

Identifying the optimal domestic cattle breed via multi-criteria decision making: the case of Turkey

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Abstract: In today's economy, agriculture plays a very crucial role as it has subsidiary effects on the life of people. Breeding and developing the optimal animal race is a challenge which is being faced by many practitioners, as they have to cope with the rising costs and rivalry. In terms of production planning, choosing the right breed to be fed is a highly important factor in gathering the desired results. The present study aims to define the optimal cattle breed by using multi-criteria decision making. In order to do so, the characteristics of domestic Turkish breeds are obtained and analyzed via TOPSIS method. The findings imply that Zavot Breed is the best option to be developed. Moreover, the present study includes some research implications for future research.

Keywords: TOPSIS, Domestic Cattle Breeds, Turkey

I. Introduction

Globalization effects the social life in many ways. The economic structure of the present day requires minimizing the costs and maximizing the profits by applying the optimal production parameters. Agriculture is a promising sector as it can sustain as long as humanity continue.

There are some prior research discussing the factors affective in breeding and obtaining greater yield (Watson, 1994: 24; Nehring et. al., 2014: 311; Madelena, 1989: 183). These factors are being modified by the use of technology and genetically modified agricultural technologies are being used globally (Cai et. al., 2017: 317). All of these research can be categorized into three main types. The initial one covers the specifications of a specific breed. The second focuses on the factors affecting yield. The last one deals with the technological aspects. Moving from here, the present study aimed to come up with the best domestic breed by the use of multi-criteria decision making. This study is identical as it is the first study to cover operations research methodology on the topic. In order to achieve the goals of the study, the author used official data obtained from TAGEM. The data is analyzed via TOPSIS method. The results indicate that Zavot breed is the best to have higher parameter values.

II. Literature Review

The literature is rich in studies focusing on one dimension of the yields. However, if someone is about to make investment on a breed, the literature needs more explanative and comparable data. The present study included a literature review of the former studies in literature. The findings are as follows;

Monson et. al. (2004) focused on textural meat quality and examined the ageing time in the breeds. They found that ageing of meat has an effect on the number of microorganisms in the texture. Although it is not directly related to the focus of the present study, one can have the idea of the importance of breeding in farms. On the other hand, Yaylak & Kumlu (2005: 55) conducted a research on the lactation yield of black race. They focused on some environmental factors affecting lactation. They concluded that before-calving period is to have the highest yield. Similar to the former one, İnci et. al. (2007: 203) investigated the lactation and fertility of the same race. Also, Uygur (2004: 23) focused the same topic. Goyache & Gutierrez (2001: 489) also made a research on the yield of a specific cattle race. Besides these, Koç (2006: 1) made a similar research in another location with similar cattle race. Akman et. al. (2001: 173) also has a similar research.

Moreover, Madelena (1989: 183) made a research on cattle breed resource utilization for dairy products in Brazil. The author makes a comparison between Holstein-Friesian and Guzera breeds. The study implies that for better production parameters, these breeds can be crossed. Similar to the former study, Nehring et. al. (2014: 311) discussed the economic factors in breeding. Zhong et. al. (2013: 526) also focused on the factors affecting milking yield. Besides these Cai et. al. (2017: 317) suggested the use of genetically modified agricultural technologies. Besides these, Galiç et. al. (2005: 87) studied calving. They concluded that the earlier the breed is ready for calving, the more productive is the breed. This finding is used in defining the parameters in the present study. Similar to the former one, Yılmaz et. al. (2003: 169) investigated the factors affecting yield in dairy products. They assert that the breeding is crucial for better production. Just like others, Subratty & Gurib, (2003: 80) asserted some factors affecting the perceptions of the customers. These factors can be utilized for further research. Choudhury, (2011: 91) also mentions the essentials of supply chains in food production. Moreover,

Goddard et. al. (2016: 1533) discusses the same topic. Şekerden et. al. (1999: 505) also defines some factors affecting the yield in milking. Lastly, Eyduran et. al. (2005: 61) mentions the duration of milking period.

Furthermore, Seaman et. al. (2002: 881) conducted a research on the impact of breed type, sex, method of rearing, winter nutrition and subsequent grazing treatment on the rate of carcass cooling and eating quality of beef. They conclude that the mentioned factors are important in obtaining better production results. Watson (1994: 24) also mentions the importance of breeding in obtaining greater yield.

To sum all up, former studies can be classified into three main categories. The first one consists of studies focusing on a specific cattle race. The second covers the factors affecting the yield in meat and milk production. The last one covers the genetically modified breeding and the use of technology in agriculture. The historical analysis of these research indicate that the scope of modern agriculture will be on the genetics and economic factors in yield. Thus, the present study will be identical as it tries to combine all of the Turkish domestic breed parameters via operations research methodology.

