Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.13, No.8, 2023

Examining Smallholder Rice Farmers' Yield Improvement Needs in Asunafo North Municipality of Ghana

Isaac Diaka [1*] Kenichi Matsui [2]
1. Graduate School of Science and Technology, University of Tsukuba, Japan
2. Faculty of Life and Environmental Sciences, University of Tsukuba, Japan
* E-mail of the corresponding author: s2230315@u.tsukuba.ac.jp

Abstract
Scholars who promoted crop production increase for food security have overlooked the fact that per-hectare yield does not necessarily increase. In Ghana, where food insecurity has become worse in recent years, domestic rice production has not contributed much to domestic rice consumption. The question remains what factors contributed to smallholder rice farmers' low yield? Also, what do these smallholder rice farmers need to do to improve yield? This study adopted a simple random sampling technique to select 154 rice farmers for a questionnaire survey in October and November 2020. The results are discussed partly by performing a correlation analysis, an independent t-test, and Kendall's coefficient of concordance. We found that 58.4% of the respondents cultivated popular high-yield varieties like AGRA and Jasmine, but their yield remained relatively lower than the national average. One of the reasons behind this low yield outcome among the respondents was that improved seed varieties were not timely available (92.8%) and the input cost was high (85.7%). The average annual income from rice farming for these respondents was too low for them to procure a sufficient amount of input. Regarding respondents' technology needs, Kendall's coefficient of concordance showed that timely access to improved varieties, irrigation infrastructure, and row planting were among the most important. As to their non-technological needs, the respondents needed timely information about rice production, more access to credit, and more frequent services from extension officers. The correlation analysis revealed that respondents' experience and off-farm income showed a significant positive and negative association with their yield levels. This paper then discusses recommendations for providing improved rice production technologies to farmers.
Keywords: Smallholder farmers, Rice, Yield improvement, Technological/non-technological needs
DOI: 10.7176/JBAH/13-8-04
Publication date: May 31st 2023

1. Introduction

In the past twenty years, rice has been widely adopted in sub-Sahara Africa as an important staple crop (Balasubramanian et al., 2007). In Ghana, its importance has become next to maize in terms of per capita consumption (MoFA, 2009). The total volume of production has increased significantly due largely to expanded cultivated areas from 391,000 in 2009 to 769,400 metric tons in 2018 (MoFA, 2019). According to the FAO, the World Food Programme, and other international organizations (FAO et al., 2022), however, these past efforts have not resulted in improving food insecurity in sub-Sahara Africa; instead, the world food insecurity has worsened in 2021.

Despite its increasing trend in Ghana's rice production, its potential rice yield of 6mt/ha remains unattainable. The national average rice yield is 2.96mt/ha (MoFA, 2019) whereas rice yields in the US and Japan, for example, are about 6-7mt/ha (FAO, 2022). Ghana's low rice yield is partly attributed to low modern farm technology adoption, including limited access to fertilizers, high-yielding varieties, and credit (MoFA, 2014; 2016; Ragasa et al., 2013; Tanko et al., 2016). Some studies emphasized inadequate infrastructure development and lack of irrigation facilities (Nyo, 2016; Iddrisu et al., 2020). The Japan International Cooperation Agency (JICA), a big proponent of rice adoption in Ghana, observed that Ghanaian smallholder farmers tended to use a single crop variety that is relatively poor in terms of productivity and quality (JICA, 2008). In the past, there were some unsuccessful attempts to improve rice yields by improving the accessibility of certified seeds, fertilizers, extension services, and market linkages (Adesoji and Tunde, 2012; MoFA, 2017).

An increasing demand for rice consumption has not been met by domestic rice production which accounted for only 40% of the total domestic rice supply (MoFA, 2009; Ouédraogo et al., 2021). The remainder is met through importation (Boansi and Favour, 2015). Between 2017 and 2020, for example, Ghana spent US$1 billion on rice importation (Zurek, 2021). Ghanaian policymakers have long expressed their concerns over this over-reliance on exports. In 2007 the Food and Agriculture Sector Development Policy (FASDEP II) was implemented to minimize rice importation and turn foreign revenue into domestic agricultural development (MoFA, 2007).

Resonating with these government emphases on technology adoption for domestic yield improvement, past academic studies emphasized that the adoption of specific agricultural technology and modernized management practices are critical to agricultural productivity improvement and poverty reduction (Ragasa, 2013; Rehman et al., 2016; Asfaw et al., 2012; Basnet, 2008; Donkor et al., 2018; Bautista and Javier, 2008). Mahajan et al. (2012)

argued that rice production in Punjab increased due to the adoption of high-yield varieties and improved crop management practices. Nyangena and Juma (2014) found that the adoption of inorganic fertilizers and improved maize varieties as a package significantly improved yield in Kenya. Donkor et al. (2016) reported that farmers in Ghana who adopted row planting, which meant to reduce competition among crops for light, nutrients, and water, increased their rice yield by 43.5%. Nonvide (2017) and Huang et al. (2006) examined that irrigation increased rice yield by 57%. Other studies emphasized the importance of need-based, accurate, reliable, and timely information to rural farmers for steady agricultural production growth (Naveed and Anwar, 2013; Ragasa and Mazunda, 2018).

