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Assessing Adoption Levels and Constraints to Modernized Rice Varieties Adoption by Rice Producers in Northern Ghana

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Abstract

The consumption of rice has increased dramatically in Ghana over the years. To enhance productivity in order to meet the demand of the commodity, some high-performing rice varieties have been disseminated to smallholder farmers in northern Ghana through a plethora of development interventions. Nevertheless, productivity is still low at farm gate compared to experimental stations, largely due to smallholders' poor adoption of enhanced varieties and other socio-economic factors. Using primary data collected from 404 farmers, the study uses descriptive statistics to examine the adoption levels as well as reasons and challenges for adopting modernized rice varieties by producers in northern Ghana. The empirical results revealed low adoption levels of modernized rice varieties in the region; with Jasmine topping the list of most adopted (41.10%) followed by Agra (37.13%) and Afife (20.30%). The five

most important reasons for farmer-use of modernized rice varieties in the region were: ready market for rice, ability of rice to withstand pest and disease attacks, higher consumer-demand, and pieces of advice from extension officers as well as advice by researchers to cultivate. High cost of production arising from input and labor costs coupled with high cost of farm credit are identified as major constraints to modernized rice varieties adoption in the region, and should be considered in any policy reforms or response by the government to address food insecurity issues within the context of current expected global food crises and to meet the sustainable development goals 1 and 2. Non-governmental and farmer-based organizations, and other actors in the rice value chain should collaborate with the government of Ghana to minimize the constraints and optimize adoption levels of modernized rice varieties in northern Ghana, which is a food basket of the country.

Keywords: adoption, non-adoption, indigenous rice, modernized varieties, Northern Ghana

1. Introduction

Rice has become the main cereal crop that feeds over 50% of people worldwide. Asia and Sub-Saharan Africa are the largest producers and consumers of rice worldwide (FAO, 2021; USDA, 2021). South East Asia alone produces more than 90% of the rice crop worldwide. China is the leading producer of rice worldwide, and also the largest consumer while the African continent accounts for only 3% of global rice production in 2019 (FAO, 2021; USDA, 2021). This implies Africa's contribution to the world rice market in terms of production volumes is very low. There is however a huge potential for the continent to increase its production and relative market share. There is the need for conscious concerted effort to attain this goal. Dissemination and adoption of high-performing rice varieties in addition to good agronomic practices among farmers are potential means of boosting rice production and productivity in Africa.

Agricultural production in Ghana is facilitated by the benevolence of several nations and donor agencies that seek to enhance crop yield, resource and increase income levels of farmers (Ragasa, and Chapoto, 2016; Ragasa et al., 2013). Farmers in the Northern Region of Ghana gained from such benevolence, which enabled them to obtain high-yielding rice varieties as well as other innovations that complemented their rice production and productivity efforts. The high-yielding rice varieties disseminated by Ministry of Agriculture (MoFA) and her development partners along the rice value chain include Afife, Agra, Digang, Faro-15, GR-18, Jasmine, Mandee, Nerica 1&2, Sakai, and Tox, among others. People who produce rice in Ghana are mainly small-scale farmers who use minimal farm inputs and simple techniques (Lamptey, 2022, 2018; Ragasa and Chapoto, 2016). Adoption of modernized agricultural technologies like modernized rice varieties are aimed at facilitating productivity and boosting financial gains, reducing financial constraints and eventually ensuring self-reliance in farming communities (Asante et al., 2004). As part of measures to address low production and productivity among rice farmers the government of Ghana with support from development partners proposed a focused and high-impact approach to transform the rice value chain, with particular emphasis on the Northern Region of Ghana (MoFA, 2016). This approach is aimed at increasing rice production and productivity in the country to facilitate the attainment of

Sustainable Development Goals one (no extreme poverty) and two (zero hunger). Northern Ghana is chosen for this initiative because that part of the country is considered the bread basket of Ghana and the hub of rice production in the country. Despite these accolades and huge potential that exist in the region, rice productivity is still low in the region (Lamptey et al., 2022; MoFA, 2016).

