Journal of Experimental Biology and Agricultural Sciences, April - 2022; Volume – 10(2) page 323 – 334

Journal of Experimental Biology and Agricultural Sciences

http://www.jebas.org

ISSN No. 2320 – 8694

An explorative study on the adoption and dis-adoption of improved rice varieties among farmers in the Northern region of Ghana

S. B. Azumah[1], C. Y. Lamptey[2], N. Sulemana[2], S. Donkoh[3], A. Zakaria[3], P. M. I. Maanikuu[4,*]

[1]DAAD climap Africa Postdoctoral fellow, University for Development Studies, P. O. Box TL 1350, Tamale, Ghana
[2]Department of Agricultural Innovation Communication, Faculty of Agriculture, Food and Consumer Science, University for Development Studies, P. O. Box TL 1350, Tamale, Ghana
[3]School of Applied Economics and Management Sciences, University for Development Studies, P. O. Box TL 1350. Tamale, Ghana
[4]Department of Agricultural Economics, Agribusiness and Extension, School of Agriculture and Technology, University of Energy and Natural Resources, Sunyani, Ghana

Received – September 25, 2021; Revision – December 06, 2021; Accepted – March 30, 2022
Available Online – April 30, 2022

DOI: http://dx.doi.org/10.18006/2022.10(2).323.334

KEYWORDS

Adoption

Dis-adoption

Improved Varieties

Rice

Northern Region

Ghana

ABSTRACT

Rice consumption in Ghana has increased steadily over the years. To enhance rice productivity to meet demand, several high-performing rice varieties have been disseminated via numerous interventions to smallholders in Northern Ghana. Nevertheless, productivity is still low at farm gate compared to research stations, due to smallholder poor adoption of the varieties. Using primary data collected from 404 farmers, the study examines the adoption levels of the main rice varieties among farmers and investigates the reasons for their adoption and dis-adoption. The empirical results revealed that rice varieties namely, Agra, Sakai, Jasmine 85, and Afife were the most adopted in the study area. Also, the study finds that GR-18, Nerica, Digang, Tox, Mandee, and Faro-15 were the most dis-adopted rice varieties. The main reasons for which farmers adopted the improved rice varieties were availability of a ready market for the produce, crop resistance to pests and diseases, consumer higher demand for rice, advice by extension staff to cultivate, and encouragement from researchers to adopt. The reasons for the dis-adoption of improved rice varieties in the study area were high input requirements, lack of ready market for the varieties, and unfavorable climatic conditions. The findings of the study give direction as to the angle from which the adoption of improved rice varieties can be stepped up while dis-adoption is reduced. Research scientists should research into rice varieties that are more suitable for the soil and climatic conditions of the study area and continue to sensitize and motivate the farmers to adopt them, while government should step up its support for the research scientists as well as the extension officers to deliver on their mandate.

* Corresponding author

E-mail: patrick.maanikuu@uenr.edu.gh (P. M. I. Maanikuu)

Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.

Production and Hosting by Horizon Publisher India [HPI] (http://www.horizonpublisherindia.in/).

1 Introduction

Rice is the main staple for more than half of the world's population. Asia and Sub-Saharan Africa (SSA) are the largest producers and consumers of rice in the world (FAO 2021). South and Southeast Asia alone produce more than 90% of the world's total rice output. 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). This implies that 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. Therefore, there is a need for a concerted effort to attain this goal. Dissemination and adoption of high-performing rice varieties in addition to good agronomic practices among farmers are a potential means of boosting rice productivity in Africa (Lamptey 2021).

The agricultural sector in Ghana has derived numerous benefits from several donor-assisted projects aimed at improving crop yield, reducing poverty, and increasing farmers' incomes (Ragasa et al. 2013). Crop farmers in the northern region of this country have gained much from the introduction of enhanced rice varieties together with other complementary innovations to boost rice production and productivity (Azumah 2019; Damba et al. 2020). The high-yielding rice varieties disseminated by the Ministry of Agriculture (MoFA) and other stakeholders along the rice value chain include Agra, Sakai, Jasmine 85, Afife, GR-18, Nerica, Digang, Tox, Mandee, and Faro-15. Rice production in Ghana is dominated by small-scale farmers and most of these farmers use low farm inputs and technologies (Lamptey 2018). Adoption of improved rice varieties are expected to enhance productivity and increase incomes, reduce poverty and consequently ensure equity among beneficiaries (Asante et al. 2004; MoFA 2019). As part of the measures to address the 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 the Sustainable Development Goals SDG 1 (no extreme poverty) and SDG 2 (zero hunger). The Northern region of Ghana is chosen for this study because it is considered the breadbasket of Ghana and the hub of rice production in the country. Despite these accolades and the huge potential that exist in the region, the rice productivity is still low (MoFA 2016; MoFA 2019).

Among the reasons for the low productivity in the region, low adoption rates of improved rice varieties are the most common ones (Azumah and Zakaria 2019; Lamptey 2021). Adoption of innovations has been studied extensively, but to the best of our knowledge, not much has been done on the dis-adoption of innovations, which is equally an important area of study. Though a few dis-adoption studies (Kijima et al. 2011; Kasirye 2013; Odeniyi et al. 2018), have been conducted recently, researchers have not focused much attention on studying dis-adoption as a general subject to formulate a unified "theory" of dis-adoption (Fournier et al. 2012).

Again to the best of our knowledge, there is no single research that combines the adoption and dis-adoption of modern and traditional rice varieties among farmers in the Northern region of Ghana. Odeniyi et al. (2018) also observed that there was no prior research to find out why Nigerian native farmers dis-adopted modern rice varieties.

Looking at adoption and dis-adoption in a single study would add impetus to the strengths of adoption research. This study, therefore, intends to make progress in that direction and look at the adoption and dis-adoption of improved and traditional rice varieties in the Northern region of Ghana.

2 Materials and Methods

2.1 Studied Location, Sample Size and Data

The study was conducted in the Northern region of Ghana (Figure 1). The Northern region is one of sixteen (16) administrative regions of Ghana. It has 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. According to the MoFA (2013), the average annual rainfall ranges between 750mm and 1050mm (30 to 40 inches). The region is the second-largest producer of paddy rice in the country, accounting for 68,407.25 metric tonnes per annum (Azumah 2019). However, the annual paddy rice yield in the region of 1.32Mt/ha is far below the national average yield of 3.65mt/ha (MoFA 2020).

