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Article

The Social Theories in Climate Change: An Analysis of the Agricultural Productivity of Farmers in the Municipality of Bustos

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Abstract

The Philippines is an agricultural country where farm products are vital to economic growth and food security. From a Structural Functionalist perspective, the Philippines' agricultural sector serves as a critical subsystem for maintaining societal equilibrium and food security, yet this stability is currently undermined by environmental dysfunctions. Using Social Ecology theory, the vulnerability of arrowroot and rice farmers in Bustos, Bulacan highlights the precarious relationship between human labor and a volatile climate, where extreme weather events disrupt the traditional "metabolic rift" between rural production and national consumption. Human Capital Theory suggests that while farmers possess indigenous knowledge, a "knowledge gap" in climate-resilient crop selection and information dissemination limits their adaptive capacity and threatens their socioeconomic survival. Moving forward, Risk Society theory explains that agricultural instability is no longer just a natural occurrence but a manufactured risk requiring institutional intervention to prevent total systemic collapse of food stability. This study employed descriptive research to examine the impacts of climate change on agriculture. Findings indicate that climate change has adverse effects on farm yields. Important predictors include farmers' training, knowledge, awareness of global warming, preparation levels, and access to climate-related information. However, two critical areas remain underemphasized: proper selection of climate-resilient crop varieties and effective dissemination of climate change information to farming communities. The practical implication of this research is clear: rice and arrowroot production are increasingly vulnerable to climate variability, leading to reduced supply and potential threats to food stability in the Philippines.

***Keywords**: Adaptive Capacity, Agricultural Productivity, Climate Change, Climate-Resilient Crops, Food Security*

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Introduction

Awareness of climate change has grown significantly, accompanied by an expanding body of research examining its effects across different sectors. Agriculture, being highly dependent on environmental conditions, is particularly vulnerable to these changes. Shifts in rainfall variability and increasing water stress disrupt traditional planting and harvesting cycles, which in turn reduces yield stability and accelerates soil degradation (Lobell & Burke et al., 2021). Moreover, these challenges extend beyond crop productivity, influencing economic stability, social systems, and governance linked to agricultural activities.

Climate change significantly influences agricultural productivity through extreme weather events, temperature fluctuations, irregular rainfall, and shifting seasonal patterns. In Bulacan, the Angat Dam—serving as the primary water source for the National Capital Region and as the main irrigation provider for extensive plantations—plays a crucial role in local farming. However, fluctuations in its water level have become a pressing concern, particularly for agricultural areas in Bustos, Bulacan.

Poblacion Bustos, the most densely populated barangay located in the northwest of the municipality near Baliuag, lies mostly above the floodplain. Despite this, it experiences recurrent flooding twice a year due to water releases from the Angat Regulator (Bustos) Dam to the northeast. Although less severe compared to the more flood-prone southern municipalities, these releases still disrupt local livelihoods. As highlighted by Habana, Briones, and colleagues (2021), recurrent flooding from dam operations across Bulacan municipalities, including Bustos, has a measurable impact on rice cultivation and farmer well-being. Overall, both climate variability and dam management practices exert strong pressures on the province's agricultural productivity.

The climate change is the rise in the temperature of the earth as the result of the ice burgs in some part of the earth is melted. The majority of the total percentage of the body of water in the earth is salt water, and the rest is the potable water, as the global warming arises the volume of the body of water is also affected. Greenhouse gases are a chemical compound which absorb the suns beam which reflects and absorb heat from the Earth's surface and retain within the atmosphere. The heat in the earth stays and it may result in global warming. Oppemheimer et al., (2019) highlighted the risks from sea level rise and the glacier melt and the ocean warming for the coastal and island nations, this underscores the serious risks climate change poses system, coasts and global populations

Sociology examines climate change as a fundamentally social issue, focusing on how human activities, social structures, and cultural values drive environmental shifts and how these changes, in turn, reshape society (Adebayo & Osunmakinde, 2024). Structural functionalism views climate change as a dysfunction that disrupts societal equilibrium, requiring institutions to adapt to restore stability. Social ecology emphasizes the interdependent feedback loops between human activities and natural systems, focusing on how these integrated dynamics drive environmental degradation and adaptation. Human capital theory analyzes how climate impacts like health crises devalue individual productivity while highlighting education as a vital investment for climate innovation. Risk society theory posits that modern industrialization creates global "manufactured risks," shifting societal focus from wealth distribution to the management and mitigation of self-generated environmental hazards.

