Acta agriculturae Slovenica, 90(november 2007)1, 45–56.

http://aas.bf.uni-lj.si

Agris category codes: E10 COBISS Code 1.01

OPTIMISATION OF PRODUCTION ACTIVITIES ON INDIVIDUAL AGRICULTURAL HOLDINGS IN THE FRAME OF DIFFERENT DIRECT PAYMENTS OPTIONS

Jaka ŽGAJNAR [a)], Emil ERJAVEC [b)] and Stane KAVČIČ [c)]

[a)] Univ. of Ljubljana, Biotehnical Fac., Dept. of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia, e-mail: jaka.zgajnar@bfro.uni-lj.si.
[b)] same address as [a)], Prof., Ph.D.
[c)] same address as [a)], Ass.Prof., Ph.D.

Received March 06, 2007, accepted July 24, 2007.
Delo je prispelo 06. marca 2007, sprejeto 24. julija 2007.

ABSTRACT

Linear programming model has been developed and applied to the hypothetical agricultural holding in the hilly part of Slovenia in order to find optimal production plans by maximizing total gross margins. The model covers especially those sectors of Slovenian agriculture, for which the most drastic changes due to the actual reform of CAP in the field of direct payments – in Slovenia implemented in 2007 – are anticipated. On the basis of developed model the economic impacts of CAP reform and importance of agri-environmental measures have been evaluated. Model results lead to the conclusion that the reform will have the most unfavorable impacts for agricultural holdings with intensive production practice, especially those with animal production activities which are under the standard scheme eligible for relatively high production coupled direct payments (up to 70% of achieved total gross margin). Negative impacts of the reform can be mitigated by combining different production activities and technologies. Economic results markedly improve (up to 28%) if farming management complies with agri-environmental measures.

Key words: agriculture / linear programming / CAP reform / direct payments / Slovenia

OPTIMIRANJE PROIZVODNIH DEJAVNOSTI NA KMETIJSKEM GOSPODARSTVU Z VIDIKA MOŽNIH KOMBINACIJ NEPOSREDNIH PLAČIL

IZVLEČEK

Razvili smo model na podlagi linearnega programa, s katerim smo na hipotetičnem kmetijskem gospodarstvu, iz gričevnatega predela Slovenije, iskali optimalen proizvodni načrt na podlagi maksimalnega skupnega pokritja. Model zajema predvsem tiste sektorje znotraj kmetijstva, pri katerih bo prišlo do korenitejših sprememb, predvsem na področju neposrednih plačil, z aktualno reformo SKP – v Sloveniji vpeljana v letu 2007. S pomočjo razvitega modela smo ocenili kakšne bodo ekonomske posledice reforme in kakšen je pomen okoljskih plačil. Na podlagi dobljenih rezultatov smo ugotovili, da bo reforma najhuje prizadela kmetijska gospodarstva z intenzivno proizvodnjo, zlasti živinorejsko usmerjena, katera so bila po standardni shemi upravičena do relativno visokih proizvodno vezanih neposrednih plačil (do 70 % doseženega pokritja). Negativne učinke reforme bo možno ublažiti s kombiniranjem različnih usmeritev in tehnologij. Ekonomski rezultati se prav tako pomembno izboljšajo (do 28 %) v primeru gospodarjenja v skladu s kmetijsko okoljskimi ukrepi.

Ključne besede: kmetijstvo / linearno programiranje / skupna kmetijska politika / CAP / reforme / direktna plačila / Slovenija

INTRODUCTION

Successful farmers can not manage their holdings just on the basis of technology and production results. They must understand and also be able to use knowledge of economics, marketing, production and finances in the meaning of planning and also in the meaning of leading (Boehlje and Eidman, 1984). At the first step they should define the aim of farming. The most important aims are economic ones, especially when agriculture is the only source of income. Kavčič (1996) mentions besides economics aims also a group of personal aims like independence in decision making, spare time and reputation in the local area.

Direct payments are important element of modern agricultural policy which could significantly influence on decision making process at the agricultural holdings level. After accession to European Union direct payments became also one of the most important income sources for farmers in Slovenia (Volk *et al.*, 2006). Policy changed significantly in year 2007 as result of the implementation of 2003 reform of the Common Agricultural Policy (CAP) direct payment scheme (Rednak *et al*., 2005) which also should have impact on the decision making process on the agricultural holdings in Slovenia.

Changing environment leads Slovenian farmers to make new decisions about which sector to choose, what to produce, by which technology in which period of the year and finally in what quantities to produce (Hazell and Norton, 1986). There exist many techniques of decision making that could help farmers to solve such problems (Boehlje and Eidman, 1984). One of them is indubitably linear programming that basis on mathematic techniques for solving optimization problems.

