# CAP REFORM POLICY ALTERNATIVES AND FARM DECISIONS' OPTIMIZATION - THE CASE OF SLOVENIA

*Jaka Žgajnar*, Emil Erjavec and Stane Kavčič*

*Univ. of Ljubljana, Biotehnical Fac., Dept. Of Animal Science,*
*Groblje 3, SI-1230 Domžale, Slovenia, B.Sc.,*
*E-mail: jaka.zgajnar@bfro.uni-lj.si.*

## Abstract

*The 2003 reform of Common agricultural policy to be implemented in Slovenia in 2007 could have significant impact on the economic position of some agricultural sectors in Slovenia. Out of economics sight one can expect a drastic impact especially in sectors like beef, where percentage of pre-reform production coupled direct payments was very high - up to 70 % of gross margin achieved. This leads farmers to seek new production plans. For this purpose detailed specified static linear programming model has been developed and applied to the hypothetical agricultural holdings in order to find optimal production plans by maximizing total gross margins. Model results confirm that the reform should have unfavourable impacts on farms with intensive production practice, especially those with high livestock density. Obtained results indicate that the negative impacts can be mitigated by combining different production activities and technologies under given constraints on resources available. Model results also confirm the growing importance of CAP rural development payments, among them particularly inclusion into agri-environmental measures.*

*Keywords: CAP reform, farm decision making process, linear programming, Slovenia*

## Introduction

Direct payments are an important element of Common agricultural policy (CAP) which could significantly influence decision making process at the farm level. After accession to European Union direct payments became one of the most important income sources for farmers also in Slovenia (Volk *et al.*, 2006). Economic conditions are relatively similar with old member states, since in pre-accession period Slovenia introduced CAP like agricultural policy and consequently results of pre-accession negotiations allowed progressively providing funds from national budget to the level of old member states reached in 2007. After accession the policy changed significantly in 2007 as result of the implementation of 2003 CAP direct payments reform. Second pillar payments under CAP are becoming more important.

Changing environment leads farmers to make new decisions about which sector to choose, what to produce and by which technology. There exist many techniques of decision making that could help farmers to solve such problems (Boehlje and Eidman, 1984). One of them is undoubtedly linear programming that basis on mathematic techniques for solving optimization problems. Linear programming models and optimization techniques have also been successfully used in recent years for estimation of potential impact (on different levels) 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 economic situation and 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 latter case the linear model has been used to assess the impact of implementing CAP in this new member state. Majewski and Was (2005) use both farm and sector model to optimize farm and production structure within a region in this changing policy environment.

