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EFFECTS OF CLIMATE CHANGE ON SHEEP AND GOAT BREEDING

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Abstract: Climate change is seen as a significant threat to the sustainability of many species, ecosystems and livestock production systems in many parts of the world. With the rise of average temperatures at the global level, a number of effects occur. These effects lead to different changes in climate, regionally and globally. Livestock sector in Turkey is the leading sector that is most affected by the global climate change due to the predomination of rural economic structure and industries based on developing livestock breeding. Health and welfare in animal production are an integral part of environmental sustainability. Extreme events and seasonal fluctuations affect the welfare of the animals and cause a decline in yield and reproductive performance. Sheep and goat are animals that can make the best use of pasture and use it in every season of the year. In addition to the effects of climate change on ecosystems, it is inevitable that it will create important problems on the natural resources that form the basis of animal production. Climatic characteristics such as temperature and precipitation patterns have a significant impact on the availability of pasture and other resources throughout the year of animals. In this study, it was aimed to reveal the effects of climate change on animal husbandry and especially on sheep and goat breeding.

Keywords: Climate change, Sheep, Goat, Heat stress, Animal health

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1. Introduction

One of the most important factors affecting life styles on earth is climate. The climate, which is formed by the effects of factors such as temperature, precipitation, humidity and wind in a particular region, affects the existence of living things, the geographical distribution and abundance of plant and animal species, the chemical structure of oceans, seas and lakes, and the formation of soil (Jackson, 2018). The change that occurs in the climate system as a result of natural factors or human activities is defined as "climate change" (IPCC, 2007). Climate changes; drought, desertification, imbalances and deviations in the speed and intensity of precipitation, floods, typhoons, storms, tornadoes, hurricanes, etc. manifests itself with increases in meteorological events. Climate change has emerged in the form of global warming, which is defined as the increase in the average temperature on the Earth's surface in recent years. The effects of global warming can be seen as a result of the greenhouse effect of the gases released into the atmosphere (Bozoğlu et al., 2003; Köknaroğlu and Akünal, 2010).

Greenhouse gases having an important place in climatic changes adsorb on long-wave infrared rays reflected back to the atmosphere and cause the atmosphere to warm. Greenhouse gases arise not only naturally but also as a result of various activities of people (Köknaroğlu and Akünal, 2010). Today, the world faces with climate change due to global warming caused by technological and chemical applications used to increase plant and animal production in meeting the needs of the increasing population as well as industrialization and urbanization (Koyuncu and Akgün, 2018). Although the events occurred due to these problems threatening the world are not fully understood yet, it seems inevitable that global warming will cause economic, ecological and sociological problems (Demir and Cevger, 2007).

Climate change threatens the welfare of present and future generations by changing the ecosystem of the planet. Climate changes caused or to be caused by global warming may be vary in different ways by different parts of the world. Turkey is included in the risk group of countries in terms of the potential effects of global warming due to increases in extreme values of eastern Mediterranean. In Turkey will be affected by the negative aspects of global warming such as the weakening of water resources, forest fires, drought and desertification, and ecological deterioration dependent on them (Yetisgin and Sen, 2020). According to Turkey's 2019 data, the total greenhouse gas emission was 506.1 million tons CO_2. Of this amount, 72% originated from energy, 13.4% agriculture, 11.2% industrial processes and product use, and 3.4% from the waste sector (TUIK, 2021). While the

amount of greenhouse gas emissions per capita in Turkey was 6.07 tons of CO_2 in 2015, it increased to 7.30 tons of CO_2 in 2020. If measures are not taken in 2030, it is expected to be 13.29 tons of CO_2 (Anonymous, 2021a). It is estimated that the negative effects of climate change in Turkey can be seen in the next 10 or 20 years' time frame (Anonymous, 2021b). For example, arid and semi-arid regions such as South East and Central Anatolia under the threat of desertification, and semi-humid Aegean and Mediterranean regions that do not have adequate water will have been more affected. Climate changes will cause changes in the natural habitats of animals and plants in agricultural activities and important problems will arise (Öztürk, 2002; Atalık, 2005; Şen, 2014; Marino et al., 2016).

