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Evaluation of Total Roughage Production and its Sufficiency for Livestock in Turkey

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ABSTRACT: In this study, total roughage production and its sufficiency for farm animals in Turkey was evaluated. Because of insufficient production, feed prices are relatively high and fluctuating in Turkey. It was estimated that, the total 40 363 210 tonnes of roughages production in Turkey was supplied by meadows and pastures (13 164 210 tonnes), shrublands (11 267 000 tonnes) and forage crops production (15 932 000 tonnes). In addition, total straw and stubble production was estimated as 31 074 800 tonnes for animal feed, indicating that half of the total roughages production in Turkey came from straw and stubble production. In Turkey, the large and small ruminant stock is composed of a total of 17 066 900 animal units and in order to meet only the maintenance requirements of these animals via roughage, 77 867 731 tons of roughage is needed in 2019. Considering the daily dry roughage requirement as 12.5 kg (approximately 2.5 percent of total 500 kg live weight), deficiency of daily feed amount was estimated as 1.032 kg per animal unit and a total of 6 429 720 tonnes in 2019 in Turkey. If shrublands, straw and stubble production is neglected or removed from the calculation, then total deficiency reaches at 48 771 521 tonnes year-1 (62.63% of the total feed requirement). For a rational animal feeding, not only the maintenance requirements of the animals but also, in addition to their maintenance requirements, at least 5-7 kg of milk production requires meeting from quality roughages. In this case, it is clear that the need for roughage will increase more. In Turkey, suffering from roughage shortage that adversely affecting production obtained from small and large ruminants, high quality forage production should be, at least, doubled by using every possible resource including natural rangelands, fallows, and cultivated lands effectively without compromising soil conservation and feed costs principles.

Keywords: Forage crops, rangelands, straw and stubble, shrublands, roughage need

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INTRODUCTION

As a result of the increase in the agricultural support, important increases have been observed in the numbers of both small and large ruminants and culture and cross-bred animals in Turkey since 2010. While the total livestock was 10 186 300 animal units (AU) in 2010, it increased to 17 066 900 AU via increasing by 67.55% in 2019. Moreover, the number of culture and cross-bred cattle has increased from 8 905 078 heads to 16 114 480 heads (80.96%) in this period as well (TÜİK, 2020b). In parallel to these increases, the need for roughage required to feed these animals increased as well, but a production increase has not been achieved at a desired level. For this reason, the quality roughage production of Turkey falls short of meeting even the maintenance requirements of the existing animal stock. However, for a rational animal feeding, not only the maintenance requirements of animals but also at least 5-7 kg of milk production should be met from quality roughages (Alçiçek et al., 2010; Alçiçek, 2012).

Roughages with high crude fiber content but low digestible organic matter and energy values are appropriate for animal nutrition physiology as well as decrease the use of more expensive concentrate feeds in animal nutrition. The use of roughages with lower costs compared to concentrate feeds increases the profitability in livestock enterprises (Alçiçek et al., 2010).

Quality roughage is obtained from two main sources, namely rangelands and forage crops cultivation. About half of the rangelands, which covered an area of 28.7 million hectares in 1960, have been lost during the period of 60 years and today they have decreased to 14.6 million hectares (Erdoğan, 1996; Anonymous, 2020b). Moreover, early and heavy grazing lasting for many years has led to decrease the yield potential of rangelands. At the same time, forage crops cultivation, another important source of quality roughage, has not developed sufficiently, either. While the share of forage crop areas within the cultivation areas ranges between 20-30% in countries with developed livestock farming (Acar, 2017), this share is only 13.6% in Turkey (TÜİK, 2020a).

