ANIMAL WELFARE COSTS AND BENEFITS IN MILK PRODUCTION

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Abstract

Common Agricultural Policy (CAP) in European Union changes dynamically. Modifications are often connected with environmental aspects, e.g. environmental externalities, and involve some influence on economic results and production organization. Therefore, research was conducted to determine that impact at the example of animal welfare in milk production. Optimization model was constructed using Positive Mathematical Programming method. It was found, that possible changes in revenues, costs and results are both positive and negative and depend on basic production method and production scale.

Key words: *common agricultural policy, externalities, animal welfare, milk farms, economic outputs*

INTRODUCTION

Externalities occur when producing or consuming goods and services causes an impact on third market-participants without there being any compensation for that third market-participant and without any direct relation to the transaction costs and prices. Externalities are an important factor in a cost and benefit analysis. They can either be positive or negative and can occur from production or consumption. (Business Dictionary n.d.; Economics Help n.d.).

In case of livestock production in agriculture it can be talked about agricultural landscape, biodiversity, carbon dioxide and methane emission, unpleasant odor and animal welfare, all called environmental externalities. This paper is focused on animal welfare as the example of externality, which is under significant political and social interest since many year, especially in European Union (EU) Common Agricultural Policy (CAP).

The initial aim of the CAP, developed in 1950s, was to address food security issues arising from the Second World War. European citizens suffered from the damages made by years of the war, agriculture was crippled and food supplies was insured (European Commision n.d.). The first task for policy makers was to encourage better productivity, ensure fair standard of living to the agricultural community and, at the same time, the availability of food supplies to the EU consumers at reasonable price. Therefore, a system of high support prices to farmers was implicated. It was connected with production level and it functioned well during next few decades.

However, in 1980s, another issue occurred. A deficit in European food production no longer existed and the negative environmental and economic impacts of the production surplus were recognized (Commission of the European Communities 1991). EU member countries were well-developed enough to take care not only about the amount of the production, but also about the food quality and other aspects like environmental-friendly farming, farm diversification, externalities, public goods etc. The MacSharry Reform in 1992 replaced price supports with direct payments to farmers shifting CAP from product support (through prices) to producer support (through income support). The reform aimed to improve the competitiveness of EU agriculture, stabilize the agricultural markets, diversify the production and protect the environment, as well as stabilize the EU budget expenditure (European Commision n.d.). Through that reform the first animal welfare requirements were implemented within the legal directive in the EU.

Later, in 2000 so-called “Agenda 2000” gave concrete form to the European Model of Agriculture – family, environmental-friendly farming. Three years later, the Luxemburg CAP reform introduced a radical rebuilding of the CAP, with important innovations such as introduction of the 'cross-compliance' requirements and continuous process of shifting direct payments from production to

"single farm payment" (Barnes et al. 2016, p. 1). Animal welfare requirements were included in the 'cross-compliance' regulations. Their fulfillment determines, among others, receipt of direct payments to farmers. In 2015 additional environmental requirement were added to the CAP, the process of "CAP greening" is continuously progressing and the discussion about further animal welfare standards upgrading is still current at the forum of European Commission as well as among consumers and NGO organizations.

Animals have been used by people for centuries what in effect led to change of their natural environment. Animal welfare has been defined in many ways, for example as a state in which animals are able to adapt to their environment (Broom 1996) and live in the harmony with it (Hurnik 1995 after Pisula 1999). It is also defined as animals' feelings (Duncan 1996). All those definitions base on animals' rights to be treated humanely in accordance with their nature and natural environment (Benson & Rollin 2004).

Provisions related to animal welfare are perceived rather as farm development constrains, because of imposing an additional restrictions and obligations for farmers. Results of numerous studies indicate, that upgraded animal welfare standards can increase livestock production costs by 5-30% (Blandford 2006; Bennett 1997 after Mitchell 2000). However, there are also some advantages from those requirements like higher prices for products (Kołacz 2000) and benefits in production characteristics and efficiency, as well as increase in amount of production (Kołacz 2006). It was found, that cows treated gently produce 600 kg milk/year (13%) more than animals treated brutally (Walczak 2005). It raises important implications for the economics of farms (Lewandowski 2008a), however, an overall impact on farms income is not always clear and is not sufficiently explored in the available literature. There are many articles describing the impact of selected welfare parameters on the health and productivity of animals, but only a few publications refer to the economic performance and farms' income.

