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EFFECTS OF CLIMATE CHANGE ON ANIMAL HUSBANDRY

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Abstract: Climate has a significant impact on agricultural production. According to scientific data, climate change is having a growing impact on the planet's life, and different regions of the world are experiencing this impact in different ways. The greatest challenge to achieving sustainable development is climate change, which also poses a serious risk to the survival of humanity. It will have far-reaching consequences within the context of animal production, and particularly in regions of vital importance to the world's nutrition and livelihoods. All species have ideal climatic parameters for survival in animal husbandry, and changes to these variables have a negative impact on the quality and quantity of farm animals and animal products. There are four key areas where the effects of climate change on animal productivity can be studied. These include effects on pasture quality, effects on animal diseases and pests, effects on animal health, growth, and reproduction. They also include implications on the availability, quality, and price of feed crops. Planning for the sector's future is crucial in order to meet the population's food needs, lessen the impact of climate change on livestock output, and reduce the sector's contribution to global warming. Adapting animal husbandry to climate change is required to reduce all these harmful effects.

Keywords: Climate change, Global warming, Agriculture, Animal husbandry

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1. Introduction

As a global problem, climate change affects the whole world deeply. Climate change, accepted as one of the major problems of our time, can be defined as changes in the global climate system over long periods of time (Houghton et al., 2001). The situation that the main reason for these changes, which can also be considered as a natural process, is human activities has gained weight. Therefore, it would not be wrong to consider the climate change, the effects of which we are experiencing intensely today, in the context of the destructive effects of human activities on the natural greenhouse effect. The deterioration of the greenhouse gas balance in the atmospheric structure as a result of human activities causes uncertain changes beyond the normal changes in the climate system (Doğan and Tüzer, 2011). These uncertain changes in the climate system, together with the effects from the past, prevent the creation of a sustainable future. Because the imbalance created by the changing climatic conditions negatively shapes not only the present but also the future socio-economic structure (Fankhauser and Tol, 2005). It is stated that the effects and consequences of climate change, defined by the UNFCCC as "change in the climate system as a result of direct or indirect human activities, in addition to natural changes that can be observed in comparable time periods", are now permanent.

One of the areas that will suffer the most from global climate change is agricultural production. Agricultural production, which changes in terms of quality and quantity as a result of fluctuations in the climate, affects food production and therefore human life socially and economically. The effects of climate change on the agricultural economy can be called a decrease in the income of farmers, an increase in food prices, a slowdown in economic development, an increase in the price of land, a decrease in the number of farmers and a decrease in exports. (Dellal and McCarl, 2013; Özçatalbaş 2014).

A significant area of agricultural production, animal husbandry is impacted both directly and indirectly by climate change. Climate change is seen as a severe threat to the survival of many species, ecosystems, and livestock systems in many parts of the world. (Moss et al., 2000). On the other hand, it is held responsible for approximately 14% of the global human-induced (anthropogenic) greenhouse gases resulting from livestock activities and it is stated that it is a source of soil, water and air pollution for human beings. These environmental issues have become an important topic of discussion in sustainability assessments of the livestock market (Herrero et al. 2014). It is predicted that the demand for animal products will increase by 100% starting from the middle of the 21st century. In addition, it is stated that competition that will arise with climate change, use of natural resources, feed quantity and

quality, animal diseases, heat stress and loss of biodiversity will affect animal husbandry. The main challenge at this point is to strike a balance between economic efficiency, food safety and environmental protection (Wright et al. 2012).

Considering this relationship between climate change and animal husbandry, the necessity of dealing with the issue multidimensionally emerges. Literature research carried out as part of the study revealed that although the subject had been investigated in many studies at the crop production level, little work had been done, particularly with regard to animal husbandry and economy. Therefore, the main purpose of this study is to examine the interaction between climate change and animal husbandry within the scope of literature and to bring forward suggestions for the solution of the problem.

