Determining the economic efficiency level of feed consumption in cow milk production

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Abstract

This research has been carried out in order to determine the resource utilization efficiency of feeds and feed combinations that are predicted to affect the amount of cow's milk production. The data used in this research were obtained using the stratified sampling method. In this study it has been determined that the share of variable costs in milk production is 64%, and the share of feed in variable costs is 80%. In this research it has been found out that the degree of explaining the milk production amount of the variables in the estimation equation is 83%, and the F value for the equation is statistically significant at the 1% level. The sum of the elasticity coefficients of the factors in the estimation equation (∑ βi: 1.016) has shown increasing returns to scale in dairy cattle enterprises. Among the variables in the function, the factor with the highest efficiency coefficient has been found as the roughage input with 6.60. The results of the analysis has revealed that the use of resources in milk production on the basis of both factors and factor combinations is not efficient and rational.

Keywords: Milk Production. Feed Consumption. Roughage. Concentrated Feed. Crushed Feed. Functional Analysis.

1. Introduction

Livestock is a source of livelihood, providing income and employment for producers. Its socio-economic roles are gaining significance as the sector grows because of the increase in human population, incomes and urbanization rates as well as the speeding up the demand for livestock products (Herrero et al., 2013). Livestock activities are an activity that keeps the producer's incomes consistent throughout the year, and it is a production area that meets the food items such as meat, milk, yoghurt and cheese needed by the producer's family. Livestock activities are also significant in terms of making use of idle labor and feed, ensuring regular cash flow, reducing risk in the enterprise and migration from rural areas.

Dairy cattle farming is one of the agricultural activities that provide a high level of added value to the Turkish economy. According to 2018 data, milk production value constitutes 44.25% of Turkey's overall animal production value. As of the same year, whereas approximately 90.58% of the total milk production, which amounts nearly 22.1 million tons in Turkey, consists of cow milk, 6.45% of this is sheep milk, 2.54% goat milk and 0.34%of this production comes from buffalo milk. Of the total cattle of 17 million heads in the country, 49.40% is cultured, 41.25% is cross-cultural and 9.35% is domestic breeds.

It could be said that dairy cattle breeding activities in Turkey have shown significant developments in terms of animal assets and animal production amounts. However, it is not possible to say the same for the milk yield value obtained per dairy animal. Likewise, according to FAO data, there has been a 44% increase in cattle stock whereas a 97% increase in milk production in Turkey during the 2003-2017 period. However, Turkey is in the 57th place with a 3.1 tons of cow's milk yield value in the world. According to TUIK data, the rate of increase in the cow milk yield value of the country remained at a level of only 27% in the 2004-2018 period. It could be stated that this situation, which is encountered in productivity, is closely related to the animal's racial characteristics (genotype structure) structure, as well as the housing conditions and nutritional level.

In the literature, there are different studies on the analysis of factors which could affect the amount of milk production in dairy cattle enterprises (Yılmaz et al, 2003; Mumba et al., 2012; Donald et al., 2015; Ma et al., 2018; Manta and Dimitriu, 2018; dos Santos et al., 2019; Majeed and Hadad, 2021). However, there are limited studies available on the determination of resource utilization efficiency of feeds used in dairy cattle farming in Turkey (Turan, 1997; Dağıstan, 1998; Gül, 1998; Bayramoğlu and Direk, 2006; Keskin and Dellal, 2011; Yılmaz et al., 2020).

According to 2019 data, in the province of Hatay, which is determined as the research area, the total cattle assets are 148036 heads and the amount of cow milk production is 168377 tons. Of the cattle assets in the province, 64.07% is cross-cultural, 31.19% is cross-breed and 4.74% is domestic breed animals (28).

In this research, it is aimed to determine the resource utilization efficiency with the help of functional analysis, in particular for roughage, concentrate feed and crushed feed inputs used in milk production in dairy cattle enterprises, which have an important place in the agriculture of Hatay province.

2. Literature Review

Again in the study conducted in Turkey, it has been calculated that in the estimation equation of milk production created, the coefficient of determination (R^2) is 0.94, and the sum of the coefficients of production elasticity (Σbi) is 1.457. Elasticity coefficients of the inputs are: Number of dairy cows (X_1): 1.279, Milking method: 0.038, Forage consumption (X_3) -0.251, Concentrate feed consumption (X_4) 0.391. In the conducted research, the amount of forage consumption has been found to be both statistically insignificant and negative (Gündüz and Dağdeviren, 2011).

