The Effect of Climate Change on Animal Diseases by Using Image Processing and Deep Learning Techniques

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***Abstract*—Climate change is one of the most talked-about topics of this decade, affecting all economic output sectors, including the economy of cow farming. In many scenarios, exceptionally severe climate change is predicted for the Mediterranean region. As a result, practical measures must be taken to strengthen the sector's resilience, particularly for smallholders involved in the cattle production industry. As a result, technology is required to stop animal disease outbreaks. There are benefits to using automatic methods for detecting animal disease and cellulite. Climate change seriously threatens animal health, which is changing ecosystems, changing weather patterns, and posing new difficulties for animal existence. But this crisis also offers a chance for imagination and cooperation in a changing climate, a comprehensive strategy that includes adaptation and mitigation strategies that can boost resilience and safeguard animal populations. In conclusion, knowledge of climate change and adaptation measures are the main factors driving the rising demand for animal products. Furthermore, we have a variety of adaptation strategies at our disposal to mitigate the effects of climate change, which must be used to limit its further expansion.**

Keywords—Climate change; sustainability; smallholder; animal disease; image processing; deep learning; animal skin diseases

I. Introduction

Animal health is a major worldwide concern and one of the many effects of climate change. Animals face increasing health risks and difficulties as temperatures rise and weather patterns become more unpredictable [1]. There is an urgent need for strategies to mitigate and adapt to the effects of climate change on animal health to solve these problems. The primary source of the increasing levels of carbon dioxide and other air pollutants that are rapidly melting the planet is the consumption of fossil fuels. In addition to causing harsh weather and the melting of the Arctic ice, climate-related factors are also directly linked to the spread of many infectious diseases. Temperature is not the only factor influencing changes in the prevalence of infectious diseases. On infections, vectors, and animal hosts, humidity and other weather-related phenomena have an impact, but they are also a component of a complex of social and environmental elements that the changing climate will impact, currently, in our country, the identification of animal illnesses is determined by hand. However, manual assessment takes a lot of time and calls for professionals with training and expertise it shown in Fig. 1.

A. Overview of Climate Change as a Global Issue

Without a doubt, the most significant ecological problem our world is currently dealing with is climate change. It depicts how a place's average temperature and weather patterns gradually alter over time Increasing mean and severe temperatures are involved in this. The following will be affected: rotational grazing, water-efficient irrigation, veterinary operations, surveillance and disease management, veterinary care, vaccination campaigns, vector-borne illnesses, continuous monitoring, assessment, and sustainable practices.

Farming farming methods, the maintenance of the environment, raising livestock, occurrences related to the global climate (such as heat waves, droughts, and floods), and modifications to the hydrological cycle [2]. The primary causes of climate change are human activities that increase the amount of greenhouse gases in the atmosphere, such as deforestation and the burning of fossil fuels for energy. All aspects of Earth's natural systems are impacted by the wide-ranging impacts resulting from climate change. Because of the melting of glaciers and the ocean's thermal expansion, coastal cities and ecosystems are at risk from rising sea levels. Because marine life depends on calcium carbonate to form its shells and skeletons, the oceans absorb more CO2 as they get more acidic, which is detrimental to marine life. The frequency and intensity of heat waves, wildfires, droughts, and floods are all rising because of climate change [3]. Globally, the effects of these quickly changing circumstances are already being felt.

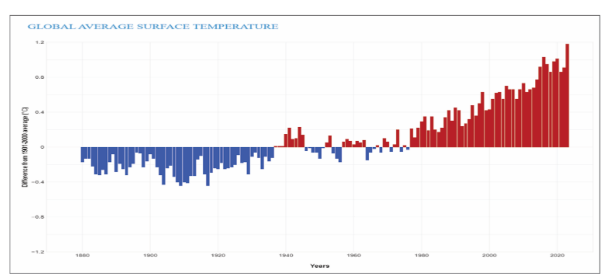

Fig. 1. Global average temperature change over time: this graph shows a clear upward trend in average world temperatures since the late 1800s. [https://www.climate.gov/// NOAA Climate.gov].

B. Climate Change's Effects on Animal Health

Animal health is facing a serious global danger from climate change. Uncertain weather patterns and rising temperatures disturb the delicate balance of ecosystems, affecting animal populations. There are several major implications when analyzing the specific ways that climate change is affecting animal health.