The fact that significant proportion of country economies like Turkey is based on the rural production such as agriculture and livestock causes to feel the effects of climate change much. Although certain improvements have been made in areas such as mechanization, productivity and health in animal feeding, the irregularity of the climate and unsettled market structure prevent sustainable production, decrease profitability and lead to rural migration. As a result of this, it becomes increasingly difficult to secure the supply in animal feeding due to increased production costs, and product prices are rising, while the import of livestock and meat frequently comes to the fore in order to meet the increasing demand. It is expected that climate change will completely affect the animal production systems in the world and cause an increase in the current demand for animal products in the coming years (Koyuncu, 2017; Sarıözkan and Küçükoflaz, 2020). This study aims to reveal the effects of climate change on animal and especially sheep and goat breeding and to present suggestions that can be made in this field.

2. Animal Production and Climate Change

The increase in gases, which are called greenhouse gases, due to reasons such as industrialization, energy production, population growth, urbanization and agriculture is the main factor that causes climate change. This interaction, which mostly takes place in a negative sense, causes many problems (Aydoğdu, 2020). With the release of greenhouse gases, climates on earth are changing and the number and frequency of extraordinary weather events are also increasing. Animal production is a factor that increases greenhouse gas emissions, and increasing greenhouse gases cause climate change on earth. Changing climates adversely affect animal production directly or indirectly. In other words, it is possible to talk about a two-way interaction between climate change and animal breeding. The animal breeding sector exhibits a structure that affects climate change due to animal-derived greenhouse gases and is also negatively affected by this changing climate (Dellal, 2008; Görgülü et al., 2009). A difference of 1°C above 30°C may cause stress in animals and animal production may be affected. The gas released as a result of feed intake and digestion is a factor that increases greenhouse gas emissions (Koç et al., 2016).

Agricultural production is largely dependent on climate, and the climate has been constantly changing in recent times. Scientific evidence points to climate change having an increasing impact on life on the planet. Climate change is not only the most important problem facing the realization of sustainable development, but also an important threat to the future of humankind. It will have far-reaching consequences within the context of animal production and particularly in regions of vital importance to the Earth's diet and livelihoods. While these impacts increase the vulnerability of livestock systems, phenomena such as drought can exacerbate the effects of emerging stresses. In addition to its impact on ecosystems, climate change will also create significant problems on natural resources that form the basis of animal production. In animal production, the most important effects of this can be listed as decreases in the amount and quality of production, increased sensitivity to diseases and pests, changes in the reproductive cycle, losses at birth, and regression in the conversion of feed into product (Koyuncu, 2017; Gökkür and Uysal, 2020; Demirbük, 2021; Koyuncu and Nageye, 2020).

Climate change represents a major global threat for ecosystems, and it is estimated that abnormal weather patterns could cause extinction of 8% animal species. Therefore, climate change is a major global threat for the sustainability of animal breeding. The most efficient production takes place under optimum environmental conditions and climatic factors such as ambient temperature, relative humidity, direct and indirect solar radiation and wind speed affect feed and water availability, feed quality and disease occurrence. Among these climatic variables, ambient temperature fluctuations have a considerable effect on livestock production and animal welfare (Pachauri and Meyer, 2014; Joy et al., 2020).

Studies show that hot and humid environments will cause heat stress in livestock as well as infectious diseases and changes in many physiological functions associated with a decrease in feed consumption, deterioration in health, reproductive efficiency and productivity while animals are trying to cope with temperature changes in the process of adaptation to climate change, behavioral and metabolic changes such as sensitivity (Thorne, 2007; Tirado et al., 2010). It is therefore essential to understand the mechanisms adopted by animals in extreme weather conditions, as well as a detailed study of the direct and indirect effect of climate change on livestock production.

3. Animal Health and Reproduction

Livestock has a range of thermal comfort zones where they can produce optimally, and this varies according to the species, breed, age and physiological state (Nardone et al., 2010; Dangi et al., 2016). Climatic factors such as

ambient temperature, relative humidity, direct and indirect solar radiation and wind speed affect the availability of feed and water, feed quality and pathogenesis where production is most efficient under optimum environmental conditions (Joy et al., 2020). Biological, physical and chemical environmental conditions or climate have a direct effect on animals. Extreme temperatures adversely affect production performance (growth, meat, milk, egg production, etc.), reproductive physiology, metabolism and the immune system (Batima et al., 2006; Koyuncu and Akgül, 2018).