In the lead of the problems related to animal nutrition in Turkey come not only the insufficiency of roughage production but also the low quality of an important part of existing roughages. In fact, most of the total roughage used in animal feeding is composed of non-quality feeds with low nutritive value like straw, stubble and seed residues (Temel and Şahin, 2011). The use of straw commonly in order to meet the deficit of roughage leads to not only health and nutrition problems in animals but also reproduction and yield losses (Ak and Akbay, 2018). The nutrient needs of animals, which cannot only be met via roughages, are met via expensive concentrate or mixed, also edible, forages. In Turkey, especially beef cattle and dairy cattle raising are performed mainly based on concentrate feed. This preference or necessity both increases costs and foreign-source dependency and leads to the increase in metabolism diseases and digestive troubles in cattle. The problems of the ruminant raising in Turkey related to forage are not limited only to the insufficiency and the poor quality of roughage. In addition to this, one of the matters of complaint for animal breeders is the relatively high and fluctuating prices of forage. Such that, apart from alfalfa hay, even straw is sold at high prices and even imported from time to time.

For this reason, meeting the need for quality, cheap and abundant roughage regularly comes in the lead of the most important problems which require solving in the development of livestock raising in Turkey. In this study, the roughage production, the livestock and the roughage sufficiency level of Turkey were evaluated.

METHODS USED IN CALCULATIONS

Calculation of Roughage Production

In this study, firstly the amount of dry roughage obtained from various sources was estimated, and then the values of the cattle, water buffalo, sheep and goat species were calculated in terms of animal unit (AU). A great part of the data used for estimation and calculation was obtained from the Turkish Statistical Institute (TÜİK) databases and the information which could not be derived from these databases was estimated by the author or compiled from different resources.

Production from meadows and pastures: The areas of rangelands and the hay yields of pastures according to the geographical regions were taken from the records of the General Directorate of Plant Production (BÜGEM) (Anonymous, 2020b). The hay yields of meadows according to the geographical regions were taken from the study conducted by Altın et al., (2011a). The hay productions of the regions were calculated by multiplying these values by the meadow and pasture areas.

Production from shrublands: The distribution of the shrublands according to the geographical regions and the grazable forage amounts were taken from the study conducted by Gökkuş (2019).

Straw production: In order to evaluate the grain and straw yields of cereals together, the criterion called "harvest index" is used. The harvest index is the ratio of the grain weight obtained from the unit area to the aerial biomass i.e. sum of straw and grain weights (Genç, 1978). In this study, the straw yield of any cereal per decare was calculated via the equation of (SY);

$$SY=GY*(100-HI)*CTS\ HI^{-1} \quad (1)$$

In the equation, GY: Grain yield (kg da^{-1}), HI: Harvest index (%), CTS: Coefficient of turning into straw, in other words, the amount of usable straw obtained from the total stems. The grain yields of the mentioned plants were taken from the TÜİK databases, the values of the other elements included in the equation were estimated by the author (Table 1).

Table 1. Harvest and feedstuff/total vegetative biomass index used to estimation straw yield of cereals

Specifications	Wheat	Barley	Rye	Oats	Triticale
Harvest index (HI)	0.30	0.35	0.25	0.30	0.30
Feedstuff/total vegetative biomass	0.70	0.50	0.70	0.75	0.70

Production from stubbles: Stubble is the common name given to residues such as root, stem, leaf, plant parts, etc. which remain on the soil surface in fields following the harvesting practices. In this study, the amount of dry matter remained as stubble was calculated via writing the value of 1-CTS, which is the ratio of the stubble remaining in the field (SRF), in place of the CTS multiplier included in the equation of straw yield per decare. It was assumed that 30% of the residue remaining in the field as stubble was grazed by animals (Deniz et al., 2010).

Production from forage crops: The information related to the sowing areas and yields of forage crops was obtained from the TÜİK databases (TÜİK, 2020a). In the calculation of the green forage in terms of hay, the maize (for silage and forage) was multiplied by the coefficient of 0.33 and the remaining plants were multiplied by the coefficient of 0.25 (Tan, 2017).

Cattle, Water Buffalo, Sheep and Goat Stocks

While calculating the roughage need, the value of each species was calculated in terms of AU by accepting a live weight of 500 kg as one AU. A great part of the coefficients used in the transformation of the numbers of animals into AUs were taken from the Rangeland Guideline published in the Official Gazette dated 31st July 1998 with numbered 23419 (Anonymous, 2020a). However, the described

subgroups for each species and their provided numbers in the TÜİK databases are more detailed compared to this guideline. Despite the consideration that it is necessary to determine new transformation values for each group included in the TÜİK databases, in this study, current evaluation criteria were applied.

