

Economic value of seasonal climate forecast for corn production in Bansud, Oriental Mindoro, Philippines

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ABSTRACT

This study assessed the economic value of seasonal climate forecasts (SCFs) for corn (*Zea mays*) production in Bansud, Oriental Mindoro, by comparing expected corn income with that of squash (*Cucurbita maxima* L.). Farmers prioritized corn partly because its farm-gate price is more stable than prices of alternative crops such as squash. The researchers integrated qualitative and quantitative assessments with decision-tree modeling to determine how access to probabilistic rainfall forecasts from PAGASA affects cropping decisions and expected incomes. Without climate information, the model showed that expected corn income was approximately 32% higher than the squash income, supporting farmers' preference for corn under baseline conditions. When seasonal rainfall forecasts were incorporated into planting decisions, simulated corn income increased further. Under PAGASA's near-normal rainfall probabilities, corn achieved 69% income advantage over squash. Comparison of modeled outcomes with and without forecast use revealed an average income difference of approximately PHP 4,800 per decision cycle, representing a meaningful gain or avoided loss for smallholder farmers. In Bansud, the combination of a stable corn market and actionable rainfall forecasts provide an opportunity to improve household income while reducing climate-related production risks. Continued investment in timely forecast dissemination, farmer training, and locally tailored decision-support tools can enhance the practical value of SCFs in smallholder farmers. Providing accessible probabilistic climate information and helping farmers translate forecasts into appropriate planting and crop-selection action can generate measurable economic benefits, strengthen adaptive capacity, and support more climate-resilient agricultural livelihoods and development.

Keywords: climate information, decision-tree analysis, economic valuation, small-holder farmers

INTRODUCTION

Climate change and climate variability present significant challenges in agriculture. The global agricultural sector is affected by climate change as the enhanced greenhouse emissions accumulate, causing temperature rise (Malhi et al. 2021), with shifting seasonality and intensity of rain will increase the vulnerability of agricultural systems (Hatfield et al. 2020). This puts food and nutritional security at risk as the increasing demand of a growing population and urbanization (Carter et al. 2018; Malhi et al. 2021) continues. The agricultural activities are affected because of their dependence on climatic factors (Yohannes 2016; Arunanondchai et al. 2018). This further results in a high land degradation rate and soil nutrient deficiency (Arora 2019).

The crop production in South Asia (Aryal et al. 2020), and in the Philippines, is also vulnerable (Salvacion and Martin Jr 2016) as the country is situated in the tropical region that is prone to high intensity of rainfall and drought. One of these crops is corn. Corn (*Zea mays*) is the second major cereal crop grown in the Philippines with 88% self-sufficiency (Department of Agriculture 2020) because of the rapid processing time used to make various flours with nutritional value for both human and livestock consumption (Hutchison and Cira 2017) making it also among the field crops that are affected by climate change (Salvacion 2015) as agriculture relies on natural resources and climatic conditions to produce crops. The changing environmental conditions have forced farmers to make decisions without fully understanding the potential consequences (Weaver et al. 2013). In the Philippines, rainfed agriculture is increasingly threatened by variability in climate, including unpredictable rainfall patterns (Sultan et al. 2009), prolonged droughts, and extreme weather events, all of which adversely affect crop yields (Vermeulen et al. 2012). These challenges pose serious risks to the livelihoods of farmers who depend on rainfed systems, highlighting the urgent need for innovative strategies to mitigate these effects. One promising solution is the advancement of seasonal climate forecasts (SCF). The SCFs are synthesized climate-model outputs, historical observations, and statistical techniques to give probabilistic guidance on upcoming seasonal conditions—such as the frequency and timing of rains, temperature trends, and likely onset and end of growing seasons—which can help rainfed corn farmers in places like Bansud, Philippines, plan planting dates, choose drought-tolerant varieties, and schedule fertilizer and water management to reduce risk and improve yields (Doblas-Reyes et al. 2013) to enhance their resilience against climate uncertainties. Farmers in Bansud report increasing unpredictability in weather patterns that has led to severe production losses. Accurate seasonal information allows them to align critical decisions—planting dates, choice of hybrid or variety, soil moisture conservation measures, and irrigation scheduling—with expected conditions. Research shows that decision-

75 makers who integrate SCFs into their management are often more efficient and better able to manage risk than
76 those who rely only on traditional cues (Wilks 1997; Rubas et al. 2006). By translating probabilistic forecasts into
77 concrete decision rules and payoff expectations, farmers can select strategies that optimize expected returns under
78 uncertainty. Effective use of SCFs requires more than raw data. It demands tailored decision frameworks that
79 combine probability distributions with farmers' risk preferences and the economic payoffs of alternative actions.
80 Models that include payoff functions, decision rules, and explicit representations of uncertainty help bridge the
81 gap between seasonal outlooks and on-the-ground choices. Studies examining ENSO years, for instance,
82 demonstrate that using SCFs to adjust management—such as altering planting windows or applying soil
83 conservation practices—can improve crop performance and profitability (Reyes et al. 2009; FAO 2016). Despite
84 the clear benefits of SCFs for managing climatic risk, the Municipal Agriculturist of Bansud reports that these are
85 not yet embedded in local corn-production risk-reduction strategies; barriers include limited access to localized
86 forecasts, lack of capacity among extension staff and farmers to interpret probabilistic information, and
87 insufficient integration of farmer decision data into forecast-driven advisory services, so addressing these gaps
88 requires concerted investment in developing locally relevant forecast products, building extension services skilled
89 in translating probabilistic guidance into concrete management options, and creating feedback mechanisms so
90 farmers' decision-making processes inform forecast design and delivery (Lemos et al. 2002; Pörtner et al. 2023).
91 Integrating SCFs into municipal agricultural planning can strengthen the resilience of rainfed systems and protect
92 livelihoods by enabling anticipatory actions—such as adjusting planting dates, selecting drought-tolerant
93 varieties, or timing fertilizer application—to reduce exposure to adverse conditions, but such benefits depend on
94 a policy that institutionalizes SCF use and supports farmer data collection, capacity building, and ongoing
95 evaluation to ensure forecasts are both usable and trusted (Tall et al. 2014; Lu et al. 2017). Collecting information
96 on how farmers make decisions, what thresholds trigger management changes, and the economic outcomes of
97 forecast-informed actions is essential to design adaptive, evidence-based agricultural governance that links
98 meteorological science with socio-economic realities and ensures investments in early action yield measurable
99 improvements in productivity and wellbeing (Klemm and McPherson 2017; Guido et al. 2020).

