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The Impact of Climate Change on Crop Yield and Livestock, Adamawa State, Nigeria

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ABSTRACT

Climate change represents a critical challenge to global food security, impacting both crop production and livestock health. This study explores the diverse consequences of rising temperatures, shifting precipitation patterns, and the increasing frequency of extreme weather events on agricultural systems. By analyzing recent climate models alongside empirical data, the paper examines the influence of these changes on crop yields, growing seasons, and pest dynamics. Additionally, the effects of climate change on livestock, such as heat stress, increased vulnerability to diseases, and feed shortages, are explored. The paper also addresses regional disparities in vulnerability, particularly highlighting the heightened risks faced by developing countries with limited capacity for adaptation. Finally, the study proposes adaptive strategies and policy measures aimed at mitigating these effects and fostering sustainable agricultural resilience in the face of ongoing climatic changes.
Keywords: Climate change, Crop yield, Livestock

INTRODUCTION

Climate change is emerging as one of the most critical challenges confronting global agriculture in the 21st century. Rising temperatures, altered precipitation patterns, and an increase in extreme weather events are collectively undermining crop yields, thereby jeopardizing global food security. Recent studies emphasize the diverse and complex impacts of climate change on agricultural productivity, underscoring the need for adaptive and resilient farming practices. One of the most evident consequences of climate change is the rise in global average temperatures. Numerous studies have found that even slight temperature increases can significantly reduce yields of temperature-sensitive crops. For instance, [1] and [2] estimated that a 1°C rise in temperature could reduce yields of wheat, rice, and maize by 6%, 3.2%, and 7.4% respectively, particularly in developing nations with limited adaptive capacity. [3], Also observed that higher temperatures accelerate crop maturation, leading to reduced grain quality and overall yield, with tropical and subtropical regions being most at risk. Emerging research continues to affirm these findings using crop modeling, predicted a global yield reduction of 15% for wheat and maize by 2050 if warming continues unchecked. [4], through meta-analysis, also confirmed a consistent negative yield response across major crops in key agricultural zones. In addition to rising temperatures, climate change has triggered significant changes in rainfall patterns. Increased rainfall variability and extreme events such as droughts and floods are severely affecting crop productivity. For example, [5], linked erratic precipitation to decreased wheat and maize yields in rain-fed farming systems, particularly in sub-Saharan Africa and South Asia. Modeling suggests that regions suffering from extreme droughts could experience yield reductions of 20 – 40% by 2100. Similarly, [6], highlighted the detrimental effects of extreme rainfall, such as soil erosion, nutrient depletion, and crop damage, stressing the importance of effective water management strategies. The growing frequency and intensity of extreme weather events such as hurricanes, storms, and untimely frosts—are also disrupting agricultural systems. [7], Reported how altered climate patterns shortened growing seasons and caused significant losses in crops like apples and grapes due to late frosts. [8], Found that extreme heat and flooding not only reduce yields but also disrupt agricultural supply chains, causing price surges and food shortages. These impacts highlight the urgent need for resilient infrastructure and climate-smart farming practices. Moreover, climate change is expanding the geographic range and lifecycle of pests and diseases. Warmer temperatures and shifting rainfall patterns create favorable

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conditions for pest outbreaks and the spread of pathogens. [9], noted an increased pest burden during critical crop stages, while [10], emphasized heightened disease risks in previously unaffected regions. These developments call for improved pest control measures and the breeding of pest-resistant crop varieties. Overall, the multifaceted impacts of climate change ranging from extreme weather and pest outbreaks to shifting rainfall patterns pose significant threats to global agriculture. Rising temperatures increase evapotranspiration, lower soil moisture, and promote pest infestations, all of which contribute to reduced yields. Meanwhile, inconsistent precipitation raises the risk of crop failure in rain-dependent regions. These effects also create socio-economic imbalances, particularly among smallholder farmers, by reducing water resources, soil fertility, and contributing to pollution and greenhouse gas emissions. Securing food for a growing global population, conserving natural resources, and integrating traditional knowledge into agricultural practices remain critical future challenges. Plants also face various biotic stresses, leading to substantial economic losses annually. It is estimated that pests alone account for 10–16% of global harvest losses, valued at around $220 billion [11]. Weeds also contribute significantly, causing yield losses of approximately 36% in major crops. As climate change continues to reshape pest and weed dynamics, there is a pressing need to adapt agricultural practices to protect productivity and ensure sustainability. Climate change is projected to create favorable conditions for the proliferation of pests and diseases in high-latitude regions. As a result, crops are expected to face heightened vulnerability to these biotic stresses, leading to adverse impacts on yield and overall food security [12]. The study therefore, seeks to assess the effects of changing climate patterns (temperature fluctuations, altered precipitation, and increased frequency of extreme weather events) on crop yields and livestock productivity in different agro-climatic regions. And, also to evaluate the adaptive strategies employed by farmers and livestock producers to mitigate the impacts of climate change and identify sustainable practices that enhance resilience in agricultural systems.