Estimation of the Sufficiency of Roughage Production

It is necessary that the hay consumption foreseen per animal or AU should be 2.5% of live weight (Altın et al., 2011b). In this evaluation, needs are calculated by transforming ruminants into AUs. However, this method might lead to some mistakes. For instance, the dry matter consumption of 2 heads of cattle weighing 250 kg is more than that of one head of cattle weighing 500 kg. This suggests that calculating the needs on the basis of age groups and yield levels would be more logical and realistic. On the other hand, the data related to the grazing duration in stubble, herbaceous and shrubby rangelands, the grazing ratios, the species grazing on these lands and the grazing capacities of rangelands is imperfect, too. For instance, the assumption that the hay yield of a rangeland is the same every year or it is benefited from the stubble at the same level every year is not correct. Moreover, since there will be losses in the processes of harvest, transportation, storage and feeding, the produced and the consumed amounts of roughage are not the same. However, there is not sufficient information about these losses.

Despite the above-mentioned deficiencies, the total production including straw and stubble was taken into account in the calculations and it was accepted that half of the hay estimated to be obtained from pastures was consumed (Gökkuş, 2019).

ROUGHAGE PRODUCTION OF TURKEY

Dry, natural or silage type of forages with a low content of nutrients compared to their volume is understood in roughage term (Kutlu and Çelik, 2018). It is possible to list these as the ones obtained from meadows and herbaceous and shrubby pastures, the ones derived from forage crops, cereal straws, the waste and vegetative parts of such plants as sugar beet, etc. and stubble. While pastures and stubbles are benefited mostly by grazing animals, straws, meadow herbage and forage crops are served to animals as important elements of daily rations. In this section, in addition to the ones obtained from meadows and pastures and the ones grown as forage crops, straws and stubbles, which are the secondary products of cereal production, were discussed.

Meadow and pasture areas and production: The meadow and pasture areas of Turkey were determined as 14.6 million ha in the 2001 General Agricultural Census, and as it is seen in Table 2, it has been assumed that this figure did not change between the years 2001-2019.

In previous evaluations made in relation to the change of meadow and pasture areas, it was generally reported that while rangelands decreased, cultivated areas increased and negative situations in animal production were linked to this change (Anonymous, 2015). However, it was not dwelled upon change of the cultivation area per capita or the rangeland area per small and large ruminants and change of yield obtained from unit area. When such an approach is accepted, the rangeland areas, which was 9.10 da in 1950 per small ruminant (sheep and goat), for instance, it has been calculated as 2.76 da in 1990, and 3.01 da in 2019. In the same years the cultivated areas per capita were 6.97 da, 4.39 da and 2.26 da respectively (Table 2).

According to the General Agricultural Census of 2001 (DİE, 2004), the pasture area is 13 167 400 ha and the meadow area is 1 449 300 ha. By benefiting from the province-specific data, the meadow and pasture areas of the geographical regions were calculated and the results were presented in Table 3.

Natural meadows and pastures are concentrated in the Eastern and Central Anatolian Regions (68.80% of the total areas).

Table 2. Rangeland area per animal head and cropland area per capita by years

Years	Cereals and other crop products		Meadows and pastures		Rangeland per animal head, da		Cropland per capita, da
	Million ha	Rate (%)[1]	Million ha	Rate (%)[1]	Small ruminants	Small and large ruminants	
1950	14.5	18.6	37.8	48.6	9.10	7.18	6.97
1970	24.3	31.2	21.5	27.6	3.84	3.08	6.88
1990	24.2	31.1	14.2	18.3	2.76	2.24	4.39
2010	20.8	26.7	14.6	18.8	4.97	3.58	2.84
2019	18.8	24.2	14.6	18.8	3.01	2.20	2.26

[1] Share of croplands (%) in total area of Turkey (77.8 million ha); Source: Erdoğan (1996); TÜİK (2014); TÜİK (2020a)