The aim of the paper is to determine the impact of possible further modifications of the CAP associated with externalities at the example of animal welfare in milk production[1].

1. EXTERNAL EFFECTS IN AGRICULTURAL PRODUCTION

The concept of externalities in economic theory derives from Alfred Marshall, but his understanding of this concept was different from today (Stankiewicz 2007). Based on the definition proposed by Meade (Meade 1952), which is much more similar to the current one, and generalizing it to all market-participants it can be assumed that externalities occur when the production efficiency or utility level of a single market-participant depends on the actions of another one and when that influence has a nonmarket nature. There are external benefits and external costs. If one market-participant's possibilities increase as a result of another one's actions (under condition, that there is a nonmarket relation) external benefits arise if these opportunities decrease there are external costs (Graczyk & Kociszewski 2013).

The importance of externalities occurs from the widely understood social welfare point of view, because privacy optimum differs from the social one when there are external effects. Standard economic calculation does not take into account externalities, and thus does not cover all costs and benefits. If it does the optimal level of production would be shifted. With positive external effects the optimal production level is higher than with the standard economic calculation, whilst with the negative externalities lower than it. Zegar (2011) drew attention to the fact that that problem also applies to the issue of the competitiveness of agriculture - the economic and social ones are not the same and not the same as to the level.

[1] Paper founded: Program Wieloletni 2015-2019 IERiGŻ - PIB, zadanie badawcze "Ekonomiczna wycena efektów zewnętrznych i dóbr wspólnych w rolnictwie"

Scitovsky (1954) distinguished four types of direct interdependence depending on who generates external effects, and who is the recipient:

- level of consumer's utility may depend on other consumers actions;
- level of consumer's utility may depend on producers activity;
- results achieved by producers may depend on consumers actions;
- results achieved by the manufacturer may depend on other producers activity.

In case of agriculture, farmers as a producers generate externalities, while consumers and other stakeholders using environmental resources associated with agriculture are their recipients. Consequently, there are relations of the third and the fourth type mentioned above. As a result, agriculture affects the utility level and production of those market participants which are even only indirectly related to it, regardless of whether they are staying in rural areas or not. According to Kociszewski (2013) in case of agriculture, there are external ecological costs and external environmental benefits. While conventional farming, intensive livestock production generate mainly external costs, organic extensive farms, especially those situated in the environmentally valuable areas, generate mostly external benefits. However, although external benefits are bigger and external costs limited in case of ecological farming in comparison to the conventional one, it is a kind of abuse to argue that conventional agriculture produces mainly environmental costs. Analyzing cattle breeding, several external benefits can be indicated, e.g. agricultural landscape preservation, landscape diversity, and animal welfare. Zegar (2010) emphasizes, that it is precisely the positive external effects that are particularly important in case of agriculture, because agriculture produces not only market goods, but also in addition to that, a range of goods that are not the subject of market transactions.

Animal welfare has a number of features which indicate that it is included to the category of externalities:

- it is not a part of a farm economic calculation;
- its level is not reflected in the level of prices of agricultural products;
- it is not the main objective of the farming;
- its level affects consumers in a way other than the price.

Consumers express interest in conditions in which farm animals are kept and want animals to be treated humanely (Reklewski 2003; Szücs, Jezierski & Kaleta 2007; Cozzi, Brscic & Gottardo 2008; Kehlbacher, Bennett & Bakombe 2012). Therefore, it can be stated, that higher welfare level contributes to increased utility of stakeholders, including consumers. However, there is no direct link between these expectations (from consumers side), animal welfare level (from producers side) and economic calculation, including prices. That is the main argument confirming that farm animals' welfare is an example of external effects, in this case – external benefits.

It should be emphasized that there is an impact of different regulations on externalities generation by agriculture. As stated Kociszewski (2013), external benefits generation was increased and external costs generation was decreased as a result of agro-environmental program implementation. This follows from the nature of the program, which involves meeting certain minimum requirements (cross-compliance) in agricultural production. Author of this paper agrees with this position. In relation to animal welfare, introducing higher maintenance standards in livestock production contributes to increased welfare level and the same too increased external benefits generation.

