Original Research Article

Adoption Rates of Nerica Innovation among Rice Farmers in Tolon and Kumbungu Districts of the Northern Region, Ghana

Comment [u1]: What's new in comparison to the article at the following link: http://www.udsspace.uds.edu.gh/handle/123456789/1772

ABSTRACT

Adoption rates of the New Rice for Africa (NERICA) has been generally low across Africa. The adoption rates of the innovation had been determined across this country. However, the specific adoption rate for the study area had not been determined. This study sought to determine the adoption rates of NERICA in the Tolon and Kumbungu Districts in the Northern Region of Ghana from 2015 to 2018. Purposive sampling technique was used to obtain a sample of 346 NERICA farmers from 16 NERICA communities for the study. A survey was conducted to obtain both quantitative and qualitative data for the study. The data was also analysed qualitatively and quantitatively using logistic regression and descriptive statistics. The study revealed low average adoption rate of 25% with a high standard deviation of 44.03%, indicating an uneven spread out of the adoption rates over the period under study. Thus, the specific adoption rates of the innovation were 91.04%, 3.18%, 2.89% and 2.89% for the 2015, 2016, 2017 and 2018 farming seasons respectively. Farmers' educational level, perception of NERICA, household size and primary occupation significantly affected their adoption of NERICA. Though NERICA is regarded as a successful innovation, its adoption rates are very low. The Ministry of Food and Agriculture should therefore intensify her innovation dissemination/diffusion campaigns in the study area, and provide ready market for the commodity through the flagship programmes, *Planting for Food and Jobs, and the National Food Buffer Stock Company.*

Comment [u2]: Why do adoption rates need to be researched and what are their goals?

Keywords: Adoption, adoption rates, dissemination, innovation, NERICA, Northern Ghana

1. INTRODUCTION

Rice is one of the staple foods in Ghana used on many occasions such as festivals, funerals, outdoorings, weddings and marriage ceremonies, installation of chiefs and kings and at social gatherings. It is also one of the main food items found on the menu charts of many institutions like prisons, clinics, hospitals, schools, colleges, and universities, and conspicuous on the menu charts of many restaurants, hotels, 'chop bars' and food joints in Ghana. However, much of the rice that is served at these functions is imported [1]. More than 50% of rice consumed in Ghana is imported [1, 2].

Ghana is predominantly an agricultural country with the sector contributing about 30 percent to gross domestic product [3]. There has been a quest for a very good variety of rice for production so as to reduce the import.

Ghana participated in and implemented the multinational NERICA Rice Dissemination Project (NRDP), and other similar rice Programmes, to affirm the Government's commitment to revamp the local rice sub sector [4]. The project, which was implemented in Benin, the Gambia, Guinea, Ghana, Mali, Nigeria and Sierra Leone, was supported by several donors, including the Government of Japan, the UNDP, the Rockefeller Foundation, the CFC, USAID, IFAD, SG2000, the FAO, the ADB and the World Bank.

The New Rice for Africa (NERICA) was created in 1994 by crossing African rice with high-yielding Asian varieties of *Oriza sativa*. The essence was to create rice varieties that would have a blend between 'local' rice and 'polished' rice, hence, 'NERICA'. Prior to the NRDP, farmers were exposed to adopt and consume perfumed rice varieties but yields had not improved as expected. As such, there was scarcity of Ghana made perfumed rice for local consumption. So much money had to be invested in the NRDP by donor agencies and the government of Ghana that it would be a disincentive to Ghana if the project's goals or its gains were short lived.

The NERICA varieties were disseminated to rice farmers in the Tolon and Kumbungu Districts from 2005 to 2010, to increase sustainability and food security as well as reduce the importation of rice into the country [4, 5]. An evaluation of the NRDP [6] revealed low levels of adoption in Ghana: the highest being 6% at Sekyere-Dumasi and the least was 1% at Tolon/Kumbungu. However, another study [7] revealed a high adoption rate (68 per cent) of NERICA in Ghana. There are over twenty improved rice varieties in Ghana, particularly the study area [9]. These include NERICA, Mandee, GR-18, Tox, Togo Marshall, Digang, Agra, Jasmine and Northern Star [8]. The adoption rates of these improved rice varieties have consistently been low, due to several factors [9].

