International Journal of Organic agricultural Research & Development
Volume 20 (3) (2025)

Evaluation of Sawah Eco-Technology in Rice Production among Rural Households in Kebbi State, Nigeria

***Adelalu, K. O. and Oyeleye A. O.**

Department of Agricultural Economics, Ladoke Akintola University of Technology, Ogbomoso
Corresponding author email: okadelalu@lautech.edu.ng.

ABSTRACT

This study examined factors influencing the awareness of sawah technology in Kebbi State, Nigeria. Sawah refers to levelled rice field surrounded by banks with inlet and outlet for irrigation and drainage. Using pre-tested interview guide, data were collected from 300 sawah farmers in the study area. Data collected were analyzed with both descriptive and inferential statistics using stata package. The results showed that respondents were predominantly male, married and had no formal education. The mean age was 48.13 years with mean household size of 14 persons; farm sizes ranged from 1–50 hectares with average of 4.70 ha, the mean yield was 6.88tha–1. The results further showed that bond construction had 60% awareness, nursery 55%, puddling 53%, flooding 65%, leveling and smoothening 56% and power tiller use 48% awareness. Awareness of sawah technology was influenced by socio economic characteristics which include sex, age, educational level, farm size, yield and income of the farmers. The study also showed that the attributes of sawah, production factors, information and extension and perception of respondent toward sawah technology influenced awareness. It is concluded that sawah eco-technology is widely aware of by rice farmers in Kebbi State. The study therefore recommended that dissemination of sawah to other states in Nigeria need to consider factors that promote its awareness. Improvement of those factors that significantly affect awareness of sawah technology is also recommended.

Key words: Awareness, eco technology, rice production, Sawah technology

INTRODUCTION

Rice remains a vital component of the Nigerian diet and its importation makes an important share of Nigerian agricultural imports (Ogundele and Okoruwa, 2006). Nigeria population is increasing at a faster rate and the consumption of rice has increased rapidly than domestic rice production can bear, thus, increasing the net importation of rice. An average Nigerian consumes 24.8 kg of rice per year, representing 9 per cent of annual calorie intake (IRRI, 2001). Nigeria has experienced rapid growth in per capita rice consumption during the last three decades, from 5 kg in the 1960s to 25 kg in the late 1990s (Warda, 2003) with a potential for increase in years to come. The consumption of traditional cereals, mainly sorghum and millet, has fallen by 12 kg per capita, and their share in cereals used as food dropped from 61% in the early 1970s to 49% in the early 1990s. In contrast, the share of rice in cereals consumed grew from 15% to 26% over the same period (Akpokodje *et al.,* 2002; Ogundele and Okoruwa, 2006). The average yield of upland and lowland rainfed rice in Nigeria is 1.8 tha^{-1}, while that of the irrigation system is 3.0 tha–1 (NISER, 2001). This is very low when compared to 3.0 tha^{-1} from upland and lowland systems and 7.0 tha–1 from irrigation systems in Côte d'Ivoire and Senegal (NISER, 2001). Poor water control, abiotic stresses (which include variable rainfall with drought and flooding occurring in the same season, iron, aluminum and manganese toxicity), biotic stresses (such as weeds, insect pests, diseases, rats and birds), inappropriate cultivation practices (broadcasting of seed which decreases the germination rate and make it difficult to maintain the proper spacing for planting) and lack of and/or poor bunding and levelling account for the low rice productivity (Buri *et al.,* 2000). In order for domestically grown rice to compete with imported rice, improved productivity of the local rice becomes essential. This necessitated the introduction and integration of sawah eco-technology in rice production in Nigeria. Sawah refers to man-made improved rice fields with demarcated, levelled, bunded and puddled rice fields with water inlet and outlet. It is a form of irrigated production system with water sources from canals, pond and spring. According to Fashola *et al.,* (2006), sawah system offers the best option for overcoming the constraints of rice production in Nigeria, namely poor soil fertility, poor water

management and poor varieties. Sawah system utilizes the inland valleys which are reported to be high in fertility (eco-technology). With appropriate water management in inland valleys, fertility can be sustained to enhance local rice production (Amusa *et al.*, 2020). In Nigeria, the sawah system was introduced through on-farm adaptive research in the two research sites of Gara and Gadza inland valleys, located in Bida, Bagudu and Jega and was introduced to Kebbi State in 2012 with 4 Fadama groups in Birni Kebbi, Argungu, in 1986 (Hirose and Wakatsuki, 2002). These groups were supported with water pumps, power tiller, fertilizer, improved rice seeds and herbicides. Adoption of improved agricultural technologies has become a critical avenue for increasing productivity in developing countries (Doss, 2006). Adoption is the mental process an individual passes through from first hearing about an innovation to final adaptation (Rogers, 2003).

