FUNCTIONS OF PERMANENT GRASSLAND IN THE PROCESS OF FEED BASE OPTIMIZATION OF DAIRY FARMS FROM GREAT POLAND REGION

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ABSTRACT
The objective of this paper was the determination of permanent grassland functions at optimization of the feed base of dairy farms in the region of Great Poland using linear programming against the background of newly developing conditions of market economy. The important factor leading to significant improvement of financial situation of farms was finding them a model of cattle feeding based on feed from permanent grasslands. However, permanent grasslands in Great Poland, when compared with arable lands, are characterized, in their models, by a low dual value. This can be attributed mainly to a low milk price and low productivity of permanent grasslands in this region.

KEYWORDS
permanent grassland, feed base, optimization, linear programming

INTRODUCTION
Rationalization of feed production in agriculture farms should focus on natural biological systems taking into consideration elements of economics and protection of natural environment (Torssell, 1994). Unfortunately, this natural system was disturbed in the past in many regions of our country, including Great Poland. Numerous manifestations of this process were frequent plowing under of permanent grasslands for use under arable crops. Consequently, only 14% of arable land area in Great Poland is occupied by permanent grasslands. The tradition of animal grazing has been abandoned so that at present only 10% of ruminant food requirements is covered by pasture sward. This explains why the feed base for ruminants in this region depends heavily on arable land. It is often said that 75% of costs of animal production in Poland are feeding costs. Therefore, in farms specializing in milk production the most urgent problem is that of developing an optimal feed base to improve production efficiency but which, at the same time, would seek to make use of the existing natural biological system. Optimization of the feed base is possible by employing theoretical model solutions which imply improvement of the feed budget in the farm (Brereton and Dillon, 1994). The aim of this study is determination of permanent grassland functions at optimization of the feed base of dairy farms in the region of Great Poland using linear programming.

MATERIALS AND METHODS
Experiments comprised a group of agriculture farms of varying area from the region of Great Poland specializing in dairy cattle of black and white lowland breed. Their average body weight was 500 kg and yielded 4000 kg milk per year. Winter feeding in the region lasted 210 days and summer - 155 days. Elements limiting the feeding norm for the dairy cow are shown under:

	minimum	maximum
dry matter (DM) roughage (kg)	12	13
dry matter (DM) ration (kg)	-	20.2
energy value (NEL) ration (MJ)	65.5	-
energy value (NEL) concentrate (MJ)	8.6	21.2
crude protein (CP) ration (g)	1468	1893
crude protein (CP) concentrate (g)	264	1004
crude fiber (CF) (% of roughage)	24	-
structural CF (% of roughage)	1	-
Ca (g)	41	-
P (g)	31	-

The share of permanent grasslands in the structure of agricultural land of the examined farms was typical for the region and ranged from 10-20%. Data characterizing farms referring to the applied technology and production conditions were gathered from interviews. More details about data collection can be found in another paper (Goli´nski, 1995). Models were elaborated using the system of linear programming LP XA (XA, 1987). The most important technological coefficients were the area of arable land and grasslands, number of stalls in cowsheds and labour resources. Each variable was allocated a pricing coefficient. For an individual production technology it was a gross margin. The basis for optimization was formulation of calculation matrixes in which a farm was presented as a system of equations and inequalities. The aim was to find such a combination of plant crops and types of animal production which would, within the limitations of a given farm's resources, allow to obtain a maximal financial result. A module of a dairy cow ration was then incorporated into optimized models of farms. Hence, in each case the problem of feed base optimization was considered in the plane of the farm understood as a whole, taking into consideration regional specificity of production factors. The total gross margin was maximized against prices from 1995. Cost and marginal analyses were carried out.

RESULTS AND DISCUSSION
Permanent grasslands in the examined farms were characterized by low yields ranging from 40-70 dt DM ha^{-1}. Such low yields can be attributed to the precipitation deficit which was clearly higher than in other regions of Poland (mean for years 1958-1994 was 546 mm $year^{-1}$) and irrational fertilization and utilization. Nevertheless, in each farm model permanent grasslands were fully utilized in the optimal feed base.

