

Theses of academic doctoral (Ph.D.) dissertation

**EFFICIENCY ANALYSIS AND MODELING MATERIAL FLOW PROCESSES
ON DAIRY FARMS**

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1. HISTORY AND OBJECTIVES OF THE DOCTORAL DISSERTATION

1.1. History of the research

I have chosen my research theme in 2008, when I have started to deal with logistics, studying the logistics processes of dairy farms. At the choice of my research topic, I strived to fit it into the program of the Doctoral School of Animal Husbandry; however, I wished to analyze the material flow processes under a new approach. I wanted to elaborate methods by which the competitiveness of dairy farms can be improved and farming will be more efficient.

1.2. Introduction and objectives

Material flow processes of animal husbandry constitute a compound system which involves the procurement, stocking and marketing tasks as well. Material flow processes are closely linked with resource management, operation and demand management. The optimal production and logistics strategy can only be determined in the light of these circumstances. These processes are much more complex in animal husbandry than in a conventional enterprise, since biological laws must also be considered at the timing of processes.

The share of agricultural enterprises from GDP is about 4%. Within this share, the bovine sector gives one-fourth of the GDP in animal husbandry, so it is of the third largest volume animal enterprise. Based on the database of Central Statistical Office (CSO), the bovine herd decreased by 200 thousand heads, the cows by 100 thousand in the last 10 years. The fact has serious influence on this that the keepers could not realize the costs of keeping in their selling prices. The number of bovine farms has also decreased to one-third within the last seven years according to the CSO's Farm Structure Survey of 2007. Since such a drastic decrease was not followed by the bovine herd's decrease, it suggests that a concentration has happened among the farms, i.e. there are fewer farms but bigger herds are being kept. Based on the statements of Dairy Board and Interbranch Organization, in 2010 Hungary could fulfill the milk quota at 80% level, which is a continuous 10% decrease in the last 3-4 years. This fact also

confirms that bovine sector is in a long-term crisis; its profitability has been failing in past years. Farms must try to make their farming as efficient as possible with every available tool so to avoid the dispose of herd and the closure. The system approach application of logistics can be such an instrument in the processes of animal husbandry.

The latest definitions and interpretations for logistics manage the whole inventory of a company (material, financial-accounting, human resource, etc.) in a uniform way. An objective of the integrated corporate system is also this, which means the system approach analysis of the processes at an animal farm. Animal husbandry and the dairy sector is in a long term crisis, so for the improvement of efficiency the optimization of both external and internal processes is needed. Thus, I set out as a **general objective** of my dissertation to give efficient tools for decision-makers that consider the characteristics of animal husbandry to establish a profitable dairy farming by applying the present methods of mathematics and operations research.

To achieve the desired general objective I defined five concrete objectives:

1. I shall systemize the material flow processes, value and supply chain of dairy farms, which makes possible to explore the logistics relations and costs.
2. Based on the data of the examined dairy farms in the Northern Great Plain Region I shall determine the rate of logistics costs to the direct costs and total costs.
3. I shall analyze the profitability and efficiency of the examined dairy farms in the Northern Great Plain Region by the farms' production and accounting data. I will examine if there is a difference among the farms by their legal status and classify them by cluster analysis. I shall compare the profitability of clusters and their efficiency by DEA analysis. After creating the deterministic version I will determine those factors that decrease efficiency on dairy farms by treating some input and output factors as probability variables.
4. I shall elaborate a technology planning system by which the whole material flow and value chain of a sample dairy farm can be modeled. I will set up the model in a way to provide an economically and professionally more sound decision-

making to make widespread sensitivity analysis by modifying the main parameters that has an effect on the system.

5. Stochastic elements of technology and economic environment can significantly influence the future effect of the decisions. This technology planning system for dairy farms makes possible to analyze risk by stochastic simulation if some elements are treated as probability variables. I will analyze the most important risk factors' effect on the results and costs as well.

2. MATERIAL AND METHODS OF THE RESEARCH

Research materials (inputs), data preparation processes, the applied analysis and modeling methods and the research results are summarized in Figure 1.

I used the sample farm database of **Research Institute of Agricultural Economics** (Hungarian abbreviation: AKI) for the regional analyses of Northern Great Plain Region. The **Farm Accountancy Data Network** (FADN) is the representative information system of the European Union that evaluates the assets and liabilities, financial position of farms.

In my research I used the sample farms' data in the Northern Great Plain Region for year 2010.

In the FADN there are 32 sample farms in the Northern Great Plain Region. Among the farms there are 22 individual and 10 corporate farms. Total dairy herd of the individuals is 1187 cows; the average farm size is 12 cows. The corporate farms' total herd is 3716 heads; the average for one farm is 371 dairy cattle. The total herd of the examined 32 farms is 4903 cows which is 6.22% of the population in the Northern Great Plain Region. The produced milk yield was more than 35.5 thousand tons in 2010.

FADN data was used for cluster analysis and for the deterministic and stochastic DEA models. Statistical calculations were executed by SPSS statistical program package. Stochastic DEA was made by Visual Basic applications.