In the Philippines, particularly in Bustos Bulacan, the stable food like rice is one of the regular agricultural aspect of the Bustosenyo in which the planting and growing of the rice is all year round because of the proper irrigation which came from the Bustos Dam aside from that the farmers also give their opportunity to plant a arrowroot which the main source of the starch in making of minasa cookies is the rhizome of these crops. Mehta, C.R. Senthilkumar, T.M.A., & Imran, S. et al., (2025) the mechanization and automation for irrigation, precision fertilizer application are helping the rice farmers to cope in the labor shortages and the present climate variability. This is more relevant to Bustos farmers who depend on irrigation from the Bustos Dam and are affected with the extreme weather condition not only in Bustos but in the whole country. But the farmers many years ago did not attempt to plant an arrowroot as they believe that this not meet the right idea to utilized it as a marketable product because the arrowroot starch is usually in less amount when it got to press it in the pressing device. Aside from that the planting of rice and its maintenance also affect with the extremely change of temperature such as drought, La Niña and even the strong typhoon which greatly affect the crops. It also affects the climate change as the farmers can't manage easily the plant as the global warming affects its cultivation and growth when producing the quality root crops. As to continue the legacy and famous products of minasa cookies, the minasa makers use alternative ingredients such as the cassava flour which is stable ingredients to sustain the minasa cookies in Bulacan. We all know that in Region III is the rice production in the Philippines which includes Bulacan specially the Municipality of Bustos. Farmers reported the declining of the rainfall and the rising of temperatures which are parallels the challenges faced in Bulacan. The adaption strategies are likely to improve the rice varieties, green manuring and alternative and drying of irrigation should be applicable to Bustos (Banjade et. al., 2024)

The problem in climate change has a clear solution and minimize its effects, this can be done through a proper preparation in that area which was affected by the climate change in Bustos Bulacan and nearby Municipality. The trainings which were conducted by the municipalities accordingly which can help each and every of the farmers to make more a productive harvest of rice and arrowroot in spites of the increasing problem in climate change. The type of soil which can also be a hindrance to make a good quality rice and arrowroot production in Bustos Bulacan. Emphasize that adaptive farming strategies such as climate smart agriculture, the conservation tillage and the agroforestry are in crucial when reducing the vulnerability of the climate change, the practices not only improve the resilience but this is also to enhance the soil quality and the key concern in Bulacan soil limitations can hinder both the rice and arrowroot production (Rithika et al., 2025). The adjustment of each farmer to the increasing condition of climate change that affects more of us and the agricultural sector in Bulacan, this is done with the water mitigation process, training for the agricultural productivity and even the alternate agricultural crops you have been use and raise in the regular season of your farming. This maybe the probable answer to the problem of the climate change which can we experience through out every year as our earth and environment would be deteriorated in the human violation and abuse for personal and technological change. On the policy side, the government in the Philippines play a critical role in climate change implementation programs. Sulistiawati & Rembeth et al., (2025), found that the national climate change goals are ambitious, local government interventions often limitations in execution. The need for stronger municipal training programs in Bulacan to equip farmers with practical knowledge on climate resilient farming techniques.

In Bustos, climate conditions have become increasingly unpredictable. Intense rainfall and recurring typhoons frequently trigger floods, while prolonged dry spells heighten the risk of drought (Harding, Iwama & Thomas, 2013). Farmers situated in the most vulnerable zones along the Angat River face declining harvests and heightened exposure to rising water levels.