The paper has objective to shortly to present developed linear programming model that can be utilized on concrete Slovene agricultural holding with aim to find optimal production plan on economics basis (maximal total gross margin). We are going to represent how important is CAP in Slovene agriculture area with its measures and consequently also the impact of current reform in different agricultural sectors. New economic conditions, caused by reform will also face farm managers with new range of solutions by improving financial results.

The paper is structured as follows. The first part is short review of literature in connection with mathematical programming stressed on linear programming, with some examples of its application in agricultural sector. In followed methodological chapter, we shortly present the structure of developed model with all included activities and constraints. Then we describe basic characteristics of analyzed farm and eight presumed policy scenarios. In the next chapter we summarize the results with discussion. The paper is concluded with short conclusion in English and Slovene language.

REVIEW OF LITERATURE

Mathematical and linear programming

Gallenti (1997) said that mathematical programming is actually a method, which finds a solution that satisfies all constraints of the analyzing problem. It chooses between farm enterprises (activities) on the bases of objective function with respect to a set of fixed farm constraints. In other words, objective function represents the preferences of the agricultural holding. One of the most commonly applied methods from mathematical programming assortment in agricultural sector is linear programming. The basic concept of linear programming procedure is to maximize or minimize a specific outcome (objective function). A set of mathematical rules known as simplex algorithm is used to solve optimization models with constraints.

In the past linear programming was already proven as a very useful tool in planning farm business. Boehlje and Eidman (1984) pointed out this technique as applicable to almost any resource allocation problem faced by decision maker on the farm. Besides that it is capable to handle more complex problems than other more simple methods (for example budgeting and marginal analysis) also used in farm management. Calculated optimal solution presents the best production-marketing-financial plan, based on efficient (optimal) resources allocation. By-product of linear programming is information on resources that are limiting for further growth of potential income of the farm operation, which resources are in excess and therefore not totally used, and also how much is worth to destine for additional units of the limiting resources. For relevance of the farm plan obtained it is also important its stability or sensitivity. This is another attribute of using linear programming in farm management analysis. It could be evaluated how the results would be changed if deviations occurred in prices or technical proportions. This is also called parameter programming or sensitivity analysis (Zadnik Sitrn, 2001b)

Mathematical formulation of linear programming

Linear program can be written in mathematical form as shown in the equation [1] and un-equations [2] and [3]. In those equations an example is shown an example where the objective function has to be maximized. If we handle with opposite problem where objective function has to be minimized, we just multiply the vector c_j (coefficient in the objective function) with –1.

$$\max Z = \sum_{j=1}^{n} c_j X_j \,, \quad \text{such that} \qquad [1]$$

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i \,, \qquad \textit{all } i = 1 \textit{ to } m \qquad [2]$$

$$X_j \geq 0 \qquad \textit{all } j = 1 \textit{ to } n \qquad [3]$$

Meanings of notations:

Z objective function (total gross margin)

c_j coefficients of objective function (total gross margin of one unit of *j-th* activity)

a_{ij} the quantity of the *i-th* resource (requirements of kilogram fodder, hours of labor) required to produce one unit of the *j-th* activity (technological coefficients)

X_j the level of the *j-th* farm activity (acreage of maize, wheat, number of animals)

b_i extent *i-th* available resource (hectare of field, capacity of stable)

Equation [1] defines maximum of objective function (total gross margin) as the sum of products of total gross margin (c_j) per single activity with its level included into solution (X_j). Un-equation [2] requires that solution with achieved maximal total gross margin does not violate any of the fixed resource constraints. Practical fact that solution can not be negative is considered in un-equation [3]. Problem defined by equations [1] to [3] is known as the primal linear programming problem (Hazell and Norton, 1986). Such problems are usually solved with set of mathematical rules also known as simplex algorithm, developed by Dantzig in 1947 (Zadnik Stirn, 2001a).

Application of linear models in agricultural sector

In the past linear programming was very commonly used for solving problems in agriculture. Winston (2004) mentions that in one survey of 500 firms in USA it is found out that 85% of them used linear programming in operation researches. If we focus only on using it in agriculture sector, we can find out that in spite of complexity of agricultural problems it is still very commonly used. But many researchers also expose (Zadnik Stirn, 2001b) that in spite of rough reduction of real optimization problems many cases can not be solved with linear programming. In such examples one should use another technique of mathematical programming (nonlinear programming, integer programming) or even another method.

Linear programming techniques and farm optimization models have also been successfully used in recent years for estimation of potential impact in changing agricultural policy. Majewski and Was (2005) exposed some analyses based on this method that had been created in connection with current CAP reform, focusing mainly on farm economic situation and their production structure. Such models could be found for Germany (Kleinhans *et al*., 2000, cited by Majewski and Was, 2005), Ireland (O'Connell, 1998, cited by Majewski and Was, 2005) and Poland (Berg *et al*., 1999) in the last case the linear model has been used to assess the impact of implementing CAP in this new member state.