Nigeria has extensive territory and potential for the cultivation, processing, marketing, and exporting of a variety of agricultural products due to its diverse climatic zones (Ayodele *et al.,* 2016). Because rice cultivation is a significant component of Nigerian agriculture, governments are working to encourage the cultivation of rice so as to make the food production increase and the food importation low in order to feed the country's population. (Amusa *et al.*, 2020).

Data suggest that the country Nigeria improved significantly in rice production as its production rose from 450,000 tons in year 2020 to 5,000,000 tons in 2021. United States Department of Agriculture (USDA, 2022).

In 2022, the quantity of milled rice produced in Nigeria was estimated at 5.4 million metric tons. Between 2010 and 2021, milled rice production in the country generally increased. The largest growth in output was registered in 2010, when the crop volume experienced a 26 percent increase compared to the previous year (Amusa *et al.,* 2022).

Rice (*Oryza sativa*) is a plant that is extremely old with its exact time and place of origin not too precise. It is a major food crop supplying over 52 percent of human calorie intake alongside wheat and maize. It has become the dominant staple with special imprint of rice-stalks, husks and grains traced to Asia, Europe and America. It found its way into African continent from movement of persons through slave trade to become an accepted staple introduced into African diet from other nations of the world (Food and Agricultural Organization - FAO, 2016).

Rice is critical for food security throughout Africa, and especially in Nigeria where it had the fastest growing consumption rate among all staple crops, determined in large part by huge growth in demand in urban centres. Consumers are exhibiting a shift in preference to rice from traditional staples such as cassava, maize and yams to rice.

The demand for rice could also be attributed to increased income levels, change in occupational structures of families. (Ado, 2017). Rice, as staple of importance in Nigeria, also provides food and income to a large number of individuals and rice farming households (Tiamiyu *et al.*, 2014). Rice is a preferred food in the urban centre of many countries including Nigeria because of the relative ease of preparation in catering for large numbers of people (Amaechina and Eboh, 2017). In Nigeria rice importance is seen in the fact that it is accepted among all cultures (Onimawo, 2012). It was estimated that the per capita consumption of rice is about 24.8kg (Ume*, et al.,* 2016). Other uses of rice to include livestock feed and industrial production of beverages, flour and starch. The crop could be found grown in all the six geopolitical zones of the country under different production systems. Currently, Nigeria cannot meet the demand of rice from its local production, hence the need for importation. However, within this period, the area of lands under rice production also increased (*Amusa et al.,* 2022). Kebbi state is a prominent producer of rice in Nigeria (Nwahia, 2020). It is well-known for its lowland irrigation and rain-fed rice growing. Rice output of Nigeria has expanded significantly; for instance, the quantity of rice that was milled there rose from 450,000 tons in year 2020 to 5,000,000 tons in 2021 (USDA, 2022).

Objectives of the Study

The main objective of this study is the investigation of the economics of Sawah technology in rice production among small-scale farmers in Kebbi State Nigeria.

The specific objective is to:

Ø identify the drivers of usage of Sawah rice technology in rice producing areas of kebbi state

Ø estimate the technical efficiency of rice farms using sawah technology.

Theory of Production

Measuring the production efficiency of farms compared to other farm holdings has been a thing of vast interest to many agricultural

economists. In theory, there is sequential exchange about the comparative importance of the different components of efficiency of farms (Lingard *et al.,* 1983). Looking at it from other perspectives, to measure efficiency is very important for the fact that it is the first step in the process of substantial resource saving.

The connection between actual and ideal or prospective output is what defines the technical efficiency level of a farm (Greene, 1980). Therefore, the determination of how well a farm is performing technically depends on how much its outputs deviate from planned or projected production and/or the boundaries of efficient crop production. Therefore, a crop farm can be considered to be totally efficient if the planned or projected production is achieved. On the other hand, it is deemed to be technically inefficient if the production is below the set border of efficient production (Ligeon *et al.,* 2013).

