ECONOMIC EFFECTS OF ON-FARM NATURE CONSERVATION FOR DAIRY FARMS

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Abstract

The economic effect for farms of on-farm nature conservation is an important issue in Dutch agriculture. As nature is a public good, nature conservation cannot do without subsidies from the government. The question of how much farmers should receive in subsidies in order to keep farms engaged in conservation activities is highly topical. In this study, economic effects of on-farm nature conservation for dairy farms in a particular area in the Netherlands were determined by means of normative modeling. Based on data from farms that deal with on-farm nature conservation and data from comparable farms that are not involved in this activity two average farms were determined. Comparison of the modeling results of these two farms showed that the farm involved in conservation earns a lower income than the farm not involved in conservation. This is due to the first farmer's smaller scale, lower intensity and lower productivity. The lower income, however, was partly compensated for by conservation subsidies.

***Keywords**: On-farm nature conservation, Landscape conservation, Agriculture, Dairy farming, Farm modeling*

Introduction

An increasing number of EU-farmers are involved in on-farm nature conservation. In the Netherlands, the area involved in on-farm nature conservation schemes has increased from 18,000 ha in 1990 to some 70,000 ha in 2003, which is about 4% of the agricultural area in the Netherlands (Van Egmond and De Koeijer, 2005). Compared to the other 14 older member states of the EU, apart from Greece this is the lowest percentage. In the EU as a whole the area covered by agri-environmental contracts in 2002 was about 25% of the total utilized agricultural area (EU, 2005).

This paper describes a study done on the economic effects of on-farm nature conservation in a region in the northern Netherlands. This region consists of a northern and southern part. The northern part can be characterised as an open area with relatively little limitations for farming. This part is called the "Open Area". The southern part, which is called "De Wouden", has an interesting landscape with hedges and small land plots. Conservation of the landscape in De Wouden is done by means of on-farm nature conservation, subsidised by the central Dutch government. In both areas dairy farming is the main agricultural activity. This study developed from the concern of the regional farmers organisation that the compensation that farmers in De Wouden receive for landscape conservation would be insufficient to cover the extra costs that originated from the landscape induced constraints on productivity, scale, and intensity. The reference situation used as a basis for the concern was that of dairy farmers in the Open Area.

Farmer interest in participation in on-farm nature conservation schemes is connected with the amount of public financial compensation that farmers receive for their conservation activities. Consequently, the economic incentive offered to farmers is important (Balk-Theuws, 2004). Economic effects of on-farm nature conservation can be determined in different ways. Normative modeling, which utilizes a model at farm level, is an approach used by Kächele and Dabbert (2002), Van Wenum et al. (2004) and Schrijver et al. (2006). This approach can be used to make a clean economic comparison between situations with and without nature conservation. Biases that occur in practice but are not relevant for the research question can be left out.

The goals of this paper are (1) to determine differences in farm internal structure and farm technical results between farms that are and farms that are not involved in on-farm nature conservation and (2) to determine the economic effects of these differences in farm internal structure and technical results by means of normative modeling.

Materials and Method

Using dairy farm data, average dairy farm data for both the Open Area and De Wouden are compared to determine differences in farm internal structure and technical results. Next, the average farms are modeled using an existing linear programming model of a dairy farm (Berentsen and Giesen, 1995). Comparison of the results of calculations shows the different economic effects of on-farm nature conservation.

Data

Farm level data from both areas were acquired from AVM, an accountancy office specialized in agriculture. AVM does the bookkeeping for some 70-80% of all farms in the northern Netherlands.
First, dairy farms whose entire agricultural area is located in De Wouden and in the Open Area respectively were identified using detailed maps of the region. Of these identified dairy farms, 42 farms in De Wouden and 54 farms in the Open Area were a client of AVM in 2005. The most recent data available for these dairy farms were acquired in order to get an idea of the current amount of nature conservation subsidies paid to these farmers. This requirement of recent data decreased the available number of farms in the database down to 23 farms in De Wouden and 33 in the Open Area. The data are from the fiscal year that runs from May 2003 to May 2004. From comparison of FADN (Farm Accountancy Data Network) dairy farming data for the Netherlands for different years it appears that 2003-2004 was quite average concerning the economic environment (LEI, 2006).