Despite all these extensive studies that showed the substantial increase in rice productivity by technology adoption, and despite years of efforts by the Ghanaian government to promote technology adoption among remote farmers, the question remains as to why smallholder farmers in remote areas of Ghana have not increased rice productivity by adopting technologies. Socio-economic backgrounds and cultural differences these farmers had can possibly explain more about the low rice yield. It is also important to understand what factors may induce these farmers to adopt the necessary technologies. Understanding farmers' needs in rice production can improve the effectiveness of policy implementation. Therefore, this paper seeks to (1) understand why smallholder rice farmers have not been able to increase per acre rice yield; (2) examine their yield improvement needs; and (3) examine the relationship between local socio-economic characteristics and their needs.

2. Methodology

2.1 The Study Area

As a case study, we selected agricultural communities in Asunafo North Municipality in Ghana. Agriculture in this area employs about 63% of the active labor force (Ghana Statistical Service, 2014; Asunafo North Municipality Assembly, 2019). Of all the agricultural production, crop production accounted for 97.2% (Ghana Statistical Service, 2014). Major crops cultivated in the area included cassava, maize, rice, plantain, cocoyam, vegetables, and other cash crops such as cocoa and cashew. Regarding food security, the 2020 Comprehensive Food Security and Vulnerability Analysis (CFSVA) report revealed that the municipality is about 17.6% food insecure (4.1% severely, and 13.5% moderately food insecure), higher than the national food insecurity level of 11.7%. However, most of these food-insecure households are in rural areas (World Food Programme, 2022).

The study area is located within Latitudes 60° 48′ N and 70° 00′ and Longitudes 20° 31′ W, covering a total area of 1,411.97km² (Asunafo North Municipal Assembly, 2019). It experiences annual bimodal rainfalls between 1250mm and 1750mm with major rainy seasons in April and July and a minor season between September and October (Ghana Statistical Service, 2014).

According to the 2021 population and housing census, the municipality had a population of 150,198 people (males 50.8%) (Ghana Statistical Service, 2021). Females in this area tended to have a higher life expectancy of 60-64 years than their male counterparts of 55-59 years (Ghana Statistical Service, 2014). The population shows a general growing trend over the 2010 census.

Rice production was relatively recently adopted in the area. The Ministry of Food and Agriculture reported that most of the farmers began rice cultivation in the study area after the introduction of the Youth in Agriculture Programme in 2010 (MoFA, 2021). Prior to rice adoption, cocoa production had been predominant as the major cash crop. However, erratic rainfall and ensued harsh weather conditions made the plantation operation difficult. Out of the total agricultural land area of 51,884ha, rice production occupies about 3,642 ha (Asunafo North Municipal Assembly, 2019). As many farmers chose to adopt rice farming due to good availability of lowland areas, its production doubled from about 1.12mt/ha in 2014 to 2.21mt/ha in 2016 (Asunafo North Municipal Assembly, 2019).

2.2 Data Collection and Analysis

The following discussion is largely based on our preliminary visit to the study area and the questionnaire survey. The lead author has worked for the Ministry of Food and Agriculture (MoFA) as an extension officer for 9 years. This experience allowed the authors to discuss with other MoFA officials regarding the adequate study area for this study. From reviewing past studies and MoFA documents, we also found that the reasons behind the low adoption of rice farming technologies have not been comprehensively explored. The only possible way to understand this was to ask farmers through a questionnaire survey.

In conducting the questionnaire survey, we used a two-stage sampling approach to select study communities and the sample size. In the first stage, purposive sampling was used to select rice-growing communities in the municipality. The communities were Betre, Kasapin, Ayomso, Asumura, and Goaso. In the second stage, a simple random sampling approach was used to select two communities (Betre and Kasapin) and 80 rice farmers each from the two communities to give a total of 160 respondents. The data were collected between October and November 2020 with the help of a municipal agricultural extension agent. The questionnaire was structured into two categories. The first part addressed the socio-demographic characteristics of smallholder rice farmers. The second

part had questions about smallholder rice farmers' yield improvement. We received valid answers from 154 respondents. Six respondents who kept some questions unanswered were not included.

We used descriptive statistics to understand smallholder rice farmers' socio-economic characteristics. To understand the reasons for not increasing yield, we first performed an independent t-test analysis. We used Kendall's coefficient of concordance to rank the importance of farmers' technological needs (e.g., high-yield varieties, irrigation infrastructure, modern machinery, nursery establishment, pest/diseases management) and non-technological needs (e.g., land, extension services, production cost reduction, farmers' association assistance, timely information about rice production, credit availability, labor availability). The agreement level ranges from 0 to 1, which means that the closer to 1, the higher the agreement level is. The need with the highest mean was ranked as the most important.

Kendall's coefficient of concordance (W) is given as:

$$W=\frac{12S}{P^2(n^3-n)-pT} \quad (1)$$

W denotes Kendall's coefficient of concordance, P denotes the number of respondents, n denotes the number of needs being ranked, S denotes the sum of squares, and T is the correction factor for tied ranks. To test the significance of W and whether or not there is an agreement among the respondents, we use the Friedman's Chi-square (X^2) statistics given by:

$$X^2 = P(n-1)\,W \quad (2)$$

We further performed a Pearson correlation analysis to understand the relationship between respondents' socio-economic factors and their needs for improved rice yield.

3. Results and Discussions

3.1 Socio-demographic characteristics

The results on socio-demographic characteristics overall indicated a number of challenges these responding farmers faced in increasing rice productivity. In the study area, males tend to outnumber females (Ghana Statistical Service, 2021a).

