doi: 10.17221/116/2014-AGRICECON

An ex-ante impact assessment of the Common Agricultural Policy reform in the North-Western Romania

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Abstract: The paper aims to assess the impact of the Common Agricultural Policy reform (post 2014) in the environmental vulnerable areas from Romania. It proposes a bio-economic dynamic farm model calibrated with the positive mathematical programming (PMP). The standard PMP approach was extended to simulate the mixed farming systems through the introduction of a livestock production activity in the first calibration step. It allows incorporating activities not available in the base year, but that can be performed by the farmers after the future policy reforms. The model provides supply-responses for both the crop and livestock farms according to the agricultural and financial policy shifts. It maximizes the farm net financial flows subject to the resource, livestock, financial and agricultural policy constraints. The initialisation data were obtained from a face-to-face stratified survey applied on the mixed-sheep farms that have used grassland areas under the Agri-Environment Schemes (AES) in the North-Western Romania (Transylvania). The results show that the most vulnerable group to the policy changes is represented by the small-size farms, to which the AES are very important economic drivers. Thus, the diversification and the off-farm employments possibilities should be integrated into the future rural development plans as a premise for their survival.

Key words: Agri-Environment Schemes (AES), bio-economic model, land abandonment, positive mathematical programming (PMP)

Agricultural policies represent a set of mandatory regulations, designed to achieve certain public goals (Oskam et al. 2011). In the European Union (EU), the Common Agricultural Policy (CAP) groups the entire legislative framework that concerns agriculture and rural development (Greer 2005). It knew important reforms over time, explained by the internal or external pressures. Since the 1992 MacSharry reform, the intervention prices together with the export subsidies and import protection have been reduced (Daugbjerg and Swinbank 2007). Furthermore, the 2003 Fischler reform and the 2008 Health Check changed the allocation philosophy of the direct income support (Regulation (EU) 1782/2003; 73/2009). It became decoupled to production within the important cross-compliance rules.

After an extensive public debate, the European Commission presented its reform proposal for the period 2014–2020. It covers all the main policy areas: the direct financial support, the market organisation and the rural development (Regulation EU 1305/2013; 1306/2013; 1307/2013).

Governments and policy agencies need to evaluate the potential outcomes of such reforms before implementing them (European Commission 2009a). In order to do so, several methods were developed over time. A first option consists in building bio-economic models, which represent the way of functioning for a farm. Such tools proved to be extensively used both in the ex-ante and the ex-post impact analysis of the policy changes in agriculture (Janssen et al. 2010). They were applied in different farm types and countries according to the particular research needs (Janssen and van Ittersum 2007). Thereby the arable, vegetable or livestock bio-economic models were used (Benoit and Veysset 2003; Dogliotti et al. 2005; Bartolini et al. 2007). In the last years, a generalised static tool for the multi-national impact assessment

Supported by the Romanian National Council of Scientific Research (Project No. 190/2010).

doi: 10.17221/116/2014-AGRICECON

was proposed at the European level (Janssen et al. 2010; Louhichi et al. 2010). Even so, important research possibilities that presume to incorporate the dynamic evolution of the agricultural system together with the investment opportunities are still left open.

The second approach is to build the Integrated Decision Support Systems (IDSS) using the partial or general equilibrium models. These models include a wider variety of sectors having less focus on the agricultural system particularities (van Delden et al. 2010). This framework was used to investigate the impact of introducing an EU wide flat area payment after 2013, together with the impact of different CAP measures on the biodiversity and land allocation (Verburg et al. 2006; Verbooma et al. 2007; Erjavec et al. 2011).

Despite all these works, few researches underline the impact of the agricultural policy shifts in the Central and Eastern Europe (Anderson and Swinnen 2010; Davidova 2011; Jitea 2011; Wegener et al. 2011). Similar information is not available for the Alpine and Sub-Alpine grassland regions in the Eastern Europe. Thus, the present study investigates the impact of the post 2014 agriculture policy reform in preventing land abandonment from the High Natural Value (HNV) areas in the North-Western Romania (Transylvania) using a dynamic bio-economic farm model that allows to incorporate the system characteristics. In the second part of the paper, several policy scenarios are empirically investigated. The farm data was obtained after a face-to-face survey conducted in a NUTS2 level Romanian region. The investigation was focused on the mixed farms specialised in sheep production since they are the main users of the HNV Romanian areas (Cremene et al. 2005). The last part concludes with the most important findings and policy recommendations.

MATERIAL AND METHODS

The model

The SIMULCAP (Simulator of the Common Agricultural Policy) is a bio-economic model that provides supply-responses for different farm types according to the agricultural and financial policy changes. It is a positive model, meaning that the simulations are based on a real observed behaviour. It can be initialised either with the data taken from the Farm Accountancy Data Network (FADN) or collected directly from farms by the end-user. It has dynamic features because an annual time step is explicitly represented into simulations. Consequently, the end-year farm endowments (land, buildings, machineries, livestock, liquidities, credits etc.) become the initial ones for the next year. The farmer is considered to be a price taker, meaning that he/she cannot influence the input/output prices (in agriculture, the number of the agents on the supply side is high and their economic power is usually low).

The farm behaviour is simulated with mathematical programming. Each farm is considered to be a linear combination between different activities. An activity is represented as a set of technical coefficients that show the necessary inputs to produce one output unit. The optimal combination between activities is obtained by maximizing an objective function subject to resource and policy constraints (Hazell and Norton 1986). It highlights the goals that a farmer wants to achieve. Over time, the profit maximisation, the profit maximisation under risk, the cost minimisation and the multiple goal programming (utility) functions were employed (Janssen and van Ittersum 2007; Louhichi et al. 2010). Even if there is no general agreement on this issue, a net financial flow function was optimised considering that it allows taking into account in the same time different types of objectives (production, off-farm revenues and investments).

To increase the degree of generalization of the model, both crop and livestock activities were simulated. Thus, the net financial flow from agricultural activities is equal to the total revenues, including the sales from agricultural products and the direct financial support (subsidies) minus the total variable costs paid to support the crop and livestock activities. The total variable costs include the total crop (tilling and soil preparation; seeds and plant material; fertilizers; crop protection; labour; fuels and lubricants) and livestock (animal feed; drugs and veterinary expenses; labour; fuels and lubricants) expenses.