MATERIALS AND METHODS

This study adopted a mixed-methods approach, integrating both primary and secondary data collection techniques to evaluate the impact of climate change on crop yield and livestock productivity. Primary data was obtained through field surveys, semi-structured interviews with farmers, and direct observations conducted in purposively selected agricultural communities representing diverse agro-climatic zones. Regular on-farm data collection focused on key indicators such as crop yield (kg/ha), livestock performance (e.g., milk production, weight gain), and local weather conditions (temperature, rainfall, humidity). To complement field observations, basic weather monitoring tools (e.g., rain gauges, thermometers) were installed, and soil and water samples were collected periodically to assess environmental changes linked to climate variability. Secondary data were sourced from national meteorological agencies, agricultural extension services, and peer-reviewed scientific literature, providing historical climate trends and long-term agricultural data. The integration of these datasets enabled a robust correlation analysis between climate variables and agricultural performance, ensuring triangulation and enhancing the validity of the findings.

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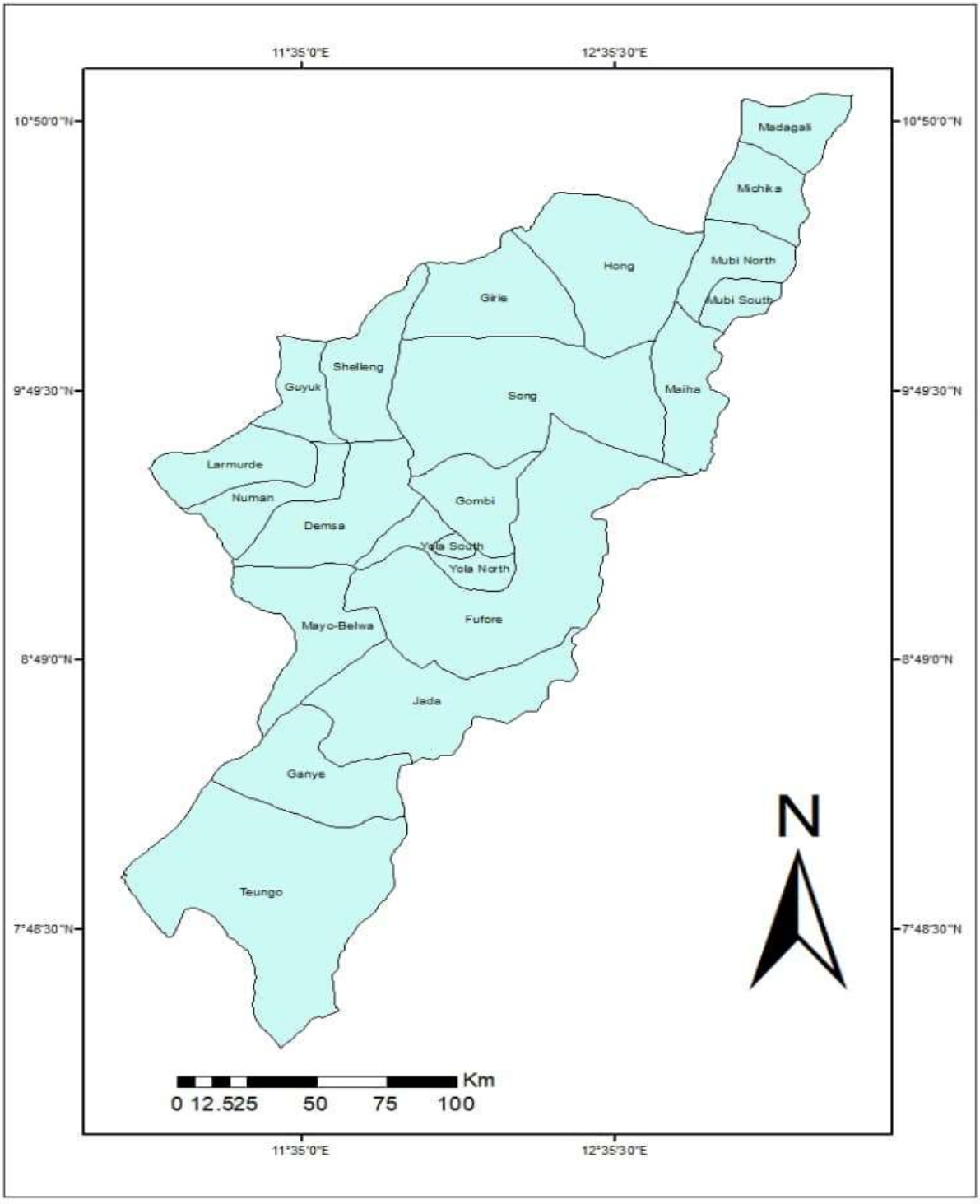