Ecosystems are severely disrupted by climate change, which makes it possible for infectious diseases to proliferate among animals. Implementing a comprehensive plan that includes stringent biosecurity protocols, meticulous disease surveillance, and trustworthy veterinary healthcare services is necessary to handle this expanding threat properly.

The Impact of Climate Change on Animal Diseases most of the numerous studies on the effects of climate change on human health and illnesses have focused on vector-borne infections [4]. With a few important exceptions, however, little study has been done on how climate change affects animals or non-vector-borne illnesses [5]. Given the global frequency of non-vector-borne diseases and the contribution of animal diseases to poverty in developing countries, focus on these areas is long overdue [6] it shown in Fig. 2. The climate impacts several animal diseases prevalent in Africa and the UK. These impacts extend beyond vector-borne diseases. A few diseases that are spread through direct contact, aerosols, or food or water are also impacted.

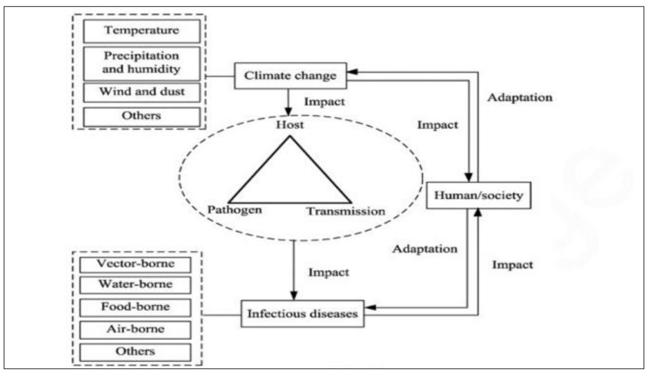

Fig. 2. Animal human society, animal infectious illnesses, and climate change [6].

Furthermore, the seasonal occurrence of non-vector-borne animal diseases seems to be more often correlated with climate than with their regional distribution. In contrast, there is a clear correlation between the climate and vector-borne diseases both in terms of time and geography. This is because the climate has a significant impact on the intermediate vectors' temporal and spatial distributions [7]. Many hypothesized mechanisms by which infectious diseases may be impacted by climate change have been presented in scientific literature. These procedures range from exact and measurable to vague and speculative. They could have an impact on hosts, vectors (if there is an intermediary host), disease transmission, natural environments, pathogens/parasites, or all the above.

It is reasonable to assume that only a portion of these procedures will apply to each unique infectious disease [8]. The pathogen, host or vector, and disease transmission are the elements of diseases that are described in the first set. The second collection of data discusses the weather and climate, including large-scale extreme weather occurrences and climate variables. The diseases covered in the third set are the ones that are specifically related to vectors, water, air, and food-borne pathogens.

C. Impact of Climatic Change on the Spread of Disease

Diseases can spread directly or indirectly, depending on how they are transferred. When an animal contracts an illness through droplet contact, direct physical contact, indirect physical contact, airborne transmission, or fecal-oral transmission, it is referred to as direct transmission [9]. "Indirect transmission" is the phrase used to describe the transfer of a disease from one organism to another via a vector or intermediary host.

Multiple investigations have demonstrated the effect of weather and climate on the spread of disease, but it is still unknown what precise mechanisms underlie this influence. This section addresses the potential effects of climate change on the spread of infectious animal diseases, as opposed to concentrating on the mechanics of disease transmission. This effect may be direct since temperature variations have a direct impact on pathogen viability and may change how diseases spread. It may be indirect if animal behavior, as well as that of vectors and hosts, changes in response to climate change [1].

Temperature differences can influence the spread of illnesses, either on their own or in conjunction with other elements like precipitation. Studies have shown a correlation between the annual temperature variations and the incidence of malaria in Africa's highlands. There is a high correlation between humidity, temperature, precipitation, and other climatic factors and the risk of hemorrhagic fever with renal syndrome. Infectious illness transmission can also be facilitated by wind and dust storms. Bacteria and viruses that are carried by the wind can result in airborne illnesses. Interregional dust storms are one way that illnesses might move from endemic locations to neighboring places.

By shifting the connection between viruses, vectors, and animal hosts, climate change may also affect the transmission of infectious diseases. Studies indicate that due to altered patterns of animal–pathogen—rodent interaction, there may be a periodic increase in the prevalence of diseases carried by rats during periods of extreme rain and flooding [3].