2. MATERIALS AND METHODS

Data was collected using an interview questionnaire in 2011 in Mazowieckie province among milk producers. Twelve deliberately chosen farmers (called "model farms" in this paper) were interviewed. Selected farms fulfilled all present welfare requirements and represented different rearing systems.

Based on obtained data the optimization models (one for each studied farm) with non-linear cost function was constructed using the Positive Mathematical Programming (PMP) method. The net farm income was the objective function and production parameters, such as number of cows or land use, were varieties. Models were solved for two scenarios:

- base – models solved for basic conditions;
- welfare – model solved for conditions assuming upgraded welfare standards.

Models "welfare" were solved for the same point in time as the models "base" and assume the following changes in welfare standard in relation to the current regulations:

- minimum 60% of roughage in daily feed ration,
- calves fed with natural milk for at least 5 days after birth,
- avoidance of horn removing without anesthesia,
- bedding material in lying area,
- avoidance of slotted floors,
- avoidance of continuous tethering: loose housing system or tied system with daily access to the open run,
- minimum space in a cowshed per one adult cow - 5 m2,
- feeding with green fodder in summer period: access to pasture or feeding with green fodder on an open run (combination of both methods allowed).

Parameters adopted in the models, such as yields, farm resources, herd structure, production parameters, inputs, as well as parameters related to upgrading welfare standards were estimated basing on data received from interviews, results of the EconWelfare Project[2], experts opinions and literature review. The parameters were individually adaptem to each model farm.

Further analysis was based on a statistical analysis of obtained results. Farms were divided into groups according to selected parameters associated with animal welfare: cowshed type and usage of pasture.

3. RESULTS AND DISCUSSION

Implementing upgraded animal welfare standards causes with some significant changes in the organization of model farms. New stricter norms, especially connected with avoidance of continuous tethering and feeding with green fodder in summer period, enforce almost each model farm to adapt to new conditions. In case of five farms there is a need to build an open run and in case of four farms there is a need to modernize a cowshed. That changes are caused by the requirement of avoidance of continuous tethering. In order to fulfill another requirement - feeding animals with green fodder in summer period, another three farms implement pasture during grassing season and four provide cows with green fodder at the open run. In case of a few farms two or three changes are necessary. All changes cause significant consequences to model farms.

Table 1. Shows production parameters characterizing model farms depending on the cowshed type.

[2] Econ Welfare - Good animal welfare in a socio-economic context: project to promote insight on the impact for the animal, the production chain and society of upgrading animal welfare standards

Cowshed type, scenario		Number of cows	Land use (ha)	Production of milk (liter)	Sale of milk (liter)	Milk yield (liter/cow)	Culling rate (%)
Tied housing system	Base	34	32,5	208 564	204 456	5 695,6	11,6
	Welfare	34	35,3	216 635	212 611	5 758,9	11,2
	Change (%)	0,0	8,6	3,9	4,0	1,1	-3,6
Loose housing system	Base	58	52,0	469 391	467 269	8 276,3	19,3
	Welfare	58	55,7	456 087	453 632	8 010,3	18,6
	Change (%)	0,0	7,1	-2,8	-2,9	-3,2	-3,5

Table 1. Production parameters characterizing model farms depending on the cowshed type

Source: own study

The average number of cows does not change in analyzed "welfare" scenario for both groups of farms, however the area of land used increase – in case of farms with tied housing system by 8,6% and by 7,1% in case of farms with loose housing system. Significant differences between groups of farms occur in the parameters: production of milk, sale of milk and milk yield. In case of farms with loose housing system these parameters decrease by about 3%, while in case of farms with tied housing system increase by about 4.0% (milk yield by 1.1%).

