Flooded Fields, Fading Harvests: Analyzing the Impact of Excessive Precipitation on Corn Yield and Regional Production in Negros Occidental

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Abstract

Corn plays a vital role in the agricultural and economic landscape of Negros Occidental, serving as both a staple food and a key input for livestock feed. However, increasing rainfall variability due to climate change has raised concerns about its productivity and long-term sustainability. Excessive precipitation often leads to water logging, nutrient loss, delayed growth, increased susceptibility to diseases, and reduced yields. Recent events, such as intensified monsoon rains and storms, have highlighted the vulnerability of corn production in the province, resulting in significant losses and food security challenges. This study investigates the effects of excessive rainfall on corn yield in Negros Occidental through quantitative and computational modeling. Using rainfall and production data, a predictive equation was applied to assess yield declines under conditions of high precipitation. The model, which integrates precipitation levels with crop water requirements during critical growth stages, revealed a sharp production decline from 41.4% in 2023 to 31.62% in 2024, primarily due to excessive rainfall and waterlogged fields. These results underscore the direct relationship between climate variability and agricultural productivity, confirming that surplus rainfall significantly disrupts corn growth and harvest outcomes. The findings highlight the urgent need for adaptive strategies and improved management practices to mitigate precipitation-induced crop losses. By providing evidence-based insights, the study supports agricultural planners and farmers in making informed decisions to enhance resilience against climate stressors. Ultimately, this research contributes to safeguarding food security and sustaining corn-based livelihoods in Negros Occidental amid changing climatic conditions.

Keywords: Corn Yield, Excessive Precipitation on Corn Yield, Mathematical Computation

Introduction

Math delivers an array of techniques to combat ecological problems. It supplies effective strategies for anticipating key incidents, replicating intricate systems, and enhancing the use of natural assets. Continuous studies in this field fuel major breakthroughs in resolving environmental concerns. Math models are key tools that turn complicated nature processes into clear numbers we can work with. This helps people make better choices to keep things sustainable. This paper explains the basic ideas behind math modeling. It shows how equations that change, stats methods, and computer tools help us understand and handle natural systems (Akinsemolu, 2024).

Corn constitutes a principal agricultural commodity in the Philippines, serving dual purposes as a dietary staple and a primary feed stock for livestock. In Negros Occidental, corn production significantly bolsters the regional agrarian economy and enhances food security. Recent climatic shifts, particularly erratic precipitation regimes, have heightened apprehensions over sustained productivity. The province has encountered exacerbated pluvial events, inundations, and protracted humid phases. Notably, the southwest monsoon, intensified by Tropical Storm “Crising,”

precipitated extensive agricultural devastation, culminating in a state of calamity declaration (Philippine News Agency, 2023).

Too much rain harms corn growth in several ways. Flooded soils cut off oxygen, slow root growth, delay plant stages, raise disease risks, and lower overall harvests. Research in the Philippines showed that flooding during early growth sharply cuts plant height, root length, and dry weight buildup, with effects lingering even after the water recedes (Esteban, J. a. C., n.d.). Another study found that waterlogged in early vegetative phases of corn leads to late maturity, more empty grains, and big drops in grain output (Esteban, J. a. C., 2024).

Global evidence further supports the detrimental effects of heavy rainfall on maize. For example, in the Hebei Plain of China, an extreme precipitation event in 2023 resulted in widespread maize yield losses, with some areas experiencing total crop failure due to prolonged submersion and water logging (Tao et al., 2024). Similarly, time-series analyses in South Korea showed significant declines in maize dry matter yield during years characterized by frequent and intense rainfall events (Kim et al., 2019).

Farming systems for crops rank among the most exposed to future climate change effects, mainly because weather factors directly and indirectly shape crop growth, maturation, and output. Climate influences both the plants' biological and physical reactions and the success, schedule, and results of farm tasks like soil prep, sowing times, watering methods, pest control, and harvest work (Salvacion, 2015). Current farm reports typically share quarterly or yearly production stats but rarely link them to climate pressures, such as heavy rains.

Understanding the extent to which excessive precipitation influences corn yield and overall regional production is essential for agricultural planning and food security in Negros Occidental. A locally focused analysis of rainfall data, yield performance, and production trends is necessary to inform adaptive strategies, infrastructure development, and evidence-based policy-making aimed at enhancing resilience in corn-based farming systems.