The estimated sample size was 385 farmers, which was appropriate enough to prevent any erroneous conclusions in this study. We adjusted this sample size to 410 to cater to some design effects that might have arisen in the study. However, 404 out of the 410 questionnaires became suitable for the analysis.

A multi-stage sampling technique was employed to select 410 rice farmers from 48 selected communities, 14 zones, and 4 districts. Smith's (2019) sample size formula was used to compute the study sample size. The proportion of the sample assigned to each district was based on the estimated population of rice farmers in each district obtained from a sample frame obtained by Smith (2019).

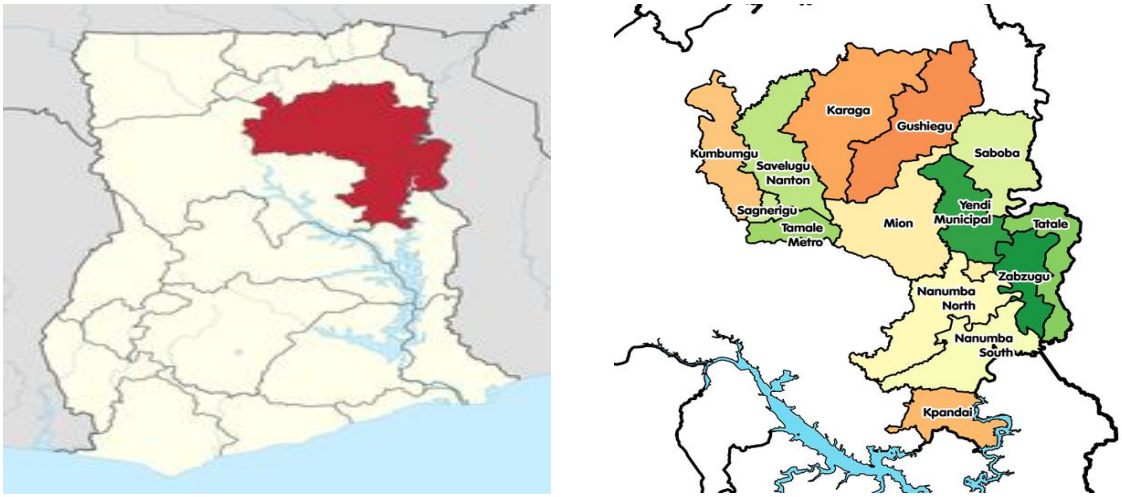

Figure 1 The study area (Source: Google Maps)

Table 1 Estimated sample size per district

District	Sample Size	Percentage	Number of Zones
Tolon	116	28.29	Four Zones
Kumbungu	112	27.32	Four Zones
Savelugu	120	29.27	Four Zones
Nanton	62	15.12	Two Zones
Total	410	100	Fourteen Zones

Source: Authors' construct, 2020

Table 2 Descriptive statistics of respondents' socioeconomic indicators

Variable	Mean	Std. Dev.
Adoption (1/0)	0.46	0.50
Age (Years)	39.69	10.65
Gender (1/0)	0.90	0.30
Education (1/0)	0.29	0.46
Household size (Number)	8.63	4.30
FBOs (1/0)	0.47	0.50
Own phone (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
Production credit (1/0)	0.35	0.48
Extension service (1/1)	0.80	0.40
Farm plot area (Acres)	3.87	3.81
Government policy (1/0)	0.87	0.34
Road Network (1/0)	0.75	0.44
Mechanization service (1/0)	0.78	0.41
Rainfall (1/0)	0.92	0.28
Harvesting method (1/0)	0.05	0.23

Source: Survey data (2020)

3 Results and Discussions

3.1 Profile of the Sampled Farmers

Table 2 shows the descriptive statistics of the sampled rice farmers. The results show that the mean age of the rice farmers was 40 years and about 30% of the farmers had formal education. Martey et al. (2013) revealed that farmers who have attained formal education are more likely to adopt 6new 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 while the mean farm size was 4 acres respectively. MoFA (2017) and Ragasa et al. (2013) reported that about 80% of the rice producers in Ghana are smallholder farmers and mostly have farmland less than one hectare in size. In addition, about 90% of the rice farmers were male. Similarly, about 87% of the farmers were aware of government policies toward rice production. The results also indicate that about 86% of respondents had access to an output market, 85% had access to an input market, 80% had access to extension services, and 35% had access to a production credit. The low level (10%) of women's participation in rice production in the study area corroborates with Martey et al. (2013) who asserted that women's roles tend to be restricted to domestic activities such that they are unable to find the time and resources required to go into farm activities.

Furthermore, about 92% of the farmers perceived a decrease in the rainfall pattern over the past decade, 75% had access to good roads, 47% were members of FBOs, 25% had personal mobile phones, 78% used tractors for land preparation for rice planting (mechanization). Lastly, about 95% harvested rice manually with the aid of sickles. That is only 5% of the farmers used a combined harvester for rice harvesting.

3.2 Levels of improved rice variety adoption and dis-adoption

The study identified twelve officially recognized and authorized rice varieties in the study area, ten of which were improved and two were traditional. The improved ones were Digang, Mandee, Faro-15, GR-18, Nerica, Jasmine 85, Agra, Afife, Tox, and Sakai while the traditional ones were Salma-Saa and Kpokpula. The study also identified two other improved rice varieties (*Moses* and *Iddi)* and seven traditional ones (*Adonga Adongo (Pole)*, *Basolugu*, *Shinkafa Kpana*, *Abugna*, *Alhaji Addae*, *Jakukuo*, and *Anyofula)* in

Table 3 Initial adoption, current adoption, and dis-adoption levels of rice varieties

