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Impact of Temperature and Rainfall on Agricultural Production in the Southern Part of Bangladesh

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ABSTRACT

Temperature and rainfall are the vital factors of agricultural production. There have lot of factors affecting rice production in Bangladesh. Researchers identified these factors under different categories like farmers individuals, demographic, environmental factors and technological changes. The purpose of this study is to illustrate the lifestyle of agricultural households and explore the connections between the production of rice and several important environmental variables. This study was conducted using a well-structured questionnaire for data collection after Aman season in 2023 and quantitative approach for identifying the impact of temperature and rainfall on agricultural production. This study used descriptive analysis and Cobb-Doughlas production function for determining impact of temperature and rainfall on agricultural production. According to the analysis, nearly all farmers are small-holders, with 53.5% earning between 1,000 and 15,000 BDT annually, 32% cultivating property under lease, and only 26% cultivating their own land. The main findings are that the temperature has a large negative impact on production, which is -.200 meaning that 1 percent increase in the temperature lead to a 0.200 percent decrease in agricultural output. Rainfall has also a negative impact of -0.071 indicates that 1 percent increase in the rainfall reduces agricultural production of 0.071 percent. Besides these, fertilizer, pesticide, irrigation and labor force positively affect the crop yield. Land area and seed usage are statistically insignificant in rice production in southern region of Bangladesh. The results of the study clearly show that rainfall and temperature have statistically significant and negative impact on the gross return on production in the southern region of Bangladesh. Temperature and rainfall appear drastically change in Bangladesh and shows extreme features of temperature and rainfall that influences agricultural production, intensive study is needed for this perspective to make effective policy regarding agricultural production.

1. INTRODUCTION

Bangladesh, a subtropical monsoon weathering country, distinguished by several seasonal variation with moderate rainfall, high temperature and winter along with less significant autumn late autumn and spring. Generally, the warmest month is April and the maximum temperature lies in between 30°C and 40°C in summer. The coldest month is January with average temperature is 10°C in most of the country. Rainfall is an important factor of environment. Bangladesh is characterized with heavy rainfall country. Most of the area in Bangladesh experienced at least 2000 mm of rain fall annually. Because of its geographic location, Bangladesh is situated in the south of the Himalayas; the greatest average precipitation is sometimes over 4000 mm per year (Weather Online: Bangladesh, 2020).

GDP is the most widely used measurement of the size of any economy. Agricultural sector has immense influence on GDP. All the goods and services produced in a country might have precise link with environment as precipitation and temperature. The study will investigate the impact of rainfall

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and temperature on agricultural production. In the temperature GDP context, there have a deficiency in literature. Climate changes have direct impact on environment in any country and environments have direct linkage with production which is the spirit of economic activity. Climate change affects the economic growth in many ways. Most of the researcher used carbon emission as the indicators of environmental degradation. A lot of factors could be the indicator of environmental degradation such as temperature, rainfall, metal existence in air, amount of CH4 and N2O in the atmosphere, presence of ozone (O3) in the environment, amount of ice melting in Antarctica, sea level rising etc.

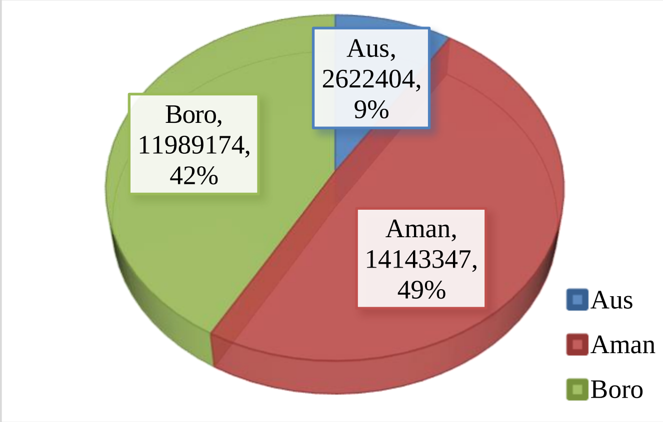
Extensive research is needed in this literature to explain the rainfall, temperature and production relationship on the basis of different countries because rainfall, temperature and production pattern is different in various countries. Salim et al. (2019) have worked on climate change and growth relationship in Bangladesh. They investigated the relationship among the variables such as climate change indicating by converting annual temperature and rain fall variation along with Rand D expenditure, human capital and total factory output. They found temperature and rainfall were significantly negative in the long-run on total factory output whereas human capital proxies by literacy rate have positive influence on total factory output. The study explains the climate change and agricultural production nexus exploration and the livelihood scenario in Southern part of Bangladesh. The main objectives are mentioned below:

- To estimate the impact of rainfall and temperature during the time of seeding planting and cropping season of agricultural production.
- To explain the scenario of agricultural labours life in southern part of Bangladesh.

2. BACKGROUND

Agricultural sector plays a fundamental role in the economy of Bangladesh. Bangladesh is renowned as one of the world's leading producers of various agricultural products, including rice(4th), fisheries(5th), potato(11th), mango (9th), pineapple (16th), tropical fruit (5th), banana (17th), jute(2nd), and tea(11th), contributing significantly to its economic output (FAOSTAT,2022). With its favourable climate and fertile land, agriculture serves as the cornerstone of the economy, employing a significant portion of the population and supporting livelihoods across rural areas. The agricultural scenario of Bangladesh has depicted in table 1.

Agriculture holds immense importance for Bangladesh's economy, contributing substantially to GDP, employment generation (employing 40.6% of the workforce), and serving as a crucial source of food and raw materials for industries (Salim and Basher, 2023). Firstly, the agriculture sector acts as a catalyst for growth in other sectors through its multiplier effect. Secondly, Bangladesh faces the challenge of a rising population coupled with a decrease in available land and an increasing demand for food. This poses a significant challenge to the agricultural sector and the rural economy of Bangladesh (Sarker et al., 2024). Rice cultivation occurs in three distinct seasons: Boro (January to June), Aus (April to August), and Aman (August to December). In the fiscal year 2022-2023, the total area under rice cultivation was 28,754,925 acres, The estimated account of Aus crop in fiscal year 2022-2023 was 2,622,404 acres of both local variety and High-Yielding Variety (HYV) of Aus rice, 14,143,347 acres of Aman rice, and 11,989,174 acres of Boro rice (BBS 2022-2023).



Source: BBS (2022-2023)

Fig. 1. Total cultivated area of rice in Bangladesh 2022-2023

The rice productivity as well as national economy has increased over the last few decades. It can be concluded as:

- Rice covers 75% of total land (Nasim et al., 2017).
- Rice provides 69% of total calorie and 50% of total protein in Bangladesh (Hussain, G.S. 2012).
- Rice takes centre stage, constituting a significant 91% of the total food grain production.
- More than 99% people of Bangladesh receives rice as their main food (Rahman et al., 2016).

In the past, agriculture relied primarily on natural elements, but the present scenario has shifted towards technology-driven practices. Bangladesh witnessed the integration of mechanized agriculture following the Green Revolution, which introduced significant technological advancements to the agricultural sector (Khan, 2021). This transformation brought about a notable shift in the

Table 1. Bangladesh Agriculture at a Glance

Total family	35552296
Total family holdings	16881757
Total area	14.86 million hectares
Forest	2.6 million hectares
Cultivable land	8.829 million hectares
Current fellow	0.431 million hectares
Cropping intensity	214%
Single cropped area	2.110 million hectares
Double cropped area	4.125 million hectares
Triple cropped area	1.867 million hectares
Net cropped area	8.126 million hectares
Total cropped area	16.057 million hectares
Contribution of agricultural sector to GDP	11.66% (2021-22)
Contribution of crop sector to GDP	5.64% (2021-22)
Manpower in agriculture	40.6%
Total food crop production	39.04 million hectares
Total food crop target	42.73 million hectares

Source: BBS (2022)

determinants of agricultural productivity. Previously, agricultural practices did not heavily rely on inputs like pesticides, chemical fertilizers, or high-yielding seed varieties, whereas modern agriculture considers these inputs crucially.