Beyond these immediate threats, agriculture is further challenged by soil erosion, land degradation, contamination, and the steady conversion of farmland for other uses. Rapid industrial growth and deforestation are compounding these problems, while outdated infrastructure adds another layer of vulnerability. To safeguard agricultural productivity, proactive strategies for both climate change mitigation and adaptation are essential. The development and implementation of a Local Climate Change Action Plan mark an important step in this direction.

The proponent tries to find out the awareness of the farmers and the people around in Bustos Bulacan in the usual practice of planting the arrowroot crops and Rice to sustain the products of quality cookies such as minasa and rice to have the stable food in the daily food consumption of every family. The effect of the climate change as it makes an endeavor in cultivation of the arrowroot and rice in Bustos Bulacan. The yield of agricultural productivity in several years as they have the changes in the output of producing the rice and starch out of the crops. In rice systems, the rainfall and sunlight duration may strongly affect the total productivity output which indicating the climate variables are key determinants of yield stability (Oyita et al., 2025)

Arrowroot (Maranta arundinacea), a member of the Marantaceae family, is an upright herbaceous plant characterized by its elongated, pointed leaves (Kinupp & Lorenzi, 2014). Its rhizomes are valued for producing a fine white starch—commonly used as a thickening agent in cooking—recognized for its easy digestibility. Traditionally, arrowroot was widely cultivated by smallholder farmers in certain regions; however, its production has gradually declined as other staple crops gained preference (Silveira et al., 2013). Recent studies on arrowroot productivity in the context of global warming suggest that climate variability may influence starch yield. This has implications not only for its use in everyday cooking and baking but also for traditional foods such as minasa cookies, where arrowroot starch is a key ingredient.

The Philippines, being an archipelagic nation, relies heavily on agriculture, which accounted for about 30% of employment and contributed around 10% to the country's gross domestic product in 2013. However, recent natural disasters have caused severe losses in crops and livestock, with impacts extending to human lives. Climate change further aggravates these challenges, worsening economic instability and threatening food security. According to Derouez & Ifa (2025), climate-related stresses such as water scarcity and flooding highlight the urgent need for renewable energy integration and sustainable agricultural practices to secure productivity under shifting environmental conditions.

Plant responses to climate change are complex, involving interactions between elevated carbon dioxide levels, variable climate factors, and air pollutants. Increased frequency of extreme events alters pest and disease dynamics, threatens biodiversity, affects animal health, and undermines soil carbon pools. These cascading effects significantly disrupt food production. For instance, the cultivation of arrowroot—typically grown in tropical climates and loamy soils—faces declining yields due to pest infestations and other environmental stressors associated with climate change (Tubiello, 2007).

Catanauan, Quezon, is recognized as a major center for arrowroot production, with the crop designated as the municipality's One Town, One Product (OTOP). The area serves as a primary source of flour in Region IV-A, supplying processors in provinces such as Marinduque and Bulacan (Olfato, 2012). Beyond local markets, the Department of Agriculture has considered arrowroot as a potential substitute for imported wheat flour. Research by the Department of Science and Technology (DOST) further indicates that up to 25% of arrowroot flour can replace 69% of corn requirements in broiler feed formulations (PDI, 2012).

Arrowroot thrives in areas with evenly distributed rainfall and, aside from being processed into flour, the crop provides multiple by-products. Its fibrous residue can be used as cattle and swine feed, while its leaves are often repurposed as natural packaging material. As Novianty et al. (2025) note, land-use changes increasingly affect food crop production and food security, with implications for arrowroot and rice-growing regions like Bulacan, where farmland is under pressure.