Table 3. Total meadows and pastures areas (ha) according to geographical regions

	Mediterranean	Eastern Anatolia	Aegean	Southeast Anatolia	Central Anatolia	Black Sea	Marmara	Turkey
Meadows	44 900	823 200	52 800	47 900	181 900	247 500	51 100	1 449 300
Pastures	614 400	4 662 300	750 100	964 600	4 388 300	1 269 200	518 500	13 167 400
Total	659 300	5 485 400	802 900	1 012 600	4 570 200	1 516 600	569 600	14 616 700

Source: Anonymous (2020b)

In accordance with the explanation done in the section of material and methods, the region-specific hay productions were given in Table 4 and as it is seen in table, the hay production from the meadows and pastures of Turkey is about 13 164 210 tonnes. An approximately of 32.07% of this production is obtained from the meadows and 67.93% of it is derived from the pastures. Moreover, 86.86% of 3 666 850 tonnes of hay obtained from the meadows and 83.20% of 7 440 005 tonnes of hay produced in pastures are obtained from Eastern Anatolia, Black Sea and Central Anatolia regions.

Table 4. Total hay production obtained from meadows and pastures according to geographical regions

		Mediterranean	Eastern Anatolia	Aegean	Southeast Anatolia	Central Anatolia	Black Sea	Marmara	Turkey
Yield, kg da^{-1}	Meadows	275	300	300	250	250	300	300	-
	Pastures	50	90	60	45	45	100	60	-
Production, tonnes	Meadows	123 475	2 469 600	158 400	119 750	454 750	742 500	153 300	4 221 775
	Pastures[1]	307 200	4 196 070	450 060	434 070	1 974 735	1 269 200	311 100	8 942 435
	Total	430 675	6 665 670	608 460	553 820	2 429 485	2 011 700	464 400	13 164 210

[1] Usable forage is accepted as a half of the total biomass production of the pastures;Source: Altın et al., (2011a); Anonymous (2020b)

Shrublands and hay production: Shrublands, maquis and shrubby rangelands take place among the important sources of roughage for sheep and partially for goat raising. In arid and semi-arid climatic regions, shrubs constitute an important source of feed in the summer when the herbaceous species turn yellow and their nutritional value decreases, and in the winter periods when growth stops (Dökülgen and Temel, 2015). The area of the shrubby rangelands in Turkey is 11 463 000 ha and the total amount of grazable forage produced from these areas is 11 267 000 tonnes (Table 5). Yields of shrublands areas change according to regions depending on not only ecological conditions such as soil and climatic factors but also productive forces and their rates in vegetation. Shrublands are concentrated in the Aegean and Mediterranean Regions (46.68% of the total areas).

Table 5. Total shrublands areas and hay production according to geographical regions

	Mediterranean	Eastern Anatolia	Aegean	Southeast Anatolia	Central Anatolia	Black Sea	Marmara	Turkey
Area, ha	2 049 000	1 173 000	3 210 000	966 000	1 453 000	1 726 000	886 000	11 463 000
Production, tonnes	2 049 000	938 400	3 210 000	772 800	1 162 400	2 071 200	1 063 200	11 267 000

Source: Gökkuş (2019)

Straw production: Although it is claimed that the overuse of the straw and stubble group of forages in animal feeding affects the digestibility of other high-value forage materials included in the ration negatively (Alçiçek, 2012; Ak and Akbay, 2018), some of the ruminant breeders in Turkey are left no choice but to feed their animals with straw and/or graze their herds in stubbles due to the shortfall of quality forage.

The cereal sown area, which was 12 100 000 ha in 2010 in Turkey, decreased to 11 713 000 ha in 2015 and 10 772 000 ha in 2019. In the mentioned period, while the cereals whose cultivated areas decreased most rapidly were wheat (1.86%) and rye (2.51%), the oat (2.44%) and triticale (10.15%) cultivated areas increased by annually. However, the annual average decrease in barley cultivated areas remained under 1% (Table 6).