The positive mathematical programming (PMP) was used to calibrate the model to a reference observed behaviour (Howitt 1995). The *standard* PMP (STPMP) means: (1) to specify a linear programming model bound by the calibration constraints, in order to find the shadow prices for the activities practiced in the base year; (2) to estimate a quadratic variable cost function that incorporates all the farming conditions not explicitly modelled elsewhere (C^v)

doi: 10.17221/116/2014-AGRICECON

(Júdez et al. 2002; Röhm and Dabbert 2003; Buysse et al. 2007):

$$\underset{x}{Maximize}\ Z = r'x - c'x$$
$$\text{s.t.} \tag{1}$$
$$Ax \le b \quad (\pi);$$
$$x \le (x_0 + \varepsilon)(\lambda);\ x \ge 0;$$

Where:

Z = farm gross margin
r = *all* x 1 vector of revenues for one activity unit
x = *all* x 1 vector of the simulated levels of agricultural activities
c = *all* x 1 vector of variable costs
A = *m* x *all* matrix of technical coefficients (*all* is the number of activities and *m* is the number of resources)
b = *m* x 1 vector of available resources
x_0 = *all* x 1 vector of the observed activities in the base year
ε = *all* x 1 vector of small positive numbers
λ = *all* x 1 vector of shadow prices

$$C^v = d'x + \frac{1}{2}x'Qx \tag{2}$$

Where:

C^v = variable cost function
d = *all* x 1 vector of the free term parameters of the cost function (c)
Q = *all* x *all* quadratic matrix with the elements that count the marginal variation of the variable costs, when the activity's volume is modified with one unit (diagonal elements) or the other activities change by one unit (outside diagonal elements)

Several critics were pointed out to the *standard* PMP (STPMP): (1) The marginal costs parameters (λ) do not permit to find all the cost function parameters (d and Q); (2) only the observed activities in the base year are incorporated into the final model; (3) there is a different treatment between the marginal activities ($\lambda_i = 0$) and the others (de Frahan et al. 2007). Some solutions were proposed to these critics: to use either the maximum entropy econometrics (Paris and Howitt 1998; Heckelei and Wolf 2003) or some *a priori* supply elasticity coefficients (Helming 2005), such as to recover all the data for an appropriate specification of the cost function; to introduce other *a priori* data about the activities that can be farmed in a specific region but not yet activated by the farmer (Arfini et al. 2001).

For the arable farming, there was developed an *extended* version of the *standard* PMP (EXPMP), which solves the PMP's criticism concerning the inconsistent calibration parameters (Kanellopoulos et al. 2010) (Equation 3). It has also two steps, but in the first one, a land renting activity is incorporated into the objective function that allows recovering the non-zero marginal costs for all the activities observed in the base year. The land value becomes equal to the weighted average gross margin calculated with the real farm data:

$$\underset{x}{Maximize}\ Z = r'x - c'x - gy$$
$$s.t$$
$$A^{-}x \le b^{-}(\pi^{-}); \tag{3}$$
$$x \le (x_0 + \varepsilon)(\lambda);$$
$$x \ge x_0 - \varepsilon(\lambda');$$
$$I'x \le y;\ x \ge 0;$$

Where:

g = average land gross margin
y = cultivated land in the base year
A^{-} = *a* (m – 1) x *all* matrix of technical coefficients (except land)
b^{-} = (m – 1) x 1 vector of the available resources
I = *n* x 1 vector of ones
λ = *all* x 1 vector of shadow prices for the activities that have a higher gross margin that the land one
λ' = *all* x 1 vector of shadow prices for the activities that have lower gross margins that the land one (for each activity, only one of the above calibrated constrains are binding)

Thus, from the second order conditions, the calibrating parameters Q and d of the quadratic cost function become (where Q is a diagonal matrix):

$$q = \alpha|\lambda + \lambda'| / x_0; \tag{4}$$
$$d = c + (\lambda + \lambda') - \alpha|\lambda + \lambda'|;$$

where α is an *all* x 1 vector of parameters that determines the costs weights of the activities in the objective function. A large α value means a model less sensitive to price changes. In practice, it can be derived either by the own supply elasticity or using successive trails (Kanellopoulos et al. 2010).

Even so, the *extended* PMP (EXPMP) version still has shortcomings that might alter the final results. The first limitation refers to the fact that it does not address the case of the mixed farming extensively presented in the European agriculture. So, farms can use a part of the crop output in the livestock production and not necessary selling it. Thereby, not only the land renting activity should enter into the first step objective function, but also an additional livestock one. To make the procedure available for all types of mixed farms, the average weighted gross

doi: 10.17221/116/2014-AGRICECON

margin for the livestock production can be introduced in the first step of the model by using the Eurostat procedure to transform different species into the comparable livestock units (1 sheep = 0.100 LSU; 1 dairy cows = 1 LSU).

The second limitation presumes that the final model uses only the activities observed to be farmed in the reference year ($x_0 \neq 0$). A realistic model should allow the end-user to define other activities that can be farmed in the region, but for different reasons (market, policy, farm endowments) not yet activated. In order to incorporate them, the model can be initialised with the average data collected from the region (cost, prices, and yields). Then, the initialisation data from the base year can be equal to small positive numbers ($x_0^* = 0.01$). After these specifications, the first step of the *extended mixed farm* approach becomes (EXPMP_MX):

$$\begin{aligned}
&\underset{x}{Maximize}\ \ Z = r'\,x - c'x - gy - g'l \\
&s.t. \\
&A^* x \le b^*(\pi^*); \\
&x \le (x_0 + \varepsilon)(\lambda); \\
&x \ge x_0 - \varepsilon(\lambda'); \\
&I'x \le y + l;\ x \ge 0;
\end{aligned} \qquad (5)$$

Where:

all = number of all farming activities (the first *n* positions represents the number of crop activities from which the last *wf* refers to winter forage crops, the next *sf* positions is the number of summer pasture activities

sh = number of sheep outputs

cw = th number of cow outputs, *oth* is the number of other livestock outputs; $n + sf + sh + cw + oth = all$)

g = weighted land gross margin computed for the crop activities

g′ = weighted livestock gross margin

l = livestock units observed in the farm

A^* = $(m - 2)$ x *all* matrix of technical coefficients (except land, and livestock)

b^* = $(m - 2)$ x 1 vector of the available resources

The objective function

After the above mentioned changes, both crop and livestock activities can be calibrated in the SIMULCAP model (5). Thus, the objective function that maximizes the net financial flows from agricultural activities is:

$$Y_t^f = (p_t q_t' - (d + \frac{1}{2} Q x_t')\ x_t + sub_t - rent_{land_t} - land_{inv_t} \qquad (6)$$

where:

Y_t^f = annual net financial flow generated by farming activities

t = the year of optimisation

sub_t = financial direct support received acordingly to the agricultural policy conditions

$rent_{land\ t}$ = additional areas of the leased land at the average annual cost from the region

$land_{inv\ t}$ = area of the purchased land evaluated at its shadow price (arable land and pasture).