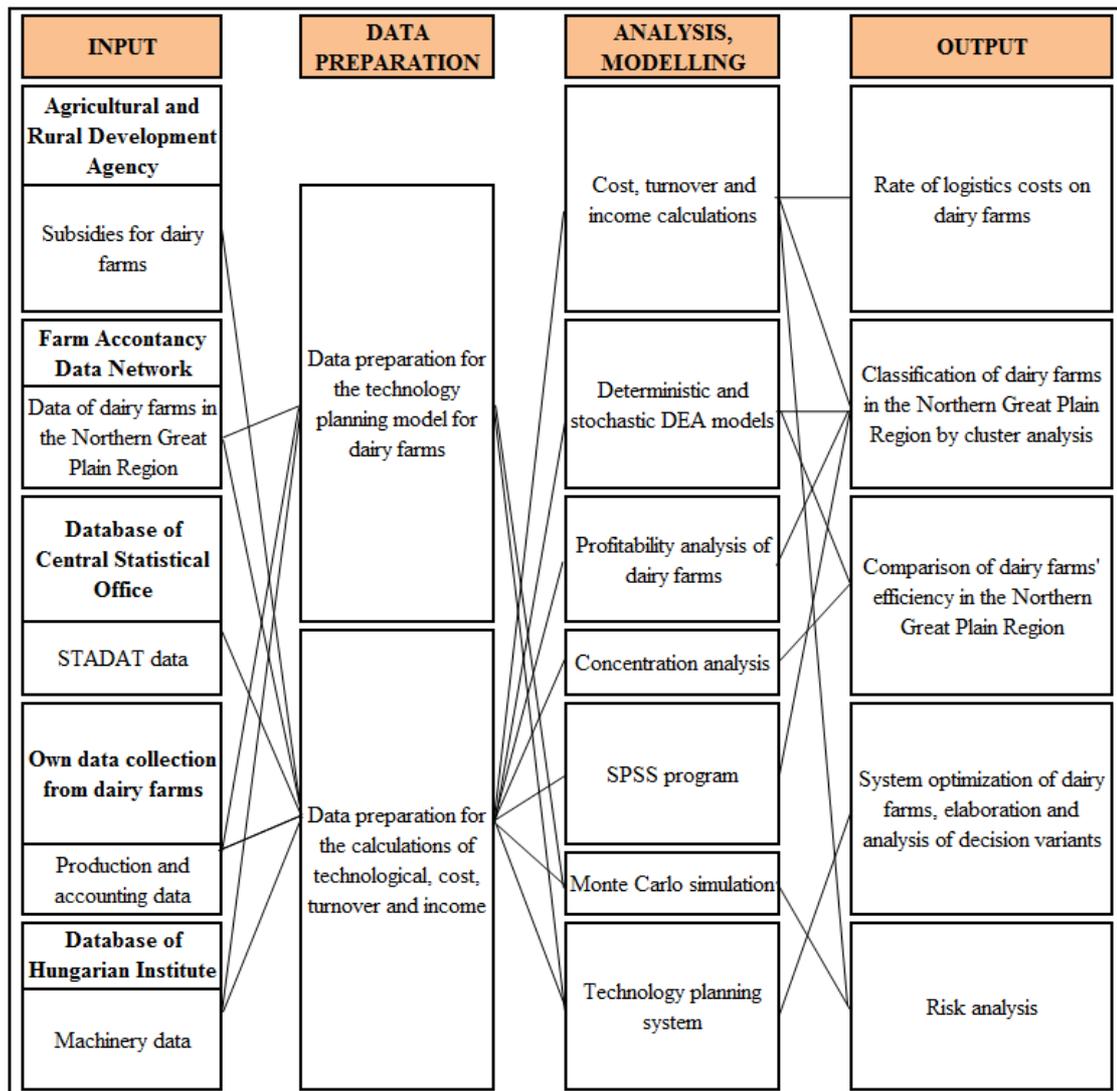


Figure 1. Input data, applied analysis methods and results of the research

Source: own composition

A further database was created by **own data collection** of 16 dairy farms' production and accounting data located in the Northern Great Plain Region. Data collection was finished in June 2011, because financial statements about the previous year must be presented by May. Farms differ in their legal status, herd sized and technology as well.

The chosen farms represent the total dairy herd in the Northern Great Plain Region. The rate of selection is more than 7% in each herd category – especially in the herd of 100-200, 200-300 and above 300 – the composition is almost the same with the regional

data. In the category of less than 100 cows there is a greater difference, because the number of individual farms of having less than 30 cows and the number of cows is quite high. However, on the whole it hardly exceeds 10% of the total herd, so it doesn't distort the results significantly.

The collected turnover and cost data made possible to compare the profitability and efficiency of the farms. The examined year was 2010.

Beyond the conventional costs I introduced the cost of logistics. I classified to this the cost of external services, machinery costs, farm maintenance costs and the farm overheads. This made possible to determine the rate of logistics costs to the direct and total cost.

The supports and aids for dairy farms were collected from the publications of Agricultural and Rural Development Agency.

For the elaboration of the technological planning system I used the technology of a dairy farm keeping 1050 cows in the Northern Great Plain Region. The basic production and technological data were given by this farm's database of 2010 and the missing and incorrect data were collected from literature or generated by the parameters of other examined farms. For the risk analysis of the technology planning system I used Crystal Ball program package.

3. MAIN FINDINGS OF THE RESEARCH

In the first part of my dissertation I clustered the sample farms of AKI, and then I analyzed the profitability of the farms by clusters and legal status as well. I examined the total cost structure, turnovers and income of 16 dairy farms from my own database and compared it to the results of AKI sample farms. I made similar analyses to determine the rate of logistics costs to total and direct costs.

Detailed analysis of AKI sample farms was needed for DEA efficiency analysis models, because in the model specific production data are needed. After that I elaborated a technology planning system that provides an economically and professionally more sound decision-making to make widespread sensitivity analysis by considering risks.

3.1. Results of production value, cost and profitability on dairy farms in the Northern Great Plain Region

In the research I wanted to make statements for different farm sizes, so I clustered 32 sample dairy farms in the Northern Great Plain Region from FADN database. The groups were made in a way to be statistically different in their main characteristics. Analyses were made by hierarchical average linkage and non-hierarchical k-means method as well. Farms were classified by 11 characteristics: arable land (ha), turnover from milk, subsidy, turnover from sold animals, cost of on-farm and bought-in feeds, average milk production and personal income. The result was the same by both method, 3 groups were established by 11 characteristics that significantly differ. The clusters:

- smaller farms, mainly family farms with lower production level (average herd: 52 cows),
- large farms with medium production level (average herd: 276 cows),
- industrial large farms with high production level (average herd: 521 cows).

Mean values of clusters are shown in Table 1. Correctness of the results was checked by variance analysis. Based on variance analysis, I stated that there is a significant difference among clusters.

Table 1. Means of clusters by characteristics

Characteristic	Cluster		
	1	2	3
Arable land (ha)	68,30	931,20	1 904,42
Average number of cows	52	276	521
Milk turnover (thousand HUF)	22 342	142 043	304 921
Turnover of sold animals (thousand HUF)	4 477	27 641	40 689
Subsidy (thousand HUF)	2 418	24 935	40 564
On-farm grain feed cost (thousand HUF)	3 340	5 869	17 392
On-farm fodder cost (thousand HUF)	3 327	30 345	31 568
Bought-in grain feed cost (thousand HUF)	1 225	3 316	17 531
Bought-in fodder cost (thousand HUF)	1 096	3 269	19 120
Milk production (kg/cow)	4 927	6 625	7 902
Personal income (thousand HUF)	1 967	41 331	87 508

Source: own calculation by AKI database

Sample farms of Research Institute of Agricultural Economics (AKI) are weighted, which means the number of farms that a sample farm represents in the similar group of the basic population. Thus, the result is not typical for the farms in the sample survey, but for the population that they represent. Needed data for weighting emerges from Central Statistical Office. By using weights I could make statements about production value, cost and income for 1571 farms based on 32 sample farms. According to the Farm Structure Survey of Central Statistical Office (CSO) in 2007 there were 3349 dairy farms in the Northern Great Plain Region, so the sample represents 46.9% of all farms. In the Farm Accountancy Data Network there are 22 individual and 10 corporate dairy farms in the Northern Great Plain Region which represent 1518 individual and 53 corporate farms. In the sample the rate of corporate farms is 3.5% compared to individual ones, while it is 4% on the whole according to CSO. By analyzing the structure of turnovers of the sample farms in the Northern Great Plain region, it can be stated that 72.3% of the production value comes from milk sale, 12.5% from the sold animals, the rate of other revenue (mainly subsidies) is 10.6% and the rate of agricultural services is 4.6%.

