Technical efficiency of dairy buffalo farms: a case of Igdir Province, Turkey

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Abstract

The study aimed to determine cost and technical efficiency of dairy buffalo farms. The data of the study were collected from 65 dairy buffalo farms by using whole counting method in Igdir province, Turkey. Data envelopment analysis (DEA) method was used to calculate technical efficiency scores of farms. The results of the research were divided into two groups as efficient and inefficient farms. The average cost of buffalo milk production per liter was calculated as $0.70 in overall farms, $0.51 in efficiency farms and $0.98 in inefficient farms. The variable costs founded 75.28% of the total milk cost and the biggest items of milk production costs were feed cost (61.42%), labor cost (12.72%) and depreciation (5.11%). According to the DEA, average technical efficiency scores of dairy buffalo farms were 0.84 and this result showed that the inefficient farms could decrease their inputs use by 16%. In order to increase the efficiency of dairy buffalo farms in the region, the farmers should manage their inputs efficiently by providing efficient extension services. In addition, for sustainability of buffalo farms, the government should be increasing the amount of support given to the farmers.

Keywords: Dairy buffalo farms, Milk cost, Technical efficiency, Data envelopment analysis, Igdir, Turkey.

1. Introduction

The livestock sector is very important in the agricultural sector of the world. According to the 2018 data of the Food and Agriculture Organization of the United Nations (FAO), 33.94% of the world's $3.5 trillion agricultural production value was obtained by the livestock sector. In Turkey, livestock sector obtained 36.72% of total agricultural production value (FAO, 2018).

A sub-branch of the agricultural sector is a lower branch of livestock sector, bovine livestock. Bovine livestock consists of cattle, buffalo and camels. Buffalo breeding is carried out for the purpose of milk, meat and skin production. Buffalo milk is being preferred for the production of cheese, cream and ice-cream and yoghurt with its high fat. Buffalo meat is being used for production of sausages and similar products due to its low fat and buffalo skin is being used in shoe and bag making industries as it is thick enough and (AKPINAR et al. 2019).

In 2019, in the world had 1.7 billion bovine livestock and the share of the buffaloes in total bovine livestock were 11.6%. But, the share of the buffaloes in total bovine livestock were only 1% in Turkey. Number of buffaloes in Turkey constituted 0.08% in the world buffalo. Between 1991 and 2019, although the number of buffaloes in the world had increased by 36%, in Turkey had decreased by 50% (FAO, 2019).

The total buffalo milk production was 133.7 million tons in the world in 2019. India was the world's largest buffalo milk producing country with 67.31%. This was followed by Pakistan and China with 25.14% and 2.14%, respectively. Turkey produced 79,341 tons buffalo milk and Turkey's share in world buffalo milk production was 0.05% (FAO, 2019). Between 1991 and 2019, total buffalo milk production in Turkey had decreased from 161 thousand tons to 79 thousand tons. In 2019, the share of buffalo milk production in total milk production in Turkey was only 0.38% (TURKSTAT, 2019). There has been a significant decrease in production of buffalo milk in Turkey since 1991. In recent years, importance has been given to buffalo breeding, the number of which has decreased considerably in Turkey (GDoAE, 2019). Although milk production of buffalo tends to increase in recent years with the agricultural supports given to buffalo breeding in Turkey after 2008, it is not sufficient level (Figure 1).

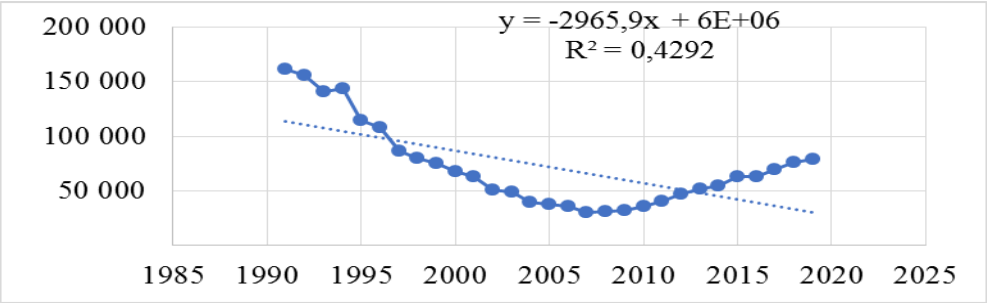

Figure 1: Changes in buffalo milk production in Turkey between 1991 and 2019

Although the milk yield per buffalo in the world has increased 78% during the period of 1991-2019, in Turkey has increased only 6% in the same period. In 2019, the milk yield per buffalo was 1,000 kg in Turkey and this data was about half of the world average (FAO, 2019). From this, it was understood that the dairy buffalo farms in Turkey could not be operated effectively.

