

Beef production based on a suckling system as an alternative to milk production at the example of Polish Red cattle*

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The population of Polish Red (PR) cattle systematically decreases because of its low milk production. However, there are farmers, who are interested in keeping PR cows in the suckling system. The aim of the study was to evaluate different forms of milk and beef production (combination of factors e.g. fattening bulls, heifers raising, milk or beef production) characterizing farm production from the rural economy point of view and to point out the most effective forms of cattle production based on the data of PR cattle. The research was carried out on the example of the farm keeping PR cattle in suckling system.

Linear programming method was used. The economic effectiveness of beef and milk production was examined by optimizing different rearing forms. The goal of the optimization was to maximize the net farm income. Parameters (all data necessary for the calculation of the demand for forage, people and machine work) were established on the basis of The Catalogue of Standards and Norms by Klepacki [1999] and records from farms keeping PR cows for beef and milk production. It was found, that the participation of direct payments in total revenue in case of forms assuming milk production and beef production is 28 and 44%, respectively. Cattle production is responsible for 60% of total revenues in milk production, whilst for 36% in beef production. In the case of the latter, the highest net farm income is possible to achieve in the form, which provides heifers rearing for farm's own needs and for sale (including fattening bulls sold at the age of 24 months). In the case of milk production, the highest net farm income is possible to achieve in the form, which assumes heifers raising only for farm's own needs (excluding fattening bulls). Net farm income amounts to 25 409 E and 28 470 E, respectively,

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while net farm income per cow is respectively 410 E/cow and 499 E/cow. Beef production based on suckling system enables to achieve the income similar to that achieved from milk production though unit profitability is much lower.

KEY WORDS: beef production /economic effectiveness / milk production / Polish Red cattle / suckling system

Active population of Polish Red (PR) cows is currently estimated to be about 2 400 head. According to the Polish Federation of Cattle Breeders and Milk Producers the average milk yield is 3 703 kg/head/year with 4.24% fat and 3.29% protein (2011). Due to such a low milk production and intensification of agriculture, since 1970s the PR cattle population has been systematically decreasing (there were about 2 millions PR cows at the end of 1960s) – Adamczyk *et al.* [2008]. In order to stop that process the system of direct payments was established. The aim of the program is to maintain a stable population of PR cows in Poland. Farmers keeping at least 4 PR cows (registered in the program) receive payments for each cow, which goal is to compensate their lower milk yield. Maintaining a stable population of PR cattle is essential because of their unique characteristics. In addition to the excellent adaptation to local environmental conditions, PR also show strength, high resistance to disease, longevity and relatively small requirements for forage [Adamczyk *et al.* 2008].

Due to low milk production, farmers keeping PR cows are largely dependent on government subsidies. In fact, their decision to maintain that breed is mostly motivated by those payments. In case of lifted or limited subsidies, about 80% farmers would abandon PR cows in favour of breeds that are more efficient and economically profitable [Adamczyk *et al.* 2008].

Some farmers keep PR cows in the suckling system, because milk production is uneconomic. The system has many advantages, such as low labour input, low financial investments needed and possibility to combine with other activities.

In suckling system calves stay with their dams up to 7 months after birth. It is quite popular only in beef production. However, calves are kept with their dams for a period of time in milk production in an ecological or organic farms [Passille *et al.* 2008]. Keeping calves with their dams instead of early separation has rational explanation. Calves separated 14 days after birth show a threefold daily weight gain than those separated one day after birth [Flower and Weary 2001]. There are also other reasons for later calves' separation associated with animal health status [Jóźwik *et al.* 2012]. Calves kept with dams 1 or 4 days instead of 6 hours were characterized by lower rate of illnesses [Weary and Chua 2000].

The aim of this study is to evaluate different forms of milk and beef production from the economic point of view and to point out the most effective forms of cattle production based on PR cattle.