Indirect effects of climate change may occur in the form of feed and water scarcity, food-borne diseases, resistance of infectious hosts, and the spread of vector-borne diseases which negatively affects the adaptation of animals to changing climatic conditions. While high temperature supports the growth of pathogens or parasites, changes in winds can lead to the spread of some pathogens and disease carriers over a wider area. While there may be changes in the spread of diseases during climate change, some severe diseases can also occur in herds with no previous disease (Petrovica et al., 2015; Koyuncu and Akgün, 2018). In many studies, hot and humid environments will cause temperature stress in livestock as well as infectious diseases and changes in many physiological functions associated with a decrease in feed consumption, deterioration in health, reproductive efficiency and productivity while animals are trying to cope with temperature changes in the process of adaptation to climate change, behavioral and metabolic changes such as sensitivity to disease (Thorne, 2007; Tirado et al., 2010; Koyuncu and Akgün, 2018). It has been reported that as the temperature increases, there is an increase in respiratory rate, body surface and rectal temperature (Aleena et al., 2018).

Some sheep and goat breeds have been found to adapt to warm environments providing acceptable productivity rates. The positive characteristics of these species are related to their relatively small body size, low water and feed requirements, good feed conversion rate, and the capacity to convert poor quality feed into quality products. Therefore, identifying tolerant breeds for higher adaptability in extreme environmental conditions (high temperature, feed shortage, water scarcity) is an applicable strategy to reduce the impact of climate change on sheep and goat production (Silanikove and Koluman Darcan, 2015; Joy et al., 2020).

High environmental temperatures endanger the productivity of lactating sheep and goats, and energy requirements increase partially due to the higher respiratory rate. Both heat stress and the progression of lactation can cause a decrease in milk yield and quality (Brasil et al., 2000; Peana et al., 2007; Sevi and Caroprese, 2012; Smith et al., 2013). Moreover, heat stress may endanger udder health and milk quality by causing more bacterial colonization in the udder in sheep (Sevi and Caroprese, 2012). Heat stress also affects meat yield and meat quality in sheep and goats. Some studies have reported higher pH and darker meat (Kadim et al., 2016; Archana et al., 2018). Increased body temperature in rams during heat stress causes testicular degeneration, a decrease in the percentage of normal and fertile spermatozoa, low ejaculate volume, high semen pH, decreased sperm motility and decreased sperm quality (Hamilton et al., 2016; Rahman et al., 2016). Temperature increases increased the risk of infection in the mammary glands of lactating animals (Koyuncu and Akgül, 2018), and caused a decrease in birth weight and viability of the offspring born in January, February and July, August of pregnant goats. It has been reported that mortality rates in the first month after birth increase in cold and warm months (Luo et al., 2020). Dairy-oriented breeds are more affected by heat stress than meat-yielding breeds (Bernabucci et al., 2010). In the research conducted in Saanen and Hair goats, a decrease in T3 (Triiodothyronine) and T4 (Thyroxine) hormones occurred when the temperature and humidity index value increased. This situation is associated with slowing down carbohydrate metabolism and reducing energy production in order to keep body temperature constant (Koluman Darcan et al., 2013). Heptaglobin, NEFA (Non-esterified fatty acids), T3 and T4 can be used as markers of metabolic adaptation to heat stress in livestock (Aleena et al., 2016).

3.1. Sheep and Goat Breeding and Climate Change

Animal production is a sub-sector that can mostly use family labor in the agricultural sector in Turkey, have high added value and contribute significantly to the adequate and balanced nutrition of the population. Sheep and goat breeding among animal breeding creates an important economic value in the geography where it has been carried out for many years (Gürer and Ulutaş, 2021). Sheep and goats are animals that can make the most of the pasture and use the pasture at all times of the year. It is inevitable that climate change will cause important problems on the natural resources forming the basis of animal production in addition to its effects on ecosystems. Climatological characteristics such as temperature and rainfall patterns have a major effect on the availability of animals for year-round pasture and other resources. Some regions in Turkey are dependent on animal breeding and animal breeding is dependent on the size of pasture areas (Gökkür and Uysal, 2020; Koyuncu and Nageye, 2020).

