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ANALYSIS OF THE INFLUENTIAL FACTORS ON GROSS VALUE ADDED IN THE HUNGARIAN SHEEP SECTOR

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Abstract: The competitiveness of the Hungarian sheep sector has been in steady decline for some time now. Crucial has been the problem that the value added in the sector is not generated in Hungary, as most of the produced lambs in Hungary leave the country with an average weight of 21 kilograms, with slaughtering happening abroad. A model has been constructed for our investigations, which introduces the connections between the product cycle phases for mutton in Hungary. This model allows us to calculate the volume of gross value added generated within specific product cycle phases. We used Monte Carlo simulation for our examination, for which the Crystall ball software package was utilized, namely the OptQuest module, for optimization. First, we conducted an optimization of an experiment number of 500,000 for "Gross value added" in the case of the slaughterhouse. During the optimization, Easter, Christmas and August lamb ratio and ewe number, as well as progeny, were set as decision variables and examined as values of gross value added, the decision variables of which contribute to obtaining the best results. The gained decision variables were set in the model and a Monte Carlo simulation was run with an experiment number of 500,000, where only the values of the conditions were changed along the pre-set dispersion; the values of the decision variables were fixed. The most significant aim of our investigation was to identify the volume of gross value added generated during processing in various phases of the product chain and the change of which inputs affected this volume the most. The findings proved that, in the case of capital uniformity, the output of processing was most influenced by sheep progeny on the bottom level of the mutton product chain. This factor is followed by that of weight gain in the source material producing and fattening sub-modules, as well as the gross wage in starter lamb feed and meadow hay in the source material producing sub-modules. Contour plots helped to describe the connections between these factors. By using contour plots, the volume of gross value added might be forecast for various combinations of factors.

Keywords: Hungarian Sheep Sector, gross value added, contour plot

Introduction

The four major products of sheep production include mutton, wool, milk and skin. In several parts of the world, especially in areas with temperate climate conditions, mutton is the most relevant product. The significance of mutton production is growing world-wide (*Morris,* 2009). In Hungary, among the major related products, mutton has been of significant importance, as the largest part of revenues in the Hungarian sheep sector have come from selling live animals (*Cehla,* 2009/a). Hungary looks back on rich sheep breeding traditions; however, sheep breeding represents only 1% of the total production value of agriculture and merely 2% of products of animal origin (*Cehla,* 2009/a). According to records of Hungarian Sheep and Goat Breeders, the number of ewes totalled 969,182 on 6,892 stock farms in 2010; along with ewe lambs over 6 months in total 1 015 556 females were recorded (MJKSZ, 2010). The average farm size means currently 141 ewes. Mutton consumption in Hungary is about 0.3 kg/person. According to the data of the Hungarian Central Statistical Office (KSH), 19 571 tons of sheep for slaughter were produced in 2008. The live weight production was 18 256 tons.

Presently, one slaughterhouse operates in Hungary, where not only primary processing takes place, but mutton production as well. Unfortunately, this slaughterhouse fails to utilize its capacity due to the low domestic demand mentioned previously.

Nábrádi (2009) finds the focal problem in the deteriorating competitiveness of the Hungarian sheep sector and in its low efficiency in terms of *value added* and innovation; accordingly, he does not deem it as being sustainable in the long run. Because this situation has been mostly caused by the poor Hungarian mutton supply chain, the authors seek to find answers to economic-market problems: namely, which factors/input variables exert the most influence on value added generation. In addition to investigating value added, total cash flow and net profit without subsidies were also examined, as these indicators have particulr significance during everyday operations.

Materials and methods

Calculations were carried out by using the product chain model of *Cehla's* (2011). As for the logic of product cycle models, *Cehla* (2009/b) modelled the correlations of product cycle phases (based on his own definition) up to the second phase of the mutton product cycle.