100 The province of Oriental Mindoro faces significant challenges regarding agricultural productivity due to
101 its exposure and vulnerability to flood and drought, particularly in rainfed systems. The Municipality of Bansud
102 exemplifies these challenges, as agriculture is a critical part of its economy, occupying 20,407.90 ha, or 51.65 %,
103 of the land, with corn being a key crop grown on 142.57 ha, representing 32% of agricultural land and yielding
104 around 200 metric tons valued at approximately 4,148,787 annually. Aside from corn farming, the farmers also

plant squash (*Cucurbita maxima* L.) since this vegetable is suitable to grow in any type of soil in dry and warm climates (DA 2017), like corn. However, climate change exacerbates threats to corn production through extreme weather events, including intense rainfall that can cause flooding and excessive heat that can dry out soil, as noted by the Municipal Agriculture Office of Bansud. The importance of SCFs becomes apparent, as they provide farmers with critical information, like updated forecasts on the amount and frequency of rainfall, and the duration of temperature change and seasonal variability, that can enhance productivity and resilience against climate variability. Research indicates that farmers who utilize SCFs experience significantly better yields compared to those who do not.

Thus, this study generally examines how SCFs can be used to improve decision-making and economic outcomes for corn farmers in Bansud, Oriental Mindoro, with a comparative look at squash production and identifies policies and practical recommendations utilizing SCFs to reduce risk and secure farmers' yield. The specific objectives focused on (1) describing the corn production system; (2) understanding the socio-demographic and socio-economic characteristics of corn farmers; and (3) quantifying and comparing the economic benefits (Jones et al. 2000) derived from implementing SCFs for corn and squash production. Such an approach not only empowers farmers with vital information to make informed decisions but also promotes sustainable agricultural practices that can adapt to changing climatic conditions, thereby reducing risks and fostering resilience in the local farming community.

METHODS

Brief Description of the Study Area

The study was conducted in the municipality of Bansud, Oriental Mindoro, Region IV-B (MIMAROPA), Philippines (Figure 1). Agriculture occupies 20,407.90 ha, or 51.65%, of the municipal land, comprising rice and corn fields, banana plantations, coconut groves, fruit-bearing trees, and vegetable production, such as squash. Corn occupies 142.57 ha, is cultivated by 183 farmers, and represents 32% of the area's agricultural land. Average production reaches approximately 200 metric tons per season, valued annually at PHP 4,148,787. However, extreme rainfall, lowland flooding, excessive heat and soil drying threaten corn production, according to the Municipal Agriculture Officer.

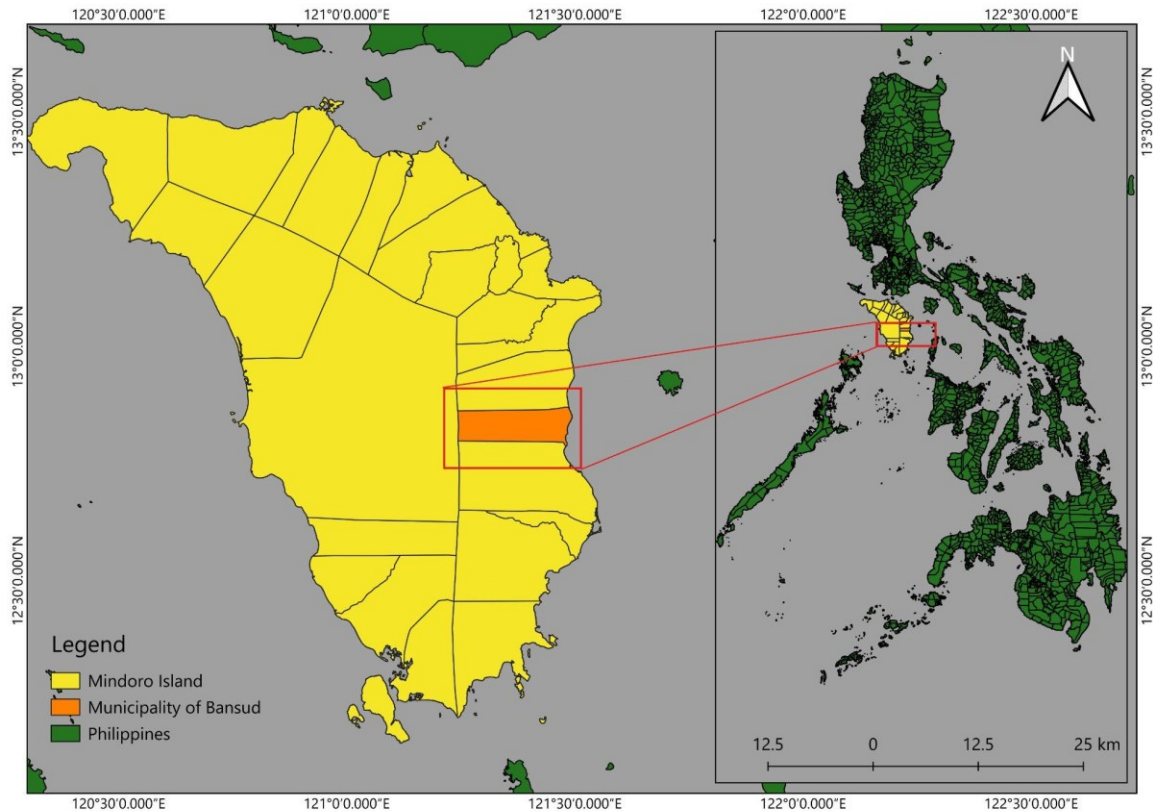


Figure 1. The location of the study site, Municipality of Bansud, Oriental Mindoro, Philippines.