2. Evaluation of Global Climate Change

The rise in the earth's surface's average temperature is referred to as global climate change and climate change due to the rapidly increasing accumulations of greenhouse gases released into the atmosphere as a result of human activities such as the burning of fossil fuels, changes in land use, degradation forest management and industrialization processes, intensification of the natural greenhouse effect. Humans are one of the most important causes of global climate change. Increasing world population, increasing consumption and industrialization, use of fossil fuels are examples of human-induced factors. Burning fossil fuels, especially coal, increases the amount of carbon dioxide in the atmosphere. According to the IPCC, 56 percent of human-caused greenhouse gases come from the use of fossil fuels. (WWF, 2019).

According to the climate assessments of the World Meteorological Organization (WMO), when the average of 1981-2010, when global warming became evident, is taken into account, the global average temperatures increased by 0.98 °C in 2018 compared to the pre-industrial revolution (1850-1900), while the global average temperatures increased by 0.38 °C has increased. In this respect, 2018 was the 4th warmest year recorded after 2015, 2016 and 2017 (WMO, 2018).

According to climate estimates from the National Oceanic and Atmospheric Administration (NOAA), global average temperatures in 2018 were 0.79 degrees Celsius higher than the 1901-2000 average (Figure 1). In 2018, while the warming in terrestrial areas was 1.12 °C, this value was 0.66°C in the oceans. Warming in the Northern Hemisphere (1.18 °C) was higher than that in the Southern Hemisphere (0.97 °C) (MGM, 2018). According to the NOAA, 2019 was the second warmest year in the last 140 years with a temperature deviation of 0.95 °C (MGM, 2019).

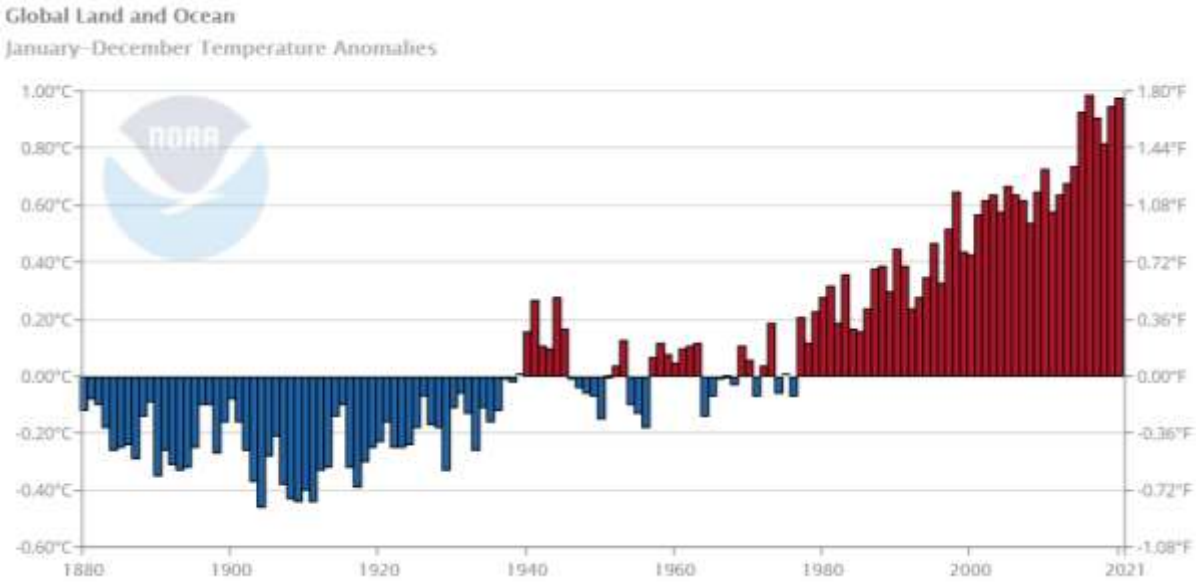

Figure 1. Global mean temperature anomaly (NOAA, 2018)

The WMO published an interim climate report in 2020 and estimated that 2020 could be one of the three warmest years on record. In this report, it was stated that 2020 was 1.2°C warmer than the pre-industrial average (1850-1900). It was also evaluated that the period 2011-2020 will be the 10th warmest year on record, and the period 2015-2020 will be the 6th warmest year on record (Figure 2; WMO 2020).