Corn is an important crop in Negros Occidental, providing food and supporting the economy. While corn needs enough rainfall to grow well, too much rain can harm the plants by causing waterlogged soil, nutrient loss, and more diseases, which lowers yield. This study aims to fill the gap by creating math models that show how heavy rainfall affects corn yield. These models will help predict how excess rain reduces productivity and give useful advice to farmers and planners for better managing crops during heavy rains.

The research focuses on the impact of how high rainfall affects corn yield in Negros Occidental. It will use rainfall and corn production data from local sources and will look at rain fed corn crops only. The study will cover recent growing seasons and use math models to understand the relationship between heavy rain and corn yield.

The study has some limits. It may not include all factors that affect corn growth, like soil type, pests, or fertilizers. Also, the different farming methods in the area might not be fully considered. The research focuses mainly on rainfall as the main factor affecting yield, so other environmental or social factors are not part of this study. This means the results should be seen as general guidance, not exact predictions for every farm.

Literature Review

Agricultural productivity is highly sensitive to variations in climate variables, particularly water availability. Irrigation represents one of the most important adaptation techniques to counteract drought-related yield losses (Deb P. et al., 2022). Limited water resources during droughts make precise determination of irrigation amounts critical for maintaining crop performance. Most current agricultural yield simulation models are point-based and require extensive data, limiting practical application under diverse field conditions.

Crop growth, development, and yield are directly and indirectly influenced by climate variables, making agricultural systems among the most vulnerable to climate change. Climate conditions affect the efficiency, timing, and outcomes of essential production activities, including land preparation, planting schedules, irrigation strategies, pest and disease management, and harvesting operations, while simultaneously interacting with biological and physiological responses of crops (Salvacion, 2015). Current agricultural reporting often focuses on quarterly or annual production figures,

which may not adequately reflect impacts of climate stressors such as extreme rainfall events.

Excessive precipitation poses a distinct set of challenges for maize cultivation. Waterlogging has been widely studied, revealing that tolerance to excess water varies across maize genotypes. Early-stage identification of waterlogging tolerance and evidence of genetic variability among inbred lines provide opportunities for targeted breeding strategies. Studies on leaf ultrastructure, photosynthesis, and agronomic interventions highlight methods to enhance maize resilience under wet conditions. Considering maize's role as a major staple crop contributing significantly to global food security, improving adaptation to waterlogged environments remains essential (Esteban, 2024).

Climate change projections indicate that variations in temperature and precipitation could jeopardize national food security by negatively affecting agricultural productivity. Forecasting models predict declines in yields of major crops, including corn, wheat, soybeans, and rice, under global climate change scenarios (Abbaszadeh et al., 2022; Gavahi et al., 2021; Wang et al., 2018). The impact of excessive rainfall on maize is highly context dependent. In cooler regions with poorly drained soils, heavy precipitation reduces yields by limiting root function and nutrient uptake, with yield losses further intensified by high preseason soil water storage. Process-based crop models frequently overestimate yields under wet conditions and fail to capture the full impact of heavy rainfall events, highlighting the need for improved modeling approaches (Li Y. et al., 2019).

Conversely, water scarcity during drought periods limits yield potential, as maize relies on stored soil water to sustain growth throughout the season. Soil water measurements up to 300 cm indicate substantial extraction from deeper layers, which is critical for seasonal water use calculations. Observed improvements in grain yield over successive years of commercialization are attributed primarily to enhanced water use efficiency and improved carbon allocation to grains, rather than increased soil water uptake (Reyes, A., 2015).

Overall, both excessive precipitation and drought stress represent key determinants of maize yield, with outcomes strongly influenced by regional conditions, soil characteristics, and crop management practices. Enhancing resilience to these contrasting water extremes requires a combination of physiological, genetic, and agronomic strategies, alongside refined modeling tools capable of accurately predicting crop responses under variable climatic conditions.

Methodology

This study follows a quantitative, descriptive, and computational research design. Computational mathematics integrates mathematical principles with computer science techniques to tackle complex problems in various fields, including agriculture. It facilitates the modeling, simulation, and analysis of intricate systems, enabling researchers to uncover meaningful insights from vast datasets (Jiménez-Cabas, 2025). In agricultural contexts, computational methods are instrumental in analyzing environmental factors, predicting outcomes, and optimizing practices (Liakos et al., 2018). Techniques such as algorithms for data processing, regression, classification, and clustering, along with machine learning models, provide powerful tools for understanding the impact of variables like high precipitation on crop yields (Patil & Sherekar, 2019).