Research Design

The study combined qualitative and quantitative methods to assess the value of seasonal climate forecasts for Bansud corn farmers. Households survey documented production systems and farmers' socio-demographic and socio-economic characteristics. Key informant interviews with agricultural experts and local leaders identified farmers' needs and challenges, while focus group discussion (FGDs) enabled farmers to share experiences, strategies, concerns and possible solutions concerning climate information use. Quantitatively, an ex-ante decision-tree model evaluated the economic value of scenarios. This approach demonstrates the benefits of accurate forecasts and risks from ineffective information dissemination (Sadok et al. 2008). Descriptive statistics identified trends affecting farmers' perception and decision (Bryan et al. 2013). Survey findings, contextualized results while interviews and discussion explained how access, understanding and trust influence farmers' forecast-based decisions.

Data Collection

Primary and secondary data were collected. Secondary sources included the Municipal Agriculture Office (MAO), Provincial Agriculture Office of Oriental Mindoro, Philippine Statistics Authority (PSA 2021), and the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA 2022). Data

included the farmer numbers and rainfall probabilities used to construct climate scenarios. Relevant published literature supplemented these records.

Primary data came from structured household surveys, Focus Group Discussion (FGDs) and key informant interviews (KIIs). The survey examined farming practices and socio-demographic and socio-economic factors affecting corn production. Sample size was determined using the Cochran's formula at 95% confidence and a 0.05 margin of error, (Cochran 1977). FGDs and KIIs examined climate variability challenges and opportunities and validated survey information on farming practices, income, and expenses. The participants included municipal agriculturists, disaster risk management officers, local government officials, and leaders from various Farmers' Associations and cooperatives, and selected corn farmers. The mixed source strategy supported triangulation and connected climate records with farmers' experiences, production costs, farming practices and livelihood conditions.

Data Analysis

Qualitative and quantitative analyses described farming practices and farmers' socio-demographic and economic conditions. Means and averages were summarized in tables and graphs. Decision-tree analysis estimated the monetary value of seasonal climate forecasts under different climate events. Revenues from corn and squash were compared with and without forecasts. Forecast value was determined by its influence on planting assigned probabilities. Microsoft Excel supported decision tree and Monte Carlo simulations used to evaluate climate variability, agricultural decision risk and profitability. For each scenario the model linked forecast probabilities, crop selection expected revenues and losses enabling comparison of choices under uncertainty,

Ethical Consideration

All respondents received study information and provided consent before interviews. Researchers coordinated with the Municipal Mayor, Punong Barangays, Municipal Agriculture Office, and Local Disaster Risk Reduction and Management Office to establish trust, transparency, and alignment with local priorities. Enumerators were here and trained in accurate, respectful and sensitive data collection. Supervisors review completed surveys and consider data cleaning to remove errors and inconsistencies. Cleaned records were then transferred to encoders for encoding and analysis. Strengthening data quality reliability and responsible treatment of community information. Participation remained voluntary and researchers protected respondent dignity through field work. These strengthened ethical compliance and confidence in the conclusions.

RESULTS

Corn Production System

Farm characteristics. Data from 124 farmers showed farm sizes ranging from 0.5 to 7.0 ha. Most managed small parcels: 36.25% cultivated 1.0-1.9 ha and 23.13% cultivated 2.0-2.9 ha, while only two respondents owned 7.0-ha farms. Moreover, 83.22% of parcels were located in the owners' barangays.

Farming practices. Focus group discussion (FGD) and KII results indicate that the farmers systematically prepared land by alternating plowing and harrowing. Contracted four-wheel or hand tractors cost PHP 5,500.00 per ha. Farmers cultivated less than 0.5 ha, particularly upland plots, commonly used animal power. Human or animal labor costs PHP 700-750 daily. Farmers fully owned 39.87% of surveyed parcels, while tenants cultivated 35.44% (Table 1). Other parcels were rented, covered by certificates of land transfer, or pawned, the latter averaging 1.86% of field area.

Table 1. Tenure status of corn farmers, Bansud, Oriental Mindoro (household survey, Bansud 2019).

Ownership	Parcel 1	Parcel 2	Parcel 3	Grand Total	%
Fully-owned	47	13	3	63	39.87
Tenant	41	12	3	56	35.44
Rented/lease,	16	3	2	21	13.29
Held under CLT or CLOA	12	1		13	8.23
Owner-like possession other than CLT/CLOA	5	-	-	5	2.98
Pawned	3	-	-	3	1.86
Grand Total	124	29	8	158	

Farms were mostly upland or lowland and depended heavily on rainfall. Rainfed agriculture occupies 80% of global agricultural land and supplies 40% of food; similarly, Philippines corn production is predominantly rainfed (DA-BAR 2011). Farmers purchased inputs and sold produce through traders, generally in the town proper. From cornfields, they transport goods by tricycle (40.37%), truck (30.43%), jeep (16.77%) or motorcycles (12.42%). Half of all parcels were 1.0-4.9 km from the nearest market, although some exceeded 17 km.

Wages for the laborers. Laborers received PHP 400.00 daily without meals or PHP 350.00 when landowners provided lunch.

Fertilizer use. Farmers combined organic and inorganic fertilizers. Urea (46-0-0) and complete fertilizer (14-14-14) were principal inorganic inputs; chicken manure was the primary organic fertilizer. Chemical fertilizer came from an agricultural store, while a local supplier provided manure. Chicken manure was incorporated as basal fertilizer 15-30 days before planting, it costs PHP 120 per sack at poultry farms or PHP 140 delivered. Applications range from 12 to 50 sacks per ha, depending on financial capacity and seed type; hybrid corn received more than traditional or local varieties. Secondary data indicated application of two to three sacks of urea and two to four sacks of complete fertilizer. Some farmers divided fertilizer between planting and side-dressing 30 days

after sowing; others applied everything during side-dressing. Farmers generally relied on experience and lacked awareness of soil testing. For 30 days, they simultaneously cultivated and removed weeds using a carabao and plow. This hilling-up practice was locally called “sungkal”.