The model also manages the farm's labour force (7) and the investments (8). A farm can use at the same time the family or employed working force. The initial resources are exogenous parameters defined by the user. Annually, it optimises these variables together with the family working force employed outside the farm:

$$Y_t^{working\ \ force} = (labor_t^{family\ out} w_t^{family\ out} - labor_t^{in}\ w_t^{employed}) \qquad (7)$$

Where:

$Y_t^{working\ force}$ = annually net financial flow generated by the working force management

$labour_t^{family\ out}$ = the number of hours for the family working force available to be employed outside the farm at an hourly gross wage ($w_t^{family\ out}$)

$labour_t^{in}$ = represents the number of hours eployed in the farm (family or employee) at an hourly gross wage (w_t^{employed})

In the investments area, the model distinguishes between the financial and productive investments. Thus, an investment catalogue that can be changed by the user is part of the SIMULCAP model. The investments types (*it*: buildings, tractors, machineries and equipment) are characterised by an integer investment value (I_t^{it}), a rate of return (δ_t^{it}), a depreciation period and a group of technical parameters (lubricants consumption, yields etc). Annually, the model decides between acquiring the additional investments ($I_t^{it}\delta_t^{it}$) and leasing the additional ones from the market ($I_t^{it}\beta_t^{it}$) at an hourly charge (β_t^{it}):

$$\begin{aligned}
Y_t^{investments} &= v_t^{placements} D_t + \sum_{it=1}^{IT} I_t^{it}\delta_t^{it} - deprec_t - espens_t^{maint} - v \\
&- v_t^{sh\,term} C_t^{sh\,term} - v_t^{l\,term} C_t^{l\,term} - \sum_{it=1}^{IT} I_t^{it}\beta_t^{it}
\end{aligned} \qquad (8)$$

Where:

$Y_t^{investments}$ = annually net financial flow generated by the farm investments

$v_t^{placements}$ = represents the interest received for the temporary financial resources D_t

$deprec_t$ = depreciation expense

$espens_t^{maint}$ = maintenance cost

$v_t^{sh\ term}$ and $v_t^{l\ term}$ = interest rate for the short and long term credits

doi: 10.17221/116/2014-AGRICECON

The sum between these net financial flows represents the annual objective function of the SIMULCAP model. It can be optimised over a finite time horizon.

$$Max \sum_{t=1}^{T} (Y_t^f + Y_t^{working\ force} + Y_t^{investments}) \qquad (9)$$

Constraints

The constraints system represents in a simplified way the environment in which the farm operates. The constraints were classified into four classes. One constraint module is activated only if the user initialises the system with the necessary inputs. For example, if the simulated farms do not have any livestock activities (*sh*, *cw*, *oth* = 0), then the livestock constraints module will not be activated.

The first class of constraints refers to land requirements (Figure 1). It limits the level of the crop production to the initial land resources, to which annually the additional plots can be either rented or purchased. Several soil types were defined, taking into consideration that the arable land, the arable land covered by the perennial crops and permanent grasslands could be observed at the same time. The land market is simulated through the new land acquisition possibilities that are available to farmers accordingly to the soil type and the available financial resources.

The second type of constraints refers to the labour requirements. For all activities, the sum of labour needs (expressed in hours) should be less than the family resources (FW) to which the permanent (PW) and temporary working (TW) units can be added. The equipment requirements and the crop rotation constraints were also added. Thus, for each equipment type (it), the sum of the required needs expressed in hours per year should be less than the farm endowments to which the new investments or the new leased material are available. The crop rotation represents a sequence of different crop activities in time and in space. In a dynamic approach, it is proved that it is better to generate rotations directly inside rather than outside the model (Janssen et al. 2009). The frequency constraints were introduced to take into account the minimum period of time before repeating the cultivation of the same crop on a specific plot. Without it, the model outcomes will produce negative effects on the physical, chemical and biological soil quality (Dogliotti et al. 2003). Cereals, tubers and oil crops cannot be cultivated on the same plot in two consecutive years.

The livestock constraints refer primarily to the herd demography simulation. It represents the intergenerational dependences between different livestock age classes (Thorne et al. 2009). In the SIMULCAP, the production process is represented in time for the cows (dairy, meat), small ruminants (sheep, goat) and the pig production. Each age class is analysed separately but in the same time they are linked to other categories by the explicit relations represented by the exogenous parameters, such as the fertility rate and the farmer's decision concerning the animal stocking and destocking rates. In the dairy production, two livestock classes are analysed according to gender. The male herd is further divided into three age sub-classes (0–3, 3–12 and 12–18 months); in the end, they are being sold as the final products in the market. The female herd is divided into five age groups (0–3, 3–12, 12–24, heifers and dairy cows) to simulate the way in which one unit passes from one class to another until it arrives to produce milk at the average age of 3 years. The main products that can be sold in the market are milk, the non-stocked heifers and the slaughtered cows after the average life period (the last being also an exogenous parameter). In the same way, the herd's demography is simulated for the small ruminants. But in this case, for the female herd, there are considered only three age classes (0–12; 12–24; mother ruminant), taking into consideration that in average, the age of the first calving is around two years. Lambs are sold in the market after the average period of 3 months.

In the mixed farming systems, the feed constraints reflect the relation between the crop activities; the livestock feed needs and the market sale opportunities. The model takes into account a summer and a winter feed balance. In the summer time, the permanent grasslands are used to assure the animal feeding together with the feed supplements. The grazing time depends on the altitude where the farm is located, this being defined by the user. In the winter time, the farm can provide feed requirements by its own production (*wf* winter forage crops number) or by acquisitions. Finally, a labour constraint, which is similar to the crop model, and the milk quota were introduced as well. The milk quota represents the maximum cow milk quantity that can be sold to the processor during one year. It is initialised by the farm endowments to which the additional quantities can be bought.