Also for Slovenian agriculture sector some researches based on linear programming have been performed. Jerič (1990) applied a linear program to find the optimal production plan at the farm level by maximizing total gross margin. Model is developed for farm holdings situated in flat and hilly part of Slovenia. It is tied to the households where their production is predominantly based on tillage. Pajntar (1991) used linear programming model to optimize production with emphasis on employment optimization and maximization of income at the farm gate. Developed model enables to find the optimal employment structure within all included activities. For evaluation of manager decisions on farm holdings, Udovč (1992) modulated a simulation model. It is based on income criterion. Model is constructed on four sub-models (crop production, animal production, labor resource and resources for production) that together represent the whole farm system. By the animal sub-model optimal herd size was searched in dependence on home produced forage. Rozman *et al.* (2002) developed an optimization model to find the optimal steer feeding ratio. Linear method has shown as useful also in searching for optimal 'trade niche' for ecological products (Ulamec, 2005). They tried to reduce distance (physical, economics and recognition) between consumers and suppliers of ecological products.

MATERIAL AND METHODS

The model has been developed in Microsoft's Excel framework. In its basic version it includes a macro called solver that is capable to solve linear and also non-linear problems. If we presume linearity the optimizer employs the simplex to find an optimal solution and sensitivity information. The "free" bundled version of the Excel Solver supports just up to 200 decision variables (Microsoft Excel…, 1999). This is the main reason why we have chosen only a few activities from the numerous possible in Slovenian agricultural sector. We decided to focus on those sectors in Slovene agriculture where we can expect significant impacts of actual CAP reform in the field of direct payments. Previous researches (Rednak *et al.,* 2005) have shown that this reform will have the most significant impact in cattle sector.

Developed linear model has quite complex structure. Different calculations with corresponding data are placed on separate sheets. Such structure enables easier overview and any further control including simulation or completion is much easier. Another reason to put emphasis to this complex structure lies in user-friendly input for analyzing individual farm case. The most elegant way to solve such problem is to gather all input data on one sheet and make links to each calculation. This makes analysis for different agricultural holdings simple and fast. Consequently also possibility for mistakes is much reduced.

Included activities and restrictions

Important step in modeling is to define activities (processes) with technological (input-output) coefficients. Boehlje and Eidman, (1984) define a process as a method of transforming resources or inputs into a specific output. Graphically it can be represented as a single linear ray that is defined by two variables: factor and final product. This means that process can vary only in size and scale, any changes in input-output proportions result in a new activity. This leads to essential increase in number of included activities, which makes model more complex. Depending on used basic platform (in our case Excel) the complexity of the model is constrained. For this reasons the spectrum of included activities in comparison with possible activities in Slovene agricultural sector is limited. Consequently the model is useful only for agricultural holdings dealing with activities included in the model. The main part of model database, especially input-output coefficients, is taken from Gross Margin Catalogue (Jerič, 2001). Since this catalogue considers prices from the year 2001 they are updated to 2005 values. We apply average prices and costs that are annually calculated for the needs of model-calculations (KIS, 2006).

Included activities could be distributed in four groups:

- In the first group we can place livestock activities including different types of cattle and sheep breeding.
- Second group includes forage production on arable and grass land.
- Very comprehensive part presents crop production activities. Their main purpose is in covering livestock nutrients needs and only minor part for selling on market.
- In the last group we can classify all other activities (purchase, commodity selling, hiring and transfers within farm household). This group is the most heterogeneous, because it connects and completes all other three groups at different stages.

Basis for sensible result interpretation is good determination of units' measurement. This is very simple in livestock activities where breeding results are annual and the units of measurement are simply an animal. Much more complicated is in the case when period of breeding is not exactly 1 year (beef fattening). Quite simple is for activities that include arable land, where the basic unit of measure is a hectare of land. More attention is also needed by activities like balance of fertilizers and forage where different units of measurement are used (kilogram, hundred kilograms and tones).

To get more realistic model we decided to sub-divide production activities according to possible technologies and consequently also to different potential achieved harvests. One part of production activities is divided into sale and production (field harvests and hay). Just the opposite is in animal-breeding activities where selling is presumed. Program is organized in the way that only one technology could be selected at once. So in the first place developed program is not meant for searching the best technology or the optimal intensiveness, but to find the optimal solution within pre-selected activities.

Different production intensity does not result only in different amounts of product and needed inputs, but also in different costs and incomes. In other words, corresponding gross margin varies. For activities with wide possible range of intensity we simplified model in the way that we didn't take into consideration function relation but we just separated them into classes (linear sections). With this step we made some mistake, but the model is much simpler.

Developed model among livestock activities includes only cattle and sheep sector. Cattle sector is presented by activities of dairy cows, suckler cows, beef and veal production. The main two reasons why we also included sheep production is that in the last few years we can notice significant increase of sheep breeding especially in the hilly parts of Slovenia and because the 2003 CAP reform is going to have also some impacts on its economic situation.