Harvesting and marketing. Farmers harvested manually with bolos or scythes. Harvesters were paid in cash or through a five-to-one sharing arrangement: one pile for the harvester and four for the owner. Powered shelling cost PHP 20-25 per 50-kg sack. Grain was sundried for two to three days, with drying labor also costing PHP 20-25 per 50-kg sack. Private traders usually collected products from farms. White corn sold for PHP 12-15 per kg, whereas yellow corn earned PHP 15-20 per kg.

Socio-demographic Characteristics

Men comprised 81% of respondents, and women 19%. Farmers aged 41-60 formed the largest group followed by those aged 61-70 (20%), 20-40 (15%), and 71-80 (8%), demonstrating participation across age groups. Most respondents were married (85%); 6 % were widowed, 4% lived with partners, 2% were single and 2% were separated. Educational attainment was generally low: 27% had no schooling, and another 27% were elementary undergraduates, 19% completed high school and only 1% completed college. Half of households had a household size of four to six members; 34% had one to three, 13% had seven to nine, and 1% had at least 12. Farming experience varied: 36% had farmed for 1-15 years, 29% for 16-30 years, 20% for 31-45 years, and for 46-60 years. Farming was the primary income source for 92% and secondary for 8%.

Socio-economic Characteristics

Agriculture remained Bansud households' principal livelihood, but earnings differed substantially (See Table 2). Farm income was below PHP 40,000 annually for 87% of respondents, indicating widespread difficulty meeting financial needs through agriculture alone. Production factors affecting productivity and profitability included input costs, market fluctuations, weather, farming methods, capital and resource access. Only 3% earned above PHP 250,000 while another 3% earned PHP 100,000-249,999. Two percent fell within each of the PHP 60,000-99,999 and PHP 40,000-59,999 brackets. The concentration of farmers in the lowest farm-income bracket suggests that small holdings, dependence on uncertain rainfall production expenses and variable selling markets, effective techniques, greater access to capital and resources, or diversified production involving higher-value crops. Farmers therefore operate under unequal conditions even when corn remains their shared principal agricultural activity. The production system also links household resources, farm management and market access. Small parcels sized influence the choice between tractor services and animal power, while capital determines the amount of chicken manure and fertilizer applied. Long distances to markets increase dependence on vehicles and

traders, who commonly purchase grain directly from fields. Farmers limited use of soil testing further means that fertilized decisions are based on experience instead of measured nutrient requirements. These circumstances may affect production costs, crop response, and returns. Harvest practices likewise combine arrangement and paid services. Manual cutting and crop-sharing reduce the need for immediate cash payments, whereas mechanized shelling and paid drying require expenditure after harvest. Grain variety also affects revenue because yellow corn commands a higher price than white corn. Together, their findings show how production decisions, labor arrangement, input use, transport, and market price shaped household earnings.

Table 2. The Socio-economic characteristics of corn farmers in Bansud, Oriental Mindoro, (household survey, Bansud 2019).

Item	No.	%
Farm income (PhP)		
< 40,000	108	87%
40,000 - 59,999	2	2%
60,000 - 99,999	3	2%
100,000 - 249,999	4	3%
> 250,000	4	3%
Off-farm income (PHP)		
< 40,000	120	97%
40,000 - 59,999	3	2%
60,000 - 99,999	1	1%
100,000 - 249,999	0	0%
> 250,000	0	0%
Non-farm income (PHP)		
< 40,000	68	55%
40,000 - 59,999	13	10%
60,000 - 99,999	14	11%
100,000 - 249,999	23	19%
> 250,000	5	4%
Remittances and cash transfer (PHP)		
< 40,000	120	97%
40,000 - 59,999	0	0%
60,000 - 99,999	3	2%
100,000 - 249,999	1	1%
> 250,000	0	0%

It is noteworthy that 97% of the respondents receive annual remittances of PHP 40,000 or less, while a small percentage, 2%, acquire a slightly higher range of PHP 60,000 to PHP 99,99. The remaining 1% of the total respondents received remittances in the range of PHP 100,000 to PHP 249,99.

Overall, the findings portray predominantly small scale, rain-dependent corn farms managed by experienced by generally low-income households. Farmers combine traditional labor and cultivation practices

with mechanized preparation and shelling, depend on traders for inputs and markets, and supplement limited farm income through off-farm work and remittances.

Economic Value of Seasonal Climate Forecast in Corn Production and Decision Tree Analysis

Corn has a consistent farm-gate price of PHP 20.00 per kilogram, with a total farming cost of PHP 22,440.00 per hectare. During a favorable dry season with normal rainfall, corn farmers could harvest 11,000 kilograms per hectare (equivalent to 12.25 US tons). Based on the farm-gate price of PHP 20.00 per kilogram, 11,000 kilograms could generate up to PHP 200,000.00 in gross revenue, which can be considered economically efficient. However, extreme rainfall, representing a worst-case scenario, might result in losses amounting to 89% of the projected net income per hectare from corn production.

On the other hand, squash, as an alternative crop to corn, can yield 2,000 kilograms per cropping cycle, equivalent to PHP 33,160.00 (at the highest price of PHP 25.00 per kilogram) after deducting total farming costs. The total farming cost for squash production was approximately PHP 16,840.00 per hectare, which was 25% lower than that of corn. The market price of squash varies from PHP 15.00 to PHP 25.00 per kilogram.