The average production value on the individual farms and in Cluster 1 was 547 thousand HUF, while the weighted average on the 16 farms in the own database was much higher (794 thousand HUF/cow). At the corporate farms the average value was 785 thousand HUF, which is not much lower than on the farms from own data

collection. If the specific values of the production value's elements are analyzed by legal status it can be stated that there is a significant difference in the revenues of milk, other products and other revenues (Figure 2.). The revenue per cow is with 165 thousand HUF higher at the corporate farms which may arise from the fact that these farms can produce higher yields (7635 kg milk/cow) and sell it at a higher price (73.96 HUF/kg) than the individual farms (72.16 HUF/kg).

Individual farms usually do not provide agricultural services and corporate farms could calculate with more other revenue (mainly direct subsidies) (80 thousand HUF/cow) than the individual ones (60 thousand HUF/cow). Among the clusters, Cluster 3 reached the highest production value (804 thousand HUF/cow), which is followed by Cluster 2 (709 thousand HUF/cow) and Cluster 1 at last (547 thousand HUF/cow). At the sale of milk Cluster 3 has the highest value again, but at the sale of animals and other revenues Cluster 2 has higher specific turnover values. Mean values of own data collection are the same with AKI corporate sample farms in an order of magnitude, however, there is a bigger difference at the other revenues: dairy farms of the own database could realize with 65 thousand HUF higher other turnover.

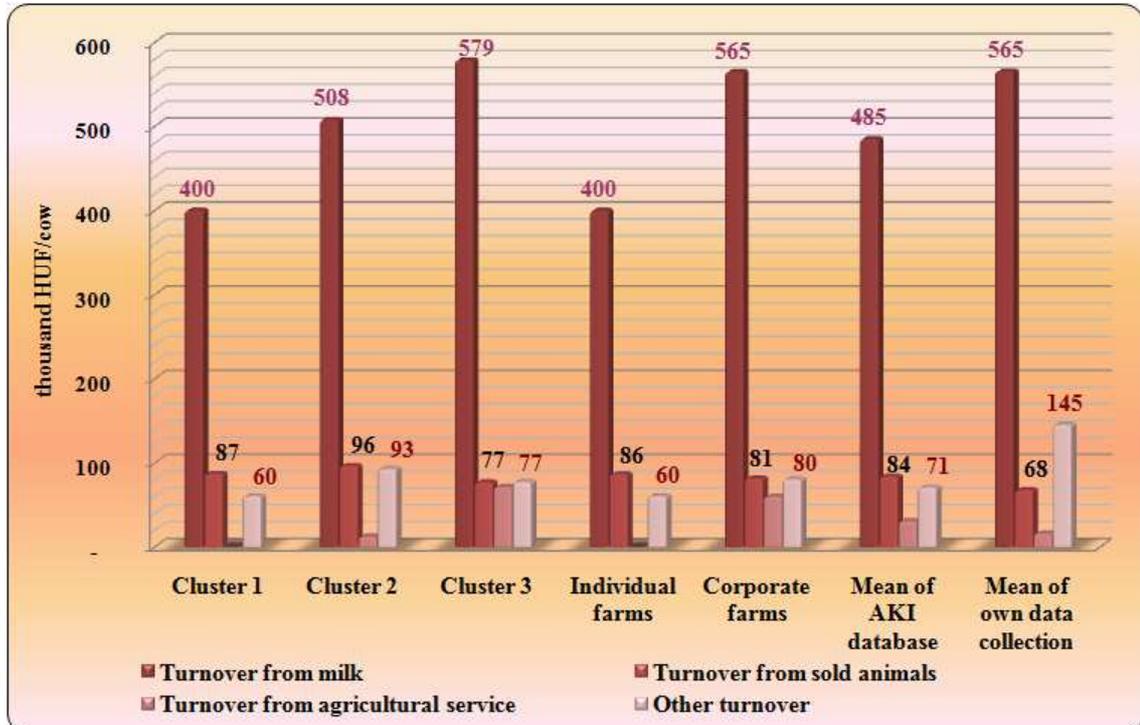


Figure 2. Elements of production value in the Northern Great Plain Region in 2010

Source: own calculation by AKI and own database

In the cost structure of dairy farms in the northern Great Plain Region, the rate of material costs on the individual farms is 15% higher than on the corporate farms (65%) (Figure 3.). The rate of material costs in Cluster 1 and on the farms of own data collection are around 80%. The maintenance cost is lower on the individual farms, at Cluster 1 and own collected farms (4-5%), which is almost half of the cost on corporate farms (at Cluster 2 and 3 it is about 8-9%).

The structural difference of labor costs is also significant among the examined groups. Individual farms spend 12% of their direct cost on labor, while the corporate farms pay almost twice more (22%). This difference may arise from the fact that on the individual farms the farmers account for less personal income, so they benefit from the profit left at the end of the year. The direct depreciation is 4-5% on average on the farms of the region, while on the farms of own database this rate is higher (8%).