Table 1. Socio-demographic characteristics of the respondents (n=154)

Variables	Category	Frequency	Percentage (%)	Mean
Gender	Male	94	61.0	
	Female	60	39.0	
Age	20-39	33	21.43	
	40-59	102	66.23	44.6
	≥ 60	19	12.34	
Household size (persons)	1-5	84	54.5	
	6-11	68	44.2	
	≥12	2	1.3	5
Education	No formal	53	34.4	
	Primary school	43	27.9	
	Junior high school	31	20.1	
	Senior high school	26	16.9	
	Tertiary	1	0.7	
Farm experience (years)	1-5	58	37.7	
	6-10	89	57.8	8
	≥11	7	4.5	
Farm size (acres)	<5	110	71.4	
	5.1-10	43	43	2.9
	≥10.1	1	0.7	
Average annual income (Gh₵)	1,000-3,000	40	26	
	3,100-5,000	98	63.6	2,985.6
	≥5,100	16	10.4	

(Source: Field survey, 2020)

Our result on gender showed a similar trend with males consisting 61% of the total respondents. About 66% of the respondents belonged to the 40-59 age group with a mean age of 44.6 years old (Table 1). Reflecting on what we indicated earlier about male life expectancy in Ghana for 55-59 years old, this mean age of 44.6 suggests an aging trend of the respondents.

Agricultural productivity can be partially understood by labor availability, farm size, and education/information availability. Our results show that the mean household size of the respondents was 5 persons which was higher than Ghana's average household size of 3.6 persons (Ghana Statistical Service, 2021a). About 34% had no formal education. This means that these farmers do not have direct access to updated rice production information, which is predominantly disseminated in English with scientific/technical terms. About 58% had cultivated rice for only 5-10 years. More than 71% cultivated less than 5 acres of land. The mean farm size of the respondents was 2.9 acres.

In Ghana, those farmers with less than 5 acres of farmland are considered smallholders and they constitute about 92% of the farming population (MoFA, 2010; 2019). Past studies showed significant correlations between land size and rice productivity. Regarding annual income, about 64% of the respondents earned between Gh₵3,100 and 5,000. The mean annual farmer cash income was Gh₵2,985.6. Even in rural Ghana, this income means a meager addition to their household income. The Ghana Living Standard Survey (GLSS 7) shows that the average national income was Gh₵33,937 (Ghana Statistical Service, 2019).

3.2 Reasons for low yield

Past studies on rice yield largely attributed the low rice yield to the dominant use of low-yielding rice varieties among farmers (MoFA, 2019; Marfo et al., 2008). However, the only study we have about the study area was published more than 15 years ago (Marfo et al., 2008); therefore, we attempted to find out if contemporary farmers in the study area have adopted improved rice varieties. With this in mind, we first asked the respondents what rice variety they cultivated. In our preliminary survey, we found that rice farmers in the study area used two improved varieties (AGRA and Jasmine) and one low-yield variety (lapese). So, we asked them to choose varieties they used among the three. In response, about 58% chose the two improved varieties and about 42% chose lapse (Table 2).

Table 2. Respondents' rice yield differentials by variety (n=154)

Varieties	Frequency	Percentage (%)	Mean yield (mt/ha)	Std. Dev	t-value	p-value
Improved (AGRA and Jasmine)	90	58.4	2.64	0.90	7.165	0.001*
Local (lapese)	64	41.6	1.62	0.61		

*P < 0.05

(Source: Field survey, 2020)

Next, we asked the respondents what was the yield achieved from these varieties. This was to give a clear understanding as to whether or not there was statistical significance in the production of these rice varieties. Using t-test analysis (Table 2), we found a statistically significant correlation between the use of the two improved varieties and rice yield. Those who cultivated the two improved varieties had a mean yield of 2.64 mt/ha whereas those who cultivated the local variety had 1.62 mt/ha. However, the overall mean yield of 2.13 mt/ha among the respondents was lower than the regional average of 2.83 mt/ha and the national average of 2.96 mt/ha (MoFA, 2021). Chandio and Yuansheng (2018) claimed that adopting improved rice varieties can double the rice yield, but our result suggests that the adoption of improved rice varieties alone does not explain about the relatively low-yield varieties in the study area.

Table 3. Reasons responsible for smallholder rice farmers' low yield (n=154) (multiple choice)

Reason	Frequency	Percentage (%)
Lack of access to irrigation infrastructure	119	77.2
Untimely availability of improved seed varieties	143	92.8
High cost of rice production inputs	132	85.7
Inadequate rice production information	108	70.1
Difficulty in credit access for rice farming	128	83.1
Inadequate land access to increase rice production	99	64.3

(Source: Field survey, 2020)

We then asked the respondents to indicate the major reasons accounting for their low rice yield. This was done with multiple choice options. These options were (1) the untimely availability of improved seed varieties, (2) a high cost of rice production inputs, (3) a lack of access to irrigation infrastructure, (4) inadequate rice production information, (5) limited credit access for rice farming, and (6) inadequate land access. In response, 92.8% of the respondents indicated the untimely availability of improved seed varieties (Table 3). This means that improved seeds were not available when farmers typically plant rice just before the onset of the rainy season. On the contrary,

local varieties like lapse can be locally reproduced without going to a market or seed breeder. This is one of the reasons Begna et al. (2015) found that Ghana's local farmers tended to use their own seeds.

Other major challenges the respondents identified were the high cost of rice production inputs (e.g., fertilizer) (85.7%), poor credit access (83.1%), a lack of irrigation services (77.2%), information shortage (70.1%), and insufficient land (64.3%). In the study area, farmers had difficulties to obtain credit due largely to their inability to secure collateral and other lending requirements (Asunafo North Municipal Assembly, 2019). These farmers need credits in order to expand production and also to be able to purchase farm inputs for increasing yield. Rice production inputs such as fertilizers, pesticides, and weedicides are relatively expensive in the area. According to the Asunafo North Municipal Assembly 2019-2022 composite budget report, the high level of post-harvest losses achieved by farmers was due to the little use of pesticides and insecticides (Asunafo North Municipal Assembly, 2019). There is no irrigation system available for rice farming in the area that also affected rice yield. This was further exacerbated by erratic rainfalls (Asunafo North Municipal Assembly, 2019).