The straw obtained from cereals is not evaluated only as forage. For instance, according to the Ministry of Agriculture and Forestry, the annual straw production is 25.0 million tonnes, 60% of which (15.0 million tonnes) is used in livestock farming (Anonymous, 2019). However, Alçiçek et al., (2010) reported that the amount of straw obtained from wheat, barley, oat and rye as 40.8 million tonnes in 2008.

The straw production calculated as explained before by multiplying yield per decare by the cultivated area was presented in Table 6. The amount of straw obtained from the commonly-cultivated cereals was estimated to be 43 085 000 tonnes in 2019. About 72.03% of the straw production was derived from wheat and 24.57% of it was obtained from barley. When it is estimated that 60% of the produced straw is fed to animals, it can be assumed that the straw production of Turkey to be used as animal forage is 25 851 000 tonnes in 2019.

Table 6. Sown areas and straw yield of commonly grown cereals by years

Years	Wheat	Barley	Rye	Oats	Triticale	Total
			Sown area (ha)			
2010	8 103 000	3 040 000	141 000	88 000	27 000	12 100 000
2015	7 867 000	2 784 000	112 000	103 000	37 000	11 713 000
2019	6 846 000	2 869 000	112 000	110 000	64 000	10 772 000
ACR*	-1.86	-0.64	-2.51	2.44	10.15	-1,28
			Straw yield (tonnes)			
2010	32 134 000	10 098 000	768 000	357 000	152 000	43 509 000
2015	36 913 000	11 143 000	693 000	438 000	204 000	49 391 000
2019	31 033 000	10 586 000	651 000	464 000	351 000	43 085 000

*ACR: The annual change rate for the years 2010-2019; Source: TÜİK (2020a)

Table 7. Straw yield (tonnes) of cereals according to geographical regions (in 2019)

Crops	Mediterranean	Eastern Anatolia	Aegean	Southeast Anatolia	Central Anatolia	Black Sea	Marmara	Turkey
Wheat	3 241 400	1 780 400	2 593 300	5 260 900	10 553 700	2 930 100	4 673 600	31 033 300
Barley	608 700	867 900	1 168 800	1 222 600	5 493 000	736 800	487 800	10 585 700
Others	66 400	111 100	192 200	800	683 600	201 800	210 100	1 466 100
Total	3 916 500	2 759 400	3 954 300	6 484 300	16 730 300	3 868 700	5 371 500	43 085 000

Source: TÜİK (2020a)

The amounts of straw produced from cereals differ according to the geographical regions. More than half of the total straw production (53.88%) is obtained from the Central Anatolia and the Southeast Anatolia regions (Table 7).

Amount of forage production from stubbles: Although there are various estimations about the amount of straw obtained from cereal cultivated areas, there is not clear information about to which extent animals benefit from stubbles. However, Deniz et al., (2010) reported in a study conducted in Şanlıurfa Province that when the wheat has an average length of 100 cm and the length of left stubble is 15 cm, 22.4% of the whole stubble weight and when the length of left stubble is 20 cm, 34% of it was left in the field. In this study, as explained before, it was assumed that only 30% of the estimated stubble was grazed by animals. When these assumptions are accepted, the amount of stem parts left as stubble in fields in 2019 was calculated as 17 412 667 tonnes and it was estimated that 5 223 800 tonnes of this were consumed by grazing animals. The great majority of the mentioned amount is wheat and barley stubble and the Central Anatolia takes the first place in terms of production (Table 8).

Table 8. Stubble yield (tonne) for grazing according to geographical regions (in 2019)

Mediterranean	Eastern Anatolia	Aegean	Southeast Anatolia	Central Anatolia	Black Sea	Marmara	Turkey
485 500	328 200	473 700	798 800	1 987 800	475 800	674 000	5 223 800

Source: TÜİK (2020a)

Cultivated area and production of forage crops: Among the cultivated areas, while the share of forage crops was 8.95% in 2010, it increased to 13.63% in 2019. In other words, while the annual increase rate of the area allocated for forage crops in this period became 4.10%, the fallow areas decreased by 2.49% and the sown areas decreased by 0.66%. In this period, the maize (for silage) and alfalfa cultivated areas increased annually by 6.26% and 1.34%, respectively and the common vetch sowing area decreased by 1.01% (Table 9).