The illness, also known as Weil's disease, and flooding have been linked in several locations, including South Africa, Central America, and South America. Flooding of streets and open sewers is one of the risk factors for the condition in peri-urban populations in low-income nations [4].

Human and other host behavior and activity patterns, including seasonal labor, migration, winter-summer lifestyles, and physical activity, are all greatly impacted by climate change. Consequently, these patterns may have a substantial effect on the transmission of diseases [5]. The seasonal patterns of influenza infection prevalence in Europe are thought to be caused by the fact that animals and humans spend more time indoors during the winter. According to studies, the transit of the virus within each flyway that wild birds utilize during migration is tightly linked to the timing of H5N1 epidemics [6].

D. Indirect Impacts of Climate Change

There are few studies that specifically address how diseases that afflict cattle and other animals, or the emergence of novel pathogens, are impacted by climate change. Several factors, such as altered host mobility patterns, increased host density, and landscape changes that eliminate portions of host populations (e.g., habitat loss or alteration), have been highlighted as potentially contributing to the emergence of illnesses [7]. The indirect impacts of climate change on the distribution and abundance of parasites, predators, and rivals of vectors are influencing disease patterns.

It is currently challenging to assess the whole impact of climate change on cattle health over an extended period, even though variations in sickness frequency and distribution have been linked to climatic variability. It seems difficult to distinguish between climatic and non-climatic components [8]. The best method for estimating the future impact of climate change is to use the experimentally established relationship between climatic conditions and their effects on the biological systems that drive disease transmission in space and time [9]. Animal diseases affect livelihoods and food security, particularly in our nation, and pose serious risks to livestock productivity. These diseases are now detected and evaluated manually. However, manual assessment takes time and calls for professionals with training and expertise. As a result, technology is required to stop animal disease outbreaks. There are benefits to using automatic methods for detecting foot-and-mouth disease (LMD) and cellulite. The literature has established methods for detecting cattle skin and foot-and-mouth disease ulceration. However, based on their severity, foot-and-mouth and lumpy skin diseases are divided differently. To ascertain the complete impact of foot-and-mouth disease and lumpy skin disease on the animal, it is imperative to distinguish the various stages of these conditions better. This study developed a cellulite and FMD detection model by using a support vector machine (SVM) for classification and a convolutional neural network (CNN) for feature extraction. The Nature of the host-pathogen relationship and the degree of climate change will often determine the result of Features and Classification. CNN is at the forefront of deep feature extraction; it can be used for feature extraction. Some of these features depend on climate change, which has led to a rise in disease incidence. A few methods for recognizing and classifying animal skin conditions are included in the review. Because climate change disrupts ecosystems, modifies weather patterns, and creates new obstacles for animal survival, it seriously threatens animal health. However, there is also a chance for creativity and cooperation because of this catastrophe. Using a comprehensive approach incorporating adaptation and mitigation techniques can increase resilience and protect animal populations in a changing climate.

II. Literature Review

A. The Effects of Climate Change on Animal Health: Reducing and Adapting to the Dangers

Strong disease surveillance networks, stringent quarantine laws, stringent cleanliness requirements, and biosecurity education for farms are a few of these tactics. In addition to helping prevent vector-borne illnesses, immunization campaigns, heat stress management strategies, and wildlife corridors can safeguard domesticated animals and livestock as well as guarantee the survival of endangered species. To safeguard both human health and animal populations, mitigation techniques are crucial [10].

B. The Ecology of Infectious Illnesses and Climate Change

A linear relationship between infectious illnesses and climate is suggested by the relationship between disease and climate as well as historical and experimental data. There is less evidence that infectious diseases have profited from climate change, even though the world is already significantly warmer than it was a century ago. More recent models indicated that disease distributions will shift over time with a little overall rise in the area, despite early projections suggesting that the global range of infectious diseases will climb dramatically in the future. Infectious diseases are influenced by many factors, some of which may even be more important than climate change [11].

