

Introducing a New Approach to Estimating Red Meat Production in Turkey

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Abstract: A common concern with official estimates of red meat production in Turkey is that they underestimate the level of production. One of the frequently cited reasons is that unregulated slaughter is undercounted. This study uses an estimation method based on the biology of red meat production to examine the potential impact of this undercounting. The production estimates obtained for 1991-1998 using this biological-based method exceed the numbers estimated by official organizations, but fall within the range of estimates obtained from other proposed approaches to estimating red meat production.

Key Words: Red meat, production, Turkey, estimating approach

Türkiye Kırmızı Et Üretiminde Yeni Bir Metodolojik Yaklaşım

Özet: Türkiye kırmızı et üretiminin resmi tahminleriyle ilgili ortak endişe, bu tahminlerin üretim seviyesini olduğundan çok daha düşük göstermesidir. Bu düşük tahminlere yönelik olarak literatürde en fazla sözü edilen neden, kayıt dışı kesimlerin, olması gerekenden daha düşük hesap edilmesidir. Bu çalışma, gereğinden daha düşük hesap edilen miktarın potansiyel büyüklüğünü incelemek için et üretiminin biyolojisi temeline dayalı bir tahmin metodunu kullanmaktadır. Üretim biyolojisi temeline dayalı bu yaklaşım kullanılarak elde edilen 1991-1998 dönemi tahminleri, resmi kurumlar tarafından yayımlanan rakamlardan yüksek çıkarken, önceki çalışmalarda önerilen yaklaşımlar kullanılarak elde edilen tahminler arasında yer almaktadır.

Anahtar Sözcükler: Kırmızı et, üretim, Türkiye, tahmin yaklaşımı

Introduction

In countries like Turkey, where a well-established public data collection and analysis system does not exist, estimates of agricultural production may contain large errors. Because production data are used by private and public decision makers, reducing errors and thus improving the quality of the data should enhance social welfare by improving the quality of decision making.

One area where current agricultural production estimates seem particularly problematic is red meat production. Accurate numbers on red meat production are important for developing countries because consumption of meat has a well-established strong,

positive relationship with the level of economic development (1).

Meat production is the meat obtained from all animals of indigenous and foreign origin, slaughtered within the national boundaries. Meat production is usually reported as dressed carcass weight, which is the weight of the carcass after removal of parts such as the skin, the head, the feet at the joints, the large blood vessels, the genito-urinary organs, the tail and slaughter fats other than kidney fats (2). Meat production includes meat produced not only by public and private slaughterhouses but also by unregulated slaughtering¹. Data on the former can be obtained from administrative records of the

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¹ Unregulated slaughter is used throughout the paper to refer to unlawful and hide slaughtering.

slaughterhouses while data on the latter must be approximated.

Turkey's State Institute of Statistics (SIS) and the United Nations' Food and Agriculture Organization (FAO) have published data on Turkish red meat production since the beginning of the 1960s. A long-standing concern with these published data is the underestimation of unregulated slaughter. In 1999, Turkey's Agricultural Economics Research Institute (AERI) adopted a method to address this concern. The adopted method uses a take-off rate², or the percentage of the animals removed from the national herd for slaughter during the year. This study proposes an alternative approach based on the number of milking animals as well as the change in the inventory of animals. The advantage of this approach is its intensive use of published data in a logical framework based on the biology of red meat production.

Official and Cited Approaches

The first approach discussed is the method currently used by the SIS. At the end of each year, it compiles data on the number of animals slaughtered at public and private slaughterhouses in each province with the help of district directorates of the Ministry of Agricultural and Rural Affairs. In addition, the Turkish Air Association compiles the number of slaughtered animals during the Celebration of Sacrifice. Meat production is obtained by multiplying the number of slaughtered animals from these 2 sources by a per animal carcass weight. This carcass weight is obtained from the 1984 Census of Livestock. Total production from these sources is adjusted upward by 10% as an estimate of unregulated production (4).