The low adoption rates of NERICA were attributed to low awareness levels of the innovation among rice farmers, particularly in the study area [6]. NERICA was a unique innovation that came with its complete package of planting methods, fertilizer application, seed production, grain production, grain processing and marketing, which needed to be studied on its own merit.

This research aimed at determining the adoption rates of NERICA among rice farmers in the Tolon and Kumbungu Districts in the Northern Region of Ghana from 2015 to 2018. Adoption rate in this context refers to the percentage of NERICA farmers that adopted (cultivated) the rice variety in each year. Since time plays a significant role in the adoption and diffusion processes of an innovation [10], it became expedient to conduct further adoption study on NERICA to help confirm or deny the findings and predictions of previous researchers [6, 7, 11]. The latest study [7], preceding this current research, surveyed 200 rice farmers and examined adoption of NERICA and its impact on farmers' technical efficiency. The study [7] revealed an adoption rate of 68% among sampled rice farmers and suggested an average technical efficiency of 69.1%. The current study also employed a sample survey rather than a census to elicit responses from 346 rice farmers in the study area. This research would contribute significantly to knowledge in agricultural extension by bringing to the fore the actual adoption rates of NERICA in the study area, from 2015 to 2018. That would help inform policy makers to provide appropriate legislation to enhance NERICA adoption in this country.

2. MATERIAL AND METHODS

2.1 Theoretical and Empirical Frameworks

The term innovation includes not only a new production technology by a smallholder but also a range of other processes, such as the reorganization of marketing strategies by a group of smallholders, the use of new processing technique by an agro-industrial company [12]. Simply put, the term innovation is an idea or a concept perceived as new by an individual or a unit of adoption in any field of endeavour.

Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system. It is a type of communication, in that the messages are concerned with new ideas. The newness of the idea in the message gives diffusion its special character. It therefore means that some degree of uncertainty is involved in diffusion [10]. Hence, there are different categories of adopters based on the perceived risk component and the individual's ability to take such risks. Hence, [10] defined the adopter categories as the classifications of members of a social system on the basis of innovativeness. This classification includes innovators, early adopters, early majority, late majority, and laggards. In each adopter category, individuals are similar in terms of their innovativeness. Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system [10, 13]. Innovativeness can also be considered as a relatively-stable, socially-constructed, innovation-dependent characteristic that indicates an individual's willingness to change his or her familiar practices [13]. In effect, [10] categorizes the adopters based on their innovativeness, as Figure 1 shows.