These results show that a combination of multiple challenges made it more difficult for farmers to increase rice productivity. However, past studies on rice productivity tended to highlight a specific factor instead of multiple ones. For example, Karlan et al. (2014) showed that poor credit accessibility limited farmers' ability to invest in more modern technologies. Naveed and Anwar (2013) reported that the provision of timely, reliable, and need-based information to farmers led to an increase in agricultural productivity.

3.3 Smallholder farmers' needs for improving rice yield

As mentioned above, past studies on low rice yield emphasized a lack of sufficient access to modern technologies. Considering this suggestion, we asked the respondents what technological needs they had in order to improve rice yield. For this question, we used a 5-point Likert-scale question, in which 1 means a strong disagreement and 5 means a strong agreement. In analyzing the responses, we ranked the level of agreement by using Kendall's coefficient of concordance (Table 4). Past studies recognized the importance of this ranking method to highlight the significance of respondents' choices (Azumah et al., 2018; Danso-Abbeam et al., 2014; Nuhu and Matsui, 2022). The need with the highest mean was ranked as the most important.

Table 4. Results of Kendall's W-test of rice farmers' technological needs for improved yield

Technological needs	Mean	Ranking
I need access to improved seed varieties	5.79	1st
I need irrigation infrastructure	5.37	2nd
I need training in pest and disease management	4.81	3rd
I need training in chemical application	3.92	4th
I need modern machinery	3.70	5th
I need training in proper nursery management	3.10	6th

N=154, Kendall's W=0.345, df=5, Chi^2=432.168, Asymptotic Significance=0.000
(Source: Field survey, 2020)

The results show that access to improved seed varieties, irrigation infrastructure, training on pest and disease management, and chemical application were the major technological needs. Kendall's coefficient of concordance (W) was 0.346 with a 1% level of significance. This suggests that about 34.6% of the respondents agreed with the rankings of technological needs.

The most important need (improved seed varieties) had a mean score of 5.79. In the study area, farmers sow rice seeds just before the onset of the major rainy season (from April to July) (Asunafo North Municipal Assembly, 2019). As mentioned above, the delay in acquiring improved seeds affected farmers. A similar result was found by Abdulai and Matsui (2022) regarding rice farming in Garu and Tempane districts of Ghana.

The second important need was irrigation infrastructure which had a mean score of 5.37. Rice farming in the area and many other parts of remote Ghana solely relies on rainfalls. The respondents did understand the importance of having steady supplies of water. In the study area, farmers live within a reasonable distance from Goa and Ayum rivers as a source of irrigation. Unlike China or Japan, where rice farming developed for centuries with intricate irrigation systems, few Ghanaian rice farmers have taken full advantage of irrigation potential. In the Volta region and Northern regions, however, international organizations have invested in rice irrigation projects, but, according to a past study (Tamekloe, 2021), those who had access to irrigation facilities experienced unreliable water supplies.

Other important options were training in pest and disease management at the farm level with a mean rank of 4.81, and chemical application with a mean score of 3.92. In the study area, pest and disease infestation affected rice yield as well as other crop yields. Regarding crop production in the Ashanti Region of Ghana, a past study (Kyei and Matsui, 2018) identified that pest infestation was the major cause of crop loss during and after harvest. Similarly, in Asia, Chatterjee et al. (2021) found that pests accounted for about 25-43% of rice yield loss. Insecticide availability was very limited in the study area. Moreover, farmers like our respondents with meager annual farm incomes could not afford to procure an appropriate amount. An integrated pest control method can be

an alternative, and some successful cases were reported in Bangladesh, for example (Fuad, 2022). However, for those who are not educated enough in English, it is difficult to have access to pest control training.

The need for modern machinery was ranked the fifth with a mean score of 3.70. In the study area, only 10% of farmers use tractor and planter services (AGRA, 2020) partly because it is expensive to obtain tractors services. Regarding rice farmers in the Upper East Region of Ghana, Abdulai and Matsui (2022) found that tractor owners preferred to deal with relatively large-scale farms. As a result, smallholder farmers tend to rely on manual labor. They tend to use traditional farming tools such as cutlass and hoes in farming.

The lowest rank of the need was nursery management. This result could probably be due to their customary practices of sowing seeds rather than buying seedlings from nurseries. In the study area, mostly men undertake land preparation. Then both men and women engage in sowing seeds.

Table 5. Results of Kendall's W-test of rice farmers' non-technological needs for improved yield

Non-technological needs	Mean	Ranking
I need more information about credit support options	6.13	1st
I need frequent extension services	5.68	2nd
I need timely information about rice production	5.11	3rd
I need more land to increase rice production	4.29	4th
I need transparency in rice prices at the market	4.20	5th
I need more help from farmers' association	4.10	6th
I need more skilled laborers	3.59	7th

N= 154, Kendall's W=0.247, df= 6, Chi^2=266.161, Asymptotic significance=0.000
(Source: Field survey, 2020)

Regarding non-technological needs, we asked the respondents to indicate the following needs with multiple choice: (1) timely information about rice production, (2) more information about credit support options, (3) more skilled laborers, (4) frequent extension services, (5) more land to increase rice production, (6) transparency in rice prices at the market, and (7) more help from farmers' association. Here we also used a 5-point Likert-scale, in which 1 suggests strong disagreement and 5 implies strong agreement. We then ranked the responses (Table 5). The result shows that overall the respondents needed credit support, more frequent extension services, timely rice production information, and land. Kendall's coefficient of concordance (W) was 0.247 with 1% significance. This implies that about 24.7% of the respondents agreed to the rankings of the non-technological needs.