The second approach discussed is the one used by the FAO. As part of its mandate, the FAO compiles information and data on various attributes of food and agriculture. Data on red meat production are part of the FAO's country-level data set, which includes agricultural production and trade, producer prices, land use, means of production, etc. (2). These data are collected through (a) tailored questionnaires sent annually to member countries, (b) magnetic tapes, diskettes, FTP transfers and websites of the countries, (c) national/international

publications, (d) country visits, and (e) reports of FAO representatives in member countries. For Turkey, the FAO estimates red meat production by multiplying its estimate of the number of animals slaughtered by the average dressed carcass weight excluding offal and slaughter fats. The FAO's estimate of the number of sheep and goats slaughtered is 3.3 times larger than the number used by the SIS, while the number of cattle and buffalo slaughtered is the same (2,4). Beef and buffalo meat includes veal; while mutton and goat meat includes meat from lambs and kids.

AERI uses a third approach that starts with the take-off rate or the percentage of animals removed from the national herd (i.e. inventory) for slaughter during the year. A meat and processed meat products consultation committee formed by the AERI from different institutions determined that the take-off rates are 48% of the sheep and goats herd and 25% of the cattle and buffalo herd (5). The number of slaughtered animals equals the take-off rate times the number of animals in the inventory. Meat production is then estimated by multiplying the estimated number of slaughtered animals by the carcass weight per animal.

The fourth, fifth and sixth approaches to be discussed were proposed because of concerns that the adjustment the SIS uses for unregulated slaughter underestimates this component of red meat production. The fourth approach, which was proposed by Güneş and Pekel (6), assumes that the total number of animals slaughtered in places other than slaughterhouses is 170% of the number of animals slaughtered in slaughterhouses. Red meat production is then estimated using per animal carcass weight. The fifth approach, which was proposed by Güneş (7), starts with the amount of red meat slaughtered in slaughterhouses as recorded by the Ministry of Agricultural and Rural Affairs. Güneş (7) then argues that based on information published by Turkey's State Planning Organization the amount of red meat slaughtered in places other than slaughterhouses is 4 times larger than the amount slaughtered in slaughterhouses.

The sixth approach, which was proposed by Düzgüneş and Güneş (8), starts with the amount of meat slaughtered in slaughterhouses as recorded by the

² State Planning Organization (SPO) also uses a take-off rate of 30% to calculate cattle meat production (3).

Ministry of Agricultural and Rural Affairs. This estimate is increased by 20% to account for unregulated slaughter. This calculation provides an estimation of the amount of red meat consumed in urban areas. The ratio of urban per capita meat consumption to rural per capita meat consumption is assumed to be 2.76 to 1.00 based on information from a consumption survey conducted by the authors. This ratio is fixed for all years and regions. Using the ratio of rural population to urban population, meat consumption is estimated for the whole country. Total meat production is then estimated by adding to the estimated red meat consumption the amount of red meat exported and subtracting the amount of red meat imported.

Materials and Methods

The Proposed New Approach

The new estimation approach we propose starts with the number of milking animals that can give birth to new animals. They are the only published data that can be used to estimate the number of newly born animals in the year. Data on milking animals are collected by provincial agents of the Ministry of Agriculture and are published annually by SIS. To determine the number of young animals added to the inventory of animals, we need to adjust for the share of milking animals that give birth to twins instead of a single offspring and the proportion of deaths among newly born animals.

Estimation of red meat production also needs to take into account changes in the inventory of animals, net foreign trade, the death loss among mature animals, and the carcass weight of slaughtered animals. Increases in the inventory and the net export of animals reduce the number of animals slaughtered during the year. Contrarily, decreases in the inventory and the net import of animals increases the number of animals slaughtered during the year. Therefore, the beginning inventory of livestock is adjusted for net foreign trade and death loss among mature animals. The ending inventory of livestock is subtracted from the sum of the total number of young animals and the net beginning inventory to find the number of animals slaughtered during the year. Multiplying this outcome by carcass weight yields red meat production.

The following equation formalizes the relationship among the variables discussed in the two previous paragraphs:

$$M = [[S*(1+T)*(1-D)] + [(B+Imp-Exp)*(1-L)] - E] * C$$

where

- M: Red meat production
- S: Number of milking animals
- T: Proportion of animals that give birth to twins
- D: Proportion of new animals that are born dead
- B: Beginning inventory of animals
- Imp: Number of animals imported
- Exp: Number of animals exported
- L: Proportion of mature animals that die
- E: Ending inventory of animals
- C: Average carcass weight

The expected advantage of this equation relative to the official estimation methods and other approaches cited in the literature is its intensive use of published data in a logical and operational framework based on the biology of animal production. Akman (9) also discussed the desirability of this approach within a theoretical framework but provided no estimates. Furthermore, Akman's (9) discussion did not identify the number of milking animals as key data for starting the estimate of red meat production.