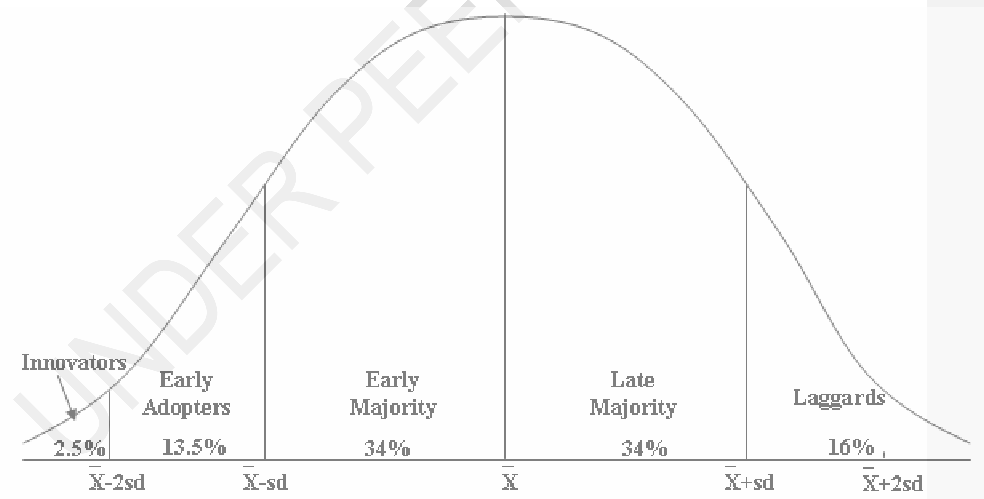

Figure 1: Adopter categorization on the basis of innovativeness

Source: Rogers, 2003

However, incomplete adoption and non-adoption do not form this adopter classification [10]. Only adopters of successful innovations generate this curve over time. In this normal distribution, each category is defined using a standardized percentage of respondents. For instance, the area lying under the left side of the curve and two standard deviations below the mean includes innovators who adopt an innovation as the first 2.5% of the individuals in a system [10, 13].

For [10], *innovators* are more willing to experience new ideas than other members of the social system. Compared to innovators, *early adopters* are more limited with the boundaries of the social system. It is believed that since early adopters are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation [10]. In fact, leaders play a central role at virtually every stage of the innovation process, from initiation to implementation; particularly in deploying the resources that carry innovation forward [13]. Innovators and early adopters therefore tend to lead the *early majority, late majority and laggards* in the adoption of innovations.

Laggards, unlike the others, tend to decide after looking at whether the innovation is successfully adopted by other members of the social system in the past. Due to these characteristics, laggards' innovation-decision period is relatively long [14].

However, according [15], adoption of agricultural innovations is highly correlated with the number of adult men in the farmer's household. The findings of [15] contradict the assertion of [10] in the sense that "adults" (in the Ghanaian context) are people above age 18 years who have the needed resources and propensity to adopt innovations. The aged (people above 60 years) tend to be slow in adopting innovations [10, 16] because they do not like to take high risks. Younger people (say those below 18 years) are daring but do not have the needed resources to enable them adopt innovations like the middle age adults do. For [10], there is no significant difference between early adopters and late adopters. The four main elements involved in the diffusion process are the innovation, communication channels, time, and the social system. These elements are identifiable in every diffusion research study and in every diffusion campaign or programme [10, 13].

Agricultural innovations are developed by researchers and communicated to farmers through Agricultural Extension Agents (AEAs), using various methods and materials (print and non-print). The various methods, materials, tools, strategies and style used by extension practitioners to create situations in which communication can take place between rural people and extension agents are referred to as Extension Teaching Methods (ETMs) [17].

Extension methods of disseminating Agricultural innovations include farm and home visits, result demonstrations, method demonstrations, frontline demonstrations, group discussions, exhibitions, general meetings, campaigns, conducted tours, printed matter (literature), radio, television, motion pictures (movies), agricultural clinic, flag method, peripatic team visits, agricultural games, snake and ladder games [18, 19].

Normally, there is a significant interval between the time an innovation is developed and available in the market, and the time it is widely used by producers [20]. Adoption and diffusion are the processes governing the utilization of innovations. They said studies of adoption behaviour emphasize factors that affect if and when a particular individual will begin using an innovation. That means measures of adoption may indicate both the timing and extent of new technology utilization by individuals. Adoption behaviour may be depicted by more than one variable. It may be depicted by a discrete choice, whether or not to utilize an innovation, or by a continuous variable that indicates to what extent a divisible innovation is used. Diffusion can be interpreted as aggregate adoption.

The innovation-decision process is described as an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation [10]. For [10], the innovation-decision process involves five steps: knowledge, persuasion, decision, implementation, and confirmation.

Knowledge Stage: This the stage at which the individual becomes aware of the innovation, how to use the innovation, and the functioning principles describing how and why an innovation works.

The Persuasion Stage: This is the stage where individual becomes persuaded about the innovation and forms either a negative or positive attitude toward it. The formation of a favourable or unfavourable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection [10]. That is because the individual shapes his or her attitude after he or she knows about the innovation. So, the persuasion stage follows the knowledge stage in the innovation-decision process.