If climate information—particularly rainfall forecasts—was not considered in farm operations, farmers' income from corn could be 32% higher than that from squash. However, when farmers utilize the probabilistic rainfall forecast from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the estimated income from corn could increase up to 69%, which is much higher than income from squash under near-normal rainfall conditions. When farmers incorporate probabilistic rainfall forecasts into their decision-making, there was a 7% advantage in expected benefits compared to farmers who do not use seasonal climate forecasts.

The difference between the estimated outcomes for crop planning with forecasts and without forecasts is approximately PHP 4,800.00 or around USD 77.80 per hectare per cropping season in either gained or foregone benefits.

DISCUSSION

Corn Production System

Farm characteristics. In communities where agriculture heavily relies on rainfall, corn farmers are increasingly turning to local or traditional varieties, such as “sinabmit,” due to their better adaptation to specific environmental conditions compared to hybrid corn varieties. These farmers understand that the unpredictable nature of rainfall can significantly impact crop yields, and traditional varieties like “sinabmit” have evolved over generations to thrive in these local climates. Unlike hybrids, which are often bred for uniformity and high yields

under controlled conditions, “sinabmit” is resilient to drought and can tolerate the fluctuations in moisture that characterize many farming environments. By utilizing these traditional varieties, farmers not only enhance their chances of a successful harvest but also preserve agricultural biodiversity and cultural heritage, creating a sustainable farming practice that aligns with the realities of their landscape.

Across different types of land, farmers consistently choose to cultivate corn due to its remarkable versatility and profitability. Regardless of land type or ownership status, corn stands out as a crop that accommodates varying soil conditions and climates, making it an attractive option for both large-scale and small-scale farmers. Its adaptability allows for a range of uses, from food products to animal feed and biofuels, thus enhancing its economic appeal. Moreover, corn generally yields a high return on investment, as it can thrive with careful management and modern agricultural techniques, ensuring that farmers can maximize their outputs. This combination of factors, such as cost-effectiveness, high yields, and multipurpose applications solidifies corn's status as a fundamental crop choice for farmers seeking sustainable and profitable agricultural practices.

Notably, corn remains one of high-value crops in the Philippines, serving as both a substitute staple food and a vital source of animal feed. With its adaptive nature and widespread cultivation, corn provides essential nutrients and sustenance to millions of people. They can be consumed in various forms, such as cornmeal, corn flour, or even as whole kernels. Additionally, corn serves as a valuable source of animal feed, contributing to the production of meat, dairy, and poultry products. Their high energy content and digestibility make them an ideal feed option for livestock (Gerpacio et al. 2004).

Farmers in the area follow two cropping seasons, wet and dry. Planting is done towards the end of the dry season, specifically, in April to May, while the second planting is usually done during November to December. This planting schedule is being practiced to make sure that their corn plants received enough water needed for optimal corn growth and development.

Farming practices. For planting, seeds were commonly treated with insecticide (Sevin) to protect the seeds from pathogens and harmful insects. Farmers used a traditional variety of corn called “sinabmit”. However, six of them were planting hybrid yellow varieties and Open Pollinated Variety (OPV) glutinous corn. The number of kilograms of corn seeds that farmers allocate to one ha of the parcel depends on the number of seeds planted per hill. Farmers were planting one to two seeds, and others two to three seeds per hill. Secondary data showed that quantities ranging from 15 kg to 24 kg of seeds were being utilized per ha. During planting, five to ten farm workers usually accomplish the tasks. Labor is either provided by family members or by groups of farm workers that could also be contracted.

According to the interviewed farmers, the occurrence of pests and diseases was observed during the entire growth period of the corn plant. The extent of pest damage varies depending on the growth stage and environmental condition of the area. This could be one of the impacts of climate change on the site since it has a great impact on the growth, and development including the physiological processes of corn crops (Challinor et al. 2007; Young and Long 2000; Sivakumar and Hansen 2007; Salvacion 2015) while the occurrence of pests and diseases are also attributed to climate change (Zhao et al. 2005). Farmers most commonly reported insect pests affecting their crops include corn borer, yellow beetles, common cutworm, earworm, aphids, armyworm, and white grub. In addition, the Municipal Agriculture Office of Bansud identified a newly emerging pest in the area, the fall armyworm. The corn borer, cutworm, earworm, and armyworms are some of the pests from the moth group that can severely damage corn crops worldwide, followed by grubs and disease carriers like aphids (Chirinos et al. 2024), which are all categorized as economically important pests of corn (Hutchison and Cira 2017). On the other hand, some of the encountered diseases were downy mildew, leaf blights, bacterial stalk rot, smut, and mycotoxins, which are plant pathogens that affect corn and other crops like potato, wheat, horticultural, and plantation crops, where 70% are due to fungal pathogens (Mahadevakumar and Sridhar 2021). To control the harmful effects of insect pests, most farmers commonly sprayed insecticides such as Prevathon, Scorpio, and Armure. Aside from using chemicals, all farmers employed traditional practices such as planting border plants such as pepper, ginger, and squash to prevent and minimize the incidence of insect pests.

To generate additional income, the majority of the farmers would plant vegetables along the side areas of their farms. These crops include squash, sweet potato, pepper, taro, string bean, cassava, eggplant, and tomato. If they could not plant corn in between cropping seasons, most of the farmers planted squash.

Socio-demographic

The socio-demographic profile of corn farmers in Bansud, Oriental Mindoro, reveals considerable diversity in various aspects, such as gender, age, educational background, household size, years of farming experience, and income sources. The fact that male farmers outnumber female farmers is due to the global setting that farm operations are often led by male as a common result of prevailing gender roles. Historically, societies have assigned certain roles and expectations to men and women. Male are typically responsible for physical labor and tasks that require strength. In the context of farming, these expectations have led to a disproportionate representation of men in farm operations. However, it is important to note that the dominance of the male is not a reflection of women's capabilities or expertise in agriculture but due to the physical activities in farms. Thus, there are efforts in promoting gender equality in farming, specifically, encouraging women's active participation in the

agricultural sector through participation in the decision-making process (Carnegie et al. 2020). The farmer population includes individuals ranging from young adults to senior citizens. The fact that farming is practiced by all ages is true for most of the countries in Asia due to the varying economic status of households, cultural and inheritance of property, in which families that farming was their main source of income. They were trained to operate farms at a young age for early exposure (Jansuwan and Zander 2021). This is the main reason that diversifies age distribution in the different farm operations in the Philippines. Educational levels among farmers vary significantly; some have received formal education, while others lack schooling entirely. Household sizes also differ, influencing the availability of labor and the economic support systems within families. Furthermore, the years of experience in farming vary among the farmers, which impacts their expertise and ability to adapt to new agricultural innovations. Income sources are multifaceted; while some farmers rely exclusively on corn production, others diversify their income through growing alternative crops or engaging in off-farm jobs, illustrating their varied economic strategies.

