ECONOMIC MODELLING OF HUNGARIAN FARMS INCORPORATING NATURE CONSERVATION

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ABSTRACT

Hungary's imminent entrance into the EU calls for a farm-level financial support system aiming at combining agricultural production with nature conservation targets. Within the Hungarian National Agri-environmental Programme (NAEP) for the Environmentally Sensitive Areas, a payment system was developed. For each individual region the amount of support for every environmentally friendly farming prescription package (tier) was established using the support calculation methodology of the EU. The purpose of this paper is to analyse the impact of the packages on the income of an individual mixed farm. In contrast to many other studies, in the current study the analysis was carried out with the context of the whole farm, taking into consideration the entire production structure. The amount of support which the farmer needs to sign up for a contract turned out to be quite different from the actual payments done by the Hungarian government.

INTRODUCTION

Today's agriculture means a lot more than simply producing goods. The rural areas are not only the scene of production, but also a biological and social living area, therefore it is also the role of the agriculture sector to sustain the diversity of the rural areas – not only it's production functions but it's aesthetics and biodiversity. This is why nature protection has to coexist with agriculture, and the agricultural production has to respect the aspects of environment and nature protection. This, however, can only be achieved if the producers are encouraged to comply with these goals. Therefore a system of economic controls and financial incentives should be developed that compensates for the loss of income resulting from the compliance.

The study described in this paper aims to analyse the economic effects of different kinds of measures taken by farmers in arable and animal production, taking into account the complete production system. These measures are collected in packages based on the Hungarian land use system which differentiates several kinds of zones for protecting the environment, nature and landscape. Within Hungarian Agri-environmental Programme for the Environmentally Sensitive Areas (NEAP) a payment system was set up. Within

NEAP the amount of payments are determined for individual packages using the support calculation methodology of the EU. This payment system determines the support on a hectare or unit of livestock basis for individual packages without taking into account the production system of the farm.

For analysis of the complete production system a deterministic and static linear programming model of a typical Hungarian mixed farm in an environmentally sensitive area (Dévaványa) is presented and tested. Special attention was given to the inclusion of the zonal based environmental packages. The objective function of the model maximises labour income. With this model the influence of the packages on the labour income of the farmers is determined and the amount of compensation is calculated which is needed to motivate the farmers to implement certain kinds of environmental protecting activities.

BACKGROUND OF HUNGARIAN AGRI-ENVIRONMENTAL PROGRAMME

Within the Hungarian Ministry of Agriculture and Rural Development, the Agri-environmental EU harmonisation Working Group analysed the implementation of the 2078/92 EU regulation in different EU-member states. This is an agri-environmental regulation on the support of agricultural production methods that are environmentally friendly and aim at the preservation of rural areas. As a result, the Ministry took legislative and institutional steps to introduce the National Agri-Environmental Programme (NAEP). In the first step, a land zone study (Ángyán-Podmaniczky, 2000.) prepared by the Institute of Environmental Management, Szent István University in 1997 evaluated the suitability of areas for agricultural production (i.e. agricultural potential) and environmental sensitivity, and made a comparison between these two sides in order to balance natural resources and to identify target areas for different agri-environmental schemes.

The schemes of the NAEP supporting environmentally friendly agricultural land use can be divided into two groups. The first group is made up of the so-called horizontal or national schemes, which cover the total area of agricultural land use. The schemes provide support for environmentally friendly cultivation and production methods (reduced use of fertilisers and pesticides, environmental farm plans) and nature oriented land use systems targeted at quality food production. Horizontal schemes combine environmental protection (soil, water) with nature conservation targets. The second group are area specific regional or zonal schemes that target areas with low production potential but significant environmental and natural values. The target areas of these programmes can be small regions, which from a nature,- land,- or water protection aspect require some kind of special utilisation. The individual schemes support the introduction of land utilisation forms and production practices developed by regions. These schemes apply to the so-called network of Environmentally Sensitive Areas (ESA) (Ángyán-Fésüs, 1999).