The Decision Stage: At the decision stage in the innovation-decision process, the individual chooses to adopt or reject the innovation. While adoption refers to full use of an innovation as the best course of action available, rejection means not adopting an innovation [10]. However, rejection is possible in every stage of the innovation-decision process. The implementation stage follows the decision stage.

The Implementation Stage: At the implementation stage, an innovation is put into practice, though with a certain degree of uncertainty about its outcomes. Hence, the implementer may need technical assistance from change agents and others to reduce the degree of uncertainty about the consequences [10, 13]. Reinvention usually happens at the implementation stage, so it is an important part of this stage. Reinforcement is necessary at this stage to enhance confirmation of the decision.

The Confirmation Stage: This is when innovation-decision has been made, and the individual looks for support for his or her decision. According to [10], this decision can be reversed if the individual is exposed to conflicting messages about the innovation. To stick to the decision, the individual has to stay away from these conflicting messages and seek supportive messages that confirm his or her decision. Thus, attitudes become more crucial at the confirmation stage. Depending on the support for adoption of the innovation and the attitude of the individual, **later adoption or discontinuance happens during this stage**.

Factors affecting adoption and diffusion of agricultural innovations include personal and socio-economic factors; socio-cultural, situational and technological forces; gender; access to extension services**,** characteristics of the innovation, institutional constraints as well as research-extension farmer linkage problems [21]. Among the factors [10] identified, is the social system into which the information is delivered. For [21], when the educational levels of farmers are too low, it would take a lot of efforts to introduce modern technologies to them.

However, age is expected to negatively influence adoption because younger farmers are more dynamic with regards to adoption of innovations than older farmers [22]. Yet, household heads that are married also have a higher probability of adoption than their unmarried counterparts [23]. This is because they are normally assisted by their spouses in production, processing and marketing decision making. Similarly, household size is expected to positively influence farmers' adoption of agricultural innovations because members of the households serve as sources of farm labour.

Unlike experienced farmers, educated farmers are more prone to adoption because they have tendency to co-operate favourably with other farmers [23]. It means educated farmers who are experienced can adopt innovation better than inexperienced educated farmers. Innovations could also meet resistance from socio-cultural, situational and technological forces. The innovation may not be compatible with social norms, values and lifestyle; or may not go well with the economic strata; or be technologically complex, leading to fear to usage, obsolescence and risk [21, 24].

The uptake of new technologies is often influenced by the farmer's contact with extension services, since extension agents provide improved inputs and technical advice. Frequency of contact with extension agents is strongly associated with the gender of the farmer [25]. Perceived characteristics of Innovations that enhance their adoption are relative advantage, compatibility, trialability, observability, complexity, and the possibility of re-invention.

Dissemination of agricultural innovations in Sub-Saharan Africa (SSA) is not an overwhelming success, due to the following: Some research has despite a long history not been translated into ground-proven technologies. Some innovations have simply been technically inappropriate. Others may work in the technical sense but have not been adapted to the place-specific situation [7, 27].

In 2015, the actual adoption rate across West Africa (Benin, Gambia, Ghana, Guinea, Nigeria, Mali and Sierra Leone) was estimated to be about 43%, while the potential adoption rate was estimated at about 63% [5]. This 20% gap seems to be due to a lack of both awareness and access to NERICA seed, showing there is still a need to increase investment in NERICA dissemination**.** This is due to the fact that the supply of NERICA seeds has been a major constraint in Uganda and in other African countries [5, 27].

The study by [6] on NERICA in the Tolon-Kumbungu District and revealed an adoption gap of 44%, due to incomplete diffusion of the innovation. The adoption gap was the difference between the actual adoption rate and the potential adoption rate [6].

2.2 Study Area, Sampling and Data

The Northern Region, and for that matter, Tolon-Kumbungu District plays an important role in agriculture and is normally described as the grain basket of Ghana, accounting for about 37% of national rice production [29]. The study area is therefore one of the key rice producing areas in this country. More than 80 percent of the inhabitants in the study area are full time farmers [29], most of whom produce rice on small scale. Most of the smallholder rice farmers in the study area have benefited from a lot of development projects aimed at increasing productivity and improving livelihoods [9, 23].

