Economic Weights of Milk Production Traits for Buffalo Herds in the Southwest of Iran Using Profit Equation

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Abstract: This study was conducted in order to calculate the economic weights of milk yield and fat percent for the dairy buffalo production systems in the southwest of Iran. We collected herd structure, milk yield and fat percent records, revenues and costs data of 30 buffalo herds under the rural system in six cities for a 14-months period of calving interval. There were two payment systems, 1) milk sale for Shosh and Shadegan and 2) milk and cream sale for Ahwaz, Dezful, Shoshtar and Dasht-Aadegan. Using profit equation, the economic values for milk production and fat percent in six cities and in the Khuzestan province were calculated as $0.53, $0.61, $0.53, $0.40, $0.38, $0.58 and $0.54 and $3.30, $14.65, $6.63, $-13.05, $-18.80, $9.14, $7.54, respectively. Results indicated that a major weight should be given to fat in the cities with cream making. Sensitivity analysis showed that an increase in the price of milk and produced cream and reduction in the feed and non-feed costs resulted in increased economic value and vice versa. In the proposed payment system based on milk and Mozzarella cheese for dairy buffaloes the profit of the herds increased and protein had a higher price compared to fat.

Key words: Buffalo • Iran • Fat percent • Milk yield and Economic weight

INTRODUCTION

According to the latest available statistics, there are about 459 thousand head of buffaloes in Iran which its ranking among 43 countries in the world is 16 [1, 2]. One of the largest buffalo populations in Iran is the Khuzestani buffalo with approximately 138 thousand head of buffaloes in the southwest region of Iran [2]. Buffalo is characterized by outstanding features such as high percentage of fat, rapid weight gain, high relative strength against some diseases, optimal use of low-quality food and producing some special products such as Mozzarella cheese. In Khuzestan province rearing and breeding practices on buffalo farms is under the rural system and buffaloes are reared in the open areas due to the long heat season of the region. Depending on financial status of farmers, buffaloes are kept in small herds and in some cases their number is less than 10 head of buffaloes. The relative importance of buffalo production in various regions of the province is the same and buffaloes are primarily reared for milk production. So that, about 40 percent of dairy products of the province is allocated to the buffaloes. Totally, buffalo population in this province and the quality and value of its products, make buffalo as an important native animal in this region and cause to pay more attention to the improvement of the buffalo products and development of the buffalo breeding in the province. However, until now an appropriate breeding program with specific target for genetic improvement of buffalo products has not been developed. Increasing production...
capacity and full use of the genetic potential of this animal could provide a significant portion of the protein requirements of the province and it is effective in economic development of the buffalo breeding.

In general, in dairy animals, milk production and its components have economic importance more than other traits and with changes in these traits, the most changes is achieved in profitability. Komlosi et al. [3] in the study of 15 milk production, functional, growth and carcass traits for Hungarian Holstein Friesian cattle reported the highest economic importance for milk production traits [3]. Also, because of importance of milk components, these components are routinely used in many countries as a criterion to determine the milk price. So, the first and most important goal of the dairy buffalo breeding programs can be increasing milk production and its components, reducing costs and maximizing net profit of the farmers. Additionally, because high percentage of fat (7-6%), buffalo milk has special features and its products can be of high economic value. The payment system is one of the important factors which influence economic weight of the production traits. Banga et al. [4] studied economic weight of milk volume, fat and protein yield of Holstein and Jersey cattle based on milk payment systems of 4 major milk buyers in South Africa and reported that economic values for these traits varied substantially among the payment systems [4].

Most researchers reported that the first step in designing a breeding program would be make decisions about suitable breeding purposes, because usually a standard global and even a national breeding goal do not exist for a particular species [5]. The purpose of breeding animals is to achieve maximum economic merit [6]. Economic merit is a linear function of additive genetic value of the traits with correction factors on the genetic level of these traits, which are called economic weight [7]. In other words, the contribution of genetic improvement of one trait in improving the efficiency of a production system is called as economic value or economic weight of the trait [8, 9]. Economic weights are also essential in predicting revenues of a breeding program. Methods for calculating economic values can be grouped in two categories: normative approaches also referred to as bio-economic modeling and positive approaches, which involve analysis of field data [9, 10]. One of the selection interests in livestock breeding is to maximize profit where great importance is given to the interests of producers. This subject is important because it shows us which trait or traits have the greatest impact on profits and should be placed in breeding program. In this way, a deterministic model is formed to explain the economic performance of the system. Many authors have defined and have used a profit equation to compute economic values in different situations [11, 12]. However, finding the appropriate definition of profit for a particular situation is not always obvious [13]. Therefore, to develop a buffalo breeding and to improve the economic status of buffalo herders in Khuzestan it is necessary to design a comprehensive breeding program with suitable goals.

The aim of this study was to evaluate the economic importance of milk production and fat percent traits for buffalo herds in Khuzestan province using profit equation and to evaluate the differences between estimated economic weights of the traits in different condition of studied herds. The selection interest assumed for this analysis was the maximization of profit at herd level. Additional analysis was also performed on the sensitivity of these economic values to changes in various factors of production.