The system of environmentally sensitive areas (ESA)

The zonal schemes of environmentally sensitive areas include the following agri-environmental measures:

- arable land / grassland conversion,
- extensive breeding of native animal species,
- nature protection focused farming,
- application of extensive, protection oriented production methods,
- biotope / reconstruction (eg. wet biotopes) and maintenance,
- establishment of biotope networks,
- development of the living area of certain species,
- protection of coastal strips of water flows, protection of sub-surface water reserves
- small parcel (mosaic) farming with soil protection objectives,
- landscape reconstruction,
- application of soil protection methods etc.

The special regional schemes developed for these areas address beside production also extensive non-production utilisation (protection) objectives. The schemes have to be developed for each region according to their specific needs (e.g. environmental objectives, employment, opportunities of rural tourism, special regional production potentials, etc.). Environmental measures often results in lower production and profit. In order to encourage farmers to take these measures the programmes aim at the support of low intensity production systems. A few potentialy promising examples are: arable-grassland mosaic, traditional, small-parcel plant production, traditional vine and fruit production, flood-plain cultivation, herb production, extensive beef cattle production, sheep husbandry, fish-and reed production.

Participation of the farmers in the programmes is voluntary. Every eligible farmer can join the national schemes, and only those can join regional (zonal) schemes who produce in the region or area in question. Therefore the precise geographical delineation of the target area is essential. The establishment of a training, demonstration and extension network is planned to improve the understanding, updating and implementation of the schemes by farmers (Ángyán-Fésus, 1999). The farmers, after becoming acquainted with the requirements, sign a 5 year contract with the obligation of keeping to the terms of the contract (the 'rules' of production that are set out in the scheme in question) for the entire period. In return the farmer receives an annual financial support payment during the contracted period (on a hectare or livestock unit base).

The current support payment covers the loss of returns due to the measures applied, the possible extra costs and contains a 20% incentive to make the scheme attractive and to make the environmentally friendly farming practices competitive. The amounts of payments are determined for the individual schemes, using the support calculation methodology of the EU.

In EU the financial effects of each prescription package are calculated on hectare base (in case of different crop types). In this methodology three kind of financial effects are taken into account:

- loss of returns which can appear because of complying to the environmental measures;
- extra costs which can appear when an action should be made, which was not included in the technological process during crop production;
- decrease of costs which can appear when actions which earlier were a part of the production technology, but the environmental measures do not allow them .

The financial effect of above mentioned three effects plus 20% incentive payment is calculated for every prescription package, and then these are added. The total amount determines the amount of payment the farmer gets (Avar, 1998).

The effect of the prescriptions is not enough to consider only in hectare (crop) base, but it needs a wider, whole farm based analyses. If certain crop prescriptions cause some changes within production technology, the whole-farm plan should be analysed, not only that particular crop. That is why the financial effects of prescriptions should be analysed on a farm level (instead of hectare level) in order to calculate the amount of payment more realistically. For these calculations a linear programming model is used.

MODEL SPECIFICATION

To analyse the effects of different zonal packages on income of farmers and the environment a linear programming model is developed for a typical, 300 ha mixed farm in the Dévaványa plain pilot area. The major activities of the farm is keeping dairy cattle, growing fodder (grass, alfalfa, silage maize) and cash crops (winter wheat and corn). The whole area of the farm is situated in an area with general nature conservation objectives. Which means that the natural values are important in these areas, such as Dévaványa. These areas serve as feeding or nesting sites for protected or strictly protected species. The aim is, especially in the case of ground-nesters, to provide undisturbed nesting and suitable feeding sites, to decrease environmental pressure and to reconstruct the habitats. In order to achieve these goals, the establishment of large uninterrupted grasslands is proposed. (In some parts of this zone arable lands that border existing grasslands were designated to be converted into grasslands. For remaining arable lands particular packages are made available.)

General structure

The general structure of the modelling approach is shown in Figure 1. The linear programming model uses the gross margins of activities – as an input for the objective function of the model – which are calculated from a basic set of descriptive data of the farm and the parameters of its economic-policy.