Tolon is the capital town of the Tolon District while Kumbungu is the capital of the Kumbungu District. These districts were chosen for the study because they were the main districts where NERICA was introduced to farmers in the Northern Region for adoption. The two districts are homogenous in nature. Therefore, data of the two districts were not delineate but discussed together.

The Tolon/Kumbungu district lies between latitude 9^0 16' and 9^0 34' North and longitudes 0^0 36' and 0^0 57' west [3]. The land area of the two districts is 2,400km^2 of which 70% is arable and therefore has potential for agricultural purposes, especially production of cereal crops like rice [3].

The Tolon District shares borders with North Gonja (Daboya District) to the west Kumbungu District to the north, Central Gonja to the south and to the east with Tamale Metropolitan [3]. The Kumbungu District also shares boundaries with Savelugu-Nanton Municipal to the east, Tolon District to the south, North Gonja District to the west, and to the north with Mamprugo/Moaduri District respectively [3].

According to the Population and Housing Census of 2010, the total human population of the Tolon/Kumbungu District stands at 112,331 comprising 56,046 males and 56,285 females [3]. The total figure constitutes 4.5% of the total population of the Northern Region while the average household size of the two districts is 9 [3].

The total population of the Tolon District is 72,990. Males constitute 36,360 and females, 36, 630 [3]. The total population of the Kumbungu District is 39,341. The number of males (19,686) is slightly higher than the females (19,655) [3]. The entire population of the district is classified as rural because all the settlements with 5,000 people or more is considered urban; otherwise it is rural [16].

The local climate has only one cropping season in a year, usually from May to October is considered as the wet season. However, there are irrigation dams at Golinga and Botanga for cultivate rice twice a year [2]. The dry season normally starts from November to April each year. The annual relative humidity ranges from 65-85%, but can be as low as 10% during the dry Harmattan period. Average temperatures range from 22-40 degrees Celsius, whereas annual rainfall is 1,000 millimetres and often unevenly distributed and erratic during the cropping season, thus posing a challenge to crop production and food security in the district [19]. So, the weather fluctuates in the study area. The vegetation is dominated by local tree species such as dawadawa (*Parkiabiglobosa*) and shea nut (*Vitellariaparadoxa*). Exotic plant species such as mango (*Magniferaindica*), and neem are also commonly found around the settlements.

The land area of the Tolon and Kumbungu Districts is 2,400km^2 of which 70% is arable and therefore has potential for agricultural purposes, especially production of cereal crops like rice. More than 70% of the population of the Districts are engaged in one form of agricultural activity or the other [2].

2.2.1 Sampling and sample size

A sample size of 378 NERICA farmers was taken from a population of 6, 888 rice farmers, using [28] formula:

$$\left[n = \frac{N}{1 + N(\infty^2)}\right]$$

Where;

N = Total population

n = Sample size

∞ = Alpha margin of error (0.05^2)

$$\left[n = \frac{6888}{1 + 6888(0.05^2)}\right] \ [n = 378]$$

Sixteen NERICA communities were randomly selected from the study area and purposive sampling was used to collect the data from the farmers, with the help of five agricultural extension officers. However, after data cleansing, 346 questionnaire were found to contain all the necessary information for the data analysis.

2.2.2 Data collection and analysis

A survey was conducted to collect data from three hundred and forty-six rice farmers on the topic, using a semi-structured questionnaire. Logistic regression was employed to analyse the socio-economic characteristics of the adopters. Unstructured interviews were used in this study to elicit detailed information from key informants to clarify and enhance data gathered from the questionnaires. Structured interviews were done at the community level using the interview guide and targeting heads of farm families and leaders of the NERICA farmers.