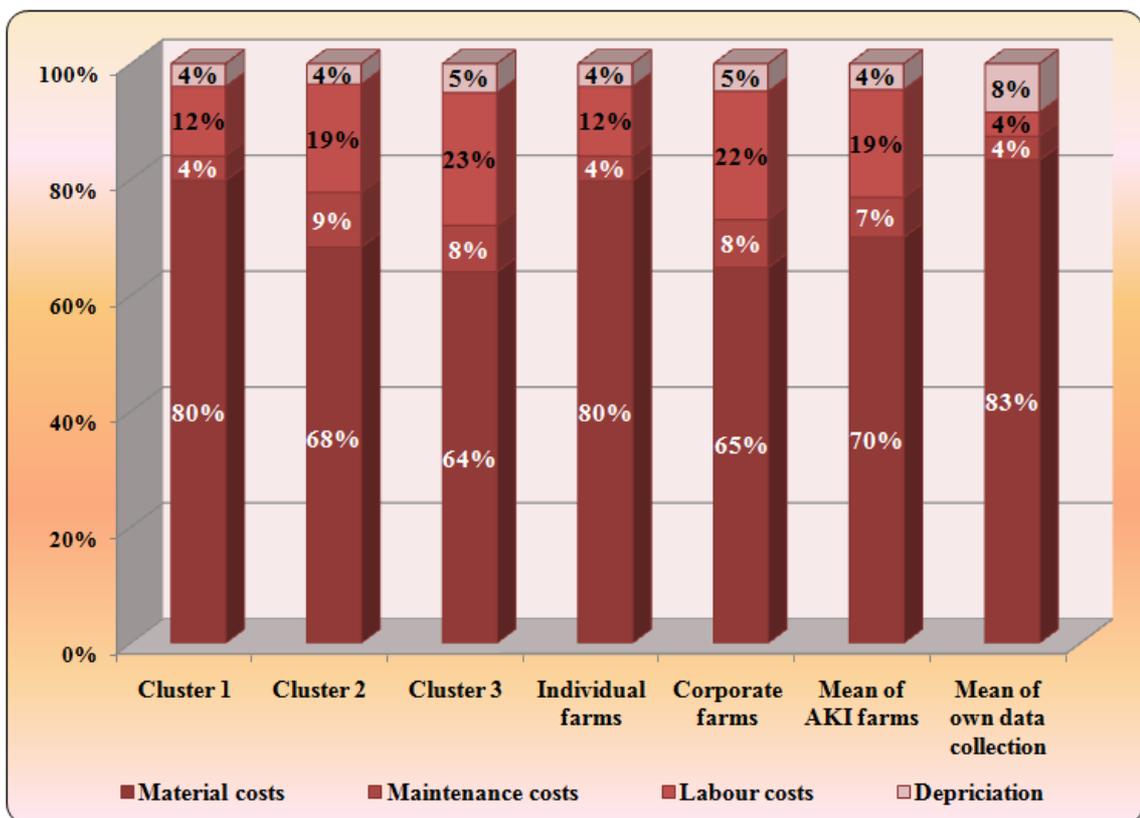


Figure 3. Structure of direct costs on the farms in the Northern Great Plain Region in 2010

Source: own calculation by AKI and own database

The specific material cost is 338 thousand HUF on the individual farms and in Cluster 1, which is with 142 thousand HUF lower than on the corporate farms (480 thousand HUF/cow) (Figure 4.) and it is even higher on the farms of own database (498 thousand HUF/cow). The specific maintenance cost is 18 thousand HUF/cow on the private farms and Cluster 1, but it is more than three times higher at corporate farms, Cluster 2 and 3 (61-62 thousand HUF/cow). There is also a large difference at labor costs, since individual farms calculate with 51 thousand HUF/cow and corporate farms with 164 thousand HUF. Farms in the primary database count with 25 thousand HUF labor costs in 2010. Corporate farms had twice more depreciation (35 thousand HUF/cow) than the individual ones (17 thousand HUF/cow). The value of this cost element is the highest on the farms of own database (50 thousand HUF/cow).

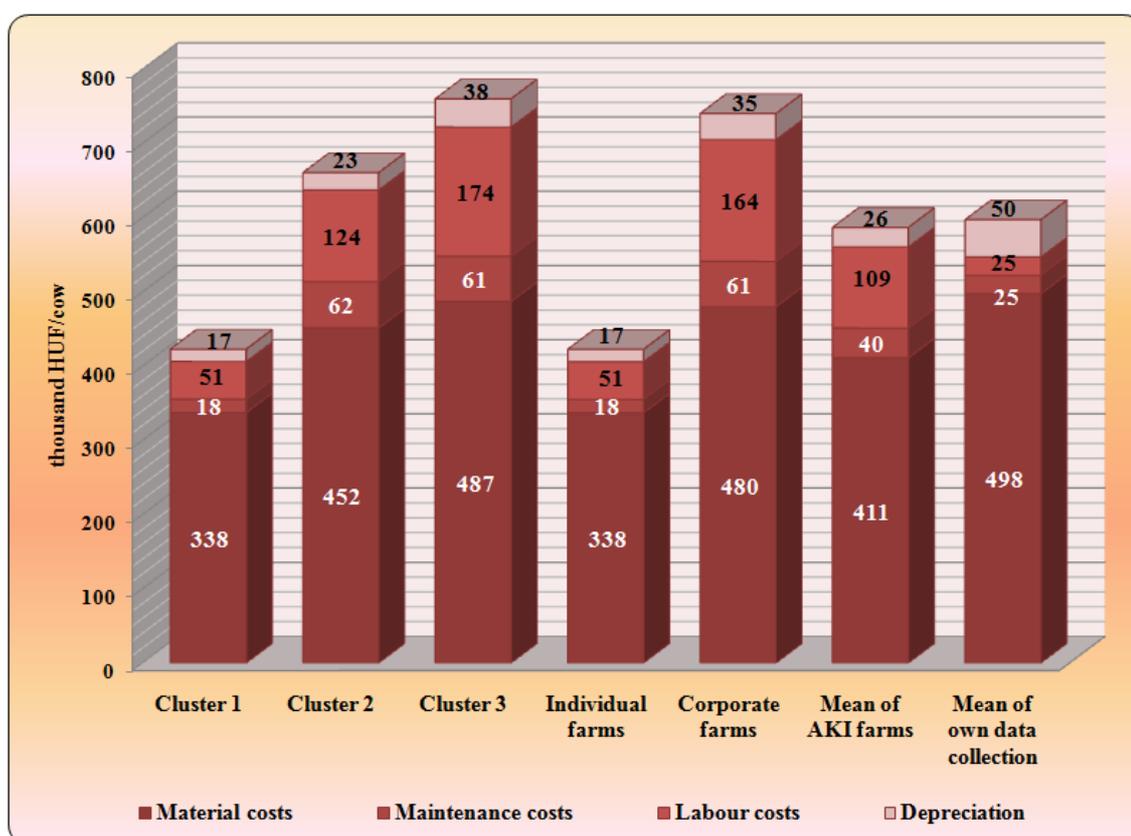


Figure 4. Specific direct costs by cost elements on the dairy farms in the Northern Great Plain Region in 2010

Source: own calculation by AKI and own database

I made a complex cost structure analysis on the own-collected 16 farms: 61% of the total cost is material cost, 10.7% is labor cost, depreciation and machinery cost is 6%

and the rate of external service is 1%. Within material costs, feed cost is significant, about 50-60% of the total cost which was also proved by POGÁNY et al. (2011). The rate of maintenance cost and other direct cost is 3.7% (which also involves the veterinary services), the rate of farm and corporate overheads is about 9% altogether. The average production cost was 812 thousand HUF/cow in 2010.

From the total cost 498 thousand HUF is the cost of materials, 430 thousand HUF is the feed cost from it (Figure 5.). The average labor cost is 86 thousand HUF/cow. The farm and corporate overheads are 75 thousand HUF altogether. Depreciation is about 50 thousand, machinery cost is 41 thousand HUF/cow. We can calculate 8 thousand HUF/cow for foreign services. The other direct cost and maintenance cost is about 25 thousand HUF each.