Main Rice varieties*	Initial Adoption		Current Adoption**		Dis-adoption**	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Agra[I]	150	37.13	116	77.33	34	22.67
Sakai[I]	2	0.50	1	50.00	1	50.00
Jasmine 85[I]	166	41.09	67	40.64	99	59.64
Afife[I]	82	20.30	19	23.17	63	76.83
Nerica[I]	68	16.83	2	5.88	64	94.12
Digang[I]	57	14.11	7	12.28	50	87.72
Mandee[I]	55	13.61	10	18.18	45	81.82
GR-18[I]	52	12.87	3	5.77	49	94.23
Tox[I]	50	12.38	6	12.82	44	87.18
Faro-15[I]	27	6.68	3	11.10	24	80.90
Salma-Saa[T]	95	23.51	64	67.37	31	32.63
Kpokpula[T]	50	12.38	3	6.00	47	94.00
Others varieties *						
Iddi[I]	52	12.87	3	5.77	49	94.23
Moses[I]	27	6.68	3	11.10	24	80.90
Anyofula[T]	50	12.38	6	12.82	44	87.18
Basolugu[T]	27	6.68	3	11.10	24	80.90
AdongaAdongo[T]	50	12.38	4	8.00	46	92.00
Abugna[T]	50	12.38	3	6.00	47	94.00
AlhajiAddae[T]	50	12.38	3	6.00	47	94.00
ShinkafaKpana[T]	17	4.21	1	5.88	16	94.22
Jakukuo[T]	20	4.95	1	5.00	19	95.00

*Multiple responses, ** Current Adoption + Dis-adoption = Initial Adoption; *I* = Improved variety; *T* = Traditional variety (Source: Survey data, 2020)

the area, which were not officially recognized. This sums up to twenty-one; twelve improved and nine traditional rice varieties in the Northern trigon of Ghana. Ragasa et al. (2013) also found several other varieties of rice cultivated by farmers in Ghana besides the officially recognized and authorized ones. The levels of initial adoption, current adoption, and dis-adoption of rice varieties in the study area are shown in Table 3.

The initial levels of adoption for all the rice varieties were generally low (below 40%), except for Jasmine (41%). However, three out of the twenty-one rice varieties in the study area had their current levels of adoption rising above 40%. These were Agra (77.33%), Sakai (50%), and Jasmine (40.64%). Though Sakai had a 50% current level of adoption, it only demanded research purposes (Lamptey 2021), meaning only Agra and Jasmine had high current levels of adoption among the farmers. The dis-adoption levels for all the rice varieties were extremely high (above 50%), except for Agra (22.67%) and Salma-Saa (32.63%). It confirms that the levels of improved rice variety adoption among farmers are indeed low, with correspondingly high levels of dis-adoption across Africa (Kijima et al. 2011; APS 2015; FAO 2021).

3.3 Processes of improved rice variety adoption and dis-adoption

This section looks at the processes of improved rice variety adoption and dis-adoption in the study area. Adoption of improved rice varieties in the study area followed the normal process of awareness, trial, acceptance, and usage but the dis-adoption followed an irregular and protracted pattern. The dis-adoption happened either gradually or abruptly, intentionally or unintentionally, corroborating (Rogers 2005). According to the farmers, when they became aware of the improved rice varieties through the various agents and channels of innovation communication, they learned how to cultivate them from either their fellow farmers or agricultural extension officers and researchers. They attended farmer field schools, demonstration farms, group discussions, and community to acquaint themselves with the appropriate ways of cultivating them.

Some of the farmers also said during FGDs that they only saw the performances and output of the improved rice varieties in their fellow farmers' farms and demonstration plots of the extension officers in their communities, and also looked for the seeds in the subsequent cropping seasons to cultivate. Other farmers also said they did not see the performances and output of those varieties but they got the seeds from either traders or their relatives who had brought them from other regions and communities and encouraged them to cultivate. The farmers explained that those of them who did not belong to farmer groups did not have the opportunity to attend the farmer field schools and demonstration farms of the researchers and extension officers, but they either saw the farms or heard about them. They explained how they adopted the improved rice varieties as follows:

"When we cultivate any new varieties continuously for about four years, we change them and grow different varieties in the same fields. If not, they mix up with wild rice varieties from the soil and neighboring fields. They also become susceptible to pests and diseases infestations as well as a decline in yields, among other reasons. We are normally advised by the extension officers and researchers to buy new certified seeds every four years but those seeds are more expensive. So, we continue to recycle our seeds for subsequent cultivation. Besides, we normally use the same rice fields for all our rice varieties so the only thing we do is a change from one variety to another. However, we normally do not revert to the old varieties because there are other new varieties available for cultivation (adoption). The best thing would have been for us to use different fields for different rice varieties but the land is limited; we have few rice fields. Our lands are also not fertile. So, we spend huge sums of money buying fertilizers and other agrochemicals. It, therefore, becomes difficult for us to keep buying new certified seeds now and then.

Sometimes, we get free improved seeds and fertilizers from MoFA, middlemen, processing companies, and NGOs, so we leave the existing varieties and cultivate those since most of them come with ready markets and other incentive packages. But when they fail us, we stop growing their rice and stick to our varieties. For example, in the case of NERICA, SARI and MoFA used to buy the seeds and grains from us but when they stopped, we had nobody to buy them from us, and we lost woefully. The market women and consumers prefer AGRA and JASMINE 85 to NERICA and other improved rice varieties. We are therefore cultivating AGRA and JASMINE 85 now because they sell".

Some individual farmers also recounted how they adopted and dis-adopted some improved rice varieties. A contact farmer at Kpachi in the Tolon District said he invested so much money into the cultivation of Jasmine 85 in 2016 because the AVNASH processing company at Nyankpala was buying huge quantities of rice grains from farmers in the district. But he lost his farm to the drought that year and had since not recovered from the shock. So, he stopped cultivating Jasmine 85 in 2016 and started Agra cultivation in 2017. Another farmer at Nabogu in the Savelugu Municipality also said he lost about twenty acres of his Mandee rice farm at Diare to a swam of birds in 2016 at the time of harvest. So, had also stopped growing Mandee since those birds were prevalent in that community, and relocated to Nabogu to cultivate Tox, also known as Nabogu rice. Similarly, a farmer at Jana in the Nanton District recounted:

"In 2017, I harvested over fifty bags of Afife rice on my farm and managed to carry them with the help of laborers to a nearby

roadside. I went to town to look for a vehicle to convey them home but upon my return to the roadside, I realized that bush fire had devoured my entire harvest. I lost both my grains and rice seeds, which I would have used for the sale and subsequent cultivations respectively. I was devastated. So, I had to look for different rice seeds (Salma-Saa) to grow the following year. The Afife was good for my soil and I used to cultivate five acres but now I only cultivate two acres of Salma-Saa".

In the same way, many farmers in the Kumbungu District said they predicted the weather to sow their rice seeds in the 2017 and 2018 cropping seasons but most of the seeds failed to germinate because the rains did not come down as expected. Those that germinated also got scorched by the sun and weathered. They then looked for different varieties of seeds to sow and those seeds also got rotten and some were washed away, due to flooding.