In case of farms with tied housing system it is clearly showed, that higher animal welfare can cause with positive impact on animals' health and productivity. These results confirm the results of studies reported in the literature (Kołacz 2006; Słoniewski 2005a, 2005b). Providing animals with access to pasture or open run would lead to improved health status of animals due to limitation in negative effects of year-round housing, e.g. predisposition to various diseases and behavioral changes, increased stress levels (Lewandowski 2008b; Sossidou 2007) and consequently to achieve better production results due to e.g. lower milk loss as a consequence of mastitis (Miciński 2015) and calves deaths reduction [Flower & Weary 2001; Weary & Chua 2000].

The significant decrease in milk yield in case of farms with loose housing system is due to a higher level of production intensity. Loose housing system is reasonable only for farms with bigger herds (and so it is the study described) and consequently characterized by better production parameters e.g. milk yield. The milk yield in base scenario is 5 600 liters per cow in case of farms with tied housing system and 8 300 liters per cow in case of farms with loose housing system. Production results obtained by cows with higher milk yield kept under intensive production are more sensitive to changes in feeding and housing.

Revenues and costs level as well as production laboriousness in model farms and its changes in the analyzed "welfare" scenario depending on the cowshed type are presented in table 2.

Cowshed type, scenario		General revenues (PLN/cow)	Revenues from milk sales (PLN/cow)	Direct costs (PLN/cow)	Direct cost of production of 1 liter of milk (PLN)	Production laboriousness (h/100 liters)
Tied housing system	Base	10 373,85	7 614,78	2 690,72	0,474	2,65
	Welfare	10 668,28	7 695,70	2 707,78	0,471	2,80
	Change (%)	2,8	1,1	0,6	-0,5	5,6
Loose housing system	Base	14 158,48	11 595,13	3 675,06	0,447	0,93
	Welfare	13 845,07	11 182,95	3 748,40	0,470	1,08
	Change (%)	-2,2	-3,6	2,0	5,2	16,8

Table 2. Revenues, costs and production laboriousness in model farms depending on the cowshed type

Source: own study

Economic parameters increase in case of farms with tied housing system and decrease in case of farms with loose housing system. The changes direction is the same as in production parameters. Veterinary costs are reduced due to improved animals' health and revenues are improved due to higher milk yield – those advantages exceed costs of introducing upgraded welfare standards in case of farms with tied housing system. On the contrary, in case of farms with loose housing system the health improvement is not as significant, whilst negative aspects of introducing stricter welfare standards e.g. increased production costs and laboriousness are more visible. Production costs increase because of the cost of green fodder delivery and higher labor costs, the decline in milk production is due to the less intensive summer feeding and increased amount of movement.

The benefits of improved welfare are higher than its costs in farms with tied housing system, while in farms with loose housing system the proportions are reversed. In case of the second group animals are provided with better conditions at the starting point, therefore advantages are not as significant as in case of farms with tied housing system, whereas adverse changes in production costs are more reflected. Also, production laboriousness increases significantly more in that group of farms. According to the literature upgrading welfare standards can contribute to an increase in production costs by 5-30% (Blandford 2006). Results obtained in the study confirm that thesis in case of some farms.

Similar conclusions can be derived by analyzing numbers in table 3, which show the economic results of agricultural production in model farms depending on the cowshed type. Economic results increase in case of farms with tied housing system and decrease in case of farms with loose housing system – the same as in case of production and economic parameters.

Cowshed type, scenario		Gross margin (PLN/farm)	Gross margin (PLN/cow)	Net farm income (PLN/farm)	Net farm income (PLN/cow)
Tied housing system	Base	281 743,80	7 683,13	147 818,09	4 162,75
	Welfare	294 374,70	7 960,50	149 445,74	4 181,65
	Change (%)	4,5	3,6	1,1	0,5
Loose housing system	Base	603 284,90	10 483,42	335 530,57	5 790,23
	Welfare	582 039,70	10 096,67	308 548,99	5 292,87
	Change (%)	-3,5	-3,7	-8,0	-8,6

Table 3. Economic results of agricultural production in model farms depending on the cowshed type

Source: own study

Table 4 shows the average cost of investments needed to carry out in the groups of farms. The average value of investments in farms with loose housing systems is lower than in the farms with tied housing systems by 23.3%. The difference is much bigger when the values are calculated per one stall – it is lower by 80,1% in case of farms with loose housing systems due to higher average number of stalls. As it was mentioned, loose housing system is more popular among farmers possessing bigger cattle herds, therefore the investment cost is divided into larger number of stalls. In addition to that, the value of the investment is significantly lower, because those cowsheds are usually relatively new and do not require to be modernize. Necessary investments are limited to the open runs building or land purchase.