There remain some researches about the factors affecting rice production in different districts in Bangladesh. Rahman and Nasrin, (2015) conducted a study on resource use efficiency on rice production in Gopalganj Sadar upazila. They tried to find which factors are accurately utilized on rice production. They missed the environmental factors like temperature and rainfall. Hussain et al, (2019) conducted a study "Effects of climate change on rice production in Khulna district". They used the variables like temperature, rainfall and humidity and they collected the data through secondary sources. Most of the researches have used the secondary data and avoided the impact of temperature and rainfall measurement through considering cross sectional data. While the estimation of production functions exists for other districts in the country, there remains a significant gap in understanding the production function specifically within the southern part of Bangladesh. Consequently, the significance of inputs in rice production and factors negatively impacting rice productivity in this region remain largely unknown.

This study is undertaken to analyse and ascertain the multifaceted influences of various key variables on rice production within the southern part. The primary concern is to attribute and comprehend the intricate relationships between factors such as temperature, rainfall, land area, seed usage, fertilizer and pesticide usage, irrigation practices, as well as labour force. Understanding the significance and interplay of these factors is crucial in delineating their individual and collective impacts on rice production in the region. By addressing this research problem, the aim is to provide comprehensive insights and recommendations that can facilitate the optimization of rice production, thereby contributing to improved food security within the area.

Despite the population's remarkable growth rate, the productivity of the agricultural sector, particularly in rice production, has not kept pace with the increasing demand in Bangladesh (Quddos and Kropp, 2020). The country strives for self-sufficiency in rice production through the implementation of new agricultural technologies and the expansion of High Yielding Varieties (HYVs) cultivation. The New Agricultural Extension Policy (NAEP) of 1996 underscored the importance of raising per-hectare rice output to free up land for other crops, particularly legumes and fodder crops. The National Agriculture Policy of 2010 further prioritized increasing productivity, income generation, and employment by promoting the transfer of appropriate technologies and effective input management. These concerted efforts reflect the government's commitment to addressing the stagnation in rice productivity and ensuring sustainable agricultural development in the face of a growing population. Since the south-west area of Bangladesh is basically agriculture-based economy, a separate study on this region would provide different and interesting results. Most of the earlier studies are found to have methodological pitfalls. Many studies dealings with determinants of agricultural productivity followed secondary data and price of the inputs to produce a report. The study aims to identify and address the challenges faced by farmers, proposing viable solutions for implementation by relevant authorities to enhance farmers' contributions to rice cultivation. By addressing gaps in earlier studies, this research specifically focuses on investigating the relationship between the widespread use of inputs and the improvement of agricultural productivity.

This study seeks to contribute meaningfully to the existing knowledge base, fostering informed decision-making among stakeholders involved in agricultural development and policy formulation. The lessons derived from the research have the potential to catalyse positive changes in the agricultural sector, leading to enhanced productivity and sustainable growth and to ameliorate the production of Aman rice as well.

3. Conceptual Framework

The primary aim of this study is to discern the optimal approach for resolving the research problem. Additionally, it seeks to grasp the background and historical context of the research problem, establish a framework and theoretical foundation based on existing research, and evaluate the pros and cons of preceding studies. Through this process, the researcher gains insights into potential gaps in existing theories and assesses the applicability of current theories to the specific problem at hand. To achieve the research objectives, the study has systematically examined numerous research works on agricultural productivity, resource use efficiency, and profitability, summarizing key insights and construct a conceptual framework for the study.

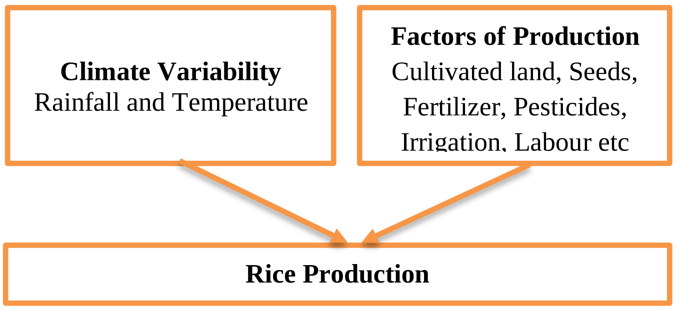


Fig. 2. Conceptual Framework

The conceptual framework depicts the basic analytical procedure or main theme of analysis in a pictorial view of theory and complex research problem The essence of this study is to outline a conceptual framework for rice production, focusing on production function. The study categorizes its findings into several areas: estimating the production function for rice, exploring returns to scale, examining socio economic characteristics of the farmers. Eight explanatory variables were considered for model specification, and Cobb-Doughlas regression analysis was employed for rice production estimation.

4. Literature Review

The literature review constitutes an exploration of the collective spirit of prior research efforts that are either wholly or partially relevant to the ongoing study (Snyder, 2019). It involves a concise analysis of data collection methods, independent or explanatory variables, methodologies, results, and identified gaps in preceding research (Goundar, 2012). Consequently, it advocates for an in-depth examination of prior literature pertinent to the present study. By offering an overview of earlier studies in the research field, the literature review enriches comprehension of the chosen research topic and brings forth the findings from previous investigations.

An article authored by Rahman and Nasrin (2015) investigated the resource use efficiency in rice production in Gopalganj sadar upazila of Bangladesh, employed systematic random sampling technique, Ordinary Least Squares and Maximum Likelihood method. Land, labour, fertilizer, pesticide, seed and irrigation were considered as independent variables while output is treated as dependent variable. The findings suggest that the use of pesticides is below optimal levels, while land, labour, fertilizer, seed, and irrigation are being excessively utilized. An uptick in pesticide usage could potentially have a favourable impact on rice production. It was discovered that none of the resources are being used efficiently, but the seed stands out as relatively efficient in its utilization. Krishnan et al., (2011) investigated the impact of climate change on rice production in the Khulna District of Bangladesh, focusing on two specific rice varieties: high-yield variety Aman and the local variety Lona Coche. The research sought to understand how variations in climatic factors and differences in local growing seasons and crop management practices influenced rice yield. It was observed that both higher and lower temperatures could lead to a decrease in rice yield due to spikelet sterility and increased respiration losses. Hossain et al., (2019) revealed a statistically significant increasing trend in both temperature and total rainfall, while relative humidity showed a decreasing trend. Despite this, there was a positive trend observed in bright sunshine, although it was relatively weak.

Jamaludin et al., (2010) identified that land size and technology were not remarkable factors affecting differences in rice production volume. On the other hand, labour availability and commodity demand were found to have a considerable relationship with rice production volume. A study was conducted by Ginting and Andari (2021) to investigate the factors influencing rice production in Tanah Miring District, Merauke Regency. A sample of 88 farmers was selected using purposive methods. MLR analysis were used to analyse the data and results indicates that 95.5% of the variance in rice production (Y) can be explained by seed variables (X1), fertilizer (X2), pesticides (X3), and labour (X4), while the remaining 4.5% is attributed to other unaccounted factors. The F-value, which is significant at 0.000, indicates that seed variables (X1), fertilizer (X2), pesticides (X3), and labour (X4) collectively have a noteworthy influence on rice production (Y). Individually, seeds and pesticides were found to affect rice production, whereas fertilizer and labour did not demonstrate a significant effect. Hossain et al., (2013) revealed that the efficiency of Boro production remains relatively consistent whether or not ecological factors. However, when environmental factors are taken into account, the proficiency of Aus and Aman production shows improvement compared to analyses excluding these factors. Conversely, A negative outcome on production proficiency exhibited by temperature, suggesting that the phenomenon of global warming could contribute to decreased efficiency in rice production. On the other hand, only rainfall positively affects Boro production efficiency. Specifically, humidity demonstrates a positive and statistically notable consequence on rice production (Wassmann et al., 2009).