The Turkish government has supported buffalo breeding to increase production and sustainability since 2008. For a sustainable and profitable livestock, breeders should benefit from government supports, as well as providing efficiency (KAYGISIZ et al. 2018). Due to the limited resources in the world, the effective use of resources also forms the basis of the science of economics. For this reason, there is great importance of research on the effective use of resources. Productive and efficient use of the production factors in the agricultural sector is very important in order to meet the food demand of increasing population, to increase life standards of farmers and to fulfil agricultural development (BOZOGLU and ALHAS EROGLU, 2012). In Turkey, it is very important that the existing farms sustainability their production in buffalo breeding which has experienced a significant decrease in recent years. For buffalo farms to sustainability production, they need to use their resources efficiently and effectively. Therefore, this study aimed to determine costs and technical efficiency of dairy buffalo farms.

2. Literature Review

In the literature, when the researches on buffalo farms are examined, it was seen that the researches were mostly on the economic analysis of buffalo farms (AYUB et al., 1990; DEL GIUDICE, 2004; BARDHAN et al., 2005; SENO et al., 2007; SIROHI et al., 2007; MENGHI et al., 2007; CICEK et al., 2009; GUNLU et al., 2010; BABAR et al., 2011; HASAN et al., 2016; ISIK and GUL, 2016; MEENA et al., 2016; PATIL and RUDRAPUR, 2016; POPA et al., 2016; GUL et al., 2018a; OZGER, 2018; KARLI et al., 2021). At the same time, there were also researches comparing the production milk cost of cattle and buffalo (SIROHI et al., 2007; MEENA, 2008; ATHAR et al., 2011; BABAR et al., 2011; GHULE et al., 2012; SINGH et al., 2012; NARAYAN et al., 2015; JADAV et al., 2016; PATIL and RUDRAPUR, 2016). While some of the studies found that the cost of cattle milk was higher than the cost of buffalo milk (MEENA, 2008; SINGH et al., 2012), there were also studies that determine the cost of buffalo milk to be higher than the cost of cow's milk (SIROHI et al., 2007). NARAYAN et al. (2015) in Rajasthan and PATIL and RUDRAPUR (2016) in Dharwad

district of India, it was determined that buffalo milk production was more profitable than cattle milk production.

In literature, there were many researches about efficiency analysis of agriculture farms. Although these researches on efficiency analysis were mostly on bovine livestock (FOGARASI and LATRUFFE, 2007; STOKES et al., 2007; BRAVO-URETA et al., 2008; CABRERA et al., 2009; GUNDUZ, 2011; KULEKCI, 2013; ŞANAL, 2013; ALVAREZ et al., 2014; HAZNECI and CEYHAN, 2015; KUMBAR, 2015; BOZOGLU et al., 2017; TERIN et al., 2017; GUL et al., 2018b; KAYGISIZ et al., 2018; MARETH et al., 2019; SHRESTHA et al., 2019), there were also researches on sheep and goat breeding (PEREZ et al., 2007; TORO-MUJICA et al., 2011; THEODORIDIS et al., 2012; FURESI et al. 2013; YILMAZ, 2019; YILMAZ et al., 2020). It has been determined that almost all of the researches on efficiency analysis are on dairy cattle. But there were very limited studies on the efficiency analysis of buffalo farms (KAYGISIZ et al., 2018; SHRESTHA et al., 2019). KAYGISIZ et al. (2018) using DEA method on efficiency analysis of buffalo farms in the Çatalca district of Istanbul, they found that 53% of the farms were efficient and 47% were inefficient. SHRESTHA et al. (2019) divided that four group of buffalo farms as low efficiency, medium low efficiency, medium high efficiency and high efficiency, they found that these four farm groups with efficiency scores of 0.42, 0.59, 0.73 and 0.88, respectively in Chitwan region.

In Turkey, the literature review revealed that only one research has been conducted about technical efficiency of buffalo farms (KAYGISIZ et al., 2018). But no study has been carried about cost and efficiency on buffalo farms in Igdir province. Therefore, this research is expected to fill this gap in the literature.

3. Material and Methods

3.1. Study area and data collection

The research was carried out in the Igdir province of Turkey. The study area is located at northeastern of Turkey and is the border of Turkey to Armenia along the Aras river, and borders Nakhchivan and Iranian to the east and southeast, Ağrı and Kars provinces to the south and the west and northwest (Figure 2). The region is located between 39°53′37″north parallels and 43°59′52″ east meridians. Igdir province is approximately 3664 km^2 in size and has a population of 201,314 living in 4 districts and 157 villages (TURKSTAT, 2020).