**MATERIALS AND METHODS**

In this study, revenues and costs information of 30 buffalo herds in six cities of Ahwaz, Dezful, Shoshar, Shosh, Shadegan and Dasht-Azadegan in Khuzestan province of Iran were used to calculate the economic coefficient for milk yield and fat percent. Data were collected for a 14-month period of calving interval from 2010 to 2011. All prices and costs were based on annual average of the herds with the average herd size of 25 buffaloes. Herds were selected from main areas of buffalo breeding which covered different climatic conditions and buffalo production systems of the province. A breeding and management in all herds is under the rural system and they have totally 640 buffalo cows. In Khuzestan, most of the buffalo herds are located close to the rivers and wetlands of the province and after morning milking, buffaloes are usually fed and then are taken to rivers or wetlands for swimming and grazing for 3 to 4 hours. Buffalo’ going out is taken place twice a day in summer days. In some cases like herds of Shoshar, buffaloes are taken to the woods or pastures, out of the village, from late of winter and remain there for 2 to 3 months of a year. In all herds, the milking is performed twice a day by hand in the presence of the calf to facilitate milk letdown.

In dairy cattle, to compute economic values for milk components like fat percent, government milk pricing system (based on components of milk) are used. Currently in Iran, the payment for cow milk is based on volume of milk and its composition but, milk yield of all buffalo herds
in Khuzestan are sold in free markets and based on its volume. However, in the cities of Ahwaz, Dezful, Shoshhtar and Dasht-Azadegan some herds separate some part of daily milk to produce and sale some local cream (This cream is produced traditionally at farms with boiling milk for 20 minutes and after cooling it separating gathered fat from top of the milk as a cream). We used this production system to calculate the economic value of fat percent for buffalo milk. Base milk in our study was defined as one kg of milk yield with the average of fat percent which was estimated for each herd. Using recorded data of milk yield and fat percent of these buffalo herds in mentioned period of time, the average of annual milk production and the fat percent per buffalo cow was calculated for 30 herds (Table 1). Costs and revenues were calculated in two systems for all herds. System in milk, all milk was sold to milk and dairy sellers. In the system of fat and milk, they remove fat from some part of milk as cream and then sale it and remaining milk with low fat (skim milk), animals (calves, and milk, they remove fat from some part of milk as cream Revenues sources (R) from the herds were buffalo milk was sold to milk and dairy sellers. In the system of fat and milk, all protein were derived using feed cost of production of 1 kg milk, all protein were derived using feed cost of production system to calculate the economic value of fat percent for buffalo milk. Base milk in our study was defined as one kg of milk yield with the average of fat percent which was estimated for each herd. Using recorded data of milk yield and fat percent of these buffalo herds in mentioned period of time, the average of annual milk production and the fat percent per buffalo cow was calculated for 30 herds (Table 1). Costs and revenues were calculated in two systems for all herds. System in milk, all milk was sold to milk and dairy sellers. In the system of fat and milk, they remove fat from some part of milk as cream and then sale it and remaining milk with low fat (skim milk), in addition to usual milk selling.

Herds in the studied cities used materials such as rice bran, wheat flour, bagasse, wheat straw and forages such as clover, Sydangras, barley silage, alfalfa and sugarcane crops depending on the desired city, to feed their buffaloes. Clover, Sydangras and barely in buffalo herds of Ahwaz and Dasht-Azadegan are often cultivated and in Shadegan the plants of the wetland is used to feed buffaloes.

Since, during the review of records from herds measuring individual feed intake per day was not possible, daily feed intake and nutrient requirements of maintenance, growth, fertility and milk production of buffaloes, were extracted using tables of NRC [14](requirements of heavy weight dairy cattle) and book of Research and Breeding of buffalo by A. Borghes [14, 15]. In this study, requirements of heavy weight dairy cattle were used because there were not the unique and complete requirements for different age and sex groups of buffalo. Then, animals were grouped and diets were balanced based on the average weight of buffalo cows (650 kg), bulls (550 kg), calves (160 and 315 kg) and heifers (450 kg). For lactating buffaloes, the milk was converted to a 4 percent FCM basis. According to the average of annual feed cost, cost per kg feed intake per day was calculated for different above groups. It should be noted that management and nutrition must be in optimum level in estimating economic coefficients, consequently, the cost of balanced diets were considered. To estimate the energy requirements for one percent of fat and protein production, we use the metabolizable energy (ME) requirement for the formation of 1 g of the milk fat and milk protein. The theoretical efficiencies for use of ME for milk fat and protein synthesis as estimated from Mertens and Dado [16] were 98 and 89 percent, respectively [16]. Reported heats of combustion of 1 g milk fat and protein are 9.29 and, 5.47 kcal. So, the theoretical ME requirements for the formation of 1 g of each of them would be 11.50 and 6.10 kcal for fat and protein [17]. For the National Research Council (NRC) estimate of the energy requirement for fat production (regression of ME requirement on fat content = 16.3 kcal/g) and efficiencies of energy conversion for the other major milk component at the same proportions derived by Mertens and Dado [16], the ME requirements for the formation of 1 g of the milk fat and protein will be 16.3 and 8.5 kcal [16]. Then feed cost of accessory one percent of fat and protein were derived using feed cost of production of 1 kg of milk.