If the financing possibilities are unlimited, the farmer would be interested in the capital short- or long-term investments, taking into consideration the

doi: 10.17221/116/2014-AGRICECON

agricultural constant returns to the scale hypothesis (Chavas 1994). However, they are incredibly limited because agriculture is perceived to be a risky activity. The banks rather prefer bigger farms that can provide better collaterals in receiving loans than the smallest ones (Lízal and Svejna 2002). Thus, the farm development is conditioned by the capital level that can be generated inside and outside the farm. Consequently, the following types of financial constraints were introduced into the model:

(1) the yearly financial balance that analyses the operational financial needs (production cost, investments) in comparison with the capital resources (starting-period cash, short-term loans and revenues). Based on it, the cash position at the end of the year is calculated as the sum between the last year liquid assets, the yearly gross margins and the loans minus the current year annuities;

(2) a set of financing constraints that simulates the way in which the farms can obtain external financial resources. Short-term credits are used to cover the gap between the due operational payments (inputs; salaries; legal duties) and the financial resources, smaller at a certain moment

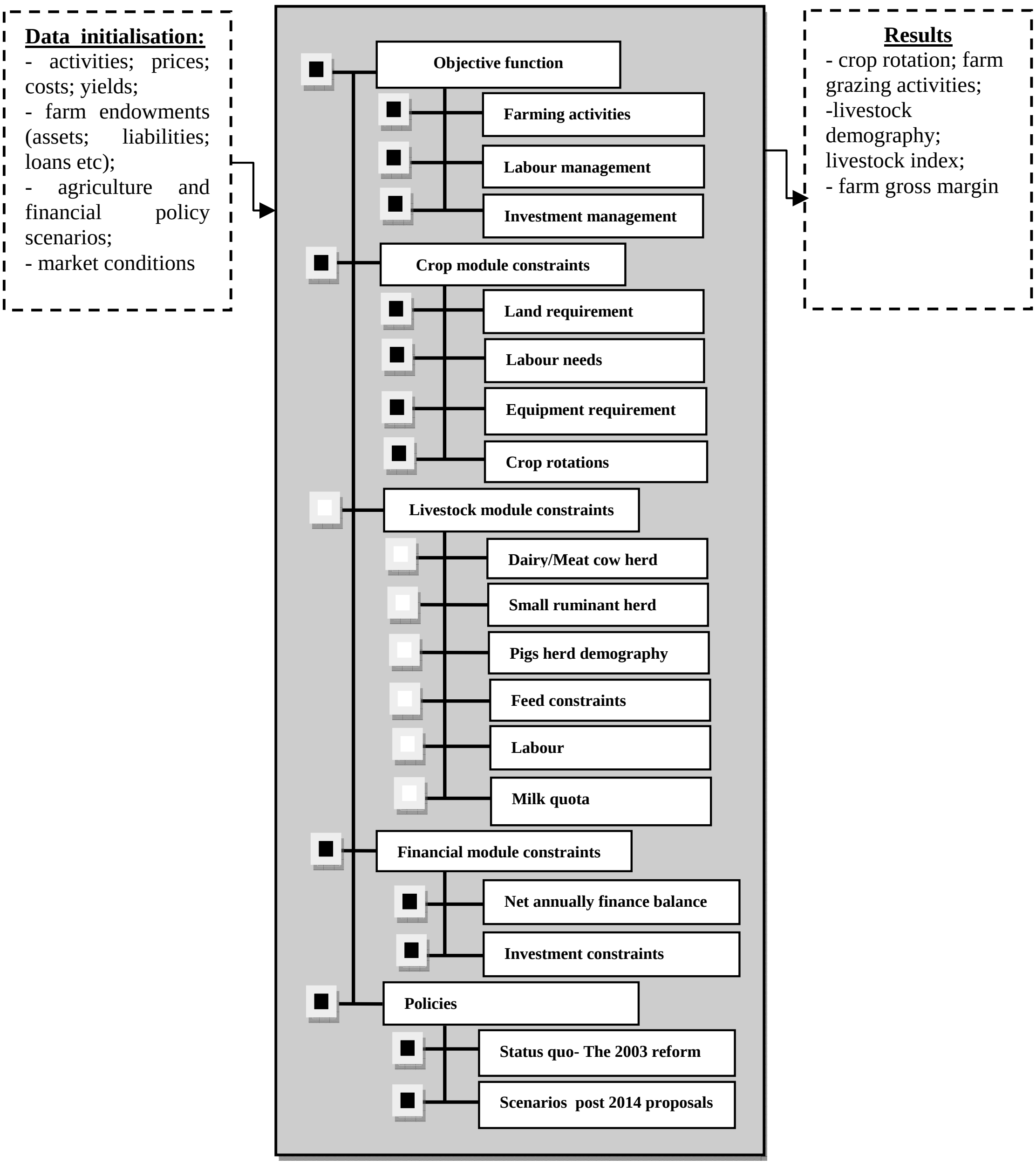

Figure 1. The SIMULCAP description

doi: 10.17221/116/2014-AGRICECON

of time. The long-term credits are used to finance the new investments. The interest costs are part of the objective function and the model accepts an investment only if the annual income value growth is higher than the depreciation rate and the financial spending. A maximum leverage threshold defined by the user according to the financial market situation is introduced to limit the financial external resources possibilities.

The data

The model was tested in the North-Western Romania, one of the eight administrative regions that were created in 1998 to match the level 2 of the European Nomenclature of Territorial Units for Statistics (NUTS2). Within its 34 159 square kilometres, it represents around 14% of the Romanian territory (Figure 2). For the administrative purposes, the region was divided in 6 counties (Bihor, Bistrița Năsăud, Cluj, Sălaj, Maramureș and Satu Mare). Agriculture plays an important economic role here; in 2012, it represented around 16% of the regional GDP (Romanian National Institute of Statistics 2013). The territory is highly environmentally sensitive. Important parts of the region are recognised as the High Nature Value Grassland Areas (more than 30% of the utilised agricultural area) or Mountain Areas (European Commission 2009b).

Data was collected from an independent survey applied by face-to-face interviews between January and September 2011 in farms specialised in the mixed-sheep production. The optimal survey size in a stratified sample without replacement, for a maximum error limit of 5% and a probability to guarantee the results of 95%, was established to 207 farms (Jitea et al. 2011). It had several strata, such as the county and the physical farm size expressed in the number of the mother sheep with a minimum threshold of 50 sheep, to take into account the moment when they become eligible for subsidies. The farms were randomly identified based upon the Romanian National Agency for the Payments database. The questionnaire contains a list of well-structured questions divided into six sections. The first one provides data about the farming type, the altitude where the farm is located and the legal status. The second draws up a deep image of the individual household socio-economic situation: the number of persons and their age, the relative degree between them and the labour resources (time devoted to agricultural activities inside the household or to other remunerated activities). The third and the fourth parts collected data about the assets and the liabilities: the land disposal, buildings, tractors and machineries, animals and the working capital. The last two sections present the farming techniques, revenues and expenses both in the crop (the fifth part) and in the livestock sector (the six one).