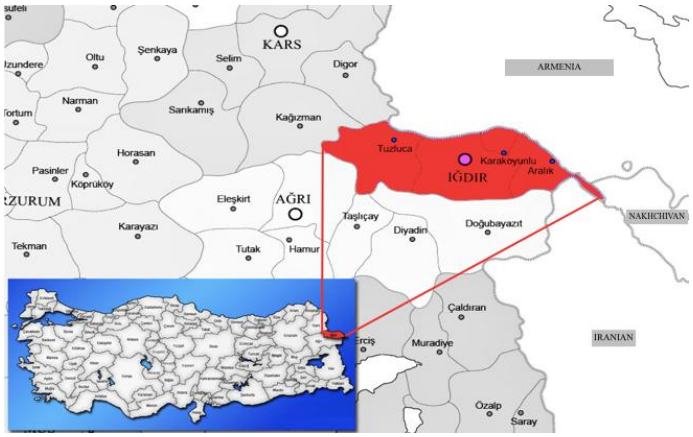

Figure 2: Map of study area in Igdir Province, Turkey

The districts of Aralik, Karakoyunlu, and Center were selected as the research area, and these districts provided 100% of the total dairy buffalo population in Igdir province. So, the data used in this study were obtained from 65 dairy farms by using whole counting method. The primary data of the study were collected from the dairy buffalo farms via face-to-face surveys from 65 farmers between February and March of 2021. The secondary data was obtained from the Food and Agriculture Organization and the Ministry of Agriculture and Forestry of Turkey.

3.2. Cost of milk production

Costs were computed variable, fixed and total costs. Variable costs included roughages feeds, concentrate feeds, grain feeds, veterinary, medicine and vaccine, salt, water, electricity, bedding, insurance, halter, and membership fee, etc. Among fixed costs, those related to the use of fixed assets have been accounted for and are represented by the depreciation associated with the usage of each fixed asset (CECCHINI et al. 2016). Fixed costs included general administration, family labor, interest of capital, depreciation, repair and maintenance, and rent of land. The general administration cost was 3% of the variable costs. Total costs were the sum of variable costs and fixed costs. To assess the animals based on the same criteria, all parameters were converted into Animal Unit (AU) with the aid of relevant coefficients (ERKUS et al. 1995).

In calculations for milk production costs of the buffalo dairy farms, total milk productions were taken into consideration assuming the milk produced were not processed into any products. The following equation was used to calculate milk production costs:

$$Unit\ costs\ \left(\frac{TL}{lt}\right) = \frac{Total\ milk\ production\ costs - Inventory\ increment}{Total\ milk\ production}$$

3.3. Technical efficiency method

Technical efficiency point out ability to reach maximum production quantity with a particular amount of input. Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis is commonly used for measure of efficiency. DEA was developed by CHARNES et al. (1978), is a non-parametric approach. The idea behind DEA is to use linear programming methods. Efficiency is measured relative to this frontier, where all deviations from the frontier are assumed to be inefficiency. Consider n farms producing m different output using h different inputs. Thus, Y is an m*n matrix of outputs and X is an h*n matrix of inputs. Both matrices contains data for all n farms. The technical efficiency (TE) measure under the assumption of Constant Returns to Scale (CRS), can be formulated as follows:

Subject to $\quad min_{\theta,\lambda}\theta$

$-y_i + Y\lambda \geq 0,$

$\theta\chi_i - \mathrm{X}\lambda \geq 0,$

$\lambda \geq 0$

$\theta\epsilon(0,1]$

and solved for each farm. θ_i is farm i's score of technical efficiency relative to the other farms. y_i expressed the output and x_i represents the input of farm i. $Y\lambda$ and $\mathrm{X}\lambda$ are the efficient projections on the frontier. A measure of θ_i=1 indicates that the farm is completely technically efficient. Therefore, 1-θ_i measures how much farm i's inputs can be correspondingly reduced without any loss in output. This equation expresses the production efficiency in conditions of CRS. However, the assumption of CRS is correct only as long as farms are run in the optimum scale (COELLI et al. 1998). Various constraints on inputs like financing, and the aims of the owner may cause the farm to operate at a non-optimal scale. Using the CRS DEA model when farms are not operating at their optimal scale will cause. The TE-measures to be influenced by Scale Efficiencies (SE) and thus the measure of technical efficiency will be incorrect. By adding a convexity constraint to the model above Variable Returns to Scale (VRS) is instead assumed:

Subject to $\quad min_{\theta,\lambda}\theta$

$-y_i + Y\lambda \geq 0,$

$\theta\chi_i - \mathrm{X}\lambda \geq 0,$

$$N1'\lambda = 1$$

$$\lambda \geq 0$$

$$\theta \epsilon (0,1]$$

The new constraint is $N1'\lambda = 1$where N1 is a n*1 vector of ones. This constraint makes the comparison of farms of similar size possible, by forming a convex hull of intersecting planes, so that the data is enveloped more tightly. The technical efficiency measures under VRS will always be at least as great as under the CRS-assumption.

Technical efficiency scores can be calculated by assuming either a CRS or VRS production process. For this research, both the CRS and VRS models that are input oriented were used to provide additional insights on dairy buffalo farming efficiency. The CRS model was selected for benchmarking purposes.

In this research, the output (y_i) was taken as buffalo annual total milk production (lt) and the inputs (x_i) were taken as roughage feeds (kg), concentrate feeds (kg), labor (Male Labor Unit), number of milking buffalo (head), cost of veterinary, medicine and vaccine ($), other costs ($) and barn size (m^2). That is, in this research, an efficiency model with 1 output and 7 inputs was created. The DEAP 2.1 package program was used to estimate the technical efficiency score of farms.