	Tied housing system	Loose housing system
Investment cost (PLN/farm)	75 000	57 500
Investment cost (PLN/stall)	2 486,24	494,44

Table 4. The average cost of investments needed to carry out in model farms depending on the cowshed type

Source: own study

Another factor used to divide model farms into groups is usage of pasture. There are considerable differences in the possible changes that occur in model farms in the analyzed scenario between farms that use and do not use the pasture in “base” scenario.

Table 5 shows production parameters characterizing model farms depending on usage of pasture. A different direction of changes in the production of milk and milk yield is the most important difference between the two groups of farms separated due to usage of pasture. In case of farms which do not use pasture in “base” scenario there is a decrease in milk production and milk yield in analyzed “welfare” scenario. It is due to two new requirements: avoidance of continuous tethering and feeding with green fodder in summer period. Higher dose of movement, slightly less intense feeding during grazing season and periodic changes in feeding system (from winter to summer one) lead to reduction in milk yield in this group of less than 1%. In case of farms which use pasture in “base” scenario there is an increase in milk production due to the changes in number of cows. In case of farms which do not use pasture in “base” scenario it is reduced by 2.0%. This is a consequence of increased workload and reduced number of stalls in cowsheds. However, in the group of farms which use pasture in “base”

scenario the number of cows increases in analyzed "welfare scenario" by 9.4%, as a result of investments and development of some farms.

Pasture („base" scenario), scenario		Number of cows	Land use (ha)	Production of milk (liter)	Sale of milk (liter)	Milk yield (liter/cow)	Culling rate (%)
Yes	Base	32	33,9	178 766	174 141	5 119,0	11,4
	Welfare	35	37,9	200 162	195 471	5 137,9	10,6
	Change (%)	9,4	12,0	12,0	12,2	0,4	-6,8
No	Base	49	35,2	344 024	361 126	7 466,5	15,6
	Welfare	48	37,1	335 146	347 406	7 402,1	15,4
	Change (%)	-2,0	5,3	-2,6	-3,8	-0,9	-1,5

Table 5. Production parameters characterizing model farms depending on usage of pasture.

Source: own study

The numbers given in table 6 show revenues, costs and laboriousness of production in model farms depending on usage of pasture.

Pasture („base" scenario), scenario		General revenues (PLN/cow)	Revenues from milk sales (PLN/cow)	Direct costs (PLN/cow)	Direct cost of production of 1 liter of milk (PLN)	Production laboriousness (h/100 liters)
Yes	Base	9 820,70	252 047,01	2 331,69	0,460	3,26
	Welfare	10 076,34	284 250,47	2 346,66	0,470	3,32
	Change (%)	2,6	12,8	0,6	0,1	1,8
No	Base	12 727,12	512 782,80	3 482,08	0,472	1,28
	Welfare	12 749,95	492 317,05	3 529,02	0,480	1,50
	Change (%)	0,2	-4,0	1,3	1,8	17,9

Table 6. Revenues, costs and production laboriousness in model farms depending on usage of pasture.

Source: own study

Less favorable changes in the revenues and costs in case of farms which do not use pasture in "base" scenario than the opposite ones can be observed. In that group of farms there is a reduction in value of revenues from milk sale, much lower increase in total revenues and higher increase in direct costs. This is due to the specific nature of farms which do not use pasture in "base" scenario. Pasturage during summer season is more popular among small and medium farms, whereas among farms which do not use pasture there are much larger farms. Those farms do not use pasturage due to organizational problems and far distance between fields and farm center. The increase in direct costs of production is due to an increase in labor's and other factors' costs to provide animals with green fodder in a situation where there is no possibility of pasturage. Similarly, an increase in production laboriousness is several times higher in case of farms which do not use pasture in "base" scenario than the opposite ones. It is also due to the fact that among this group there are larger farms, in which an increase in

workload is greater than in small and medium farms, due to higher workload at fulfilling new feeding requirements.