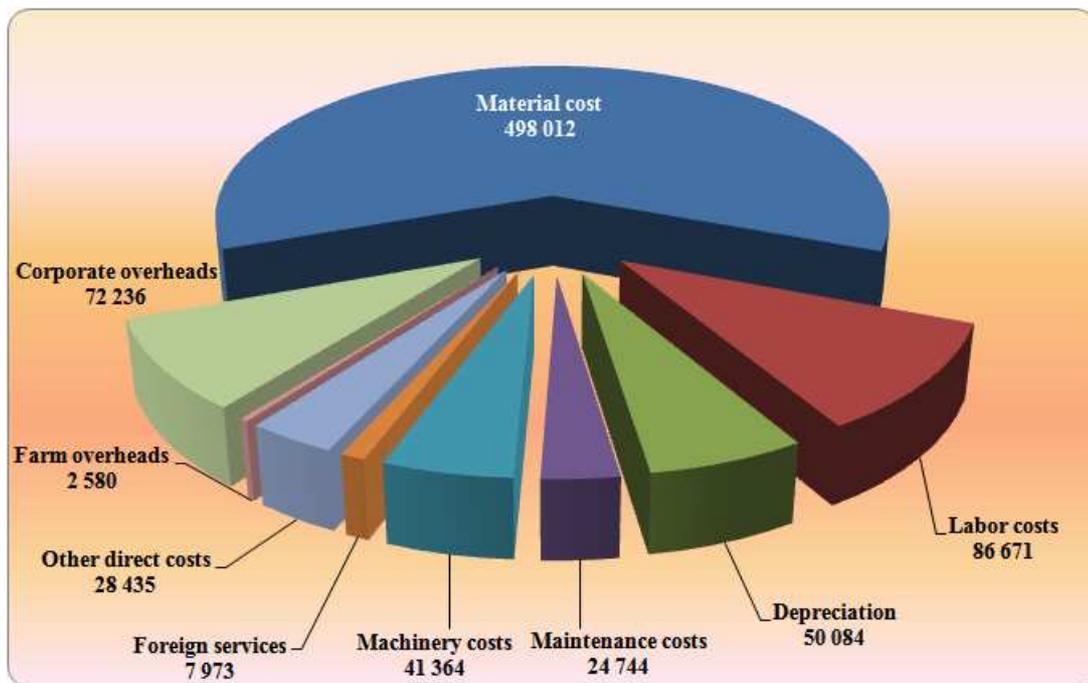


Figure 5. Specific costs in the average of 16 dairy farms from own database in 2010 (HUF/cow)

Source: own calculation by own database

Analyzing the logistics cost I found that the individual farms spend 7.77% (34 thousand HUF/cow), the corporate farms 8.81% (65 thousand HUF/cow) of their direct costs for logistics activities (Figure 6. and 7.). The highest logistics costs were measured on the farms in Cluster 3 (69.3 thousand HUF/cow). The level of logistics costs in rate and

value is the same in Cluster 1 and the individual farms, while the average rate at the corporate farms (8.81%) is between the clusters 2 and 3. The rate of logistics costs on the farms in the own database (8.79%) is higher than at the AKI farms (8.45%). In value it means that the specific logistics cost was 49.6 thousand HUF on the AKI sample farms, while on the farms in the primary database it was higher (52.5 thousand HUF/cow) in 2010 and the rate was 6.35% to the total production cost. When calculating cost prices we can count with 7-10 HUF/liter logistics cost from the cost price of milk.

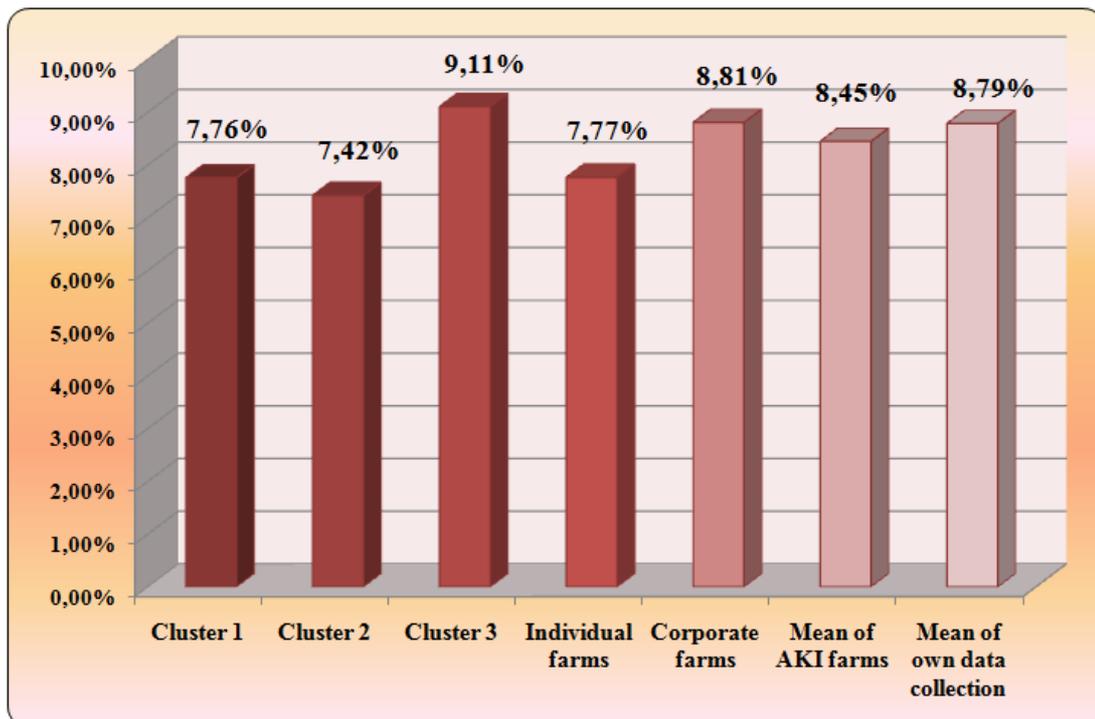


Figure 6. Rate of logistics costs to direct costs on dairy farms in the Northern Great Plain Region in 2010