They said they could not get the same varieties they usually cultivated on their farms (Faro-15, GR-18, Agra, and Jasmine 85) after those horrible incidents, for re-cultivation. So, they resorted to the cultivation of Mandee and Kpokpula, which matured in about four months. However, due to the reduced rainfall pattern in recent years, those two varieties also dried up in the fields before maturity. Hence, they could not break even in 2017 and 2018. They therefore resorted to the cultivation of an improved rice variety called "Moses" and a traditional variety known as "AlhajiIddi", which were common in the study area. Many farmers at Botanga and Dallon did not experience those devastating effects of droughts and flooding due to the presence of irrigation facilities in their communities. It means adoption of the improved rice varieties occurred after farmers became aware of them, had tried them, and were convinced to accept and grow them for commercial purposes, corroborating (Rogers 2005). The dis-adoption of the improved rice varieties occurred after adoption when farmers faced adverse conditions for their continuous adoption and had lost the needed utility from their adoption decisions, corroborating (Oster and Thornton 2009).

This shows that adoption and dis-adoption are indeed two sides of the same coin. There was relatively little uncertainty in the dis-adoption processes about what farmers were missing, compared with the adoption processes in which uncertainty was inherent. The farmers also adopted the rice varieties by receiving them but dis-adopted them without getting rid of them in their communities. The farmers as well went through several psychological processes such as loss phobia and possession utility in the dis-adoption processes than in the adoption processes, which were more fulfilling and satisfying. The farmers, therefore, showed excitement narrating their adoption experiences but sadness when recounting the processes that led to their dis-adoption decisions. That confirmed the fact that the psychology of choice is markedly different from the psychology of rejection (Oster and Thornton 2009).

The processes of improved rice variety dis-adoption in the study area therefore comprised withdrawal, disengagement, discontinuity, abandonment, desertion and rejection. Each of these process terminologies can be investigated as an entity, over a long period (Taxler and Byerlee 1993). This makes dis-adoption studies a protracted phenomenon compared to adoption studies that are quite dichotomous. The protracted nature of dis-adoption studies discourages many researchers from venturing into that terrain, especially in Ghana.

Thus, the farmers said all of them do not stop cultivating a particular improved rice variety at the same time because every farmer has the reasons for which he or she cultivates rice. However, they said they all cultivate rice for food and income. So, when they realize cultivating a particular improved rice variety does not meet their expectations for food and income, they stop its adoption, one after the other farmer, until the whole community dis-adopts it. They also said they do not re-adopt rice varieties they have once dis-adopted since they keep getting better varieties for adoption. This practice is called "Variety Seeking", whereby adopters move from adopting one innovation to the other till they get what suits them most (Fournier et al. 2012; Odeniyi et al. 2018). The fact that all the farmers do not dis-adopt improved rice varieties at the same time confirms (Fournier et al. 2012), the view that dis-adoption involves a gradual alienation or a more liminal state of dissociation and separation over time.

3.4 Reasons for adoption

Farmers' reasons for adopting the improved rice varieties are shown in Table 4. The specific reasons farmers gave for adopting improved rice varieties, in order of importance are, ready market for the produce (81.68%), resistance to pests and diseases (76.73%), higher demand for produce (56.93%), advice from extension staff (51.98%) and advice from researchers (50.00%). The ready market for the products existed when the paddy rice was bought at the farm gate by MoFA and SARI staff, middlemen, and processors, who in turn stored, processed, and repackaged it for sale. The farmers were therefore sure of who would buy their produce after harvest and at predetermined prices. Demand for the product, on the other hand, came from consumers or the general public, whose tastes and preferences for the various rice varieties cause farmers to produce those particular varieties, even in the absence of 'ready markets'. A ready market for the product did not guarantee higher consumer demand for the produce. The farmers, therefore, produced some particular rice varieties like Agra or Jasmine and sold them either directly to consumers or to retailers in the open markets. That way, they did not depend on fixed prices or predetermined bulk buyers such as SARI, MoFA, rice aggregators and processors, or the National Food Buffer Stock Company. However, these produce buying companies purchased paddy rice from the farmers in compliance with government policy

Table 4 Farmers' Reasons for Adopting Improved Rice Varieties

Reasons for Adoption*	Frequency	Percentage
Ready market for the produce	330	81.68
Crops are resistant to diseases/pests	310	76.73
Higher demand for the product	230	56.93
Was advised by extension staff to cultivate	210	51.98
Was advised by researchers to cultivate	202	50.00
Seed more suitable for the soils	120	29.70
Crops very resistant to droughts	145	35.89
Others (nice taste/aroma, easy to cook, easy to mill)	67	16.58
Low input requirements	27	6.68
Got free seeds from promoters	20	4.95

Source: Survey data, 2020 * Multiple responses N=404

for the rice sector, to help keep the farmers in business, even if a particular rice variety was not in high demand by consumers in the general public. Only 4.95% of the farmers said they adopted the varieties because they got free seeds from promoters such as Non-Governmental Organizations (NGOs), Rice Aggregators, Crop Researchers, and Agricultural Extension Agents (AEAs).

The finding implies that the farmers were mostly motivated by the marketability of the produce after harvest because rice has now become a commercial crop in Ghana (Ragasa et al. 2013; APS 2015). The farmers said during FGDs that most of them farmed rice to sell for money and not only for food. Hence, many of them adopted Agra, Jasmine, and Salma-Saa, which had a ready market and other good qualities such as nice taste and aroma. It means the farmers adopted rice varieties that had a relative advantage over other varieties and these results are in line with Rogers's (2005) hypothesis that innovation would be adopted if it is perceived to have relative advantages over other innovations.

The farmers also emphasized during the FGDs that they normally do not reject any improved rice varieties introduced to them. Rather, they try them for some time before adopting them and they may continue to do so until other newly improved varieties with better qualities are introduced to them for adoption. This also explains why Agra and Jasmine had higher adoption levels than other improved rice varieties, which were promoted earlier in the study area. This means that Agra and Jasmine are also likely to give way to the adoption of other better-improved rice varieties to be promoted in the region, these results are corroborating with Oster and Thornton (2009), who posited that understanding the procedure of innovation adoption, can help to predict adoption patterns.