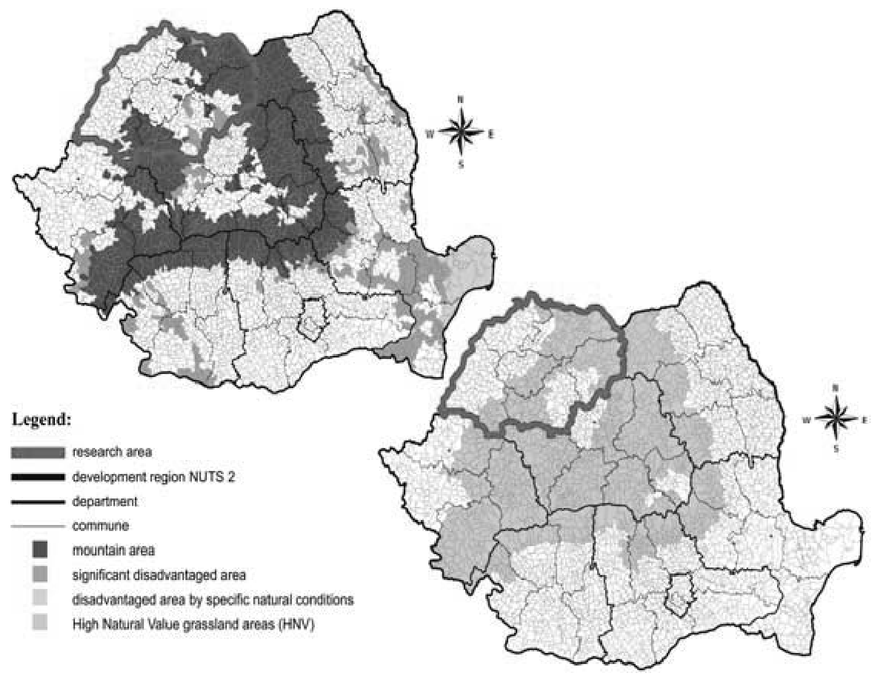

Figure 2. The study area

doi: 10.17221/116/2014-AGRICECON

The data was processed in the SPSS 11.1 (Statistical Package for the Social Sciences) in order to initialise the model. A hierarchical cluster analysis using the Ward's algorithm identified 12 homogenous farm classes (clusters) in the overall sample (Table 1). The *k*-means algorithm used to distribute them into classes created seven groups that counted for more than 90% of the total number. The most important

Table 1. Significance of the comparison of means by the ANOVA analysis according to the farm cluster membership

Indicators	C.1	C.2	C.3	C.4	C.5	C.6	C.7	*F*-test
Number of farms	36	35	35	35	33	13	9	–
I. Assets and liabilities								
UAA (ha)	23.9	32.4	23.8	94.8	62.9	47.4	210.8	9.035[a]
UAA in property (%)	22.4	16.7	18.0	21.8	15.4	45.3	37.1	6.684[a]
UAA in concession (%)	28.1	39.8	33.4	34.2	56.7	0.00	15.5	3.659[b]
Livestock unit (LSU)	16.7	21.9	16.7	62.3	38.9	71.3	154.6	9.384[a]
Sheep in LSU (%)	72.9	66.4	73.6	92.9	82.4	84.5	84.1	15.572[a]
Cattle in LSU (%)	15.7	27.4	15.3	4.0	12.6	8.7	12.7	14.699[a]
Constructions (Euro/LSU)	87.4	64.8	60.3	81.7	59.7	66.4	268.6	4.527[a]
Tractors (Euro/LSU)	36.4	77.7	25.3	103.2	42.1	51.5	110.4	4.085[a]
Machinery (Euro/LSU)	83.2	41.9	28.9	53.0	41.6	41.4	100.0	2.194[c]
Loans (Euro/LSU)	34.9	57.1	11.5	95.7	0.00	128.1	978.5	93.484[a]
II. Inputs and land livestock index								
Farming family working time AWU/LSU	0.15	0.13	0.17	0.08	0.09	0.08	0.04	8.768[a]
Family household employed outside (AWU/LSU)	0.07	0.03	0.01	0.01	0.02	0.01	0.01	29.68[a]
Arable land (LSU/Ha)	8.5	6.2	24.4	9.2	8.6	15.7	5.7	2.774[b]
Forage crops (% in arable)	26.8	37.8	22.8	36.6	32.8	30.8	74.9	2.024[c]
HNV (% in UAA)	59.0	78.3	90.6	68.9	7.1	0.0	12.3	14.234[a]
III. Revenues								
(1) Revenues (Euro/LSU)	681	673.8	543.4	715.8	517.9	414.9	772.7	11.159[a]
Total subsidies (%)	47.9	55.1	70.7	47.9	50.8	34.5	30.9	22.143[a]
Single area (%)	18.7	19.4	23.3	18.6	26.6	14.4	17.9	14.874[a]
Environmental (%)	13.4	19.7	25.2	16.9	2.0	0.0	0.31	24.366[a]
Lambs sales (%)	14.9	15.2	14.4	27.4	22.4	29.9	23.2	8.144[a]
Cheese sales (%)	8.1	8.4	8.2	17.4	11.1	23.0	11.0	13.271[a]
Revenues from outside (%)	22.6	8.7	2.6	2.8	8.1	0.4	2.0	23.348[a]
Milk sales (%)	0.00	0.7	0.7	0.00	1.7	0.4	22.7	9.409[a]
IV. Costs								
(2) Direct costs (Euro/LSU)	305.3	159.6	327.5	266.4	235.8	219.2	254.2	7.837[a]
Intermediate costs (%)	46.3	42.1	58.3	33.7	35.4	48.4	48.7	5.177[a]
Labour (%)	27.8	9.3	21.0	24.6	26.8	23.1	20.1	3.899[a]
Purchased forage (%)	2.9	15.2	1.9	8.0	10.1	8.9	3.4	7.814[a]

Significant at [a]$p < 0.001$; [b]$p < 0.01$; [c]$p < 0.05$; C1–C7 = Clusters; UAA = Utilised Agricultural Area; AWU = Annual Working Unit

doi: 10.17221/116/2014-AGRICECON

group comprised 36 farms, the second, the third and the fourth had 35 farms each. The last three groups are formed by 33, 13 and 9 farms. The remaining undistributed items represented five clusters from which 3 had only one farm. They were identified as the outliers of the sample.