Table 7 shows economic results of agricultural production in model farms depending on usage of pasture. The conclusions that can be drawn are consistent with those resulting from the analysis of revenues and costs. In analyzed "welfare" scenario there are less favorable changes in case of farms which do not use pasture in "base" scenario than the opposite ones. Both gross margin and net farm income decrease, while in the second group of farms its growth can be observed, due to the reasons described in case of production and economic parameters (see table 5 and table 6).

Pasture („base" scenario), scenario		Gross margin (PLN/farm)	Gross margin (PLN/cow)	Net farm income (PLN/farm)	Net farm income (PLN/cow)
Yes	Base	261 248,02	7 489,01	158 701,62	4 584,31
	Welfare	289 270,14	7 729,68	168 594,54	4 676,51
	Change (%)	10,7	3,2	6,2	2,0
No	Base	459 594,22	9 245,04	232 604,72	4 625,19
	Welfare	442 461,03	9 220,93	213 040,03	4 324,87
	Change (%)	-3,7	-0,3	-8,4	-6,5

Table 7. Economic results of agricultural production in model farms depending on usage of pasture.

Source: own study

According to numbers presented in table 8 on the average cost of investments needed to carry out in model farms depending on usage of pasture, the capital expenditures are lower by about 50% in case of farms which do not use pasture in "base" scenario. This is due to the fact that in the majority of farms from that group there already is a loose housing system or an open run in "base" scenario, what significantly reduces the cost of the necessary modernization.

	Pasture („base" scenario)	No pasture („base" scenario)
Investment cost (PLN/farm)	98 750	48 000
Investment cost (PLN/stall)	2 897,98	1 147,22

Table 8. The average cost of investments needed to carry out in model farms depending on usage of pasture.

Source: own study

CONCLUSIONS

Common Agricultural Policy of European Union changes dynamically and there were several reforms, that implemented additional environmental-friendly requirements within the legal directive, among others in order to support the generation of environmental public goods and positive externalities by agriculture. It may result in significant consequences for the farms economy. That influence was analyzed at the example of implementing higher animal welfare standards in milk production. Animal welfare requirements were included in the 'cross-compliance' regulations. Their fulfillment determines, among others, receipt of direct payments to farmers. In 2015 additional environmental requirement were added to the CAP and the process of "CAP greening" is continuously progressing

and the discussion about further animal welfare standards upgrading is still current at the forum of European Commission as well as among consumers and their organizations.

It was found, that further animal welfare standards upgrading would lead to significant changes both in organization and economic outputs of the farms. There are significant differences between groups of farms separated by the cowshed type in parameters such as production of milk, sale of milk and milk yield. In case of farms with loose housing system these parameters decrease by about 3%, while in case of farms with tied housing system increase by about 4.0% (milk yield by 1.1%). In case of farms with tied housing system it is clearly showed, that higher animal welfare can cause with positive impact on animals' health and productivity, whereas in case of farms with loose housing system costs associated with it are higher than benefits. Also economic parameters, e.g. revenues, costs, gross margin and net farm income increase in case of farms with tied housing system and decrease in case of farms with loose housing system confirming previous conclusion.

A different direction of changes in the production parameters, like production of milk and milk yield is also the most important difference between the two groups of farms separated due to usage of pasture. In case of farms which do not use pasture in "base" scenario there is a decrease in milk production and milk yield in analyzed "welfare" scenario. It seems that there are less favorable changes in case of farms not using pasture. It is confirmed by changes in the revenues, costs, gross margin and net farm income. In that group of farms there is a reduction in value of revenues from the milk sale, much lower increase in total revenues and higher increase in direct costs. This is due to the specific nature of farms which do not use pasture in "base" scenario. Pasturage during summer season is more popular among small and medium farms, whereas among farms which do not use pasture there are much larger farms. Those farms do not use pasturage due to organizational problems and far distance between fields and farm center.

Summarizing, it was found, that economic consequences are both positive and negative depending on the conditions from the "base" scenario. In case of all farms there were costs as well as benefits and the final results differ significantly. That shows the need of further studies in that field.

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