The second activities group joins all kinds of fodder conservation like grazing, preparing hay, silage etc on arable and grass land. Several technologies of cereals production like maize, corn and barley are joined in the third group. As said, the last group is the most heterogeneous. It includes buying and selling produced fodder, labor hiring, arable and grass land renting, storehouse balance, demand and supply of milk quota and of several premium rights.

The model includes only the most important constraints that must be satisfied to find the optimal solution. We can separate them into four major groups:

- zootechnical constraints (herd size, animal nutrition needs, maximal livestock density)
- agrotechnical constrains (arable land surface, grass land surface, pasture surface, crops rotation, mineral nutrition balance, share of cultivation)
- policy (milk quota, premium rights for suckler cows, premium rights for sheep)
- specific farm constraints (labor capacities, harvesting technology, storehouse capacity)

For all crop and animal products we assumed their full utilization. In reality this assumption is not realistic. But we still think that this simplification does not cause significant errors since we analyze farms that already sale their products.

Characteristics of analyzed farm household

Developed linear model is capable to analyze different types of farm households (specialized or mixed) within included sectors and activities. It is also capable to analyze effects of variation in production factors, within each farm plan, on the final residual – different production plans. All necessary and available data are collected in a linear programming matrix that can be used to evaluate the optimal production – organization. At the beginning user defines constraints within which linear model search for the optimal solution. By description of farm characteristics constrains are focused on labor resources, arable and grass land surface, stables' capacities and potential activities on individual farm.

We tested developed model on hypothetical farm, situated in the hilly part of Slovenia possessing 5 hectares of arable land and 10 hectares of grassland. Half of total area belongs to less favoured area. On this land farm produces forage, mainly for their own herd and in the case of overproduction also for sale. By searching for the optimal crop production on the arable land also crop rotation was considered (maize up to 70%, cereals 60% and at list 20% clovers). We assumed that farm was specialized in dairy and suckler cows. The farm owns 120 tones of milk quota and 20 premium rights for suckler cows. In searching for new production plan it is also possible to include other animal production activities (beef, calves and sheep). The labor available is estimated on 1.6 annual working units (1 AWU equals to 1800 hours). When additional labor is necessary it is possible to hire it.

With developed model we tested what kind of economic result is possible to achieve on the farm according to different specializations and policy scenarios. Since production factors were assumed to be fixed in all plans, excessive production could be sold (in many cases this enables linear program to find possible solution). Six different types of specialization were observed: dairy cows, bulls fattening, suckler cows, calves fattening, dairy sheep and fattening sheep.

Scenario analysis

Developed model includes three different direct payments' schemes: (i) until 2006 valid standard scheme assuming 100% level of payments, (ii) combined scheme to be implemented in the period 2007 to 2013 and (iii) regional scheme that is likely to follow after 2013. According to given conditions and constraints of each scheme we analyzed their effects on optimal production plans. It was taken into consideration that within each scheme it is possible to combine different types of CAP measures dependent on livestock density. On the basis of these conditions (types of subsidies and livestock density) eight different policy scenarios were analysed (Table 1).

Except in the forth scenario (KP0) where no budgetary support is assumed, all other scenarios envisage also payments for less favor areas (LFA).

Table 1. Scenarios analysed
Preglednica 1. Proučevani scenariji

Scenario abbrev. Oznaka scenarija	Scenario specification (type of direct payments and inclusion into agri-environmental measures (SKOP)*) Opis scenarija (vrsta neposrednih plačil in vključenost v SKOP plačila*)	Livestock units (GLU ha^{-1}) ** Obtežba (GVŽ ha^{-1})**
SSOS	Until 2006 implemented standard scheme; farm not included in Slovene agri-environmental scheme (SKOP) Do leta 2006 veljavna standardna shema, kmetija ni vključena v SKOP	2.5
SSSKOP	Standard scheme; farm included in SKOP Standardna shema, kmetija je vključena v SKOP	1.9
SSSEKP	Standard scheme; farm included in SKOP; farm eligible for extensification premiums Standardna shema, SKOP plačila, kmetija je upravičena do ekstenzifikacijske premije	1.4
KP0	Liberal-market (no subsidy is in place) Liberalno-tržna shema (ni nobenih proračunskih podpor)	No restriction
RK	Combined scheme, implemented during 2007–2013; farm not included in SKOP V obdobju 2007–2013 veljavna kombinirana shema, kmetija ni vključena v SKOP	2.5
RKSKOP	Combined scheme; farm included in SKOP Kombinirana shema in SKOP plačila	1.9
RR	Regional scheme with single area payment; farm not included in SKOP Regionalna shema z enotnimi plačili na površino, kmetija ni vključena v SKOP	2.5
RRSKOP	Regional scheme; farm included in SKOP Regionalna shema in SKOP plačila	1.9

* Model includes agri-environmental payments (SKOP) for the period 2004–2006
** Maximal livestock density per hectare of agricultural land (for some payments utilized agricultural area, for the other agricultural land for forage production)

RESULTS AND DISCUSSION

Developed linear programming model was employed to find optimal production plan under different conditions for analysed hypothetical specialized farm. Results are summarized in table 2.