The correlations between precipitation and rice production in Rangpur district studied by Rokonuzzaman et al., (2018). Rice cultivation, being a water-intensive crop, heavily relies on rainfall and specific temperature conditions. The study examined maximum and minimum temperature alongside rainfall as key environmental variables. They revealed negative relationship between climate fluctuations and agricultural output and found that flood may also occurs due to higher levels of rainfall during certain months from April to September, whereas insufficient precipitation caused drought during the same period. Akter et al., (2019) conducted descriptive and functional investigations, the Cobb-Douglas production function, with net return of rice as the endogenous variable and twelve independent variables, power tiller cost, hired labour, and fertilizer that remarkably influenced the profitability of rice cultivation across different study areas. Notably, the use of fertilizer and irrigation emerged as meaningful and positive components of successfulness for small-scale rice farmers. Akter et al., (2021) delved into the intricate relationship between environmental elements and rice production in Bangladesh employing methodologies like OLS, GLS, FGLS the study spanned across 64 districts of Bangladesh. Panel data encompassing the cultivation of Aus, Aman, Boro, and High Yielding Varieties of each type across the districts were juxtaposed with climate data. The findings revealed a disparate template in temperature fluctuations across the divisions. Meanwhile, rainfall and humidity showcased an escalating trend over the years across all divisions. Although the minimum average rainfall witnessed a decline, the maximum average rainfall surged, indicative of erratic fluctuations in rainfall patterns.

Tun and Kang (2015) studied to gain deeper insights into the current state of rice production in Myanmar and conducts Data Envelopment Analysis and Stochastic Frontier Approach with variable returns to scale to gauge the proficiency of rice production. Drawing upon the findings, it is essential to exercise caution in interpreting the results to ensure accurate conclusions regarding the efficiency levels of sampled farms. The Cobb-Douglas production model was taken to analyse the effects of various factors on agricultural production and results indicate a crucial relationship between the distribution of seeds and agricultural output (Badar et al., 2007). Faruq-Uz-Zaman (2021) Cobb-Douglas production function, incorporating several production factors categorized broadly as land, labour, and capital to ascertain the respective rates of contribution or economic significance of these factors in crop production in Bangladesh. Data analysis employed, specifically utilizing the Cobb-Douglas function, to examine the degree of influence that one or more independent variables on a dependent variable. The study aimed to shed light on the factors like land area, fertilizer, seeds etc. impacting rice production in the Labuhan Batu District, Indonesia (Elvina et al., 2023). Zevaya (2018) investigate several aspects identifying the determinants that influence on rice production with assessing the return of scale conditions within rice production. Data analysis involved employing multiple regression and the Cobb-Douglas function to evaluate economic efficiency and identify key factors affecting rice production. The findings indicate that land area, seed quality, and fertilizer application prominently affect rice production in the area, while the number of workers does not have a notable impact. Moreover, the return of scale condition within rice production is identified as exhibiting returns to scale at a growing rate. Dhamira and Irham (2020) examined how climate change influences rice farming in Indonesia. The analytical framework employed in this study is based on the Just and Pope Production function, utilizing the Cobb-Douglas function for analysis and found that maximum and minimum temperatures positively related to rice production.

The effects of maximum temperature and rainfall are more pronounced compared to those of minimum temperature and humidity on rice yield. Chowdhury and Khan (2015) employed multiple regression analysis with the Ordinary Least Squares (OLS) method to assess the relationships between climate factors and crop yield in Bangladesh. Results show that climate variables significantly influence rice yield over the study period, though the effects vary among the three rice crops. Maximum temperature has a statistically substantial and negative impact on the yield of all three rice crops. In contrast, minimum temperature significantly and positively affects the yield of Boro rice only. Rainfall emerges as a significant factor for all rice yields, with positive effects on Aus and Aman rice, but negative effects on Boro. Additionally, humidity significantly impacts the yield of all three rice crops. Beside this, temperature and rainfall affecting the agricultural production, cropping pattern plays role on agricultural output. The examination of agricultural land use and the distribution of cultivated crops, as expressed in cropping patterns, forms the foundation for enhancing productivity. Nasim et al. (2017) carried out a comprehensive study on the prevailing cropping patterns in Bangladesh and found a total of 316 CPs across Bangladesh, excluding minor ones. The top five CPs were solely rice-based, encompassing 51% of the net cropped area. The most prevalent CP was Boro Fallow-T. Aman, covering 27% of the net cropped area. Additionally, the study presents findings on major crop-wise CPs, location-specific CPs, CP diversity, and crop diversity.

Most of these previous researches are conducted on the basis of secondary data. Most of them also used either environmental or other factors of production. There are many researches about environmental factors affecting rice production in different countries. In spite of providing large share of the rice production to the country from the southern part of Bangladesh, but there have not been conducted enough research yet. The study mainly focused the impact of temperature and rainfall on rice production.

5. DATA AND METHODOLOGY

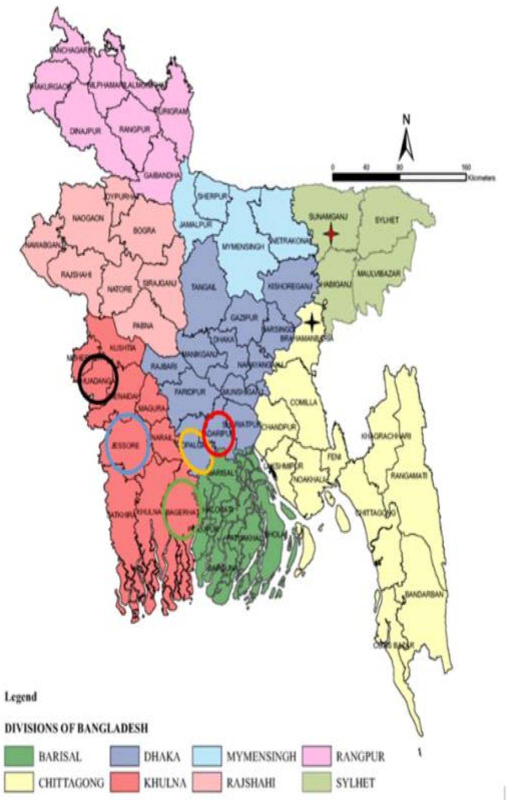
5.1 Rationale of the Selection of the Study Area

The careful selection of the study area is a paramount step in conducting farm governance research. The chosen area should align with the specific objectives of the study and should facilitate cooperation from the farmers involved. While Aman cultivation is widespread across Bangladesh, the districts of Gopalganj, Jessore, Chuadanga, Bagerhat, and Madaripur as well as the broader southern region of the country stand out as significant areas where Aman is extensively grown. Given the substantial concentration of Aman production, five specific zillas, namely Gopalganj, Jessore, Chuadanga, Bagerhat and Madaripur within the southern region, were purposefully chosen for this study. The rationale behind selecting these areas includes the following factors. There present a substantial number of Aman growers in the chosen study areas. The study finds similar physical characteristics, including topography, soil composition, and climatic conditions conducive to Aman cultivation. Convenient accessibility and well-developed communication facilities in the selected villages. Anticipation of high cooperation from the respondents, ensuring the acquisition of reliable and comprehensive data for the study. The selection of sample areas necessitates careful consideration of the researcher's intellectual and financial capabilities, as well as time constraints.

5.2 Description of the Study Area

The depiction of the study area involves delineating the distinct attributes, characteristics, and tangible aspects of a particular region, locale, vicinity, urban setting, or society under scrutiny for research endeavours (Von Hippel et al., 2003). Describing the study area is a crucial aspect of research, holding significance not only for the researcher but also for all stakeholders, both presently and in the future. In research literature, the study area may interchangeably be termed as the study site. Certain academic institutions might designate the depiction of the study area as the profile of the study area (Cohen et al., 2002). To accurately provide a comprehensive description of a specific area, researchers must possess a thorough understanding of the study locale. This understanding is typically acquired through an extensive review of pertinent literature, including published journals, textbooks, and works by experts in the relevant field. Alternatively, researchers may already be familiar with the area in question. However, regardless of the method used to acquire knowledge about the area, it is essential to maintain conciseness in the presentation of information. Therefore, captions pertaining to this subject are often labelled as "A brief description of the study area." This designation is not intended to limit the scope of information provided but rather to ensure that the presentation maintains a smooth flow and clarity, thereby avoiding confusion for the reader.