The research findings were given by separating into two groups as efficiency and inefficiency. The independent samples t test and chi-square tests were used to measure the differences within efficiency groups using Statistical Package for the Social Sciences (SPSS) 24 program.

4. Results and Discussion

4.1. Technical efficiency of the dairy buffalo farms

The distribution of the technical efficiency scores obtained using the DEA model results was provided in Table 1. The mean technical efficiency score was determined to be 0.84 with CRS, 0.95 with VRS and 0.88 with SE. The mean technical efficiency score of 84% with CRS means that the possibility of the inefficient farms could decrease their inputs use by 16%. KAYGISIZ et al. (2018) determined that the mean efficiency score of 0.81 in dairy buffalo farms in İstanbul of Turkey, it means that the possibility of the inefficient farms could decrease their inputs use by 19%. SHRESTHA et al. (2019) found that production efficiency score of low, medium, medium high and high efficiency group on dairy buffalo farms in Chitwan region were 0.42, 0.59, 0.73 and 0.88, respectively.

AYDEMIR et al. (2020) reported that total efficiency score of dairy cattle farms in Artvin province with CRS, VRS and SE were 0.544, 0.650 and 0.860, respectively. GUL et al. (2018b) found that the mean technical efficiency score of dairy cattle farms 69% with CRS and 78% with VRS in East Mediterranean Region in Turkey. BOZOGLU et el. (2017) found that a lower efficiency score of dairy cattle farms under CRS (0.530) and VRS (0.89) in Bafra district in Turkey. JOHANSSON (2005) found that the average technical and economic efficiency scores were found to be 0.77 and 0.43 respectively, meaning that there are considerable inefficiencies in Swedish average dairy production. So, it could be suggested that technical efficiency of buffalo dairy farms was higher than the dairy cattle farms.

Table 1: The distribution of the technical efficiency scores by DEA model

Efficiency score	CRS		VRS		SE	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
≤0.70	15	23.0	4	6.2	11	16.9
0.71-0.80	6	9.2	7	10.7	4	6.2
0.81-0.90	9	13.8	2	3.1	10	15.3
0.91-0.99	8	12.4	7	10.7	13	20.0
1.00	27	41.6	45	69.3	27	41.6
Average		0.846		0.950		0.885
Minimum		0.314		0.605		0.454
Maximum		1.00		1.00		1.00

Distribution of the estimated technical efficiency score of input-oriented DEA method result are provided in Figure 3. Out of the 65 dairy buffalo farms, 27 farms (41.6% of the overall farms) were managed efficiently under CRS and SE, 45 farms (69.3% of the overall farms) were managed efficiently under VRS. It has been determined that 23% of the farms have technical efficiency score below 70% under CRS. On the other hand, the technical efficiency scores of 35.4% of dairy buffalo farms were between 71% and 99% under CRS. In the research area, a technical efficiency score of 16.9% of the dairy buffalo farms were smaller than 80% and 13.8% of the dairy buffalo farms were between 81% and 99% under VRS.