Table 9. Sowing areas (ha) of forage crops by years

Years	Cereals and other crop products		Forage crops						
	Sown area	Fallow land	Alfalfa	Maize	Vetch	Sainfoin	Grasses**	Others***	Total
2010	16 333 000	4 249 000	569 000	294 000	429 000	157 000	0	12 000	1 461 000
2015	15 723 000	4 114 000	662 000	423 000	437 000	191 000	111 000	39 000	1 863 000
2019	15 387 000	3 387 000	641 000	507 000	391 000	175 000	345 000	38 000	2 097 000
ACR*, %	-0.66	-2.49	1.34	6.26	-1.01	1.23	33.08	13.66	4.10
Share in the sown area, %		2010 year	3.48	1.80	2.63	0.96	0.00	0.07	8.95
		2019 year	4.17	3.30	2.54	1.14	2.24	0.25	13.63

*ACR: The annual change rate for the years 2010-2019; **: Oat, barley, triticale, wheat, annual ryegrass (The annual change rate for the years 2015-2019); ***: Forage pea, grass pea, forage rape, sorghum, bitter vetch; Source: TÜİK (2020a)

The forage crops taking the first place in Turkey in terms of both of the area as well as production are maize, alfalfa, vetch and sainfoin. The green forage production of these four forage crops is 89.50% of 55 519 000 tonnes, which is the total production of 2019. In the total production, the share of maize (for silage and forage) was 46.20% and that of green alfalfa was 32.33%. While the total production of forage crops was 30 074 000 tonnes in 2010, it increased to 55 519 000 tonnes in 2019 by increasing annually by 7.05% (Table 10). These values can be interpreted in the way that the intensive ruminant breeding in Turkey has become widespread and, hence, the roughage production has been made mainly from maize and alfalfa.

Table 10. Total green forage yields (tonnes) obtained from forage crops by years

Years	Alfalfa	Maize	Vetch	Sainfoin	Grasses**	Others***	Total
2010	11 676 000	12 654 000	4 019 000	1 509 000	0	216 000	30 074 000
2015	13 950 000	19 920 000	4 281 000	1 656 000	1 475 000	754 000	42 036 000
2019	17 949 000	25 652 000	4 304 000	1 782 000	4 986 000	846 000	55 519 000
ACR*, %	4.89	8.17	0.76	1.86	35.59	16.38	7.05

*ACR: The annual change rate for the years 2010-2019; **: Oat, barley, triticale, wheat, annual ryegrass (The annual change rate for the years 2015-2019); ***: Forage pea, grass pea, forage rape, sorghum, bitter vetch; Source: TÜİK (2020a)

The productions of forage crops differ significantly according to the geographical regions. In the production of alfalfa and sainfoin, the Eastern Anatolia Region takes the first place while in the production of maize and other forage crops, the Aegean and Marmara Regions take the first places (TÜİK, 2020a).

Total roughage production: The roughage sources examined in detail above compose nearly all of the roughage which Turkey can provide and the 2019 geographic region-specific values of these were given in Table 11. As it is seen in the table, of 71 438 010 tonnes of dry roughage estimated to have been produced in 2019, 5.91% is obtained from meadows, 12.52% from pastures, 15.77% from shrublands, 43.50% from sum of the straws and stubbles, and 22.30% from forage crops production. In the forage crops production, the first two ranks are occupied by the Aegean and the Central Anatolia regions; in the straws and stubbles production, the Central Anatolia and the Southeast Anatolia regions take the first and the second places; in the production made from pastures, the Eastern and the Central Anatolia occupy the first and the second places.