Gopalganj District, situated in the Dhaka division, spans an area of 1468.74 square kilometres, positioned between 22°50' and 23°01' north latitudes and 89°40' and 90°02' east longitudes (Momotaz et al., 2019). It shares boundaries with Faridpur district to the north, Pirojpur and Bagerhat districts to the south, Madaripur and Barisal districts to the east, and Narail district to the west. According to Banglapedia (2023), the total population of Gopalganj is 1,172,415, comprising 577,868 males and 594,547 females. Among its five upazilas, Gopalganj Sadar is the largest, covering 391.35 square kilometres, which accounts for 26.27% of the district's total area, while Tungipara is the smallest upazila, spanning 127.25 square kilometres (Bangladesh National Portal, 2024). Bagerhat district locates on the south side of Gopalganj. It’s the district of Khulna division. According to census 2011, there are almost 1476090 people living in total 9 upazilas. 156388-hectare arable land consists in this district. Main crops are rice, jute, banana, betel leaf, betel nuts, coconut, and vegetables (Bangladesh National Portal, 2024). Jessore district occupies the 13th position in terms of area in Bangladesh. Total land area of this district is 2594.95 square kilometres. 2764547 people live in total eight upazilas. Chuadanga zilla is located at the near of Indian boarder of the south-west region of Bangladesh. It’s a district of small area, that is 1170.87 square kilometres. Almost 1129015 people live in total 4 upazilas of this district (Bangladesh National Portal, 2024). Madaripur is quite closer to Dhaka. Its total area is very much same to Chuadanga which is, 1125.69 square kilometres. Total 5 upazilas are there and almost 1293027 people live there (Bangladesh National Portal, 2024).



Source: (Ahmed et al., 2019)

Fig. 3. Study area

The methodology employed in this study encompasses a variety of tools aimed at achieving the specific goals and objectives of the research, with a primary focus on the examination of rice production. The core element of the study revolves around the systematic collection of data. As highlighted by Kothari (2003), the reliability of any research study is contingent upon factors such as the research objectives, the nature of the data, and the methodologies employed for sampling and analysis. In alignment with this perspective, the chapter also delineates key characteristics and features of the collected data, emphasizing their significance in ensuring the robustness of the study.

5.3 Sampling Technique and Sample Size

The ideal sample size should be maximized to ensure robust statistical analysis, while also allowing for an adequate number of degrees of freedom. However, it's essential to balance this with practical considerations such as the limitations of resources both human and financial required for field research administration, data processing, and analysis. (Ahmed, 2018). In the sampling technique, we employed multi- stage sampling method to collect data. At first, the southwest part of Bangladesh is purposively selected as the area of study. From these we select 4 districts and make a cluster of 8 Upazilas. Then we collect the list of thana in the Upazilas and randomly select thana from population list of thana. Then we will purposively select the villages that have agriculture intensity in the thana. We collect the data for 400 respondents from the selected villages. Due to limitations in time, finances, and manpower, it was not possible to include all farmers in the study area. Thus, a sample of 400 farmers was selected. Respondents were chosen using basic random sampling procedures and purposeful sampling. First, the district's significant concentration of rice growing led to its purposeful selection from among the 16 districts in Western Province. Second, the district's six (6) agricultural camps were specifically chosen. Lastly, a random selection of 20 farmers was made for each agricultural camp (Musaba, 2019).

A questionnaire acts as an effective assessment instrument, enabling the structured gathering of information by incorporating questions that cover multiple dimensions (Taherdoost, 2022). The effectiveness of a questionnaire hinges on the clarity of its goals and purpose. A poorly constructed questionnaire, lacking a clear objective, is bound to neglect crucial issues, resulting in the squandering of both enumerators' and respondents' time through the inclusion of irrelevant questions (Gaertner and Schokkaert, 2012). In the development of the survey questionnaire, careful attention was given to addressing these concerns to the best possible extent. This ensures that the questionnaire is purposeful, targeting relevant aspects and minimizing the likelihood of asking and responding to superfluous questions.

The data collection method employed for this study involved face-to-face interviews (Sarker et al., 2021). A meticulously crafted and structured questionnaire, aligned with the research questions derived from the research objectives, was prepared by the researcher. To validate the accuracy of the questionnaire, pilot surveys were conducted. The questionnaires underwent modifications based on expert feedback, were pre-tested, and finalized after necessary corrections. The researcher personally conducted the interviews by visiting the houses of farmers. A total of 400 farmers were interviewed in this manner, ensuring a direct and interactive approach to gather comprehensive and accurate data for the study.

Table 2. Size of Sample

Zilla	Sample Size
Gopalganj	100
Jessore	100
Bagerhat	100
Madaripur	50
Chuadanga	50
Total	400

Source: Authors

A pilot survey was conducted with the primary objectives of assessing the time required for completing interviews, testing the reliability of the survey instrument in capturing desired information, and examining the consistency of the gathered information with the overall purpose of the survey. The test also aimed to evaluate the logistical requirements for the successful implementation of the survey. Pilot studies play a critical role in designing a robust study. While they don't assure success in the main study, they significantly enhance the chances of its success (Van Teijlingen & Hundley, 2002). To ensure optimal performance of the questionnaire in terms of data collection, processing, and analysis, a pre-testing phase was carried out in November 2023. This pre-testing specifically took place in the rural area of Sadar upazila in the Gopalganj district, allowing for the identification and resolution of any potential issues or challenges before the actual survey commencement. Data editing and coding constitute crucial stages in the survey process, playing an indispensable role in data processing (Weston et al., 2001). These phases need to be finalized before proceeding with data processing activities. Data processing is a critical phase that significantly influences survey results, and several important steps were undertaken during this process to ensure accuracy and reliability (Zhang et al., 2017). Following data processing, the collected data were manually edited and coded. A thorough summary and scrutiny of the data were performed. Subsequently, data entry into the computer was carried out, and analyses were carried out using Microsoft Excel and SPSS software. It is important to note that the initially collected information in local units was converted into standard international units after necessary checks were completed.

5.4 Variable Specification

The dependent variable used to measure the quantity of the aggregate output was expressed in kilograms of grain equivalent, neutralized to the completely measured in various grades. By attaining the quantity of rice, we may able to measure which factors affect the crop yield more or less.

Independent variables are temperature (X1) - Represents the how the extreme temperature affects the crop yield. This study also measures this amount through applying Mean Weighted Index (Ma et al., 2022). According to BRRI, Gopalganj and Basak et al. (2013) extreme heat has much negative impact on rice yield. This helps the researchers to apply the wights. Rainfall (X2) - Measures the amount of rainfall for rice production. This study divides this by four section such as rainfall at the time of land preparation, at the time of plantation, at the time of growing and at the time of harvesting. Here also we use the mean weighted index according to literature (Basher et al., 2019). Manatsa et al. (2011) employed weighted mean approach to obtain national average water requirement satisfaction index. Land area(X3) – Through this variable we may came to know that how the amount of land area affects the rice production and to whom it provides benefits the small or large holdings of land. Seed usage (X4) -This variable helps to identify the ideal quantity of seed for cultivation. Is one more unit of seed positively or negatively affect the production? Also provide the answer of this question. Fertilizer (X5) - Encompasses various types of fertilizer used in rice production, initially measured in the number of bags and later converted to kilograms per shatok of cultivated land. Pesticide usage (X6) - Involves different types of pesticides used in rice production, measured in taka because it can be used as liquid form or powder form. Irrigation (X7) – Initially this variable taken as day and hour basis, then convert the total amount needed per shatok. Amount of labour (X8) – Represents the amount of labour required including family and hired labour and also the amount of female labour per shatok. This variable also taken in four steps such as labour required in seed bed preparation, plantation, mid time caring and harvesting.

Table 3. List of Variables

Variables	Literature Support
Y = Gross return of rice production (Kg)	Montakim (2016), Zevaya (2021), Ginting and Andari (2021).
X_1 = Temperature (Days with extreme heat and coldness during the season)	Dhamira and Irham (2020), Mahmood et al (2012), Maniruzzaman et al. (2018), Wang et al. (2016), Akter and Sarker (2021), Maya et al (2019).
X_2 = Rainfall (Day)	Dhamira and Irham (2020), Mahmood et al. (2012), Hossain et al (2019), Hossain et al. (2013), Akter and Sarker (2023).
X_3= Land area (shatok)	Nisad and Nasrin (2015), Jamaluddin et al. (2010).
X_4 = Seed usage (Amount per Shatok)	Nisad and Nasrin (2015), Ginting and Andari (2021), Ahmed (2018).
X_5 = Fertilizer usage (kg per shatok)	Nisad and Nasrin (2015), Ginting and Andari (2021), Ahmed (2018).
X_6 = Pesticide usage (Taka per shatok)	Nisad and Nasrin (2015), Ginting and Andari (2021) Ahmed (2018).
X_7 = Irrigation (hours)	Nisad and Nasrin (2015), Ahmed (2018).
X_8 =Labor force (Number of labour days)	Nisad and Nasrin (2015), Jamaluddin et al. (2010), Ginting and Andari (2021).

