Farm Income, Production, and Labor Use Under CAP: The Case of Diversified Mountain Farms in Serbia

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Abstract

The Republic of Serbia is a candidate country for accession to the European Union, which entails certain changes in agricultural and rural policy in order to harmonise it with the Common Agricultural Policy. These changes will have an impact on farmers' income, their production plans and the utilisation of resources. This paper analyses the impact of compensatory payments, greening payments and decoupled payments on farms in Areas with natural constraints in Serbia. A linear programming model was developed to simulate the effects of the proposed measures. The main results show that the simulated scenarios improve the economic situation of a diversified group of farms and preserve natural resources in Areas with natural constraints.

INTRODUCTION

Farmers in Areas with natural constraints (ANC) confront immense challenges, risks and pressures that affect their agricultural production and livelihoods. Farming in these areas is hindered by difficult geographical conditions, climatic problems, poor soil conditions, etc. In addition, these areas are usually far away from logistics centres and agricultural support services, so there is a risk of land abandonment. In the European Union (EU), farmers in ANC are supported with compensation payments which ensures a decent income and allow farmers to continue agricultural activity. There are no specific environmental commitments for this type of support, but these payments can contribute to maintain more extensive farming and discourage land abandonment (European Commission - EC, 2023). Some authors state that compensation payments are not sufficient for the development of ANC (Pelucha et al., 2013; Kazakova-Mateva, 2017), while others found that ANC payments in combination with other agricultural measures, especially those related to the environment, strengthen agricultural incomes and better protect the natural environment (Czekaj et al., 2013; Wąs et al., 2014; Zieliński et al., 2025). The researchers also analysed the impact of decoupled payments on the income and production structure of farmers in mountainous and underdeveloped regions. The results show that the effects on income and production plans depend on the type of farm (Acs et al. 2010; Shrestha et al., 2007). Previous studies also explain that diversification in marginal areas is used as a strategy mainly to reduce risk exposure (Boncinelli et al., 2017) and that farmers with diversified activities are more capable to cope with external factors – such as changes in agricultural policy (Douxchamps et al., 2016).

The effects of different policy measures on agricultural resources have generally been analysed using normative, positive and econometric mathematical programming (Buysse, 2007). Arriaza and Gomez-Limon (2003) emphasise that the classical linear programming (LP) model, despite its simple and normative nature, is still useful for estimating the impact of agricultural policies. There are many applications of LP in the field of policy analysis (Acs et al., 2010; Morgan Davis, 2014).

In Serbia, there are no special policy measures for farmers in ANC, although 28.6 % of farms and 22.8 % of utilised agricultural area (UAA) are located in these areas (Papić, 2022). Farms in ANC are mostly dependent on direct payments, which predict lower thresholds for applications from these areas. Considering the fact that Serbia is a candidate country for EU accession, the national policy is expected to be reformed in line with the Common Agricultural Policy (CAP). The aim of this paper is therefore to assess the impact of different policy scenarios on income, production plans and labour utilization on a typical farm in ANC in Serbia. We construct an LP model to simulate the effects of the following scenarios: decoupled payments; compensatory payments; greening payments and abolition of agricultural subsidies.

METHODS

Data collection and selection of typical farms

The *first step* of the methodology involves the collection of detailed data at farm level. The survey was conducted in the summer months of 2018 in the ANC mountain regions in the east and south of Serbia. The sample comprised 370 economically and demographically viable farms (Papić, 2021; Papić Milojević and Bogdanov, 2024). Data was collected on animal and crop production, animal nutrition, income, variable costs, household members, facilities and equipment, subsidies, future plans, etc. *The second step* of the methodology involves the separation of farms into

groups with similar characteristics and selection of typical farms. The multivariate techniques – namely Principal component analysis (PCA) and Two-step cluster analyses were used for this purpose. The results show that 3 clusters can be distinguished: a) farms with mixed livestock production dependent on income from agriculture (197 farms from the sample) b) farms with mixed livestock production and income from salaries and pensions (103 of the farms in the sample); and c) farms with mixed livestock and crop production and diversified income (70 farms in the sample). The process of grouping the farms is explained in detail in the research (Papić, 2021; Papić Milojević and Bogdanov, 2024). The resulting typology was then used to construct real typical farms based on their similarity to the average farm situations of each cluster (Papić Milojević et al., 2022). In this paper, a farm with diversified income – fruit and livestock production was employed as a case study to illustrate the effects of changes in agricultural and rural policy measures. Therefore, we try to answer which support measures would have the most favourable effects on the sustainability of diversified group of farms and rural areas.