Due to limited available information, trade was not included in the model. The constructed model consists of three sub-modules:

1. source material producing sector (lamb rearing)
2. lamb fattening farms (fattening lambs produced by source material producers)
3. slaughterhouse (slaughter of fattened lambs and production)

The indicators analyzed in our calculations are total cash flow, gross value added and net profit without subsidies. The net cash flow indicates the change in the capital of the participants of the product chain; thus, it shows the difference between planned revenue and expenses. The net profit without subsidies reflects the difference of production value and cost. In the case of subsidies, Hungarian subsidies and those from the European Union are taken into consideration, as these subsidies significantly influence the result for this sector. For value added calculation, the method used by the Hungarian Central Statistical Office (KSH, 2010) was applied and our calculations were completed by taking the following concepts into consideration:

Gross value added *at basic prices: + output (at basic prices) – intermediate consumption (at purchaser's prices):* The output of the source material producing sector, which was calculated from the value of the produced lambs and other products (wool, manure) counted at basic price. The output of lamb fattening farms came from the value of fattening weight of lambs in fattening farms evaluated on basic price. The value of specific slaughterhouse output was calculated by the product of multiplication from useful lamb body parts and prices applied at the investigated slaughter-house *Cehla–Nábrádi,* (2010).

Intermediate consumption: during production, the value of products and services purchased from another producing unit in the accounting period which is used for the production of new products and services. However, the depreciation of tangible assets is not included in intermediate consumption. Intermediate consumption is evaluated at purchaser's prices. Similarly to output calculations, slaughterhouse intermediate expenditure was calculated separately in the case of intermediate consumption.

Certain sub-modules of the model were connected under the rubric capital uniformity. In this case, capital uniformity means that the product chain or the participants in the product chain belong to one owner or one owner group. The participants of the product chain operate as a cost center, while processing operates as a profit center. The cost centers pass the semi-ready products on at overhead cost prices.

The most important objective of the investigation was to identify which input changes most influence the value added generated in the various phases of the product chain. In order to reach the set objectives and to test the constructed product chain, we applied Monte Carlo simulation using the Crystall ball software package. OptQuest is a multiple optimization tool of Crystal Ball developed by Glover, Kelly and Laguna (1996) on the basis of the so-called "scatter search methodology" principle. "Scatter search" is a population-based method which bears common similarities with so-called genetic algorithms, but it is basically built on another search philosophy (*Laguna,* 1997). In OptQuest, the objectives (e.g. the minimization of gross value added distribution or the maximization of gross value added or its fall between two values) are actually values which become known merely after the Excel model has been evaluated for actual input values (*Laguna,* 1997). When determining the stock size, the simulation of the lamb fattening farms sub-module was run in the case of a farm size of 500 to 1000 ewes.

During simulation, response surface methodology was used to describe the function of input values saved by the program and gross value added. Response surface methodology (*RSM*) is a combined method of mathematical and statistical techniques, which is especially instrumental if the modelled variable is a function of several other variables (*Montgomery* 2005). In addition, we also attempt to optimize and exploit the multi-dimensional surface generated by dependent and independent variables, its local maximums, minimums and terrain and to identify the location of the area where the optimal (maximum, minimum) values of the dependent variable can be found (*Bradley,* 2007). Quadratic response surface methodology is a mixture of polynomial and factorial regression. The regression function includes the secondary polynomials of variables and the interaction effects (i.e. the products of variables in pairs) (*Statsoft,* 2011; *Bradley,* 2007):

$$y = \beta_0 + \sum_{j=1}^{q} \beta_j x_j + \sum_{j=1}^{q} \beta_{jj} x_j^2 + \sum_{i<j} \sum \beta_{ij} x_i x_j + \varepsilon$$

In order to illustrate the gained results in two dimensions, contour plots were applied.

Contour plot is a two-dimensional plot which shows the one-dimensional curves on which the plotted quantity q is a constant. These curves are defined by as follows (*Boyd,* 2000):

$$q(x, y) = q_j,\ j = 1, 2, \ldots, Nc \quad (1)$$

where Nc is the number of contours that are plotted. These curves of constant q are known as the "contours" of q or as the "isolines" of q or as the "level surfaces" of q (*Boyd,* 2000).

We fitted a second-order polynomial surface to the points in the 3D scatterplot by using Statistica 7.0.

Results and discussion

During optimization, the ratio of Easter, Christmas and August lambs, ewes and progeny was set. The model was run 250,000 times, in such a way that the values of decision variables were fixed and merely conditions (e.g., input variables: feed prices, fodder prices, feed sales, weight gain, gross wages.) varied.

The distributions of conditions (in the case of inputs) were fitted on the grounds of time series data from previous years, farm level data and expert assessments.