The data acquired from AVM were mainly concerned with size and productivity. Size is measured by available milk quota, agricultural area, number of dairy cows and farm size, the latter of which is measured in Dutch Size Units (DSU). Productivity is measured by milk production per cow and by grass production per ha. Grass production per ha is not something that is recorded, but this was calculated by working out the total energy requirements per farm given the number of animals and subtracting from this all energy from purchased fodder, which is mainly concentrates. The remainder is the total energy production on the farm. Dividing this by the total area results in the energy production per ha. In addition to data on size and productivity, nature conservation subsidies, fertilizer costs, and costs of contract work and of mechanization were also acquired. The latter can show if the smaller parcels in De Wouden lead to higher costs of using the land.

Table 1 shows that the dairy farms in De Wouden are significantly smaller than those in the Open Area in terms of milk quota and DSU. Consequently, the ratio between milk quota and area, which amounts to 10,322 and 11,875 kg/ha for De Wouden and the Open Area respectively, shows a lower intensity of production in De Wouden. Also, productivity in general and grass production/ha in particular is significantly lower in De Wouden. The latter can be explained by lower nutrient input from manure (nr. of cows/ha is smaller) and from fertilizer (fertilizer costs are lower) and by the effect of shadow of and nutrients used by trees.

Table 1: Average farm data for both areas on size, productivity, costs, and subsidies

	De Wouden	Open Area	Significance [1]
Size of the farm :			
- milk quota (kg)	501665	700644	++
- dairy cows (nr.)	69.7	96.0	++
- area (ha)	48.6	59.0	-
- Dutch size units	101.5	151.5	+
Productivity:			
- milk production per cow (kg/year)	7197	7297	-
- net grass production (MJ NEL[2]/ha)	39447	45437	++
Costs:			
- fertilizer (E/ha)	116	126	-
- contract work and mechanization (E/ha)	857	805	--
Landscape subsidy (E/ha)	218	-	++

[1] (++) variables are different at the 1% level of significance, (+) variables are different at the 5% level of significance, (-) variables are not different at the 5% level of significance, (--) variables are not different at the 20% level of significance

[2] NEL = Net Energy for Lactation

As a result from the lower grass production/ha, lower costs of contract work and mechanization can be expected, since less mowing and ensiling and less manuring per ha have to take place in De Wouden. However, the opposite is true. Costs for contract work and mechanization are higher, pointing to more time/ha needed per cut of mowing and ensiling, and per ton of manure applied. Finally, nature conservation subsidies were prevalent only in De Wouden.

LP-model of a dairy farm

The model that is used to determine the effects of landscape conservation is a whole farm linear programming model. The objective function maximizes labour income, i.e. the remuneration for labour and management that is left after all other costs have been paid. The initial farm situation is specified by the right-hand side values for land and milk quota and by farm-specific coefficients representing milk production per cow and grass production per hectare. Table 2 shows the general structure of the model with grouped activities and constraints.

The central element in the model is a dairy cow with a fixed milk production, which is assumed to calve in February. A minimal ratio is required between the number of young stock and the number of dairy cows to guarantee replacement of dairy cows. The feeding part of the model consists of four parts. The dairy cows and young stock are fed separately, and a division is made between summer, when cows and young stock can graze, and winter, when livestock is kept indoors. For dairy cows, feeding constraints reflect demand and supply of energy and protein, dry matter intake capacity, and demand for fiber in the ration. Feed for dairy cows and young stock consists of grazed and conserved grass and maize silage produced on the farm, three types of purchased concentrates that differ in protein content, dried beet pulp, and purchased maize silage.