Revenues sources (R) from the herds were buffalo milk, cream and remaining skim milk, animals (calves, heifers, culled buffalo cows and buffalo bulls) and manure sales. Annual costs (C) were calculated as the cost of producing a kilogram of milk (feed cost + non-feed costs), accessory cost for one percent milk fat (feed cost), variable costs of herd (including of the average cost of transportation, construction and repairing, electricity, water, labor, health, the annual average of feed cost) and fixed costs per herd with an average of 30 buffalo cows. The average feed costs was including of feed cost of buffalo bulls, calves, heifers, pregnant buffaloes in 3-month dry period and also maintenance of lactating buffaloes. Fixed costs included cost of buildings and equipments.

As mentioned above, studied herds are under rural system that usually depending on the farmer financial and building materials of the region, buffalo barns are made from different building materials. Most of the materials used in these buildings are locally available substances such as wood, reed, palm branches and leaves and thatch. But there are buffalo herds with new construction or repaired buildings which used mostly iron, brick or cement block and fiberglass sheet as roof. Because of this reason and also these buildings often have been made more than two to three decades ago, therefore, these structures have no significant cost to insert in the profit balance. However, 300 m² barn and hay loft was considered per herd with the average of 30 buffalo cows, that with considering the costs required to construct such buildings currently ($ 12235) and 30-years life of the buildings as an average, the annual cost structure for each herd is $ 407.83. It is important to note that the currency used in Iran is the Rial ($1=12260 Rials).
According to the experimental cream producing done at our laboratory with 5 samples of milk with different fat percent, results showed that for each accessory percent of fat, 11 g of cream will be added to the cream. For calculating the amount of Mozzarella cheese, we also use the reported index below [18]:

\[
PKM = \frac{3.5 \times (\% \text{Protein}) + 1.23 \times (\% \text{Fat}) - 0.88}{100}
\]

A deterministic model was developed with the aid of Microsoft Excel 2007 for the calculation production performance, revenues and costs, as well as economic values for the milk production and fat percent traits and balancing diets in a system production of dairy buffaloes. Annual herd revenues (TR) and annual herd costs (TC) were calculated using equation 1 and 2:

\[
TR = N \left[ M \left( (1-m)B + (m* u) + m(C*q) \right) + r \right]
\]

where,
- \( N \) is the Number of lactating buffaloes in the herd; \( M \) is the average of milk yield per lactation; \( m \) is part of milk sale as cream and remaining milk (low fat milk); \( B \) is the average of buffalo milk price; \( u \) is the average of milk price remaining after cream making (low fat milk); \( C \) is the amount of cream yield per kg basic milk with specified fat percent; \( q \) is the average of cream price; \( r \) is the revenues from buffalo calves, heifers, buffalo bulls, culled buffalo cows and manure sales per lactating buffalo cow;

\[
r = \left( \frac{NBS}{N} \right) \times BS + \left( \frac{NLs}{N} \right) \times LS + \left( \frac{NHs}{N} \right) \times HS + \left( \frac{NCS}{N} \right) \times CS
\]

where, \( NBS \) is the number of buffalo bulls sold in year, \( BS \) is buffalo bull payment, \( NLS \) is the number of culled buffalo cows sold in year, \( LS \) is culled buffalo cow payment, \( NHS \) is the number of buffalo heifers sold in year, \( HS \) is heifer payment, \( NCS \) is the number of buffalo calves sold in year and \( CS \) is buffalo calf payment.

\[
TC = N \left[ M \left( b + S \right) + D + h \right]
\]

where, \( T \) is the average cost of transportation per cow in year, \( CR \) is the average cost of construction and repairing per cow in year, \( E \) is the average cost of electricity per cow in year, \( W \) is the average cost of water per cow in year, \( L \) is the average cost of labor per cow in year and \( H \) is the average cost of health practices per cow in year.

\[
\text{FeedCosts} = \frac{\text{FCM} \times \left( \frac{\text{NB}}{N} \right) \times \text{FCB} \times \left( \frac{\text{NC}}{N} \right) \times \text{FCC} \times \left( \frac{\text{NH}}{N} \right) \times \text{FCH} \times \left( \frac{\text{ND}}{N} \right) \times \text{FCD}}{}
\]

where, \( \text{FCM} \) is the average maintenance feed cost of a lactating buffalo in year, \( \text{NB} \) is the number of buffalo bulls in the herd in year, \( \text{FCB} \) is the average feed cost of a buffalo bull in year, \( \text{NC} \) is the number of buffalo calves in the herd in year, \( \text{FCC} \) is the average feed cost of a buffalo calf in year, \( \text{NH} \) is the number of buffalo heifers in the herd in year, \( \text{FCH} \) is the average feed cost of a buffalo heifer in year, \( \text{ND} \) is the number of dry buffalo in the herd in year and \( \text{FCD} \) is the average feed cost of a pregnant buffalo cow in dry period in year.