During simulation, saved data were analyzed and a sensitivity report was prepared on gross value added, net profit without subsidies and cash flow revealing which conditions (input data) and in what way influenced gross value added more significantly. Variables influencing considerably the examined outputs are summarized in Table 1.

On the basis of the results of the sensitivity report, the value of every examined indicator was significantly determined by primarily progeny and full-time wage. When investigating inputs, the prices of lamb feed and meadow hay significantly influence the examined indicators and their values exceed one percent. Regarding technological parameters, weight gain and feed conversion have particular relevance. It is important to emphasize the ratio of slaughtering percentage, as the result of the slaughterhouse depends on its ratio in practice. In addition to sensitivity analysis, it was relevant to investigate the absolute values of the gained indicators. The results are summarized in Table 2.

Table 1: The Results of Sensitivity Analysis

	Source material producing sector	Fattening farms	Slaughterhouse	Total
Cash flow %				
Progeny	56.90%	42%	66%	65.20%
Full-time wage	-23.40%	-26.50%	-10.90%	-18.10%
Meadow hay price	-4.70%	-4.70%		-2.90%
Slaughtering percentage			7.70%	2.20%
Rearing lamb feed price	-2.80%			-1.10%
Starter lamb feed price		-6.50%	-1.70%	1.50%
Daily weight gain H		-3.60%	5.60%	
Daily weight gain VB			1.50%	
Feed conversion H		-4.30%		
Feed conversion AT	-2.50%			
Alfalfa hay price	-2.30%			
Gross value added %				
Progeny	79%	72.8	66%	77.10%
Meadow hay price	-5.10%		-1.20%	-3.30%
Full-time wage		25.20%	-10.9	-2.90%
Slaughtering percentage			7.70%	2.80%
Daily weight gain H			5.60%	2%
Rearing lamb feed price	-3.10%			-2%
Feed conversion AT	-2.60%			
Alfalfa hay price	-2.40%			
Corn price	-2.10%			
Starter lamb feed price			-1.70%	
Daily weight gain VB			1.50%	
Feed conversion H			-1.10%	
Net profit without subsidies %				
Progeny	54.90%	76.70%	66%	65.70%
Full-time wage	-26.80%	-13.10%	-10.90%	-18.7
Meadow hay price	-4.50%	-1.50%		-2.70%
Slaughtering percentage			7.70%	2.10%
Rearing lamb feed price	-2.60%			-1.50%
Daily weight gain H		-1.10%	5.60%	1.40%
Starter lamb feed price		-2.10%	-1.70%	
Daily weight gain VB			1.50%	
Feed conversion H		-1.40%		
Feed conversion AT	-2.30%			
Alfalfa hay price	-2.10%			

Source: own construction

Examining cash flow, the average of cash flow of fattening and slaughtering is negative under the given conditions. Only source material production is able to generate positive cash flow. Under capital uniformity, the average of cash flow is positive, as well. All these results explain why fattening and slaughtering do not exist in Hungary. In the case of maximum values, cash flow may exceed even 75.5 EUR. From practical aspects, only farms utilizing mutton-producing breeds can generate this result, as according to Cehla's previous examinations, the utilized breed provided the basis for profitability in sheep mutton production. Primarily fattening lamb production contributes to cash flow of the product chain, which is turned into positive by subsidies (ewe subsidies, single area payment scheme, agri-environmental farming subsidies).

Regarding gross value added, an average of 3.8 to 5.5 EUR per lamb is generated in the various phases of the product chain. Considering the best values, value added exceeds 64.2 EUR.

The average of net profit without subsidies is negative in every case, thus altogether a deficiency of 58 EUR per lamb

Table 2: Several Important Statistical Parameters of the Examined Indicators

	Minimum	Maximum	Standard deviation	Mean
	Cash flow EUR/lamb			
Source material producing sector	-17.8	55.6	8.9	23.5
Fattening farms	-2.0	3.7	0.4	-0.8
Slaughterhouse	-91.3	26.8	12.0	-4.2
Product chain	-100.9	75.8	20.0	18.3
	Gross value added EUR/lamb			
Source material producing sector	-29.2	31.8	7.8	5.5
Fattening farms	2.0	22.7	1.7	4.5
Slaughterhouse	-83.0	35.2	12.0	4.0
Product chain	-90.2	65.1	17.6	13.9
	Net profit without subsidies EUR/lamb			
Source material producing sector	-83.8	-13.9	8.6	-45.0
Fattening farms	-10.0	-3.3	0.7	-4.8
Slaughterhouse	-95.2	22.9	12.0	-8.3
Product chain	-182.5	0.4	20.6	-58.1