That notwithstanding, the adoption levels of improved rice varieties among farmers is reportedly low in the study area (Azumah et al., 2022). The adoption levels are poor due to farmers' consistent use of low-yielding crop varieties and poor agronomic practices (Azumah, 2019; Ragasa and Chapoto, 2016). Rice farmers still operate at low levels of productivity mainly because they hardly use new farming ideas and techniques meanwhile modern farming ideas are needed for smallholder agricultural productivity and food security (Kasirye, 2013). The World Bank Report of 2008 highlighted the fact that over a 30-year period substantial public resources have been allocated for developing improved crop varieties in Sub-Saharan Africa. However, overall adoption of these new technologies still significantly lag behind the rest of the world. To best of our knowledge, none of the adoption studies in the region adequately examines the use of modernized and traditional varieties of rice by rice producers in northern Ghana. Therefore, this current study was carried out to analyse the factors that affect farmers' adoption decisions of rice varieties in northern Ghana.

2. Methodology

2.1 Study Locality, Size of Sample, Data Gathering and Analysis

Figure 1. Ghana map showing research location

Source: Google Maps

The Northern region is one of sixteen (16) administrative regions of Ghana. It is further divided into fourteen (14) administrative districts. The natural vegetation of the area mainly consists of grasslands, shrubs and clusters of trees including the shea tree, baobab, acacia and other drought resistant trees. The region experiences mainly two seasons in a year, the dry season which typically starts between November and May while the rainy season lasts between June and October. However, changes in the climatic conditions have led to shifts in the seasonal calendar with the rainy season getting shorter. Average annual rainfall ranges between 750mm and 1050mm (30 to 40 inches) (MoFA, 2017). The region is the second largest producer of paddy rice in Ghana, and it is responsible for 68,407.25 metric tonnes of paddy rice per annum. However, the annual paddy rice yield in the region of 1.32Mt/ha drastically falls below the average yield of 3.65mt/ha in Ghana (MoFA, 2019).

A mixture of sampling techniques such as purposive sampling, cluster sampling as well as simple random sampling were employed to select a total of 410 respondents for the study. The sample size for this research was computed with Smith (2019) sample size determination formula. The breakdown of the sample size was in accordance with MoFA (2019) sample frame obtained for the study. The estimated sample size (385 respondents) was large enough to help draw accurate conclusions on the research. That notwithstanding, we modified the sample size to 410 to give room to any limitations of the study. Eventually, 404 questionnaires became consistently reliable for the analysis.

Table 1. A breakdown of the sample size

Sampled District	Size of Sample	Per Cent	Zones Involved
Tolon District	116.00	28.29	4.00
Kumbungu District	112.00	27.32	4.00
Savelugu Municipal	120.00	29.27	4.00
Nanton District	62.00	15.12	2.00
Total	410.00	100.00	14.00

Source: Authors' construct, 2020

3. Results and Discussions

3.1 Profile of the Rice Producers Sampled

Table 2 shows the descriptive statistics of the rice producers sampled for the research. The results showed that the optimum age of a rice producer was about 40 years and about 30% of the farmers had formal education. Martey et al (2013), reported that educated rice producers are more likely to adopt new technology because they are more exposed and have a better understanding of the benefits of the technology being introduced. The average household size was found to be 9 persons per household while and the mean farm size was found to be 4 acres respectively. MoFA (2017) and Ragasa et al, (2013) found that majority (80%) of the rice producers in Ghana are peasant farmers and mostly have farmland less than one hectare in size. In addition, about 90% of the rice farmers were males, corroborating Azumah et al, (2022). In terms of awareness of government policy for rice production, about 87% of the farmers knew about government policies towards cereal production. The results also indicates that majority (86%) of the rice producers had readily available places to sell their produce, 85% had reliable places to buy their farm input, 80% got farming assistance from extension services, and 35% were able to get rice production capital/credit. The low level (10%) of women participation in rice production in the study area corroborates with Martey et al. (2013), who asserted that women's role tends to be restricted to domestic activities such that they are unable to find the time and resources required to go into farm activities.