Similarly, the adoption level of Salma-Saa was higher than that of Kpokpula because Kpokpula is much older in the study area than Salma-Saa. FGDs with the farmers and KIIs with researchers and extension officers revealed that Kpokpula is an indigenous variety that has been in the region for over half a century now but Salma-Saa is a strain (an incomplete breed) of Jasmine 85 that had been under cultivation in the region before the release of Jasmine 85 about a decade ago. This is in line with Ragasa et al. (2013) who reported that Jasmine 85 (Saa Rice) got accreditation a decade ago, but it was already being cultivated by many farmers in different parts of the country. Salma-Saa has some of the unique characteristics of Jasmine 85, in addition to the fact that it has adapted to the growth and climatic conditions of the area. The farmers explained that the indigenous rice varieties such as Salma-Saa and Kpokpula, have low input requirements and minimal agronomic practices than the improved varieties. They, therefore, continued to cultivate those traditional varieties even when they did not have good markets, milling, and cooking abilities. The farmers added; "we do not buy those seeds", "those seeds are easy to obtain" and "they can still give us some yields even when the rains fail", corroborating Taxler and Byerlee (1993) that grain quality, straw yield, grain yield, and input requirements affect farmers' propensity to adopt farm technologies.

The farmers emphasized that there was no way they would entirely abandon their native varieties to "foreign" ones. According to them "We met our fathers and fore-fathers growing those varieties and we are used to them." They further explained that these varieties have more medicinal, cultural, and religious values than the improved ones: "Some herbalists and traditional authorities prefer the indigenous varieties to the improved ones, as custom demands." They went on to state that the traditional varieties were economical (affordable, easily accessible, easy to cook) for occasions such as marriage, outdooring, passing out, and funeral ceremonies as well as festivals where a lot of people need to be fed. They reiterated that "Kpokpula" owed its name to the fact that it was more suitable for making "rice balls" than any other rice

variety in the region. Their responses show that some of them were conservatives who exhibited the characteristics of peasant farmers or laggards (Rogers 2005). This is in tandem with Azumah (2019), who found that 35% of the rice farmers in northern Ghana produced solely for a subsistent purpose.

Finally, some of the farmers said they were seed growers in their communities. Therefore, researchers and other farmers from different localities normally contacted them for seeds of various improved rice varieties. So, they produced seeds of various improved rice varieties even when their fellow farmers were no more adopting them. That accounted for the 50% current adoption rate of Sakai even though its initial adoption rate was 0.50%. The reason for seed growers' adoption decision is what is referred to as Future Viability, whereby farmers continue to adopt certain innovations to preserve them for future engagements (Fournier et al. 2012)

3.5 Reasons for dis-adoption

This section also discusses farmers' reasons for dis-adopting the main rice varieties, with particular emphasis on the improved ones. The farmers' main reasons for dis-adopting improved rice varieties were high input requirements (95.80%); absence of a ready market for the produce (69.31%), output was no longer demanded by consumers (51.98%), and when seeds made the crops too susceptible to droughts (42.08%). The least reason they gave for their dis-adoption of improved rice varieties was that they were advised by extension staff to stop (26.49%). Other reasons are as shown in Table 5, which are consistent with Doss (2006), who found that farmers willingly adopt high-yielding rice varieties when promoted, but they significantly abandon the varieties in subsequent years, partly due to liquidity constraints. These findings on the dis-adoption of the rice varieties are also consistent with Taxler and Byerlee (1993) who observed that crop characteristics like grain quality, straw yield, grain yield, and input requirements influence farmers' decisions in assessing agricultural innovations. Other attributes of innovations that determine their levels of dis-adoption include adaptability, reliability, observability, profitability, complexity, and relative advantage (Rogers 2005).

Demand and supply are market forces that determine the market price for products and which also influence their adoption. It implies that the farmers dis-adopted improved rice varieties that had high input requirements and were no longer driven by market forces as well as those that were not compatible with the environment.

Thus, farmers were no longer deriving maximum utility from adopting those innovations and decided on their own to dis-adopt them, without being coerced or intimidated by external forces. Hence, they cited extension officers as having contributed the least (26.49%) to their dis-adoption of improved rice varieties. This is in line with Rogers (2005) who penned that adoption is an individual affair.

KIIs revealed that the advice by extension agents or researchers was not meant for farmers to dis-adopt the varieties but to revert to purchasing certified seeds for their fields after every three or four years and also to desist from cultivating the same improved rice varieties on the same piece of land after four successive years of cultivating those varieties; thus, these results are corroborating with Lamptey (2018). They were likewise advised to avoid "recycling" the same seeds or using hybridized seeds year after year since those seeds do not have the same vigor as the certified seeds. These findings are consistent with Doss (2006), Ragasa et al. (213), APS (2015), and AGRA – SSTP (2016). The idea is to avoid the build-up of pests and diseases associated with those varieties and also to prevent the recessive traits of those varieties from showing up. Martey et al. (2013) and Donkoh and Awuni (2011) also found that rice farmers in the study area discontinued the use of organic manure to fertilize their rice fields due to their poor perception of it.

Table 5 Farmers' reasons for dis-adopting improved rice varieties

Reasons for Dis-adoption*	Frequency	Percentage
High input requirements	387	95.80
No ready market for the produce	280	69.31
Output of seed no longer demanded by consumers	210	51.98
Seeds make crops too susceptible to droughts	170	42.08
Seed are no longer suitable for the soils	150	37.13
Seed too costly	130	32.18
Was advised by researchers to stop	119	29.46
Other Reasons (seed contamination, variety seeking)	113	27.97
Seeds make crops too susceptible to diseases/pests	110	27.23
Was advised by extension staff to stop	107	26.49

Source: Survey data, 2020 *Multiple responses N =404

According to the key informants, the farmers sometimes complain of seed contamination due to flooding and cross-pollination with wild varieties (bad rice) in their fields. So, they advise them to replace the impure seeds with pure improved seeds or practice roguing. However, the farmers' perception of the high cost of pure or certified seeds and labor intensiveness of roguing (high input requirements), make them resort to either cultivating local varieties on their fields or not reverting to cultivating the improved varieties they once cultivated. The farmers confirmed during FGDs that they normally do not re-adopt improved rice varieties they dis-adopt because there are several other improved rice varieties to choose from. "We stopped growing them because they were no longer good for us. If they were good for us, we would not have dis-adopted them in the first place. So, why should we go back for them when there are better ones around?" This shifts the reason for dis-adoption to the doorsteps of institutions and agents that promote several improved rice varieties incessantly in the study area. Even though institutions rarely advise farmers to dis-adopt innovations, they do so when the innovations become undesirable or obsolete (Price et al. 2000; Lastovicka and Karen 2005; Martey et al. 2013).