Figure 1: Study Area

RESULTS AND DISCUSSION

The data highlights widespread concern about the future impact of climate change on crop yields and livestock. A large majority of respondents (46.6%) expect a gradual worsening of climate conditions, while 38.8% foresee a significant deterioration. These findings reflect growing awareness of extreme weather events, rising temperatures, and biodiversity loss, all of which could negatively affect agricultural productivity and livestock health. Only a small portion of respondents remain optimistic, with 8.6% believing that climate change may improve and just 1% expecting no change at all. These results suggest a general expectation of increasingly difficult environmental conditions in the coming years [13]. The majority of respondents foresee deteriorating climate conditions, with 46.6% predicting a gradual decline and 38.8% expecting significant worsening. This highlights the concern about the negative effects of extreme weather, temperature fluctuations, and loss of

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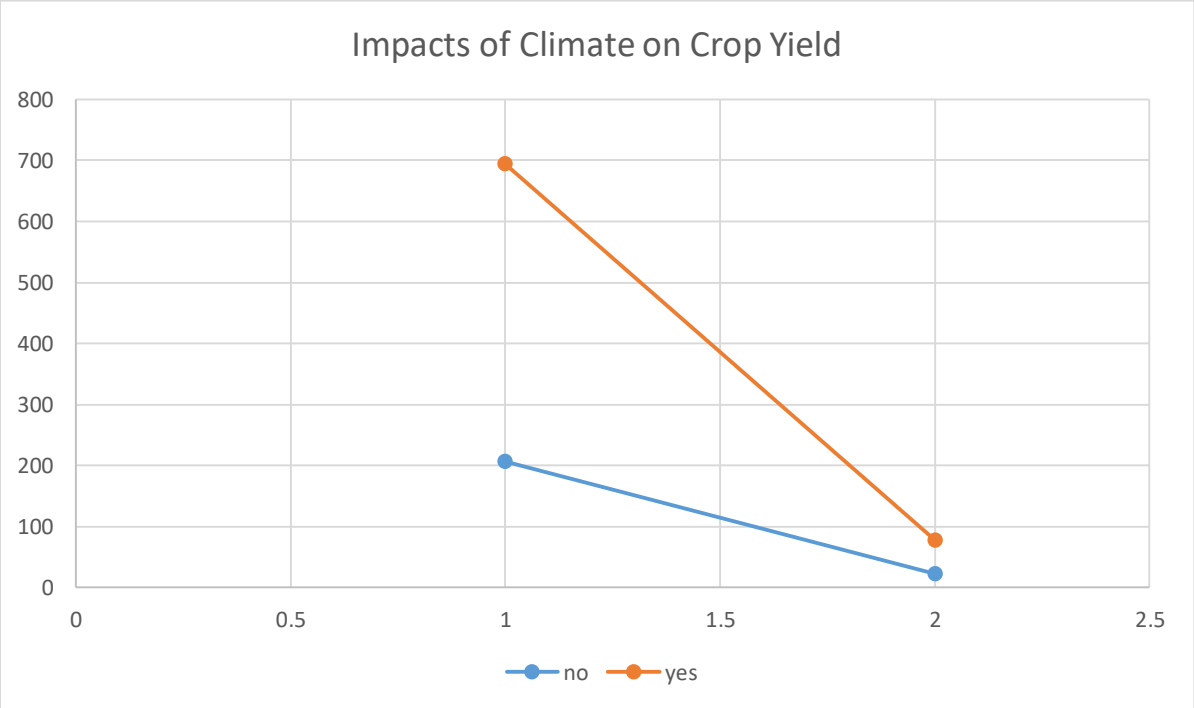
biodiversity on agriculture. In contrast, only a small group (8.6%) believe that climate change could improve, and just 1% anticipate no change. This perception aligns with studies by [14], which discuss how climate variability affects crop yields, and [13], who explore how climate change threatens livestock in developing nations.