It is inevitable that climate change will cause a decrease in the productivity of pastures. A significant part of the amount and quality of feed is affected by the increase in CO_2 level and increase in the temperature (Chapman et al., 2012). Environmental stress that limits the availability of pasture and feed resources may arise from drought, high/low temperature, ozone, high carbon dioxide, soil water and salinity. Perennial plants have a limited yield but grow in barren soils with low rainfall or irrigation and high salt content. Heat stresses can reduce the amount of crop harvested, change nutritional value, and degrade the composition of the species (Chauhan

and Ghosh, 2014). While this causes a decrease in available nutrients for animals, it causes losses in animal production by affecting food safety and incomes as a result of reduced milk and meat production for small herd owners (Koyuncu and Nageye, 2020). There are many ways that climate change affects grazing through thermal stress which changes especially the quality and quantity of meadows and increases the occurrence of pests and diseases. Each of these may endanger both livestock productivity and welfare (Baumgard et al., 2012; Stocker et al., 2013). Climate change has many direct and indirect effects on animal production. The main effects on animal breeding are submitted in the headings below.

3.2. Climate Change and its Effects on Biochemical Parameters in Sheep and Goats

Generally, climate change is associated with an increasing global temperature. Severe weather conditions (intense heat waves, floods, and drought) to which animals are exposed, in addition to production losses, can result in animal deaths, in extreme cases (Gaughan and Cawsell-Smith, 2015). Animals can adapt to warm climates, but response mechanisms helping survive can have adverse effects on their yield performance. Livestock perform their best between 10-30°C. It is stated that there is an average of 3-5% decrease in the feed consumption of cattle, sheep, goats and chickens with every 1°C increase in ambient temperature above 30°C (NRC, 1981; Koyuncu, 2017).

Heat stress will cause changes in nutrition by causing physiological effects on the digestive system of sheep and goat. It will decrease rumen fermentation and rumen volatile fatty acid production (Pragna et al., 2018) and cause metabolic (acid-base balance and cortisol release) changes (Wojtas et al., 2013). Changes will also be seen in the hormones NEFA (non-esterified fatty acids), T3 and T4 in the blood (Sejian et al., 2019). This may cause an increase in Streptococcus bacteria and a decrease in Fibrobactor bacteria. The response of goats to heat stress varies due to genetic differences (Pragna et al., 2018). Research is needed to detect genetic differences and to identify and breed breeds that are resistant to climatic changes in regions.

3.3. Pasture and Grazing

Desertification process caused by global warming causes a decrease in the carrying capacity of feed-based cultivated areas and the buffering capacity of agricultural systems (Koyuncu and Akgül, 2018). Light, temperature and rainfall are important factors for plant production, and these factors must be at a level to meet the needs of the plants. Prolonged temperature or rainfall above or below normal values can adversely affect plant life, causing a significant decrease in productivity or even complete destruction. Water, which is a very important element for vital activities, is provided by rainfall for natural pasture areas, and the reduction in the total amount of rainfall or anomalies in seasonal distribution is a very important factor for production in pasture areas, especially in arid and semi-arid regions. Climate changes, where the changes in the atmosphere have an accelerating effect, cause changes in the productivity of pasture areas, as in all plant production, abnormal climatic conditions occurring with misuse accelerate this change negatively and cause it to be disposed irrevocably (Herbel and Pieper, 1991; Pittock, 1995).

In Table 1, the change of pasture areas in Turkey by years, in Figure 1, the distribution of annual average temperature values in Turkey, and in Figure 2, the distribution of annual average total precipitation values in Turkey are given.

When Table 1 is examined, it is seen that there are significant decreases in our pasture areas in all regions. There are many reasons for this decline, such as the conversion of pasture lands to agricultural areas, misuse, faulty grazing, overcapacity and untimely grazing, covering the pasture by species with low fodder value, sparse vegetation and decreasing yield levels, and deterioration of the natural vegetation cover of the pasture.