In a study conducted in India, the factors affecting milk production according to the size of the farms were examined in a total of 150 farms consisting of those enterprises which are both members of dairy cattle cooperatives and non-members. When we examine the elasticity coefficients, it has been determined that green fodder, dry fodder and concentrated feed (concentrate) are statistically significant at the level of 5% in all of the enterprises that are members of the cooperative. In enterprises which are not members of cooperatives; concentrated feed is important in all farm size groups, dry fodder and green feed are important at the level of 1% in small and medium sized farms. As for the highest coefficient of elasticity, in concentrated feed, it is obtained from large enterprises that are not members of the cooperative (0.8999), in roughage (dry fodder) from small enterprises that are not members of the cooperative (0.7001), and in green feed however, it is obtained from large enterprises that are members of the cooperative (0.4036). In the research, it has been revealed that none of the factors is used effectively in dairy cattle enterprises (Meena et al., 2012).

In another study, the coefficient of determination (R^2) of the estimation equation of milk production was calculated as 0.565. The elasticity coefficients of the variables in the equation were calculated as; silage feed cost as 0.392, concentrate feed cost as 0.47, labor cost as -0.124, the capital used as 0.510 and dairy cattle's experience as -0.006. Among the variables, silage feed, concentrate feed and capital variables were found to be statistically significant at a level of 5%. In the examined enterprises, it has been determined that the milk yield is 9.14 lt/head and the milked cow number is 2.4 heads (Haloho et al., 2013).

In a different study, the factors affecting the amount of milk production (concentrated feed, green roughage, dry roughage, labor and veterinary health expenditures) have been examined with the help of the Cobb-Douglas production function. The coefficient of determination (R^2) of the estimation equation has been determined as 0.743, and the factors excluding labor force were found to be statistically significant at the level of 5%. The sum of the production elasticities of the variables in the function (Σbi) is calculated as 1.056, and there is an increasing return to scale. The efficiency coefficients of the variables in the function are determined as follow; for concentrated feed 1.596, for green roughage 0.929, for dry roughage 1.960, for labor force -0.079 and for veterinary health expenditures 37.243.

Evaluating the research in view of economy,it has been emphasized that the most important production factors affecting the amount of milk production in the examined enterprises are concentrated feed and veterinary costs (Pandian et al., 2013).

In the study conducted on 37 dairy cattle farms in Turkey, the coefficient of determination (R^2) of the estimation equation in milk production was 0.94, and the sum of the elasticity coefficients (Σbi) was calculated as 0.945. It was determined that a total of 19.93 kg of feed, 12.37 kg of roughage and 7.56 kg of concentrated feed per dairy cow was consumed per daily in the surveyed enterprises. The cost of feed constituted 91.74% of the variable costs. Among the variables in the equation, the number of dairy cattle (head), concentrate feed (kg) and roughage (kg) factors were found to be statistically significant at a level of 5%. Among the variables in the equation, the elasticity coefficient of the concentrated feed was calculated as 0.194, and the value of the roughage variable was calculated as 0.237. In the study, it has been found that the assets of dairy cows per farm were 4.46 heads, the daily milk yield per cow was 11.74 liters and the lactation period was 237.6 days (Gençdal et al., 2016).

In the recent study, which is conducted on 44 dairy cattle farms in Turkey, it is calculated that the coefficient of determination (R^2) value of the estimation equation related to milk production is 0.606, and the sum of the elasticity coefficients (Σbi) is determined as 1.66. Among the variables in the equation, the number of dairy cattle (head), lactation period (days) and concentrate feed (kg) factors have been found as statistically significant at the 10% level. Among the variables in the equation, the elasticity coefficient of the concentrated feed has been calculated as 0.355 and the value of the roughage variable as 0.529. In the study, the presence of milking cows per farm has been found to be 4.46 heads, the daily milk yield per cow has been 7.08 lt and the lactation period has been determined as 212 days. It has been calculated that per cow per day, 11.19 kg in total, 9.29 kg of roughage and 1.90 kg of concentrated feed is used. Feed cost constitutes 88.21% of the variable costs (Gençdal et al., 2016).