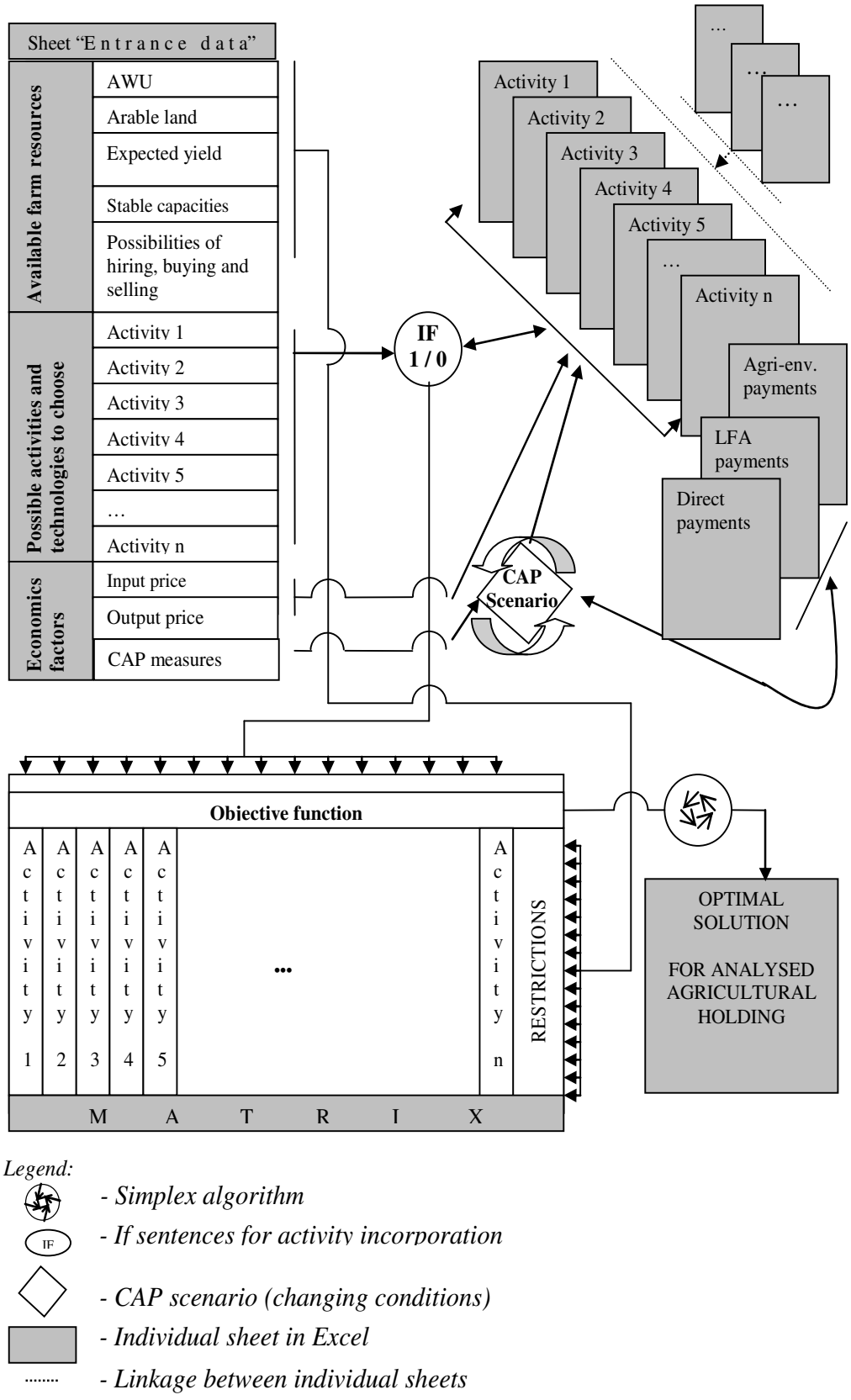
The paper aims to present developed linear programming model that can be utilized on Slovene agricultural holdings with the objective to find the optimal production plan on economic basis (maximising total gross margin). We are going to represent importance of CAP in Slovene agricultural area and consequently also the impact of current reform in different agricultural sectors. The new economic environment caused by reform presents farm managers with a new range of solutions to improve economic outcome.

***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 assume linearity the optimizer employs the simplex method to find an optimal solution and give us 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 interesting in Slovenian agricultural sector. Therefore we decided to focus on those sectors in Slovene agriculture where one can expect significant impacts of actual CAP reform in the field of direct payments. Previous research (Rednak *et al*., 2005) shows that this reform will have the most significant impact in the cattle sector.

Developed linear model is shown schematically in Figure 1. The figure shows interactions between different calculations with corresponding data, placed on separate sheets. Such structure enables easier overview and any further improvement including simulation procedure is much easier. Another reason to put emphasis to this complex structure lies in user-friendly input for analysing 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 (Figure 1). This makes analysis for different agricultural holdings simple and fast. Consequently the possibility for mistakes is also much reduced.

**Figure 1: Organization scheme of developed optimisation model based on linear programming method**



***Included Activities and Restrictions***

An important step in building a linear model is to define activities (processes) with technological (input - output) coefficients. Depending on the basic platform used (in our case Excel) the complexity of the model is constrained. For this reasons the spectrum of included activities in comparison with interesting 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 applied average prices and costs that are annually calculated for the needs of model-calculations (KIS, 2006).

Included activities could be classified in four groups:

2. The first group comprises livestock activities (different technologies and purposes of cattle and sheep breeding).
3. Second group includes forage production on arable and grass land.
4. A very comprehensive part presents crop production activities. Their main purpose is covering livestock nutrients' requirements in relation to intensity achieved on analysed farm, and surplus for selling on market.
5. In the last group we can classify all other activities (purchase, commodity selling, hiring of land and labour and transfers within farm household). This group is the most heterogeneous, as it connects and completes all other three groups at different stages.

To get more realistic model we decided to construct sets of production activities according to possible technologies and similarly also to different potential harvests achieved. One part of production activities is divided further into sale and production (field harvests and hay). Just the opposite is in livestock production activities where selling is assumed. Model is organized in the way that only one technology could be selected at once. So the developed model is not meant in the first place for searching the best technology or the optimal intensity, but to find the optimal solution within pre-selected activities, defined by the user.