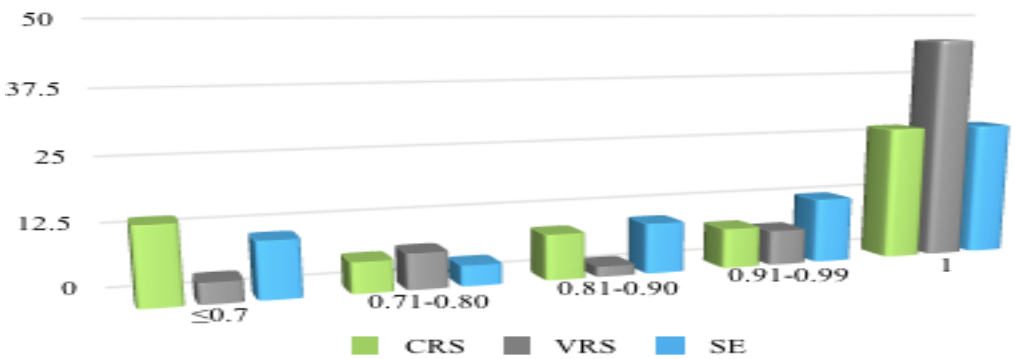

Figure 3: Distribution of the estimated technical efficiency scores

4.2. Socio-demographic and structural characteristics of the dairy buffalo farms

The descriptive statistics of buffalo farms characteristics were given in Table 2. The average age of almost all male farmers is 48 years. The average household size was 6 person and the average education status was 5.6 year. While the social security of farmers in the efficient farms were 33.4% and 21.1% in inefficient farms. The rate of the primary profession as farmer were determined 96% in efficient farms and 94% in inefficient farms. GUNLU et al. (2010) found that producer's education levels were determined as 62.12% primary school, 19.70% secondary school and 18.18% high school and buffalo breeding was the main occupation in 87.88% of farms and a secondary profession for the rest with 12.12% in Afyonkarahisar province of Turkey. The average buffalo farming experience and land size was around 15 years and 5.7 hectares for overall farms, respectively. While the proportion of owing the farm land was 81.2% for all groups and the farm land consisted of 6.8 parcels. OZKAN et al. (2017) found that the average age and experience of buffalo farmers in Samsun province were 52 and 29.6 year, respectively. The rate of farmers insuring animals (24.61%) and members to agricultural organization were very low (18.46%). The rates of insurance to animals were found by BASER and BOZOGLU (2021) and OZKAN et al. (2017) as 18% and 3.8%, respectively. However, the rates of members to farm organizations were found by BASER and BOZOGLU (2021), OZKAN et al. (2017) as 28.6% and 67.4%. SHRESTHA et al. (2019) emphasized also that buffalo farms in the low efficiency group less access to dairy co-operatives.

The results highlighted that while the rate of insuring animals of farms in Igdir province is higher than in Samsun province, members to organizations in Igdir province is very lower than other province. The average distance of the farm to the district and province center were 5.96 km and 28.87 km, respectively. There was a statistically significant difference among the groups in terms of the distance to district ($p<0.05$). Although, efficient farms were closer to the province center than the inefficient farms, inefficient farms were closer to the district center than the efficient farms. Number of Animal Unit (AU) in the all farms, in the efficient farms and in inefficient farms were 22.28, 29.08 and 17.45, respectively. There was a statistically significant difference among the groups in terms of the number of AU ($p<0.05$). KAYGISIZ et al. (2018) found that number of AU and number of milking buffalo were 44 and 26 head, respectively in Istanbul, Turkey. Number of buffaloes in the all farms, in the efficient farms and in inefficient farms were 11.04 head, 14.77 and 8.39 head, respectively. There was a statistically significant difference among the groups in terms

of the number of buffalo ($p<0.05$). Efficient farms had more animal and buffalo compared inefficient farms. Number of milking buffaloes in the all farms, in the efficient farms and in inefficient farms were 8.89 head, 12.03 and 6.65 head, respectively. The number of milking buffaloes owned by efficient farms were twice that of inefficient farms. There was a statistically significant difference among the groups in terms of the number of milking buffalo ($p<0.05$). GUNLU et al. (2010) found that number of milking buffalo in Afyonkarahisar province was 6.74 head. The average age of milking buffalo was 6.21 year of all farms. Twenty five percent of the efficient farms used machines for milking buffalo, this rate was 28.94 in inefficient farms. The average indoor barn area in the efficient and inefficient farms were 105 m^2 and 97 m^2, respectively. While the average open barn area in the efficient and inefficient farms were 34 m^2 and 72 m^2, respectively. So, these rates showed that using open barns of inefficient farms is higher than others. OZKAN et al. (2017) stated that the average indoor barn area in buffalo farms in Samsun province was 131 m^2. It is stated that the lactation period of buffaloes in Turkey is between 180-280 days (ATASEVER and ERDEM, 2008). In this research, it was determined that the average lactation period of buffaloed was 180 days in all farms. This period was slightly lower than the other research (GUNLU et al., 2010; HASAN et al., 2016; ISIK and GUL, 2016; KAYGISIZ et al., 2018; KOYUNCU et al., 2021).

Table 2: Descriptive statistics of buffalo farms' characteristics

Characteristics	Efficiency Farms (N=27) (%41.6)		Inefficiency Farms (N=38) (%58.4)		Overall Farms (N=65) (%100.0)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Gender						
Female (%)	3.70	-	2.63	-	3.07	-
Male (%)	96.29	-	97.36	-	96.92	-
Age (year)	48.48	9.93	48.21	8.29	48.32	9.01
Household size (person)	6.07	2.73	6.73	2.34	6.46	2.53
Education (year)	5.66	4.13	5.60	3.82	5.63	3.95
Social security (%)	33.44	-	21.10	-	26.15	-
Main profession as Farmer (%)	96.29	-	94.73	-	95.38	-
Buffalo farming experience (year)	16.14	9.87	15.42	9.97	15.72	9.94
Non-agricultural income (%)	33.44	-	21.05	-	26.15	-
Total agricultural land (da)	72.11	74.08	46.94	58.73	57.49	66.71
Forage crop lands (da)	72.14	74.15	47.07	60.06	57.49	67.42
Number of parcels (unit)	7.74	5.03	6.13	4.37	6.80	4.72
Owing the farm land (%)	78.00	-	83.69	-	81.23	-
Insuring animals (%)	18.51	-	28.94	-	24.61	-
Member to agri. organization (%)	11.11	-	23.68	-	18.46	-
Distance to district (km)*	6.29	6.71	5.72	5.39	5.96	5.98
Distance to province (km)	24.18	18.01	32.21	19.32	28.87	19.20
Number of AU*	29.08	21.23	17.45	7.52	22.28	15.91
Number of Buffalo (head)*	14.77	12.25	8.39	4.01	11.04	9.04
Number of milking buffalo	12.03	10.29	6.65	3.57	8.89	7.65