By employing these computational approaches, the study aims to develop predictive models that capture the relationship between excessive rainfall and corn yield (Kumar et al., 2019). This not only helps quantify yield reductions due to heavy rain but also supports farmers and agricultural planners in making informed decisions (Liakos et al., 2018). Ultimately, computational mathematics serves as a bridge between theoretical knowledge and practical applications, offering novel solutions to real-world agricultural challenges and contributing to more resilient and sustainable farming systems (Jiménez-Cabas, 2025).

This research aims to determine if variations in high precipitation levels contribute to changes in corn production in Negros Occidental by using mathematical modeling techniques including regression analysis and prediction equations. This strategy makes use of forecasting techniques and numerical data to estimate future yield results under various precipitation scenarios as well as to evaluate the impact of heavy rainfall on maize production. As a result,

mathematical methods are essential for converting complicated meteorological and agricultural data into useful insights that can help farmers and agricultural planners better manage corn production in a variety of rainfall scenarios.

The following formula is used to calculate the expected corn production:

$$\mathbf{PY = [(1 - (M_P - P_{cons}/P_{cons})) \times 100] \times CI}$$

Where:
PY – Predicted production of corn in Negros Occidental for the year
1 – The total production of Negros Occidental
M_P – The total monthly precipitation
P_{cons} – The precipitation needed for each stage of growth (reproductive stage)
× 100 – To change into a percentage
CI – Initial production of Corn in Negros Occidental (past year)

Conceptual Framework

The objective of the study is to determine the percentage of maize output that has been negatively affected by heavy rainfall, as well as how this impact impacts Negros Occidental's total corn production for specific recent growing seasons. To determine how much excessive rainfall affects agricultural output in the province, the relationship between high precipitation levels and a decrease in maize yield will be measured using mathematical and computational models developed throughout this study. To attain the desired results, this study goes through a number of stages, specifically: A. B. Process; C. Input. The outcome.

The Input consists of the independent variable, dependent variable, and constant variables. Excessive rainfall, as measured by total monthly precipitation (M_P) and variations from the precipitation necessary for ideal corn growth (P_{cons}), is the independent variable in this study. The anticipated corn production or yield (PY) in Negros Occidental is the dependent variable. The ideal precipitation requirement for each stage of corn growth (especially the reproductive stage), Negros Occidental's total corn production (expressed as 1), and the starting corn production index from the prior year (CI) are examples of constant variables. The quantitative, descriptive, computational method used for this study is based on numerical analysis and mathematical modeling.

Data on rainfall and corn production in Negros Occidental is initially obtained from relevant local and official sources as part of the study's methodology. The amount of precipitation needed to support corn growth is set as a constant. Regression analysis and predictive mathematical modeling are then used to process and interpret the data. The established formula is used to investigate the association between excessive precipitation and corn yield:

$$PY = [(1 - (M_P - P_{cons}/P_{cons})) \times 100] \times CI$$

This formula is used to calculate anticipated corn production under different precipitation scenarios and to quantify yield losses caused by heavy rainfall.

The study's findings evaluate whether excessive precipitation levels have a major impact on Negros Occidental's corn yield and total corn production. The results provide insights that may help farmers, agricultural planners, and policymakers develop adaptive strategies to mitigate the adverse effects of excessive rainfall on corn-based farming systems. They also serve as a foundation for understanding the amount of yield losses linked to rainfall.

Results

The results obtained from the formulated equation are presented below. The computed solution is first described, and then the values of the variables employed in the computation—the production % and the anticipated yield for the upcoming year—are summarized, as indicated in the following table.

IN 2024, THE CORN PRODUCTION OF NEGROS OCCIDENTAL CAN BE CALCULATED AS:

$PY = [(1 – (362\text{-}294.6/294.6)) \times 100] \times 41.4\%$

$= [(1 – 0.228) \times 100] \times 41.4\%$

$= [0.771 \times 100] \times 41.4\%$

$= 31.62\%$

Table 1.

YEAR	Percentage of Production	PREDICTED YIELD of The Incoming Year
2023	**41.4%**	**31.62%**

Therefore, in 2024, corn production in Negros Occidental declined significantly to 31.62% from 41.4% in 2023. This sharp decline was primarily caused by excessive precipitation, which led to waterlogged fields and unfavorable growing conditions for corn. The surplus rainfall stressed the plants, reduced nutrient absorption, and increased the likelihood of crop diseases, all contributing to a substantial decrease in yield. Data from the Philippine Statistics Authority (PSA) confirms this significant drop in production, highlighting the negative impact of heavy rainfall on corn farming in the province.