Table 2: General structure of the dairy farm LP-model

Activities / *Constraints*	Feed production for on-farm use	Purchase of feed	Animal production	Manure application	Purchase of fertilizer	Other operations: owner's mechanization or contract work	Machinery for owner's mechanization	Nutrient losses	*Right-hand side*
Land requirements	+1								≤ Available hectares
Milk production			$a_{i,j}$						≤ Available quota
Housing requirements			$a_{i,j}$						≤ Available cow places
Labour requirements	$a_{i,j}$		$a_{i,j}$	$a_{i,j}$	$a_{i,j}$	$a_{i,j}$			≤ Available labour
Feeding requirements	$-a_{i,j}$	$-a_{i,j}$	$a_{i,j}$						≤ 0
Fertilizing requirements	$a_{i,j}$			$-a_{i,j}$	$-a_{i,j}$				≤ 0
Linking animal production and manure application			$-a_{i,j}$	$a_{i,j}$					= 0
Nutrient balances:									
- farm level		$-a_{i,j}$	$a_{i,j}$		$-a_{i,j}$			$a_{i,j}$	= 0
- herd level	$-a_{i,j}$	$-a_{i,j}$	$a_{i,j}$	$a_{i,j}$					= 0
- soil level	$a_{i,j}$			$-a_{i,j}$	$-a_{i,j}$			$a_{i,j}$	= 0
Linking production activities and operations	$a_{i,j}$					$-a_{i,j}$			≤ 0
Linking owner's mechanization and new machinery						$a_{i,j}$	$-a_{i,j}$		≤ 0
Object function	Costs per ha	Costs per unit	Gross margins	Costs per unit	Costs per unit	Costs per unit	Annual costs		

In the model, the land can only be used for growing grass at five rates of mineral nitrogen (Nmin) from fertilizer and manure (100, 200, 300, 400 and 500 kg/ha year). Five Nmin rates are used to include decreasing marginal energy production with increasing Nmin rates. Together, the five production points (the combination of Nmin rate and energy production) form the grass production curve. In the model this curve can be shifted up or down to reflect higher or lower productivity of grassland.

Nutrients for grass production are supplied by manure and fertilizer. The model estimates nutrient balances for N and P_2O_5 at the farm level based on nutrient inputs and outputs. For a more detailed description of the model see Berentsen and Giesen (1995).

Set up of the calculations

Table 3 shows the calculations that were done for six situations. The total difference between the average farm in De Wouden (the first situation in table 3) and the average farm in the Open Area (the final situation in table 3) is split up into five main differences concerning farm structure and productivity. This division is done to show the separate effects of differences in parcel size, intensity, scale and animal and plant productivity. Table 3 shows the relevant variables to describe each situation.

Parcel size is not a direct input variable for the model. It was used to determine costs of contract work for mowing, ensiling and manuring which are input values for the model. Calculations to determine these costs per given parcel size were done with Agrowerk, a software package (Vink and Kroeze, 1999), As result of these calculations, it followed that costs of mowing and ensiling per ha and per cut were 25% and 29% higher with 1 ha parcels as compared to 2 ha parcels while costs of manuring per ton were 11% higher. The resulting costs for contract work per activity and per ha are input for the model.

Feed purchases are used as input in the initial and the final situation in table 3 to fix the exact level of the grass production curve because the level of this curve represents the basic conditions for the productivity of grassland. In the intermediate situations, the curve is on the same level as in the initial situation, so in these situations feed purchases are output, as these are determined in the optimization process.

Table 3: Characterization of the modeled situations

	De Wouden	Larger parcel size	Higher intensity	Larger scale	Higher milk production per cow	Higher grassland productivity (= Open Area)
Parcel size (ha)	1	2	2	2	2	2
Milk quota (kg)	501665	501665	577141	700644	700644	700644
Area (ha)	48.6	48.6	48,6	59.0	59.0	59.0
Milk production per cow (kg milk/year)	7197	7197	7197	7197	7297	7297
Feed purchases (1000 MJ NEL)	1617	--	--	--	--	2296

Results

The effects of the individual changes in farm structure and productivity on farm economics are shown in table 4. Compared to table 3, the first column is left out and a final column (Total) is added. In this final column, the economic effects of the individual changes are summed up.

The increase of the parcel size and the resulting lower contract work tariffs result in an increase of the fertilizer level of grassland, meaning a more intensive use of the grassland. The effect on economic results is an increase in the costs of grassland and of fertilizer and a much larger decrease in the costs of purchased feed and contract work. As a result, labour income of the farm increases by 2214 euros. Due to more intensive grassland use labour hours increase by 23.

The higher intensity, meaning an increase of the number of cows from 69.7 to 80.2, further increases the fertilizer level on grassland to have enough grass for grazing. The economic effects are multiple. Revenues from both milk and sold animals go up. The costs of grassland and contract work decrease as less grass is ensiled. All other costs increase substantially. Fixed costs increase because of extra housing costs for the larger herd. No fixed costs are included for acquiring extra milk quota. The net result is an increase in labour income by 8836 euros. The higher intensity requires 295 extra hours of labour.