5.5 Cobb-Douglas Production Function

In this study, to determine the factors affecting rice production the Cobb-Douglas production function is used. The study aimed to ascertain the key factors impacting rice production among the selected rice farmers. Utilizing the Cobb-Douglas production function model, an analysis was conducted to identify significant influences on rice production (Gujarati, 2008).

The equation of Cobb-Douglas production function is:

$$Y = AL^{\beta 1} K^{\beta 2} \quad (1)$$

where, Y = crop production (output)

A = factor productivity

L = labor input

K = capital input

β1 = share of labor for output

β2 = share of capital for output

The Cobb-Douglas Production Function used in this study is as follows:

$$Y= AX_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} X_7^{\beta 7} X_8^{\beta 8} \varepsilon \quad (2)$$

To solve the Cobb-Douglas production function using the ordinary least squares (OLS) technique, it is transformed into the logarithmic form as follows (Montakim, 2020)

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \varepsilon \quad (3)$$

Where, β_0= lnA (constant)
Y = Gross return of rice production (Kg)
X_1 = Temperature (days with extreme heat and coldness during the season)
X_2 = Rainfall (Day/ season)
X_3= Land area (shatok)
X_4 = Seed Usage (Amount per Shatok)
X_5 = Fertilizer usage (kg per shatok)
X_6 = Pesticide usage (taka per shatok)
X_7 = Irrigation (hours)
X_8 =Labor force (number of labors per days)
ε = Error Term

5.6 Returns to Scale

The β values (β_1 …. β_8) Represent the elasticity of rice production with respect to the corresponding inputs. The summation of ($\beta_1 + \beta_2 + \ldots + \beta_8$) values represent the degree of returns to scale.

- The constant return to scale (CRS) when ($\beta_1 + \beta_2 + \ldots + \beta_8$) = 1, indicates when changes in all inputs cause an increase in output by the same amount.
- Increasing return to scale (IRS) when ($\beta_1 + \beta_2 + \ldots + \beta_8$) > 1, occurs when an increase in all inputs causes a larger increase in output.
- Decreasing return to Scale (DRS) when ($\beta_1 + \beta_2 + \ldots + \beta_8$) <1, occurs when an increase in all inputs by the same amount causes a less proportional increase in total output.

6. RESULT AND DISCUSSIONS

This chapter provides a concise overview of the study and the scenario or the characteristics of the farmers. The socioeconomic profiles of sample farmers play a crucial role in shaping the production plan. Individuals exhibit significant variation in various aspects, and their behaviour is intricately linked to their unique characteristics (Chandra et al., 2023). A myriad of interconnected attributes defines an individual, exerting a profound influence on their behaviour and personality development. It is reasonable to assume that the combination of enterprises, consumption patterns, and employment choices within different farm households is intricately tied to these diverse characteristics (Mishra et al., 2004).

Ultimately, the socioeconomic profiles of sample farmers serve as pivotal factors influencing their decision-making processes in agriculture. Several socioeconomic characteristics of producers, such as age, farming experience, education, occupational status, credit access, residence, income, pesticide and fertilizer usage are integral components of this analysis (Alassaf, 2011). By delving into these factors, one can gain insights into the dynamics of enterprise choices, consumption behaviours, and employment preferences within the farming community. Understanding these intricate connections is essential for developing effective strategies and interventions that align with the diverse needs and circumstances of individual farmers.

6.1 Scenario of Agricultural Labor in Southern Part of Bangladesh

The table 4 provides an overview of various variables related to farmers, including their age, education level, marital status, family size, gender distribution within the family, earnings, land size for residence and cultivation, income, savings, working experience, sources of seed, family and hired labour, agricultural credit, and production of rice.

6.2 Farmers Age

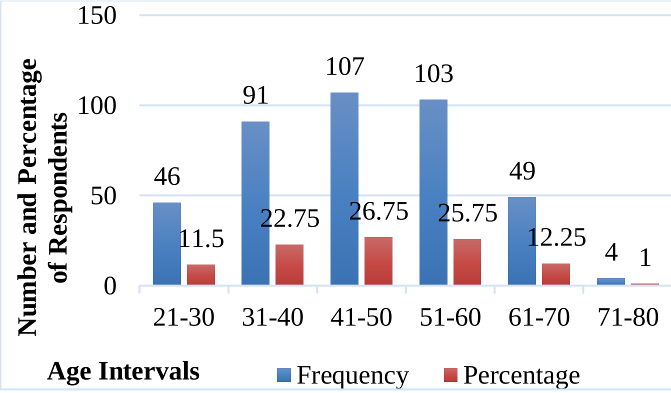
Country which has more young people may be able to make the country more developed by engaging them in different sector. They may work more efficiently and accurately than an old or child as well as able to work for a long period of time.

Table 4. Descriptive Statistics

Variables	Mean	Min	Max	SD
Age of Farmers	47.247	22	76	11.87
Education of Farmers	1.955	1	2	0.20
Size of Family	5.515	2	14	1.875
Male Member of the Family	2.91	1	9	1.23
Female Member of the Family	2.60	0	7	1.18
Size of Land for Residence	13.89	3	54	7.76
Size of Land for Cultivation	86.89	10	400	54.96
Income of the Farmers	19762.5	1000	140000	14846.6
Savings of the Farmers	3343.5	0	30000	5450.926
Working Experience of the Farmers	22.85	3	50	11.55
Family Labor	0.20	0	2	0.13
Hired Labor	0.23	0	1.85	0.179
Agricultural Credit	12520	0	100000	18304.43
Production of Rice	16.31	7.11	30.3	4.29
Seed Usage	0.291	0.051	2.6	0.232
Fertilizer Usage	1.400	0.1	5	0.60
Pesticide Usage	22.27	1.69	80	11.98
Irrigation Hour	1.18	0.038	12	1.61
Days Above 35 Degree	8.69	2	20	3.939
Fertilizer for Local Variety	0.35	0	4	0.68
Fertilizer for HYV	1.06	0	9	0.89
Irrigation for HYV	0.08	0	7.31	1.46
Irrigation for LV	0.31	0	51	0.88
Market Price of Rice	28.57	11.5	40	3.19

Source: Authors

In this study, figure 4 shows farmers lowest age was 22 and the highest age was 76. The results found that farmers mostly were in between the range of 41-50 years, the number is 107 among 400 farmers in the study. The lowest number of farmers are found in the age intervals between 71-80, the number is only 4. The study reveals that more working aged farmers are involved in agriculture and 86.75 percent farmers are in the age between 21 years to 60 years.



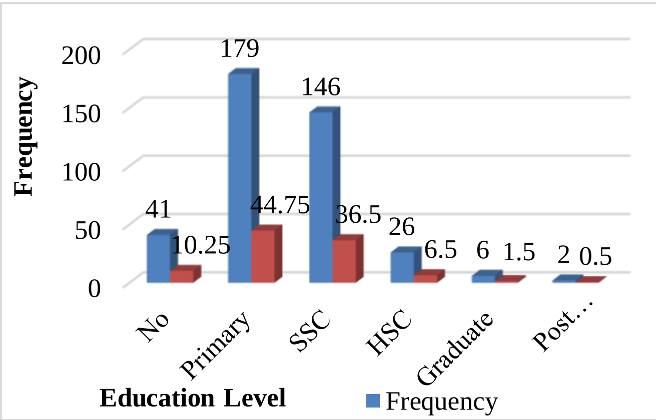
Source: Authors

Fig. 4a. Distribution of farmer's age

The good sign for country's economy is that there are lots of young farmers are engaged in Aman rice production.