III. Basic Domestic Cattle Breeds in Turkey

Turkey is a fertile country for cattle breeding. Many people are earning their lives by farming. This part of the study includes some characteristics of domestic cattle breeds. In Table 1, these characteristics are depicted.

Table 1. Characteristics of Cattle Breeds

	South Anatolian Red	Indigenous South Yellow	Indigenous Black	East Anatolian Red	Zavot	Grey race	Anatolian Water Buffalo
Cidago Height (cm)	137,5	110	105	115	122,75	121,5	132,5
Body Length (cm)	137,5	115	110	127,5	137,75	117,5	140
Birth Weight (kg)	25	14,5	18,5	19,5	22	24	30
Mature Live Weight (kg)	487,5	200	300	350	430	412,5	500
Age of giving birth (months)	25	33	26	25	26	26	25
Daily Live Weight Increase (g)	800	600	800	800	862,5	1050	575
Lactation Milk Yield (kg)	2000	625	1050	950	2800	1100	900
Lactation Time (days)	225	190	250	210	287,5	220	225
Milk Fat Percentage (%)	4	3,5	4,5	4,5	4	4,5	7

As demonstrated in Table 1, the cidago height, body length, birth weight, mature live weight, age of giving birth, daily live weight increase, lactation milk yield, lactation time and milk fat percentage are listed according to official statistics (TAGEM, 2009).

The breeds are reviewed in terms of general features. First of all, The South Anatolian Red is reported to be prolific both in meat and milk. It is widely being fed in the Southern parts of the country. Similarly, Indigenous Southern Yellow is also productive both in meat and milk production. This breed is being fed in the Eastern part of the country. On the other hand Indigenous Black is another productive race in milk and meat production. It is being grown in the middle parts of the country. Just like others, East Anatolian Red is being fed in the Eastern parts of the country. On the other hand, Zavot is being fed in the same region. This breed has some superior qualities when compared to the other breeds. Grey race is the particular breed of Thracian region. Besides these, the Anatolian Water Buffalo is being fed in the whole country. Although there is a regional distribution for all of these breeds, there cannot cope with the imported races. Furthermore, they cannot afford the international standards because of many factors, namely untutored breeders, malnutrition and not paying attention to develop better breeds.

IV. Methodology

In the former parts of the study, the context is introduced and the literature is reviewed. The findings and methodology of the former studies are adopted and the features of cattle breeds are assessed. In this part of the study, these features are going to be compared by using TOPSIS method. In order to do so, breeders are interviewed they are asked to rank the parameters that are obtained from TAGEM. The weights are turned into percentages and minimized into one.

Table 2. Weights of the criteria

0.12987	0.12987	0.116883	0.12987	0.090909	0.12987	0.077922	0.103896	0.090909
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According to these weights the breeders consider cidago height, body length, mature live weight and daily live weight increase at the same weight. The calculations include six stage in TOPSIS (Ertuğrul and Özçil; 2014: 271-273; Şimşek et al., 2015: 140-142; Gökdalay; 1999: 162; Jahanshahloo et al. 2006: 1377-1378; Supçiller and Çapraz, 2011: 9-12);

Stage 1 : Creating Decision Matrices

$$U_{ij} = \begin{bmatrix} u_{11} & u_{12} & \dots & u_{1j} \\ u_{21} & u_{22} & \dots & u_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ u_{i1} & u_{i2} & \dots & u_{ij} \end{bmatrix} \quad (1)$$

Here, “i” designated the number of alternatives, “j” stands for the number of criteria.

Stage 2: Normalizing Decision Matrices

Normalization is calculated as in the following formula;

$$r_{ij} = \frac{u_{ij}}{\sqrt{\sum_{i=1}^m u_{ij}^2}} \quad i = 1, \dots, m \quad j = 1, \dots, n \quad (2)$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1j} \\ r_{21} & r_{22} & \dots & r_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ r_{i1} & r_{i2} & \dots & r_{ij} \end{bmatrix} \quad (3)$$

Stage 3: Weighting decision matrices

$$X_{ij} = Y_j r_{ij} \quad i = 1, 2, \dots, m \quad j = 1, 2, \dots, n \quad (4)$$

Her Y_j stands for the weight of the j^{th} criteria.