A popular method of summer cattle feeding in Great Poland is feeding animals green forage from arable land in the cowshed. The most popular crops cultivated for this purpose are lucerne, red clover, grain-pulse mixtures, rye and maize. The modelled feed base developed for farm forages from these crops were not taken into account in the optimal solution and the summer feeding was based entirely on pasture and silage from from wilted sward (Table 1). During winter, apart wilted sward silage, animals were fed maize silage, sugar beet tops silage and lucerne hay. In contrast to trends in Western Europe countries where sugar beet tops are treated as green manure and plowed under, in Great Poland sugar beet tops silage remains an important source of nutrients in cattle feeding. In the model, the share of this feed in diet DM was limited to 20%. There is no room, in the optimized model, for the cultivation of fodder beets, despite their high yield (600-700 dt roots ha^{-1}). There is a conspicuous tendency visible in optimized models towards reduction of cows in herds, even up to 38%, at the accompanying increase in the total gross margin by up to 60-156% in comparison to the actual state of the farm. The feeding area calculated per cattle unit (CU) dropped from 1.05 ha CU^{-1} before to 0.95 ha CU^{-1} after optimization. This allows better utilization of permanent grasslands and the area of arable land released from cultivation of fodder crops can be used to produce cash crops, especially cereals.

Cost analysis was performed for feeds which affect the composition of the optimal ration (Table 2). It consisted of the determination of the top and bottom production unit cost confines for each of these

feeds at their constant quantity in the ration. High stability was observed in the case of barley straw in both periods of feeding and silage from sugar beet tops in winter feeding. Silage from wilted sward and maize silage was characterized by low stability.

In the examined farm models marginal analysis was performed to obtain the dual values for fully utilized technological coefficients. They indicate the level of increase of the total gross margin in the model if the technological coefficient is expanded by a unit. It must be remembered that the size of the dual value refers only to the determined interval of the technological coefficient. A characteristic example may be the results of one of the examined farms in which the increase of permanent grassland area by 1 ha in the range 62.9-103.6 ha will lead to the rise in the total gross margin by 82 zl. However, fully utilized area of arable land will increase the financial results by 481 zl per hectare in the range from 795.8-1027.6 ha.

Modelling of the farm feed base constitutes an important assistance in the decision making process by indicating both the optimal range of production and proper ways of utilization of available resources (Faberberg and Torssell, 1992). The important factor which led to the remarkable improvement of the financial condition of the examined farms was elaboration for them of dairy cattle feeding models based on feeds from permanent grasslands. However, in Great Poland, permanent grasslands have in the applied models low dual value in comparison with arable lands. The main cause of this situation is low milk price and poor productivity of permanent grasslands in this region.

Table 1
Differences between the model solution and actual state of typical feed base of dairy farms from Great Poland region

Share of crops in the feed base (%)

Type of crops	Type of feed	Actual state	Optimized model
lucerne	green	16.5	-
lucerne	hay	-	20.6
grain-pulse mixtures	green	10.6	-
grain-pulse mixtures	silage	5.7	-
rye	green	7.1	-
maize	green	7.0	-
maize	silage	15.6	7.5
sugar beet	tops silage	10.6	26.2
pasture	sward	-	17.1
meadow	fresh sward silage	14.1	-
meadow	wilted sward silage	-	28.6
meadow	hay	12.8	-

Table 2
Stability of feeds in optimal ration for dairy cows in individual feeding periods

Type of feed	Feeding period			
	Winter		Summer	
	Quantity kg	Stability*	Quantity kg	Stability*
pasture sward	-	-	26.0	++
lucerne hay	4.1	++	1.2	++
wilted sward silage	2.3	+	8.7	+
sugar beet tops silage	12.1	+++	-	-
maize silage	9.3	+	-	-
barley straw	2.3	+++	2.3	+++

* Stability of feeds in optimal ration (1 zl = $0,368 US):

+++ high (difference between the upper and lower limit = above 0.005 zl kg^{-1})
++ medium (difference between the upper and lower limit = 0.003-0.005 zl kg^{-1})
+ low (difference between the upper and lower limit = under 0.003 zl kg^{-1})

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