Demographic profiles shape the practices and productivity of corn farming in the municipality of Bansud, as an example scenario, age is a significant demographic factor in agriculture. Younger farmers often bring new technologies and innovative practices to corn farming, which can enhance efficiency and yield. They may be more adept at adopting digital tools for precision agriculture, such as data analytics and automated equipment. Conversely, older farmers may possess valuable traditional knowledge and experience that can be beneficial, particularly in understanding local climatic conditions and pest management. The blend of youth and experience can create a dynamic farming environment, where new ideas are balanced with tested strategies. Educational background also plays a vital role in corn farming. Farmers with formal education in agriculture or related fields are more likely to implement scientific methods and sustainable practices. They tend to be better equipped to analyze soil health, optimize crop rotation, and utilize fertilizers effectively. Additionally, education fosters access to research and extension services, allowing farmers to stay updated on advancements in agricultural techniques and technologies. In contrast, those with limited educational opportunities may rely on conventional methods, which could limit productivity and sustainability. Household size impacts labor availability and resource allocation on farms. Larger households may provide a greater labor force, allowing for more intensive farming operations, while smaller households may struggle to manage the demands of corn farming (Osei-Kofi et al. 2023). The dynamics of household responsibilities also affect the decision-making process. Families with multiple members involved in farming can share the workload and diversify income sources, which is essential for resilience against market fluctuations. Years of farming experience correlate strongly with a farmer's ability to

manage risks and adapt to changing conditions. Experienced farmers often have a deeper understanding of local market demands and environmental challenges. They are typically better at implementing effective crop management strategies, thereby increasing their yield and profitability. However, reliance on traditional practices without openness to innovation can be a drawback, potentially hindering progress in a rapidly evolving agricultural landscape (Bertolozzi-Caredio 2024).

Income sources are another critical aspect of the demographic profile that impacts corn farming. Farmers who rely solely on corn as their income source may face greater risks due to market volatility. Diversifying income streams such as integrating livestock, engaging in agritourism, or participating in local farmers' markets can enhance financial stability. This diversification allows farmers to cushion against poor harvests or price drops, providing a safety net that can sustain their operations through challenging times (Mayo and Villarta 2023).

The demographic profile of corn farmers significantly influences their agricultural practices and overall success. Age, educational background, household size, years of farming experience, and income sources are intertwined factors that shape decision-making and adaptability in corn farming. Understanding these implications can help policymakers and agricultural organizations tailor support and resources to meet the specific needs of farmers, ultimately promoting sustainable and productive farming practices.

These findings underline the challenges faced by corn farmers in Bansud, highlighting the importance of exploring avenues for financial support and stability. The socio-economic situation of farmer respondents reveals that their financial stability is not solely reliant on farm income; rather, many farmers engage in various supplementary income-generating activities. These alternative sources, which can include alternative sources such as off-farm employment, small business or entrepreneurial ventures, and part-time employment, often yield higher profits than those derived from agricultural products. As a result, while farming remains a crucial aspect of their livelihood, it is often complemented by these additional income streams, allowing farmers to mitigate risks associated with fluctuating crop prices and seasonal uncertainties. Consequently, some respondents indicate a dependence on farming primarily as a means to support their overall income strategy (Nering and Fernandez-Cornejo 2005).

The demographic profile of corn farmers significantly influences their agricultural practices and overall success. Age, educational background, household size, years of farming experience, and income sources are intertwined factors that shape decision-making and adaptability in corn farming. Understanding these implications can help policymakers and agricultural organizations tailor support and resources to meet the specific needs of farmers, ultimately promoting sustainable and productive farming practices.

Economic Value of Seasonal Climate Forecast in Corn Production and Decision Tree Analysis

Economic value of seasonal climate forecast in corn production. It is apparent that corn farmers in Bansud prefer the dry season over the wet season. Farmers describe how the wet season affects their farming patterns, as they often need to shift to alternative crops in anticipation of adverse weather conditions. Aside from corn cultivation, they also plant squash as the second-best crop option during the dry season. For them, both corn and squash farming are financially rewarding agricultural activities. Farmers recognize that favorable weather conditions play a crucial role in achieving higher crop yields, particularly for corn and squash, which are essential to their agricultural livelihood. Corn, as the priority crop due to its relatively stable farm-gate price, thrives during favorable dry seasons with normal rainfall, which can significantly increase its yield. However, extreme rainfall represents a worst-case scenario that can lead to the loss of most or all net income because of its negative effects on crop production. In situations where corn yields decline, farmers often turn to squash as an alternative crop. Notably, the total farming costs associated with squash are lower than those for corn. Therefore, understanding and adapting to weather patterns is vital for farmers seeking to optimize their harvests and maintain economic viability (Salvacion 2015).

Seasonal climate forecasts provide valuable information to farmers in Bansud regarding expected weather patterns and climatic conditions over a given period. These forecasts analyze various meteorological variables, including temperature, precipitation, and humidity, allowing farmers to anticipate potential changes in growing conditions and plan their agricultural activities accordingly. For example, a forecast indicating a higher probability of drought can encourage farmers to adopt water-conserving practices or to select drought-resistant crop varieties, thereby improving resource efficiency and crop performance. Furthermore, reliable seasonal forecasts can inform decisions regarding planting schedules, pest management strategies, and harvesting periods, ultimately contributing to higher agricultural productivity and sustainability. By integrating seasonal climate forecasts into farm planning, farmers in Bansud are able to make more informed decisions that not only enhance their farm operations but also contribute to food security and economic stability within their communities.