Furthermore, most (92%) of the farmers realized a decline in the pattern of rainfall for the past decade, 75% had access to motorable roads, 47% were members of FBOs, 25% possessed personal phones, 78% used tractor for land preparation for rice planting (mechanization). Similarly, about 95% harvested rice manually with the aid of sickles. That is, only 5% of the farmers used combined harvester for rice harvesting, corroborating Azumah et al, 2022.

Table 2 Descriptive statistics of rice producers

Variable	Mean	Std. Dev.
Adoption (1/0)	0.46	0.50
Age (Years)	39.70	10.65
Gender (1/0)	0.90	0.30
Education (1/0)	0.29	0.46
Household size (Number)	8.63	4.30
FBO membership (1/0)	0.47	0.50
Mobile phone ownership (1/0)	0.25	0.43
Access to output market (1/0)	0.86	0.34
Access to input market (1/0)	0.85	0.36
Access to production credit (1/0)	0.35	0.48
Access to extension service (1/1)	0.80	0.40
Area of farm plot (Acres)	3.87	3.81
Awareness of government policy (1/0)	0.87	0.34
Access to good road network (1/0)	0.75	0.44
Use of mechanization service (1/0)	0.78	0.41
Rainfall perception (1/0)	0.92	0.28
Harvesting method (1/0)	0.05	0.23

Source: Field data, 2020

3.2 Adoption Levels of Rice Varieties

Ten (10) modernized rice varieties identified to be commonly cultivated by farmers in the region comprised Agra, Afife, Digang, Faro-15, GR-18, Jasmine, Mandee, Nerica 1&2, Sakai

and Tox while the indigenous rice varieties were Salma-Saa and Kpokpula. The results of the adoption and non-adoption levels in the region are presented in Table 3. The adoption levels (rates) in this study are the ratios of the rice producers who continuously cultivated each of the rice varieties for at least three cropping seasons in northern Ghana, from 2010 to 2020. The adoption levels of rice varieties in the region were generally very low, corroborating Azumah et al. (2022), Lamptey (2022, 2018), APS (2015) and Bruce et al. (2014).

Among the modernized rice varieties, Jasmine had the highest adoption rate (41.10%), followed by Agra (37.13%) and Afife (20.30%). It means the three most adopted modernized rice varieties in the region were Jasmine, Agra and Afife. The adoption levels of Agra and Jasmine were in the lead in the region because they were the most dominating rice breeds in the localities over the past decade. This finding corroborates with Lamptey et al. (2022), MoFA, (2017) as well as APS (2015), likewise Ragasa et al. (2013) who found that Agra and Jasmine were the latest modernized rice varieties promoted in the region. Farmers tend to crave for newly introduced rice varieties in the region than those previously promoted (Lamptey et al., 2022; Moser and Barrett, 2002).

Concerning the indigenous varieties, the adoption level of Salma-Saa was 23.63% while that of Kpokpula was 12.68%. Salma-Saa was therefore the most adopted (used) indigenous rice variety in the catchment area. None of the rice producers cultivated only one rice variety at any given time. They grew a number of different varieties, whether modernized or indigenized, or a combination thereof, year after year. That made each farmer an adopter of both modernized and localized rice varieties in the catchment area. The reason for adopting multiple modernized rice varieties and indigenized rice varieties is attributed to the fact that farmers are risk averse and may want to diversify their risk by cultivating different rice varieties in order to spread their risk and reduce its potential impact, corroborating Zakaria et al. (2019) and Ragasa and Chapoto, (2016).

