FOODER CROPS AND CLIMATE CHANGE

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Review

Abstract
Fodder crops are valuable agricultural due to the high dry matter yield they achieve but equally the quality of the fodder obtained. The global distribution of grasslands is determined by climate, primarily temperature and precipitation, which prevent the formation of forests or deserts but also some researchers affirm that grassland reduces the risk of illnesses. Climate change is an imminent threat to the world we live in, but we can all do something to combat it and build a better future. The change in the general character of the objectives for agriculture, from a priority for production towards an increased concern for environment is consistent with more general trends that occur with economic development. Finding the best solutions for feeding humanity with a rethinking of actions regarding environmental consequences is urgently needed. Therefore, global population growth, degradation and reduction of agricultural land areas, climate change accompanied by acute and long-term droughts, imperatively require the mobilization of resources from different areas that can capitalize on new climate conditions while ensuring food security.

Keywords: fodder crop, temporary grassland, climate change

INTRODUCTION

Global food security threatened by climate change is one of the most important challenges in the 21st century to supply sufficient food for the increasing population while sustaining the already stressed environment (Kang *et al*., 2009). Changes in both the mean and the variability of climate, whether naturally forced, or due to human activities, pose a threat to crop production globally (Slingo *et al.*, 2005). In a study conducted in 2011 by Havilah in Encyclopedia of Dairy Sciences (Second Edition) it is shown that annual forages and fodder crops are used worldwide as key feed sources for dairy systems and grasses, legumes, and brassicas either sown alone or in mixtures are used as annual forages. Reddy *et al*, 2003, in other study, shows that pastures (herbaceous plants, fodder trees/shrubs), crop residues,

cultivated forages, concentrate feeds (agro-industrial by-products, grains, feed supplements, etc.) and household wastes are the main resources used as livestock feed.

Kumar *et al.*, 2022, said that fodder, also known as hay, silage, or forage, is any crop or crop by-product used as feed for livestock, making it an essential source of protein and fat. As well as yield, changes in crop quality can have a major impact on food systems and their vulnerability to climate variability and change (Slingo *et al*., 2005).

GRASSLAND'S IMPORTANCE IN CLIMATE CHANGE

Agriculture and livestock farming are deeply interrelated in the cultural, religious, and economic ways of human society engaged with mixed farming and livestock rearing serving as important source of rural people (Dagar, 2017, Dhamodharan *et al*, 2024).

Petermann and Buzhdygan, 2021, said that ecosystem functioning and ecosystem services provided by grasslands are part of global feedback loops in which grassland biodiversity, human well-being and global change are linked.

Grassland ecosystems can constitute a source or a sink in the global C balance, and their management affects their position in that balance (Casals *et al*., 2004).

In a study conducted in North Kazakhstan, Shayakhmetova *et al*, 2024 concluded that climate change has significantly impacted the phenology of fodder grasses. Excessive increases in temperature and a lack of moisture have stressed plants, leading to slower growth and consequently reduced biomass and productivity of fodder crops. They recommend combining crops more effectively in the developed green conveyor system ensures the collection of high-quality green mass despite the instability of climatic factors. Optimizing sowing and utilization times provides a stable and high-quality feed base for agricultural producers and farmers.

In another study in India, Kumar *et al*., 2022, emphasizes the fact that livestock sector also plays a significant role in supplementing family incomes and generating gainful employment for rural poor, particularly among the landless labourers, small and marginal farmers and women. It also provides balanced and cheap nutritional food in the form of milk to millions of people.

Sagalbekov *et al*., 2022 shows the fact that the improvement of productivity in modern livestock farming is directly dependent on feed production and the rational feeding of animals. However, further development of feed production is constrained by the low productivity of agricultural lands,

the insufficiency of varieties adapted to specific soil and climatic zones, and the poor resilience of fodder crops to adverse environmental conditions (Nasiyevich, *et al.*, 2013). As well as yield, changes in crop quality can have a major impact on food systems and their vulnerability to climate variability and change (Porter and Semenov, 2005).

Agricultural systems that increase reliance on biodiversity can mitigate risks associated with climate change and should be considered a crucial component of the solution (Henry *et al*., 2012).

CLIMATE CHANGE IMPACTS ON FOODER CROP

Shayakhmetova *et al*, 2024 affirm that ensuring global food security is one of the most serious challenges facing humanity in the 21st century due to ongoing climate change and rapid population growth. Global demand for food has been on the rise, driven by a growing population, rapid urbanization, and changing diet preferences (Hu *et al*, 2024). Understanding crop responses to climate change is crucial for ensuring food security.