The ANOVA test showed that there are important differences between the clusters. The first three are relatively small in the physical size (land and livestock), being different in the terms of revenues and costs. The first one obtains important off-farm revenues (22%). The second one has an important dairy cattle production (27% in LSU) and finally, the third utilised important HNV areas (91% of the UAA) being at the same time heavily subsidised (more than 70% from the total income). The last four clusters are relatively big in the terms of size. C1 is the biggest one, with 211 hectares of the utilised agricultural area and 155 livestock units. It is specialised in the sheep milk being the least subsidised (31%). The clusters means (Table 1) were used to initialise the SIMUCAP model.

Policy scenarios

In the policy base line scenario (S_0), the farms could obtain the direct payments available after the Romania joining the EU (Regulation (EU) 73/2009). The single area payment scheme is the first type of the direct subsidy. It is paid once a year for the eligible area and it is conditioned by the farm size and the cross-compliance rules. The minimum farm threshold was established in Romania at one hectare, with plots bigger than 0.3 hectares (Romanian Government 2007). This payment is annually increased by 10% to arrive at the average EU level.

Except this scheme, Romania also uses the coupled top-up payments. They are allocated from the national budget only for the cultivated arable land (Table 2). In the livestock sector, there are available two coupled payments. The first one is received only by the farms that recorded in the reference year at least three dairy cows of more than six months age. The second one is granted to the sheep and goat production. Consequently, a farm that has at least 50 mother sheep or 25 mother goats becomes entitled for payments. From the Rural Development Program, a farm could access four Agri-Environment Schemes (AES) for a five year engagement contract: the high value natural grasslands; the traditional agricultural practices; the meadows important for bird conservation; the green crop productions. The area situated above 600 m of altitude is considered to be the Disadvantaged Mountain Areas, therefore receiving an annual payment equal to 50 Euros/ha.

After 2014, the agricultural policies will face important changes. The payments will be oriented towards the innovation support and the CAP greening (Regulation (EU) 1307/2013). Furthermore, they will be conditioned by reinforced cross-compliance and modulation rules. Different types of schemes will be available. The Member States have to decide how to allocate their budget without exceeding the annual financial envelope and the maximum threshold established for each type of payment (Figure 3). Based on these options, two sets of *a priori* policy scenarios were investigated. The first one (S_2.1) presumes that Romania will finance all types of the payments schemes only from the financial allocation

Table 2. The evolution of different types of direct payments in the base line scenario (Euro per hectare or per livestock head)

Payment type	2010	2011	2012	2013	2014	2015	2016	2017
Single Area Payment	80.36	90	100	110	120	140	160	200
National Complementary Payments (crops) (top up)	50.64	50.64	50.64	50.64	50.64	50.64	40	0
National Complementary Payments (cattle)	97.39	90	90	90	90	90	90	90
National Complementary Payments (goat and sheep)	9.50	10	10	10	10	10	10	10
High Natural Value Grasslands	124	124	124	124	124	124	124	124
Disadvantaged Mountain Area payments	50	50	50	50	50	50	50	50

Source: selective Romanian legislative framework

doi: 10.17221/116/2014-AGRICECON

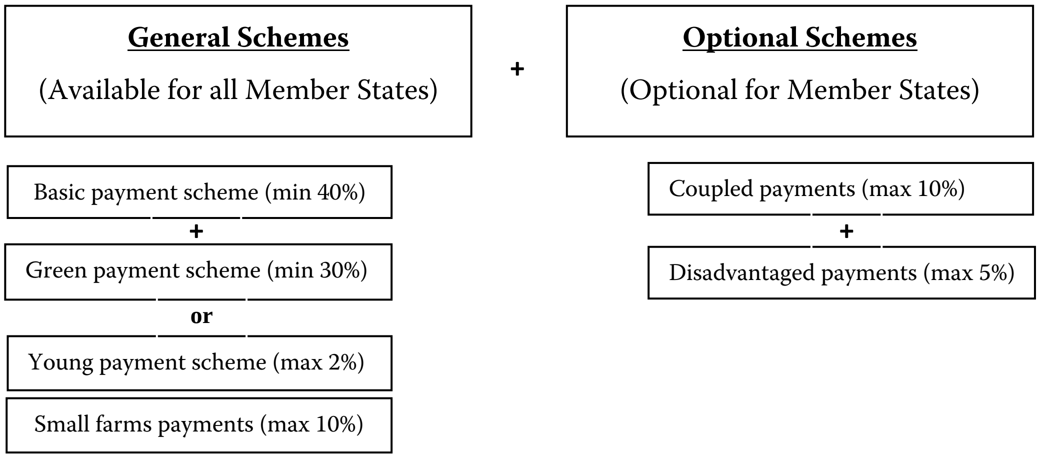

Figure 3. Payments schemes into the first CAP pillar after 2014 together with their financial envelope

of the first CAP pillar (1 475 005 thousands Euros in 2014 for Romania). Moreover, the budget will go to the maximum threshold for all types of schemes.

This approach will diminish the basic payments scheme by more than 50%, in comparison to the actual direct financial support (Table 3). All the other payments (HNV, the disadvantaged and coupled crop payments) will also decrease. In this scenario, no coupled payments are allocated to the livestock sector. The second scenario (S_2.2) supposes to change the funds allocation into the first pillar. The budget will be used to sustain the mandatory schemes (basic-65%, green-30%) and the crop complementary payments (5%) without changing the present eligible area. The AES will arrive at the level observed before the reform.

RESULTS

Simulations were made for an eight year time horizon (starting with 2011, the initialisation year) using the MATLAB 7.1 software. This procedure allows the model to be applicable in other areas or for other research purposes as well.

Crop rotation and the permanent HNV grasslands areas in use

The starting period crop rotation (S_0) was compared with the averages for the eight-year simulation period obtained in the base line scenario (S_0_2019) and the post 2014 agriculture policy scenarios

Table 3. The level of direct payments in different *a priori* policy scenarios (Euro per hectare)

Payment type	Scenario	2014	2015	2016	2017	2018	2019
Basic payment scheme	S_2.1	68	78	88	90	90	90
	S_2.2	103	118	132	136	136	136
Coupled payment (for crop production only)	S_2.1	16	18	20	21	21	21
	S_2.2	8	9	10	10	10	10
Green payments – HNV areas	S_2.1	45	52	58	59	59	59
	S_2.2	124	124	124	124	124	124
Green payments – ecological zones	S_2.1	68	78	87	89	89	89
	S_2.2	68	78	87	89	89	89
Disadvantaged Mountain Areas payments	S_2.1	16	18	21	21	21	21
	S_2.2	50	50	50	50	50	50

Source: own calculations

doi: 10.17221/116/2014-AGRICECON

(S_2.1_2019 and S_2.2_2019). The payment allocation highly influences the farm crop rotation and the permanent grassland areas in use. Under the status-quo policy payments, all clusters that used the HNV permanent grassland tend to increase the meadows share in the overall utilised agriculture area (Cluster 1 up to 4). On the other hand, in Cluster 5 the permanent meadows are substituted by pastures and the farm tends to intensify (Figure 4).