The Concept of Sawah Rice Technology

Sawah rice technology reported to be one of the best agricultural practices capable of increasing rice yield per hectare (Wakatsuki *et al.,* 2013). Sawah rice technology has a lot of advantages: it enhances effective water control and management, it encourages biodiversity, it encourages nitrogen fixation through decomposition, there is effective weed control through flooding and it can also improve accumulation of soil organic matter and increases the yield per hectare of rice production (Wakatsuki, 2013). Thus, Sawah ecology technology could make improvement to irrigation water management and efficiency of fertilizer use (Wakatsuki *et al.,* 2011).

Sawah rice technique includes crucial elements like: (a)hydrology demarcation through bunding soils and topography; (b) puddling with levelling to manage and then save water and soil; and tillage. (c) Water outputs for drainage as well as inlets for water for various irrigation facilities (d) Better fertilizer and chemical application techniques; (e) Better seed types. The National Centre for Agricultural Mechanization (NCAM, 2018) noted that these are major fundamental components of Sawah farms for managing irrigation water and using other innovation.

Sawah ecology technology is thought to be able to increase watering and fertilizer efficiency, which would enable it to address water scarcity and inadequate nutrients supply (such Nitrogen and Phosphorus as well as Silicon and Calcium) (Wakatsuki, 2012). This could neutralize alkalinity or acidity and raise supply of micronutrients. Weeds are effectively controlled with water control and puddling. With macro scale natural geological fertilization and micro scale methods to increase the delivery of various nutrients, the low land Sawah could support rice yield greater than 4 tons/ha. To achieve the best outcomes, suitable low lands must be chosen, developed, and efficiently managed.

According to Oladele and Wakatsuki, (2008), the technologies involved in Sawah are as follows: Levelling, Bounding, Puddling, Canal design, basin formation, transplanting and fertilizer application. It is designed principally to cultivate rice in the low land. It originated from Japan and has been widely used in other African countries (Wakatsuki, 2010).

Materials and Methodology

The study was conducted in Kebbi State, Nigeria. 300 Rice farmers were selected for the study. 160 for users of Sawah Technology and 140 for non-users. The Logistic Regression-Model was used to identify characteristics impacting the adoption of Sawah rice innovation by rice growers in Kebbi State, a logistic regression approach was utilized.

The model is given as follows.

$$Logit\text{-}(E[Y]) = Logit(P) - X^{T}\beta \quad (1)$$

where

[Y] = binary-dependent variable which represents 1 if the farmer used Sawah technology and 0 if not, and other terms are as defined in Equation (7)

Logit (P)=natural log of odds

X^T= Transpose of the vector of independent variables

The independent variables include:

β =coefficient of regression

X_1 =Age (Years)

X_2 = Marital Status (married =1; not married=0)

X_3 = Household size (Number)

X_4=Farm Size (Ha)

X_5= Cooperative membership (Yes=1; No=0)

X_6= Amount of credit obtained (Naira)

The Sawah rice technology use is represented by a dichotomous variable that is the dependent variable. It takes the value of 1 if the rice farmer used Sawah technology and 0 if not.

RESULTS AND DISCUSSION

Determinants of Usage of Sawah Rice Technology

To identify factors impacting the usage of Sawah rice technology by rice farmers in Kebbi State, the logistic regression model was utilized. The outcome variable is a dummy variable shows the users of Sawah rice technology in the study areas take is equal to 1 if the rice farmers are willing to use and 0 if otherwise. The socio-economic

elements are the independent variables. It was revealed that the age (t = 3.26**; p = 0.001), number of plots of land in separate places (t = 2.03**; p = 0.042), were variables that significantly influenced the use of Sawah rice technology amongst rice farmers in Kebbi State. Age and number of plots with coefficients (odd ratios) of 1.096161 and 0.7573respectively positively influenced the use of Sawah rice technology at a significance level of 5% as presented in Table 1. Age and the number of plots showed positive associations with Sawah rice technology usage, with coefficients (odds ratios) of 1.096161 and 0.7573, respectively. These results indicate that age and number of plots increase the livelihood of usage of Sawah rice technology.