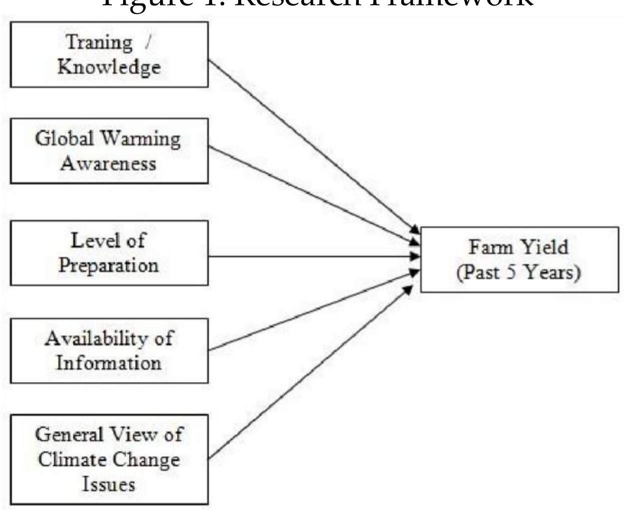
This study highlights the significance of understanding how global warming influences arrowroot productivity and related cultural practices. Findings are expected to support farmers in Bulacan by improving cultivation methods, raising productivity, and ultimately enhancing livelihoods. For extension workers, the research can guide the dissemination of new technologies and practices. For local authorities and researchers, it offers updated knowledge that may serve as a foundation for expanding arrowroot production.

In the Philippines, arrowroot has traditionally been cultivated in marginal soils and upland areas with minimal inputs. According to the Department of Agriculture – Bureau of Agricultural Research (DA-BAR, 2020), arrowroot remains an important crop for food security, particularly due to its adaptability and role in producing starch for traditional delicacies such as minasa. However, erratic rainfall and rising temperatures threaten tuber development and starch yield. To address these challenges, the adoption of climate-smart agricultural practices and modern farming technologies facilitated through agricultural extension services can help secure sustainable arrowroot production and strengthen the resilience of farmers in Bulacan. The research study response in the corresponding questionnaires which test the training, preparation, knowledge acquired in the climate change which cause the productivity of the rice and arrowroot should be take place in problem of climate change that shorten the food production of the Bustos Bulacan. The training in the climate change preparation should clearly adapt by the farmers and the knowledge of preparing the agricultural product should always be in proactive which the climate change comes a year last a few numbers of months and even more. De Jesus et. al., (2025), examined the rice farmers in Nueva Ecija and found that modern technologies increase productivity, training is essential to overcome adaptation barriers such as cost and technical aspects. This supports the idea that training in climate change preparation is vital in Bustos, Bulacan.

Methodology

Subjects of this study were 99 farmers in Bustos, Bulacan. Their perceptions of climate change and their farm productivity were acquired through the use of a questionnaire. The research framework of the study is shown in the following diagram.

Figure 1. Research Framework



In this figure the instrument used in this study has been utilized in these following criteria which the famers can perform and gain by the numerous numbers of preparations and improvement in their lives as a farmer. The study was conducted in the last 5 years of being a farmer if they have experienced a climate change problem in this period of time. The proponent clearly points out the possible entity of the climate change expectations in the rice and arrowroot productivity. The training/knowledge as a farmer to have an alternate procedures and practices in agricultural productivity in this period of time. The global warming awareness is one of the adjustments that the farmers should do in this period of time which is really affects the productivity. The level of preparation for the climate change is also a lead problem in occurring the success in rice and arrowroot productivity. The availability of information is also a common problem as a farmer in terms of their skills as a farmer, the trending issues in the climate change and other root cause of achieving less as a farmer. The last in the general view of climate change issues that can lead the performance as a whole of the farmers in producing a quality and large number of rice and arrowroot in their career as a farmer. Training and knowledge sharing are important as they equip farmers with climate smart agriculture techniques such as crop rotation, conservation farming and soil fertility management, the improve productivity and resilience (Tembo et al., 2025)

Results and Discussion

Overview of the Results

The results of this study show the farm productivity in the past five years as perceived by farmers in Bustos, Bulacan.