The results as shown in Table 3 indicate that the modernized rice varieties not very well adopted were Sakai (99.50%), Faro-15 (93.32%), Tox (87.62%), GR-18 (87.13%), Mandee (86.39%), Digang (85.89%) and Nerica 1&2 (83.17%). The local variety called Kpokpula was not very well adopted (87.62%) relative to its counterpart Salma-Saa (76.49%), which confirmed that the rice producers chose Salma-Saa over Kpokpula, though both were not modernized rice varieties. That was because Salma-Saa appeared to have similar morphological traits as Jasmine, the most used modernized rice variety in the catchment area, corroborating Lamptey et al. (2022), APS, (2015) and Ragasa et al. (2013).

Table 3. Adoption levels of rice varieties

Rice varieties*	Adoption Levels		Non-Adoption Levels	
Modernized varieties	Frequency	Percent	Frequency	Percent
Agra	150	37.13	254	62.87
Sakai	2	0.50	402	99.50
Jasmine	166	41.10	238	58.90
Afife	82	20.30	322	79.70
Nerica 1&2	68	16.83	336	83.17
Digang	57	14.11	347	85.89
Mandee	55	13.61	349	86.39
GR-18	52	12.87	352	87.13
Tox	50	12.38	354	87.62
Faro-15	27	6.68	377	93.32
Indigenous varieties *				
Salma-Saa	95	23.51	309	76.49
Kpokpula	50	12.38	354	87.62

Source: Field data, 2020 *several options Total respondents = 404

3.3 Reasons for Which Rice Producers Adopt Certain Rice Varieties

This section discusses the farmers' specific reasons for adopting modernized and traditional rice varieties, especially the modernized ones as shown in Table 4. The rice producers' reasons for cultivating modernized rice varieties, as a matter of priority, were readily available markets to sell rice (81.70%), rice' ability to resist pests and diseases attack (77.00%), higher consumer preference for rice (57.00%), advice from extension officers to produce rice (52.00%), and advice given by crop researchers for farmers to produce rice (50.00%). A few rice producers (5.00%) used the rice varieties because they had free seeds from rice disseminators such as

agricultural extension officers, produce aggregators, agro-chemical dealers, market women and non-governmental or farmer-based organizations. The primary motivation of the rice producers was the possibility to earn income from rice cultivation, since rice is a commercial crop in Ghana (MoFA, 2019; APS, 2015). The farmers therefore said during Focused Group Discussions (FGDs) that they produced rice for income, besides food. So, they cultivated Agra and Jasmine as well as Salma-Saa, which sold better and had good aromatic properties. Rice varieties cultivated by the farmers were therefore better than the other varieties in the region (Rogers, 2005).

It was also realized during the FGDs that the rice producers normally accept any modernized rice varieties brought to their door steps for cultivation. That way, they try them for a while prior to total utilization and they may continue with the practice until such a time that other modernized varieties with preferable traits are promoted for cultivation. This likewise explains the reason for which the usage of Agra and Jasmine were more than the other modernized rice varieties, disseminated early on in the vicinity. It implies Agra as well as Jasmine cultivation is likely to be replaced by the use of other better modernized rice varieties that are yet to be promoted in the locality, which corroborates with Oster and Thorton (2009), who penned that knowing the process of technology adoption can help forecast patterns of adoption. In the same way, the rate of Salma-Saa usage was more than that of Kpokpula since Kpokpula was an older variety relative to Salma-Saa.