Given the increasing unpredictability of weather patterns associated with climate change, the integration of SCF into agricultural planning can serve as an effective strategy for improving both productivity and resilience in farming practices in the municipality of Bansud. Local agricultural policies can be informed by SCF data in order to strengthen government programs aimed at climate change adaptation and resilience. Such policy integration can help ensure food security and economic stability in communities that rely heavily on agriculture as a primary source of income. This proactive approach not only helps mitigate the adverse impacts of climate

variability but also promotes a more sustainable agricultural system capable of adapting to future environmental changes. Through the use of SCF data, policies can be adjusted to provide more practical and viable support mechanisms for farmers, particularly in improving programs and interventions designed to assist them during hydrometeorological hazards.

Decision tree analysis. The economic returns of farmers in Bansud are significantly higher from corn farming compared to squash farming, with income from corn estimated to be 32% higher, even in the absence of specific climate information such as rainfall forecasts (Figure 2). This difference can largely be attributed to the adoption of improved agricultural technologies for corn production. Farmers employ enhanced seed varieties, improved fertilization practices, and more efficient tillage methods, all of which contribute to higher productivity. These innovations have enabled farmers to substantially increase corn yields despite the uncertainty of climate conditions. The adoption of such technological advancements has proven crucial for sustaining corn production, thereby contributing positively to both the local agricultural economy and the broader food supply chain (Hapinat and Montero 2022).

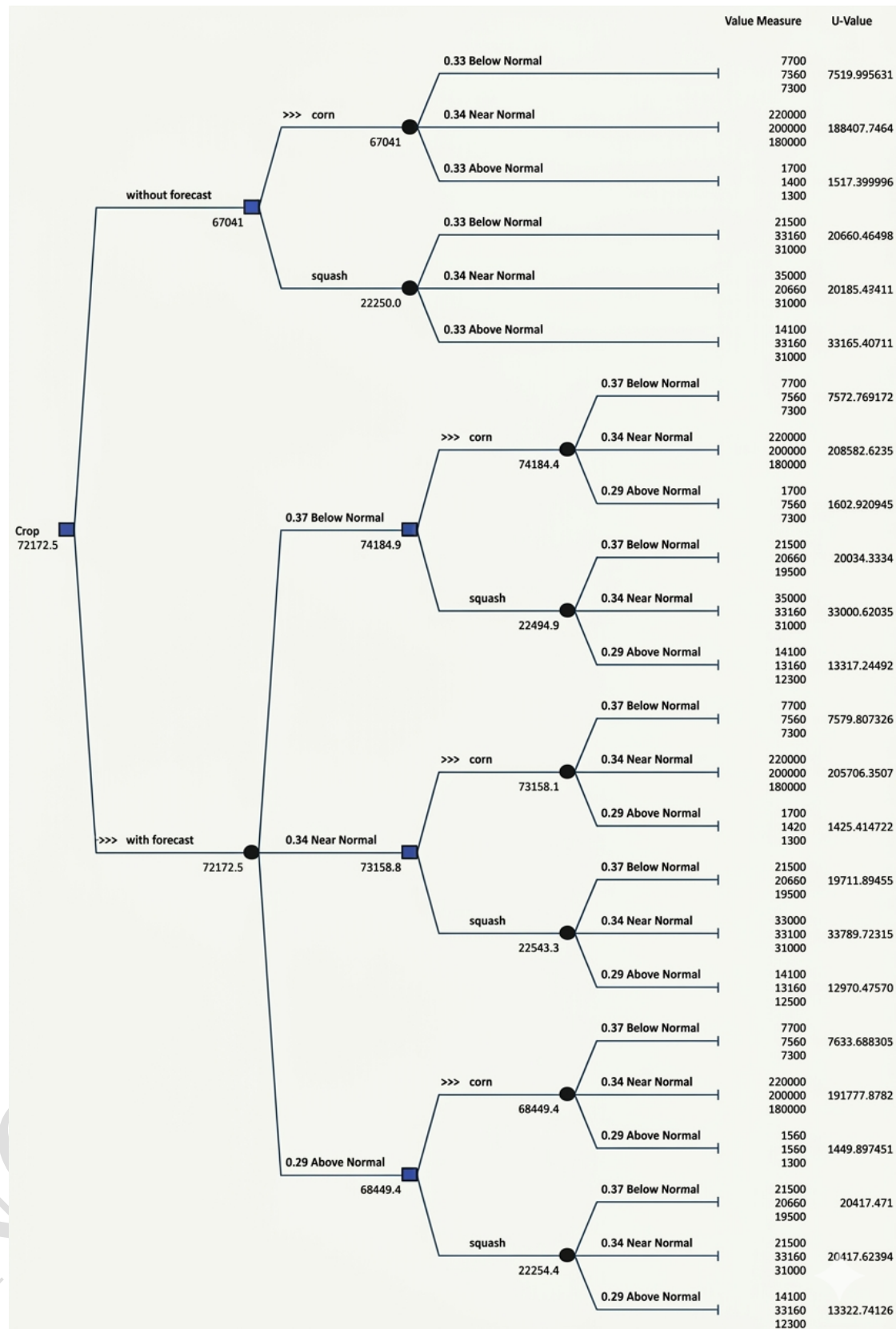


Figure 2. Decision tree analysis of Bansud corn farmer's income with and without seasonal climate forecast.