In this study, all costs and revenues are in US $, the production unit is a lactating buffalo cow and a production time unit was considered as a year. Total annual profit of buffalo herd (TP) was calculated as the following equation:

\[
TP = TR - TC
\]

where, \( TR \) is the total revenue of the herd in a year ($/ herd per year) and \( TC \) is the total cost of the herd in a year ($/ herd per year). The economic value of a trait has been defined as the change in profit of the farm expressed per average present lactating cow per year, as a consequence of one unit of change in genetic merit of the trait considered [9]. So, in our study, economic value was calculated as the change in profit (revenue less costs) per unit change in the trait:

\[
V_i = TP_i - TP_{i0}
\]

where, \( V_i \) is economic value of \( i^{th} \) trait, \( TP_i \) is the profit after the genetic change of \( i^{th} \) trait and \( TP_{i0} \) is the basic profit.

The difference of economic coefficients of two traits in terms of the different situation of buffalo herds in each city and province were also studied. In order to test the sensitivity of derived coefficients to changes in prices and costs, the rate of ±20 percent changes was done in prices and costs. Economic values were also recalculated for all traits assuming as change in production factors and then stability of coefficients were determined.
RESULTS AND DISCUSSION

Data collected from 30 buffalo herds through a 14-month period were used to derive the average of annual milk yield and fat percent, basic and economic parameters of the studied herds. The average of two traits and economic herd parameters for 6 cities of the province are summarized in Table 1, 2 and 3, respectively.

The average of total profit is estimated as \$ 43.7, \$ 109.2, \$ 48.3, \$ -98.2, \$ -273.7 and \$ 206.3 per cow per year for herds in Ahwaz, Dezful, Shoshtar, Shosh, Shadegan and Dasht-Azadegan, respectively. Milk revenues accounted for 62, 69, 63, 51, 56 and 78% of total revenues for above cities, respectively. Among cities, the most revenue from cream sale was 19.5 and 17% of milk revenues for herds of Dezful and Shoshtar, respectively. A profitability of the herds (profit to cost ratio) in the cities were also calculated as 0.022, 0.056, 0.035, -0.067, -0.13, 0.088 and -0.04 for Ahwaz, Dezful, Shoshtar, Shosh, Shadegan, Dasht-Azadegan and Khuzestan province, respectively. The calculated total profit and profitability for each city showed the relationship between revenues from milk, especially cream sale and the profitability.

The feed costs accounted for 66, 70, 77, 75, 76 and 68% of variable costs in the herds of Ahwaz, Dezful, Shoshtar, Shosh, Shadegan and Dasht-Azadegan, respectively, which was the most important cost for the herds especially in city of Shoshtar, Shadegan and Shosh.

The economic values calculated according to the described model for milk production and fat percent are given in Tables 4 and 5. These tables show that at the base condition and maximized profit interest, coefficient of milk production in the city of Ahwaz, Dezful, Shoshtar, Shosh, Shadegan, Dasht-Azadegan and in the province, as the average of six cities, are \$ 0.53, \$ 0.61, \$ 0.53, \$ 0.40, \$ 0.38, \$ 0.58 and \$ 0.54, respectively and the coefficient of fat percent for these cities and the province are \$ 3.30, \$ 14.65, \$ 6.62, \$ -13.05, \$ -18.80, \$ 9.14 and \$ 7.54, respectively. This means that if the average of milk production of one dairy buffalo is increased as one kg in one lactation period, the profit in the basic system in the herds in these six cities and in the province will be increased as \$ 0.53, \$ 0.61, \$ 0.53, \$ 0.40, \$ 0.38, \$ 0.58 and \$ 0.54, respectively. Also, with increasing fat percent of one buffalo milk yield as one percent per year, the above amounts are added to the profit of the system.

Table 1: The average of milk yield and fat percent in the buffalo herds of six studied cities at the province

<table>
<thead>
<tr>
<th>City</th>
<th>Milk yield (kg)</th>
<th>Fat percentage</th>
<th>Protein percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahwaz (Average of 5 herds)</td>
<td>1639</td>
<td>5.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Dezful (Average of 5 herds)</td>
<td>1670</td>
<td>6.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Shoshtar (Average of 5 herds)</td>
<td>1171</td>
<td>6.0</td>
<td>4.6</td>
</tr>
<tr>
<td>Shosh (Average of 5 herds)</td>
<td>1059</td>
<td>5.0</td>
<td>4.3</td>
</tr>
<tr>
<td>Shadegan (Average of 5 herds)</td>
<td>1502</td>
<td>5.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Dasht-Azadegan (Average of 5 herds)</td>
<td>2515</td>
<td>6.0</td>
<td>4.3</td>
</tr>
<tr>
<td>The Average of six cities</td>
<td>1593</td>
<td>5.7</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Table 2: Estimates of the economic parameters of the revenue equation for each city and the province as the average of six cities (\$)