Major greenhouse gas concentrations rose, particularly in 2019 and 2020. Carbon dioxide (CO_2) mole fractions have surpassed 410 parts per million on a global scale (ppm).Board of experts predict that the CO_2 concentration will surpass 414 ppm in 2021 if the trend from recent years continues. Rising global temperatures are more frequent and severe worldwide, including rising global temperatures, cold and heat waves, floods, droughts, wildfires and storms. causes weather events (WMO, 2021).

In the upcoming years, it is anticipated that the negative consequences of climate change would worsen depending on the rise in greenhouse gas emissions. In addition to its effects on the environment and society, climate change has significant economic ramifications for both industrialized and developing nations. (Doğan and Tüzer, 2011). The cost of compensating for disasters brought on by climate change and taking steps to limit greenhouse gas emissions weighs heavily on national economies. A few of the key businesses affected by climate change include agriculture, cattle, foreign commerce, tourism, forestry, food production, fisheries, health, air conditioning, construction, logistics, and finance (Bayraç and Doğan, 2016).

Agriculture is a naturalistic activity. Changes in production that will result from climate change are essential for both the nation and global trade because agriculture is an economic activity. Agriculture is an industry that both contributes to and is impacted by climate change. Carbon emissions are caused by a variety of processes, including tillage, fertilization, spraying, operations along the product-food supply chain, changes in how agricultural lands are used, energy use, and animal waste (Topçuoğlu and Doğan, 2011).

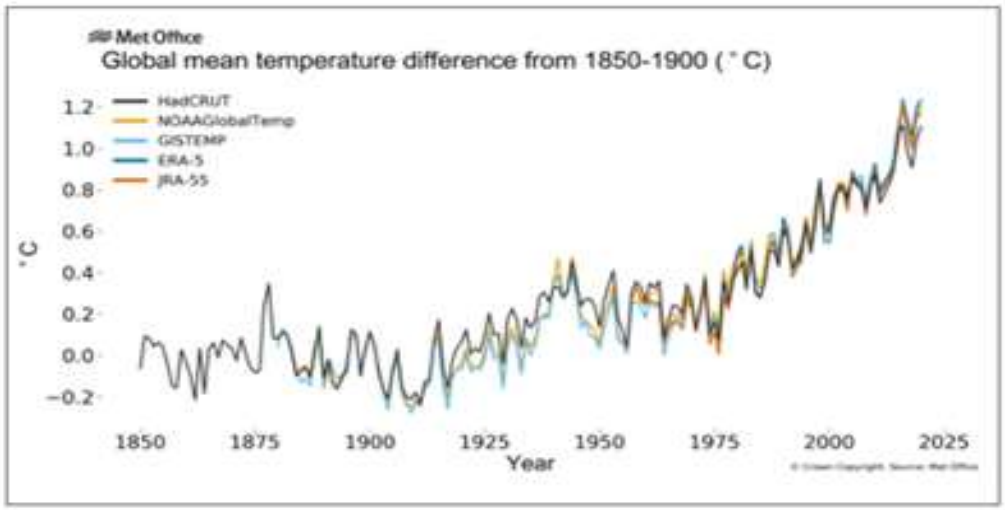

Figure 2. Change of global average temperatures for the period 1850-2020 (WMO, 2020)

3. Interaction between Climate Change and Agriculture

The scientific world has a large consensus that climate change is a real problem today and will continue to be experienced by increasing its effects in the future (Öztürk, 2002; Şen et al., 2013; Şahin et al. 2015). The adverse effects of these continuous climate changes are felt by rural residents, who are already at a disadvantage because of their location and way of life. Particularly the poor who work in agriculture and reside in rural regions are considerably more affected by the disastrous effects of climate change (Vural, 2018).

Climate change will probably make it more difficult for the poor to acquire clean water, jeopardizing their health. The destructive effects of climate change threaten agricultural production and food security in many developing and underdeveloped African, Asian, and Latin American nations. Given that over a billion people worldwide suffer from hunger as a result of a lack of convenient and dependable access to basic food supplies, it should come as no surprise that climate change will have an even greater impact on agriculture in the years to come (FAO, 2009).