Non-Participant observations were made in the communities, especially on markets gatherings, cultural occasions, funerals, rice mills and popular food joints to obtain additional information for the research questions and issues. The researcher was physically present at such gatherings to ask questions and to see at first hand the extent to which NERICA was patronized and used, especially in dishes in the study area. The researcher also observed the farmers' farms, grain barns as well as gestures and mannerisms of farmers during interviews, questionnaire administration and focus group discussions to deduce the authenticity of the data being gathered. One Focus Group Discussion (FGD) was held in each community for farmers who answered the questionnaire interview questions. The findings from the FGDs helped the researcher to gain insight and clarify data obtained from the questionnaire.

The researcher had informal interactions on regular basis before, during and after administration of the questionnaire to verify non-participant observations made in the communities and also to clarify certain assertions made by the farmers. The researcher also asked salient questions about the facts and figures obtained from the project reports presented to donors and the government of Ghana.

This study therefore used a combination of qualitative and quantitative methods to analyse the data, by employing Statistical Package for Social Science (SPSS). That generated all the necessary tables, charts, descriptive statistics (frequency and percentages) from which the survey results were interpreted. The qualitative data was mainly in the form of narratives and explanations, which helped to describe the information, generated from the SPSS in much detail and made real meanings out of them.

At the same time, data gathered from the FGDs, interviews and key informant stories on the research issues were analysed on a daily basis in the data collection process, which helped to clarify issues and ensure consistent and systematic work. The analyzed qualitative and quantitative data and information processed provided the basis for making interpretations, inferences, deductions and meanings to address the research objectives and questions for the final work.

2.3 NERICA Adoption Model

The dependent variable in this model is adoption. The Wald Chi-square (F- statistic) is the parameter of determining whether an independent variable is significant or insignificant. A probability of .000 indicates that Wald Chi-square is significant and this means that the independent variables jointly influence farmers' decision to adopt NERICA. The Pseudo R-squared (R^2) indicates the variation in the probability of adoption explained by the factors

used for the study. The other variations are explained by other factors. Institutional factors such as extension, credit, input market and price of seeds were redundant in explaining farmers' adoption decision, and were therefore removed from the model.
The key factors that affected NERICA adoption are represented mathematically as,

Y= *f* (X1, X2, X3, X4, X5, X6, X7, X8)

Where;

Y = Adoption of NERICA (Yes = 1; No =0) (Dependent Variable)

X = Factors affecting adoption of NERICA (Independent Variables)

X1 = Age of farmer (In years; Categorical)

X2 = Marital status (Dummy: Married =1; Not married = 0)

X3 = Level of education (In years; Categorical)

X4 = Years of experience in rice cultivation (In years; Categorical)

X5 = Household size of farmer (In ranges; Categorical)

X6 = Primary occupation of farmer (Dummy: Rice = 1; Other = 0)

X8 = Farmers' perception of NERICA (Dummy: Better = 1; Poor = 0)

3. RESULTS AND DISCUSSION

3.1 Adoption Rates of NERICA in the Study Area from 2015 to 2018

All the respondents in this study were NERICA farmers who willingly adopted the magic crop. The term adoption rates refers to the percentages of farmers that grew and used the crop between 2015 and 2018.

Table 1 presents the specific adoption rates of NERICA in the study area from 2015 to 2018. About 91.04% of the farmers cultivated NERICA in 2015, meaning most of them adopted the innovation that year, which was consistent with the findings of [7]. The adoption rate for 2015, in the study area, was higher than what was estimated for West Africa in general and the study area in particular because the farmers anticipated that the gains from the innovation could turn around their fortunes. In 2015, the actual adoption rate across West Africa (Benin, Gambia, Ghana, Guinea, Nigeria, Mali and Sierra Leone) was estimated to be about 43%, while the potential adoption rate was estimated at about 63%, leaving an adoption gap of 20% [5]. This is due to the fact that adoption rates of NERICA are location specific. Researchers therefore estimate average adoption rates for certain geographical areas. For example, the average adoption rate of NERICA, as at the end the 2010 farming year in Ghana, was 3%. However, the Southern Belt recorded 6%, the Middle Belt recorded 3% and the Northern Belt had 1%, resulting in the average of 3% for the year [6]. The average adoption rate of NERICA in the study area from 2015 to 2018 was 25% with a standard deviation of 44.03%. The fact that the average NERICA adoption rate in the study area was less than 50% shows that adoption of the innovation for the period was very low.