Table 1. Change of rangeland in Turkey (Anonymous, 2021c)

Regions	1970	1991	2001	1998-2020 years change		Average hay yield (Kg/ha)
	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	
Aegean	1027900	615900	802879	440166	0.56	600
Marmara	463600	564100	552662	287943	0.37	600
Mediterranean	1002400	434300	659334	569546	0.73	500
Central Anatolia	5884200	3890300	4570182	4297862	5.51	450
Black Sea	1993100	1556000	1533605	1315925	1.69	1000
Eastern Anatolıan	9162100	4573400	5485449	4976736	6.38	900
Southeast Anatolia	2165100	743600	1012576	1057158	1.36	450
Total	21698400	12377600	14616687	12945335		

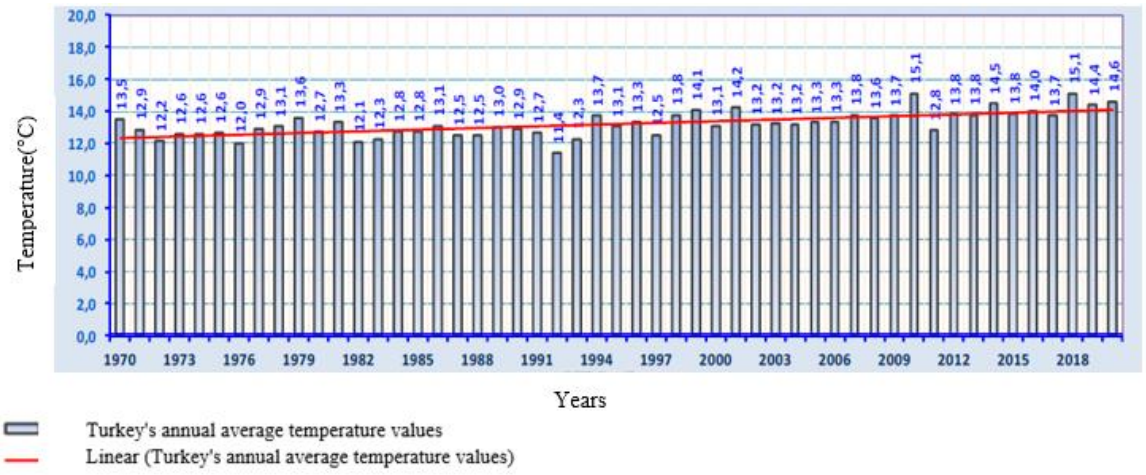

Figure 1. Turkey's annual average temperature values (Anonymous, 2021d).

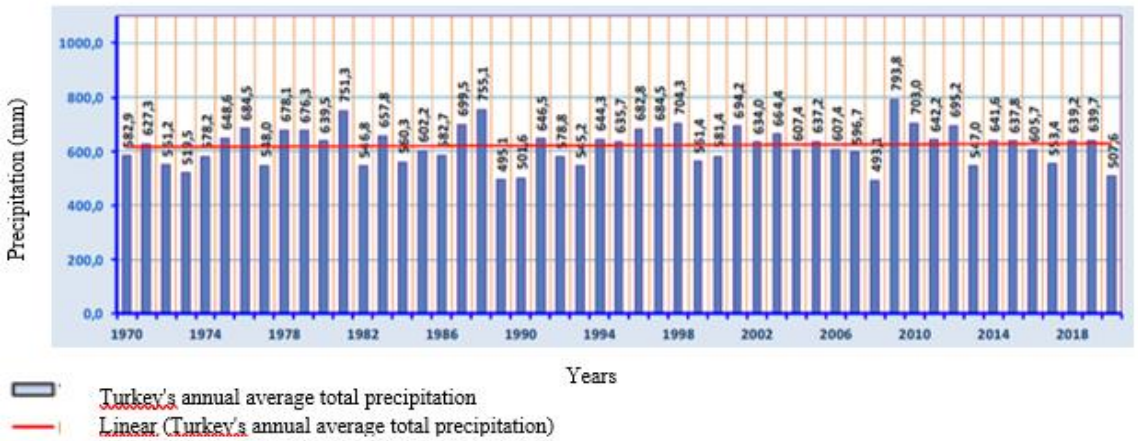

Figure 2. Turkey's annual average total precipitation (Anonymous, 2021d).