C. A Conceptual Framework for Forecasting and Handling Zoonotic Disease and Climate Change-Related Health Concerns in the United States

Through the use of transdisciplinary research, predictive modeling, and public health policy, the framework aims to improve the country's ability to anticipate, prevent, and minimize the health risks associated with zoonotic illnesses brought on by climate change. The framework aims to identify vulnerable people and high-risk areas, provide evidence-based treatments to reduce health risks and clarify disease transmission patterns through the development of prediction models. To integrate research findings into practical strategies and policies that safeguard public health and increase resilience in the face of climate change, the framework promotes collaboration among researchers, policymakers, and public health practitioners. The framework should enhance surveillance and early warning systems, deepen knowledge of the intricate connection between zoonotic diseases and climate change, and assist decision-makers in making well-informed choices regarding the most effective way to focus public health efforts. Giving American communities and decision-makers the information and resources they need to adapt to shifting environmental conditions and lessen the harmful effects of zoonotic diseases on public health is the framework's goal [12].

D. The Effects of Climate Change on Animal Health: Reducing and Adapting to the Dangers

Describe the positive correlations between these extreme events: droughts, El Niño/southern oscillation (ENSO) weather patterns, East African Rift Valley fever outbreaks, and some adaptation measures put in place to mitigate the effects of climate change that may make it more likely that people will meet infectious pathogens. Lastly, we go over adaptation and mitigation tactics that the cattle business could use to lessen the impact of climate change-related livestock diseases.

E. The Overview of how Animal Diseases are Increasing and how Climate Change is Impacting Livestock Productivity

The amount and quality of grains and fodder crops, as well as the severity and dissemination of parasites and diseases, are all indirectly impacted by climate it shown in Fig. 3. Climate change-related animal disease outbreaks and production declines are serious issues for our nation. Thus, the seminar's goals are to: Recognize and raise knowledge of how diseases spread as a result of climate change; and to recognize and raise awareness of how climate change impacts animal productivity [12].

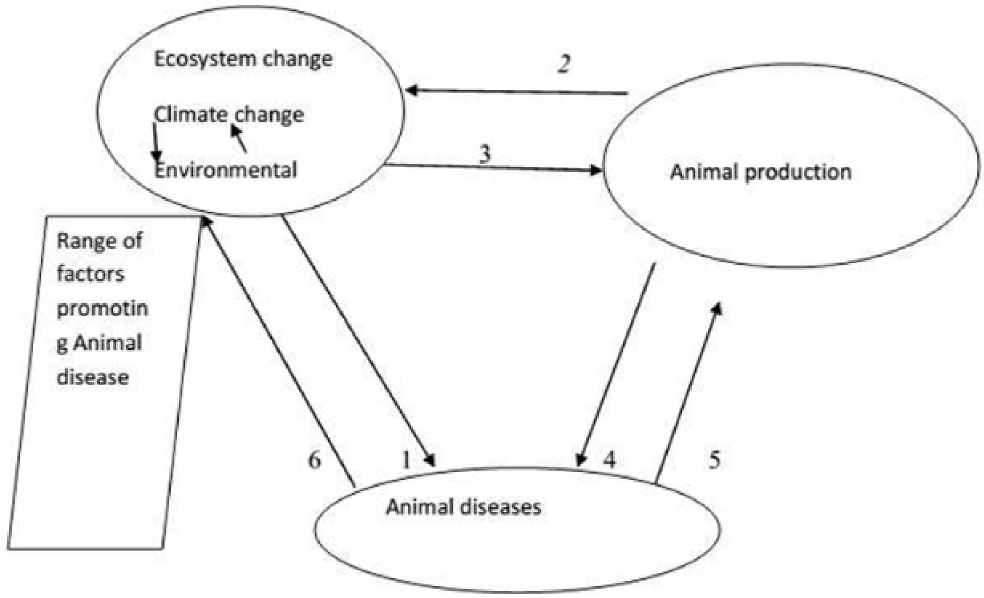

Fig. 3. The main relationship between animal diseases, climatic change, environmental change, and animal.

F. Climate Change's Effects on Animal Production and the Spread of Animal Illness: An Ethiopian Perspective

Climate change, animal production methods, and animal diseases are closely related. Even worse, alterations to the environment and animal production systems have a substantial influence on the incidence, dissemination, development, and reemergence of animal diseases. Research on the state of climate change and its direct and indirect effects on animal production and health is necessary. Sustainable animal farming and land use, as well as strategies for climate adaptation and mitigation, must also be developed. Disease, animal production, and climate change are closely related. The threat that climate change poses to the animal production and health sector is growing. All parties involved in the environment, animal production, and health must work together in an integrated and methodical manner [13].