Source: own calculation by AKI and own database

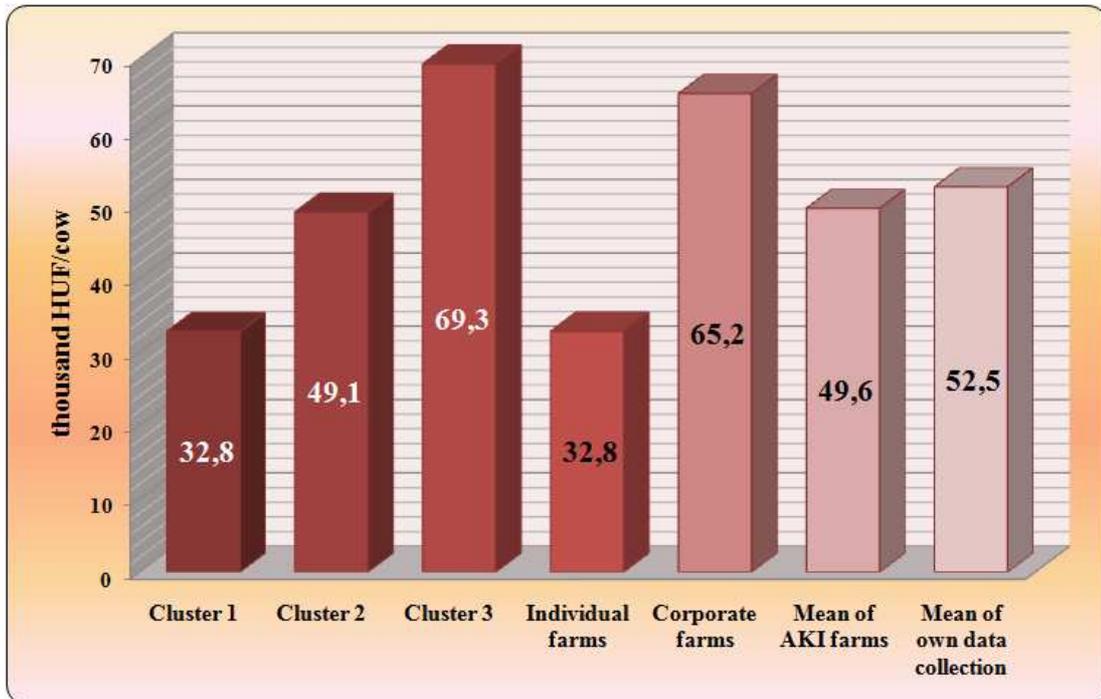


Figure 7. Specific logistics costs on dairy farms in the Northern Great Plain Region in 2010

Source: own calculation by AKI and own database

For the analysis of average gross profit I compared the data of farms from different databases (Figure 8.). It is found that the average gross profit of the individual sample farms is 123.5 thousand HUF/cow, but it is only 45.2 thousand HUF/cow at the corporate farms. The smaller farms (Cluster 1) operate with lower cost level; their revenues are also much lower than on the larger farms (Cluster 2. and 3.). However, the gross profit of smaller farms is still higher (124 thousand HUF/cow) compared to the other groups. The state of the farms in Cluster 2 is less favorable, since the average gross profit was 48 thousand HUF in 2010, but the farms in Cluster 3 (with the highest production value) realized the least gross profit (43 thousand HUF/cow). The highest gross profit was measured on the dairy farms of own database (149.8 thousand HUF/cow).

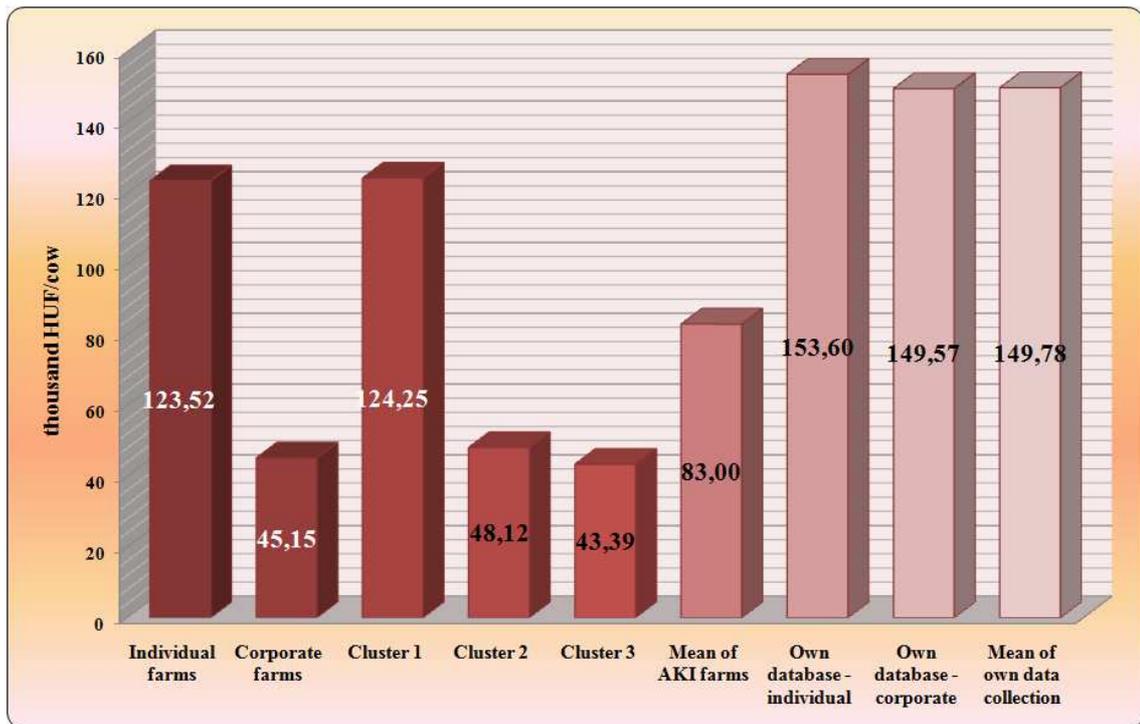


Figure 8. Specific gross profit by different databases on dairy farms in the Northern Great Plain Region in 2010

Source: own calculation by AKI and own database

3.2. Efficiency analysis of dairy farms by DEA method

3.2.1. Efficiency analysis of dairy farms in Northern Great Plain Region by deterministic DEA model

The aim of the analysis is to examine the farms' efficiency, to explore the critical factors in cases of non-efficient farms and to determine the direction of further analyses. I analyzed the efficiency of 32 dairy sample farms in the Northern Great Plain Region in the deterministic version of DEA. The basic data was collected from the Farm Accountancy Data Network of AKI and the milk quality parameters were gathered from Animal Husbandry Performance Analyzer Ltd. For the calculations the examined year was 2010.

In the efficiency model arable land (ha/cow), herd size, on-farm and bought-in grain feed and fodder costs (thousand HUF/cow), labor cost (thousand HUF/cow) and direct costs were taken into account as input factors. Milk production for 305 days, average

milk fat and protein from milk quality parameters, and turnover both with and without subsidies were set into the model as outputs.

After solving the model it can be stated that considering the given input and output constraints 20 farms (63%) from the examined 32 operate in an efficient way, the others (12 farms, 37%) does not (i.e. DEA efficiency value is less than 1). Among the efficient farms there are 3 corporate and 17 individual farms, while among the non-efficient ones there are 5 individual and 7 corporate farms, so according to the examinations 30% of the corporate farms and 77% of the individual farms work in an efficient way. Consequently, it can be stated that medium and large sized individual dairy farms work more efficiently in the Northern Great Plain Region than the industrial large corporate farms.