Linear programming maximises labour income by finding the optimal set of activities, under the restrictions such as maximum building capacity, crop rotation etc. Given the objective function, the solution procedure determines the optimum set of activities under given the restrictions. New production techniques and packages can easily be incorporated by adding new activities to the model.

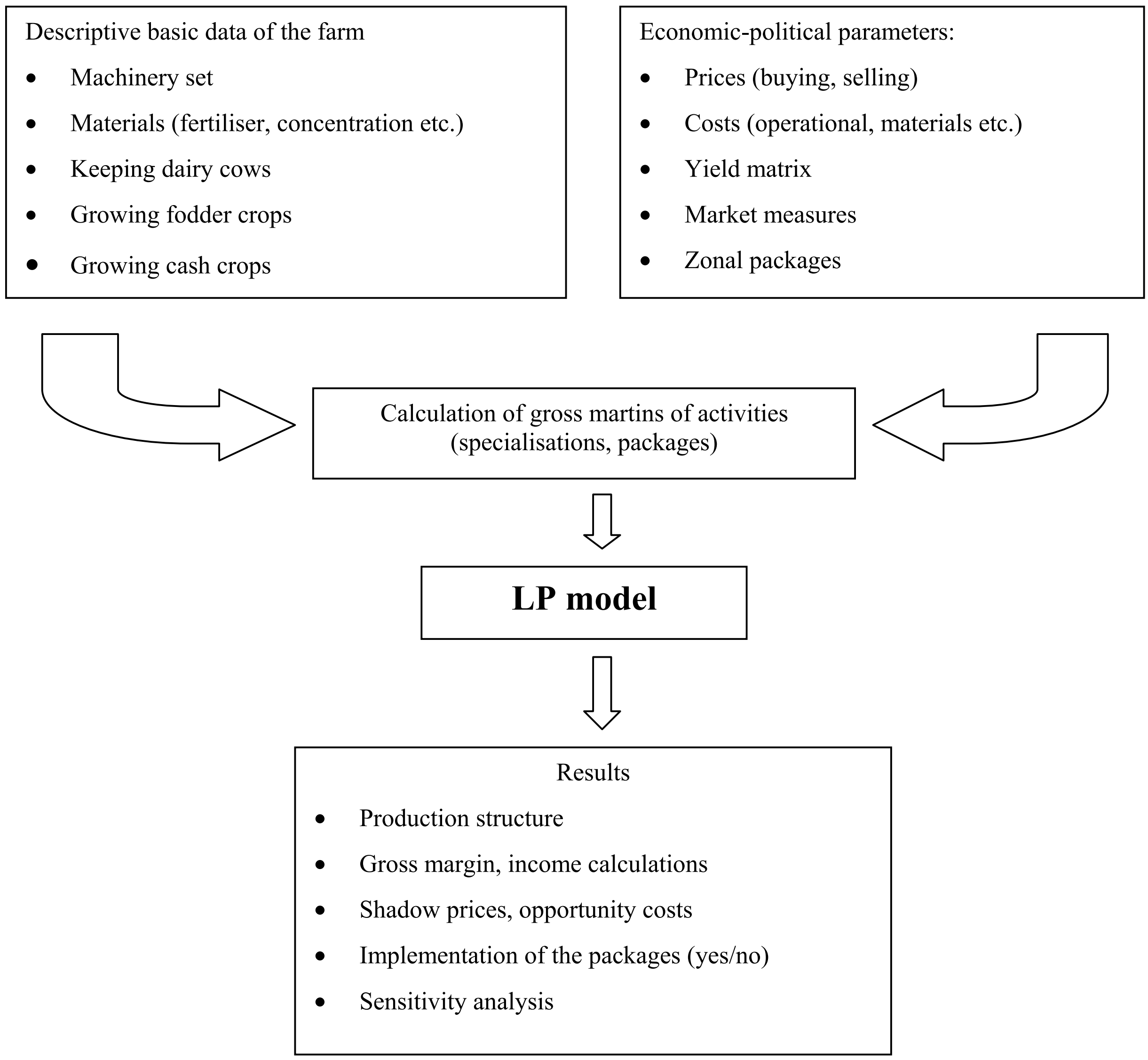

Figure 1: The modelling approach

The result of the LP model is the optimal labour income and the corresponding optimal production structure (i.e. activities) including certain packages. Part of the solution is the marginal product values (shadow prices and opportunity costs). It shows the additional income that non-optimal activities should 'produce' in order to be in the optimal plan of the model. Sensitivity analysis is performed to test the influence of the individual packages on the income of the farmer and on the production structure of the farm.