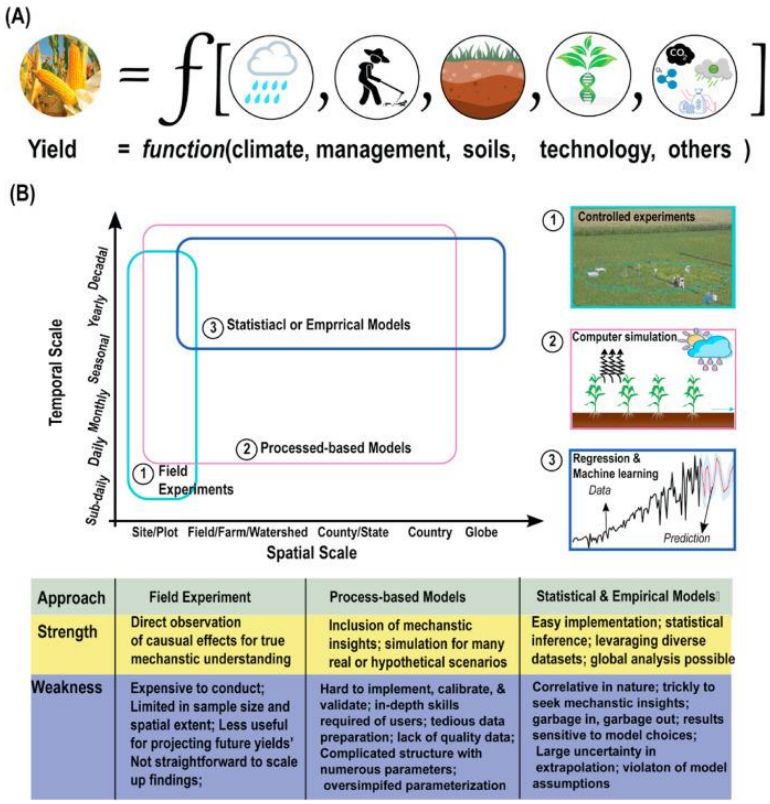
In a Technical Report in August 2012, Grover and Kumar shows that for exploiting fully the production potential of livestock, balanced and adequate feeding is the most crucial. Other examples of the effects of climate on crop quality include pests and diseases, such as dangerous levels of mycotoxin. Relatively little is known about the potential impact of climate change on crop quality (Slingo *et al*., 2005).

In crop production, fodder is the end product, the quality of which significantly affects the livestock (Kumar *et al*., 2022). Paterson and Lima, 2011, declare that climate change will affect mycotoxins in food. The changes in the management and status of grasslands lead to a powerful variation of soil microbial communities' assemblage and functionality (Stoian et Vidican, 2024).

Hu *et al*, 2024 to demonstrate the impact of climate change in the study entitled *Climate change impacts on crop yields: A review of empirical findings, statistical crop models, and machine learning methods* reviewed 226 studies that used statistical models to characterize the impacts of climate change on crop yields. In these studies, the authors show the importance of field studies, because they emphasize that if not informed collectively by field experiments of all kinds, the implementation of process-based models for the digital twin is unlikely to be successful. Even so, in Figure 1 they highlighted the strengths and weaknesses of the 3 models they applied (scientific methods for

investigating crop yield responses to climate change fall roughly into three categories: field experiments, process based modeling, and statistical modeling).

This could be a reason why Gobin *et al*, even from 2006 show that the management of monitoring and control of permanent pastures requires the creation of a comprehensive geoinformation platform that allows for spatio-temporal analysis to monitor changes, account for protective zones, keep record of abandoned pastures and establish sensitive zones.



Approach	Field Experiment	Process-based Models	Statistical & Empirical Models
Strength	Direct observation of causual effects for true mechanstic understanding	Inclusion of mechanstic insights; simulation for many real or hypothetical scenarios	Easy implementation; statistical inference; levaraging diverse datasets; global analysis possible
Weakness	Expensive to conduct; Limited in sample size and spatial extent; Less useful for projecting future yields' Not straightforward to scale up findings;	Hard to implement, calibrate, & validate; in-depth skills required of users; tedious data preparation; lack of quality data; Complicated structure with numerous parameters; oversimpifed parameterization	Correlative in nature; trickly to seek mechanstic insights; garbage in, garbage out; results sensitive to model choices; Large uncertainty in extrapolation; violaton of model assumptions

Fig. 1. (a) Crop yield as a function of multiple drivers. (b) Characteristics of three common approaches--field experiments, process-based, and empirical modeling--for evaluating climatic impacts on crop yield. These approaches are applied typically at contrasting spatial and temporal scales (i.e., colored boxes in the temporal-spatial scale plot), Source: Hu *et. al*, 2024

INSTEAD OF CONCLUSIONS…

The tensions caused by the substantial reduction of non-renewable natural resources, the threat to food security, amplified by

global climate change, force us to react, according to the potential and resources we have, to find solutions, means and measures that must be taken, to prevent and mitigate the catastrophic effects that can occur when reckless measures are taken or to obtain profit at any cost (Hera, 2015). In this context, fodder crops are appreciated as necessary and particularly useful not only for specialists in the field, but also for those in related fields.

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