In another study on the subject, it has been found out that milk yield per cow in a lactation period is 6636.98 lt whereas it is 18.81 lt daily. And also the number of dairy cows per farm has been calculated as 20.68 heads, concentrated feed per cow is 4705.54 kg and roughage is 10960.65 kg. In the research, the coefficient of determination of the equation obtained in the enterprises that are members of the milk producers' association has been determined as (R^2) 0.58 and Durbin Watson d_h coefficient is 1.264. The sum of the elasticity coefficients of the variables in the equation has been calculated as 0.241. Among the variables, the factor affecting milk production at the highest level has been determined as the concentrated feed variable with a coefficient of 0.234. The coefficient of determination (R^2) of the equation obtained in non-member enterprises has been determined as 0.593 and Durbin Watson d_h coefficient as 1.832. The sum of the elasticity coefficients of the variables in the equation (Σbi) has been calculated as 0.675. Among the variables, the factor affecting milk production at the highest level was the concentrated feed variable with a coefficient of 0.261. The MRTS value between roughage and concentrate was found to be -0.257 (Oguz and Canan, 2016).

In a study conducted in New Zealand, the elasticity coefficient of concentrated feed was determined as 0.271 and forage feed as 0.075 in milk production function. It was determined that concentrate feed was statistically significant at the level of 1% and forage at the level of 5% (Manta and Dimitriu, 2018).

In the research conducted in Turkey examining the dairy farms, it was calculated that 85.20% of gross profit value was the milk production value, 9.80% of it was the increase in the asset value and 5% of it was the farm manure. Variable costs accounted for 72.02% and fixed costs for 27.98% in the cost of milk production. Feed costs accounted for 59.95% of total costs and 83.24% of variable costs in milk costs (Oguz and Yener, 2018).

In the research carried out on100 dairy cattle farms in Kosovo in the Balkans, the factors affecting dairy cattle were analyzed using the Cobb-Douglas production function. In the estimation equation obtained in the study, the production elasticity coefficient of the concentrated feed cost (X_1) variable was found as 0.44, the production elasticity coefficient of the silage feed cost (X_2) variable was 0.45, and the coefficient of other costs (X_3) was 0.21. All of the variables in the equation were found as statistically significant at the 5% level, and the sum of the elasticity coefficients of the factors (Σbi) was calculated as 1.10 (Musliu et al., 2019).

In the research conducted in Indonesia, the coefficient of determination (R^2) of the equation related to the factors affecting milk production was calculated as 0.91 and the coefficients of elasticity were calculated as 0.10 in concentrated feed and 0.13 in roughage. And both variables were found to be statistically significant at the 5% level (Kustopo et al., 2020).

3. Materials and Methods

3.1. Materials

The primary data of the study consisted of the data for the 2013-2014 production period obtained from 141 dairy cattle farms operating in the province of Hatay and which have been determined as a result of the sampling method applied. In the evaluation and analysis phase of the data, appropriate statistical package programs were used. Various reports and theses prepared in the country and around the world on dairy cattle were referred to in the study.

3.2. Methods

3.2.1. Method used in sampling

The data obtained from the Turkish-Vet System in the province of Hatay, which has been determined as the research area, revealed that the dairy cattle enterprises in the province showed a heterogeneous structure due to their different sizes. Stratification process is an appropriate method for data collection in cases where the population is heterogeneous. While with the stratification process, the ability of the sample volume to predict the main mass, that is, the sensitivity, increases, it is also possible to adequately represent different units in the population (Singh and Masuku, 2013).

As one of the Stratified Random Sampling Methods used in the determination of the sampling frame and sample number (volume) in the research, the "Neyman Method" formula is given below (Yamane, 1967).

$$n = \frac{[\Sigma(Nh * Sh)]^2}{N^2 * D^2 + [\Sigma(Nh * Sh)]^2}$$

$$D^2 = \left(\frac{d}{t}\right)^2$$

n = Sample Volume

N_h= The number of enterprises in the sampling frame belonging to the layer h

S_h= Standard deviation of data in the layer h

S_h^2= Variance of data in layer h

t= Table value of t for a certain confidence interval

N= Total Number of Enterprises per Sampling Frame

d= Represents a certain % of deviation from the mean.