FGDs with the rice producers as well as Key Informant Interviews (KIIs) with research officers and agricultural extension agents brought to the fore that Kpokpula is a traditional variety that has been in the locality for more than fifty years now. Salma-Saa, on the other hand, is a strain (an incomplete breed) of Jasmine that is being cultivated in the region shortly before the release of Jasmine in 2009. This finding is supported by Ragasa et al. (2013) who penned that Jasmine, otherwise known as Saa Rice, was officially released in 2009, but it was already being planted by some rice producers before then. Salma-Saa shares the same desirable traits with Jasmine, besides the fact that it has acclimatized itself to environmental conditions of the region. The rice producers emphasized that a traditional rice variety like Salma-Saa or Kpokpula does well with minimal farm inputs as well as few farm operations relative to the modernized varieties such as Afife or Agra. They therefore held on to the cultivation of certain traditional varieties even when they did not have people who were willing to buy from them either at the farm gates or the open markets, good milling properties as well as ability to cook well. The rice producers elaborated thus; “we normally get those seeds for free”, “those seeds are easy to come by” and “they still produce some grains even in times of drought”. Their responses show that some of the rice producers were peasant farmers or laggards who only accepted to use those rice varieties after other farmers had benefited from using them, and they (laggards) continued to use the same varieties even when many farmers had stopped cultivating them (Rogers, 2005). This corroborates Azumah (2019), findings that about 35% of the rice producers in northern Ghana are subsistent farmers.

Eventually, a few of the rice producers intimated that they mainly produced rice seed to sell to research officers and other crop farmers from various destinations. Their pre-occupation was to produce seeds of diverse modernized rice varieties whether their fellow rice producers were

still cultivating those varieties or not. That accounted for the 50% current level of adoption for Sakai even when its initial level of adoption was only 0.50%. The adoption decision of rice seed growers in this research is termed adoption for Future Viability (Donald and Parker, 2012), meaning farmers would continue to use certain innovations by way of preserving them for use in the near future.

Table 4. Reasons for which rice producers cultivate certain rice varieties

Reasons for Adopting Rice Varieties*	Frequency	Per Cent
Ready market for paddy rice	330	81.70
Rice' ability to resist diseases/pests attack	311	77.00
Higher consumer preference for rice products	230	57.00
Advice by extension staff to produce rice	210	52.00
Advice by crop research scientists to cultivate rice	202	50.00
Rice seeds are more suitable for the local soils	120	29.70
Rice' ability to withstand droughts/floods	145	35.89
Other good aromatic/agronomic properties of rice	67	16.58
Ability to produce rice with minimal input	27	6.68
Availability of free seeds from rice disseminators	20	5.00

Source: Field data, 2020 *several options Total respondents = 404

3.4 Rice Producers Reasons for not Adopting Certain Rice Varieties

The reasons for which rice producers did not adopt certain rice varieties in the region are discussed here. The producers' primary reasons for not adopting the modernized rice varieties were high requirements for farm inputs (96.00%) corroborating with Azumah et al. (2019), difficulties in selling paddy rice (69.31%), low consumer demand for rice products (52.00%), and rice seeds being too susceptible to droughts/floods (42.10%). The least reason for farmers' non-adoption decision of modernized rice varieties was based on pieces of advice farmers received from agricultural extension officers (26.50%), as shown in Table 5. These findings are in tandem with Moser and Barrett (2002) and Azumah et al., (2022) who found that rice producers easily adopt modernized rice varieties as soon as they are promoted, but they hardly produce the same varieties when faced with financial limitations. Consumer demand for rice and producers' ability to supply rice for sale go a long way to determine the selling price for

rice products, and likewise influence producer adoption of rice varieties. The implications are that the rice producers did not cultivate modernized rice varieties that needed more farm inputs for their production and those that were no longer influenced by demand and supply (Lamptey et al., 2022; Donald and Parker, 2012).

This means the rice producers made their own decisions not to use the modernized rice varieties that did not give them maximum satisfaction for their usage, without being forced or intimidated by other people. Hence, they indicated that agricultural extension officers contributed very little (26.50%) to their non-adoption decision of modernized rice varieties. This is in tandem with Doss (2006) and Rogers (2005) who opined that adoption is a personal choice.