As a result of wrong applications, the productivity of the soil decreases, the soil is moved, erosion begins and the environment in which the plant will hold is destroyed. In addition to these, due to the effects of climate variability, the increase in temperature and the decrease in forage crops production due to drought also cause significant yield losses in pastures. In addition, the annual total precipitation is low, and the distribution and intensity of precipitation throughout the year directly affect the growth timing and duration of pastures. In addition to the decrease in plant production due to drought, the species composition of pasture vegetation and feed quality are also negatively affected (Peterson et al., 1992; Snyman and Fouche, 1993; Moldenhauer, 1998). On the other hand, rainfall has a direct effect on the yield of pasture areas, as well as on the performance of pasture-based agricultural activities. During periods of low rainfall, plant production decreases in pastures and animals cannot graze properly in the pasture area with the effect of high air temperature on days without rain (Tuvaansuren and Bayarbaatar, 2003; Holechek et al., 2004). The increase in the amount of rainfall generally causes a yield increase in meadows and pastures. However, the effect of excess rainfall as a result of global warming will be suppressed by water loss. Seasonal distribution and intensity of rainfall will have a greater effect on pastures than rainfall as it will affect seasonal soil water dynamics and plant water use efficiency (Giorgi et al., 1998). Heavy rains will cause an increase in runoff and erosion. The drying effect of global warming will be particularly important in arid and semi-arid regions of the world where climate change will not affect or decrease rainfall much. However, the increase in CO_2 concentration will cause an increase in water use efficiency (Hatipoğlu et al., 2019).

3.4 Effects of Climate Change on Sheep and Goat Welfare

Livestock sector in Turkey is the leading sector that is most affected by the global climate change due to the predomination of rural economic structure and industries based on developing livestock breeding. While the agricultural sector has a structure directly affected by the climate, especially in terms of plant production, animal breeding is indirectly affected by its inter-sectorial interaction with agriculture in terms of forage plant production (Sarıözkan and Küçükoflaz, 2020). Extreme events and seasonal fluctuations affect the welfare of the animals and cause a decline in yield and reproductive performance (Sejian et al., 2015). Stress can lead to behavioral changes (decrease in feeding and

rumination, increase in lying, standing and self-grooming behavior) in terms of animal welfare in sheep and goats (Ergul Ekiz et al., 2020). It also caused an increase in respiratory rate and water intake (Bernabucci et al., 2010) and an increase in water drinking frequency (Aleena et al., 2018). The behavioral response created by heat stress varies according to the perceived temperature threat. Heat stress is a phenomenon that negatively affects animal welfare, decreases productivity in animal production, increases health problems and causes economic losses (Ettinger and Feldman, 2009; Sucu et al., 2015). Improving the barn conditions according to the changing climatic conditions will prevent the loss of offspring and positively affect the productivity of the animals (Ünal et al., 2018).

In brief, heat stress affects various breeding characteristics and reproduction in sheep and goats, and timely interventions are required to improve animal welfare and production.

3.5. Climate Change and the Advantages of Sheep and Goat Breeding

Due to the high ability of sheep and goat to digest various plant species and feed sources that may be affected by climate change, they will come to the fore as species that will provide advantages in animal production in the future. Among the ruminant animals, the animal species with high resistance to diseases and adaptability to heat stress is the goat. The importance of sheep and goat breeding will increase, especially in meeting the needs of the dairy industry. Goats have lower metabolic requirements due to their low body mass, ruminant species due to their large salivary glands, large mucosal surface area that absorbs roughage, and anatomical and physiological features that increase the foregut volume. They can live in desert conditions (Silanikove and Koluman Darcan, 2015). More than 50% of goats in the world are bred in arid climates. This shows that goats are advantageous compared to other species in terms of adaptation to heat stress (Monteiro et al., 2018). The greenhouse gas emission share of goats among sheep and goat breeding is low compared to other species (Koluman Darcan and Silanikove, 2018). It is reported that HSP 70 (Heat shock protein 70) for heat tolerance in goats can be used safely as a genetic marker in determining the thermo tolerance capacities of domestic goat breeds (Aleena et al., 2018). In Figure 3, CO_2 emission values by species are given. Cattle account for approximately 62% of sector emissions, while pigs, poultry, buffalo, sheep and goat account for 7 to 11% of sector emissions.

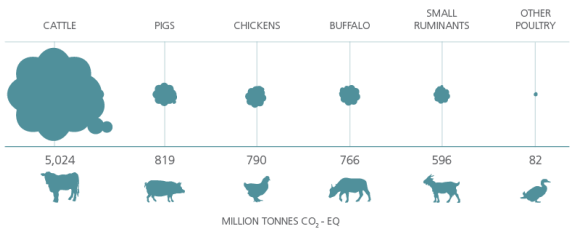

Figure 3. Emissions by species (FAO, 2021a).