Each variable in this equation is explained in detail in the Materials section that follows. Recent data for each variable are also reported.

Materials

Statistics published by the SIS on livestock are compiled from the province and district directorates of the Ministry of Agricultural and Rural Affairs. Questionnaire forms are sent to the province directorates at the end of the year. Completed forms are sent back to the SIS at the end of January. Information on twinning and death rates are provided from several published studies.

Number of milking animals

The number of milking animals is determined by counting the number of female cattle and buffalo of age 2 and over and the number of female sheep and goats of

age 1 and over. The number of milking animals is then estimated by using the milking ratio among female animals of these ages. The ratio is obtained from the 1984 Census of Livestock (10). Table 1 provides estimates of the number of milking animals for the years between 1990 and 1998. These figures suggest that the number of milking sheep, goats, cows and buffalo has declined. The greatest numerical decline was 6.9 million head in the number of milking sheep. The largest percentage decline was 55% in the number of milking buffalo. The number of milking cows declined by approximately 7%, while the number of milking goats declined by 29%.

Animals that give birth to twins

The share of cows that give birth to twins is low. Kendir (11) reported a ratio of 0.05% for local breeds and 0.68% for Brown-Swiss. Bıyıkoğlu (12) found that this ratio varied between 0.5% and 3.1% depending on breed; the average was 2.0%. Given these findings and the finding by Akbulut and Yavuz (13) that local breeds account for 44% of the number of cows, a ratio of 1% (i.e. 0.01) is used in the equation for cows and buffalos.

The twinning rate for sheep and goats depends on several factors, with the environment considered the most important. The rate also varies by breed. Studies by Yalçın and Aktaş (14), and TİGEM (15) found twinning rates for Karaman sheep of 28.7% and 29.5%, respectively. Given these findings and the finding by Tufan and Akmaz (16) that a very high proportion of sheep in Turkey are Karaman, the average rate of the 3 studies, 29%, is used. Therefore, the coefficient for the twinning rate of sheep and goats is 0.29.

Animal death

Some animals are born dead, some die shortly after birth and some die as they approach maturity. Aysan (17) found an average death rate among newly born cattle of 12.5%. This ratio is converted to a coefficient of 0.125 in the equation for cows and buffalo. Pekel and Düzgüneş (18) and Akçapınar and Kadak (19) found death ratios of 26% and 24%, respectively, for newly born lambs. The average is converted to a coefficient of 0.25 for sheep and goats in the equation.

Since death rates among animals approaching maturity are not available for Turkey, data from the USA is used to approximate a rate for Turkey. Death rates for animals approaching maturity in the USA are 1.5% for cattle and 5% for sheep (20,21). However, the death rate is expected to be higher in Turkey than that in the USA. To approximate the unknown higher rate for animals approaching maturity in Turkey, we use the finding that the death rate among newly born animals in Turkey is 2.3 times higher than the comparable losses in the USA. Multiplying the death rates for animals approaching maturity in the USA by 2.3 yields a loss ratio for animals approaching maturity in Turkey of 3.45% and 11.5% for cattle and sheep, respectively (i.e. 0.0345 and 0.115 in the equation).

Inventory number of animals

Data for the number of livestock in the inventory are collected only at the end of the year. An increase in the inventory means that animals were saved for future production, thus reducing slaughter during the current year. The opposite happens if the inventory decreases. The inventory numbers by type of animal are shown in

Table 1. Number of milking animals by type, end of year, Turkey, 1990-1998.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
	thousand head								
Sheep	23,699	23,222	22,399	21,532	20,508	19,263	18,890	17,169	16,766
Goats	6,013	5,878	5,603	5,464	5,163	4,908	4,726	4,407	4,247
Cows	5,893	6,119	6,070	6,032	6,082	5,886	5,968	5,594	5,489
Buffalo	188	171	165	148	150	122	114	92	85

Source: 4 and 10

Table 2. Except for an increase in the number of cattle in 1991 and 1996, the inventory of each of the 4 animal types declined every year. In total over the 1990-1998 period, the inventory declined 53% for buffalo and 27% for sheep and goats, but only 3% for cattle.