The highest total gross margin is attainable with dairy production. This seems logical because predominant part of utilized area is grassland where farm can produce only voluminous forage. Optimal solution under standard scheme (SSOS) includes 33 dairy cows, while their number is reduced proportionally with livestock density constraints in scenarios SSSKOP and SSSEKP. Almost the same herd size and slight financial improvement in all reform scenarios (RK, RKSKOP, RR and RRSKOP) show that economic interest on the analyzed farm will not significantly change under the assumption of constant commodity and input prices. Stability of this solution is mostly dependent on achieved milk price and price for purchased milk quota. Because of its abolition we took into consideration lower price in all four reform scenarios. This presumption improves the result for 1,300 or 700 EUR dependent on purchased milk quota.

Significant financial improvement is noticeable in all schemes if farm enters in agri-environmental scheme (SKOP) and just the opposite holds for farming without any subsidy (KP0).

Already on the basis of area available we can expect that bulls fattening is not competitive to dairy production on analyzed farm, except this is an additional activity on the holding (therefore farming does not represent the main source of income). Since under beef production physical resources are only partly utilized, financial result could be quite interesting for additional activity. For the optimal feed ration of animals essentially higher percentage of arable land would be necessary on the farm (current share only 33%). Since this share on hypothetical farm is assumed to be fixed, it could be expected that herd size is more or less the same for all scenarios. The number of fattened bulls is reduced only in the third scenario of standard scheme (SSSEKP), where the reduction is imposed by lower livestock density (1.4 LSU). In this case extensification premiums efficiently compensate deficit of revenue caused by lower livestock density.

Bulls fattening is one of those sectors, where CAP reform will have the most negative impacts on economic outcome (RK, RKSKOP, RR and RRSKOP). This is the consequence of total or partial reduction of production coupled direct payments. Almost 4,000 EUR better financial results are obtained under combined scheme compared to regional scheme, since in the former one part of payments remains coupled and another one in form of historical payments. The same tendency in all reform scenarios can be observed also in gross margin per working hour.

Suckler cows optimal herd size is more or less constant in all standards (SSOS, SSSKOP and SSSEKP) and combined scheme (RK and RKSKOP) scenarios. Slight decrease in number of suckler cows is indicated in KP0 and both regional scheme (RR and RRSKOP) scenarios, where no coupled payments are in place. Economic outcome in comparison with dairy and meat production is not simulative, but it has to be taken into consideration that extensive organization in this case brings lower harvests and consequently also lower labor demand. Suckler cows specialization seems interesting especially when farming represent only a supplementary source of disposable agricultural household' income.

Under standard scheme farm could improve financial result with involvement into agri-environmental measures and managing under limits of 1.4 livestock units per hectare to get additional payments (extensification premiums). From 2007 it is undoubtedly sensible to adapt agricultural practice in compliance with CAP rural development program conditions (LFA and egri-environmental payments), which will help farmers to improve financial result. In the analyzed case this means up to 4,000 EUR increase of total gross margin. The importance of subsidies confirms also the fourth scenario (KP0) where financial result (gross margin, not income!) in general is halved compared with actual policy environment.

Even though calves fattening is not very frequent specialization on Slovene farms, we simulate it. What is interesting in this sector is that breeding is actually not connected with land, because all forage is possible to purchase. Linkage to land is required through allowed livestock density. In all scenarios with exception of KP0 (where the main limited factor is forage), area is the most limiting factor. Except smaller amounts of hay all other farm harvests are sold. In standard scheme scenarios (SSOS and SSSKOP) high level of direct payments are considered, especially slaughtered payments that are going to be cancelled after CAP reform. This fact will not have an important impact on the optimal herd size, but in worsening financial situation of the sector.

Sheep specialization was also tested with the model. If we focus on sheep for milk production with further milk processing and direct sale of dairy products at farm gate. It demands very high labor input. This leads to lack of labor supply and consequently in all scenarios labor force is hired (more than half of needs). Consequently is expected gross margin per hour is decreased, but it has to be taken into consideration that all hired force was paid (4 EUR/hour).