Table 1. Farm Productivity (N=99)

FARM PRODUCTIVITY	Mean	S.D.	Interpretation
Farm Yield last 5 years	3.13	1.00	Very little increase in yield (kgs)
5 years of farm yield	4.03	0.86	Yield increase in past year no. 4

The level of farm productivity is 3.13 interpreted as very little or negligible increase in farm yield in terms of kilograms. Scales used are 5 – much increase, 4 – some increase, 3 – no increase, 2 – some decrease and 1 – much decrease. Farmers perceived that there was negligible increase in their harvest or yield the past five years. A time-based perception of when there was an increase in yield show that it was in year number 4 of the last five years. This indicates that all the other years and the past 3 years show no observable Analysis of Farm Yield in Kilograms increase in the yield of their farms. Hussain and Majarjan et al., (2025) examined on farm demonstrations and found that extension services significantly improved a certified seeds, fertilizers and pesticides. These interventions resulted in a 0.41 tons/ha increase wheat yield the effects diminished without continued supervision.

Table 2. Farm Productivity Square of 0.25

Years (2020-2024)	Farmers	%
1. 2024	2	2.0%
2. 2023	2	2.0%
3. 2022	17	17.2%
4. 2021	48	48.5%
5. 2020	30	30.3%
Total Farmers	99	100.0%

Table 2. Farm Productivity square of 0.25, which accounts for about 25% of any (N=99) variation in farm yield per kilogram. This means that the predictors in this regression model accounts for 25 farm yield % of any regression in the dependent variable.

The slight increase in farm productivity was experienced by many of the farmers in 2024 and 2023, four years and five years ago, respectively. In the immediate past three years there was an indication of the large decrease in perceived farm productivity. This may be interpreted as a decrease in farm productivity, the cause of which is the focus of this study. Wang et. al., (2025) conducted a state level analysis of the farm productivity and found that while total factor productivity has historically driven growth, rates have decelerated in recent decades. The slowdown reflects technological plateaus, input inefficiencies and environmental challenges which the factors may also explain farmers perceptions of declining productivity.

Table 3. Predictors of Farm Productivity

AREAS	Mean	SD	Interpretation/Level
1. Training	3.52	1.02	Moderate
2. Knowledge	3.88	0.92	Moderate
3. Awareness	3.56	0.61	Moderate
4. Preparation	3.49	0.97	Moderate
5. Information	3.35	0.78	Moderate
6. Issues	3.61	0.41	Moderate

The above table shows the predictors of farm productivity as it relates to climate change and global warming perception of the farmers. Training, knowledge, awareness, preparation, information and relevant issues. All of the variables were observed to have varying moderate levels, from 3.35 to 3.88. these predictors were further subjected to statistical inferential tests to determine their effects on agricultural productivity of farmers. Mzingula et al., (2025) demonstrated that long term adoption of climate smart agriculture increased yields and strengthened resilience to extreme weather events. Preparation, therefore, converts knowledge into sustained productivity gains.

Table 4. Regression of Farm Yield in Kilograms N=99

Regression Model	Adjusted R Square		0.25
FARM YIELD IN KILOGRAMS	ANNOVA	SoS	24.41
		df	6
		Mean Sq.	4.07
		F	5.33
		Sig.	0.000
Predictors	Beta (std)	t	Sig.
1. Training	-0.02	-0.11	0.912
2. Knowledge	0.07	0.49	0.628
3. Global warming Awareness	0.07	0.63	0.527
4. Level of Preparation	0.55	5.39	0.000
5. Availability of Information	-0.29	-2.39	0.020
6. Climate Change Issues	0.10	0.90	0.370
**p<.01 highly significant *p < .05 significant			

The regression of farm yield in kilograms is shown in Table 4. The regression model has an adjusted r yield % of any regression in the dependent variable. Level of preparation for climate change has highly significant effect on farm yield with sig = 0.000. A unit increase in yield may have been attributed 50% to increase in level of preparation for climate change. Availability of information on climate change has a significant effect on farm yield, sig = 0.20. The beta of -0.29, indicates an inverse relationship with yield. This may mean that more information caused lesser farm yield. Interpreted here that increase in information has no positive effect on farm yield. This means that information about climate change was the level of preparation, in the previous Table 5, shows that it may have been influenced by crop variety. All other preparation factors were found insignificant. Crop variety has a significance = 0.05 and a beta coefficient of 0.31. This may mean that the proper choice of variety or selection of the type of crops is significant to yield. This would also indicate that climate found as irrelevant to farm productivity. The volume **of** information does not correspond to effective preparation to the farmers, an assessment of information that was given to farmers. A Ghanaian study that while 72% of farmers accessed rainfall related climate information adoption of climate smart agriculture remained low 22% for crop rotation, 15 % for pest resistant varieties, the reflection of regression results availability of information indicates the negative beta, suggesting that information without practical and actionable guidance may overwhelm or mislead farmers (Damba et al., 2025).