<table>
<thead>
<tr>
<th>City</th>
<th>*m%</th>
<th>B</th>
<th>u</th>
<th>C (g)</th>
<th>c1 (g)</th>
<th>q</th>
<th>BS</th>
<th>LS</th>
<th>HS</th>
<th>CS</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahwaz</td>
<td>17</td>
<td>0.73</td>
<td>0.41</td>
<td>72</td>
<td>11</td>
<td>8.2</td>
<td>1678.00</td>
<td>1480.00</td>
<td>1085.00</td>
<td>798.00</td>
<td>785.00</td>
</tr>
<tr>
<td>Dezful</td>
<td>24</td>
<td>0.77</td>
<td>0.41</td>
<td>85</td>
<td>11</td>
<td>8.2</td>
<td>2181.30</td>
<td>1448.61</td>
<td>1482.33</td>
<td>755.10</td>
<td>636.02</td>
</tr>
<tr>
<td>Shoshtar</td>
<td>21</td>
<td>0.70</td>
<td>0.41</td>
<td>78</td>
<td>11</td>
<td>8.2</td>
<td>1870.20</td>
<td>1216.50</td>
<td>1719.87</td>
<td>580.00</td>
<td>530.57</td>
</tr>
<tr>
<td>Shosh</td>
<td>0</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1660.45</td>
<td>1377.30</td>
<td>1356.33</td>
<td>614.50</td>
<td>665.36</td>
</tr>
<tr>
<td>Shadegan</td>
<td>0</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1725.47</td>
<td>1118.62</td>
<td>1594.03</td>
<td>575.45</td>
<td>781.57</td>
</tr>
<tr>
<td>Dasht-Azadegan</td>
<td>19</td>
<td>0.73</td>
<td>0.41</td>
<td>78</td>
<td>11</td>
<td>8.2</td>
<td>1817.75</td>
<td>1121.53</td>
<td>1649.96</td>
<td>758.73</td>
<td>554.82</td>
</tr>
<tr>
<td>The Average</td>
<td>20</td>
<td>0.73</td>
<td>0.41</td>
<td>74</td>
<td>11</td>
<td>8.2</td>
<td>2125.15</td>
<td>1510.52</td>
<td>1637.10</td>
<td>719.87</td>
<td>649.41</td>
</tr>
</tbody>
</table>

\*m = the share of milk sale as cream and remaining milk (low fat milk) in year; B = the average price of buffalo milk in year; u = the average price of milk remaining after cream making (low fat milk) in year; C = g of cream production per kg milk with specified fat percent of the city in year; c1 = g of cream was added for each accessory percent of fat; q = the average price of cream in year, BS the average of buffalo bull payment in year, LS the average of culled buffalo cow payment in year, HS = the average of heifer payment in year, CS = the average of buffalo calve payment in year and r = the revenues from animals and manure sales per cow in year.
Table 3: Estimates of the economic parameters of the cost equation for each city and the province as the average of six cities ($)

| City          | \( b^* \) | S1  | S2  | T     | CR   | E    | W    | L     | H     | FCM   | FCB   | FCC   | FCH   | FCD  |
|---------------|-----------|-----|-----|-------|------|------|------|-------|------|-------|-------|-------|-------|------|------|
| Ahwaz         | 0.24      | 0.012 | 0.010 | 69.85 | 51.23 | 2.13 | 3.58 | 160.16 | 3.18 | 503.63 | 1260.21 | 383.41 | 579.32 | 165.58 |
| Dezful        | 0.23      | 0.012 | 0.007 | 140.64 | 51.47 | 1.95 | 3.50 | 125.84 | 19.27 | 554.93 | 1031.76 | 367.50 | 445.85 | 202.77 |
| Shoshtar      | 0.23      | 0.012 | 0.007 | 41.56  | 22.10 | 1.54 | 2.60 | 108.18 | 2.32 | 318.86 | 1176.82 | 461.88 | 690.20 | 111.04 |
| Shosh         | 0.25      | 0.012 | 0.007 | 24.06  | 38.74 | 1.72 | 1.72 | 138.18 | 1.30 | 212.96 | 908.81  | 314.87 | 638.37 | 391.80 |
| Shadegan      | 0.27      | 0.012 | 0.007 | 32.91  | 27.10 | 2.26 | 5.31 | 108.70 | 6.72 | 314.83 | 1634.82 | 574.74 | 740.05 | 374.72 |
| Dasht-Azadegan| 0.20      | 0.013 | 0.007 | 95.85  | 17.64 | 7.55 | 12.20 | 545.32 | 12.63 | 493.97 | 1370.5  | 396.35 | 630.29 | 183.60 |
| The Average   | 0.24      | 0.012 | 0.007 | 75.27  | 33.78 | 3.50 | 7.16 | 254.02 | 8.50 | 427.94 | 1230.48 | 411.65 | 660.25 | 221.97 |