Table 2. The main results for different specializations of analyzed farm household
Preglednica 2. Pomembnejši rezultati za različne primere specializacije na analiziranem kmetijskem gospodarstvu

	Agricultural policy scenarios / Scenariji kmetijske politike							
	SSOS	SSSKOP	SSSEKP	KP0	RK	RKSKOP	RR	RRSKOP
Specialization (GLU) Specializacija (GVŽ)								
Dairy cows Krave molznice	33	28	20	33	33	28	33	29
Bulls fattening Pitanje bikov	16	16	14	16	16	16	16	16
Suckler cows Krave dojilje	19	19	19	12	19	19	12	17
Calves fattening Pitanje telet	38	29	14	55	37	28	37	28
Sheep breeding - milk Ovce za prirejo mleka	15	15	9	15	15	15	15	15
Sheep breeding - meet Ovce za prirejo mesa	21	21	14	21	21	21	21	20
Total gross margin (EUR) Skupno pokritje (EUR)								
Dairy cows Krave molznice	29,791	33,321	27,925	20,677	31,673	35,507	29,661	33,433
Bulls fattening Pitanje bikov	22,509	23,727	23,794	9,765	18,499	19,592	14,138	15,315
Suckler cows Krave dojilje	14,501	18,628	20,560	5,654	12,748	16,875	10,320	14,751
Calves fattening Pitanje telet	23,869	21,224	15,636	15,089	21,532	20,385	17,581	16,433
Sheep breeding - milk Ovce za prirejo mleka	27,120	29,644	27,491	20,614	23,744	26,281	25,138	27,704
Sheep breeding - meet Ovce za prirejo mesa	16,203	18,716	16,199	7,833	11,830	14,342	12,999	15,482
Gross margin per hour (EUR/hour) Pokritje/uro (EUR/uro)								
Dairy cows Krave molznice	8.64	10.90	12.14	6.00	9.19	11.62	8.60	10.94
Bulls fattening Pitanje bikov	21.91	23.10	19.11	9.51	18.01	19.07	13.76	14.91
Suckler cows Krave dojilje	14.08	18.09	19.96	7.79	12.38	16.38	14.20	15.14
Calves fattening Pitanje telet	12.24	12.94	13.52	6.00	11.05	12.43	9.02	10.02
Sheep breeding - milk Ovce za prirejo mleka	3.57	3.90	5.72	2.77	3.13	3.46	3.38	3.64
Sheep breeding - meet Ovce za prirejo mesa	11.13	12.85	13.54	5.38	8.12	9.85	8.93	10,82

In all scenarios herd size is the same, except in the third scenario (SSSEKP) with more restricted livestock density. The reason is not alone in available land, but in the fact that farm applies for direct payments for cereals which are otherwise taken into account for GLU constraint. Anyhow, adapting management to conditions of SSSEKP scenario would be irrational since no extra payments are on disposal for sheep. The optimal financial plan would be achieved with involvement into agri-environmental measures (SSSKOP). Comparing with other livestock sectors this is the only one where regional scheme would lead to better financial result. Difference between combined and regional scheme is approximately 850 EUR and both results can be improved for 2,500 EUR by agri-environmental payments.

Less intensive in terms of working hours is lamb production. Scenario results assume only around 37% of available labor resources. This percentage includes all working hours necessary for animal and crop production. Farm would improve obtained result by substitution of 5 hectares of fields for meadows. As we already found out for sheep milk production, scenario SSSEKP has no sense also for lamb production. Even though farm has to purchase individual premium rights in scenarios SSOS, SSSKOP, RK and RKSKOP, herd size does not reduce compared to other scenarios. From this fact we can conclude that the most limiting factor for herd size increase is forage produced on grassland. Regional scheme gives improved economic outcome compared to combined scheme. One reason can be found in very low livestock density achieved which makes regional (totally decoupled) payments more efficient in comparison with premium rights and partial decupled payments that are presumed in combined scheme. Another reason lies (860 EUR) in purchased premium rights that are in conditions of regional scheme not presumed. But in both reform scenario financial results deteriorate for 3,000 to 4,000 EUR compared with standard scheme. In all four reform scenario cases deterioration for 2,500 EUR is caused by expected lover price, because of quota system abolition, for sold milk quota (120 tones). So this result doesn't reflect general position of the sheep sector after reform but includes links with analysed farm.

CONCLUSIONS

Model results confirm the hypothesis that the reform will have negative economic impacts on farms with intensive production practice, especially those with high livestock density. But in many cases it is possible to improve economic outcome of farming just with more efficient production plan.

In analyzed livestock sectors high importance of subsidies is shown, ranged between 23% and 73% of total farm gross margin. In both CAP reform schemes this percentage is reduced. In combined scheme it remains between 26 and 60% dependent on farm' involvement in agri-environmental measures. Compared to combined scheme under regional scheme drastic change in achieved total gross margin is noticed. Nevertheless, the share of subsidies remains comparable to those in combined scheme or decreases only for few percentages. Model results confirm that calves fattening specialization is most dependent on subsidies (in standard scheme) and consequently this sector experiences the highest shock. Just the opposite holds for dairy farming – both cows and sheep –, where share of subsidies in farm gross margin will remain stable. Budgetary support will remain at the highest level in suckler cows sector (65–82% of gross margin).

Model results also confirm growing importance of CAP pillar II payments, among them particularly agri-environmental support. In all three schemes observed direct payments enable farmers to improve financial results and in both reform schemes they alleviate economic impacts of CAP reform.