Analysis of Five-Year Farm Yield

Time based analysis indicates that global warming awareness and level of preparation for climate change have significant effect on farm yield per year for the last five years considered in this study. The regression model used has an adjusted r square of 0.17, which means that 17% change in farm yield may be explained by the variables selected. ANOVA sig = 0.030 indicates that our model has significant influence on the dependent variable time-based farm yield. Nondlazi et al. (2025) emphasized the role of integrating agricultural sciences strengthen the climate change adaptation research. Their study reveals that farmer awareness and decision making are shaped not only by information but also by the capacity to act on that information, the results of information volume does not directly improve yield without effective preparation.

Table 6. Regression of Five-Year Farm Yield N=99

Regression Model	Adjusted R Square		0.17
FARM YIELD FIVE YEARS (2020-2024)	ANNOVA	SoS	10.31
		df	6
		Mean Sq.	1.72
		F	2.5
		Sig.	0.030
Predictors	Beta (std)	t	Sig.
1. Training	0.23	1.48	0.144
2. Knowledge	-0.30	-1.94	0.056
3. Global warming awareness	-0.27	-2.12	0.038
4. Level of Preparation	0.28	2.51	0.014
5. Availability of Information	-0.07	-0.57	0.572
6. Climate Change Issues	0.16	1.34	0.186
**p<.01 highly significant *p < .05 significant			

Level of preparation has a significant effect on farm yield. Beta coefficient of 0.28 indicate a positive directly proportional effect on farm yield time-based productivity. An increase in level of preparation was observed to correlate with an increase in the year number being considered here. This means that as number of years increase towards the past, 5 years, the higher the productivity in relation to preparation. Conversely as the years decrease towards the present, farm yield or productivity, decrease as level of preparation decrease also. Global warming awareness has a significant effect, but the magnitude of the effect is inversely proportional. This indicates that as the number of years increase towards the past, 5 years, there is a decrease in awareness level. As time goes to the present, years going to value 1, the level of global warming awareness increases. At the same time farm productivity decreases towards the present. This would indicate that although there is an increase in awareness in climate change, that awareness is not suited or appropriate for increase in farm yield. The interpretation here is that global warming and climate change information is not relevant to increasing farm productivity. Abdeen, S. (2025), this review stresses the importance of preparation through the effective water sources management. This aligns with your results showing that preparation improves productivity while climate change awareness without proper adaption fails to translate into yield of improvements.

Sociological Analysis

Structural Functionalism theory views the agricultural system in Bustos as a vital social organ whose stability depends on the "functional" balance between environmental conditions and production. Citing a specific study on agricultural adaptation in the Philippines by Lizarondo (2025), Climate change acts as a "dysfunction" that disrupts established farming schedules and productivity, necessitating institutional adjustments—such as government-led irrigation or subsidized technology—to restore societal equilibrium.

Social Ecology Theory highlights the "human-nature" interdependence, suggesting that the productivity of Bustos' farmers is not just a biological outcome but a product of the interaction between the social system and the natural ecosystem. Direct evidence concerning the productivity and climatic challenges of farmers specifically in Bustos, Philippines was presented by Mendoza and Dela Cruz (2024). It emphasizes that sustainable adaptation requires "socio-ecological transformation," where community-level knowledge and local environmental stewardship co-evolve with shifting climatic patterns.

The Human Capital Theory, proposed by Gary Becker, posits that investments in farmers' "human capital"—specifically education, vocational training, and technical skills—directly enhance their ability to adopt climate-smart practices (Becker, 2024). In Bustos, higher human capital allows farmers to better analyze climate risks and implement advanced managerial or technological responses, thereby safeguarding productivity.