Source: own construction (1 EUR = 265 HUF)

is realized in the whole product chain. In the case of best values, only slaughtering may be considered to be a profitable activity to a rate where the ratio of profit compensates the losses from fattening and slaughtering. All in all, positive cash flow may be realized if every condition is given for profitable production. In other words, parameters (progeny, weight gain, feed conversion) identified as a result of the sensitivity analysis should be paid more attention to in the sector. The value of these indicators depends mainly on genotype.

The tendencies of values of indicators influencing gross value added selected during the sensitivity report were investigated in contour plots. In contour plots, chiefly the effect of two variables (full-time wage and progeny) was examined in connection with output (gross value added, cash flow, net profit). The reason why these two factors were analyzed is that during simulation these two factors had relevant effect on the outputs in every sub-module, except for the source material producing one, where instead of wage the price of meadow hay was the second most determinant factor after progeny. Due to the extent limit, the contour plots of gross value added is detailed among the contour plots constructed from the results.

Observing the contour plots, the contours of two types of surfaces may be separated. The first type of surface is an inclined plain; on its contour inclined lines may be found (Bradley, 2007). The other type of surface is similar to a plain, which has a bulge or a valley on a part of it, and the plain bends to any direction. The lines (contours) reflect the varying combinations, which represent equal gross value added (or cash flow, or net profit) in the simulation (Bradley, 2007). The color shades indicate the size of the output variable. The darker green color shows the smallest output values, while the dark red color shows the biggest ones (Fanning, 2011). The width of the contours is also dominant; its ratio reflects that under fixed value of an input variable, its change shows what ratio causes an increase in the output by one isoline, i.e. the interval of which hides in the inputs separately (Bradley, 2007). The steepness of the contours serves information. If the lines were vertical or horizontal (it is not possible in our case), one of the factors would not influence the output variable, only the other factor. In the horizontal axis, progeny was illustrated. The steeper the contours are, the greater the effect of the progeny on the output is contrary to the full-time wage, as the vertical situation would mean that full-time wage could be neglected. If there is a bugle or valley on the surface, the direction of the lines will change, thus it may happen that the line curves back on a given area. The contour plots of the gross value added generated in the source material producing sub-module is illustrated in Figure 1.

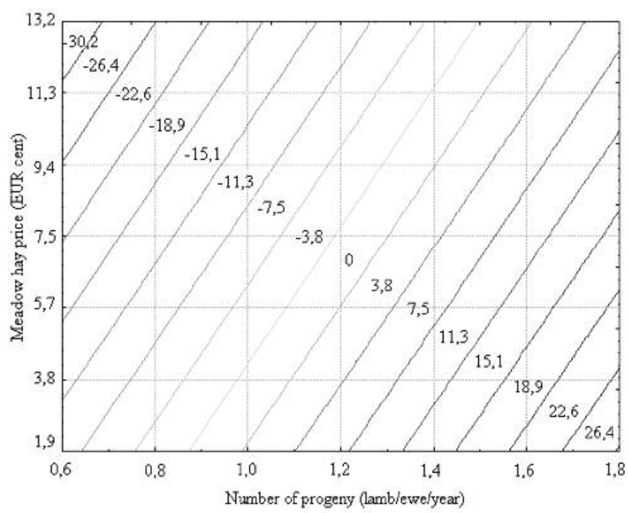

Figure 1: The Contour Plot of Gross Value Added in the Source Material Sub-Module
Source: own construction

The surface may be classified typically into inclined surface contour plots. The width of lines is around 0.1 for progeny, while in thecase of meadow hay, it increases one isoline by 2 EUR cents. Regarding the steepness of the lines, the effect of the two variables is balanced relating to the isoline increases; the dispersion of gross value added is similar to normal in connection with its skew. On the basis of the figure, in order to reach positive value added, at least one lamb per ewe has to be produced; however, this does not mean any improvement of the profitability of the sector. Regarding the price of meadow hay, it should be lower than 6 EUR cents per kilogram. The next participant of the product chain is fattening farms, the contour plot of which is summarized in Figure 2.