Innovation dis-adoption caused by researchers, extension agents, and market forces are referred to as institutionally induced dis-adoption of undesirable innovations (Lastovicka and Karen 2005; Fournier et al. 2012). Dis-adoption of Nerica, Digang, and Tox was institutionally induced because the farmers abandoned their cultivation due to a lack of ready market for their produce, these results are corroborating with the findings of previous researchers who observed that even though Nerica was also keenly promoted in the study area about a decade ago, the farmers had dis-adopted it alongside the older varieties like Digang and Tox, due to lack of ready market for its output (Kijima et al. 2011; Lamptey 2018; Lamptey 2021). Similarly, Kijima et al. (2011) found that more than 50% of Nerica adopters in Uganda who adopted the Nerica in 2004 abandoned it in 2006, due to the low profitability of Nerica relative to other crops. This finding is contrary to that of Carletto et al. (2007), who opined that pressure to dis-adopt agricultural technologies sets in after 20 years of use. According to the farmers: "sari and MoFA staff normally bring us new improved rice varieties to cultivate, which they claim are better than the existing ones in terms of yield, resistance to pests, diseases and water stress. So, we normally have many varieties at our disposal to choose from. When we produce the newly improved rice varieties, we get high yields but poor markets for them because most consumers and traders are not familiar with them. When we produce them for sale and we do not get good markets for them, we stop and go in for those that the market women like buying. We do that because we need money to pay for our input and tractor services, children's school fees, hospital bills, light bills, and to meet other social and family responsibilities. Besides, we farm to make profit, not losses".

The above extract shows that researchers, extension agents, and market forces served as institutional factors leading to farmer dis-adoption of improved rice varieties. This type of dis-adoption did not occur because the rice varieties had outlived their usefulness in the communities but since they did not meet the tastes and preferences of their target audience. This does not mean that the rice varieties did not have good tastes and nice aroma. Rather, farmers, consumers, and traders were not used to them. They were therefore readily available for adoption but incompatible with the ideals, norms, and values of the social system, corroborating (Rogers 2005). Hence, they were dis-adopted. The best thing should have been to promote their adoption and consumption at the same time. It means rice dissemination projects should factor in promotional campaigns to enhance their demand and consumption by the public.

Rice varieties dis-adopted mainly due to unfavorable environmental factors were Jasmine, Mandee, and Afife. These types of improved rice were dis-adopted due to the effects of pests, birds, floods, drought, bushfires, and poor soil fertility on their cultivation. The type of dis-adoption caused by unfavorable environmental factors including, "when seeds make the crops too susceptible to droughts", or pests and diseases infestations are known as nature induced dis-adoption as in termination of human relationships (Duck 1982; Lastovicka and Karen 2005; Fournier et al. 2012). That is because the same principle applies when an adopter dies, migrates, relocates, or stops farming for other occupations that do not need the innovation in question.

However, dis-adoption does not always terminate relationships but it can create brand enemies and former friends (Johnson 2011). Hence, most of the farmers appeared to have abandoned GR-18, Faro-15, Digang, and Nerica, yet those varieties were still in the communities because some farmers were cultivating them. That is perhaps, as the saying goes, "one man's meat is another man's poison". It means the fact that farmers dis-adopt some particular improved rice varieties does not necessarily mean those improved rice varieties are no longer in existence and therefore cannot be adopted by other farmers or be re-adopted by their dis-adopters.

Improved rice varieties, especially Faro-15, GR-18, and Sakai, were dis-adopted by farmers in this study due to "high input requirements". The type of innovation dis-adoption is known as farmer-initiated dis-adoption of unsustainable innovations (Fournier et al. 2012). That is because the farmers complained that the improved rice varieties had high input requirements relative to the traditional varieties. The rationale is that farmers are rational beings, who advise themselves when they realize they can no longer afford an innovation, sustain it with its associated practices, or derive maximum utility from its continuous adoption. This is in tandem with Doss et al. (2003), who found that farmers do not

adopt innovations "wholesale". Rather, they pick and choose aspects of the innovations that are convenient, applicable, and relevant to them. The farmers said, during FGS that: "We sometimes do not farm certain improved rice varieties because they demand plowing and harrowing, more fertilizers, herbicides, weedicides, and other agro-chemicals. They are also labor-intensive time consuming to plant, transplant and harvest. They do not give good yields when we do not have time for them. The old improved rice and traditional varieties are not like that. They can still give some yields even if we do not have much time and resources for their cultivation".

The above narrative, therefore, exemplifies what is termed a farmer-initiated type of dis-adoption of unsustainable innovations, this is corroborating with Fournier et al. (2012). It means the farmers dis-adopted some improved rice varieties to adopt other ones. Rogers (2005) described this practice as replacement discontinuance. The farmers' responses also show that they dis-adopted those varieties due to the negative aspects of the innovations, this is corroborating with Fournier et al. (2012) who posited that technologies dis-adopted are as ineffective as technologies not adopted. That explains why some researchers classify dis-adopters as non-adopters Doss (2006) but Lamptey (2021) classified them as two separate entities with similar characteristics. The reason for the farmers' behavior above is termed 'Variety Seeking', a phenomenon that occurs when the farmers have several alternatives to choose from (Rogers 2005; Fournier et al., 2012).

However, it is not always the case that when farmers dis-adopt some particular improved rice varieties, they would be adopting other improved rice varieties (Lastovicka and Karen 2005). That is why the dis-adoption levels of some improved rice varieties in the study area were high, yet the adoption levels of other improved rice varieties were very low (Asuming-Brempong et al. 2011; Lamptey 2021). Rogers (2005) referred to that practice as disenchantment discontinuance, where a farmer discontinues an innovation with or without replacement as a result of dissatisfaction with the innovation's performance. Also, the fact that farmers dis-adopt some particular improved rice varieties does not necessarily mean they dislike all improved rice varieties. Hence, though there were higher levels of dis-adoption of many improved rice varieties in this study, the adoption levels of a few improved rice varieties were equally high.