Number of animals imported

Imports by type of animals are given in Table 3. In general, animals, especially dairy cows with a high level of production, have been imported by Turkey to improve the genetics of local breeds (13). Imports have declined to zero in recent years because of the changes in import policies of dairy cows with high levels of production.

Although a downward trend exists, the number of imported sheep and cattle increased in 1995 because of temporary increase in import subsidies (22).

Number of animals exported

During the early 1990s, Turkey exported a substantial number of sheep and goats to Middle Eastern countries. However, these exports have declined dramatically in recent years as shown in Table 4. This decline may have occurred because of restrictions on the use of pasture lands in the Eastern part of Turkey where around 40% of sheep and goats are raised.

Table 2. Total number of animals in inventory by type, Turkey, end of year, 1990-1998.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
	thousand head								
Sheep	40,553	40,433	39,416	37,541	35,646	33,791	33,072	30,238	29,435
Goats	10,977	10,764	10,454	10,133	9,564	9,111	8,951	8,376	8,057
Cattle	11,377	11,973	11,951	11,910	11,901	11,789	11,886	11,185	11,031
Buffalo	371	366	352	316	305	255	235	194	176

Source: 4 and 10

Table 3. Number of animals imported by type, Turkey, 1990-1998.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
	thousand head								
Sheep	7.1	1.0	0.4	0.1	4.8	48.1	0.3	0.4	0.0
Goats	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattle	181.8	180.7	182.0	167.4	22.1	423.7	176.6	0.0	0.0
Buffalo	1.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0

Source: 3

Table 4. Number of animals exported by type, Turkey, 1990-1998.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
	thousand head								
Sheep	2,276.1	1,901.2	799.1	1,201.3	1,659.9	740.4	240.6	232.4	129.5
Goats	332.0	143.2	10.6	22.4	48.4	7.1	0.4	0.0	2.6
Cattle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buffalo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: 3

Carcass Weight

Data on dressed carcass weight are taken from publications of the SIS, the FAO and the Ministry of Agriculture. These data are obtained primarily from the records of slaughterhouses. Of specific note, the carcass weight of cattle has increased substantially over the last 10 years (Table 5).

Results

Red meat production in Turkey is calculated using the generalized equation presented in the proposed new approach section and the data presented in the Materials section. To illustrate this calculation, the equations using data for 1998 are presented below for sheep, goats, cattle and buffalo. Production for both the individual livestock types and for all livestock is in metric tons.

Sheep meat production:

$$M = [[16,766*(1+0.29)*(1-0.25)]+ [(30,238+0-129.5)*(1-0.115)]-29,435]*15.7 = 210,885$$

Goat meat production:

$$M = [[4,247*(1+0.29)*(1-0.25)]+ [(8,376+0-2.6)*(1-0.115)]-8,057]*15.4 = 53,322$$

Cattle meat production:

$$M = [[5,489*(1+0.01)*(1-0.125)]+ [(11,185+0-0)*(1-0.0345)]-11,031]*163.2 = 753,824$$

Buffalo meat production:

$$M = [[85*(1+0.01)*(1-0.125)]+ [(194+0-0)*(1-0.0345)]-176]*155 = 13,396$$

Total meat production:

$$M = 210,885 + 53,322 + 753,824 + 13,396 = 1,031,427$$

According to these calculations, total red meat production in Turkey increased between 1991 and 1997 by 15%, and then decreased by 11% in 1998 (Table 6). This decline in 1998 may have occurred because of the crisis in animal production and the increase in meat imports in 1997 that caused a decline in prices of red meat received by farmers. Beef's share of production increased from 65% in 1991 to 73% in 1998. In contrast, the share of production accounted for by sheep and goats declined from 32% in 1991 to 26% in 1998. The share of production accounted for by buffalo meat also declined.

Discussion

To provide a comparison, official data and estimates of red meat production derived from the 3 other proposed alternative approaches discussed earlier are presented in Table 7, along with the estimate derived using our proposed approach.

The official estimate by the FAO is larger than the official estimate by the SIS, primarily because the FAO estimates the number of sheep and goats slaughtered at 3.3 times larger than the number used by the SIS. The official estimates by the SIS and FAO are approximately 50% and 70%, respectively, of the estimates derived using the method proposed in this paper.