6.3 Farmers Education

Education plays a pivotal role in fostering the capacity of individuals. Moreover, education among farmers holds significant importance in embracing new technologies and cultivation strategies, as well as in resolving various challenges related to managing daily family activities.



Source: Authors

Fig. 4b. Farmers educational status

It is found from the figure 5 that agriculture is the main occupation and source of livelihood of the farmers in the study. In this study, 10.25 percent farmers have no formal education while 44.75 percent farmers have achieved primary education. 36.5 percent of farmers have secondary school certificate and 6.5 percent farmers have higher secondary certificate. Beside this 1.5 percent have graduation degree among the farmers. Only 0.5 percent farmer are post-graduate in the southern part of Bangladesh.

6.4 Farmers Working Experience

An experienced farmer possesses the knowledge and skills to efficiently till land, apply pesticides, and determine the optimal doses of fertilizers, among other tasks, compared to an inexperienced counterpart. Figure 5 shows that 24.5 percent farmers have working experience in farming. 30 percent farmers have farming experience in between 13 to 23 years. 56.25 percent farmer's working experience is lied in between 13 to 33 years in the given study area along with 14.5 percent have working experience in the range of 33 years to 43 years. Only 4.75 percent farmers have highest experience that is between 43 to 53 years in the study area and it may be concluded that most of the farmers have enough working experience.

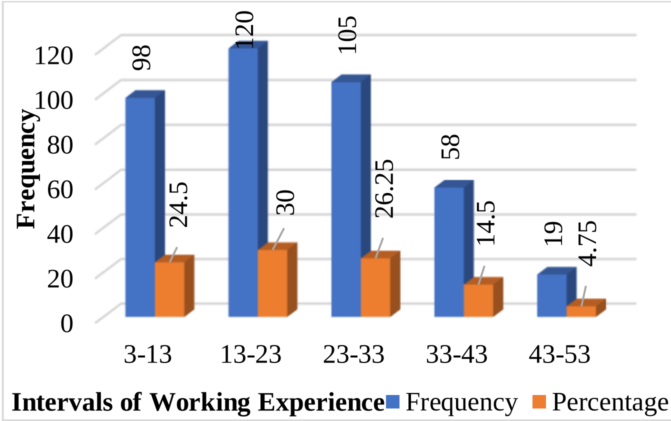


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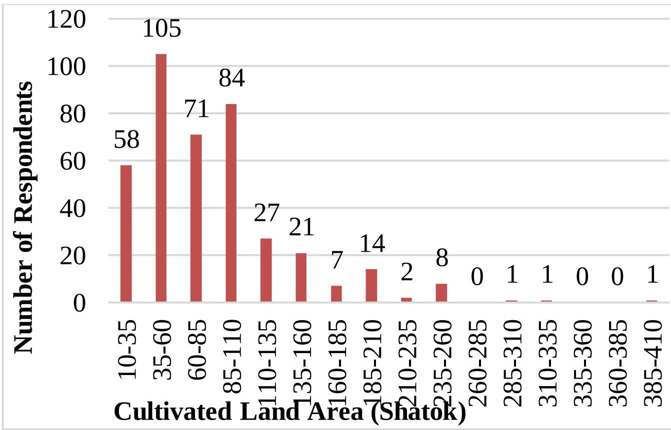
Fig. 5. Distribution of farmers working experience

6.5 Size of Land for Cultivation

Commercial and industrial farms are highly mechanized, often monoculture-based, and may use advanced technologies for efficiency and productivity. Subsistence farmers cultivate land mainly to feed themselves and their families, with little surplus for sale. Figure 6 shows the size of land is being cultivated by different respondents of the study area. In this study area, 14.5 percent farmers cultivate the area of land is 10 to 35 shatok. the largest number of respondents (26.25percent) cultivated rice between 35 to 60 shatok. The range between 60 to 85 shatok of land, there exist 17.75 percent of respondents. 21 percent farmers have cultivated the area of land is 85 to 110 shatok. A very few farmers (20.5 percent) used land more than 110 shatok for Aman rice cultivation. This study found that all the farmers in this region is small farmers (Small: less than 5 acres). There are not even medium farmers in this region (Medium: 5 to 25 acres and Large: more than 25 acres).

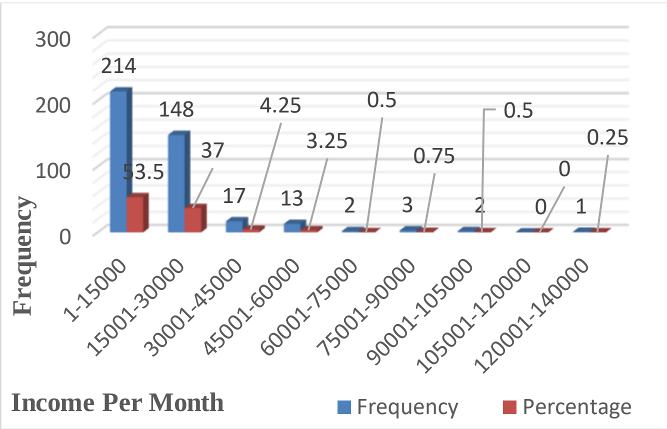


Source: Authors

Fig. 6. Distribution of farmers size of land for cultivation

6.6 Farmers Monthly Income Scenario

Generally, farmers' incomes can be categorized into different groups such as low-income, middle-income, and high-income earners. Low-income farmers often struggle to make ends meet while middle-income farmers typically earn enough to sustain their operations and high-income farmers usually have larger operations to generate substantial profits. Main occupation is determined considering the contribution of different sectors to the household income. Figure 7 shows that the 53.5% farmer's monthly income is in the range between 1 thousand to 15 thousand in the study area. And between 15001 to 30000 income is earned by 37% respondents. On the other hand, only 4.25% famer's monthly income are large that is more than 45000 Taka. Majority of the farmers in the study area having lower income and they live very deplorable life.



Source: Authors

Fig. 7. Distribution of farmers monthly income

6.7 Farmers Savings

Generally, some farmers may have substantial savings, especially those with larger operations or successful harvests, while others may have minimal savings due to various challenges such as low productivity, high input costs, or adverse weather conditions. Figure 8 shows that in this study area 40% respondents have no savings. When only 27% of the farmer's savings is bellow or equal to 2000 taka per month. In this study, most of the farmers' monthly savings are below 6 thousand. Basically, farmers have lower income as a result they have very lower savings in the study area.

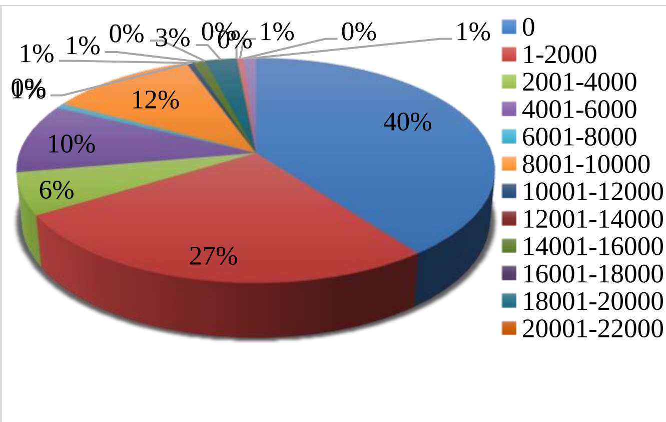


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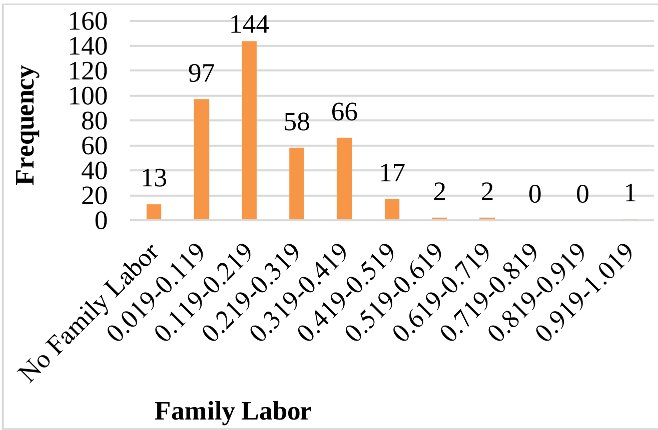
Fig. 8. Distribution of farmers savings

6.8 Farmers Use of Family Labor

Figure 9 shows the family labour distribution of the respondents in the study area. In the figure horizontal axis represents the number of family labour used per shatok of land, and the vertical axis shows the number of farmers using that number of labours. In the study area, the unit of land is measured by 52 shatok is equal to one bigha. For example, if a farm owner having 1 bigha land and use 30 unit of family labour. Then the farmer uses 0.56 unit of family labour per shatok for that crop. The study found that most farmers (144) rely on 0.119-0.219 unit of family labour per shatok, indicating this range of family labour might be optimal for achieving good yields. A substantial number of farmers (97) use 0.019-0.119 units of family labour per shatok. After the peak range, the number of farmers decreases, with 66 farmers using 0.319-0.419 unit of family labour per shatok and only a few using labour beyond this. Figure shows that 13 respondents don't use any types of family labour in their farms.