The high standard deviation shows the uneven spread out of the adoption rates over the period under study.

The adoption rates of NERICA in the study area dropped from 91.04% in 2015 to 3.18% in both 2016 and 2.89% each in 2017 and 2018 respectively, due to incomplete diffusion of the innovation. Though NERICA has its good properties that made it 'better' than other rice varieties in the study area, inability of the producers to find ready market for the produce, seed contamination, poor soil fertility, pests and diseases infestation and lack of access to credit facilities resulted in incomplete diffusion of the innovation. Hence, the adoption rates were reduced by climatic, environmental and market forces.

It could therefore be concluded that the fact that an innovation is regarded as successful does not automatically make its adoption to be successful or higher, because NERICA adoption rates declined in the study area. Adoption rates increase with time but the rates of NERICA adoption in the study area decreased drastically in 2016 and plateaued in 2017 and 2018, due to factors beyond the farmers' control. Such factors normally render agricultural innovations unsustainable, unsuccessful and prone to disadoption [10, 15].

Table 1: Adoption rates of NERICA in the study area from 2015 to 2018

Adoption year	Adoption rate	
	Frequency	**Percentage**
2015	315	91.04
2016	11	3.18
2017	10	2.89
2018	10	2.89
Mean adoption rate	25.00	
Standard deviation	44.03	

Source: Field Survey, 2018

3.2 Socio-Economic Factors of Farmers Affecting Adoption of NERICA

The logistic regression analysis was used to analyse these factors and the results presented in Table 2. The probability of .000 indicates that Wald Chi-square (F- statistic) is significant and this means that the independent variables jointly influence farmers' decision to adopt NERICA. The Pseudo R-squared of 0.208 indicates that about 20.8% of the variation in the probability of adoption is explained by the factors used for the study. The remaining 79.20% of the variations are explained by other factors.

Farmers' educational level, household size, primary occupation and their perception of NERICA significantly affected their adoption of the innovation. Out of these 4 statistically significant variables, 2 had a positive effect on NERICA rice technology adoption.
These indicate that as farmers' educational level increases their ability to adopt NERICA also increases. In other words, farmers with a higher level of education have higher probability of adopting the technology than those with lower educational level. This may be due to the fact that educated farmers are more business oriented than their uneducated counterparts. Those who are more business oriented with farming will always want new and improved varieties of crops such as NERICA. In addition, farmers with more years of education are expected to have better information and knowledge about improved technologies than those who are not educated. As a result, the positive sign of education was expected since educated farmers are more prone to adoption because they have tendency to co-operate favourably with other farmers and in turn pass on the innovation to them [23].

As expected, farmers in the study area who think NERICA is better the other rice varieties have a higher probability of adopting the technology than those who think otherwise.
Household size was significant at 10% but had a negative effect on NERICA technology adoption. This implies that as household size increases, the probability of technology adoption reduces. In other words, households with fewer members adopted the technology better than those with more household members, which seem to contradict the expectations of this study. The nature of the NERICA technology required more labour and was favoured by large household size. On the other hand, the technology required higher level of financial commitment such as the acquisition of more and new input and that did not favour households with large members since funds to be used for farming was reduced to settle the high household expenditure. Hence, farmers with large household sizes who lacked funds to farm did not adopt NERICA better than those who had smaller household size but had funds and other resources to farm.

Primary occupation was significant at 10% but negatively influences NERICA technology adoption. The negatively sign coefficient favours respondents whose primary economic occupation was crop production. Such farmers have dedicated much of their time to crop production and obtain most of their livelihood from crop farming. As a result, they may be more interested in new and high yielding crop varieties like NERICA than their counterparts who have taken crop production as a secondary occupation and may not give it more attention since it serves as a minor source of livelihood for them. This result was expected and plausible.