The selected farm is situated on mountain slopes, around 20 km from the city centre. The farm cultivates 3.4 hectares of arable land (maize, wheat and alfalfa), 3 hectares of orchards (2 hectares of cherries and 1 hectare of plums) and 7 hectares of meadows and pastures (3 hectares of the pastures are not used). The farm produces fodder on the arable land, mainly for its own use and also for sale if there is a surplus. Cherries are the most important market product, while plums are processed into brandy, which is partly sold and partly used in the household. The farm is focused on cow's milk production. The milk is mainly processed into cheese and sold on the market. Additionally, one part of calves' production is intended for market. The farm produces piglets both for the market and for household consumption. The household consists of 5 members. Two of them are fully involved in farming, the other two are unable to carry out agricultural work due to their age[1]. The youngest member of the household has a job in the formal sector, so he is occasionally engaged in the farm. The farm hires additional labour in order to complete cherry harvest. The share of subsidies in gross margin is around 5%. The farm holder uses payments per hectare and payments for quality breeding dairy. The farm holder does not utilize rural development measures and remains uncertain about their future use. However, he is interested in using the subsidies at the local level. The farm holder perceives their production relatively independent of subsidies.

Model components and descriptions
The third step of the methodology involves developing and optimising mathematical programming models which maximise an objective function within a number of limiting constraints. This technique has demonstrated strong effectiveness in analysing policies related to land use in marginal areas (Acs et al., 2010; Žgajnar et al., 2008). The model maximizes the gross margin and it is expressed by the following relationship:

Max $Z = \sum_{j=1}^{n} c_j x_j$

Subject to the linear constraints:

$\sum_{j=1}^{n} a_{ij} x_j (\leq, =, \geq) b_i$;   i=1,2,…,m
and
$x_j \geq 0$;   j=1,2,…,n

Where,
Z - gross margin of farm in Euros,
c_j - gross margin per unit of j-th activity in Euros,
x_j - the level of j-th activity,
a_{ij} - amount of i-th resource required for the j-th activity and
b_i - total available quantity of i-th resources.

The initial assumptions for the formulation of the diversified farm model in ANC are based on real data from the selected typical farm. The analysed models include comprise the following activities: crop and livestock production; purchase of livestock feed, hiring of labour, sale, consumption and processing of agricultural products and agricultural policy measures. The following constraints were integrated into the model: land constraints, market constraints, labour constraints, housing constraints, consumption constraints, agricultural policy constraints and balance constraints. An important aspect of this step is the definition of the technical coefficients (input-output coefficients), which represent the amount of resource consumed per unit of activity.

Scenarios definition
The baseline scenario (B) is based on the policy model applicable in 2018 in Serbia when the research was conducted (Table 1). The farm uses direct payments per hectare which are intended for arable and permanent crops for a maximum 20 hectare (34 €/ha). The payments are not intended for pastures and meadows. Additionally, the farm uses direct payments per animal head – granted for quality breeding dairy cows (212 €/head). Thresholds have been introduced for the minimum and maximum number of quality breeding dairy cows (minimum 2 and maximum 300).

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[1] The available number of working hours of the farm members was based on the assumption that members who are exclusively engaged in the farm work 26 working days per month, 10 hours per day. The available working hours are reduced for members who have jobs outside the farm and for members who, due to their age, cannot work the full working hours (Krstić and Smiljić, 2003).

Table 1. Overview of the simulated scenarios

Acronym	Short description	Simulated amounts of new measures	Requirements
B+ANC+MPG	Compensatory p. and payments for maintaining permanent grassland with the existing system of direct p.	25€/ha+31€/ha	ANC are intended for all UAA; min. 0.1 UG/ha for sheep farming
SAPS	Decoupled payments	115€/ha	Decoupled payments for all UAA
SAPS+ANC+MPG	Decoupled p. with compensatory p. and payments for maintaining permanent grassland	115€/ha+25€/ha+31€	Combination of the above-mentioned requirements
NO S.	Abolition of all forms of subsidies	-	-

Source: Authors' systematisation

The ANC scenario represents compensatory payments in accordance with the EU regulation on rural development policy[2]. They are paid annually per hectare for all categories of UAA. A minimum amount of ANC payment proposed in the EU regulation has been simulated in this paper.