In determining the sample volume, a 3.5% margin of error and a 95% confidence limits have been allowed. As a result of the sampling, 141 enterprises were identified. The following formula has been used to distribute the sample volume to the layers.

$$n = \frac{(N_h * S_h) * n}{\sum(N_h * S_h)}$$

In the determination of the enterprises to be surveyed, the enterprises have been divided into 3 groups considering the total dairy cattle (including calf, calf, heifer, cow) owned by the enterprises in the villages determined primarily. In the research, the first group consisted of 3-5 heads, the second group 6-10 heads, and the third group consisted of enterprises with 11 or more dairy cattle. The research has been carried out in 24 villages in 12 districts, taking into account the number of dairy cows and the amount of milk production in the districts which make up the province of Hatay. The number of samples in each group (n_h),

$nh = \frac{Nh}{N} * (\frac{n}{\sum NhSh})$ has been found with this equation.

It has been calculated that the number of questionnaires applied in the research is 141 units in total, 27 of which are in the 1st group enterprises, 32 in the 2nd group enterprises and 82 in the 3rd group enterprises.

3.2.2. The method used in determining the production cost of table tomatoes

The method applied in the functional analysis of milk production: Cobb-Douglas production function has been used in order to determine the relationships between the milk income obtained in the study and the factors affecting milk production. The Cobb-Douglas type of production function is widely used in applied research. The main purpose of the implementation of this model is that it complies with the data obtained regarding the production activity in question, it provides an easy calculation and a sufficient degree of freedom even when the statistical evaluation of the records obtained is not easy and the data is scarce (Dillon, 1966). This type of function is the most suitable one for functional analyzes in agricultural production research. Equation of the function (Ulveling and Fletcher, 1970); is in this form:

Taking the logarithm of the equation to transform the function in the exponential pattern into linear form, it could be written as this;

The "Y" dependent variable which is in the function expresses "$X_1, X_2, X_3, \dots, X_n$" independent variables. It takes the $b_i = 1, 2, 3, \dots, n$ values and reveals the production elasticity.

The "b" coefficients in the equation represent the production elasticity of the inputs. In the study, the coefficient of determination (R^2) has also been calculated. It expresses the rate of change of the value of the dependent variable "Y", which can be explained by the function type tried. Here the R^2 coefficient expresses what percentage of the total change in the dependent variable is explained by all of its variables. Autocorrelation in the econometric model has been analyzed with the Durbin-Watson test (Dawson and Lingard, 1982).

At a certain production level, the ratio of the percentage changes in any of the production factors to the percentage change on the production amount is referred as the production elasticity. Accordingly, the marginal production elasticities of the factors; If b1>1 is interpreted as increasing return for the x1 factor, if b1=1 as a constant return for the x1 production factor, if b1<1 is interpreted as the decreasing return for the x1 factor. In the Cobb-Douglas type production function, the sum of the b coefficients (production elasticities) gives the return to scale. This elasticity; If $\sum\beta_i < 1$, it means decreasing returns to scale, if $\sum\beta_i = 1$, it means constant return to scale, if $\sum\beta_i > 1$ means increasing returns to scale (4).

Average production has been calculated for the variables in the production function. Since the logarithmic transformation has been used in the Cobb-Douglas type or logarithmic production function, the average value of the X and Y is the geometric mean. The marginal yield value in exponential functions such as the Cobb-Douglas function has been calculated as

Marginal yield (MVi)= $\frac{Y}{X_i} * b_i$

.Marginal revenue (MR) is obtained by multiplying marginal yield and product price. The formula used in the marginal revenue calculation is shown below.

Marginal revenue $(MG_i) = MV_i * F_y$

Marginal Efficiency Coefficients (MEC), which are obtained by dividing marginal revenues by factor prices, express which factor is used more or less effectively and which factor is used more or less economically. The equation used to calculate the marginal efficiency coefficient is shown below (Singh et al., 2004; Mobtaker et al, 2010; Rafiee et al., 2010).

$$MEC = \frac{\text{Marginal Factor Revenue}}{\text{Marginal Factor Cost (Factor Price or Opportunity Cost)}}$$

In variables such as land and building, alternative returns of factor prices can be used. To what extent a factor is used effectively in a particular production can be determined by the efficiency coefficient. If the calculated efficiency coefficient is EC=1, it means that the factor is used effectively; if EC<1, the factor is overused and should be reduced; if EC> 1, it indicates that the factor is used less.