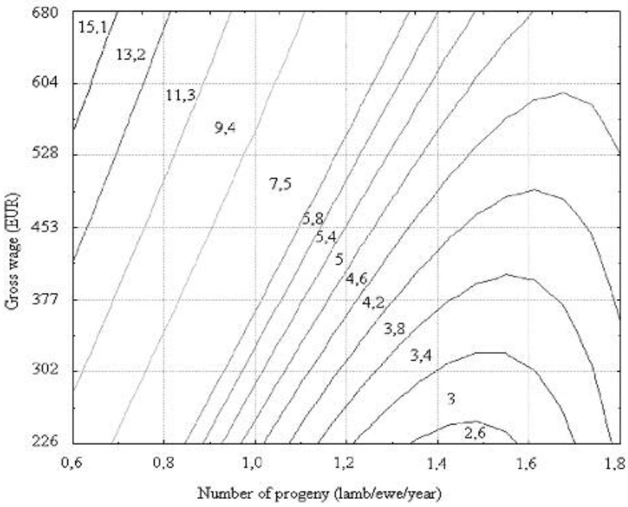

Figure 2: The Contour Plot of Gross Value Added of Fattening
Source: own construction

The contour plot of fattening farms may be classified into plots of bended surfaces. The width of the contours is narrower relating to progeny (0.04), while it increases an isoline by 22.6 to 30.1 EUR cents in the case of full-time wage, which results in about 28 to 38 EUR cents gross value added. There is one valley in the surface, which may be detectable in the case of progeny above 1 to 1.1, especially when the full-time wage is below 453 EUR. The gross value added is the smallest this time (Min.: 1.96 EUR, max: 22.7 EUR, mean: 4.52 EUR). The distribution bends to the left, which means that values below the average are most likely to occur. This is reflected by the figure in a way that the ratio of green area is greater. Firstly, it may be a surprise that the biggest value added is generated under low progeny and high personal cost. In our opinion, the reason for this result is that fattening is a separate economic activity and source material production does not necessarily influence the ratio of its tendency. This is why it may be realized in practice that a few farms purchase lambs and deal with fattening as a sole main activity. However, the value added of the slaughterhouse depends significantly on the ratio of progeny (Figure 3).

Figure 3 may be classified into the second-type one, as there is one bulge on the surface, which may be detected if the progeny is above 1 to 1.1, especially when full-time wage is under 453 EUR. The gross value added is the highest this time (Min: -83, max: 35.2, mean: 3.95). The distribution bends to right, which means that values above the average are most likely to occur. This is reflected by the figure in a way that the ratio of areas colored by red is greater. The width of the contours is 0.05 to 0.06 till 1 to 1.1 progeny; in case of full-time wage it is 37.74 to 56.6 EUR, the isoline increases cause approximately 3.77 EUR gross value added. The

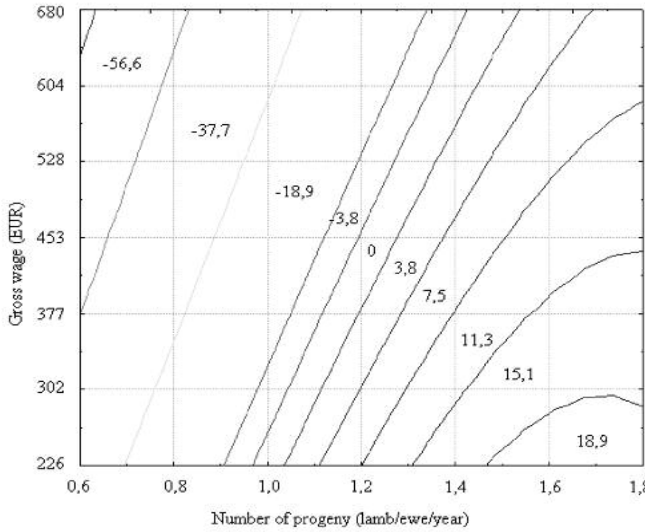

Figure 3: The Contour Plot of Gross Value Added of the Slaughterhouse
Source: own construction

highest value added may be reached in case of 1.2 lambs per ewe or even higher realized progeny.