(head)*						
Age of milking buffalo (year)	6.37	2.16	6.10	2.38	6.21	2.29
Milking with machine (%)	25.92	-	28.94	-	27.69	-
Indoor barn area (m^2)	105.62	51.38	97.36	50.08	100.80	50.79
Open barn area (m^2)	34.07	71.40	72.63	29.27	56.61	19.60

* $p<0.05$

4.3. Production cost of dairy buffalo farms

Table 3 shows the production costs of buffalo farms and rational distribution. Total costs of buffalo milk production in all farms were $6,551 for 8.89 milking buffalo. The average total costs of buffalo milk production were $7,020 for 12.03 milking buffalo in efficient farms and $6,218 for 6.65 milking buffalo in inefficient farms. According to calculations made total buffalo milked in farms, the ratio of costs for variable and fixed were 75.28% and 24.72%, respectively. The biggest items of milk production costs were feed cost (61.42%), labor cost (12.72%), depreciation (5.11%). BARDHAN et al. (2005) found that feed costs account for 60-70% of total costs in milk buffalo farms. PATIL and RUDRAPUR (2016) determined that cost of concentrates (45%), green fodder (25%) and cost of dry fodder (13%) were the major contributor to the total cost of buffalo milk production. DEL GIUDICE (2004) determined that the percentage of milk production costs items of buffalo farms in Italy was 72% on feed, 18% on labour, 5% on veterinary care and certificates, and the remainder on other costs. GUNLU et al. (2010) emphasized that the most important factor for expenses were feed (42.84%) and labour cost (27.48%) in the field of water buffalo breeding. KAYGISIZ et al. (2018) found that the biggest items of buffalo milk production costs were feed cost (54.23%), labor cost (25.87%) and depreciation (10.15%). AYUB et al. (1990) determined that maximum expenditure of buffalo farms were feed cost with 47.88% and labour with 29.50%. CICEK et al. (2009) determined that biggest item cost of buffalo farms were feed cost (42.19%), labour cost (27.26%) and veterinary medicine and drug cost (21.57%) in Afyonkarahisar region of Turkey. OZKAN et al. (2017) determined that biggest item cost of buffalo farms were feed cost (31.31%), labour cost (13.18%) and depreciation (11.55%) in Samsun province. So, it could be suggested that the biggest items of buffalo milk production costs in the literature were similarly with the present research findings.

While the shares of concentrate feed in efficient farms and inefficient farms were found as 19.30% and 16.83%, the shares of grain feeds in efficient farms and inefficient farms were found as 19.34% and 22.42%, respectively. The quantity of family labor use in the efficient farms ($922) was higher than the inefficient farms ($770). The inefficiency buffalo

farms have higher production costs. SHRESTHA et al. (2019) emphasized also that buffalo farms in the lower efficiency farm group tend to have higher production costs.

Table 3: Production costs of dairy buffalo farms and rational distribution

Cost items	Efficiency Farms (N=27) (%41.6)		Inefficiency Farms (N=38) (%58.4)		Overall Farms (N=65) (%100.0)	
	Costs ($)	%	Costs ($)	%	Costs ($)	%
Roughage feeds	1,595.3	22.72	1,380.9	22.21	1,469.9	22.44
Concentrate feeds	1,355.2	19.30	1,046.2	16.83	1,174.6	17.93
Grain feeds	1,357.6	19.34	1,394.3	22.42	1,379.1	21.05
Barn cleaning	78.3	1.12	75.8	1.22	76.8	1.17
Animal care (grooming)	55.0	0.78	23.5	0.38	36.6	0.56
Buffalo calves care nutrition	292.6	4.17	320.9	5.16	309.1	4.72
Hired labor	13.4	0.19	4.5	0.07	8.2	0.12
Salt	31.7	0.45	6.7	0.11	17.0	0.26
Veterinary	138.2	1.97	112.8	1.81	123.4	1.88
Medicine and vaccine	64.2	0.91	64.8	1.04	64.6	0.99
Electricity	47.3	0.67	38.4	0.62	42.1	0.64
Halter	8.0	0.11	0.7	0.01	3.8	0.06
Membership fee	7.0	0.10	1.8	0.03	4.0	0.06
Tool Machine repair maintenance	129.5	1.84	212.2	3.41	177.8	2.71
Marketing	46.2	0.66	44.4	0.71	45.1	0.69
Total variable cost (A)	5,219.5	74.35	4,727.9	76.03	4,932.1	75.28
General administration	156.6	2.23	141.8	2.28	148.0	2.26
Family labor	922.6	13.14	770.0	12.38	833.4	12.72
Depreciations	398.4	5.68	289.6	4.66	334.8	5.11
Interest of capital	245.0	3.49	236.9	3.81	240.3	3.67
Repair and maintenance	78.3	1.12	52.1	0.84	63.0	0.96
Total fixed cost (B)	1,800.9	25.65	1,490.4	23.97	1,619.3	24.72
Total costs (C=A+B)	7,020.4	100.00	6,218.2	100.00	6,551.4	100.00