KIIs brought to the fore that the advice by agricultural extension officers or crop research scientists was not intended induce non-adoption of modernized rice varieties but to facilitate farmers' adherence to procuring certified seeds for cultivation every third or fourth year in the farming cycle and also to avoid producing the very modernized rice varieties on the same rice fields continuously for about half a decade. This is in tandem with AGRA-SSTP (2016) and APS (2015) as well as Ragasa el at. (2013), who penned that hybridized rice seed give low yields. The purpose of the extension advice was to help rice producers avoid the multiplication of rice pests and diseases as well as to prevent the weak traits of those varieties from surfacing. Instead, the rice producers ended up not adopting the rice varieties that normally do well with the use of certified seeds. The reason being that, the rice producers preferred to use hybridized seeds or seeds from their previous harvests for subsequent cultivation of rice on their fields, season after season, against professional advice (Ragasa, and Chapoto, 2016; Doss, 2006). Martey et al. (2013) as well as Donkoh and Awuni (2011) likewise found that rice producers in northern Ghana stopped using farm yard manure to enrich the fertility of their soils due to their poor perception of its usage.

The experts in rice production explained that the farmers usually complained of not having pure seeds from their farms as a result of flooding and cross pollination of their pure breeds with unwanted varieties that grow on their own in the rice fields. So, they admonished the rice producers to change the impure seeds for pure modernized seeds and rather do manual weed control, relative to the use of herbicides or weedicides. However, the rice producers' perception of increasing cost of pure and certified seeds as well as cost of labour for manual weed control, compelled them to rather cultivate traditional varieties on their rice fields or refuse to produce the modernized varieties.

The rice producers confirmed at the FGDs that they usually did not cultivate some modernized rice varieties due to the availability of several other modernized rice varieties at their disposal. That shifted the blame for farmer non-adoption of modernized rice seeds to the door steps of crop research institutions and agricultural extension agents that disseminate several modernized rice varieties continuously in the region. Even though crop research institutions hardly advice rice producers to reject modern farming practices, this non-adoption decision of the rice farmers is considered to have been initiated by be crop research institutions (Donald and Parker, 2012).

The FGDs likewise made it clear that the rice producers did not adopt modernized rice varieties they once rejected: "We did not grow those varieties since they did not meet our expectations." If they did, we would not have rejected them, to start with. Hence, we see no reason for growing them while there are equally important varieties available for cultivation in our communities" The rational for this adoption decision or behaviour of rice producers, as indicated above, is termed Variety Seeking, which is a phenomenon that occurs at a time when crop producers are exposed to varied options of agricultural innovations (Azumah et al, 2022; Donald and Parker, 2012; Rogers, 2005). This implies that the rice producers reject some modernized rice varieties so as to adopt other potentially better varieties. This way of treating agricultural innovations is considered as replacement discontinuance (Rogers, 2005). It is a situation that usually occurs if a farmer rejects a technology to accept a superior technology. The rice producers' explanations also show that they did not accept those varieties due to the negative tendencies associated with their usage. This is corroborated by Donald and Parker (2012) as well as Jones (2005) who opined that, innovations that are rejected are normally the ineffective ones.

Since most of the rice producers do not cultivate modernized rice varieties they once reject, it renders this type of farmer non-adoption behaviour similar to what pertains in human relationships (Lastovicka and Karen, 2005). Humans are social beings who choose whom to relate with and whom not to relate with. This implies that rejection of innovations is a human phenomenon, corroborating Perrin-Martinenq (2004).