Impacts of Climate Change on Livestock

The impact of climate change on livestock is also a significant concern among respondents, with 92.2% expressing fears about its negative effects. These concerns include heat stress, deteriorating pasture quality, and an increased risk of diseases, all of which could undermine livestock health, productivity, and the sustainability of animal farming systems. Only 6% of respondents believe that climate change has no effect on livestock, suggesting that some may feel unaffected or have not noticed any significant changes in livestock conditions. Additionally, 6.2% view climate change as potentially beneficial, citing longer growing seasons or better grazing conditions, although this perspective is rare. This data mirrors broader concerns about climate change's negative impact on livestock and supports research by [14], which discusses agricultural challenges linked to climate change, and [13], who highlight the vulnerability of livestock to changing climate conditions, particularly in developing countries.



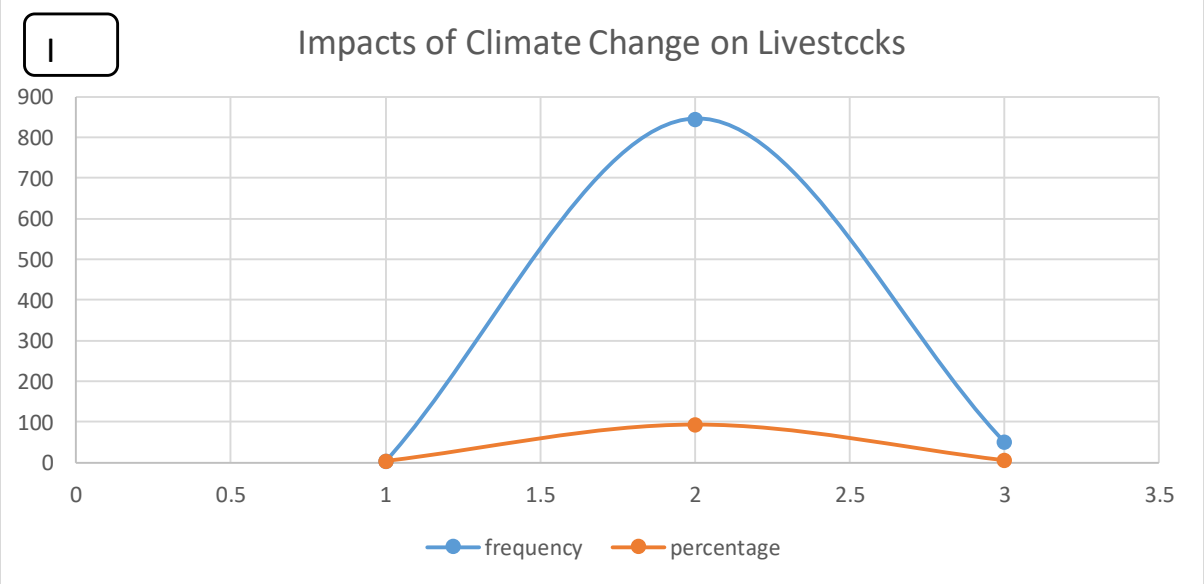


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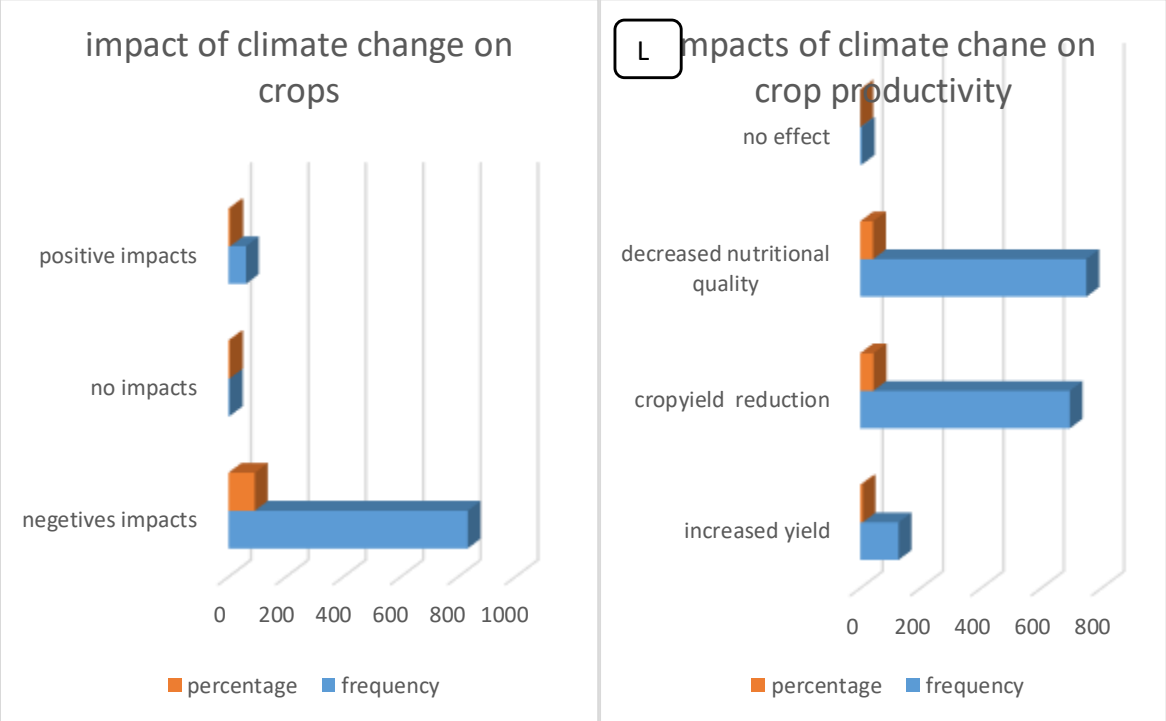
Figure 2: Impact on Nutritional Quality, Crop Yield, No Effect, and Increased Yield

The data reveals significant effects of climate change on various aspects of livestock management, with respondents indicating noticeable changes in behavior, water intake, growth rates, feed costs, and overall production. Specifically, 94% of respondents reported that climate change has affected livestock behavior, with factors such as temperature fluctuations, heat stress, and changing grazing conditions leading to stress, altered feeding habits, and shifts in herd dynamics. Additionally, 59.9% of respondents believe that climate change has reduced water intake among livestock, driven by rising temperatures, water scarcity, and changes in water availability and quality. This has the potential to cause dehydration and reduce productivity. Furthermore, 71.8% of respondents observed a decrease in growth rates, attributed to