When the figure is examined, it is seen that the greenhouse gas emission share of sheep and goats among farm animals is lower than other species (FAO, 2021a). In Table 2, global production, emissions and emission intensity values are given according to species. The average emission intensity from sheep and goats in the world was determined as 6.5 kg CO2-eq/kg product from milk production and 23.8 kg CO2-eq/kg product from meat production (Gerber et al., 2013; Opio et al., 2013; Macleod et al., 2013).

Table 2. Global production, emissions and emission intensity for species (Gerber et al., 2013; Opio et al., 2013; Macleod et al., 2013)

Species	Production (Million tons)		Emissions (Million tons CO_2-eq)		Emission intensity (kg CO_2-eq/kg product)	
	Milk	Meat	Milk	Meat	Milk	Meat
Cattle dairly	508.6	26.8	1419.1	490.9	2.8	18.4
Cattle beef	-	34.6	-	2345.9	-	67.8
Totals	508.6	61.4	1419.1	2836.8	2.8	46.2
Buffalo milk	115.2	2.4	389.9	40.4	3.4	16.6
Buffalo meat	-	0.95	-	139.9	-	143.9
Totals	115.2	3.4	389.9	180.2	3.4	53.4
Sheep	8.0	7.8	67.4	186.9	8.4	24.0
Goat	11.9	4.8	62.4	112.5	5.2	23.5
Totals	20.0	12.6	129.4	299.4	6.5	23.8
Pigs	-	110.2	-	668	-	6.1
	Eggs	Meat	Eggs	Meat	Eggs	Meat
Chickens	58.0	72	217	389	3.7	5.4

4. Conclusion

Pasture-based livestock systems are expected to be more affected by global warming than industrial livestock systems. Because solar radiation caused by global warming, high temperature, low precipitation and drought directly affect the pastures and plants. Pasture-based livestock is the preferred system mainly in developing countries, and a 25% loss in animal

production due to global warming is predicted in these countries. After remaining virtually unchanged from 2014 to 2019, the prevalence of malnutrition (PoU) rose from 8.4 percent a year ago to 9.9 percent in 2020. In terms of population, taking into account the additional statistical uncertainty, it is estimated that between 720 and 811 million people worldwide are facing hunger in 2020 (FAO, 2021b). However, the increase in per capita consumption in parallel with the population growth in the coming years will also cause an increase in the demand for animal products (Nardone, 2002; Delgado, 2003). Therefore, the grazing capacity of pastures should be taken into account. The use of heat-resistant plant patterns and the use of agricultural wastes in animal nutrition can be increased by technological improvements. In addition, the production of forage crops that will capture methane, nitritoxide emissions and carbon dioxide, which have a significant effect on greenhouse gas emissions in pastures, can be encouraged (Durmuş and Koluman, 2019). Preventing the possible effects of climate change on animal breeding systems depends largely on the interactions of the components involved in this process. Transforming animal production into sustainable systems can significantly contribute to reducing the effects of climate change. It is necessary to establish specific and regional policies to ensure both humane and sustainable global food production. Native breeds are stronger and more durable than culture breeds raised in industrial enterprises. Therefore, our native breeds will provide an advantage in overcoming the problems caused by climate change (Koyuncu, 2017; Koyuncu and Akgün, 2018).

As a result, climate change poses a potential threat, directly or indirectly, for livestock and sheep and goat farming as well as humans. About half of the sheep and goat population are found in arid and semi-arid regions. Sheep and goats can adapt to stress factors better than other species due to the situation and physiological characteristics they are in. Studies show that sheep and goat adapt better to harsh environmental conditions and can be used for genetic improvement, especially in heat tolerance. By identifying genetic markers for heat tolerance, heat stress resistant breeds can be produced. However, it is known that the effects of climate change will vary in different regions, so region-specific studies are needed. In this direction, more studies should be done on genetic markers in addition to breeding studies on our native breeds. In order to prevent the negative effects of temperature changes, existing barns should be restructured and renewed with air conditioning systems. In order to reduce the possible effects of climate change on maintaining the production of sheep and goats, local breeds adapted to breeding programs that will be put forward by studies taking into account their environmental and genetic characteristics can be an alternative.

Author Contributions

All authors had equal contribution. All authors reviewed and approved the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

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