Among livestock activities cattle sector is presented by activities of dairy cows, suckler cows, beef and veal production. Other livestock activities are not included yet.

The second activities group joins all kinds of forage conservation like preparing hay, silage etc. on arable and grass land and also grazing. Several technologies of cereals production like maize, wheat and barley are in the third group. The last group includes buying and selling produced fodder, labour 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:

6. zootechnical constraints (herd size, animal nutrition requirements)
7. agrotechnical constrains (land available (arable, grassland, pastures), crops rotation, mineral nutrition balance, share of cultivation)
8. policy (milk quota, premium rights for suckler cows, premium rights for sheep headage payments; maximum livestock density allowed)
9. specific farm constraints (labour capacities, harvesting technology, storehouse capacity)

For all crop and livestock products full utilization of produced quantities is assumed.

***Characteristics of Analysed Agricultural Holding***

Developed linear model is capable to analyze different types of agricultural holdings, i.e. specialized or those with mixed production plans.

The model was tested on a hypothetical farm, situated in the hilly part of Slovenia possessing 5 hectares arable land and 10 hectares grassland. Half of this area is located in less favoured areas. On the land available farms produces forage mainly for their own use and in the case of surplus also for sale. By searching 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 optimal production plan it is possible to include other livestock production activities (beef, calves and sheep). The labour available equals to 1.6 annual working units (1 AWU equals to 1,800 hours). When additional labour is necessary it is possible to hire it.

***Scenario Analysis***

The developed model includes three different direct payments' schemes: (i) until 2006 valid standard scheme assuming EU-15 pre-reform 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. Except in the fourth scenario (KP0) where no budgetary support is assumed, all other scenarios envisage payments for less favoured areas (LFA) and some of them also payments for implementing agri-environmental measures. On the basis of these conditions (types of subsidies and livestock density) eight different policy scenarios were analyzed (Table 1).

**Table 1: Scenarios Analyzed**

| *Scenario abbrev.* | *Scenario specification (type of direct payments and inclusion into agri-environmental measures (SKOP)*)* | *Maximum livestock density (GLU/ha) *** |
|---|---|---|
| *SS* | *Until 2006 implemented standard scheme; farm not included in Slovene agri-environmental scheme (SKOP)* | *2.5* |
| *SSSKOP* | *Standard scheme; farm included in SKOP* | *1.9* |
| *SSSEKP* | *Standard scheme; farm included in SKOP; farm eligible for extensification premiums* | *1.4* |
| *KP0* | *Liberal-market (no budgetary support is in place)* | *No restriction* |
| *RK* | *Combined scheme, implemented during 2007-2013; farm not included in SKOP* | *2.5* |
| *RKSKOP* | *Combined scheme; farm included in SKOP* | *1.9* |
| *RR* | *Regional scheme with single area payment; farm not included in SKOP* | *2.5* |
| *RRSKOP* | *Regional scheme; farm included in SKOP* | *1.9* |

**Model includes level of agri-environmental payments (SKOP) from the period 2004-2006*

*** Maximal gross livestock units 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 (i.e. specializations) for analyzed hypothetical farm. The main results are summarized in table 2.

**Table 2: The Main Results for Different Specializations 0n Analysed Farm Household**

| | Agricultural policy scenarios | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SS | SSSKOP | SSSEKP | KP0 | RK | RKSKOP | RR | RRSKOP |
| Specialization (GLU) | | | | | | | | |
| Dairy cows | 33 | 28 | 20 | 33 | 33 | 28 | 33 | 29 |
| Bulls fattening | 16 | 16 | 14 | 16 | 16 | 16 | 16 | 16 |
| Suckler cows | 19 | 19 | 19 | 12 | 19 | 19 | 12 | 17 |
| Calves fattening | 38 | 29 | 14 | 55 | 37 | 28 | 37 | 28 |
| Sheep breeding - milk | 15 | 15 | 9 | 15 | 15 | 15 | 15 | 15 |
| Sheep breeding - meet | 21 | 21 | 14 | 21 | 21 | 21 | 21 | 20 |
| Total gross margin (EUR) | | | | | | | | |
| Dairy cows | 29,791 | 33,321 | 27,925 | 20,677 | 31,673 | 35,507 | 29,661 | 33,433 |
| Bulls fattening | 22,509 | 23,727 | 23,794 | 9,765 | 18,499 | 19,592 | 14,138 | 15,315 |
| Suckler cows | 14,501 | 18,628 | 20,560 | 5,654 | 12,748 | 16,875 | 10,320 | 14,751 |
| Calves fattening | 23,869 | 21,224 | 15,636 | 15,089 | 21,532 | 20,385 | 17,581 | 16,433 |
| Sheep breeding - milk | 27,120 | 29,644 | 27,491 | 20,614 | 23,744 | 26,281 | 25,138 | 27,704 |
| Sheep breeding - meet | 16,203 | 18,716 | 16,199 | 7,833 | 11,830 | 14,342 | 12,999 | 15,482 |