On the basis of interpretation of the contour plots regarding the factors significantly influencing the profitability of lamb mutton production, progeny has to exceed one lamb per ewe. The price of meadow hay has to be lower than 6 EUR cents; the personal costs should not exceed 453 EUR. Furthermore, largely progeny contributes to the increase of value added in the levels of source material producing and slaughterhouse product chain, while fattening does not depend on progeny.

Analysis of the contour plots revealed the fact that the joint examination of certain factors makes taking further consequences into account possible. In this way, we illustrated how the cash flow, gross value added as well as gross profit without subsidies, change during the simulation in a 3D-figure (Figure 4).

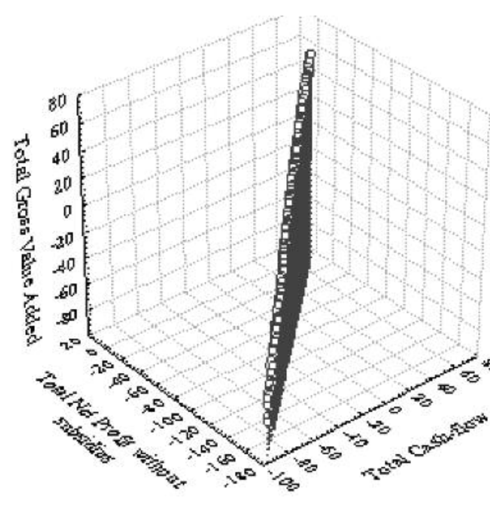

Figure 4: The Tendencies of Total Value Added, Cash Flow and Net profit
Source: own construction

The maximum value of total cash flow is 75.78 EUR, its minimum may reach -98.11 EUR, while the mean is 18.3 EUR. The dispersion of total cash flow bends to right, i.e. the relevant part of the values is located right to the average. This indicates that values above the average are more likely to occur. Furthermore, the dispersion is leptocurtic, which means that extreme values are more likely to occur contrary to normal. The minimum of the total gross value added is about -90.24 EUR, its maximum is 65.1 EUR, while the average is 13.9 EUR. The feature of the dispersion is the same as in the case of cash flow. Regarding net profit the dispersion may be characterized by the above mentioned. The minimum value is -182.5 EUR, while the maximum is only 38 EUR cents, the mean is – 58.1 EUR cents. The net profit is negative in almost every case, which occurred due to primarily source material production. All these indicate that subsidies have highlighted role in the sector. The ratio of loss is not compensated by the normative ewe subsidies and ewe supplementary subsidies, as their per ewe volume is 6.42 EUR + 4.68 EUR, altogether 11.1 EUR. The remaining loss is turned into a positive result by the value of area payment projected to one ewe. The 3D-figure of the values shows that these three financial indicators move in one lane, which means that they are connected in a linear way.

Conclusion

In our investigations, factors influencing the generation of value added in the Hungarian sheep mutton product chain were examined in a way that, in addition to value added, net cash flow and net profit without subsidies were also focused on among the results of the simulations. All these were necessary because only value added does not serve to provide sufficient information relating to the operability of the activity, which may lead to improper consequences.

On the basis of the sensitivity report, the examined output data depend on mainly progeny as well as full-time wage. When investigating the inputs prices of lamb feed and meadow hay significantly influence the examined indicators, with regard to technological parameters, weight gain and feed conversion have particular relevance. It is important to emphasize the ratio of slaughtering percentage from slaughtering parameters.

According to the statistical analysis of output data of the simulation, cash flow may be positive if parameters (progeny, weight gain, feed conversion) as a result of the sensitivity analysis are paid more attention to in the sector

The contour plots made the quantification of factors influencing profitability of sheep mutton production possible, and on the basis of all these progeny has to exceed one lamb per ewe. The price of meadow hay should be lower than 6 EUR cents, and personal cost cannot be higher than 453 EUR. On the basis of the gained results, chiefly progeny contributes to the increase of value added at the various levels of the product chain, while in the case of fattening, value added does not depend on progeny.

The 3D-figure obviously reflects that the value of net profit may be negative if the value of the other two indicators is positive. All these further strengthen the fact that sheep mutton production generates losses without any subsidies.

To sum up, the chief consequence of our modelling research is that primarily any development may be expected in the Hungarian sheep sector if the processing industry is expanded. Following such a change, the integration of production should occur, under conditions which provide new alternatives to every producer. If producers finally change their breeds or apply the well-tried cross-breeding combinations, the realization of more effective production would have greater opportunity.

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