\( b^* \) = the average cost of production 1 kg of basic milk in year (feed cost + non-feed cost), S1 = accessory feed cost for 1 percent milk fat, S2 = accessory feed cost for 1 percent milk protein, T = the average cost of transportation per cow in year, CR = the average cost of construction and repairing per cow in year, E = the average cost of electricity per cow in year, W = the average cost of water per cow in year, L = the average cost of labor per cow in year and H = the average cost of health practices per cow in year, FCM = the average of maintenance feed cost of a head lactating buffalo cow, FCB = the average feed cost of a head buffalo bull in year, FCC = the average feed cost of a head buffalo calve in year, FCH = the average feed cost of a head buffalo heifer in year and FCD = the average feed cost of a head pregnant buffalo cow in dry period in year.

Table 4: The economic value of milk production in the basic situation and 20% variation in level of any production factors with respect to basic situation ($)

<table>
<thead>
<tr>
<th>Milk production</th>
<th>Ahwaz</th>
<th>Dezful</th>
<th>Shoshtar</th>
<th>Shosh</th>
<th>Shadegan</th>
<th>Dasht-Azadegan</th>
<th>The province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic condition</td>
<td>0.53</td>
<td>0.61</td>
<td>0.53</td>
<td>0.40</td>
<td>0.38</td>
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<td>Non-food costs +20</td>
<td>-0.02</td>
<td>-0.01</td>
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<td>-20</td>
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<td>0.03</td>
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</tr>
<tr>
<td>Price of buffalo milk +20</td>
<td>0.12</td>
<td>0.12</td>
<td>0.11</td>
<td>0.13</td>
<td>0.13</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>-20</td>
<td>-0.19</td>
<td>-0.11</td>
<td>-0.10</td>
<td>-0.13</td>
<td>-0.13</td>
<td>-0.11</td>
<td>-0.11</td>
</tr>
<tr>
<td>Price of local cream +20</td>
<td>0.02</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
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<tr>
<td>-20</td>
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<td>-0.03</td>
<td>-0.03</td>
<td>-0.03</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.02</td>
</tr>
<tr>
<td>Share of selling local cream +20</td>
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<td>0.02</td>
<td>0.014</td>
<td>0.02</td>
<td>0.02</td>
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</table>

Table 5: The economic value of milk fat percentage in the basic situation and 20% variation in level of any production factors with respect to basic situation ($)

<table>
<thead>
<tr>
<th>Fat Percent of Milk</th>
<th>Ahwaz</th>
<th>Dezful</th>
<th>Shoshtar</th>
<th>Shosh</th>
<th>Shadegan</th>
<th>Dasht-Azadegan</th>
<th>The province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food costs +20</td>
<td>-4.1</td>
<td>-3.9</td>
<td>-2.86</td>
<td>-2.61</td>
<td>-3.76</td>
<td>-6.32</td>
<td>-3.93</td>
</tr>
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<td>-20</td>
<td>4.1</td>
<td>3.9</td>
<td>2.88</td>
<td>2.61</td>
<td>3.76</td>
<td>6.31</td>
<td>3.92</td>
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<tr>
<td>Non-food costs +20</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Price of buffalo milk</td>
<td>+20</td>
<td>5</td>
<td>7.2</td>
<td>4.4</td>
<td>-8.6</td>
<td>-5.7</td>
<td>-5.7</td>
</tr>
<tr>
<td>-20</td>
<td>-5</td>
<td>-7.2</td>
<td>-4.4</td>
<td>-8.6</td>
<td>-5.7</td>
<td>-5.7</td>
<td>-5.7</td>
</tr>
<tr>
<td>Price of local cream +20</td>
<td>4.2</td>
<td>7.12</td>
<td>4</td>
<td>8.57</td>
<td>5.43</td>
<td>8.57</td>
<td>5.43</td>
</tr>
<tr>
<td>-20</td>
<td>-4.2</td>
<td>-7.5</td>
<td>-4</td>
<td>-8.57</td>
<td>-5.43</td>
<td>-5.43</td>
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</table>
As shown in Table 4, economic value of milk production, estimated for each city is different, which shows different management performance and production system in these cities. However, the economic value of milk trait for Dezful herds is close to the economic value for this trait in Dasht-Azadegan, the economic value of milk trait for Ahwaz herds is the same that in Shoshtar and the economic value of milk trait for Shosh herds is close to that in Shadegan. Also, Dasht-Azadegan and Dezful had the highest economic value for milk production which directly can be linked to the fact that these cities also had the highest milk price and milk yield among other cities ($0.77, 1670 kg for Dezful and $0.73, 2515 kg for Dasht-Azadegan, respectively). Thus, it becomes clear that the importance of milk production trait for the buffalo herds in these cities is more than any other cities. However, the estimated values were obtained in the same range for herds in each of two systems.