G. Evidence Review: The Effects of Climate Change on the Food Chain that Supplies Cattle with Food

We investigate how the food chain for cattle raised on land can be impacted by climate change. The entire impact of climate change on the livestock industry is beyond our current understanding, but a wealth of data indicates that it will have an impact at every point of the supply chain, from farm production to processing, storage, transportation, retailing, and human consumption. Hotter places are expected to have fewer institutional and economic opportunities for adaptation, which raises the possibility that the hazards indicated by climate change will materialize, even though the risks vary greatly depending on the situation. There is still much to learn about the future of the climate and how interdependent nature and human systems will react to future climate change. Therefore, a wide range of potential outcomes, including some that appear unlikely but have significant ramifications, must be taken into consideration when making decisions regarding adaptation [14].

H. An Overview of the Connection Between Animal Illness Prevalence and Climate Change

Animal diseases are more likely to emerge and reoccur as a result of ecosystem changes, particularly climate change. It affects cattle health in several ways. These include how high temperatures affect pathogens, altering the rate at which parasites or pathogens develop; how they affect hosts, altering the distribution of diseases that could endanger susceptible animal populations; how they affect vectors, altering the number and distribution of disease vectors; and how they affect epidemiology, altering food safety, animal husbandry, and host-transmission rates. Climate change has effects on disease formation, reproduction, and distribution, as well as on illness appearance and transmission across vectors or hosts [15].

I. A Summary of the Information and Present Lines of Inquiry Regarding Infectious Illnesses and Climate Change

Nearly every biological system on the earth is seriously threatened by climate change. According to recent research, there might be a link between the expansion of infectious diseases and climate change. Simulations based on in silico data are frequently given precedence over empirical investigations based on field and laboratory data in these works. There is currently a dearth of empirical research on the relationship between infectious diseases and climate change synthesis [16].

J. An Overview of the Information and the State of the Field for Infectious Disease and Climate Change Research

It looked at how Egypt's livestock is being affected by rising temperatures, as there are usually not enough resources to mitigate the effects. Even if there are ways to mitigate some heat stress, such as using agroforestry production techniques, reduced food security may be the outcome this century. These aren't expected to make a big impact, though [17] the comparison between different techniques shown in Table I.

TABLE I. COMPARISON BETWEEN DIFFERENT TECHNIQUES

Name of paper	Year of publication	Methodology	Pro	Cons	Result
A Deep Learning Approach to Detect Lumpy Skin Disease in Cows [1]	2024	To extract features, use machine learning-based models like Inception-v3, VGG-19, and VGG-16.	Applies to a variety of medical scientific domains. It can assist veterinary surgeons in identifying issues with animal disease early on.	There are no comparisons with other techniques in the same area. The time taken to get the original message is not mentioned.	92.5% accuracy over the test set
Detecting Lumpy Skin Disease Using Machine Learning Techniques [2]	2023	An algorithm for classifying and identifying animal lumpy skin conditions. We employed SOFTMAX, RF, and SVM classifiers for classification and a convolutional neural network for feature extraction.	Achieved high accuracy.	The information is not necessary to be emulated or taken as a reference.	The validation accuracy to 95.7%.
Application of Artificial Intelligence Algorithm in Image Processing for Cattle Disease Diagnosis [3]	2022	The expert system's reasoner component used a convolutional neural network (CNN) technique to classify the final diagnosis outcome.	Created a working prototype system that combines the reasoner component and the picture classification techniques.	Text information is not necessary to be emulated or taken as a reference. Time taken to get the original message was not mentioned.	With 95% accuracy, the system classified the input symptoms.
Assessing machine learning techniques in forecasting lumpy skin disease occurrence based on meteorological and geospatial features [4]	2022	ANN may be used to accurately predict the occurrence of LSDV infection by utilizing meteorological and geographic data.	The technology might offer a quick and accurate identification of illnesses affecting cattle.	There are no clinical studies or patient data in the publication. Conflict of interest: The writers say they have no conflicting agendas.	Accuracy of up to 97% in anticipating the incidence of LSDV in test data
Detecting high-risk Areas for Lumpy Skin Disease in Cattle Using Deep Learning Feature [5]	2023	An extreme learning machine (ELM) classifier is used for classification.	Physician surgeons in early disease detection of animals.	It wasn't stated how long it took to receive the initial communication.	The ELM classifier used in this paper has an accuracy of 0.9012.