The SAPS (Simplified Area Payment Scheme) scenario implies that the existing forms of coupled payments in live-stock farming (per head, per litre) have been excluded from the model and new payments[3] decoupled from production are introduced. New payments per hectare were intended for all UAA (including meadows and pastures) and the amounts for direct payment per hectare will be increased compared to the current payments.

The MPG (Maintaining permanent grassland payments) scenario represents a situation when a farm uses existing pastures and it is not allowed to plow them or change their purpose (convert them into arable land, orchards, vineyards or other forms of agricultural land use). This scenario implies a new production line has been introduced—sheep farming (meat and wool production)[4] and as a result, farmers started using pastures. The proposed greening payment is an annual payment per hectare calculated as 70% of the payments per hectare in Serbia.

The *No subsidy scenario (No S.)* assumes the abolition of agricultural subsidies for farmers, as well as mandatory requirements related to agricultural production that farmers must fulfil.

RESEARCH RESULTS

The results show that all applied scenarios increase the gross margin, except for the case when subsidies are abolished. The scenario which involves maintaining permanent pastures through grazing with a coupled payments and compensation, led to the highest increase in gross margin – around 44% (B+ANC+MPG). The introduction of SAPS payments also increased the gross margin by 10.7%, and together with MPG and ANC payments by 42% (SAPS+ANC+MPG). This is not surprising because all scenarios assume that payments per hectare increase, which positively affects gross margin of the farm with diversified plant production (Fig. 1)
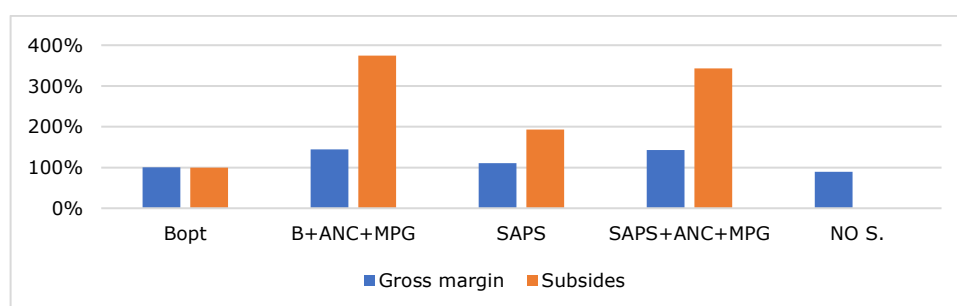

Figure 1. Changes in economic indicators under different scenarios (B=100%)
Source: Authors' calculation

The introduction of a measure for maintaining permanent pastures together with coupled and ANC payments de-creases the number of pigs (and thus sale of the piglets), while the number of cattle remains unchanged. The area under wheat also decreases, unlike the area under corn and alfalfa. There were no changes in the areas under plums and cherries. The introduction of SAPS payments reduces the number of cattle by 4.3% and together with the MPG scenario by even more (-21.56%). The decrease in cattle production happens because decoupled payments do not have requirements of mandatory keeping a certain number of cattle on the farm. Also, in the MPG scenario (which includes the introduction of sheep production), the farmer receives larger amounts of payment for pastures, and

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[2] ANC payment ranges from 25 euros per ha to 450 euros per ha for mountainous areas (Council Regulation (EC) No 1305/2013).
[3] The amount per hectare was calculated via EU SAPS method by dividing the total realized direct payments in Serbia by the total UAA area subsidized in 2018 (Report on the State of Agriculture 2018; Directorate for Agrarian Payments, internal data).
[4] During the field research, it was found that local governments give 10 sheep for free to farms that have the capacity (land and willingness) to engage in this type of production.

this farm has no need to hire additional labour for the grazing period, so cattle production is not competitive to sheep production. The complete abolition of subsidies leads to the same changes as in the SAPS scenario (Table 2).

Table 2. Changes in the production structure under different scenarios compared to the Baseline (%)

Scenarios	Wheat (ha)	Maize grain (ha)	Alfalfa (ha)	Pig (su) [a]	Cattle (su) [a]	Sheep (su) [a]
Bopt	-11.3	6.0	0.0	4.2	0.0	/
B+ANC+MPG	-31.2	5.7	37.6	-17.8	0.0	100.0
SAPS	-0.3	1.2	-4.3	4.2	-4.3	/
SAPS+ANC+ MPG	-27.5	10.7	14.1	4.2	-21.6	100.0
No S.	-0.3	1.2	-4.3	4.2	-4.3	/

[a] As an activity in livestock production, a structural unit for individual species is used (as an aggregate) due to the need to generalize the obtained results. This means that the final category of livestock is presented in the model and the requirements and effects of the accompanying categories are expressed through the final category (Vico, 2012).
Source: Authors' calculation