Economic coefficients obtained for fat percent trait also indicates the importance of this trait for the buffalo herds in the city of Dezful ($14.65), since herds in this city have the largest share of milk fat sales among the other cities. Economic value of fat percent for the city of Shosh and Shadegan were negative, because for these regions, the sale of cream was not considered. Among cities with cream sale, Ahwaz had the lowest value for milk fat percentage that it is inconsistency with the lowest share of milk for production of cream in that city.

As shown in Table 4 and 5, the sensitivity of the system were studied. For this analysis, changes of ±20% of milk and cream prices, feed cost and non-feed costs with respect to the original values were considered. A 20% larger feed cost, the economic value of milk production decreased as $0.02 to $0.03. With a 20% increasing of non-feed costs, this value decreased at least to $0.01 and up to $0.03. Meanwhile, apart from its little effect in reducing values, the role of feed costs in reducing milk economic value is approximately the same as non-feed costs which causes to reduce of $0.03, $0.03, $0.03, $0.02, $0.03 and $0.02 for the city of Ahwaz, Dezful, Shoshtar, Shosh and Dasht-Azadegan, respectively. Economic values of the average of fat percent depend on the average of milk production, the share of cream making and feed cost of producing one percent of fat. So, with a 20% increasing in feed cost, the coefficients obtained for fat percent trait decreased as $4.1, $3.9, $2.86, $6.32 and $3.93 for herds in the city of Ahwaz, Dezful, Shoshtar, Dasht-Azadegan and the province, respectively, whereas, for non-feed costs increased 20%, there was no reduction for the all cities. Also, decreasing feed cost cause to increase economic weights for milk yield and fat percent.

As shown in Table 4, increasing the price of buffalo milk by 20 percent changed the economic weight of milk production. This value in buffalo herds of six studied cities and the province increased as $0.12, $0.12, $0.11, $0.13, $0.13, $0.12 and $0.12, respectively, which indicates that the importance of these traits can be increased with raising the milk price. Decreasing milk price reduced the economic value of the milk in the cities, as well. Increasing milk price and reducing it to 20 percent did not any influence on the economic value of the fat percentage because in milk pricing system of dairy buffalo the fat percent was not considered. Milk price shows the greatest impact for buffalo herds in city of Ahwaz when it decreased ($-0.19 for milk trait) (Table 4 and 5).

For four cities with buffalo milk fat sale, increasing the share of milk fat to sale separately and raising the price of cream cause to increase obtained economic value for milk production and 20% reduction of these two factors decreased this economic value as the same amount. The variation from price of cream was the maximum for the city of Dezful. It can be due to higher share of cream sale in the herds of Dezful compared to that of others.

Increasing of 20 percent in the share of fat sale and the price of local cream also increased obtained coefficients for fat percent trait in the cities of Ahwaz, Dezful, Shoshtar and Dasht-Azadegan as $5, $7.2, $4.4 and $8.6 and $4.2, $7.12, $4 and $8.57, respectively. Reducing these factors change values as the same amount but in the negative direction.

In this study, profit selection interest was chosen because the purpose of this study was investigate the current economic situation of buffalo herds in Khuzestan province of Iran and suggest the appropriate payment system and breeding objective to improve economic efficiency of the herds. For the herds in four cities of Ahwaz, Dezful, Shoshtar and Dasht-Azadegan the payment system was based on milk and produced cream, so the economic value of milk yield and fat percent traits were positive indicating selection should aimed at the increasing direction. But for two other cities (Shosh and Shadegan), the payment system was just on milk sale and economic values was achieved negative for fat percent. Because the feed cost is increased due to one percent of fat in these cities but there is not any payment paid for it. Economic values for milk yield reported in some literatures in which fat and protein yield was paid for are negative [19, 20]. However, in some other studies, this coefficient
was positive for milk in the same payment system [21]. Among studied cities, in the buffalo herds of Dezful and Dasht-Azadegan as mentioned, due to the high milk payment and the average of milk production in a year, economic value of milk is $0.08, $0.08, $0.21, $0.23 and $0.05, $0.05, $0.18, $0.20 more than other four cities (Ahwaz, Shoshtar, Shosh and Shadegan), respectively. So, the importance of milk production for the herds of these cities is more. This comparison shows that more the average of milk production or the price of milk sale, more weight will be given for that trait in the selection (Table 4 and 5).

The estimated economic value of fat percent in the cities with cream sale was obtained higher than milk production, which agreed with other literature results obtained for production system with dairy cattle. Komlosi et al. [3] in the study of milk production traits for Hungarian Holstein Friesian cattle calculated the economic weights for milk yield and fat percentage for two milk payment systems. Under payment system based on milk volume they reported economic value for milk yield and fat percent as 1.99 and -8 RMB and under payment system based on milk composition they reported this coefficient for fat percent as 64.21 RMB [22]. Seno et al. [23], in the study of estimating economic values for milk, fat and protein yield in two commercial buffalo milk production systems (1- milk is sold to dairy industry and 2- the milk is used to produce and sale Mozzarella cheese at the farm) in São Paulo State of Brazil reported economic value of milk, fat and protein yield in two production systems as $0.71, $-0.74, $-0.82 and $3.05, $18.66, $54.38, respectively [23]. In our study, we have two payment systems as only the sale of milk based on its volume and milk with cream sale.