POVZETEK

Cilj raziskovalne naloge je bil razviti orodje za optimiranje proizvodne usmeritve na podlagi skupno doseženega pokritja na konkretnem kmetijskem gospodarstvu. V ta namen smo uporabili pristop linearnega programiranja. S pomočjo rezultatov razvitega orodja smo poizkušali odgovarjati na vprašanja konkretnih kmetijskih gospodarstev, še zlasti z vidika reforme skupne kmetijske politike v letu 2003, ki bo v Sloveniji izpeljana v letu 2007.

Model smo razvili v Excelu, ki že v osnovni različici vključuje makro za reševanje linearnih problemov. Orodje je zasnovano tako, da je na preprost način možno spreminjati nabor vključenih aktivnosti in pogoje ter na ta način prilagajati matriko analiziranemu problemu, za katerega z linearnim modelom iščemo optimalno rešitev. Glavnino podatkov in tehnoloških parametrov smo povzeli po Katalogu kalkulacij (Jerič, 2001). Osredotočili smo se na tiste živinorejske sektorje, znotraj katerih po izvedeni reformi SKP pričakujemo najbolj drastične spremembe. Poleg neposrednih plačil smo v modelu zajeli tudi izravnalna plačila iz drugega stebra SKP (OMD in SKOP).

Razviti model smo testirali na hipotetičnem kmetijskem gospodarstvu. Predpostavili smo, da leži v gričevnatem predelu Slovenije in razpolaga z 1,6 PDM (polno vrednih delovnih moči), ki so na voljo za gospodarjenje na 15 ha površin – od teh je 2/3 travnikov, preostali del pa njive. Analizirali smo različne proizvodne načrte, ki se v grobem razlikujejo v različnih proizvodnih možnostih. Z vidika živinoreje jih lahko razdelimo na specializirane in mešane. V tem prispevku smo se omejili le na proizvodne načrte specializacije. Obravnavali smo šest tipov specializacije: prirejo mleka, prirejo govejega mesa, pitanje telet, rejo krav dojilj ter rejo drobnice za meso in mleko.

Poleg obsega vključenih aktivnostih smo spremljali vrednost in strukturo doseženega pokritja. Vse proizvodne načrte smo analizirali v pogojih različnih ukrepov, ki jih ponuja SKP pred in po reformi. Glede na dovoljene obremenitve površin z organskim gnojem in aktualne ukrepe neposrednih in izravnalnih plačil smo jih združili v osem scenarijev kmetijske politike (SSOS, SSSKOP, SSSEKP, KP0, RK, RKSKOP, RR in RRSKOP), pri čemer je scenarij KP0 povsem hipotetičen, saj predvideva ukinitev vseh proračunskih plačil. Z njim smo testirali, kako bi se spremenila optimalna rešitev, če bi se država umaknila iz kmetijskega sektorja in bi hkrati prenehale vse pravne omejitve, znotraj katerih so kmetje dolžni gospodariti. S scenarijsko analizo smo skušali odgovoriti na vprašanje, kakšna je optimalna rešitev pri različnih shemah SKP, ki se spreminja in tako ugotoviti, kaj prinaša njena postopna liberalizacija na konkretnih kmetijskih gospodarstvih.

Dobljeni rezultati veljajo le za analizirano kmetijo, ugotovljene spremembe pa se da v veliki meri posplošiti. Vseeno bi pri drugačnih pogojih (zlasti z vidika dosežene intenzivnosti in osnovnih proizvodnih virov) lahko dobili povsem drugačne rešitve, a bi te po vsej verjetnosti kazale podobne zakonitosti.

Izmed vseh analiziranih tipov se je kot najzanimivejša izkazala reja krav molznic, kjer po reformi SKP lahko pričakujemo celo rahlo izboljšanje doseženega pokritja (predvsem na račun predvidene cenejše mlečne kvote, kar je posledica napovedane ukinitve kvotnega sistema). Nasprotno smo potrdili, da pri pitanju bikov lahko pričakujemo poslabšanje rezultatov. Ta usmeritev sicer ni najbolj primerna za analizirano kmetijo, saj razmerje med njivskimi in travnatimi površinami zanjo ni ugodno. V primeru, da imamo možnost zaposlitve v izven-kmetijski dejavnosti, se reja krav dojilj izkaže kot zanimiva alternativa. Specializacija kmetije v pitanje telet ne bi bila najboljša odločitev, ekonomski rezultati pa se z letošnjo reformo še poslabšajo. Specializirana reja drobnice za prirejo mleka in predelavo tega na kmetij bi bila zanimiva v primeru možnosti najema cenene, a zanesljive delovne sile. Za prirejo jagnjet za meso velja obratno, saj bi bila zanimiva le pri manjši zaposlitvi delovne sile za delo na kmetiji.