The highest total gross margin is attainable with dairy farming. This seems logical since a predominant part of utilized area is grassland where farm can produce only voluminous forage. The optimal solution under standard scheme (SS) 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 economic improvement in all reform scenarios show that economic interest for dairy production on the analyzed farm will not significantly change under the assumption of constant commodity and input prices. Stability of this solution is most dependent on achieved milk price. Significant improvement is noticed in all schemes if farm includes in agri-environmental measures (SKOP) and just the opposite holds for farming without any subsidy (KP0).

Already on the basis of area available (low proportion of arable land) one can expect that bulls fattening is not competitive compared to dairy production on analyzed farm, except if this is an additional activity on the holding (therefore farming does not represent the main source of income). 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 the standard scheme (SSSEKP), where the reduction is imposed by lower livestock density (1.4 GLU). In this case extensification premiums efficiently compensate the deficit of revenue caused by lower livestock density.

Bull fattening is one of those sectors, where CAP reform will have the most negative impacts on economic outcome. This is the consequence of total or partial reduction of production coupled direct payments. More than 4,000 EUR better economic outcome is obtained under combined scheme compared to regional one, since the former keep one part of direct payments coupled and another one in form of historical payments.

Suckler cows optimal herd size is more or less constant in all standard and combined scheme scenarios. Slight decrease in number of suckler cows is indicated in KP0 and both regional scheme scenarios, where no coupled payments are in place. Economic outcome in comparison with dairy and beef production is not stimulative, but it has to be kept in mind that extensive organization in this case brings lower harvests and consequently also lower labour demand. Suckler cows seem interesting especially when farming represents only a supplementary source of disposable agricultural household income. Under the standard scheme farm could improve economic result with involvement into agri-environmental measures and managing under limits of 1.4 GLU 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 agri-environmental payments). In the analyzed case this means up to 4 thousand EUR increase of total gross margin. The importance of subsidies confirms also the fourth scenario (KP0) where result is in general halved compared with actual policy environment.

Even though calf 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 it is possible to purchase all forage. 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 small amounts of hay all other farm harvests are sold. In standard scheme scenarios (SS and SSSKOP) high level of direct payments are considered, especially slaughtered payments that are cancelled with CAP reform implementation. This fact will not have an important impact on the optimal herd size, but in worsening economic 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 labour input.

This leads to lack of household labour supply and consequently all scenarios include hired labour force (more than half needs).
In all scenarios herd size is the same, except in the scenario with more restricted livestock density. 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 outcome. Difference between combined and regional scheme is approximately 1,000 EUR and both results can be improved for 2.5 thousand EUR by agri-environmental payments.

Less intensive in terms of working hours is lamb production. Scenario results utilise only around third of household labour available. The farm would improve obtained results by substitution of 5 hectares of fields for meadows. Even though the farm has to purchase individual premium rights in scenarios SS, 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. A regional scheme improves economic outcome compared to a combined scheme. The reason can be found in very low livestock density achieved in optimal solutions. But in both reformed schemes result deteriorate significantly compared with standard scheme.

## Conclusions

The 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 the economic outcome of farming just with more efficient production plan.
In analyzed livestock sectors the 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 a combined scheme it remains between 26 and 60%, depending on farm involvement in agri-environmental measures. The regional scheme would bring drastic change in achieved total gross margin compared with this year's implemented combined scheme. Nevertheless, the share of subsidies in total gross margin remains comparable to those in combined scheme. Model results confirm that calf 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. The highest share of budgetary support is noticed in suckler cows (65 % - 82 % of gross margin).

The 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.

## References

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

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

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

KIS. 2006. Data for model calculations (unpublished)
Majewski E., Was A. 2005. Optimal structure of farms in a region - a modeling approach. In: 99th seminar of the EAAE (European Association of Agricultural Economists), Copenhagen, Denmark, 24-27 avg. 2005 (unpublished)

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

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

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