Table 5. Reasons for which rice producers do not adopt certain rice varieties

Reason for farmer non-adoption decision*	Frequency	Per Cent
High cost of farm inputs needed to produce rice	388	96.00
Difficulties in selling paddy rice	280	69.31
Low consumer demand for rice products	210	52.00
High susceptibility of rice seeds to droughts/floods	170	42.10
Rice seeds no longer being suitable for the local soils	150	37.13
Unaffordability of modernized rice seeds	130	32.18
Advice by crop researchers to stop rice cultivation	119	29.50
Other agronomic/aromatic properties of rice varieties	113	28.00
Susceptibility of rice seeds to diseases/pests infestations	110	27.23
Advice by agricultural extension officers to stop usage	107	26.50

Source: Field data, 2020 *several options Total respondents = 404

3.5 Constraints to Cultivation of Modernized rice Varieties in Northern Ghana

Factors that hinder cultivation of modernized rice varieties in northern Ghana are discussed below. The limitations to modernized rice varieties adoption facilitated non-adoption of modernized rice varieties by farmers in the region. The results in Table 6 reveal that the most predominant limitation to modernized rice variety cultivation in the region was high cost of farm inputs (96.00%) followed by lack of rice production capital/credit (91.60%) and scarcity of skilled labor (90.60%), corroborating Lamptey (2021). These three factors overshadowed the list of factors that hindered rice producer's adoption of modernized rice varieties in northern Ghana because they were financially driven. The hindrances to modernized rice varieties adoption in the region are therefore synonymous to the limitations of farmers who produce rice for domestic purposes in this country, corroborating Azumah et al. (2022), MoFA (2017); and DAI (2015). Many small-scale farmers in Ghana are normally saddled with financial insecurity, which at times makes them complain of lack of production credit or funds to farm. So, whenever it become very imperative for them to part with money or raise funds for their farming activities, it poses huge problems to them. Hence, they are always very eager to embrace rice production innovation projects associated with financial incentive packages (Lamptey et al., 2022).

Table 6, recorded that 87.00% of the rice producers indicated that absence of incentives or policies of government for the rice sector was their main constraint while 78.50% of the producers also indicated difficulty in accessing tractor or mechanization services as their major constraint, similar to the financial limitations. That is why the rice producers usually yearn for governmental projects and supports for the rice sub-sector, NGOs as well as other philanthropists in the rice value chain to come to their aid. This view is corroborated by Lamptey (2022, 2018), Mustapha et al. (2012) as well as (Diagne et al. 2010). The finding is also consistent with those of MoFA, (2019, 2017) and ISSER, 2008), that reported that the agricultural sub sector in the economy of Ghana has gained several benefits from numerous interventions purported at enhancing rice yield, reducing financial deprivation among rice producers and multiplying financial gains of farm families.

Most of the respondents explained in FGDs that they had money to hire tractor and mechanization services but such services were hard to come by in their communities. So, they requested that the government should provide them with such services at no or low costs to facilitate their adoption and large-scale production of modernized rice varieties. The constraints that are not financially driven are also indicated in Table 6.

The results, as presented in Table 6, show that most of the rice producers had no challenges with matters that did not need financial obligations on their part. Hence, 74.00% of the respondents indicated that 'unwillingness to use modernized rice seeds' was not a hindrance to their crop production businesses. In the same way, 72% of the respondents said they were not unwilling to use agricultural innovations. The farmers' responses affirm that most modernized rice seeds and new production ideas either come to them at no/low costs or both. Such packages are also usually associated with incentives like fertilizer subsidies, corroborating Azumah and Zakaria (2019) as well as Salifu, (2016). The farmers therefore usually expect to

receive such incentive packages so as to gain immense profits from their usage (Lamptey, 2022, 2018). The rice producers elaborated the phenomenon at FGDs held in their communities and indicated; "We usually accept new ideas by trying them for a while to see if they are ok for us, if not, we abandon them for different ideas." As far as the farmers were concerned, it is inappropriate for them to decline the use of a new idea without ascertaining its usefulness. So, they welcome new ideas of farming before deciding whether to use or not to use them. That principle is corroborated by Rogers (2005), who asserted that refusal to accept an innovation is possible in the course of deciding to use the innovation.