Material and methods

The research was done using linear programming method that is the mathematical form of optimizing function:

$$\text{Max } Z = p'x - c'x - fc$$

where:

Z – objective function value (net farm income);

p – vector of product prices;

x – vector of production activity levels;

c – vector of accounting variable costs;

fc – fixed costs.

The linear models are used to plan the organization of farms or a production system within farms. A simple linear model was used to optimize a crop production pattern in order to meet the nutritional requirements of dairy herd [Wattiaux 2001]. The other application was to anticipate impacts of GMO introduction on production pattern [Maciejczak, Wąs 2008] or to assess a farm income risk within the assumptions of policy reforms in UE [Majewski *et al.* 2007].

The economic effectiveness of beef and milk production was examined by optimizing different rearing forms. The rearing form was defined as a combination of factors (e.g. keeping fattening bulls, heifers raising, milk or beef production) characterizing farm production. Rearing forms considered in the study are shown in Table 1.

Table 1. Rearing forms taken into consideration in this study

Item	Milk production						Beef production based on suckling system			
	form 1	form 2	form 3	form 4	form 5	form 6	form 7	form 8	form 9	form 10
Heifer breeding for sale				x	x	x			x	x
Fattening bulls sold at the age of 7 months		x		x			x		x	
Fattening bulls sold at the age of 24 months			x		x			x		x
Fattening heifers* sold at the age of 7 months							x			
Fattening heifers* sold at the age of 24 months								x		

*Heifers not necessary for herd replacing.

The goal of the optimization was to maximize the net farm income. Resources of the existing farm (called “model farm”) keeping PR cows in the suckling system were taken as limitations into the model. The study excluded farmer’s household and part of the farm devoted to the crop production. The additional revenues from outside the farm and direct payments received for an area not devoted to cattle production were not considered. Parameters were established on the basis of The Catalogue of Standards and Norms [Klepacki 1999] (parameters necessary for the calculation of the demand

for forage, people and machine work), information from the model farm (resources, prices devoted to the beef production, yields of crop production, herd parameters) and information from the other farm keeping PR cows for milk production (milk price and milk yield). Data for 2011/2012. The most important limitations and parameters in the models were:

- resources and main assumptions (500 hectares of agricultural area, 3 full-time employees, no additional part-time employees, no family work, two tractors – mean engine power 55.85 kW, access to all required agricultural machines, no heifers or cows buying, extensive farming);
- herd parameters (calving rate 93%, culling rate: cows 12%, heifers 7%, calves mortality at the age of: less than 3 weeks – 2%, 3 weeks - 3 months – 1%, 3-6 months – 1%);
- milk sales: 3 3250 kg year/cow;
- prices (milk 0.31 E/litre, bulls 1.98 E/kg of live weight, culled cows and heifers 370.37 E/head);
- yields (hay 3.2 t/ha, silage 14 t/ha, fodder 17 t/ha, barley 3.5 t/ha);
- direct payments including those for less-favoured areas (crop area 308.35 E/ha, forage area 338.46 E/ha);
- revenues (subsidies, revenues from cattle production);
- costs (e.g. fuel, salary, veterinary treatment, depreciation, taxes).

Results and discussion

It was found that both milk and beef production were effective from the economic point of view. The model farm currently produces within the assumptions of the form 10. There is a beef production based on the suckling system, heifers are reared for farm's own needs and for sale, whereas fattening bulls are sold at the age of 24 months. The model solution shows, that the optimum¹ number of cows is 62 and optimum land area is 169 ha. The revenues possible to achieve from the farm as a whole is 126 963 E including subsidies – 74 096 E (63%). The value of revenues per cow is 2 048 E. It consists of subsidies (911 E/cow – direct payments, 284 E/cow – cow payments) and revenues from cattle production (853 E/cow – sales of animals). Cost of production amounts to 101 554 E. Therefore, net farm income possible to achieve amounts to 25 409 E.