The largest increase in labour utilization compared to the baseline was observed in the scenarios which imply the maintenance of permanent grassland (B+ANC+MPG; SAPS+ANC+MPG). These increases are the result of the introduction of sheep farming into the model. The decrease in labour utilization occurs when the farm uses only SAPS payments and in the scenario, where subsidies are abolished (Fig 2.).
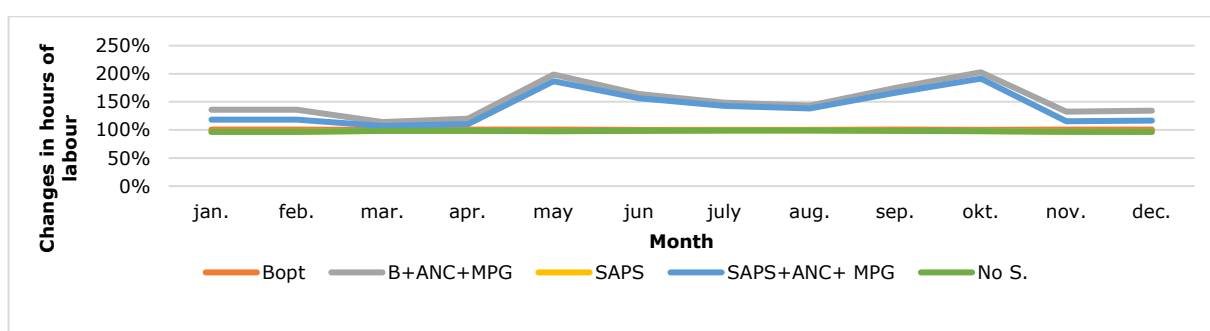

Figure 2. Changes in the use of the hours of labour force per month (B=100%)
Source: Authors' calculation

Discussion

For the farm with diversified income – fruit and livestock production, scenarios which include MPG and ANC payments proved convenient in case of both coupled and decoupled payments. Namely, in both cases, additional payments *(MPG and ANC)* increase the gross margin and lead to the better utilization of agricultural resources, i.e. labour. Similar findings are presented in the research of Gocht et al. (2016) and Helming and Terluin (2011) who explain that the measure for maintaining permanent grassland positively affects the economic results of farms – especially for those that do not rely solely on livestock production. These results show that for farms in mountain areas different types of payment for pastures can result favourable effect on overall rural areas. This is because maintain the grazing system leads to sustainable management of the ecosystem, and economic benefits are ensured through the production and processing of traditional agricultural products.

Research shows that *SAPS* payments (especially in combination with greening and compensation payments) increase the gross margin of farms that have diversified their agricultural production. Previous studies show that decoupled payments cause reduction in gross margin in mountain areas only for farms with mixed livestock production (Papić Milojević et al., 2022; Manos et al., 2009; Manos et al., 2011). Also, findings from this paper show that SPAS payments reduce cattle production which is also confirmed in previous studies in marginal areas (Shrestha et al., 2007, Morgan-Davis, 2014, Acs et al., 2010). These findings explain that a diversified group of farms in ANC will benefit from SAPS payments, and therefore some mechanisms should be found to target this type of payments to these characteristic group of farms in the ANC.

Scenario where no budgetary support is assumed *(No. S)* decreases the gross margin, reduces the use of labour and number of cattle, indicating that farms in these areas still need policy support. Similar findings are confirmed in previous studies (Žgajnar et al., 2008; Acs et al., 2010).

Conclusion

The results of the applied scenarios indicate that instruments based on the EU model of agricultural policy and in accordance with the specificities of farms, can improve the economic situation of family farms in the ANCs and contribute to the sustainable development of these areas. In the ANC in Serbia there is a group of farms that have diversified their income and are less dependent on state support. This group, which is located in specific parts of the

ANC gives priority to plant production (fruit production) that achieve a high gross margin. Therefore, instruments that favour plant production (e.g. decoupled payments) are certainly necessary for this type of farm. Also, farms in ANC have significant share of the area under meadows and pastures, so measures that influence suitable pasture management are also suitable for them. It is evident that for farms with diversified income – fruit and livestock production, abolition of the current coupled support system and the transition to decoupled support (which is mandatory in the EU policy) is not a problem. Therefore they can be easily adapt to the changes that come with the CAP policy. The research results represent a valid basis for various discussions and studies related to the creation of effective development policies and strategies in marginal areas.

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