The use of probabilistic rainfall forecasts provided by the PAGASA has important implications for farmers, particularly with respect to crop selection and potential income. Studies indicate that under near-normal rainfall conditions, farmers who cultivate corn may achieve income levels that are approximately 69% higher than those who grow squash. This finding highlights the importance of climate information in agricultural decision-making. Farmers who utilize probabilistic rainfall forecasts can improve their economic outcomes by strategically planning their cropping activities. An analysis of the rainfall forecast for May 2020 further demonstrates these benefits, suggesting that farmers who used this forecasting approach could obtain an estimated 7% advantage in overall benefits compared with those who did not incorporate seasonal climate forecasts into their planning. By utilizing such decision-support tools, farmers are better able to manage the uncertainties associated with climate variability, ultimately leading to improved economic performance and more resilient farming systems (Haigh et al. 2015).

Seasonal climate forecasts (Figure 3) provide valuable insights for farmers in Bansud regarding expected weather patterns and climatic conditions over a specific period. These forecasts analyze various meteorological variables, including temperature, precipitation, and humidity, enabling farmers to anticipate changes in growing conditions and plan their farm operations accordingly. For instance, a forecast indicating a higher likelihood of drought may encourage farmers in Bansud to adopt water-saving practices or select drought-resistant crop varieties, thereby optimizing both yield and resource use. In addition, reliable seasonal forecasts (Hansen et al. 2009) can guide decisions on planting schedules, pest management strategies, and harvesting periods, ultimately contributing to improved agricultural productivity and sustainability. By integrating seasonal climate forecasts into their farm planning, farmers in Bansud can make more informed decisions that not only enhance their agricultural operations but also contribute to food security and economic stability within their communities.

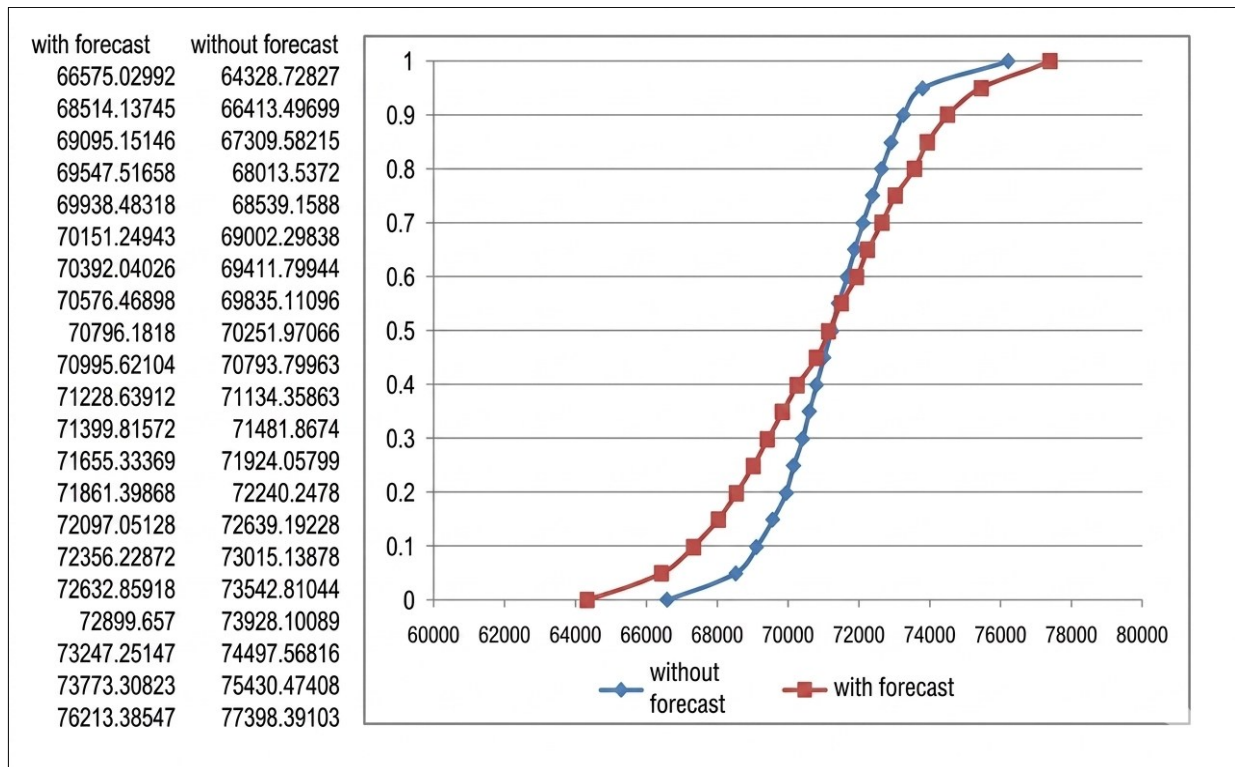


Figure 3. Simulation for different outcomes with and without seasonal climate forecast.

Given the increasing unpredictability of weather patterns associated with climate change, the integration of SCF into agricultural planning can serve as an effective strategy for enhancing both productivity and resilience in farming practices in the municipality of Bansud. Agricultural policies at the local level can be informed by SCF data to strengthen government initiatives related to climate change adaptation and resilience. Such policy alignment can help ensure food security and economic stability for communities that depend heavily on agriculture as a primary source of livelihood. This proactive approach not only helps mitigate the impacts of climate variability but also promotes a more sustainable agricultural system capable of adapting to future environmental changes. Through the use of SCF data, policies can be refined and adjusted to more viable strategies that support farmers, particularly through programs and projects designed to assist them during hydrometeorological hazards.

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GENERATIVE AI STATEMENT

No generative artificial intelligence (AI) tools were used in the conduct of this study, writing, analysis, interpretation, or preparation of this manuscript.

ETHICAL CONSIDERATIONS

This study observed ethical standards in social science research. Participants were informed on the purpose of the study, procedures involved, willingness to participate, and confidentiality measures. Informed consent was obtained prior to interviews. Personal identities were omitted from the final dataset, and all information was handled with stern confidentiality.

DECLARATION OF COMPETING INTEREST

The authors declare that there are no competing interests to any authors.

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