Table 5. Carcass weight by type of animal, Turkey, 1990-1998.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kg/head								
Sheep	15.7	15.7	15.7	15.7	15.7	15.8	15.7	15.7	15.7
Goats	15.7	15.7	15.7	15.9	15.6	15.4	15.7	15.4	15.4
Cattle	118.6	143.1	145.6	141.9	140.7	160.6	166.2	159.3	163.2
Buffalo	138.1	147.0	146.0	141.7	143.7	159.1	156.5	155.4	155.0

Source: 3

Table 6. Red meat production by type of animal estimated using the new approach, Turkey, 1991-1998.

	1991	1992	1993	1994	1995	1996	1997	1998
	thousand metric tons							
Sheep	255.0	272.1	268.6	250.5	249.3	233.9	242.3	210.9
Goats	70.8	70.4	69.8	67.9	63.1	57.8	58.7	53.3
Cattle	657.4	749.7	726.7	702.7	853.2	821.2	833.9	753.8
Buffalo	21.1	21.5	21.9	19.1	23.4	17.5	17.8	13.4
Total	1,004.3	1,113.7	1,087.0	1,040.2	1,189.0	1,130.4	1,152.7	1,031.4

Source: Original calculations

Table 7. Alternative estimates of red meat production, Turkey, 1991-1998.

Estimation method ¹	1991	1992	1993	1994	1995	1996	1997	1998
	Official estimates (thousand metric tons)							
SIS	466.6	448.8	432.1	466.1	414.8	415.4	516.9	532.2
FAO	715.3	673.6	666.1	696.7	670.5	671.0	763.2	737.7
AERI	863.7	878.8	889.1	853.8	883.3	944.7	966.4	947.7
	Estimates from alternative proposed methods (thousand metric tons)							
DÜZGÜNEŞ and GUNEŞ	615.4	585.6	586.9	583.7	536.5	522.7	577.7	559.6
YAVUZ and ZULAUF	1,004.3	1,113.7	1,087.0	1,040.2	1,189.0	1,130.4	1,152.7	1,031.4
GUNEŞ and PEKEL	1,209.2	1,150.9	1,153.4	1,147.0	1,054.3	1,027.3	1,135.3	1,099.7
GUNEŞ	2,239.3	2,131.3	2,136.0	2,124.1	1,952.4	1,902.4	2,102.5	2,036.4

¹Estimation methods are described in the text. Official estimates are provided from publications except for estimates of the AERI for 1991-95, which are calculated according to the method they used.

In terms of methodology, the approach proposed in this study is slightly similar to the approach currently used by the AERI (5). Thus, the AERI estimates are on average the closest official estimates to the estimates produced by this study. They do not account for the general inventory decline that has occurred over the last decade and, thus, it is not surprising that the method proposed in this study resulted in higher red meat production. The AERI estimates are roughly 85% of the estimates produced by this study.

Three of the four proposed alternatives to the official estimates, including the one proposed by this study, resulted in higher numbers than the official estimates.

This observation is consistent with the common concern that the current official estimates underestimate unregulated slaughter.

Sensitivity tests were conducted by increasing (decreasing) the coefficients used in the estimation equation for the twinning rate and death ratio for newly born and mature animals. Increasing (decreasing) these coefficients by 10% increased (decreased) total meat production by 2.7 to 3.4%. These changes did not alter the ranking of the results generated by the approach proposed in this study relative to the other production estimates.

The official estimates of red meat production for 1991-1998 by Turkey's State Institute of Statistics, the United Nation's Food and Agriculture Organization, and Turkey's Agricultural Economics Research Institute are approximately 50%, 70%, and 85%, respectively, of the

estimates derived using the method proposed in this paper. This finding buttresses the common argument that official estimates are substantially understating red meat production in Turkey.