Hence, this study revealed three types of improved rice variety dis-adoption in the study area, with the farmers at the center stage. They were; farmer-initiated type of dis-adoption, institutional initiated farmer dis-adoption, and nature induced dis-adoption as in the termination of human relationships. Since all the three types of innovation dis-adoption occurred in the study area, it means the dis-adoption of improved rice varieties in the region cannot be blamed solely on the farmers, institutions, or nature because they all served as collaborative actors. This is in tandem with Fournier et al. (2012) that dis-adoption is a process in society that involves many people, besides the dis-adopters. It means many people were implicated in a dis-adoption phenomenon in the study area.

4 Conclusions and Future Recommendations

4.1 Conclusions

Over the years, rice farmers in Ghana have gained immense benefits from the introduction of enhanced crop varieties that come along with other innovations like tillage, fertilizer, agrochemical application methods, and planting and harvesting methods, among others. However, the levels of adoption of improved rice varieties in the study area have been very low with alarming rates of dis-adoption. While studies on the adoption of improved seed varieties abound in Ghana, there is none on the reasons for the dis-adoption of improved rice varieties, to the best of our knowledge. The objectives of this study were to investigate the levels of adoption and dis-adoption of the main rice varieties in the Northern region of Ghana, for the past ten years and examine the process and reasons for the adoption and dis-adoption.

The findings indicate that the adoption levels were generally low with the most adopted improved rice varieties being Agra (77.33%), Sakai (50%), Jasmine (40.64%), and Afife (23.17%), and the rest falling below 20% each. The dis-adoption levels on the other hand were very high, with the six most dis-adopted improved rice varieties being GR-18 (94.23%), Nerica (94.18), Digang (87.72%), Tox (87.18%), Mandee (81.82%) and Faro-15 (80.90%). The dis-adoption level of Kpokpula, a traditional variety, was 96.00%, which was higher than that of any of the improved rice varieties. It means the farmers had dis-adopted both improved and traditional rice varieties and were more inclined towards the adoption of the newly improved ones, especially Jasmine and Agra.

Adoption of improved rice varieties in the study area followed a dichotomous process of awareness, trial, acceptance, and usage but the dis-adoption assumed a protracted pattern. The processes of improved rice variety dis-adoption in the study areas comprised withdrawal, disengagement, discontinuity, abandonment, desertion, and rejection. The study revealed three types of innovation dis-adoption in the region, with the farmers at the center stage. Firstly, farmer-initiated dis-adoption of rice varieties such as Faro-15, GR-18, and Sakai which are associated with unsustainable practices. Secondly, institutional initiated dis-adoption of rice varieties like Digang, Nerica, and Tox, having undesirable characteristics. Lastly, nature-induced dis-adoption of rice varieties such as Jasmine, Mandee, and Afife are caused by farmers' death, relocation, change of occupation, or the effects of climate change.

The five most important reasons for which farmers adopted improved rice varieties in Northern Ghana were a ready market for the produce (81.68%), crop resistance to pests and diseases (76.73%), consumer higher demand for rice (56.93%), advice by extension staff to cultivate (51.98%) and motivation for adoption from researchers (50.00%). Only 4.95% of farmers adopted the varieties because they got free seeds from promoters. It means adopters were mostly motivated by the marketability of the produce after harvest because rice had become a commercial crop in Ghana. The farmers' main reasons for dis-adopting improved rice varieties were high input requirements (95.80%), absence of a ready market for the produce (69.31%), the output being no longer demanded by consumers (51.98%), and when seeds made the crops too susceptible to droughts (42.08%). The least reason for which the farmers dis-adopted improved rice varieties was that they were advised by extension staff to stop cultivation (26.49%). These reasons confirm the fact that farmers readily adopt high-yielding rice varieties when introduced, but they significantly abandon them in subsequent years, partly due to liquidity constraints.

The presence of several improved rice varieties in the study area made the farmers exhibit "replacement discontinuance", by dis-adopting some varieties to adopt other superior varieties. The farmers also exhibited "disenchantment discontinuance", by dis-adopting some varieties with or without replacement, due to dissatisfaction with the performances of those varieties. Thus, the reasons for the dis-adoption of improved rice varieties in the study area were multi-faceted.

4.2 Recommendations

The government could increase the levels of adoption of Agra, Sakai, Jasmine, and Afife, but decrease the levels of dis-adoption of GR-18, Nerica, Digang, Tox, Mandee, and Faro-15 by subsidizing their input requirements and providing ready markets to them through the School Feeding Programme. Researchers should also breed improved rice varieties that are adaptable to prevailing climatic conditions in the study area, to be promoted by the AEAs of MoFA and their collaborators. The government, through MoFA, should come out with approved and recommended varieties to be adopted and ensure their compliance. That would help to regulate the proliferation of improved rice varieties in the study area and control the diffusion of existing varieties before new ones are introduced.

Since the government finances the dissemination and adoption of improved rice varieties in the study area, they should also finance disadoption studies to help monitor and evaluate the post-adoption behavior of farmers of improved rice varieties. The monitoring and evaluation officers of MoFA should be adequately resourced to carry out this responsibility for the state and give appropriate feedback to the state research institutions like sari and Csir. Also, academic researchers in Ghana should be sponsored to study the phenomenon of dis-adoption, to augment the efforts of MoFA staff. Civil society, including NGOs, should likewise collaborate with the government in promoting the adoption and mitigating dis-adoption of improved rice varieties in the region.

The three-fold dis-adoption of rice varieties in the study area has policy implications such that the government and all stakeholders in the rice value chain in this country would have to ensure that farmer-initiated dis-adoption of unsustainable varieties, institutional initiated dis-adoption of undesirable varieties, and nature induced dis-adoption of rice varieties are minimized.

References

AGRA – SSTP. (2016). Ghana Early Generation Seed Study, Final Report for the United State Agency for International Development theory. Retrieved from https://agrilinks.org/sites/default/files/resource/files/ghana_early_generation_seed_report.pdf.

Agricultural Production Survey for the Northern Regions of Ghana. (2015). 2013-2014 Results (2015). Final Report, Retrieved from www.agmanager.info.file.

Asante, E. G., Appiah, M. R., Ofori-Frimpong, K., & Afrifa. A. A. (2004). The economics of fertilizer use on some peasant cocoa farms in Ghana. *Ghana Journal of Agricultural Science 33*, 183–190.

Asuming-Brempong, S., Gyasi, K. O., Marfo, K. A., Diagne, A., et al. (2011). The exposure and adoption of New Rice for Africa (NERICAs) among Ghanaian rice farmers: What is the evidence? *African Journal of Agricultural Research*, *6*(27), 5911-5917.