Risk Society Theory frames climate change as a "manufactured risk" where agricultural productivity is no longer threatened by natural hazards alone but by modern industrial consequences (Mythen, 2025). Farmers in Bustos must navigate these complex, globalized risks by shifting from traditional "fatalism" to a proactive "risk management" mindset, often balanced against perceived social risks within their local networks.

Conclusion

The result of the study shows that climate change perception of farmers has significant effect on farm yield or productivity among the farmers in Bustos. As climate change evidenced by global warming progresses, farm productivity has been going down in the past five years which reflect a failure in Structural Functionalism, as the interconnected systems of information and government support fail to maintain social and economic stability. Crop selection was found to be significant, and it was the only fac tor that has direct proportional relationship with the level of preparation. Information or awareness has an inverse relationship with productivity through time indicating the irrelevance of climate change information given to farmers. The scope of the study is for climate change awareness and its effect to the agricultural productivity of rice and arrowroot in the Municipality of Bustos Bulacan.

Farmers face heightened vulnerability to extreme weather under Social Ecology Theory, which highlights how the deteriorating relationship between the local ecosystem and social structures necessitates a shift toward climate-resilient crops like arrowroot. The findings revealed that farmers increasingly the vulnerable and to extreme weather events, irregular rainfall and rising of temperatures are even, which may affect the crops yield and its quality. The results emphasized the importance of Human Capital Theory, which suggests that investing in farmer training and specialized knowledge should drive efficiency, an inverse relationship between current information and productivity indicates that existing "capital" is poorly aligned with practical needs. Arrowroot, as a climate resilient crop that serves into multiple uses for foods, livestock feed and packaging materials emerged for potential alternative to diversify the farm production and enhance food security. The limitations in farmers knowledge, technological access and government support continue to hinder sustainable productivity.

The study concludes that strengthening climate change awareness, promotes adaptive farming practices and providing institutional support are essential in improving the rice and arrowroot farmers in the province. The gaps in knowledge, technology and policy implementation, agricultural productivity can be safeguarded, thereby contributing to food stability and improved livelihoods for farming communities in Bulacan. Finally, the findings underscore Risk Society Theory, as farmers must navigate the "manufactured risks" of modern climate change where traditional knowledge is insufficient, requiring modernized institutional policies and technological access to safeguard agricultural output

Recommendations

1. Make climate change information dissemination relevant to more efficient farming techniques and technologies.
2. Enhance the level of farmer preparation as this study show a steady decline in farm productivity the past five years.
3. Focus on developing variety of crops that can withstand climate change. Crop varieties must be developed to be more resilient and productive in cases of increased temperatures and less availability of water.
4. Collaboration between farmers, LGUs, NGOs and national agencies is needed to integrate the climate change adaptation into local agricultural development plans. Policy interventions focus on subsidies for climate resilient seeds, irrigation facilities and post-harvest technologies
5. Reliable and timely weather report and forecasts, early warning systems and agricultural advisories should be made accessible to farmers. Information dissemination can be enhanced through mobile applications, radio programs and barangay level information centers
6. Adoption of sustainable methods the organic fertilizer, crop rotation and integrated pest management not only improve yield but also developed

resilience against climate related stresses. Arrowroot products should be further explored for livestock feeds and packaging materials maximizing resource use.

7. Provide financial and technical support to farmers which credit facilities, crop insurance and financial safety nets will help farmers recover from changing climate induced losses. Technical support that accesses the mechanized equipment and irrigation technologies that boost productivity.
8. Future research should investigate digital climate information services such as mobile based weather forecasting apps and satellite monitoring can improve/developed farmers decision making.
9. In depth analysis of arrowroot as a climate resilient crop as future studies explore the physiological responses of arrowroot to extreme climate conditions such as drought, excessive rainfall, and heat stress, the study addressed productivity concerns further investigation on varietal improvement and genetic adaptation can provide scientific evidence as the role for complementary crop to rice.

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