heat stress, lower feed quality, and environmental instability, all of which hinder livestock development and productivity. More than half of the participants (56.8%) noted an increase in feed costs, mainly due to reduced availability of quality forage and declining crop yields. Lastly, 43.7% of respondents perceived negative impacts on overall livestock production, including declines in milk and meat production, as well as lower reproductive rates. These findings highlight the interconnected nature of climate-induced stressors and their cumulative effect on livestock management and productivity. This is consistent with research by [14], who discuss the broader impacts of climate change on agricultural systems, and [13], who examine the vulnerability of livestock to climate variations in developing countries. Regarding crop production, the data reveals a predominantly negative perception of the effects of climate change on yield, nutritional quality, and overall impact. A small group (8%) of respondents believes climate change could result in increased crop yields, possibly due to perceptions of longer growing seasons or more favorable weather in certain regions. However, a larger portion (44%) reports that climate change leads to reduced crop yields, citing the negative effects of unpredictable weather, droughts, floods, and temperature fluctuations that can impair crop growth and harvests. Similarly, 42.6% of respondents believe that climate change lowers the nutritional quality of crops, likely due to factors such as heat stress, water scarcity, and nutrient depletion in soils, which can reduce essential nutrient concentrations in crops, thus impacting food security and public health. Only 0.3% of respondents indicated that climate change has no effect on crop yield or nutritional quality, suggesting that the vast majority recognize climate-related changes. These findings align with recent studies, such as those by [15], who explores the impact of climate variability on crop yields, and [16], who examine how climate change influences agricultural productivity
and food security.