Source: Authors

Fig. 9. Distribution of farmers according to family labour

6.9 Farmers Use of Hired Labor

Figure 10 shows the hired labour distribution of the respondents in the study area. The horizontal axis represents the hours of hired labour employed in per shatok of cultivated land, and the vertical axis shows the number of farmers using that hour of labour per shatok. As the use of family labour, farm owner use hired labour also. The majority of respondents (125 farmers) use 0.13-0.22 unit of hired labour per shatok of land. This might indicate that this range of labor usage provides an optimal balance for achieving the best yield without excessive labour costs. A significant number of farmers (86) use 0.03-0.12 units of hired labour per shatok, followed by 48 farmers who use 0.23-0.32 units. Beyond this range, the number of farmers decreases significantly. Another key finding is that, 31 respondents among 400 use no hired labour.

6.10Farmers Access to Agricultural Credit

Figure 11 shows the Agricultural credit received by the respondent in the study area. In this study, 50.5 percent farmers didn't get any credit because of complicated banking process or financial ability. 14.75 percent respondents take loan from bank or other credit agencies between ranges between 1-10 thousand tk.

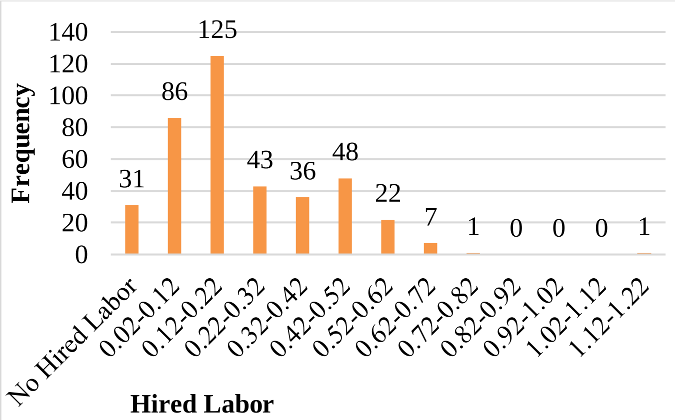


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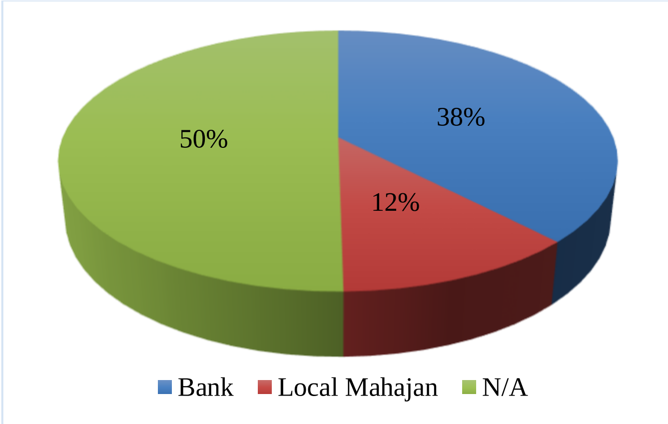
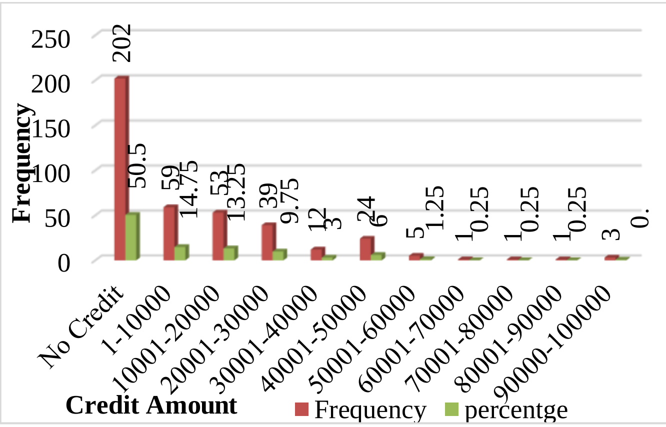
Fig.10. Distribution of farmers use of hired labour



Source: Authors

Fig. 12. Distribution of farmers according to sources of credit

Only 13.25% and 9.75% people in the study area receive loan between the range between 10-20 and 20-30 thousand respectively. 3 percent farmers have above 30,000 to 40,000 taka and 6 percent farmers have above 40000-to-50000-taka credit. Again only 3 farmers received the largest amount of credit between 90000 to 100000 Taka.



Source: Authors

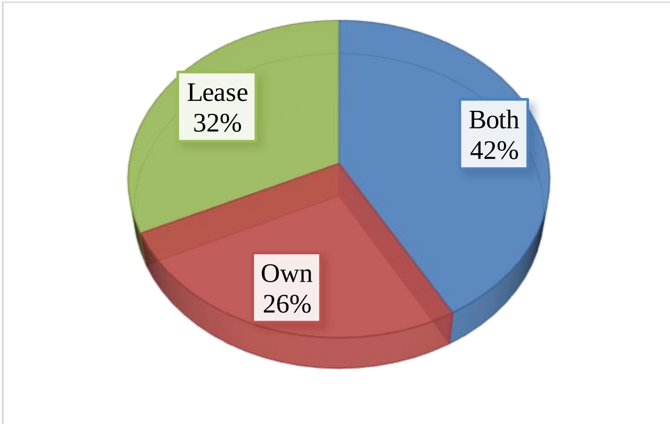
Fig. 11. Distribution of Farmers Agricultural Credit

6.11 Farmers Sources of Credit

Farmers need credit for functioning their farm. There have lot of reason that majority of the farmers don't borrow enough fund from financial institute. We may see that 50 respondent receive no agricultural credit. And among them 38% takes the credit from Bank and other 12% receives from Local Mahajan.

6.12Cultivated Land

Most of the farmers in the study area cultivate the land of other owners. Farmers of Bangladesh in a large scale live below the poverty line. They cultivate the land of others and have to pay the share of their crops. In figure 13 we may see that 32%, 42% and only 26% farmers cultivate the land of other landowners, cultivate the own plus the land of others and cultivate their own land respectively.

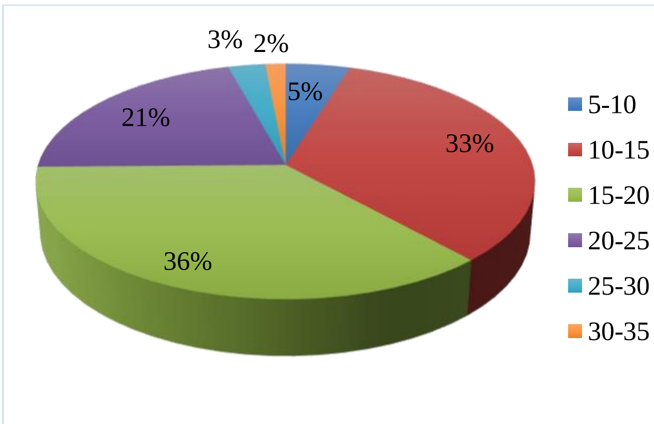


Source: Authors

Fig. 13. Distribution of farmers cultivated land

6.13Farmers Gross Yield

Most of the farmers in this area having small farm land for cultivation. Yield largely depend on farm mechanization financial investment and environmental disaster etc. Figure 14 shows farmers gross yield. 36% farmers got the yield between 15-20 kg per shatok. 33% got in the range between 10-15 kg. In the range between 20-25 there are almost 21% farmers. Only 2% farmers got less than 10 kg and 8% got more than 25 kg rice yield per shatok.