In the study, marginal technical substitution ratios (MTSR) between inputs were also calculated. As it is known, in cases where one of the two inputs has a negative and the other positive production elasticity, there is no substitution relationship between them. However, no negative correlation has been confirmed between the inputs in the study. From the calculated production equation, the MTSR between the factors, in other words, the amount of the factor X_1 versus the amount of the factor X_2 to obtain a production amount at the Y level has been calculated with the help of the formula below (Semerci, 2013).

$$MRTS\ xi, xj = -bjXig/biXjg$$

In the formula, b_i is the coefficient of the variable i, and X_{iG} is the geometric mean of the data related to the variables.

Marginal efficiency coefficient of factor combination:

For calculation of marginal efficiency coefficient of factor combination, marginal rate of technical substitution and price ratio should be known. Marginal efficiency coefficient of factor combination is calculated by dividing of marginal rate of technical substitution (MRTS) to price ratio (PR) (Semerci, 2013).

$$MRTS = \frac{\mathrm{dxi}}{dxj}$$

$$PR = \frac{\mathrm{Fxi}}{Fxj}$$

4. Research Findings

In the research, a regression analysis has been carried out in order to determine the relationships between the roughage, concentrate feed and crushed feed inputs used in milk production in dairy cattle enterprises and the amount of milk production. The dependent and independent variables in the prepared model are given below.

Y = Amount of milk produced (lt/enterprise),

X_1 = Amount of roughage (kg/enterprise),

X_2 = Amount of concentrated feed (kg/enterprise),

X_3 = Grain feed amount (kg/enterprise), The model obtained as a result of the regression analysis and the coefficients and significance levels of the variables in the model are given below.

$$Y = 1{,}144 * X_1^{0{,}488} * X_2^{0{,}249} * X_3^{0{,}279}$$

It has been found that the coefficient of determination of the function (R^2) is 0.833 and it has been referred as meaningful with a 1% probability level ($F_{calculation}$ 228.03 > F_{table}3.95). The coefficient of determination (Y), which is the dependent variable, states that 83.30% of the changes in the amount of cow's milk production can be explained by the variables in the model (Table 1 and Table 2).

Table 1: Variables and their importance levels in the regression equation

Variables	Coefficients	Standard errors of coefficients (S_e)	“t Value”	“P Value”
Constant	1,144	0,131	8,737	0,000
X_1	0,488	0,043	9,543	0,000
X_2	0,249	0,053	4,289	0,000
X_3	0,279	0,036	5,065	0,000

[S=0.118; R^2 = 83.30%; Corrected R^2 = 82.90%; F:228.03 (P>0.01); Durbin Watson-D Statistics = 1,700]

Table 2: Variance analysis table of dairy cattle production function

	DF	SS	MS	F	P
Regression	3	9,565	3,188	228,03	0,000*
Remainder	137	1,915	0,014		
Total	140	11,480			

(*): Significant at 1% level.

It has been found out that all of the variables in the model are statistically significant at a level of 1%. The coefficients obtained in the function express the increase that will occur in the dependent variable by a single unit increase in an independent variable while the other variables are constant. In the study, Durbin Watson-D Statistical Value has been calculated as 1,700. Since the Durbin Watson-D Statistical Value is above D_U, no autocorrelation has been found at the 1% significance level ($D_{L1,584}$ and $D_{U\ 1.665}$).

The correlation matrix which shows the relationships between the variables in the milk production function is given in Table 3. The relationships between the dependent variable and the independent variables and the independent variables have been found as significant at a level of 1% significance.

Table 3: Correlation coefficients between the factors in the production function (*)

Variables	Y (Milk production amount)	X_1 (Roughage)	X_2 (Concentrated feed)

X_1 (Forage)	0,848	-	-
X_2 (Concentrated feed)	0,801	0,703	-
X_3 (Grain feed)	0,788	0,662	0,750

(*): All the relationships between the variables are significant at the 1% level.

When we examine Table 3, it could be understood that there is no high-level of relationship between the variables. This shows that there is no multicollinearity. In the obtained function, the sum of the coefficients of the production elasticity has been calculated as 1.016. It is predicted that if the variables in the function are increased by 10%, the cow milk production amount of the enterprises could increase by 10,16%. Since the sum of the elasticity coefficients of the production factors is greater than 1, the function related to the estimation equation has increasing returns to scale. The marginal production elasticities of each of the factors of production in the production function are explained below.

X_1 (Forage): Whereas the sign of the production factor is positive and other variables are constant, a 10% increase in the amount of roughage will provide a 4.88% increase in the amount of milk production.