In the alternative situation the following separate activities are included into the model:

- SZ1: alfalfa establishment and production;
- SZ6: fallow;
- GY2: grassland management with grazing.

These packages are added as new activities to the model, which compete with the existing activities. In case of alfalfa the model chooses between the traditional alfalfa (basic alfalfa) production method and SZ1 alfalfa establishment and production (alternative alfalfa), which incorporates certain measures to protect nature. In Table 1 only those actions are included which influence the production method and the income of the farmer.

Table 1: Difference between basic and alternative activity of alfalfa

Basic alfalfa	Alternative alfalfa (SZ1)	Effects
Use total area for production	A margin of at least 5-m wide must be left non-mown	20% less yield, less cost
NPK fertiliser	Excluding fertiliser	10% less yield, less cost
Use herbicides and pesticides	Excluding every chemical application	5% less yield, less cost
Total changes:		35% less yield

In case of fallow, the situation is a bit different because its incorporation into the model depends on the crop type it replaces. In case of grass the alternative grass production with grazing is more expensive, because the grass production is less per hectare due to the lack of fertiliser, and the cow density is 2 cows per hectare instead of 6.

The gross margins of basic and alternative activities which are the input data for the objective function in LP model are shown in Table 2.

Table 2: Gross margin calculation of competitive activities (Ft)

on ha base	Alfalfa	Sz1 alfalfa	Grass	Gy2 grass	Wheat	Corn	Fallow
Costs	-21086	-11500	-27030	-9250	-65280	-100989	0
Returns	x	x	x	x	75250	110000	0
Costs counted by government	0	-39000	0	-30200	0	0	-31800
Government payment	0	46800	0	36240	0	0	38160
Gross margin	-21086	-3700	-27030	-3210	9970	9011	6360

X – Returns from animal production

MODEL TEST AND RESULTS

In order to analyse the effect of certain environmental packages on the optimal labour income and production structure of the farm, two situations (basic and alternative) are compared.

In the basic situation the farmer's income is optimised without applying any packages. His main activities in the chosen pilot area would be keeping livestock, growing roughage (grass, alfalfa, silage maize) and cash crops (winter wheat and corn). The total income is 18.785.575 Ft per year (Table 3).

First the above mentioned three packages were built into the basic model and then with sensitivity analysis one additional case was analysed. In this last case we modelled how the production structure of the farm will change if the government gives enough support (calculated from the LP shadow price) for the alternative package which couldn't get into the model (in our case GY2 grass).

Production structure and the income of the farmer in all three cases is shown in Table 4. In all cases the number of dairy cows are at the maximum stall capacity (120 cow places), because it is economically the most attractive activity in the farm. In the basic situation on one half of the area of the farm fodder crops are produced (alfalfa, silage maize and grass) to fulfil the needs of animals, and on the other half cash crop (winter wheat). In the alternative case only SZ1 alfalfa activity could have a base in the production structure instead of basic alfalfa activity, the GY2 grass and SZ6 fallow activities are not attractive enough to get into the base. SZ1 alfalfa package needs more area to produce the same amount of fodder (as in the basic situation) which is taken from the area of winter wheat.

Table 3: Production structure and income results from the LP model

	Basic case	Alternative case	Gy2 + 25%
Number of dairy cows	120	120	120
Use of area (ha):			
Winter wheat	151	137	100
Corn	0	0	0
Silage maize	64	64	61
Alfalfa	61	0	0
Grass	24	24	0
SZ1 alfalfa	0	75	62
GY2 grass	0	0	77
SZ6 fallow	0	0	0
Total area	300	300	300
Income	*18785575*	*19382818*	*19684586*

The shadow prices of the activities (Table 4) show the amount of money the certain activity has to be supported with to get into the base, otherwise the total income of the farmer will be less if he includes the less profitable activity in his production structure.