Azumah, S. B. (2019). Agricultural Technology Transfer, Adoption and Technical Efficiency of Rice Farmers in Northern Ghana. PhD Thesis, *University for Development Studies, Ghana*. Retrieved from www.udsspace.uds.edu.gh.

Azumah, S. B., & Zakaria, A. (2019). Fertilizer Subsidy and Rice Productivity in Ghana: A Microeconomic Study. *Journal of Agricultural Studies, 7*(1), 82-102.

Carletto, C., Kirk, A., & Winters, P. (2007). Non-traditional exports, traditional constraints: The adoption and diffusion of cash crops among smallholders in Guatemala. *World Bank Policy Research Working Paper No*., 4347.

Damba, O. T., Ansah, I. G. K., Donkoh, S. A., Alhassan, A., et al. (2020). Effects of technology dissemination approaches on agricultural technology uptake and utilization in Northern Ghana. *Technology in Society*, *62*, 101294.

Donkoh, S.A., & Awuni, J.A. (2011). Adoption of Farm Management Practices in Lowland Rice Production in Northern

Ghana. *Journal of Agricultural and Biological Science*, *2* (4), 084-093.

Doss, C. R. (2006). Analyzing technology adoption using microstudies: limitations, challenges, and opportunities for improvement. *Agricultural Economics 34*, 207–219.

Doss, C. R., Mwangi, W., Verkuijl, H., & de Groote, H. (2003). Adoption of Maize and Wheat Technologies in Eastern Africa: A Synthesis of the Findings of 22 Case Studies, International Maize and Wheat Improvement Center (CIMMYT), Mexico. *E C O N O M I C S Working Paper*, 03-06.

Duck, S. (1982). *Personal Relationships 4: Dissolving Personal Relationships.* London: Academic Press.

Food and Agriculture Organization of the United Nations. (2021). World Rice Production and Trade in Brief-Cotecna, FAO; Rome, Italy. Retrieved from https://www.cotena.com.

Fournier, S., Alvarez, C., & Avery, J. (2012). Disadoption Through the Relationship Lens", in NA - Advances in Consumer Research Volume 40, eds. Zeynep Gürhan-Canli, Cele Otnes, and Rui (Juliet) Zhu, Duluth, MN : *Association for Consumer Research*, *Pages*: 313-317. Retrieved from http://www.acrwebsite.org/volumes/1013118/volumes/v40/NA-40.

Johnson, A. R., Maggie, M., & Matthew, T. (2011). A Coal in the Heart: Self-Relevance as a Post-Exit Predictor of Anti-Brand Actions, *Journal of Consumer Research*, *38* (1), 108-125.

Kasirye, I. (2013). Constraints to Agricultural Technology Adoption in Uganda: Evidence from the 2005/06-2009/10 Uganda National Panel Survey, Economic Policy Research Centre, Makerere University, Kampala, Uganda.

Kijima, Y., Otsuka, K., & Sserunkuuma, D. (2011). Assessing the impact of NERICA on income and poverty in central and western Uganda. *Agricultural Economics*, *38*, 327–337.

Lamptey, C. Y. (2018). Adoption of NERICA among Rice Farmers in the Tolon and Kumbungu Districts in the Northern Region of Ghana. MPhil Thesis, *University for Development Studies*, Ghana. Retrieved from www.udsspace.uds.edu.gh.

Lamptey, C. Y. (2021). Adoption and Disadoption of Improved Rice Varieties among Farmers in the Northern Region, Ghana. PhD. Thesis, *University for Development Studies*, Ghana. Retrieved from www.udsspace.uds.edu.gh.

Lastovicka, J. L., & Karen V. F. (2005) Three Paths to Disposition: The Movement of Meaningful Possessions to Strangers. *Journal of Consumer Research*, *31* (4), 813-823.

Martey, E., Wiredu, A. N., Asante, B. O., Anim, K., et al. (2013) Factors Influencing Participation in Rice Development Projects: The Case of Smallholder Rice Farmers in Northern Ghana. *International Journal of Development and Economic Sustainability*, *1* (2), 13-27.

Ministry of Food and Agriculture (2016). Agriculture in Ghana, Facts and Figures 2015, Statistics, Research and Information Directorate (SRID), October 2016, Accra, Ghana.

Ministry of Food and Agriculture (2019). 2019 Annual Report on Rice Farmers in Kumbungu District, December, 2019, Northern Region, Ghana.

Ministry of Food and Agriculture. (2013). Agriculture in Ghana: Facts and Figures (2012), Statistics, Research and Information Directorate (SRID), 1–45. August, 2013, Accra, Ghana.

Ministry of Food and Agriculture. (2017). Planting for Food and Jobs, Strategic Plan for Implementation (2017-2020), Republic of Ghana.

Ministry of Food and Agriculture. (2020). Agriculture in Ghana, Facts and Figures 2015, Statistics, Research and Information Directorate (SRID), September 2020, Accra, Ghana.

Odeniyi, K. A., Elizabeth J. Z., Robinson, C., & Srinivasan, S. (2018). Agricultural Technology Disadoption: Why Rural Farmers Abandon Improved Rice Varieties, Tropentag, September 17-19, 2018, Ghent, United Kingdom.

Oster, E., & Thornton, R. (2009). Determinants of technology adoption: Private value and peer effects in menstrual cup take-up, mimeo University of Chicago.

Price, L., Eric A., & Carolyn, C. (2000). Older Consumers' Disposition of Valued Possessions, *Journal of Consumer Research*, *27*, 179-201.

Ragasa, C., Dankyi, A., Acheampong, P., Wiredu, A. N., et al. (2013). Patterns of Adoption of Improved Rice Technologies in Ghana, *GSSP Working Paper*, IFPRI, Accra, Ghana. DOI: 10.13140/2.1.5093.4727.

Rogers, E. M. (2005). *Diffusion of Innovations* (6th Ed.). The Free Press. New York.

Smith, S. M. (2019). Determining Sample Size, How to Ensure You Get the Correct Sample Size. Retrieved from www.qualdrics.com.

Taxler, G., & Byerlee, D. (1993) A Joint-Product Analysis of the Adoption of Modern Cereal Varieties in Developing Countries. *America Journal of Agriculture Economics*, *75*, 981-989.