The reduction of the basic payment scheme and the AE payments reduces the meadow areas (Scenario 2.1). There are substitution effects between the HNV meadow areas and the pastures and forage crops. The impact is more important for the small sheep farms with the important HNV areas (Cluster 1 up to 3). If the value of the AE payments increases (Scenario 2.2), then the farms start to use more meadows and pastures showing that these policies' incentives are the important drivers against the land abandonment. The clusters that are relatively big in the terms of the physical size have different responses to the policy scenarios (Cluster 5 up to 7). The AES do not affect

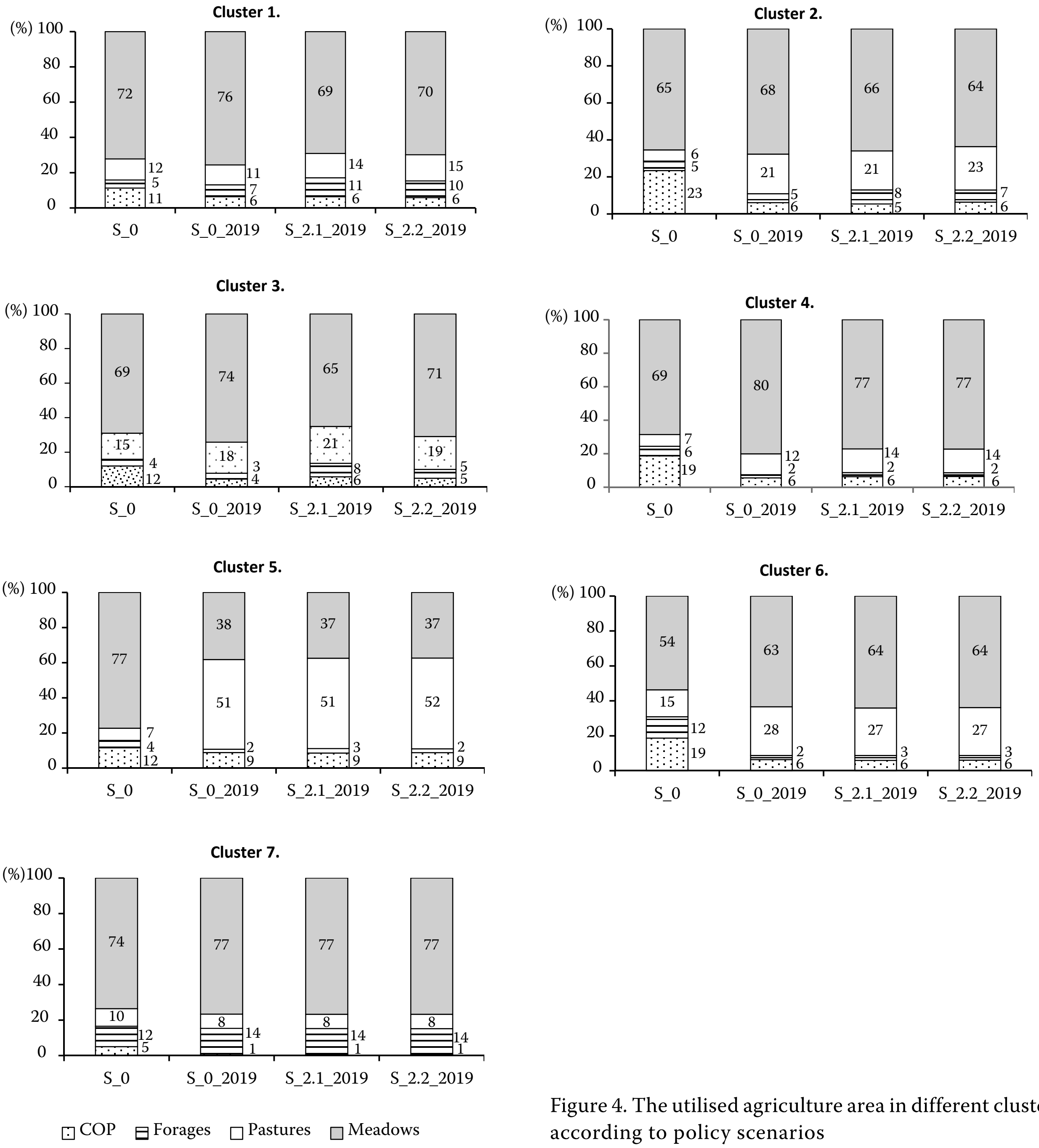

Figure 4. The utilised agriculture area in different clusters according to policy scenarios

doi: 10.17221/116/2014-AGRICECON

the crop rotation. The reduction of the basic payment and the coupled crop scheme diminish the area covered by cereals and oil crops.

Livestock distribution and livestock index

In both *a priori* policy scenarios, the current coupled payments for the livestock production will not be granted starting with 2014 and no dairy milk quota will be in force. Without such payments, all farms will reduce their livestock (Table 4). The most important reductions are observed in the farms that utilised the HNV grassland areas (Cluster 1 and 3). The intensive big size farms (Cluster 6 and 7) are the most stable during such agriculture policy shifts. The livestock index decreases for all farm clusters after implementing the new agriculture policy. Its level remains important enough to assure the minimum uses for the permanent meadows.

Gross margin fluctuation and the investment decision

The analysis of the gross margin fluctuation reveals that the individual farms grouped into Cluster 1 and Cluster 3 will suffer the most important average gross margin loses when the AE payments are reduced according to the Scenario 2.1 (Table 5). Labour released from agricultural activities goes to the off-farm employments. Keeping the AE payment for the HNV grasslands at the same levels as before the reform will not produce any important changes to the farms revenues. The biggest size farms (Cluster 4 and 7) are best prepared to face the new reform. The farm investment capacity is extremely low (Table 6). The model showed that for four farm types out of seven, no investments decision was available in all the three scenarios. Only the biggest clusters invested into the small grass cutting machinery (Cluster 4 and 7).