Table 4: Shadow prices of the activities (Ft/ha)

	Basic case	Alternative case	Gy2 +25%
Winter wheat	0	0	0
Corn	1499	1499	1499
Silage maize	0	0	0
Alfalfa	0	11666	11666
Grass	0	0	7891
SZ1 alfalfa	not	0	0
GY2 grass	not	1420	0
SZ6 fallow	not	4150	4150

From the shadow prices the amount of minimum support for this farm is calculated for each package (Table 5). In SZ1 case less payment would be. In case of GY2 grass and SZ6 fallow the payment given by the government should be higher.

Table 5: Calculated payment from LP (Ft/ha)

	Sz1 alfalfa	Gy2 grass	Fallow (wheat)
Government payment	**46800**	**36240**	**38160**
Shadow price	-11666	1420	4150
Sum	35134	37660	42310
20% incentive	7027	7532	8462
Suggested payment	**42161**	**45192**	**50772**
Difference in %	-10	25	33

In the last step, changes in the production structure were analysed in case that the payment is as much as calculated from the shadow price of GY2 activity. The area of the grass land is three times bigger, and the area of silage maize and alfalfa production are less due to the changes in density of the cows per hectare, which means they need less alternative fodder (silage maize, alfalfa). The difference between calculated and original payment is substantial, because the area of winter wheat also gets smaller. On the same area which would be converted into grassland less fodder could be grown than alfalfa or silage maize.

DISCUSSION

Within Hungarian Agri-environmental Programme for the Environmentally Sensitive Areas a payment system was set up. The amount of payments was determined for the individual schemes using the support calculation methodology of the EU. This payment system calculates the support on a hectare or units of livestock basis for individual packages without taking into account the production system of the farm. In real life the farmers will incorporate these packages into their farm production structure thereby influencing also other activities. With similar kind of calculation it is possible to analyse the amount of necessary payments for these packages. The shadow prices and opportunity costs show, support or refute the amount of payments for the individual packages.

Because of the general nature of the current model it is not yet useable in all real world situations, but it can give a reliable indication of the effects connected to management decisions. With some more development the system could be a considerable asset in evaluating the financial consequences of nature conservation and environmental protection packages.

BIBLIOGRAPHY

Szvetlana Acs – She finished MSc in Agricultural Economics and Management at Szent Istvan University in Hungary. Currently she is a PhD researcher at Farm Management Group, Wageningen UR, the Netherlands. Research topic is about 'Bio-economic Modelling of Traditional and Organic Mixed Farming Systems'. The aim of this research is to make a recommendation for improving existing policy by making an assessment of economic incentives in order to stimulate farmers to adopt organic farming systems. She has experience in economic-environmental modelling at farm level, quantitative modelling of animal production, quantitative analysis of agro-ecosystem, regional agricultural development and policy.

REFERENCES

Avar, B., 1998: Adaptibility of the System of Environmental Sensitive Areas in Hungary, Gödöllõ

Ángyán-Fésüs, 1999: National Agri-environmental Programme; for the support of environmentally friendly agricultural production methods ensuring the protection of the nature and the preservation of the landscape, Ministry of Agriculture and Rural Development, Budapest, 1999. November, Linograf Ltd.

Ángyán-Podmaniczky, 2000: Aspects of integrated land use planning and land resource management in Hungary, Agricultural background study of the preparation of CSD VIII, Gödöllõ

Ángyán-Podmaniczky, 2000: ESA program plan of Dévaványa pilot area, Gödöllõ

Berentsen, P., 1999: Economic-environmental modelling of Dutch dairy farms incorporating technical and institutional change, PhD-Thesis, Wageningen

Hannah Bartram, Matthew Rayment, Jim Dixon and Szabolcs Nagy, 1997: Proposals for pre-accession agri-environment schemes in Hungary. With potential for implementation in other Central and Eastern European countries.

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