Since the economies of developing countries are based on agricultural production, the impacts of climate change are felt more in these countries. Especially extreme weather conditions make agricultural production impossible in developing countries and therefore cause migration (Demirbaş and Aydın, 2020). According to estimates from the UN, more than 500 million people worldwide have been displaced as a result of climate change. Despite significant advancements in the agricultural sector, including product types that are adapted to various environments, spraying, fertilizer, and irrigation systems, climatic factors continue to play the most crucial role in agricultural productivity.

The agriculture sector, one of the industry's most vulnerable to climate change, is affected by it on both the positive and negative sides. Agriculture is impacted by climate change, and agricultural practices also contribute to it. (Polat and Dellal). Agricultural operations in tropical and sub-tropical countries are negatively impacted by extreme floods and droughts as a result of climate change, whereas agricultural productivity is anticipated to increase as a result of the extension of the crop growing season in temperate regions. Arid regions' agricultural production declines and even vanishes owing to desertification brought on by rising global warming. (Atabay et al. 2014). A shortage or surplus of agricultural production as a result of climate change significantly alters the economic balances because agriculture is a productive industry in addition to providing food for people (Miraglia et al., 2009). Due to the decrease in the volume of production, the increase in agricultural prices negatively affects inflation; the supply

of agricultural products through imports negatively affects the current account deficit; the decrease in the number of people employed in the sector negatively affects unemployment; and producers' drought-related losses are fully or partially covered negatively by governments (Baptista et al., 2022).

Agriculture productivity is significantly impacted by particular climatic conditions. Although the increase in temperature and elevated carbon dioxide levels brought on by climate change seem to have a positive short-term influence on the quantity of agricultural products in some regions, these factors may lead to a decline in production and quality of goods in the long run (Akalın, 2014). It takes more than just raising the temperature and carbon dioxide levels to boost agricultural output. To have a favorable impact on agricultural production, rising temperatures and carbon dioxide levels must be combined with good soil structure and quality. Additionally, it is crucial that the soil moisture levels are ideal and that the area to be planted has access to water. These requirements must come together to form an environment that is conducive to agriculture (Lou et al., 2003).

Agriculture production methods are evolving as a result of climate change. This condition puts pressure on the amount of the global food supply and lowers the productivity of agricultural products. According to the FAO, 790 million people in developing nations did not have access to enough food as of the late 1990s. Despite all the cutting-edge culinary innovations, this number has now surpassed one billion. More than half of the population residing in Central, South, and East African countries was reported to be inadequate and malnourished in the FAO report on food security, which also identified countries and populations at risk. Human activities and environmental conditions, which are both considered to be natural elements, are also cited as contributing contributors to the decline in agricultural production. The main factors contributing to the loss in the global food supply are improper land use, drought, barren soils, harsh droughts, cold temperatures, landslides, and extreme precipitation. The individuals who live in undeveloped and emerging countries find it challenging to maintain a healthy development due to these cutbacks in food availability. Particularly, this condition has a negative impact on children's mental and physical development (FAO, 1999).

On the other hand, agricultural production is among the main causes of climate change, since various greenhouse gases are produced as a result of agricultural activities (energy consumption, animal breeding, paddy production, fertilization and spraying, etc.). The amount of environmental pollution produced by animal husbandry has significantly increased in recent years due to the intensification of the meat-and-dairy cow breeding, poultry farming, and dairy industries (Demir and Cevger, 2007). It is stated that ammonia from farm animals causes acid rain and CH4 gas causes global problems by causing greenhouse effect. Ruminant animals release greenhouse gases through gastric fermentation during the digestive process. Paddy grown under water releases CH4 throughout its production. As paddy cultivation areas increase, greenhouse gas emissions also increase. Greenhouse gas emissions in the atmosphere rise when the fertilizer breaks down in the soil or as the CO2 buried during plowing escapes (Iyai and Runtuboi, 2016). Energy use accounts for 26% of greenhouse gas emissions globally, followed by industrial activity at 19%, land use changes at 17%, agricultural at 14%, and transportation at 13% (Lamb et al. 2021).