DISCUSSION

The paper proposes two main methodological contributions. The SIMULCAP model extended the PMP calibration procedure to mixed farming systems (EXPMP_MX) by introducing a livestock activity in the first PMP step. Beside the observed activities from the initialisation year, the model can also incorporate other production possibilities that can be activated by farmers after future agriculture policy shifts. They are initialised by the average farm data taken from the region. The performance of the model can be assessed by its forecasting capacity. Hazell and Norton (1986) indicated that a model which can reproduce the calibration year activity level can be used for the forecasting purposes. All the farm clusters analysed in this paper were well reproduced, proving good forecasting capacities.

The policy scenarios analysed the effects produced after decreasing the basic payments and reinforcing the agri-environment schemes. Also, the coupled subsidies were previewed only for the crop productions. The permanent grasslands areas are reduced especially by small extensive farms that use important labour resources. The livestock production also decreases, especially in the same type size. Similar results were obtained for the extensive German and Poland farming practice (Uthes et al. 2011). This means that the labour intensive farming is in general the most sensitive one to the policy agriculture changes. In Romania, such farms are the keepers of the traditional pastoral practices on the HNV grassland areas very rich in biodiversity (Cremene et al. 2005). Thus, in the future CAP framework, a special attention should be devoted to them.

The most important policy incentives are the AES payments. Their decrease produces the grasslands abandonment and the important farm revenue decreases. Even if there is no commonly accepted definition about the measurement of the farm policy dependency (Offermann et al. 2009), this study highlights the importance of the policy payments' transfer for farms as a percentage of their total income. This relationship provides an image of the contribution of the AES payments compared to other revenues (market or other policy payments). It was shown that the farms using the important HNV grasslands for livestock grazing are the most policy depended ones (C1 up to C3). They are the most vulnerable farming groups to the agriculture policy shifts. Farms sustain their revenues by diversification strategies. Such strategies can only be applied by bigger farms with important financial capital resources, as also pointed out by Meert et al. (2005). The off-farm employment represents another type of the survival strategy (Cluster C1). The mountain area proved to have the most economic vulnerable farms with low outputs sales. Thus, the future Rural Development Program should support alternative economic activities in these areas. Diversification

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Table 4. Livestock distribution in different policy scenarios (mean livestock units)

	C1			C2			C3			C4			C5			C6			C7		
	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2
Sheep	12.6	−11.0	−8.3	18.8	−6.9	−7.0	11.2	−6.3	−5.8	57.1	−10.3	−9.9	37.7	−16.9	−16.6	57.1	−4.4	−4.2	94	−3.7	−3.7
Cattle	5.5	−40.9	−13.6	11.1	−7.7	−6.8	6.3	−32.0	−32.0	10.5	−9.5	−9.5	29.5	−72.9	−72.9	13.8	−10.9	−10.9	142	−5.6	−6.3
Pigs	0.5	50.0	50.0	0.8	0.0	0.0	0.3	0.0	0.0	0.8	0.0	−33.3	1.3	0.0	0.0	1	0.0	0.0	1.5	0.0	0.0
Total LSU[e]	19.4	−17.5	−8.3	30.7	−7.0	−6.7	18.6	−14.5	−14.2	69.3	−10.0	−10.0	69.9	−40.0	−39.9	74.6	−5.4	−5.2	240.5	−4.8	−6.2
LSU/Meadow	0.28	−16.7	0.0	0.45	−4.7	−0.8	0.25	−2.5	−10.2	0.86	−6.6	−6.7	1.8	−38.9	−38.5	1.18	−6.3	−5.9	3.14	−4.9	−6.3

C1–C7 = clusters; B = base scenario; Δ_1 = percentage change in average for Scenario 2.1. as compared with the basic one; Δ_2 = percentage change in average for Scenario 2.2. as compared with the basic one; LSU = livestock units after the EUROSTAT procedure (1 sheep = 0.1 LSU; 1 dairy cattle = 1 LSU)

Table 5. Gross margin in different policy scenarios (eight year mean data)

	C1			C2			C3			C4			C5			C6			C7		
	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2
Gross margin per LSU	334.8	−1.8	−1.3	494.6	−4.5	−0.5	237.9	−12.9	−1.9	468	−6.8	−2.7	181	5.7	6.1	192.0	1.1	1.2	344.5	3.8	4.9
Gross margin per ha	135.3	−11.6	−9.3	153.3	−2.2	−3.6	56.0	0.1	−5.9	120.9	−5.8	−3.4	125.1	−2.1	−0.8	70.0	−0.2	1.6	126.2	−1.1	−0.6

Explanation see Table 4

Table 6. Investment capacity in different policy scenarios –in Euros (eight year mean data)

Investments	C1			C2			C3			C4			C5			C6			C7		
	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2	B	Δ_1	Δ_2
Constructions	1463	0.0	0.0	1085	0.0	0.0	1010	0.0	0.0	1367	0.0	0.0	1000	0.0	0.0	1112	0.0	0.0	4496	0.0	0.0
Tractors	700	0.0	0.0	1800	0.0	0.0	430	0.0	0.0	1800	0.0	0.0	704	0.0	0.0	900	0.0	0.0	2500	−26.1	0.0
Machinery	1500	0.0	0.0	800	0.0	0.0	484	0.0	0.0	900	−5.4	−5.4	695	0.0	0.0	700	−4.2	−4.2	2000	−16.3	0.0
Long term credits	600	0.0	0.0	940	0.0	0.0	150	0.0	0.0	1500	0.0	0.0	0	0.0	0.0	1800	0.0	0.0	18000	−16.7	0.0

Explanation see Table 4

doi: 10.17221/116/2014-AGRICECON

towards new agriculture activities or the agro-tourism is seen all around Europe as a viable strategy for the small farms survival (Hjalager 1996).

CONCLUSION

This analysis has examined the outcomes of the post 2014 CAP reform in an environmental vulnerable area from a NUTS 2 Romanian region. A bio-economic model was built to evaluate the consequences of different policy scenarios. It was initialised by the data collected from 207 farms after an independent survey. The results show that the most vulnerable groups of farms in the terms of the agricultural policy changes are those coming from the environmentally sensitive areas (HNV grasslands). Without the AE payments, their economic sustainability is threatened, which can lead to the land abandonment that can ultimately affect the biodiversity. For the future agriculture policy, special programs have to be created for the farms that maintain the traditional, low intensive farming techniques.

Acknowledgment

The research is part of the scientific project financed by the Romanian National Council of Scientific Research with the title “Assessing the impact of the Common Agricultural Policy reform in Romania using a simulative approach” (post-doctoral fellows PN II – project No. 190/2010).

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Received: 6th August 2014
Accepted: 11th September 2014

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