Table 11. Total roughage production (tonnes) according to geographical regions (in 2019)

Regions	Forage Crops	Meadows	Pastures	Shrublands	Straw	Stubble	Total
Mediterranean	940 000	123 475	307 200	2 049 000	2 349 900	485 500	6 255 075
Eastern Anatolia	2 525 000	2 469 600	4 196 070	938 400	1 655 640	328 200	12 112 910
Aegean	3 790 000	158 400	450 060	3 210 000	2 372 580	473 700	10 454 740
Southeast Anatolia	655 000	119 750	434 070	772 800	3 890 580	798 800	6 671 000
Central Anatolia	3 304 000	454 750	1 974 735	1 162 400	10 038 180	1 987 800	18 921 865
Black Sea	1 688 000	742 500	1 269 200	2 071 200	2 321 220	475 800	8 567 920
Marmara	3 030 000	153 300	311 100	1 063 200	3 222 900	674 000	8 454 500
Turkey	15 932 000	4 221 775	8 942 435	11 267 000	25 851 000	5 223 800	71 438 010
Share, %	22.30	5.91	12.52	15.77	36.19	7.31	100.00

Source: Altın et al., (2011a); Gökkuş (2019); TÜİK (2020a); Anonymous (2020b)

Cattle, Water Buffalo, Sheep and Goat Stock in Turkey

The number of animals: The small and large ruminants of Turkey between the years 2005-2019 according to the TÜİK and their annual average change rates were presented in Table 12. It is seen that the livestock in the species included in the table has been increased rapidly starting from 2009. Such that, the average rate of increase in the period of 10 years between the years 2009-2019 was 5.13% in cattle, 7.75% in water buffalo, 5.54% in sheep, 8.21% in hair goat, and 5.07% in Angora goat.

The change in the number of animals between the years 2009-2019 did not remain limited to numerical increase but the share of culture cattle increased from 31.86% to 40.58% (TÜİK, 2020b). Especially, it is expected that the increase in the shares of culture and cross-bred in the species of cattle has made the need for quality roughage and concentrate feed more evident. In fact, that the productions of alfalfa and maize (for silage and forage) have increased rapidly especially in recent years can be evaluated as a result of this change.

Table 12. Cattle, buffalo, sheep and goat numbers (heads) by years

Years	Cattle	Buffaloes	Sheep	Goats - Hair	Goats - Angora
2009	10 723 958	87 207	21 749 508	4 981 299	146 986
2010	11 369 800	84 726	23 089 691	6 140 627	152 606
2015	13 994 071	133 766	31 507 934	10 210 338	205 828
2019	17 688 139	184 192	37 276 050	10 964 374	241 055
ACR*,%	5.13	7.75	5.54	8.21	5.07

*ACR: The annual change rate for the years 2009-2019; Source: TÜİK (2020b)

Livestock in terms of animal units (AU): By accepting the live weight as 500 kg for an AU, the values of each species were calculated in terms of AU and the results were presented in Table 13. As it is seen in the table, total AU were calculated as 17 066 900 in 2019. Between the years 2009-2019, the AU increased 1.8 times but there was non-significant change in the shares of the species, particularly those of cattle and sheep.

Table 13. Animal unit values of cattle, sheep, goat and buffalo and their shares in livestock by years

Years	Cattle		Buffaloes		Sheep		Goats		Total
	AU	%	AU	%	AU	%	AU	%	AU
2009	7 021 600	74.10	69 200	0.73	2 006 200	21.17	378 900	4.00	9 475 900
2010	7 489 200	73.52	66 700	0.65	2 156 100	21.17	474 300	4.66	10 186 300
2015	9 784 300	71.62	104 500	0.77	2 975 400	21.78	798 000	5.84	13 662 300
2019	12 434 200	72.86	145 200	0.85	3 613 800	21.17	873 700	5.12	17 066 900

Source: Anonymous (2020a); TÜİK (2020b)

Sufficiency of Total Roughage Production for Livestock

The roughage production per AU, which was a total of 6 318.53 kg in 2010, declined to 4 185.76 kg with a decrease of 33.75% in 2019 (Table 14). During this period, the AU increased by a total of 67.55% (Table 13), while the total increase observed in roughage production remained at the level of 10.99%. The increase in the forage crops production, which is the only source of this increase, reached 86.76%. However, due to the increase in the number of animals, the reflection of this increase into daily consumption per AU took place in the form of increasing the dry matter production obtained from forage crops from 837.48 kg to 933.50 kg (Table 14). If the total roughage per AU is divided by 365, it is seen that the amount of daily consumable roughage decreased from 17.31 kg to 11.47 kg. However, nearly half of this value came from straws and stubbles production.