The model analysis shows that those farms are efficient which direct costs (409 thousand HUF/cow on efficient and 620 thousand HUF/cow on non-efficient farms) are much more lower compared to their turnover (541 thousand HUF/cow without subsidy, 667 thousand HUF/cow with subsidy) and produced less milk per cow (5365 kg/cow) but with better quality parameters. In cases of the efficient farms the feed cost was lower (151 thousand HUF/cow) than on the non-efficient ones (193 thousand HUF/cow).

3.2.1. Efficiency analysis of dairy farms in Northern Great Plain Region by stochastic DEA model

At the evaluation of the results for stochastic DEA model the **rate of efficiency (%)** was an index that I applied. We can calculate it if the number of simulation runs that were 100% efficient is divided by the total number of simulation runs. The number of simulation tests was 5000. This large number was justified in order that the simulated values for variables shall cover the range of observation in the given parameter intervals based on the distributions, because this way the results represent better all situations for the future.

After running the stochastic model, it is found that 9 farms are efficient with considering the risks, which is half of the result for deterministic DEA. The rate of

efficiency is better on those 11 farms that were efficient according to the deterministic version, but the rate of efficiency is above 50% in case of only 3 dairy farms. This rate fluctuates around 10-50% on all other farms, which indicates that if the conditions change a bit to a less favorable way, these farms will not meet the criteria of the farms with good practice in the region.

According to the deterministic DEA there were 20 efficient farms. After 5000 simulation runs, in the most favorable cases, the number of efficient farms was 22 and the minimum value was 7. The distribution is presumed to be close to symmetric, because mean and median are close to each other in every category. Median in the efficient category is 13 farms, which means that in 50% of the cases (in 2500 cases) 13 farms were efficient from 32. This is better than the presented 9 farms at the rate of efficiency, but the constraints are much more solid as well.

I decreased the efficiency values by 0.1 and calculated the cumulated statistical indices to the given categories. The value of DEA efficiency shows the extent of interventions to be made for the best practice. The lower the efficiency value, the more drastic action is to be made. In case of deterministic DEA all 32 farms show values above 0.5, moreover, 24 farms – $\frac{3}{4}$ of dairy farms – have efficiency above 0.8. If the results of stochastic DEA is analyzed we can see that the median value of category for >0.5 is 24, which means that for these 24 farms the chance of having efficiency above 0.5 is 50%. The median of category above 0.8 is 15, so we can expect efficiency above 0.8 at less than half of the number of farms in 2500 runs.

These results are in full compatibility with the consequences drawn at the rate of efficiency, so it can be stated that at present most of the dairy farms (62.5%) in the Northern Great Plain Region have good practice according to the deterministic version of DEA analysis. However, if the risks of inputs and outputs are also considered, it is found that even most of the farms with 100% efficiency can correct a small split of the present balance with difficulties.

As the next step, the influence of input and output factors was analyzed on the efficiency. The partial regression coefficients in the regression analysis show the absolute effect of the influencing factors. The measurement unit and the order of

magnitude for input and output factors in this DEA model are significantly differ, so it is practical to apply the standardized regression coefficient, the β -coefficient (EZÉKIEL–FOX, 1970) in the comparison.

Based on beta-weights, the milk fat has the greatest effect on DEA efficiency. This factor was the most important at 2/3 of the farms. According to the ranks, milk production is on the second place, direct cost is the third and turnover is the last one. Analyzing the average beta values we can see that on the second and third place the milk production and direct costs change places, which implies that direct cost has smaller influence, but on those farms where its significance is higher, its effect is stronger on DEA efficiency.

3.3. Risk results of the technology planning system for dairy farms

For the technology planning system I created a schematic chart in which I drafted the material flow processes and value chain of dairy farms (Figure 9.). On the top of the chart the prices of inputs and outputs are shown. In the technology planning system the physical and value flow processes are presented in a connected way. Any physical flow process can be evaluated in the value chain and the modification of the value chain's input data immediately appears in the cost and revenue calculations and through this in the profitability indices.

The most important objective of my research is that based on the flowchart (Figure 9.) I established a dairy decision-support technology-planning system, by which the whole material flow and value chain of a sample dairy farm can be modeled. I set up the model in a way to provide an economically and professionally more sound decision-making to make widespread sensitivity analysis by modifying the main parameters that has an effect on the system. I validated the risk inputs, outputs and technological factors in a way that I modeled a farm with 1050 cows and I compared the results to the values of the AKI database. This model can be successfully used for modeling dairy farms from 100 to 1500 cows.