X_2 (Concentrated feed expenses): While the sign of the production factor is positive and other variables are constant, a 10% increase in the amount of concentrated feed will provide a 2.49% increase in the GOV of the milk.

X_3 (Grain feed): If the sign of the production factor is positive while other variables are constant, a 10% increase in grain feed amount will provide a 2.79% increase in milk production amount.

Marginal income and efficiency coefficients of the factors

The coefficients of marginal yield, marginal income and efficiency of the factors affecting the amount of milk produced in the examined enterprises are given in Table 4. Geometric mean values have been taken into consideration in the calculations carried out within the scope of the research. As can be understood by examining the relevant table, marginal revenue is below 1 in all of the variables.

Table 4: The marginal yield, marginal revenue and efficiency coefficients of the factors

Y = 20770.03 liters	X_1 (Forage)	X_2 (Concentrated feed)	X_3 (Crushed feed)
Geometric Average	7679,69	7589,15	7948,47
Marginal Yield	1,32	0,68	0,73
Marginal revenue	0,66	0,34	0,37

Factor price ($)	0,10	0,47	0,38
Efficiency coefficient	6,60	0,73	0,96

In the calculation of the efficiency coefficients of the variables in the estimation equation within the research, the factor price has been taken for milk as $0.50/lt, for roughage as $0.10/kg, for concentrated feed as $0.47/kg and for grain feed as $0.38/kg. By calculating the efficiency coefficients (EC), an answer could be found to the question of whether to reduce or to increase the amount used according to the current usage of a production factor. Calculated EC=1 (MG=MM) means that the factor is used effectively, EC<1 (MG>MM) means that it is overused, and EC>1 (MG<MM) means that it is used less and should be increased.

It could be understood from the calculated values that only the crushed feed input (X_3) is the closest to the optimum input (0.96) in the milk production of the enterprises. In the study, in order to reach the optimum economic point in milk production, it is necessary to increase the roughage (X_1) input in the function, and decrease the concentrate feed input (X_2) and other inputs as there is excessive use.

Marginal rates of technical substitution and price ratios of factor combinations

The fact that the production elasticity of the variables is positive indicates that the feed factors in the equation are in a substitute relationship. Considering the combinations between the factors, the estimation equation which is obtained reveals to what extent the factors could be reduced in order to stay at the same production level, . In the research conducted, it has been tried to measure to what extent the optimum level is approached by dividing the factor combinations to the rate of marginal rate of technical substitution rate factors. MTSR/FR values among the factors are given in Table 5.

Table 5: Marginal technical substitution rates and price ratios between factors (MTSR/PR)

	Marginal Technical Substitution and Price Ratios	X_2 (Concentrated Feed)	X_3 (Crushed feed)
X_1 (Forage)	$(dX_1 / dX_2) / (FX_2 / FX_1)$	(0,52) / (4,70) -0,11	(1,26) / (3,80) -0,33
X_2 (Concentrated feed)	$(dX_2 / dX_3) / (FX_3 / FX_2)$	-	(1,38) / (0,81) -1,71

Considering the Marginal Technical Substitution Rates; it could be understood that coarse feed is used more than concentrated feed, less than crushed feed, and concentrated feed is used less than crushed feed. In other words, provided that the same milk production amount is maintained, when we increase the amount of roughage by 1 unit, it is necessary to decrease 0.52 units in concentrate feed and 1.26 units in crushed feed. However, when comparing factor combinations, it is necessary to interpret the value obtained by dividing the Marginal Technical Substitution Rates by the price ratios of the inputs. In this case, according to the relevant chart, it could be seen that there is no near-optimal input component among the factor combinations.

Examining the factor combinations, it could be said that the use of roughage is less than concentrated and crushed feed, and it should be increased whereas concentrated feed input is used more than grain feed input and should be reduced. Obtained findings reveal that no feed factor has been used effectively in dairy cattle farms in the research area and that the optimum level could not be reached in any of the factor combinations. In other words, the feed combinations demonstrate that the use of resources is not at a rational level in the dairy cattle farms examined.

5. Conclusion and Recommendations

Studies on the subject reveal that the multiple determination coefficient (R^2) of the estimation equations showing the relationship between the amount of cow milk production or production value and the production factors that affect these variables is at a high level. This situation shows how high the level of explaining the relations between production and production factors with the determined variables is. It could be seen that the sum of the efficiency coefficients of the variables included in the equation (Σbi) is below 1 in some studies (Oguz and Canan, 2016; Gençdal et al., 2019) and above 1 in others (Gündüz and Dağdeviren, 2011; Pandian et al., 2013; Musliu et al., 2019). This is a significant indicator that reveals whether the enterprises are producing profitably or not.