The most important need was information about credit support with a mean score of 6.13. Of all the technological and non-technological needs the respondents chose, this option had the highest score. In the study area, smallholder farmers need enough capital to procure improved seeds, agrochemicals for pest and disease control, fertilizer for enriching the relatively mineral-poor soil, cash for obtaining tractor or irrigation services, and land. However, it is difficult to obtain credit support from some financial institutions due to a lack of collateral (Abdulai and Matsui, 2022).

The second and third most important non-technological needs were extension services and timely information about rice production with mean scores of 5.68 and 5.11, respectively. These needs are interconnected. In the study area, the extension officer-to-farmer ratio is about 1:3,134 whereas the average national ratio is 1:1,500 (Asunafo North Municipal Assembly, 2019). Osanyinlusi and Adenegan (2016) found that rice farmers who received more extension services experienced higher productivity in Nigeria.

The fourth important need was additional land to increase rice production with a mean score of 4.29. In the study area, securing land for farming is either owned or rented. There are so-called immigrant farmers who came to the study area from other parts of the country for various reasons. These farmers usually obtain a usufructuary right to use farmland according to the local custom by paying with wine to the head of the family or chief who owns the land. This is called *abunu* or *abusa* system in a local language. The land these farmers use can be taken away from them at the owner's will. The owner may decide to allow other immigrant farmers to use the same lowlands or uplands as those farmers who were already using the land. This practice is not recognized in Ghana's legal system; hence, causing a number of land conflicts (Oppong-Kusi et al., 2018). Kyei and Matsui (2018) similarly found that female farmers in the Upper East Region could not increase their rice production due largely to a lack of access to land.

The fifth important need was transparency in rice prices which had a mean score of 4.20. In the study area, most of the rice farmers do not store their harvested paddy for a long period of time. They prefer to sell early in the form of paddy or milled rice, depending on the market demand. Smallholders are eager to gain quick cash income to enhance their meager incomes. However, due to their insufficient access to market information, middlemen tend to exploit smallholders, particularly during the glut period in the area (Asunafo North Municipal, 2019). This affects their income and their incentive to increase rice production.

The sixth non-technical need was an assistance from farmers' associations with a mean score of 4.10. Our result on socio-demographic characteristics revealed that the respondents had limited rice farming experience. This means that they had recently migrated from other parts of Ghana and needed to learn more from other experienced

rice farmers in the study area. In the study area, several farmers' associations exist. The most active one is the Asunafo North Farmers Union with more than 8,000 members spread across 67 communities (Fairtrade Africa, 2022).

The least important need considered by the respondents was skilled labor which had a mean score of 3.59. The little need for labor is due to the large household size of the respondents. Smallholders tend to rely on family members for rice production. Abdulai and Matsui (2022) similarly found that in Garu and Tempane districts of Ghana farmers coped with their low income by using their children as a source of farm labor. Female farmers in the Upper East Region experienced low productivity mainly due to insufficient labor (Kyei and Matsui, 2018).

3.4 Relationship between socio-economic factors and needs

To understand possible relationships between respondents' socio-economic characteristics and their needs for improved rice yield, we conducted a correlation analysis. The socio-economic characteristics we considered were age, education, household size, farming experience, and off-farm income.

Table 6. Correlation between respondents' socio-economic factors and their needs

Variables	Correlation coefficient (r)	p-value
Age	0.0586	0.4707
Educational level	- 0.1136	0.1608
Household size	0.1451	0.0725
Farming experience	0.4788	0.0265*
Off-farm income	- 0.2312	0.0039*

*P < 0.05, (Source: Field survey, 2020)

The results show a significant correlation between respondents' experience (r = 0.4788; p-value = 0.0265), off-farm income (r= -0.2312; p-value=0.0039), and their need to increase yield (Table 6). Regarding experience, the positive correlation supports our discussion above that the respondents were relatively inexperienced rice farmers and they were well aware of the need to be trained more about increasing their rice yields.

Off-farm income on the other hand shows a negative correlation regarding respondents' need for increasing rice yield. This suggests that those respondents who find off-farm business lucrative had little need in undertaking rice farming activities. This finding is corroborated by Pfeiffer et al. (2009) who found that off-farm income had a negative effect on agricultural output. There was no correlation between yield improvement needs and age, education, and household size.

4. Conclusion

This paper examined smallholder farmers' needs for improved yield in Asunafo North Municipality of Ghana. In doing so, we tried to understand why smallholder rice farmers have not been able to increase per acre rice yield. Our study identified that overall multiple factors were interconnected to explain the low yield outcome in the study area. We showed that giving improved varieties alone would not improve low-yield situations. The respondents needed to obtain improved seeds timely as rice depends on water availability. Without irrigation systems installed, these farmers must rely on the arrival of the wet season. The respondents, however, could not obtain the two improved varieties timely partly due to unreliable services from seed dealers. Also, the respondents did not have enough extension services/information or connection to experienced rice farmers. Rice production processes were hampered by high cost of inputs/agrochemicals, poor access to tractors/farming machinery, and a lack of reliable water supplies. Pest/disease control could have reduced the amount of crop loss during and after the harvest. For the respondents and many other smallholder farmers in rural Ghana, much of these challenges can be alleviated by having good access to credit or bank loans. However, the traditional tenure system and land conflicts have made it difficult for them, especially immigrant farmers, to obtain collaterals. Thus, they tend to rely more on non-farm incomes. Another challenge was an aging trend among the respondents. Extension programs have focused on youth participation in agriculture, particularly rice production.

