringbone	21	5	37	55	41	59

[1] 2*14 indicated the number of stand per side

Automatic milking is an attractive option compared to three times milking because of the reduced labour costs. It is recommended to milk the high attention cows in a small, for example a 2*6 herringbone, milking parlour. In a situation with a milking parlour and two times milking per day a swing over with 2 * 48 is the cheapest option. In a three times a day milking situation a rotary with 48 stands is the cheapest option.

Feeding system

Four feeding system options are compared: the self feeding concept (cows go to silo face to feed), the TMR concept with tractor and mixing equipment, the stock feeding system (maize and grass silage is provided on the feeding table every two to three days) and automatic feeding (feed is supplied automatically on feeding table. e.g. Mullerup system). Table 5 gives an overview of the costs of the different systems.

Table 5: Overview of cost of feeding systems

	Self feeding	TMR	Bunker feeding	Automatic feeding
Daily amount of labour (minutes/ton)	3	7	6.5	4.2
Yearly amount of labour (hours)	878	2048	1900	1229
Number of employees	0.4	1.0	1.0	0.6
Costs				
Labour	22	51	48	31
Equipment	46	41	67	37
Storage	107	33	29	33
Energy	3	64	20	13
Total	178	190	163	122
Total costs (€/100 kg milk)	1.7	1.8	1.6	1.2

Total costs between the systems do not differ much. The structure of the costs however is different. Savings on labour and energy at self feeding are not higher than extra costs for storage. Energy costs are high when TMR is fed with tractor and mixer. The investment for selection gates, when feeding directly from the silo face, is high. Most attractive is automatic feeding because of relatively low investments and low costs for energy and labour.

Conclusion

Critical success factors

To run a profitable large scale dairy farm, choices have to be made based on critical success factors:

- Core business. Either produce milk with low costs or create extra value from manure, milk and/or create extra income from education, research or promotional activities.
- Amount and aim of grazing: grazing as image building for public relations or as an economic activity.
- Amount of technology as for example automatic feeding, milking versus the use of labour depending of the availability and labour costs in the region.
- Relation with suppliers. Long term contracts with preferred suppliers or purchase of feed and cattle on the free market.
- Ratio between the amount of grass and maize, which is optimal with respect to region, landscape and slurry legislation.
- Growth possibilities: compact built housing or prepared for herd growth.
- Amount of innovation and risk.
- Be transparent about animal welfare and environment.
- Capacity of milking parlour is limiting the scale of the farm.
- External investors can facilitate a faster growth rate.
- Focus on cow management and not on the cow manager.

These choices determine the farming concept to a large extend but leave enough freedom of choice depending on price developments, legislation, regional circumstances and personal preferences.

Innovation challenges

The five concepts are evaluated on innovation challenges. What has to be innovated to make this concept a success? The innovations are summarized below.

- A large scale dairy facility as an attractive partner in education and research cooperation.
- Differentiation in milk streams is possible on this scale and would lead to extra income.
- Slurry handling or processing such as anaerobic digestion
- Sand as litter for walking and resting areas is animal friendly. The problems of separation of sand and slurry need to be solved.
- A system where ammonia containing ventilation air is chemically washers to reduce ammonia

and odour emissions.

- With an intelligent location and detecting system attention, cows are detected and separated with less labour.
- Entering and leaving at several places would increase the capacity of a rotating milking parlour significantly.
- To make grazing possible, attention should be paid on flexible fencing or virtual electric fence (VEF):
- With mobile milking systems grazing is possible on more locations and fields. Development of mobile parlours of automatic systems is needed.
- Alternative dairy system not described in the current concepts is for example a dairy landscape. Several smaller farms combining milking and feeding equipment and part of the labour demand is provided by non-agricultural inhabitants of these so called ‘dairy villages’
- Alternative dairy system not described in the current concepts is for example a large scale dairy facility in a region with surplus of grassland or other roughage, for example nature reserve areas.

References

CBS. 2007. Statistics Netherlands, www.cbs.nl