The average of total profit estimated for the herds in each city showed that Dasht-Azadegan and Dezful with the highest milk production and share of cream sale had the most profit per buffalo cow. So, according to profitability of the herds, payment system for milk sale (only based on milk volume) cannot be profitable for buffalo herds of Khuzestan and its fat percent should be considered in milk payment as profit of the herds of cities which have not cream making such as Shosh confirms that. Also, results showed that the biggest part of herd costs in the studied herds is related to feeding cost which is the most for the herds in Shoshtar because of higher forages price. Totally, in all studied herds concentrate was not used by the farmers because of its high price and they preferred to use some other substances such as wheat flour and rice bran. Farmers don not use balanced diet for their buffaloes at farm level and buffaloes were often overfeed. Promotion of using concentrate should be done by government and feeding of the herds must be controlled.

One of the other purposes of this study described earlier was testing the sensitivity of derived coefficients to changes in milk and cream prices, feed cost and non-feed costs (Table 4 and 5). Changes were performed at their original time, keeping all other parameters at their original values. With respect to basic situation and the maximized profit interest and described profit equation which used to derive economic weights for milk yield and fat percent, these coefficients have the positive relationship with revenues and the negative relationship with costs of milk production, thus, any factor that increases costs will reduce these coefficients and any factor that increases the income will increase these values. In this study changes of production factors (feed cost, non-feed costs, milk price, cream price and share of selling cream) caused the same changes on economic values but in negative direction. For example, as the average a 20% lower feed cost resulted in an increase in economic value of milk yield by 5.6% ($0.03) and a 20% larger feed cost resulted in a decrease in economic value of this trait by 5.6% ($-0.03). In general, changes that have caused increase in revenues (an increase in the price of milk and cream and reduction in the feed costs and non-feed costs) resulted in increased economic values and vice versa (Table 4 and 5). The effect of share of selling cream and price of cream changes on economic values was the largest for fat percent. Vargas et al. [24] calculated economic value of milk and fat percent for Holstein cattle of Costa Rica and reported the values were 0.04 and 5.25, respectively with the fixed herd-size evaluation base. They indicated that economic values of fat percent increased significantly in sensitivity analysis with higher prices of milk solids [24].

At the end, the proposed production system of selling Mozzarella cheese instead of cream producing for the buffalo herds that are sold cream was also studied. By replacing the cheese producing, profit for the herds was increased. As a consequence, cheese sale will bring the most significant profit in buffalo dairy farming system of Khuzestan. Economic value recalculated for milk yield and its components (fat and protein percent) in this proposed production system for the cities which have
cream sale. The estimated values in this system for the cities of Ahwaz, Dezful, Shoshtar and Dabst-Azadegan were $0.66, $0.80, $0.70, $0.73, and $7.53, $20.70, $10.34, $16.35, and $67.52, $102.93, $61.78, $117.85 for milk yield, fat and protein percent, respectively. In the milk and cream payment system, estimated economic value of fat percent is higher than milk. So, it has higher price for fat percent compared to milk. However, in proposed system, the higher value obtained for fat percent compared to milk and cream system and also the results showed that in this system, the economic weight of protein percent is the highest.

The relative importance of milk production traits (milk yield and fat) is very sensitive to the payment system [25]. In our study, differences among economic values in different payment systems were remarkable. Cardoso et al. [26] to evaluate the relative economic importance of milk and its components under different milk payment policies, in the three main genetic groups involved in the milk production in the southeast of Brazil, (Holstein x Gir crosses, Holstein and Gir), calculated economic values for milk, fat and protein yield using a bio-economic model. The payment policy in the basic situation was based exclusively on the volume and alternative payment policies were based on volume plus different proportions of fat: protein values. They reported differences between genetic groups and all payment policies and indicated that these results should be accounted when designing breeding programs [26].

CONCLUSIONS

Results found in this study provide important information about milk production and fat percentage traits that should be considered in a breeding goal for Khuzestan dairy buffaloes in Iran. The milk sale payment based on its volume is not profitable for the dairy buffalo herds in this province and economic weights of these two traits are different in the buffalo herds of two systems. The economic values found for studied traits indicate that major weight should be given to fat percent in relation to milk in the sale milk and cream system. In general, the milk and cream payment system used in Ahwaz, Dezful, Shoshtar and Dabst-Azadegan has higher price compared milk payment system and fat percent should be considered as a trait in the breeding objective. In the proposed payment system for dairy buffaloes, protein percent has a higher price compared to fat percent and this system can increase the profit of the buffalo herds in Khuzestan. The influence of milk payment changes on economic values was the greatest as its influence on milk and fat percent economic values is substantial. Also, the effect of fluctuations of various production factors on the economic values of the traits is not the same. In the average case, sensitivity analysis indicated that economic values for fat percent and milk with respect to price changes (milk price, feed and non-feed costs) were the most sensitive and less sensitive, respectively.

REFERENCES