In case Ghana wants to increase rice yield in the near future, it is critical to address how the government can better support older and uneducated smallholder farmers who do not see much incentive to invest more in rice farming. It is well within the power of the Ministry of Food and Agriculture to make seed dealers' services more reliable. It may also reduce the prices of fertilizer and agrochemicals for low-income farmers. Offering regular extension training programs in local languages or providing radio programs that inform local farmers about modern farming techniques can encourage farmers to improve their rice yields.

Acknowledgment

We appreciate the effort of the Ministry of Food and Agriculture in Asunafo North Municipal for assisting us in collecting data for this paper. We wish to also extend our gratitude to the rice farmers for spending time to provide answers and share with us their experiences during the questionnaire interview.

References

Abdulai, Y. & Matsui, K. (2022) "Examining Socio-Economic Constraints of Smallholder Women Rice Farmers: A Case Study of Garu and Tempane Districts, Ghana", *International Journal of Gender Studies*, 7(1), pp. 30-41.

Adesoji, S. A. & Tunde, A. (2012) "Evaluation of the linkage system of research-extension-farmers in Oyo State, Nigeria: Lesson for agricultural extension administrators", *Journal of Agricultural Extension and Rural Development*, 4(20), pp. 561-568.

Alliance for a Green Revolution in Africa (AGRA). (2020) "Opportunity to Influence and Impact Policy on Mechanization, and Infrastructure Delivery for Rice Production – Ghana", Available at https://agra.org/wp-content/uploads/2020/10/Annex-Ghana-Rice-Mechanisation-Report.pdf [accessed on 02/05/2021].

Asfaw, S. *et al*. (2012) "Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia", *Food Policy*, 37(3), pp. 283-295.

Asunafo North Municipal Assembly. (2019) "Composite Budget for 2019-2022; Program Based Budget Estimate for 2019", Available at https://www.mofep.gov.gh/sites/default/files/composite-budget/2019/BA/Asunafo-North.pdf [accessed on 3/02/2021].

Azumah, S. B., Donkoh, S. A. & Awuni, J. A. (2018) "The perceived effectiveness of agricultural technology transfer methods: Evidence from rice farmers in Northern Ghana", *Cogent Food and Agriculture*, 4(1), pp. 1-11. Available at: https:// doi.org/10.1080/23311932.2018.1503798.

Baah, F. (2008) "Harnessing farmer associations as channels for enhanced management of cocoa holdings in Ghana", *Scientific Research and Essay*, 3(9), pp. 395-400.

Bautista, E. U. & Javier, E. F. (2008) "Rice Production Practices. Philippine Institute for Development Studies". *Research Paper Series*, 2(1), pp.1-64.

Begna, B. *et al*. (2015) "Characterization of the seed demand dynamism in wheat growing areas of Ethiopia", *Journal of Biology, Agriculture and Healthcare*, 5(15), pp. 32-38.

Boansi, D. & Favour, R. M. (2015) "Why the persistent increase in Ghana's rice imports? Prescriptions for future rice policy", Asian *Journal of Agricultural Extension, Economics and Sociology*, 7(4), pp. 1-21.

Basnet, B. M. S. (2008) "Environment friendly technologies for increasing rice productivity", *Journal of Agriculture and Environment*, 9, pp. 34-40. Available at: https://doi.org/10.3126/aej.v9i0.2114.

Chandio, A.A. & Yuansheng, J. (2018) "Determinants of adoption of improved rice varieties in Northern Sindh, Pakistan", *Rice Science*, 25(2), pp. 103-110.

Danso-Abbeam, G., Armed, M. & Baidoo, F. (2014) "Determinants of consumer preference for local rice in Tamale Metropolis, Ghana", *International Journal of Education and Social Science*, 1(2), pp. 114-122.

Donkor, E. *et al*. (2018) "The adoption of farm innovations among rice producers in Northern Ghana: Implications for sustainable rice supply", *Agriculture,* 8(8), pp. 121-134. Available at: https://doi.org/10.3390/agriculture8080121.

Donkor, E. *et al.* (2016) "Impact of row-planting adoption on productivity of rice farming in Northern Ghana", *Review of Agricultural and Applied Economics* (RAAE), 19(2), pp. 19-28.

Djokoto, J. G., Owusu, V. & Awunyo-Vitor, D. (2016) "Adoption of organic agriculture: Evidence from cocoa farming in Ghana", *Cogent Food & Agriculture*, 2(1), pp. 1-15. Available at: https://doi.org/10.1080/23311932.2016.1242181.

Fairtrade Africa. (2022) "Asunafo North Farmers Union Awarded Small Producer Organization of the Year by Fair Trade International", Available at https://fairtradeafrica.net/asunafo-north-farmers-union-awarded-small-producer-organisation-of-the-year-by-fairtrade-international/ [accessed on 23/03/2022].

FAO *et al*. (2022) "The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable", Rome, FAO. https://doi.org/10.4060/cc0639en.

Fuad, M. A. F. (2022) "Development and Extension of Organic Agriculture Entrepreneurship: In the Context of Developed Countries and Bangladesh", MSc. Thesis, University of Tsukuba, Japan.