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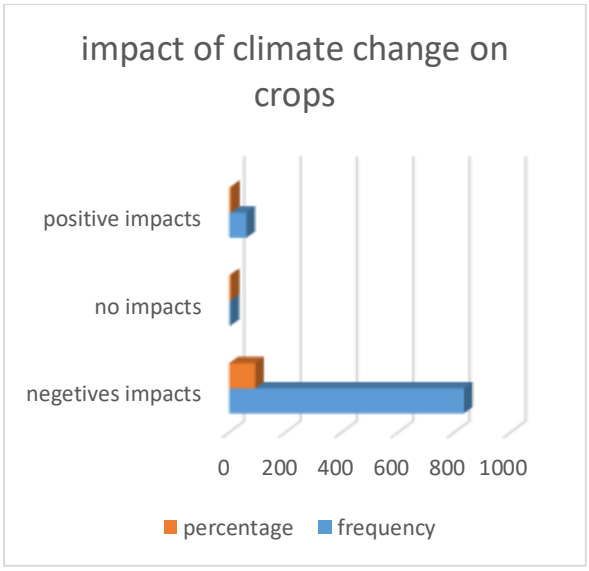

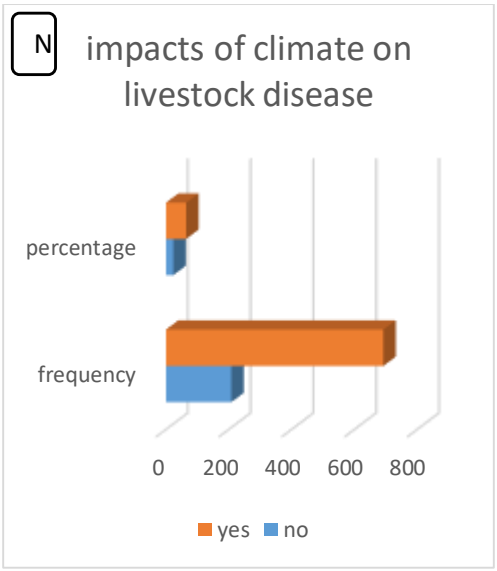

Figure 3 showing: K. Impacts of climate change on crops, L. Impacts of climate on crop production, M. Impact of climate change on nutritional on animals, and N. Impacts on livestock diseases.

CONCLUSION

Climate change is profoundly affecting agricultural systems worldwide. Shifts in temperature, precipitation patterns, and the frequency of extreme weather events are leading to reduced crop yields, disrupted growing seasons, and increased vulnerability to pests and diseases. Similarly, livestock production is under stress due to rising heat levels, reduced water availability, and declining feed quality. These impacts are more severe in low-income regions, where adaptive capacities are limited. The evidence is clear: climate change is a major threat to global agricultural productivity and food security. Both crop and livestock systems are experiencing strain that could worsen without decisive action. If unaddressed, these challenges will lead to reduced food availability, higher prices, and increased rural poverty, especially in climate-vulnerable regions.

RECOMMENDATIONS

1. Invest in Climate-Resilient Crops and Breeds: Develop and distribute drought-resistant crop varieties and heat-tolerant livestock breeds.
2. Improve Water Management: Promote efficient irrigation, rainwater harvesting, and soil moisture conservation techniques.
3. Enhance Early Warning Systems: Implement better forecasting tools for weather and pest outbreaks to help farmers prepare and respond.
4. Promote Sustainable Agricultural Practices: Encourage agroecological methods, crop diversification, and integrated farming systems.
5. Support Farmer Education and Capacity Building: Provide training and access to information to help farmers adapt to changing conditions.
6. Strengthen Policy and Financial Support: Governments should create supportive policies and provide insurance schemes or subsidies that buffer farmers against climate-related risks.

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