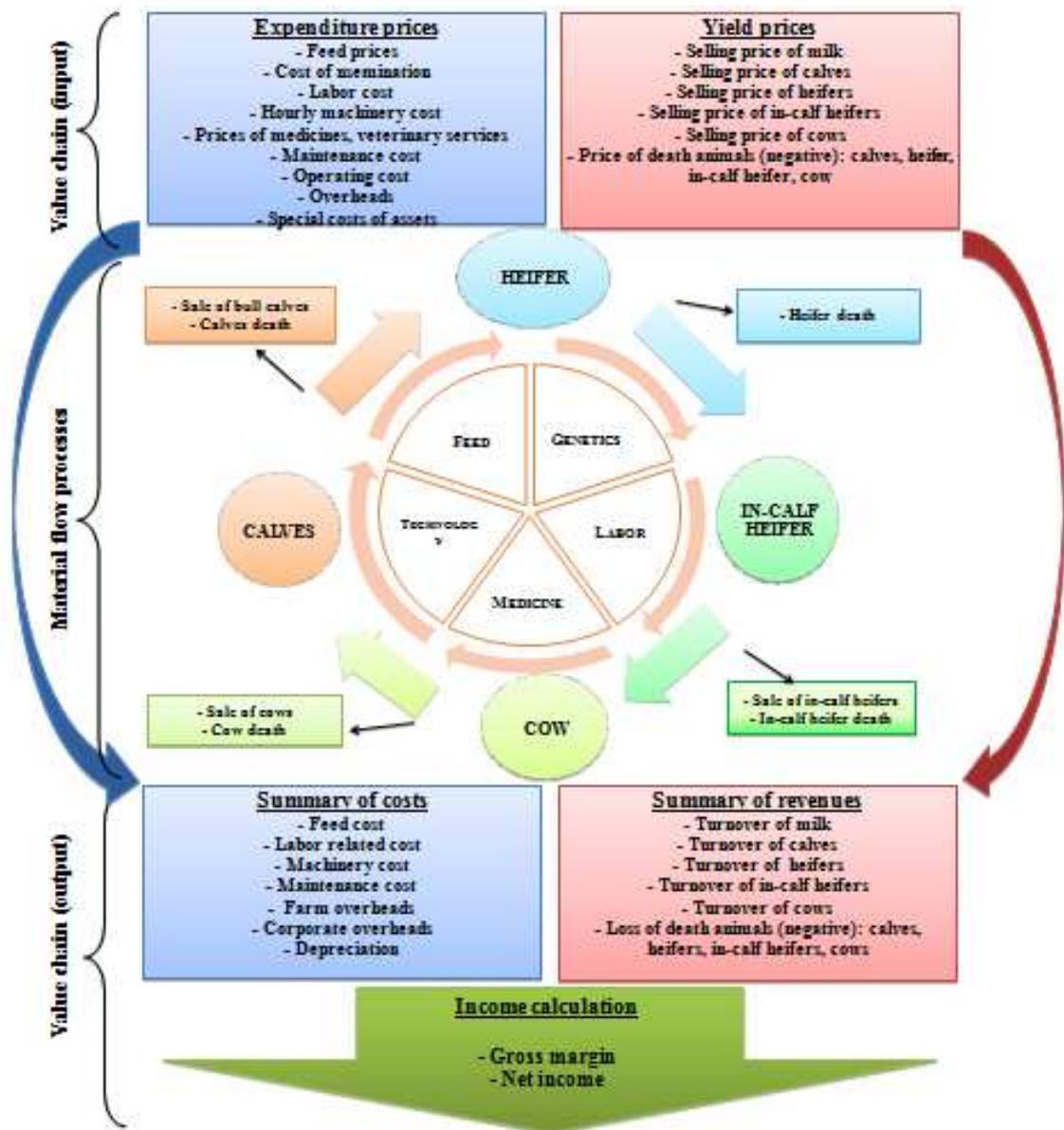


Figure 9. Material flow processes and value chain of dairy farms

Source: own composition

By applying simulation methods we can quantify the error, the risk; we can determine the probability of fulfilling the economic requirements in case of a dairy farm. I validated the risk inputs, outputs and technological factors. The number of simulation was 10.000 and according to this the average income was 21.1 thousand HUF/cow, which is almost the same with median (21 thousand HUF), so in 50 percent of the cases we can reach higher income than 21 thousand HUF/cow. The probability of reaching zero income is almost 70%. Considering the total cost, the mean and the median

coincides again (860 thousand HUF/cow), the range of distribution is very wide, it fluctuates between 768 and 957 thousand HUF/cow. The fluctuation is higher in case of the turnover (728-1052 thousand HUF/cow), the mean is 880 thousand HUF/cow.

Examining the influencing factors of the result variables, it can be stated that the **net income** is affected by the yields of the dairy farm, after that the feed cost (the highest is the basic grain feed, lucerne senage and the cost of milk feed). Among the biological factors, generation of calves is the most important. Basic grain feed, lucerne senage and the cost of milk feed among feeds and generation of calves and service period among biological factors have the highest influence on the **total cost**. Among the **yields**, the milk production's effect on turnover is of great significance. Among biological factors, generation of calves is the most important, but the service period, calves and cow death are also significant.

The technological planning module makes possible to establish a farm-specific planning, and exploring and quantifying the risk factors makes the decision-support more efficient and sound.

4. NEW RESULTS OF THE DISSERTATION

1. Based on the analysis of the value and supply chain of the material flow processes I explored the logistics relations and costs on dairy farms. Based on my calculations the rate of logistics cost compared to direct costs is 8.45% on the FADN sample farms in the Northern Great Plain Region in 2010. The rate is similar at the individual (7.7%) and corporate farms (8.8%), but in value the individual farms realize 34 thousand HUF and the corporate farms almost twice more (65 thousand HUF/cow). The highest logistics costs were measured on the industrial large farms in rate (9.11%) and value as well (69.3 thousand HUF/cow). The level of logistics cost was 33 thousand HUF/cow on the smaller farms with lower production level, and 49 thousand HUF/cow on larger farms.
2. The rate of logistics costs to the total cost was 6.35% in 2010 on the farms of primary database (16 farms in the Northern Great Plain Region). The rate of logistics cost to the direct cost is 8.09%, which is lower than on FADN farms (8.45%).
3. Based on the deterministic DEA efficiency analysis I proved that almost 2/3 of the examined dairy farms have “good practice”. I found that those farms were efficient which direct costs were much more lower compared to their turnover and produced less milk per cow, but with better quality parameters.
4. If risk is also considered, after 5000 simulation runs the rate of farms with good practice reduces below 1/3, which implies that even half of the efficient farms are quite sensitive to the unfavorable change of conditions. Based on β -weights, milk fat is the most important factor among the risk factors, which is followed by milk production, direct cost and turnover.
5. In my research I elaborated a decision-support technology-planning system for dairy farms that follows the whole material flow and value chain, in which the physical and value flow processes appear in a related way. Any physical flow process can be evaluated in the value chain and the modification of the value chain’s input data

immediately appears in the cost and revenue calculations and through this in the profitability indices.

6. I complemented the technology planning system with a stochastic module which is suitable for measuring risk. Examining the influencing factors of the result variables in the modeled sample farm, I stated that the net income is affected by the yields of the dairy farm, after that the feed cost (the highest is the basic grain feed, lucerne senage and the cost of milk feed). Among the biological factors, generation of calves is the most important. I found that basic grain feed, lucerne senage and the cost of milk feed among feeds and generation of calves and service period among biological factors have the highest influence on the total cost.

5. PRACTICAL USE OF THE RESULTS

Within animal husbandry cattle farming is of great significance. Past years the profitability and competitiveness of the Hungarian bovine sector has been declining, so it is of high priority to ensure tools for decision-makers that makes farming more efficient. The objective of my research work was to explore the supply and value chain of dairy farms, to present the significance and cost of logistics processes and to elaborate a decision-support system.

To achieve the objectives of my research work:

- I systemized the material flow processes, supply and value chain of dairy farms, explored the logistics relations and their costs. According to my calculations the rate of logistics cost compared to direct costs is 8.45% on the AKI sample farms in the Northern Great Plain Region in 2010 and the rate of logistics costs to the total cost was 6.35% on the farms of primary database (16 farms in the Northern Great Plain Region). The rate of logistics cost to the direct cost is 8.09% on the farms of own database, which is lower than on the AKI sample farms (8.45%). Logistics cost were not defined on dairy farms, so this information can be used in the course of planning.
- By using DEA efficiency analysis models, those factors can be determined on dairy farms that decrease efficiency, and these risk factors can be quantified in dairy enterprise.
- The elaborated technology planning system has novel elements compared to other decision-support systems on the market, which is suitable for soundly preparing and supporting decisions and analyzing the risk of dairy farms. The system can be used in an efficient way to model dairy farms with herd from 100 to 1500 cows, to determine risk factors and to even provide controlling tasks.

6. PUBLICATIONS

BOOKS, BOOK CHAPTERS

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