Table 6. Constraints to modernized rice varieties adoption in northern Ghana

Constraints to adoption*	Responses			
	Yes		No	
	Frequency	Percent	Frequency	Percent
High cost of farm inputs like seeds, chemicals, land, labour, and fertilizers.	388	96.00	16	4.00
Lack of access to farm credit/production capital	370	91.60	34	8.40
Scarcity of skilled labour	366	90.60	38	9.40
Pests/diseases infestations/poor weather conditions	358	88.60	46	11.40
Lack of incentives/governmental policies for rice	351	87.00	53	14.10
Scarcity of fertile land needed to produce rice	345	85.40	59	14.60
Competitiveness of imported rice/other cereal crops	330	81.70	74	18.30
Scarcity of tractor/mechanization services	317	78.50	87	21.50
Little/no information from producers to researchers	306	75.70	98	24.20
Poor infrastructure/bad road network	301	74.50	103	25.50
Politicization/bureaucracies in farmer associations	295	73.00	109	27.00
Lack of knowledge on associated technologies	274	67.80	230	32.20
Inadequate/low publicity on modernized rice seeds	163	40.30	241	59.70
Unwillingness to use new farming methods/practices	113	28.00	291	72.00
Unwillingness to use modernized rice seeds	105	26.00	299	74.00

Source: Field data, 2020 *several options Total respondents = 404

4. Conclusions and Policy Implication

This study assessed the adoption levels and constraints to modernized rice varieties adoption in northern Ghana. Descriptive statistics were used to determine the adoption levels and reasons for the adoption and non-adoption as well as limitations to the adoption. The adoption levels for each of the modernized rice varieties were less than 50%, with the highest being Jasmine (41.10%) followed by Agra (37.13%) and Afife (20.30%). The rest were less than 20% each. The most non-adopted modernized rice varieties in northern Ghana were Sakai (99.50%), Faro-15 (93.32%), Tox (87.62%), GR-18 (87.13%), Mandee (86.39%), Digang (85.89%) and Nerica 1&2 (83.17%). The non-adoption level of Kpokpula (87.62%) was higher than that of Salma-Saa (76.49%), confirming that the farmers preferred Salma-Saa to Kpokpula, though both were traditional rice varieties.

The five prevailing reasons for which the rice producers adopted modernized rice varieties were, the ease with which farmers sold paddy rice (81.68%), the ability of rice plants to resist pests and diseases infestations (77.00), higher consumer-demand for rice products (57.00%), advice from agricultural extension officers to cultivate rice (52.00%) and advice from crop research officers to produce rice (50.00%). About 5% of the rice producers used the varieties as a result of obtaining seeds at no costs from disseminators, indicating that adopters were mainly encouraged by the possibility of earning income from rice cultivation, since rice is now produced in Ghana for commercial purposes. The primary reasons for which rice farmers did not adopt certain modernized rice varieties were high demand for farm inputs to cultivate (96.00%), difficulties involved in selling paddy rice (69.31%), consumers' indifference towards rice products (52.00%) and susceptibility of rice seeds to droughts/floods (42.10%). The least reason given for farmer non-adoption of modernized rice varieties was advice by extension officers to stop cultivation (26.50%). The explanations above prove that rice producers easily use modernized rice seeds when promoted, but markedly reject the varieties, when they are confronted with production constraints. This means that institutions or the social system is partly to blame for the farmer rejection of modernized rice varieties in the northern Ghana. The highest constraints to modernized rice varieties adoption in northern Ghana were high cost of farm inputs (96.00%), lack of credit/rice production capital (91.60%) and scarcity of skilled labour (90.60%). The study concludes that adoption levels of modernized rice varieties in the region were very low due to the constraints identified above. These factors should therefore be taken into consideration in planning government interventions for the rice section in northern Ghana. Besides, NGOs, FBOs and other actors in the rice value chain should collaborate with the government of Ghana to minimize these constraints and optimize adoption levels of modernized rice varieties in northern Ghana, which is a food basket of the country.

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