Ghana Statistical Service. (2014) "2010 Population and housing census. District analytical report. Asunafo North Municipality Ghana", Available at https://new-ndpc-static1.s3.amazonaws.com/CACHES/PUBLICATIONS/2016/06/06/Asunafo+North+2010PHC.pdf [accessed on 12/06/2020].

Ghana Statistical Service. (2018) "2013–2017 Annual GDP, Old and New Series (September 2018 Edition), Accra", Available at https://www.statsghana.gov.gh/nationalaccount_macros.php?Stats=MjkwMzA1NjI0LjE0MTU=/webstats/oq43q9p651 [accessed on 24/03/2021].

Ghana Statistical Service. (2019) "Ghana living standards survey (GLSS 7) 2017: Main report", Available at https://www.statsghana.gov.gh/gssmain/fileUpload/pressrelease/GLSS7%20MAIN%20REPORT_FINAL.pdf [accessed on 12/3/2020].

Ghana Statistical Service. (2021a) "Ghana 2021 population and housing census. General report volume 3A:

Population of Regions and Districts", Available at https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/2021%20PHC%20General%20Report%20Vol%203A_Population%20of%20Regions%20and%20Districts_181121.pdf [accessed on 27/07/2022].

Ghana Statistical Service. (2021b) "Ghana 2021 population and housing census. General report volume 3B: Age and Sex Profile", Available at https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/2021%20PHC%20General%20Report%20Vol%203B_Age%20and%20Sex%20Profile_181121.pdf [accessed on 27/07/2022].

Graphic online. (2022) "Seed producers petition over unpaid PFJ supplies", Available at https://www.businessghana.com/site/news/general/265943/Seed-producers-petition-over-unpaid-PFJ-supplies [accessed on 23/03/2023].

Huang, Q. *et al.* (2006) "Irrigation, agricultural performance and poverty reduction in China", *Food Policy*, 31(1), pp. 30-52. Available at: https://doi.org/10.1016/j.foodpol.2005.06.00

Iddrisu, A. M. *et al.* (2020) "How the fertilizer subsidy program can boost economic growth and employment in Ghana", *Policy Brief* (205). https://www.africaportal.org/publications/how-fertilizer-subsidy-program-can-boost-economic-growth-and-employment-ghana/ [accessed on 11/02/2021].

Japanese International Cooperation Agency (JICA). (2008) "The study on the promotion of domestic rice in the republic of Ghana. Final report", Available at https://openjicareport.jica.go.jp/pdf/11900487_01.pdf [accessed on 23/04/2021].

Karlan, D. *et al*. (2016) "Getting to the top of mind: How reminders increase saving", *Management Science*, 62(12), pp.3393-3411. Available at: https://doi.org/10.1287/mnsc.2015.2296.

Kyei, K. & Matsui, K. (2018) "Efficiency analysis of rice farmers in the Upper East Region of Ghana", *IICSEEHawaii2018: The IAFOR International Conference on Sustainability, Energy and Environment in Conference Proceedings, Hawaii*, *USA*, 4-6 January, pp. 1-8.

Mahajan, G., Singh, K. & Gill, M. S. (2012) "Scope for enhancing and sustaining rice productivity in Punjab (food bowl of India)", African *Journal of Agricultural Research*, 7(42), pp. 5611-5620. Available at: https://doi.org/10.5897/ajarx11.027.

Marfo, K. *et al.* (2008) "Identifying seed uptake pathways: The spread of Agya amoah rice cultivar in southwestern Ghana", Experimental *Agriculture*, 44(2), pp. 257-269. Available at: https://doi.org/10.1017/s0014479708006170.

Ministry of Food and Agriculture. (2007) "Food and Agriculture Sector Development Policy (FASDEP). Ministry of Food and Agriculture, Ghana", http://rhody.crc.uri.edu/wp-content/uploads/sites/10/2018/04/Ghana-Food-and-Agriculture-Sector-Development-Policy-2007.pdf [accessed on 12/12/2020].

Ministry of Food and Agriculture (MoFA). (2009) "National Rice Development Strategy (NRDS)-Draft", https://riceforafrica.net/images/stories/PDF/ghana_en.pdf [accessed on 01/07/2020].

Ministry of Food and Agriculture (MoFA). (2010) "Agriculture in Ghana, Facts and Figures (2009)", Accra, Ministry of Food and Agriculture.

Ministry of Food and Agriculture (MoFA). (2014) "2014 Agric Sector Annual Progress Report. Monitoring and Evaluation Directorate. Available at https://new-ndpc-static1.s3.amazonaws.com/CACHES/PUBLICATIONS/2016/02/27/Ministry+of+Food+and+Agriculture_APR_2014.pdf [accessed on 13/04/2020].

Ministry of Food and Agriculture (MoFA). (2016) "Agriculture Sector Progress Report", Available at https://ghanalinks.org/documents/190376/199086/Agricultural+Sector+Progress+Report+2016/940dddc7-b708-4535-b140-b690faa37ff2?download=true [accessed on 13/04/2020].

Ministry of Food and Agriculture (MoFA). (2017) "Agricultural Sector Progress Report 2017", Available at https://www.coursehero.com/file/50417936/MoFA-2017-AGRICULTURAL-PROGRESS-REPORT-FinalPPMEDMoFApdf/ [accessed on 19/12/2019].

Ministry of Food and Agriculture (MoFA). (2019) "Agriculture in Ghana; Facts and Figures 2018.Accra, MoFA-SRID", Available at https://mofa.gov.gh/site/publications/research-reports/376-agriculture-in-ghana-facts-figures-2018 [accessed on 13/01/2020].