References

1. Pense, N.A.: The Future of Red Meat in Human Diet. Outlook on Agriculture. Int. Cent. Agricult. Biosci. 1997; 26: 159-164.
2. FAO: Web Page of the Food and Agriculture Organization. www.fao.org. 2001.
3. DPT: Sekizinci Bes Yıllık Kalkınma Planı Hayvancılık Özel İhtisas Komisyonu Raporu. Devlet Planlama Teşkilatı, DPT:2547-ÖİK:587. Ankara, 2001.
4. DİE: Agricultural Structure (Production, Price, Value). State Institute of Statistics. Ankara, 1990-1998.
5. Ertürk, Y.E., Tan, S.: Et ve Et Mamülleri Durum ve Tahmin Raporu. Tarımsal Ekonomi Araştırma Enstitüsü Yayınları. Ankara, 1999.
6. Güneş, T., Pekel, E.: Türkiye'de Et Üretimini Artırılması ve Kalitenin Yükseltilmesi İmkanları. DPT: 846, IPD: 285. Ankara, 1970.
7. Güneş, T.: Hayvansal Ürünlerin Üretimi, Pazarlanması ve Üretim Planlaması İlişkileri. Türkiye'de Hayvansal Üretim Planlamasının Ekonomik Yönü Semineri. Batı Almanya, 1981.
8. Düzgüneş, O., Güneş T.: Türkiye Ziraatında Uzun Süreli Arz ve Talep Tahminleri. Et Talep ve Arzının Trendi. Robert Koleji İş İdaresi ve İktisat Okulu. Ankara, 1965.
9. Akman, N.: Bir Populasyonda Et ve Süt Üretimini Hesaplanması. Devam Eden Çalışma Raporu. A.Ü. Ziraat Fakültesi Zootečni Bölümü. Ankara, 2000.
10. DİE: Türkiye İstatistik Yıllığı. Devlet İstatistik Enstitüsü, Ankara, 2000.
11. Kendir, H.S.: İsviçre Esmeri - Boz Irk Melezlemede G2 Melez Kuşağının Değerlendirilmesi. Lalahan Zoot. Araş. Derg., 1970; 10: 1-9.
12. Bıyıkoğlu, K.: Türkiye Devlet Müesseselerinde Saf ve Muhtelif Kan Dereceli Esmer Sığırların Yetiştirme, Vücut Yapıları ve Çeşitli Verimleri Üzerinde Araştırma. Atatürk Üniv. Yayınları No: 96. Erzurum, 1967.
13. Akbulut, Ö., Yavuz, F.: Türkiye Sığırcılık Sektöründe İslah Çalışmaları ve Destekleme Politikalarının Etkileri Üzerine Bir Araştırma. II. Ulusal Zootečni Bilim Kongresi. Bursa, 22-25 Eylül 1998.
14. Yalçın, B.C., Aktaş, G.: Ergin İvesi ve Akkaraman Koyunlarının Konya Ereğlisi Şartlarındaki Performansları. Lalahan Zoot. Araş. Derg., 1969; 9: 1-14.
15. TIGEM: Tarım İşletmeleri Genel Müdürlüğü Malya Tarım İşletmesi Müdürlüğü Kayıtları. Boztepe-Kırşehir, 1996.
16. Tufan, M., Akmaz, A.: Güney Karaman (Karakoyun), Kangal-Akkaraman ve Akkaraman Kuzularının Farklı Kesim Ağırlıklarında Kesim ve Karkas Özellikleri. Türk. J. Vet. Anim. Sci., 2001; 25: 495-504.
17. Aysan, İ.: Hayvancılık Tarama Projesine Ait Hayvan Hastalıkları Anket Formlarının Tatbikatından Alınmış Sonuçlar. Atatürk Üniv. Ziraat Fak. Ziraat Araştırma Enstitüsü Araştırma Neticeleri. Proje No: 1/26. Erzurum, 1967.
18. Pekel, E., Düzgüneş, O.: Malya Devlet Üretim Çiftliğindeki Çeşitli Merinos Melezleri ile Akkaraman Kuzularında Yaşama Gücü ve Gelişme. Ankara Üniv. Zir. Fak. Yıllığı. Ankara, 1966.
19. Akcapınar, H., Kadak, R.: Morkaraman ve Kangal-Akkaraman Kuzularının Büyüme ve Yaşama Kaabiliyeti Üzerine Karşılaştırmalı Araştırmalar. Fırat Üniv. Vet. Fak. Derg., 1982; 7: 203-213.
20. USDA: Sheep and Lamb Death Loss 1995. Animal and Plant Health Inspection Service. United States Department of Agriculture. Washington, May 1995.
21. USDA: Reference of 1997 Beef Cow-Calf Health and Health Management Practices, Part II. Animal and Plant Health Inspection Service, United States Department of Agriculture. Washington, July 1997.
22. Yavuz, F.: Türkiye Besi ve Süt Hayvancılığına Yönelik Politikaların Analizi. I. Türkiye Besi ve Süt Hayvancılığı Sempozyumu. Menemen, İzmir, 2-3 Aralık 1999.