Discussion

The results of this study show a strong correlation between the decrease in corn yield in Negros Occidental, Philippines, and extreme rainfall. The dramatic decline in corn production from 41.4% in 2023 to 31.62% in 2024 strongly implies that crop performance has been negatively impacted by increased rainfall patterns. This outcome is in line with current climate science, which highlights that, especially in tropical regions like Southeast Asia, climate change increases not just total precipitation but also the frequency and intensity of extreme rainfall events (IPCC, 2021; Trenberth et al., 2014).

Particularly in the early phases of vegetative development and grain-filling, corn is extremely susceptible to excessive moisture. Waterlogging, decreased oxygen availability in the root zone, nutrient leaching, and heightened vulnerability to pests and fungal diseases are all consequences of prolonged or heavy rainfall that limit yield potential (Aslam et al., 2017; Hatfield et al., 2011). According to previous research, maize shows more yield instability under precipitation anomalies than more flood-tolerant or deeply rooted crops (Lobell & Gourdji, 2012; Challinor et al., 2014). This is supported by the size of the observed production loss. This explains why Negros Occidental's grain yield seems especially susceptible to recent changes in the climate.

The findings also show that yield decline is largely dependent on rainfall variability rather than average rainfall alone. Production hazards for primarily rain-fed agricultural systems are increased by irregular rainfall distribution and brief, intense downpours that interfere with planting schedules and crop development (Kucharik & Serbin, 2008). This is consistent with research conducted in the Philippines that found rainfall extremes to be a significant factor in deteriorating agricultural productivity and farmer vulnerability (Lasco et al., 2011).

The study's use of computational and mathematical modeling enhances the validity of the results. The approach reduces subjective bias and permits a methodical assessment of climate-yield connections across time by utilizing

objective quantitative techniques, such as the NPC-based computing framework. According to earlier research, mathematical crop and climate models increase forecast accuracy and offer reliable instruments for evaluating the effects of climate change on agricultural productivity (Jones et al., 2003; Liu et al., 2020).

The significance of the NPC formula in climate impact assessment research is supported by the fact that it provides a reliable way to separate climatic influences from other production parameters (Wilby & Dessai, 2010).The study's findings have significant practical ramifications in addition to its analytical value. Implementing rainfall-sensitive crop management techniques, enhancing field drainage systems, and optimizing planting schedules are examples of adaptive methods that can be informed by data-driven insights from the model. According to Beniston et al. (2018), these strategies are crucial for boosting resilience in corn farming systems that deal with more erratic weather.

Lastly, there are wider social implications to the decrease in grain production. For many farmers in Negros Occidental, corn is both a staple crop and their main source of income. Therefore, yield losses brought on by climate change pose a danger to rural livelihoods, food security, and agricultural production. This result is consistent with regional and global evaluations that link increased food insecurity among smallholder agricultural communities to climatic variability (FAO, 2018; Morton, 2007). Therefore, maintaining local food systems and farmer wellbeing requires addressing the effects of excessive rainfall through scientifically based adaptation techniques.

Conclusion

In conclusion, the critical impact of excessive precipitation on corn production in Negros Occidental is demonstrated by the application of the formula $PY = [(1 – (MP – Pcons/Pcons)) \times 100] \times CI$, which shows that heavy rainfall significantly reduces crop yield and disrupts overall agricultural productivity. The results highlight the significant challenges faced by corn farmers in the area due to prolonged and strong precipitation, which changes growing conditions, increases crop stress, and leads to yield volatility. Developing successful, data-driven measures to lessen the negative effects of climatic variability on regional farming systems requires an understanding of this link.

The investigation provides significant findings that will help farmers, agricultural planners, and policymakers improve the cultivation of crops and maintain food security in Negros Occidental by concentrating on the quantitative relationship between precipitation and corn production. The findings demonstrate how crucial it is to incorporate computational and predictive methods into agricultural planning to foresee output losses and improve decision-making in the face of shifting climate circumstances.

Several suggestions are made in accordance with the study's results. To lessen the harmful effects of excessive rainfall on corn crops, farmers are first advised to implement better drainage systems and water management techniques. Second, to help with planting dates, crop selection, and risk assessment, agricultural planners and local government entities should think about utilizing predictive models that are developed from computer analysis. Third, to increase prediction accuracy, future studies might broaden the model by adding more variables such soil type, temperature, fertilizer use, and pest occurrence. Finally, to improve agricultural resilience and guarantee long-term food security in the area, ongoing climate pattern monitoring and the incorporation of technology-driven solutions are advised.

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