Ministry of Food and Agriculture (MoFA). (2020) "Facts and Figures: Agriculture in Ghana, 2020", MoFA-SRID, Accra.

Ministry of Food and Agriculture (MoFA). (2021) "Asunafo North Municipal", Available at http://mofa.gov.gh/site/directorates/district-directorates/brong-ahafo-region/138-asunafo-north-municipal [accessed on 17/02/2022].

Mishra, A. *et al*. (2021). "Food security and climate-smart agriculture in the lower Mekong basin of Southeast Asia: evaluating impacts of system of rice intensification with special reference to rainfed agriculture", *International Journal of Agricultural Sustainability*, 19(2), pp. 152-174. Available at: https://doi.org/10.1080/14735903.2020.1866852.

Naveed, M. A. & Anwar, M. A. (2013) "Agricultural information needs of Pakistani farmers", *Malaysian Journal*

of Library and Information Science, 18(3), pp. 13-23. Available at: http://escholar.umt.edu.pk:8080/jspui/bitstream/123456789/848/1/1432.pdf.

Nonvide, G. M. A. (2017) "Effect of adoption of irrigation on rice yield in the Municipality of Malanville, Benin", African *Development Review*, 29(S2), pp. 109-120. Available at: https://doi.org/10.1111/1467-8268.12266.

Nuhu, M. G., & Matsui, K. (2022) "Gender dimensions of climate change adaptation needs for smallholder farmers in the upper east region of Ghana", *Sustainability*, 14(16), 1043. Available at: https://doi.org/10.3390/su141610432.

Nyangena, W. & Juma, O. M. (2014) "Impact of Improved Farm Technologies on Yields: The Case of Improved Maize Varieties and Inorganic Fertilizer in Kenya", *Environment for Development Discussion Paper*. Available at https://www.cabdirect.org/cabdirect/abstract/20143174870 [accessed on 13/04/2022].

Nyo, A. K. (2016) "Inadequate infrastructure: The bane behind food loss and food security in the Savannah zone of Ghana", *Journal of Developments in Sustainable Agriculture*, 11(1), pp. 43-47.

Ololade, R. A. & Olagunju, F. I. (2013) "Determinants of access to credit among rural farmers in Oyo State, Nigeria", *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences*, 13(2), pp. 16-22.

Oppong-Kusi, B. *et al.* (2018) "Examining Conflicts Over Land Acquisition and Ownership in the Dormaa Traditional Area, Ghana", *IICSEEHawaii2018: The IAFOR International Conference on Sustainability, Energy & the Environment Hawaii, USA*, 4-6 January. Available at https://papers.iafor.org/submission38916/ [accessed on 23/03/2023].

Osanyinlusi, O. I. & Adenegan, K. O. (2016) "The determinants of rice farmers' productivity in Ekiti State, Nigeria", *Greener Journal of Agricultural Sciences*, 6(2), pp. 49–58.

Ouédraogo, S. A. (2021) "Rice value chain in Ghana: Prospective analysis and strategies for sustainable and pro-poor growth", FAO. Available at https://doi.org/10.4060/cb1659en [accessed on 12/05/2020].

Pham, T. T., Theuvsen, L. & Otter, V. (2019) "Determinants of smallholder farmers' marketing channel choice: evidence from the Vietnamese rice sector", *Asian Economic Journal*, 33(3), pp. 281-300.

Pfeiffer, L., López-Feldman, A. & Taylor, J. (2009) "Is off-farm income reforming the farm? Evidence from Mexico", Agricultural *economics*, 40(2), pp. 125-138.

Ragasa, C. *et al*. (2013) "Patterns of adoption of improved rice technologies in Ghana", *International Food Policy Research Institute Working Paper,* 35, pp. 6-8.

Ragasa, C. & Mazunda, J. (2018) "The impact of agricultural extension services in the context of a heavily subsidized input system: The case of Malawi", *World Development*, 105, pp.25-47. Available at: https://doi.org/10.1016/j.worlddev.2017.12.004.

Rehman, A. (2017) "Modern agricultural technology adoption its importance, role and usage for the improvement of agriculture", *Life Science Journal*, 14(2), pp. 70-74.

Satoh, M. & Ishii, A. (2021) "Japanese Irrigation Management at the Crossroads", *Water Alternatives*, 14(2), pp.413-434.

Tamekloe, M.K. (2021) "An Assessment of Opportunities for Sustainable Small-Scale Irrigation for Rice and Vegetable Production in the South - Tongu District of Ghana", MSc. Thesis, University of Tsukuba, Japan.

Tanko, M., Iddrisu, A. & Alidu, A. F. (2016) "Determinants of rice yield in Northern region of Ghana, the role of policy", Asian *Journal of Agricultural Extension, Economics and Sociology*, 9 (2), pp. 1-11.

World Food Programme. (2011) "Fighting Hunger Worldwide; WFP in Africa 2010 Facts and Figures", Available at https://documents.wfp.org/stellent/groups/public/documents/communications/wfp236720.pdf [accessed 24/10/2022].

World Food Programme. (2022) "2020 comprehensive Food Security and Vulnerability Analysis (CFSVA) Ghana". World Food Programme, Rome, Italy.

Zurek, K. (2021) "Ghana spent $1billion on rice imports between 2017-2020", Available at https://www.graphic.com.gh/news/general-news/ghana-spent-1billion-on-rice-imports-between-2017-2020.html [accessed on 7/7/2022**].**