Table 14. Total roughage production, and roughage per animal units by years

Years	Forage Crops	Meadows*	Pastures*	Shrublands*	Straw	Stubble	Total
Total roughage production (tonnes)							
2010	8 530 820	4 221 775	8 942 435	11 267 000	26 105 400	5 295 000	64 362 430
2015	12 102 600	4 221 775	8 942 435	11 267 000	29 634 600	6 019 000	72 187 410
2019	15 931 910	4 221 775	8 942 435	11 267 000	25 851 000	5 223 800	71 437 920
Roughage per animal units (kg year^{-1})							
2010	837.48	414.46	877.89	1 106.09	2 562.80	519.82	6 318.53
2015	885.84	309.01	654.53	824.68	2 169.08	440.56	5 283.69
2019	933.50	247.37	523.96	660.17	1 514.69	306.08	4 185.76

*It is assumed that the area has not changed after 2010 with the yield per decare

Considering the daily dry roughage requirement as 12.5 kg (approximately 2.5 percent of total 500 kg live weight), deficiency of daily feed amount was estimated as 1.032 kg AU-1 in 2019. In this case, the total roughage deficit can be calculated as 6 429 720 tonnes in 2019. If shrublands, straw and stubble production is neglected or removed from the calculation, then total deficiency reaches at 48 771 521 tonnes year-1. In previous studies, Acar et al., (2020) reported annual quality roughage production as 31.0 million tonnes, roughage need 86.9 million tonnes, roughage deficit as 55.9 million tonnes. Özkan

(2020) determined the annual quality roughage production as 29.1 million tonnes, the roughage need as 85.4 million tonnes, and the total roughage deficit as 56.3 million tonnes. Our findings are in fully agreement with those previous studies.

However, considering the sugar beet, vegetable and fruit residues and the weeds on the fields and roadsides, it may not be mentioned about the roughage deficit. The main problem is the lack of quality roughage. Only 37.37% of the total roughage requirement, which is 77 867 731 tonnes, is provided by quality roughages obtained from forage crops, meadows and pastures. Since the remaining part (approximately 62.63% consists of feeds having low nutritional value, breeders have to give more concentrated feed especially to the culture cattle. This situation increases the cost of animal products. The total roughage deficit is 40.36% of the total forage crops production. Hence, in order to meet the need of our country, it is necessary to increase the forage crops production to about 22 500 000 tonnes. Apart from the widely produced legume and grass forage crops, alternative forage crops that are cultivated or found in natural vegetation, resistant to adverse climatic conditions, diseases and pests should also be evaluated (Tan and Temel, 2012).

CONCLUSION

Overall data obtained in this study suggest that it is necessary to focus on the products that will cover the quality roughage gap in animal feeding. Increasing the amount of hay produced from forage crops, meadows and pastures will serve this aim. By considering the climatic and topographical features, crop cultivation patterns and fallow areas of Turkey, it can be suggested that areas to cultivate forage crops can be increased by acreage. In addition, the abandoned agricultural land, which has been 3 250 000 ha for the last 20 years, should be reserved to production, winter fodder crops should be rotated in irrigated agricultural land and forage plants should be used to decrease fallow lands. Besides, a series of precautions should be taken to conserve our meadows and pastures. The appropriate management and improvement of rangelands should be the primary target. The regulations facilitating the change of allocation aim included in the 14th article of the Rangeland Law should be abolished and the allocation aim changes should be made more difficult. In Turkey, many shrublands were taken within forest borders and grazing animals in these areas has been prohibited. Grazing should be allowed both in these areas, which will never turn into forests and in higher forest areas, where grazing doesn't harm to ecosystem. Region-specific and production system-specific grazing regulations should be prepared and primarily breeders should be made to adopt these regulations.

Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

The authors declare that they have contributed equally to the article.

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