The level and structure of earnings in various rearing forms are shown in Figure 1. The highest revenues in case of milk production are possible to achieve in the case of forms 1 and 2 (heifers raised for own needs, no fattening bulls – form 1, or fattening bulls sold at the age of 7 months – form 2), while in case of beef production in the forms 9 and 10 (suckling system, heifers raised for own needs and for sale,

¹The optimum number of cows is defined as a number of cows, which gives the highest net farm income in each form with the limitations of farm's resources.

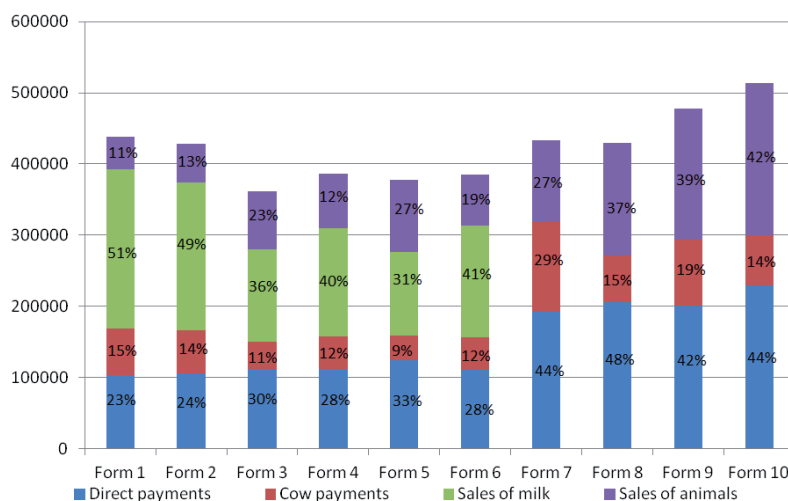


Fig. 1. Level and structure of revenues in various rearing forms.

fattening bulls sold at the age of 7 months – form 9 or at the age of 24 months – form 10). Furthermore, there is a possibility to achieve higher revenues in case of forms assuming beef production (forms 9 and 10) than in case of forms assuming milk production (forms 1 and 2). It is a result of higher direct payments due to higher land usage. The mean revenues from cattle production in the forms 1 and 2 are much higher than in the forms 9 and 10. The difference is about 16 550 E. Total revenues in the forms 1 and 2 are lower than in the forms 9 and 10, because of lower land use – 77 ha compared to 158 ha (Tab. 2). Achieved direct payments are twice as high in the forms 9 and 10 than in the forms 1 and 2. The share of direct payments in total revenue is respectively 43% and 24%. Beef production is much more dependent on received subsidies.

The value of revenues per cow in the form 10 is 2 048 E, while in the form 1 – 1 900 E/cow. It consists of subsidies (respectively 911 E/cow and 446 E/cow – direct payments, 284 E/cow – cow payments) and revenues from cattle production (853 E/cow – sales of animals in form 10, 1 169 E/cow – sales of milk and animals in form 1). Average revenues per cow are higher in milk production (2 422 E, forms 1-6) than in beef production (1 586 E, forms 7-10). The difference is even higher when taking into account only revenues from cattle production – 1 439 E and 590 E, respectively. Unit profitability is more than twice higher in milk production.

The participation of direct payments in total revenue in case of all models assuming milk production is 28%, while 44% in case of all models assuming production of beef. Cattle production is responsible for 60% of total revenues in milk production, whilst for 35% in beef production. Total revenues achieved in milk production depend mostly on cattle production, while in the case of beef production depend equally on cattle production and direct payments.

The net farm income, revenues and costs of production in each model solution shows Figure 2. Total costs of production do not differ as much as revenues in each rearing form.