In addition to the increasing effects of agriculture on climate change, its reducing effects should not be ignored. Agriculture has the power to lower greenhouse gas emissions and carbon sinks. Through photosynthesis, green plants remove carbon dioxide from the atmosphere. Once more, soil is where carbon is kept. Biofuels are agriculture's second means of reducing climate change. Reducing greenhouse gas emissions into the atmosphere by favoring the use of biofuels rather than fossil fuels. It is anticipated that the increased atmospheric CO2 concentration may benefit the cultivation of some agricultural goods. The increased CO2 level will have a good impact on plants classed as C3 class, such as rice and wheat (temperate zone plants that require high CO2 concentration and low temperature, low light intensity capabilities). (Doğan and Tüzer, 2011). On the other hand, the increasing CO2 will have a negative impact on C4 class plants like corn and sugar cane.

4. Effects of Climate Change on Animal Husbandry

One of the most important sub-branches of the agricultural sector is animal husbandry. The livestock sector, which is included in agricultural activities, has great value for all underdeveloped, developing and developed countries. Animal products produced are important in terms of healthy and balanced nutrition of the country's population, creating raw materials for industry and foreign trade income (Yurdakul and Ören, 1995). According to the 2020 data of the FAO, 30.8% of the world's $4.1 trillion agricultural production value is provided by the livestock sector (FAO, 2020). In Türkiye, according to 2020 data, the share of animal product value in the total agricultural production value of 354 billion ₺ is 19.75% and 50% of the animal product value is obtained from milk production (TUIK, 2020).

Livestock is the most important sub-sector of agriculture in terms of social, economic and environmental aspects, in terms of its place in the human diet, its contribution to agricultural income, the livelihood of 1 million people, the amount of land used and fresh water resources (Herrero et al., 2013). It is estimated that animal husbandry will maintain this importance in the future and the demand for animal products will double in 2050

(Alexandratos and Bruinsma, 2012). Climate change and animal production systems interact in a complex way since they are both causes and effects of one another. Animal husbandry is badly impacted by climate change in a variety of ways and negatively influences climate change in a variety of ways (Malik et al., 2015). Livestock are impacted by climate change both directly and indirectly. Among the direct consequences are increased physiological stress, landslides, floods, productivity losses, and drought. Feed quality and quantity, access to drinking water, an increase in diseases, and an increase in input prices are examples of indirect effects (Thornton and Gerber, 2010).

Reilly (1996) identified four ways in which climate has an impact on animal husbandry. These include changes in the supply and cost of grains used to feed livestock, their impact on the yield and quality of forage crops and livestock pastures, shifts in the geographic distribution of animal diseases and pests, and the immediate effects of weather events on animal health, development, and reproduction. In livestock, most species perform well at 10-30 °C. For every 1 °C increase above 30 °C, the feed intake of cattle, sheep, goat, pig species decreases by 3-5% (NRC, 1981). Changes in the amount, distribution and intensity of precipitation directly affect the timing and duration of growth of pastures and crops. Disease vectors are affected by high temperatures, which affect the emergence, spread and distribution of diseases in livestock, and the rate of development of pathogens and parasites. These effects cause loss of live weight and milk yield in animals (Malik et al., 2015).

Global climate change has caused a decrease of around 1-5% per decade in agricultural production in the last 30 years. There is limited information about its effects in animal production, unlike plant production. In general, it is estimated that there will be decreases in feed consumption, reproduction and yield levels depending on the increasing temperature in different animal species. While climate change will increase the susceptibility of animals to diseases, it will cause mutations in disease and parasitic agents, increase in zoonotic diseases and the emergence of some new diseases. For this reason, there is a need for an integration in terms of developing genotypes with good adaptability and high ability to overcome environmental stress, improving soil and water management at the point of reducing the possible effects of climatic changes (Thorne, 2007).