Table 2 further suggests that farmer's age, marital status and years of experience in rice cultivation were insignificant and had no effect on NERICA technology adoption. This means that older and experienced farmers did not adopt NERICA technology more than the younger and inexperienced farmers. This result was as expected because the study postulated that farmers who have more experience may rely on their accumulated experience and may be unwilling to adopt new technologies. It confirms [10] position that aged or older farmers tend to be laggards who are sceptical when it comes to adopting new technologies. This finding is true because most of the NERICA farmers were young and productive (below 60 years) but inexperienced. This finding contradicts [30] finding that farmers' experience in growing rice has a positive and significant effect on the NERICA yield (adoption) in Uganda. Although majority of the farmers were married, marriage was not a necessity for NERICA adoption because the farmers who were married did not adopt NERICA more than those who were not married.

Table 2: Logistic regression of factors affecting NERICA adoption

Variable	Coefficient	Standard Error
Age	-0.165	0.314
Marital status	1.731	1.559
Educational level	0.464***	0.106
Years of experience in rice cultivation	0.326	0.213
Household size	-0.347*	0.213
Primary occupation	-1.750*	1.048
Farmers' perception of NERICA	1.879***	0.508
Number of Observations 368		

Probability	.000	
Pseudo $R^2$0.208		

Note: ***, ** and * implies significance level at 1%, 5% and 10% respectively

Source: Field Survey, 2018

4. CONCLUSION

Though NERICA was considered a successful innovation, its adoption was not successful, due to incomplete diffusion. This study sought to determine the adoption rates of NERICA in the Tolon and Kumbungu Districts in the Northern Region of Ghana from 2015 to 2018. The study revealed low average adoption rate of 25% with a high standard deviation of 44.03% of NERICA in the study area for the period under review. Meanwhile, the specific adoption rates of the innovation were 91.04%, 3.18%, 2.89% and 2.89% for the 2015, 2016, 2017 and 2018 farming seasons respectively. The persistent low adoption rates resulted in disadoption since the farmers virtually abandoned the innovation. Inability of the farmers to find ready market for the produce, seed contamination, poor soil fertility, pests and diseases infestation all contributed to the disadoption. Farmers' educational level, household size, primary occupation and their perception of NERICA were the only factors that significantly affected their adoption of the innovation in the study area

Though NERICA is regarded as a successful innovation, its adoption rates are very low. The Ministry of Food and Agriculture (MOFA) should therefore intensify her innovation dissemination and diffusion campaigns in the study area, especially among educated rice farmers with small household sizes and positive perception of NERICA. The adoption rates of NERICA would also rise if the government, through MOFA, provides ready market for the commodity through its flagship programmes, *National Food and Buffer Stock Company*, and *Feed the Future initiative.* The problem of seed contamination, poor soil fertility, pests and diseases infestation can likewise be addressed through the *Planting for Food and Jobs* programme of the government, to help boost NERICA adoption rates in Ghana.

Comment [u3]: The conclusion only contains important things related to the goal and does not need to be described too long

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author.

COMPETING INTERESTS DISCLAIMER:

AUTHORS HAVE DECLARED THAT NO COMPETING INTERESTS EXIST. THE PRODUCTS USED FOR THIS RESEARCH ARE COMMONLY AND PREDOMINANTLY USE PRODUCTS IN OUR AREA OF RESEARCH AND COUNTRY. THERE IS ABSOLUTELY NO CONFLICT OF INTEREST BETWEEN THE AUTHORS AND PRODUCERS OF THE PRODUCTS BECAUSE WE DO NOT INTEND TO USE THESE PRODUCTS AS AN AVENUE FOR ANY LITIGATION BUT FOR THE ADVANCEMENT OF KNOWLEDGE. ALSO, THE RESEARCH WAS NOT FUNDED BY THE PRODUCING COMPANY RATHER IT WAS FUNDED BY PERSONAL EFFORTS OF THE AUTHORS.

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Comment [u4]: Reference should use Mendeley

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