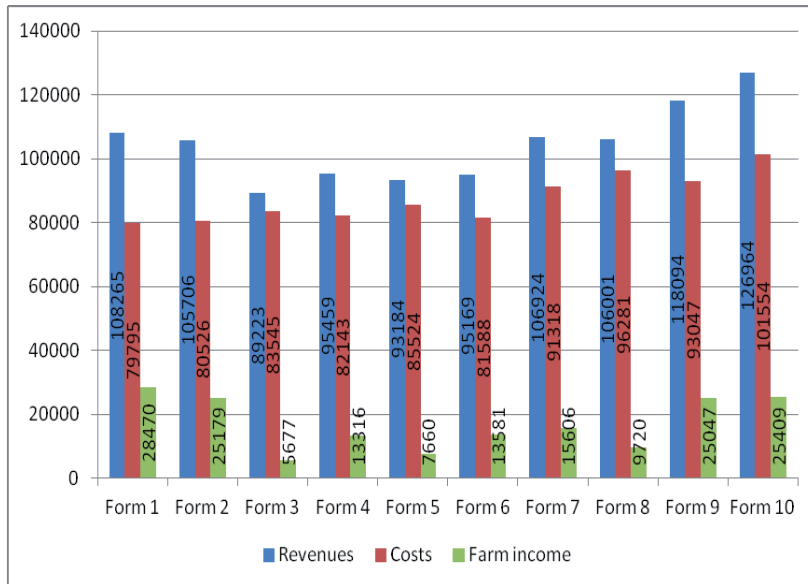


Fig. 2. Net farm income, revenues and costs in various rearing forms.

The average net farm income per cow possible to achieve in case of beef production based on suckling system (forms 7-10) is 281 E. It is in accordance with the study of Hughes [2004], which shows that profit per beef cow is 150 to 300 dollars.

The highest net farm income is possible to achieve in the forms 1, 2 (specialized in milk production – no heifers raising for sale, no fattening bulls or fattening bulls sold at the age of 7 months, called „milk production”) and 9, 10 (specialized in beef production – fattening bulls sold at the age of 7 or 24 months with heifers raised for sale, called „beef production with “heifers raising „) – the same forms as in case of revenues. Net farm income achieved in the forms 3-6 (mixed production – milk sale, but also heifers raised for sale, fattening bulls sold at the age of 7 or 24 months, called „mixed production”) and 7-8 (specialized in beef production – fattening bulls and heifers sold at the age of 7 or 24 months, called „beef production with fattening heifers”) is much lower. The main income in the case of milk production is 26 793 E, whilst in the case of beef production with heifers raising is 26 790 E. It is almost equal and seems to be in contradiction with available literature. Milk production is said to be more profitable than beef production [Spaltabaka 2009]. However, the average net farm income per cow in the case of milk production is 487 E, whilst in the case of beef production with heifers raising – 382 E. Total net farm income is very similar in those forms, but the unit profitability is higher in the case of milk production.

It is in accordance with some earlier studies that found the suckling system to be less profitable than milk production. However, it can still give a satisfactory income [Spaltabaka 2009, Skarzyńska 2009]. Beef production with raising heifers enables to achieve similar income, because of much higher scale of production.

The other rearing forms are much less effective from the economic point of view. The average net farm income deriving from mixed production and beef production with fattening heifers is 11 621 E. It is still high, though much lower. It shows, that the most reasonable way of production in case of PR cattle and other protected cattle breeds, is specialization. However, mixed suckling and milking system remains popular in many parts of the world [Hernandez *et al.* 2006, Combellas *et al.* 2003].

Beef production enables to achieve as high income as milk production only in case of specialization and in higher scale of rearing. Lower unit profitability forces an increase of the production scale. The earlier study found that in France, satisfactory income is possible to achieve in herds of 60 to 100 suckled cows [Wohlgshaft and Hoffmann 1994]. Therefore, for small and medium size farms keeping PR cattle it is reasonable to specialize in milk production. The same number of cows enables to achieve much lower income in beef production. Average net farm income in the case of beef production is 382 E/cow, while in the case of milk production – 487 E/cow. For large farms, like the model farm, it is possible to accomplish significant income both in milk and beef production. A significant advantage of keeping suckled cows derives from the possibility of maintaining much more cows than in milk production, because of lower labour consumption. The unit profitability is much lower, but the volume of herd feasible to keep with limited labour resources is much bigger. Therefore, beef production based on suckling system is a recommended solution for farms with large land resources.