Table 4: Effects of five differences in farm structure and productivity and total effect on economic results (in euros) and on labour hours (effects relate to the previous situation).

	Larger parcel size	Higher intensity	Larger scale	Higher milk production	Higher grassland productivity	Total
Revenues:						
- milk	0	+ 25508	+ 41741	+ 207	0	+ 67456
- sold animals	0	+ 3677	+ 6017	- 467	0	+ 9227
Total	0	+ 29186	+ 47757	- 260	0	+ 76683
Costs:						
- grassland	+ 302	- 9	+ 1927	+ 13	+ 149	+ 2382
- fertilizer	+ 310	+ 494	+ 710	- 72	- 162	+ 1280
- purchased feed	- 1401	+ 9385	+ 9758	- 459	- 1361	+ 15922
- other cattle costs	0	+ 3599	+ 5903	- 447	0	+ 9055
- contract work	- 1424	- 301	+ 2499	+ 130	+ 696	+ 1600
- fixed costs	0	+ 7179	+ 15035	- 840	0	+ 21374
Total	- 2214	+ 20349	+ 35832	- 1675	-678	+ 51614
Labour income	+ 2214	+ 8836	+ 11926	+ 1415	+ 678	+ 25069
Labour hours	+ 23	+ 295	+ 610	- 32	+ 14	+ 908

The increase of scale (more land and more milk quota) results in proportionate increases in cattle and in purchased feed, contract work and fertilizer. Consequently, it leads to an increase of all revenues and costs, labour income and labour hours.

The change of milk production includes an increase in milk production of 100 kg per cow, a decrease of the fat content by 0.01% and an increase of the protein content by 0.01%. It results in a decrease of the number of cows by 1.4. Milk revenues slightly increase because of the changed fat and protein content. Revenues of sold animals slightly decrease because of the lower number of animals kept. As total feed requirements decrease because of a decrease in maintenance requirements, costs of purchased feed and fertilizer decrease. Increase of milk production per cow is very effective because it leads to higher income and less labour hours.

To match the feed purchases in the situation with the higher grassland productivity, the net grass production curve in the model is shifted upwards by 1104 MJ NEL/ha. The model partly compensates for this higher production by slightly decreasing the fertilizing level. The result is a decrease in fertilizer and purchased feed costs and an increase in the costs of self-produced grass. Both labour income and labour hours go up.

From the model calculations it appears that, labour income of the optimized situation in the Open Area in total is 25,069 euros higher than that of De Wouden, and this extra income costs 908 hours of extra labor. This difference in income is mitigated by the subsidy farmers in the Wouden receive for the on-farm nature conservation. From Table 1 it can be calculated that farmers in De Wouden on average receive 10,605 euros for on-farm nature conservation, leaving a net income difference of 14,464 euros.

Discussion and Conclusion

The results show that due to the smaller farm size and lower productivity, income on the farms dealing with on-farm nature conservation is considerably lower, although the work load is also lower. This picture, however, is not complete as some economic aspects which are hard to quantify were not included in the calculations.

First of all, costs of the larger milk quota on the farm in the Open Area are not included in the calculations so far. With current prices of milk quota in the Netherlands at some 2 euros per kg and 4% interest on a yearly base, yearly costs of quota amount to 8 euro cents per kg. Taking into account the 200,000 kg larger milk quota on the farm in the Open Area would increase yearly costs by 16,000 euros. It is, however, impossible to say how far these higher milk quota costs apply to the situation in reality. This depends on the milk quota history of the farms in both areas. In other words, farms in the Open Area might have had a larger milk quota from the introduction of the quota system without facing extra quota costs because quota was obtained for free at that time. A second point is that the farms in De Wouden have extra work from on-farm nature conservation (next to extra income via subsidy) which was not included in modeling. The amount of extra work for landscape maintenance is unknown. Taking into account the net income difference, costs of extra quota that were not included and a probable difference in working hours, the economic situation on the farms in De Wouden cannot be considered worse than that of farms in the Open Area.

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