III. METHODOLOGY

Create a hybrid model for diagnosing animal diseases based on Machine learning methods for dealing with our problem depending on the related work. We will create a methodology to deal with the problem by using Feature extraction methods to detect diseases using Machine learning and deep learning techniques. We will detect the level of the disease (Normal, mild, Severe). Apply our model to other diseases with the highest result. Get the final report that explains and detects diseases based on Climate change features depending on a hybrid model based on one or more machine-learning techniques.

IV. DISCUSSIONS AND RESULTS

A. Learning of Climate Change

A study on cattle farmers in Africa [18] found that these farmers are very worried about the risks associated with climate change and actively monitor it and its expected effects on their farming operations. These findings are consistent with the high degree of knowledge among our sample regarding the effects of climate change on smallholder livestock output. These findings from various countries suggest that rather than attempting to inform smallholder livestock producers about the phenomenon and its potential repercussions, the government should concentrate on putting the right mechanisms in place to help farmers lessen the effects of climate change. However, our data does show that some smallholder farmers raise cattle. Women, those without formal education, people who rear animals primarily for domestic use, and people who use outdoor or mixed breeding techniques may all benefit from increased awareness of climate change. Our survey revealed that only a small number of farmers were able to access pertinent information through extension and advisory services, even though these sources could be a useful tool for raising public awareness of climate change and its detrimental implications [19–21]. Rather, they learned about it through firsthand experience, discussions with coworkers, or the media. Our research thus emphasizes the necessity of increased communication on climate change challenges between consultants and smallholder livestock farmers.

B. Important Changes in Climate and how they Affect Livestock Production, According to Smallholder Livestock Farmers

Our survey indicates that farmers' assessments of the possible adverse effects of climate change on their livestock are consistent with the information that is already available. Our respondents stated that the main worries related to climate change are the spread of illness, the creation of new diseases, the overuse of medication [22, 23], and the shortage of feed and water. Each of these has a connection to the problem of climate change. Both the genesis of new diseases and the spread of existing ones are influenced by high temperatures and humidity. For instance, temperatures in northern Europe should increase by 5 °C by 2050, which would be ideal for the bluetongue virus to spread to new regions [24]. Additionally, aflatoxin B1 may spread more readily to newly planted maize and wheat crops.in Europe because of rising temperatures [25-26]. As a result, both people who eat meat or drink animal milk and the animals themselves may be at higher risk of contracting aflatoxin B1 from tainted feed. The increase in illnesses affecting animals could result in a higher demand for antibiotics and other medications, particularly in Egypt where there are no regulations governing the supply of antibiotics. This is the only way that notable rises in temperature, humidity, and other variables can encourage the development of antibiotic resistance [27]. Smallholder livestock producers may have shortages of feed and water due to factors like drought, rising temperatures, and increased humidity [28]. This is partly because the majority of their range is located in arid and semi-arid regions. It is well recognized that heat waves affect reproductive performance, livestock immunity [28], crop productivity, feed quality, animal productivity overall, and wool production specifically [.Our research linked heat waves to the notable drops in milk yield, wool production, and reproductive efficiency. Additionally, respondents to our survey indicated a higher fatality rate. Our results are consistent with studies that predict a 25% decline in animal output due to century-long high temperatures [29]. According to our responses, the most sensitive animals to the consequences of climate change are dairy cows and their ability to give milk, particularly when it comes to heat stress (heat waves). This is because heat stress reduces the feed dairy cows ingest, despite their high metabolic rate. Mediterranean dairy cows produce less milk as the temperature rises. Globally, big cattle generate more than 96% of the milk produced. Most milk-producing animals in Egypt are cattle and buffaloes, of which smallholder farmers possess 85%. Animals with larger statures are more susceptible to heat stress [30]. According to those who responded, there was less chance that heat stress would have an impact on egg development and yield. This could be explained by the fact that raising hens for eggs is one instance of a short, controlled production cycle that reduces the effects of climate change [31]. More research is required to determine which cow breeding techniques and animal breeds may withstand the extreme weather brought on by climate change.