Global climate change has caused a decrease in agricultural production at varying levels, such as 1-5% every ten years, in the last 30 years. In general, depending on the increasing temperature in different animal species, decreases in feed consumption, reproduction and yield performance occur (Figure 3). On the other hand, in countries where animal production is intense, in addition to its direct effects, it may adversely affect animal production with indirect effects such as pathogens, as well as reductions in water and feed (roughage/concentrate) resources. Animals can cope with heat stress by changing feeds, refrigeration or various farm management practices. However, the construction of climate-controlled shelters to adapt the animals to the ambient temperature will result in increased production costs.

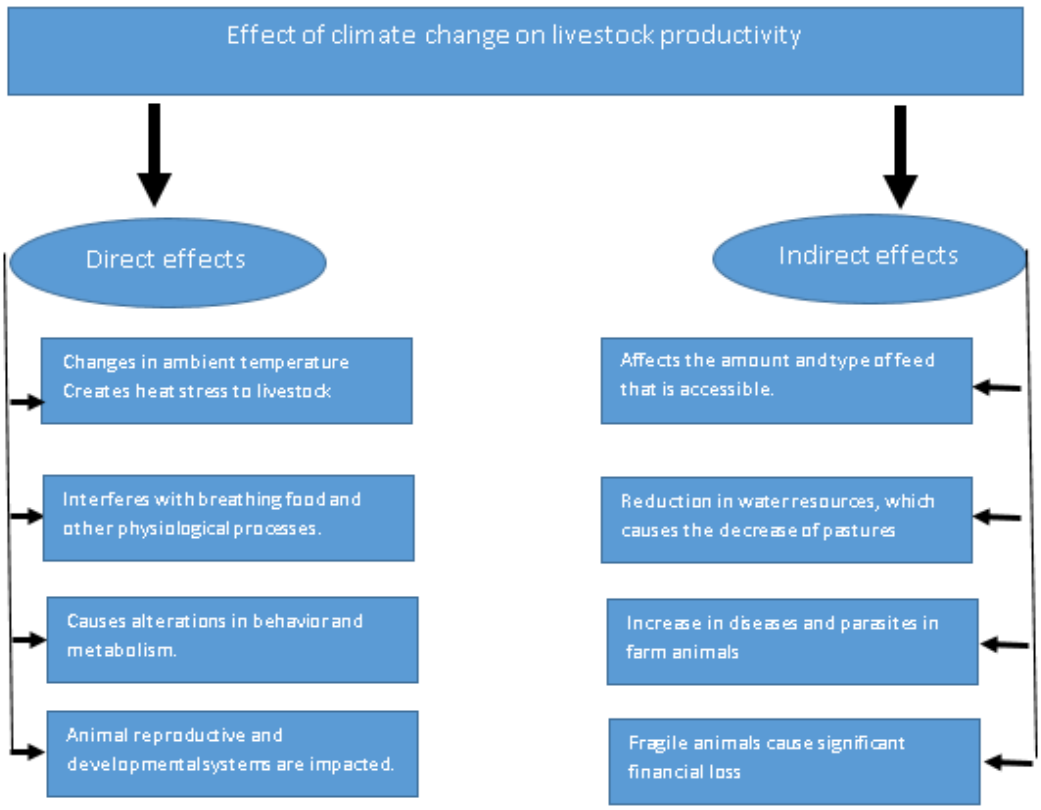

Figure 3. Effects of climate change on livestock productivity (Naqvi and Sejian, 2011).

Extreme occurrences and seasonal changes impair animal wellbeing and reduce productivity and reproductive efficiency. In the world, the sustainability of livestock systems is being threatened by climate change. The fight against the harmful impacts of climate change on animals involves both adaptation and mitigation strategies (Sejian et al., 2015). Global temperatures have been known to rise in response to climate change. According to predictions from different climate models, the average global temperature by 2100 might be 1.1–6.4 °C warmer than it was in 2010. In extreme circumstances, the adverse weather that animals are exposed to (such as intense heat waves, floods, and drought) can cause animal mortality in addition to output losses (Gaughan and CawsellSmith, 2015). Although animals may adapt to hot conditions, the methods they use to help them survive can have a negative impact on how much they produce. Climate change is anticipated to have a significant impact on global animal production systems in the coming years, which will raise demand for already available animal products. Food and water security are among humanity's main concerns in the twenty-first century.