$1= 7.38 ₺ (average exchange rate of dollar in February and March of 2021)

Unit milk cost of dairy farms is provided in Table 4. Total buffalo milk net costs of all farms were $5,629 for 8.89 milking buffalo. Average total net costs per buffalo in the efficient and inefficient farms were $494 and $812, respectively. GUL et al. (2018a) found that total production costs were $833 per buffalo. The average annual total buffalo milk production of the all farms, efficient and inefficient farms were 8,028, 11,586 and 5,499 liters, respectively. It has been determined that total milk production of efficient farms twice as much milk than inefficient farms. The average total milk production was found higher as 4,355 liters by ISIK and GUL (2016).

The average costs of buffalo milk production per liter in the efficient and inefficient farms were $0.51 and $0.98, respectively. The cost of buffalo milk in the inefficient farms were about twice as high in the efficient farms. The cost of one-liter buffalo milk in overall farms were calculated $0.70. ISIK and GUL (2016) determined that the cost of per kilogram buffalo milk in the Mus province of Turkey was calculated as $0.64. KAYGISIZ et al. (2018)

determined that the cost of per kilogram buffalo milk in the İstanbul province of Turkey was calculated as $1.74.

Table 4: Unit buffalo milk cost of farms

	Efficiency Farms (N=27) (%41.6)	Inefficiency Farms (N=38) (%58.4)	Overall Farms (N=65) (%100.0)
	Value ($)	Value ($)	Value ($)
Total costs (A)	7,020.4	6,218.2	6,551.4
- Increase in value of calves	807.0	616.9	695.9
- Buffalo calves' sales	260.0	201.5	225.8
Total additional income (B)	1,067.0	818.4	921.6
Total net costs (C=A-B)	5,953.4	5,399.9	5,629.8
Total net costs per buffalo	494.8	812.0	633.2
Total milk production (lt) (D)	11,586.7	5,499.5	8,028.0
Unit cost of milk ($/lt) (C/D)	0.51	0.98	0.70

4.4. Economic indicators of dairy buffalo farms

According to the research findings, the average annual milk yield per buffalo of the overall farms were 928 liters. While this data was very close to the Turkey average, it was half of the world average. The average annual milk yield per buffalo of the efficient and inefficient farms were 1,100 and 806 liters, respectively. It was %36.5 less in the inefficient farms. BOZOGLU et al. (2017) found that milk yield per cow in the inefficient farms were 26.3% less than in the efficient farms. GUNLU et al. (2010) reported that milk production of buffalo per year in Afyonkarahisar province was 1,078 kg. ISIK and GUL (2016) stated that the average milk production of buffaloes per year in Mus province was 954.4 kg. SHRESTHA et al. (2019) found that the average annual milk yield per buffalo on a farm was 900 litres in Chitwan region of Nepal and PATIL and RUDRAPUR (2016) determined that the milk yield per buffalo in a year was 2,470 lt in Dharwad district of India. Although the total milk production results of the present study were agreement with the related literature in Nepal and other province of Turkey, it was less than half of the average buffalo milk yield of India. The average milk yield per buffalo per day in all farms, efficient farms and inefficient farms were 5.15, 6.11 and 4.47 liters, respectively. KOYUNCU et al. (2021) found that lactation period and daily milk yield were determined as 240 days and 5 liters, respectively in Mustafakemalpaşa district of Bursa province. AYUB et al. (1990) found that average daily milk yield per buffalo was 5.73 liters in Muzaffargarh, Pakistan. BABAR et al. (2011) underlined that average milk yield per buffalo per day was 12.4 liters and buffalo milk yield was positively associated with green fodder and concentrates in Maharashtra of India. It was determined that while daily buffalo milk yield in this research was similarly the related literature in Turkey, less than the Pakistan.

The price-cost ratio for the overall farms, efficient farms and inefficient farms were 1.56, 2.11 and 1.11, respectively. The price-cost ratio in efficient farms were about twice as high in the inefficient farms. This value is higher than that of KAYGISIZ et al. (2018) report but lower than that of OZGER (2918) and OZKAN et al. (2017) reported. The rates of the input-output ratio and the cost/benefit ratio for buffalo farms were determined by AYUB et al. (1990) and GUNLU et al. (2010) as 1.37 and 0.92, respectively. The rates of the benefit/cost

ratio for buffalo farms were determined by PATIL and RUDRAPUR (2016) and KAYGISIZ et al. (2018) as 2.37 and 1.27, respectively.