C. Strategies for Adaptation and Assistance to Reduce the Adverse Impacts of Climate Change on Small-Scale Livestock Production

Farmers' ability to understand the nature of climate change and find appropriate answers will determine how well adaptation strategies are used [32]. According to 60% of respondents to our survey, they adapt their living arrangements and adhere to food programs to cope with climate change. Only a smaller percentage of interviewees said they used genetically modified animals, and about 39% said they needed assistance utilizing this method. One of the most crucial long-term adaptation options to improve cattle's resistance to heat stress, drought, and other climate change issues is genetic selection, as the effects of climate change on animals become more apparent [33].

Even in informal and mixed breeding environments with unpredictable housing conditions, this tactic can be effective. Even though nearly all the participants in our survey were aware of the potential harm that climate change could do to animal productivity and health, 30% of them said that they were not putting any adaptive or mitigation measures into place. The absence of a veterinarian, consultation, or extended services was the main cause of this. According to research from Bangladesh and Zambia, farmers who have access to agricultural extension services are more likely to be aware of the threats that climate change poses to their industry and to employ a range of effective adaptation techniques [34].

The importance of financial insurance and infrastructure development was also mentioned by our respondents. Due to their sometimes remote locations and lack of infrastructure, smallholder cattle farmers are particularly vulnerable to the effects of climate change [35]. To compensate for feed shortages, farmers, particularly smallholders with mixed breeding systems or pastures, should be exposed to drought-tolerant shrubs and plants, which are common in the Mediterranean basin. To properly store feed, farmers must be skilled in silage production, agricultural waste processing, and growing a variety of crops.

Like the participants in our study, smallholder livestock producers in Sierra Leone, an African country, have mentioned a lack of financial resources, poor management competency, and limited infrastructure as obstacles to climate change mitigation [36]. To increase financial support for coffee-livestock integration, another study conducted in Indonesia focused on integrating coffee and livestock to implement climate-smart agriculture for smallholders. This study emphasized the significance of forming strategic partnerships with non-financial service providers and offering technical assistance for the best possible usage of credit.

D. Recommendations and Limitations

This study examines how smallholder cattle producers in the Mediterranean Basin perceive extreme climate change, the negative impacts it has on livestock performance, and the obstacles and solutions required to mitigate those consequences. There were significant regional differences even if the opinions of the respondents from Egypt and Spain were generally similar. For example, Spain was mostly suffering from drought, whereas Egypt was dealing with heat waves and high humidity. Due to regional differences in temperature, animal breeding methods, and smallholders' livestock output goals, more countries than just Egypt and Spain need to be examined to give a comprehensive picture of how resistant Mediterranean farmers are to climate change. Furthermore, future studies should evaluate other types of animal farms, including dairy farms, fattening farms, and poultry farms, rather than all of them together as they were in this study.

V. Conclusion

When climate change changes the environment, modifies weather patterns, and creates new obstacles to animal survival, it poses a serious threat to animal health. Cattle production systems are beginning to feel the effects of climate change, especially during Egypt's hot season. The new study predicts that Egyptian cattle will experience more heat stress throughout the summer months in two of the country's livestock-producing regions. While livestock adapts to these changes in a variety of ways to survive, heat stress seriously reduces the productivity of the livestock. Failure to promptly adopt mitigation measures may result in injury and death. Egypt needs to find other ways to ensure food security, which probably include relying less on ruminant animals to produce milk and meat.

The primary environmental variables in this case study that negatively impact the production of cattle owned by smallholders are heat waves, humidity, and drought. Reduced availability of animal feed and fodder, increased heat stress, and drops in animal productivity and reproductive efficiency due to virus diseases are a few of these consequences of climate change.

Significant geographical differences existed despite the general similarity of the respondents' opinions between Egypt and Spain. Egypt, for example, was suffering from heat waves and high humidity, whereas Spain was mostly suffering from drought. This work proposed combining deep-learning image processing with an expert system to address some of these issues. Because of its importance to the economy:

1) We will employ techniques to identify or forecast diseases based on several characteristics, such as meteorological and geographic.

2) Using the predictive ability of these methodologies for screening and awareness campaigns, vaccination campaigns, and other preventive measures could be very beneficial in areas with a high risk of LSDV infection.

3) Early and precise viral identification can be used to treat the sickness rather than control it. This can also be used as an implicit way to identify the illness and halt its spread.

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