Source: Authors

Fig. 14. Distribution of farmers according to gross yield

6.14 Estimation of Rice Production

The estimation of rice production based on data collected from 400 farmers. The analysis includes calculations for inputs such as temperarture,rainfall,land area,seeds, fertilizers, pesticides, labor and irrigation. Additionally, the distribution of inputs across various operations is determined using the production function.

F-value: 24.92; R square value: .338; Adjusted R square value: .324; And Durbin-Watson Test: 1.45.

Table 5 shows that overall regression model is statistically significant since p=0.000. The R-squared value is 0.338. This suggests that approximately 34% of the variations in rice output were explained by the independent variables temperature (X1), rainfall (X2), land area (X3), and seed usage (X4), fertilizer (X5), Pesticides(X6) and irrigation(X7) and labour force(X8). While remaining 66% variations were affected by some other variables outside the model. This table also shows that the Durbin Watson test value (1.45) is greater than R2 (0.338). The larger the value of Durbin-Watson test than R2 says that OLS is unbiased. The table also shows that F test value is 24.92 with a significance of 0.000 indicating that the model is statistically significant.

The estimation results of rice production in southern part of Bangladesh using the Cobb-Douglas production function shows that six parameters, namely temperature(X1), rainfall (X2), fertilizer(X5), Pesticides(X6), irrigation(X7) and labour force(X8) indicate that coefficients of these six independent variables are statistically significant since, p=0.000, 0.008, 0.008, 0.000 0.002, 0.003 respectively. Meanwhile, coefficients of land area(X3) and seed usage(X4) are not statistically significant because of p=0.719 and p=0.515 respectively. It is evident that temperature and rainfall have a significant negative impact on rice production, while the number of other factors fertilizer, pesticide, irrigation and labour force have a positive impact on crop yield.

6.15Decreasing Returns to Scale

Decreasing returns to scale is a situation that an increase in all inputs by the same amount causes a less proportional increase in total output. It does not lead to increase the output in a same or greater proportion. In the long run the diminishing returns to scale might be seen. From the above table we may see that sum of the coefficients is less than 1, that represents the law of diminishing returns. From above table we found that $\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8 = 0.651$, this means that an increase in all inputs by the same amount the crop yield decreases by the less proportion. By holding technology constant this thing can happen. Since we have seen that F value with a significance of 0.000, this indicates that overall model is statistically significant that means all the variables have a significant impact on crop yield simultaneously. The partial test of variables is discussed below.

- **Temperature (X1)**

The regression coefficient of temperature is significant at 5% level of significance.The regression coeffient of temperature is negative, -.200. It indicates that considereing all other factors constant, 1 percent increase in temperature (extreme heat and extreme cold) will lead to decrease the gross yield by -.200.

- **Rainfall** ***(X2)***

The regression coefficient of rainfall is significant at 5% level of significance.The regression coeffient of rainfall is negative, -0.071. It indicates that considereing all other factors constant,1 percent increase in rainfall will increase the gross yield by -0.071.

- **Land Area (X3)**

The regression coefficient of land area is insignificant at 5% level of significance. The regression coeffient of land area

Table 5: Results of Cobb-Douglas Production Function

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.	Collinearity Statistics	
LnY	B	Std. Error	Beta			Tol	VIF
C	2.883	0.161		17.94	0.000		
Ln_X1	-0.200*	0.042	-0.302	-4.743	0.000	0.417	2.399
Ln_X2	-0.071*	0.026	-0.162	-2.683	0.008	0.463	2.161
Ln_X3	0.008	0.023	0.019	0.361	0.719	0.638	1.568
Ln_X4	-0.017	0.026	-0.047	-0.652	0.515	0.333	3.007
Ln_X5	0.066*	0.025	0.117	2.649	0.008	0.872	1.147
Ln_X6	0.131*	0.029	0.344	4.576	0.000	0.300	3.336
Ln_X7	0.043*	0.014	0.185	3.047	0.002	0.460	2.173
Ln_X8	0.097*	0.032	0.182	2.998	0.003	0.461	2.168

* Represent significant at 5% significance level.

Source: Authors

is positive, 0.008.

- **Seed Usage (X4)**

The regression coefficient of seed usage is insignificant at 5% level of significance. The regression coeffient of seed usage is negative, -.017.

- **Fertilizer (X5)**

The regression coefficient of fertilizer is statistically significant at 5% level of significance. The regression coeffient of fertilizer is positive, 0.066. It indicates that considereing all other factors constant,1 percent increase in fertilizer will increase the gross yield by 0.066.

- **Pesticides (X6)**

The regression coefficient of pesticide is significant at 5% level of significance. The regression coeffient of pesticide usage is positive, 0.131. It indicates that considereing all other factors constant,1 percent decrease in presticides will increase the gross yield by .131.

- **Irrigation (X7)**

The regression coefficient of irrigation is significant at 5% level of significance.The regression coeffient of irrigation is positive, 0.043. It indicates that considereing all other factors constant,1 percent increase in irrigation will increase the gross yield by 0.043.

- **Labor force (X8)**

The regression coefficient of labor force is significant at 5% level of significance.The regression coeffient of labor force is positive, 0.097. It indicates that considereing all other factors constant,1 percent decrease in labor force will increase the gross yield by 0.097.

7. Conclusion and Policy Implications

In the present thesis study, the researcher investigated the correlation between various inputs and rice production, emphasizing the differential impact of these variables among different groups of farmers. The Cobb-Douglas production function was adapted to evaluate the influences of temperature, rainfall, seed, fertilizer, pesticide, land area, and labour on rice production. The findings of the study indicate that certain variables significantly affect rice production, while others exhibit insignificance, with variations observed among different farmer groups. The modified Cobb-Douglas production function was employed to discern the effects of temperature, rainfall, seed, fertilizer, pesticide, land area, and labour force on rice production for diverse respondents. Upon analysing the regression results, it becomes evident that environmental factors, specifically temperature and rainfall, play a pivotal role in determining the gross return from rice cultivation in the southwest part of Bangladesh. Other variables, although important, do not exhibit the same level of significance as environmental factors in this particular district. The estimation results reveal noteworthy relationships between certain parameters. Temperature (X1) and rainfall (X2) are found to have a negative association with rice production. Conversely, fertilizer (X5), pesticide (X6), irrigation (X7) and labour force (X8) demonstrate a positive relationship with rice production. Coefficients of two variables land area (X3) and seed usage (X4) are statistically insignificant that means they have not any valuable insights on rice production in the southern region of Bangladesh. The study highlights the distinct impacts of various factors on rice production, with environmental elements proving to be particularly influential in this region.

The majority of survey participants expressed concerns about the substantial input costs associated with Aman rice production. Consequently, it is recommended that the government take necessary measures to alleviate these costs, with a focus on inputs that significantly impact yield. Supplying subsidies for essential inputs such as fertilizers and pesticides is proposed as an effective strategy. Most of the times farmers wouldn't get the proper price of rice, they face loss in-spite of being profitable. Implementing a fair pricing policy is essential to minimize fluctuations in rice prices, enabling farmers to obtain a more equitable return from their harvests. Based on their feedback of farmers and suggestions, the policy should be updated and promptly implemented to prevent further loss of arable land. Khas land should be safeguarded from diversion for housing purposes, and instead, it should be distributed to landless farmers for extensive cultivation. Farmers faces serious issue of destruction of crop yield by rabbits. Government should employ experts to protect the farmers of this region. Credit should be made easier for the farmers. Most of the farmers can't go through the tough process of credit institutions. Only a few farmers get subsidy from government and different NGO's. According to the most of farmers, farmers who are financially stable and no need subsidies get the subsidies. Government should take care of this major issues. Temperature now a days becomes a monumental issue for Bangladesh as it's increasing every year. Experts should be appointed to diminish the negative impacts of temperature or technology should have to be made available.

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