Table 5: Economic indicators of dairy buffalo farms

	Efficiency Farms (N=27) (%41.6)	Inefficiency Farms (N=38) (%58.4)	Overall Farms (N=65) (%100.0)
	Value	Value	Value
Milk yield (L/buffalo/year)	1,100.5	806.5	928.38
Milk yield (L/buffalo/day)	6.11	4.47	5.15
Milk price ($/L)	1.1	1.1	1.1
Price-cost ratio (%)	2.11	1.11	1.56
Gross production value per buffalo	1,196.7	885.2	1,015.2

Agricultural income and profit of investigated farms is given in Table 6. The total agricultural income of all farms, efficient farms and inefficient farms were $14,116, $21,393 and $8,946, respectively. Total buffalo milk income was calculated as $9,975 in efficient farms, and $4,994 in inefficient farms. Total buffalo milk income of efficient farms were twice as high in the inefficient farms. The average total buffalo dairy farming income in efficient and inefficient farms were $17,363 and $7,273, respectively. Non-agricultural income of efficient farms were higher than $284.4 (37.54%) inefficient farms.

While the average livestock supports of the all farms, efficient and inefficient farms amounted to $365, $470 and $290, respectively. The average forage supports of the all farms, efficient and inefficient farms amounted to $243, $277 and $219, respectively. The efficient farms have received total agricultural supports %46.65 more than the inefficient farms.

Table 6: Agricultural income and profit of investigated farms ($)

Income	Efficiency Farms (N=27) (%41.6)	Inefficiency Farms (N=38) (%58.4)	Overall Farms (N=65) (%100.0)
Total agricultural income	21,393.0	8,946.9	14,116.8
- Total buffalo milk income	9,975.6	4,994.9	7,063.8
- Total buffalo dairy farming income	17,363.1	7,273.4	11,464.5
Non-agricultural income	1,041.8	757.4	875.5
Total agricultural supports	748.4	510.3	609.2
- Livestock supports	470.6	290.6	365.4
- Forage supports	277.8	219.7	243.8
Total farm income	23,183.3	10,214.5	15,601.5
Gross product value per buffalo	1,196.7	885.2	1,015.2

5. Conclusions

In the last thirty years, while the number of buffaloes in the world has increased by 36%, there has been decrease by 50% in Turkey. Similarly, although milk production from buffaloes increased by 300% in the world, decreased by 50% in Turkey during the period of 1991-2019. Although the number and milk production of buffalo tend to increase in recent years with the agricultural supports given to buffalo breeding in Turkey after 2008, it is not sufficient level. In addition, although there has been a significant increase (78%) in buffalo milk yield in the world, buffalo milk yield in Turkey has remain the same, moreover it is half of the world average in the last thirty years. From this, it is understood that the dairy buffalo farms in Turkey cannot to be operated effectively.

This research provides detailed insights into the economic sustainability of dairy buffalo farming within the scope of technical efficiency in Igdir province of Turkey. Input-oriented Data Envelopment Analysis (DEA) approach was used to estimate the technical efficiencies of dairy buffalo farms. The research findings were given by separating into two groups as efficiency and inefficiency. According to the DEA, average technical efficiency scores of dairy farms were 0.84. This result showed that the possibility of the inefficient farms could decrease their inputs use by 16%. The cost of buffalo milk production per liters was $ 0.70 and price/cost ratio of 1.56 in overall farms. Total milk production and price/cost ratio of efficient farms were twice of inefficient farms. The cost of buffalo milk in the inefficient farms were about twice as high in the efficient farms. This shows that production was a profitable in study area but the inefficient farms were not being operated to produce enough profitability. In order to increase the efficiency of dairy buffalo farms in the region, the farmers should manage their inputs efficiently by providing efficient extension services.

The variable costs founded 75.28% of the total milk cost and the main cost items in dairy farming were feed cost (61.42%), labor cost (12.72%) and depreciation (5.11%). In order to reduce production costs in farms, buffalo breeders should be encouraged to plant more forage crop lands. At the same time, the support given to forage crop lands should be increased.

Organizations are very important tool for solving economic, social and professional problems of farmers. According to the research findings, it has been determined that the level of organization of the buffalo milk producers is very low since there is no organizations to be a member. Based on the results from this study, the organizations of buffalo milk producers should be encouraged in the research area for on efficient use of inputs and increase their profitability and efficiency. The share of agricultural supports in total agricultural income was only 4.31%. If sufficient agricultural support is not given to buffalo breeders, buffalo farming will face the danger of extinction. In order to increase the size and sustainability of dairy buffalo farms, the government should be increasing the amount of support given to the dairy buffalo farmers.

In order to increase the demand and the awareness of the consumers, public spots should be created for the promotion of buffalo milk and its products. In addition, farmers' days, panels and symposiums should be organized in which buffalo milk and its products are promoted. This study was carried out with dairy buffalo farms in Igdir province. Researches on buffalo farming in other provinces in Turkey were very insufficient. So, there is need for research to determine the efficiency of buffalo farms in other provinces of country for sustainability.

6. References

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