Stage 4: Calculation of Positive and Negative Ideal Solutions

The positive-ideal solution value U^+ and negative-ideal solution value U^- are calculated as follows;

$$U^+ = \{X_1^+, X_2^+, \dots, X_j^+, \dots, X_n^+\} \text{ (maximum)} \quad (5)$$

$$U^- = \{X_1^-, X_2^-, \dots, X_j^-, \dots, X_n^-\} \text{ (minimum)} \quad (6)$$

Stage 5: Calculation of the distance to the ideal points

The distance between the positive ideal solution point T_i^+ and negative ideal solution point T_i^- are calculated as follows;

$$T_i^+ = \sqrt{\sum_{j=1}^n (X_{ij} - X_j^+)^2} \quad i = 1, 2, \dots, m \quad (7)$$

$$T_i^- = \sqrt{\sum_{j=1}^n (X_{ij} - X_j^-)^2} \quad i = 1, 2, \dots, m \quad (8)$$

Stage 6: Calculation of degree of proximity to ideal solution

It is done as follows:

$$H_i^+ = \frac{T_i^-}{T_i^- + T_i^+} \quad i = 1, 2, \dots, m \quad (9)$$

Here, H_i^+ takes a value between 0 and 1. $H_i^+ = 1$ stands for the ideal positive solution and $H_i^+ = 0$ designates ideal negative solution.

The decision matrix is constituted as following the stages above. The notations in the formula “ u_{ij} ” are replaced with the cattle breeds and the features are also placed.

Table 3. Normalized Martix

1:	0.42918	0.409275	0.42151	0.465828	0.353837	0.378937	0.496053	0.36742	0.322329
2:	0.343344	0.342303	0.244476	0.191109	0.467064	0.284203	0.155017	0.310266	0.282038
3:	0.327737	0.32742	0.311917	0.286663	0.36799	0.378937	0.260428	0.408245	0.36262
4:	0.358951	0.37951	0.328778	0.33444	0.353837	0.378937	0.235625	0.342926	0.36262
5:	0.383141	0.41002	0.370928	0.410884	0.36799	0.408542	0.694474	0.469482	0.322329
6:	0.379239	0.349744	0.404649	0.394162	0.36799	0.497355	0.272829	0.359256	0.36262
7:	0.413573	0.416717	0.505812	0.477772	0.353837	0.272361	0.223224	0.36742	0.564076

Initially the normalized values are calculated and these are depicted Table 3.

Table 4. Weighted Matrix

1:	0.055738	0.053153	0.049267	0.060497	0.032167	0.049213	0.038654	0.038174	0.029303
2:	0.04459	0.044455	0.028575	0.024819	0.04246	0.03691	0.012079	0.032235	0.02564
3:	0.042563	0.042522	0.036458	0.037229	0.033454	0.049213	0.020293	0.042415	0.032966
4:	0.046617	0.049287	0.038429	0.043434	0.032167	0.049213	0.01836	0.035629	0.032966
5:	0.049759	0.053249	0.043355	0.053362	0.033454	0.053057	0.054115	0.048777	0.029303
6:	0.049252	0.045421	0.047297	0.05119	0.033454	0.064592	0.021259	0.037325	0.032966
7:	0.053711	0.054119	0.059121	0.062048	0.032167	0.035372	0.017394	0.038174	0.05128

The values in Table 3 are recalculated according to the weights and the weighted matrix is obtained.

Table 5. Relative Proximities

South Anatolian Red	0.616998
Indigenous South Yellow	0.603928
Indigenous Black	0.320905
East Anatolian Red	0.358611
Zavot	0.658833
Grey race	0.516683
Anatolian Water Buffalo	0.547866

Lastly the relative proximities are obtained and the maximum relative proximity is reported for Zavot Breed. Breeders should pay attention to hybrid or pure instances of this breed.

V. Conclusion, Limitations, Ideas for future research

In production management selection of the production factors are noteworthy. Firms should optimize the inputs of production lines in order to obtain more yield. In cattle breeding the selection of the cattle breed is prominent as the cost of breeding is increasing day by day. Moving here, this study aimed to compare the domestic cattle breeds of Turkey by using the official statistics. In order to do so, initially a literature review is carried out and the characteristics of the breeds are determined. Then, interviews are conducted with breeders and they are asked to rank the qualities mentioned by TAGEM. These ranks are turned into weights and analyzed via TOPSIS. The results of the study indicate that Zavot breed is the optimal race to be improved. Besides this contribution the present study has some limitations. The use of imported herds are widely being used in the field. This study excludes them and future studies can include them into the context. The criteria used for benchmarking can also be expanded. The use of other analysis techniques such as AHP can also make contribution in order to see the differences between the two tests. Moreover, researchers can use the weights of the present research in their work. Lastly, the interviews can be expanded to more breeders and this may cause higher precision.

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