The effect of roughage and concentrate feed used in dairy cattle production on the production function (efficiency coefficient) may differ from research to research. Gençdal et al., (2019) calculated the elasticity coefficient of the roughage variable as 0.529 and 0.355 for concentrated feed, which is one of the factors involved in milk production. In the study conducted by Oguz and Canan (2016), among the independent variables, the factor affecting milk production at the highest level was the concentrated feed variable with a coefficient of 0.234. In the study by Pandian et al. (2013), efficiency coefficients of the variables in the production function were measured as 1.596 in concentrate feed, 0.929 in green roughage and

1.960 in dry roughage. Haloho et al. (2013), on the other hand, determined that elasticity coefficients were 0.392 for silage feed cost and 0.47 for concentrate feed cost. In the study by Musliu et al. (2019) however, production elasticity coefficient of concentrate feed variable was determined as 0.44 and production elasticity coefficient of silage feed variable was determined as 0.45. In the study by Gündüz and Dağdeviren (2011), it was determined that elasticity coefficient of inputs was -0.251 in roughage consumption and it was 0.391 for concentrate feed consumption. In the study by Gencdal et al. (2019) on the other hand, elasticity coefficients were determined as 0.194 for concentrate feed and 0.237 for roughage. In this study, however, the elasticity coefficients of the factors were determined as 0.228 in roughage, 0.183 in concentrate feed and 0.284 in grain (crushed) feed. When the feeds used in cow milk production are evaluated as roughage and concentrated feed, these values reveal that the enterprises have positive effects on milk production. The marginal yield, marginal income, factor prices and marginal efficiency coefficients of the factors involved in milk production vary from country to country. The findings obtained in this study revealed that dairy cattle enterprises should increase their roughage use levels and reduce the amount of concentrated feed used, and that the use of crushed feed is utilized at a level close to optimum.

When the findings obtained in this study are compared with the other research findings, it has been shown that the variable costs constitute the most important part on the overall costs and the feed costs consist of the most significant cost among the variable costs in dairy cattle enterprises. The main result obtained in this study, which has been carried out in parallel with other research findings, is that the enterprises do not utilize their feed resources (roughage, grain feed and concentrate feed) effectively. Likewise, this situation shows itself both in examining the factors one by one and in factor combinations.

In this study, rational use levels of feed resources that are effective in milk production have been investigated with the help of the data obtained from 141 dairy cattle farms determined according to the sampling method in Hatay province. Within the scope of the research, it has been attempted to analyze how effectively the roughage, concentrate and grain feed inputs, which are effective in milk production, are used both on the basis of factor and on the basis of factor compositions.

In the examined enterprises, the gross income of the dairy cattle business branch is $ 2.3 million, the highest share belongs to milk and dairy products with 83%. The average milk production in the surveyed enterprises is 27.4 tons, and the average milk yield per cow has been determined as 18.73 lt/head/day. Variable costs have a share of 64% in the total cost of milk production, and the share of feed costs in variable costs has been calculated as 80%.

The present research reveals that the feed production areas are insufficient in the examined enterprises. This situation entails that the enterprises meet their feed needs from feed factories. The fact that feed factories in Turkey are dependent on foreign resources for raw material increases the cost of the feed to the enterprise. This situation, especially the abnormal increase in the US$ exchange rate sometimes makes it difficult for feed imports and animal nutrition.

In the regression analysis for the amount of milk production, all of the variables have been found to be statistically significant. It has been determined that there is no autocorrelation and multicollinearity in the derived function. The marginal income of the variables in the estimation function has been found below 1. The factor with the highest efficiency coefficient of the inputs has been the roughage input with a value of 6.60. In order to reach the optimum economic level in terms of feed utilization in dairy cattle activities in the province of Hatay, it is concluded that the roughage input in the estimation equation should be increased and other inputs should be decreased.

The research findings showed that none of the inputs have been used effectively in the examined enterprises and yet the optimum economic level could not be approached in any of the factor combinations. In other words, the results of the research have revealed that there is no rational use of resources in milk production in dairy cattle enterprises, and it is not at a rational level.

6. References

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