The optimum number of cows and area of land required in each model solution is shown in Table 2.

Table 2. The optimum number of cows and area of land required in rearing forms

Item	Form 1	Form 2	Form 3	Form 4	Form 5	Form 6	Form 7	Form 8	Form 9	Form 10
Cows	57	53	33	39	30	40	109	57	81	62
Area	76	78	83.5	83	92	81.5	141.5	152	147.5	169

The number of cows in each form is significantly different from the others. It is the result of both direction of production and raising form. The mean number of cows captive in the forms which deliver milk production (42 cows) is lower than in the case of forms which deliver beef (77 cows). It is the result of higher labour effort, lower capacity of livestock buildings and differences in volume of other cattle groups. In milk production higher labour inputs are required, because of milking and general care of animals. The rearing form has a significant impact on the number of cows due to the necessity to provide animals from the other groups with space and care. The volume of those groups is remarkably different in the various rearing forms. In

order to achieve a satisfactory income in the suckling system there is a need to keep big herd. It is related to results of the other study reporting that in France the herd of 60 to 100 suckled cows is necessary to reach a satisfactory income [Wohlgshaft and Hoffmann 1994].

Differentiated is also the land area. It is lower in the case of milk than of beef production. The optimum average land area needed for milk production is 82 ha, while 152.5 ha for beef production.

It should be stressed, that the model farm holds a few hundred hectares of land. Outside the beef production there is also a crop production. Therefore, the herd size was not constrained by the land resources in the models. The same situation takes place in the model farm. The herd size is constantly increasing. Land area is being taken from the crop production and dedicated to the cattle production. It was assumed in the models, that the whole farm's land can be dedicated to a cattle rearing. Labour resources were the main factor limiting size of an optimum herd. It is a noteworthy observation. In case of small and medium farms it is often not possible to maintain larger herds of cattle due to the limited land resources. Those farms have large labour resources, but do not use them fully with the remarks on the low land resources. The model farm has high land resources, which may be devoted to the cattle production. In consequence, work but not land was a limiting factor. It should be also stressed, that the research results depend mostly on that fact. Beef production based on the suckling system seems to be effective only with a large scale of production, because of low unit effectiveness. There is no need for a farmer to possess substantial labour resources in order to increase a scale of production. The only indispensable factor is land resources. Therefore, beef production based on the suckling system seems to be a good solution for farms similar to the model farm – with huge land resources.

This study being a comparison of milk production with two systems on the basis of farm keeping of PR cattle indicated that both milk and beef production based on the suckling system are economically effective. The highest net farm income possible to achieve in milk and beef production is comparable. However, a unit economic effectiveness is higher in the case of milk production. In the case of beef production much larger land area is needed and there is a possibility to keep more cows with the same labour inputs. It is a good solution for farmers holding high land resources.

The model farm is currently producing within the assumptions of form 10. There is beef production based on suckling system, heifers are raised for farm's own needs and for sale, fattening bulls are sold at the age of 24 months. It has wide land resources – both milk and beef production is reasonable from the economic point of view in its case. Farmers made a decision to keep PR cattle and produce within the assumptions of form 10. It is one with the highest revenues from forms assuming beef production. Therefore, it was a good decision made by the farmers to produce within that specialized form. In case of any other form there is no possibility to achieve higher revenues for them.

In the case of the model farm, net farm income analysis gave the same conclusions as revenues analysis. When deciding to keep PR cattle in beef production systems, there is no better rearing form, than the one, which is currently in force. There is a possibility to achieve higher net farm income in case of transition to milk production. However, the difference is small.

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