Climate change has direct effects on livestock animals. Extreme temperatures negatively affect production performance (growth, meat, milk, egg production, etc.), reproductive physiology, metabolism and immune system (Koyuncu and Akgün, 2018). Changes in the amount, distribution and intensity of precipitation directly affect the timing and duration of growth of pastures and crops. Disease vectors are affected by high temperatures, which affect the emergence, spread and distribution of diseases in livestock, and the rate of development of pathogens and parasites. These effects cause losses in live weight and milk yield in animals (Koç et al., 2016). Animal production has a significant impact on the world's water, soil, and biodiversity resources, and adversely affects climate change in many ways, including land use change (CO_2), enteric fermentation (CH_4), and manure management (N_2O) (Steinfeld et al., 2006). It is noteworthy that 65% of greenhouse gas emissions come from beef and beef milk (Herrero and Thornton, 2013).

Mauger et al. (2015) think that cows are vulnarable to extreme temperature and humidity, therefore climate change will negatively affect milk yield in cows. Authors examined microclimate data and county-level dairy industry data to predict declines in milk yields from Holstein cows in the USA. In the study, it was determined that the decrease in milk yield throughout the country was around 2%. It is predicted that the decrease in milk yield due to climate change will increase to around 6.5% by the beginning of the 22nd century. This production loss is equivalent to 2.2 billion dollars. Sheikh et al. (2017) reported that the reproductive activities of animals would be adversely affected by heat stress in their research examining the effects of climate change on dairy cows and buffalo production. It has been determined that the extreme heat in summer causes low estradiol levels in buffaloes. For this reason, 80% of the heat is not noticed in the summer months and reproductive activities are interrupted. In addition, when the buffalo's body temperature rises above 40 °C, mature follicles are adversely affected and even become lifeless. In addition, the pregnancy rate of dairy cows falls to the range of 20-27% in summer.

5. Conclusion and Recommendations

This investigation of the current state of climate change and its effects on animal production was undertaken. This paper was conducted using the literature as a review. The study has demonstrated the relationship between agriculture and climate change. In addition, many viewpoints are explored about the direct and indirect effects of climate change on livestock.

Climate change is one of the biggest environmental problems of our time, and the main reason for this is human activities. Human-induced natural climate change, which emerged with the industrial revolution and increased its speed as of the 20th century, has left its place to climate change due to global warming. Climate change affects animal welfare and productivity directly and indirectly.

Diseases that may arise in arid and semi-arid regions of animal production, accessibility to water, etc. It is predicted that it will be adversely affected due to various reasons. At the same time, climate change will affect the nutrient content of animal products, which are the global supplier of calories, protein and essential micronutrients. On the other hand, livestock activities also have an impact on climate change. The expansion of pasture and cultivation areas within the scope of production activities, especially feed raw material production, constitutes half of the contribution to greenhouse gas emissions in the entire animal production process, and this is expected to increase further due to the increase in production.In this context, in order to ensure sustainability in global agriculture and food production and consumption; It is necessary to develop the resources of animal husbandry and increase its environmental performance. In addition, social and economic impacts must be taken into account. It is important to plan the future of the sector in order to reduce its contribution to climate change, to minimize the effects of climate change on livestock productivity and to meet the food needs of the population. In order to minimize all these negative effects, it is necessary to adapt animal husbandry to climate change. To reduce greenhouse gas emissions from agriculture, stopping animal production greenhouse gas growth should be a priority. There are many different ways to do this; using better quality feeds and improving animal nutrition according to changes in temperature, developing new breeds of animals that are resistant to stress, effective manure handling and stocking management, grazing management and pasture improvement studies are some

of them. These studies will both eliminate the low yield in animal husbandry caused by climate change and reduce the effects of animal husbandry on climate change.

Author Contributions

The percentage of the author(s) contributions is present below. The authors reviewed and approved final version of the manuscript.

	M.B.	C.Ö.
C	50	50
D	100	
S		100
L	50	50
W	50	50
CR	50	50
SR	50	50

C=Concept, D= design, S= supervision, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The authors declare that there is no conflict of interest.

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