Zanimal nas je tudi pomen proračunskih plačil v doseženem - optimalnem - rezultatu gospodarjenja. Deleži se med posameznimi sektorji zelo razlikujejo. Pri standardni shemi neposrednih plačil se gibljejo med 23 in 73 % skupnega pokritja, odvisno tudi od tega, ali kmetija uveljavlja plačila tudi iz drugega stebra SKP. Finančni rezultat se pri obeh reformnih shemah - z izjemo specializacije v prirejo mleka pri kombinirani shemi - večinoma močno poslabša, delež proračunskih plačil v doseženem pokritju pa je bolj stabilen. Pri kombinirani shemi se ti deleži gibljejo med 26 in 60 %, pri specializirani reji krav dojilj celo do 82 %. Ob bistveno slabšem ekonomskem rezultatu večine specializacij pri regionalni shemi se delež proračunskih plačil v pokritju tudi pri tej shemi ohranja ali pade le za nekaj odstotkov.

REFERENCES

Berg, E./ Davies, S./ Majewski, E. Einkommenswirkungen unterschiedlicher agrarpolitischer Szenarien auf landwirtschaftliche Betriebe in ausgewählten MOE- und EU - Länder. Agrarwirtschaft 48(1999), 8/9, 331–337

Boehlje, M.D./ Eidman, V.R. Farm management. Canada, New York, John Wiley & Sons, 1984, 806 p.

Gallenti, G. The use of computer for the analysis of input demand in farm managment: A multicriteria approach to the diet problem. In: First european conference for information technology in agriculture, Copenhagen, 1997-06-15/18, Denmark. http://www.dina.dk/efita-conf/program/paperspdf/viii_20.pdf (3. apr. 2006).

Hazell, P.B.R./ Norton, R.D. Mathematical programming for economic analysis in agriculture. New York, Macmillon, 1986, 400 p.

Jerič, D. Optimiranje proizvodnje na kmetijah v ravninskem in gričevnatem svetu s pomočjo metode linearnega programiranja. Diplomsko delo. Domžale, Univ. Edvarda Kardelja v Ljubljani, Biotehniška fak., VTOZD za živinorejo, 1990, 76 p.

Jerič, D. Katalog kalkulacij za načrtovanje gospodarjenja na kmetijah v Sloveniji. Slovenj Gradec, Kmetijska založba, 2001, 169 p.

Kavčič, S. Ekonomika kmetijskega gospodarstva: delno neprečiščeno učno gradivo. Domžale, Biotehniška fakulteta, Oddelek za zootehniko, 1996, 149 p.

KIS. Data for model calculations (unpublished), 2006.

Majewski, E./ Was, A. Optimal structure of farms in a region – a modeling approach. In: 99th seminar of the EAAE (European Association of Agricultural Economists), Copenhagen, 2005-08-24/27, Denmark, (unpublished).

Microsoft Excel 2000 step-by-step. Washington, Microsoft, 1999, 414 p.

Pajntar, N. Matematični model za optimiranje zaposlenosti v kmetijstvu. Magistrsko delo. Ljubljana, Univ. v Ljubljani, Biotehniška fak., Odd. za agronomijo, 1991, 150 p.

Rednak, M./ Erjavec, E./ Volk, T./ Kožar, M./ Kavčič, S. CAP reform might lead to significant redistribution of funds between the farmers and sectors – the case of Slovenia. Sevilla, 2005.

Rozman, Č./ Nemec, J./ Janžekovič, M./ Repič, M./ Turk, J. Ekonomska optimizacija krmnega obroka pri pitanju volov. In: Posvetovanje o prehrani domačih živali "Zadravčevi-Erjavčevi dnevi", Radenci, 2002-11-11/12. Murska sobota, Živinorejsko-veterinarski zavod za Pomurje, 2002, 78–89.

Udovč, A. Simulacijski model za vrednotenje poslovnih odločitev na kmetijskem gospodarstvu. Magistrsko delo. Ljubljana, Biotehniška fak., Odd. za agronomijo, 1992, 118 p.

Ulamec, G.P. Optimiranje tržnih poti ekološko pridelanih kmetijskih pridelkov. Magistrsko delo. Ljubljana, Biotehniška fak., Odd. za agronomijo, 2005, 121 p.

Volk, T./ Cunder, T./ Štebe, T./ Pintar, M./ Bedrač, M./ Moljk, B./ Kuhar, A. Ocena stanja v slovenskem kmetijstvu v letu 2005. Spomladansko poročilo. Ljubljana, Kmetijski inštitut Slovenije, 2006, 92 p.

Winston, W.L. Operations research: applications and algorithms. 4th edition. Belmont, Thomson Learning, 2004, 1418 p.

Zadnik Stirn, L. Metode operacijskih raziskav za poslovno odločanje. Novo mesto, Visoka šola za upravljanje in poslovanje, 2001a, 182 p.

Zadnik Stirn, L. Operacijske raziskave (Podiplomski študij biotehnike – za interno uporabo). Ljubljana, Biotehniška fak., 2001b.