Table 1: Result of determinants of Sawah rice technology usage among rice farmers

Variables	Coefficient	Standard error	t-value	p-value
Constant	0.0686285	0.1052421	-1.75	0.081
Farm size	0.9842621	0.0875327	-0.18	0.858
Educational status of the farmers	1.042596	0.0350937	1.24	0.215
Sex	1.69041	0.7760401	1.14	0.253
Marital status	0.4769349	0.4702562	-0.75	0.453
Household size	0.9714538	0.0223177	-1.26	0.207
Age	1.096161	0.0308628	3.26**	0.001
No of plots of land in separate places	0.7573714	0.1037202	-2.03**	0.042
Extension services (number of visits)	1.085621	0.1061652	0.84	0.401
Farming experience	0.9605664	0.0220102	-1.76	0.079
Amount of credit obtained	0.999999	9.29e-07	-1.13	0.260
Membership of farmers association	1.849993			

The results revealed that the respondents are still in their active and productive age with a mean age of 52 years. A large number of the respondents (users and non-users) were male (87.9% of users and 92.6% of non-users) and married (98.2% of users and 97.8% of non-users). The mean household size were 14 and 16 years for users and non-users respectively. The mean years of Education was 10 years and 8 years for users and non-users while the mean farming experience was 25 and 27 years for users and non-users respectively, It was shown that more of the respondents (users and non-users) used purchased land (46.7% and 48.9%) for rice cultivation. More of the respondents depended on hired labour to carry out their farm activities, though others still depended on family labour. Majority (97.6% and 89.6%) of the respondents (users and non-users) used or planted improved variety of rice last season as more (78.2% and 88.1%) of the respondents claimed preference for improved variety of rice. Personal savings (68.3% and 66.7%) was identified as the major source of finance or capital for rice production among users and non-users of Sawah technology. The extension agent visited the farmers 3 times in the 2021 cropping season.

The logistic regression model revealed that age (t = 3.26**; p = 0.001), no of plots of land in separate places (t = 2.03**; p = 0.042), were variables that significantly influenced the likelihood of usage of Sawah rice technologies among rice farmers in Kebbi State.

Recommendations

Based on the findings, the following recommendation are necessary:

1) A lot of the farmers in the study location lacked public funding in form of micro credits, which would have helped them produce more rice, hence there is therefore need to make credit facilities accessible by all stakeholders.

2) Sawah rice technology has been known to significantly improve rice production.

REFERENCES

Ado, G.S (2017). Agriculture: Panacea for Nigeria's Economic Recession. Invited paper presented at the 22nd Ummah convention held at Sultan Muhammad Maccido Institute of Qur'an and General Studies, Sokoto. Pril 15-17, 2017, pp.30.

Akpokodje, K., Awoyemi, O. and Babatunde, A. (2002).Climate change and its effects on agricultural outputs in Nigeria. *Asian Journal Agricultural Extension, Economics and Sociology*, 25, 1–11.

Amaechina, E.C and Eboh, E.C. (2017). Resource use efficiency in rice production in the lower anambra irrigation project, Nigeria. *Journal of Development and Agricultural Research* 4(1): 1-4

Amusa, T.A., Anugwo, S.C. and Egwue, O.L. (2022).Comparative Analysis of the Contributions of Men and Women to Farming Decisions among Rice Producing Households in Ebonyi State, Nigeria. *Journal of Agricultural Extension* Vol. 26 (3) July, 2022.

Amusa, T.A., Igwe, K.C. and Oti, O.G. (2020). Environmental risks management practices among rice farmers in rice producing areas of Imo State, Nigeria. *Journal of Sustainable Agriculture and the Environment*, *18* (1), 97 - 115.

Amusa, T.A., Igwe, K.C. and Oti, O.G. (2020). Environmental risks management practices among rice farmers in rice producing areas of Imo State, Nigeria. *Journal of Sustainable Agriculture and the Environment*, *18* (1), 97 - 115.

Ayodele, K., Awoyemi, O. and Babatunde, A. (2016).Climate change and its effects on agricultural outputs in Nigeria. *Asian Journal Agricultural Extension, Economics and Sociology*, 25, 1–11.

Buri, D. Spielman, D.J., Dawit Alemu and Gautam, M. (2000).*Policies to Promote Cereal Intensification in Ethiopia: A Review of Evidence and Experience.* IFPRI Discussion Paper 00707, International Food Policy Research Institute, 2033 K Street, NW, Washington, DC 20006-1002, USA.

Doss, C. R. and Morris, M. L. (2006). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana.*Agricultural Economics, 25*, 27–39.

FAO. (2016). Fertilizer Development in Support of the Comprehensive Africa Agriculture Development Programme (CAADP). Paper presented at FAO Twenty-third regional conference for Africa, 1-5 March, Johannesburg, South Africa.

Fashola, T., Shinmura, Y., Otoo, E. and Olaniyan, G.O. (2006). African based Sawah systems for the integrated watershed management of small inland valleys in West Africa. In FAO Water Report No. 17.Institutional and Technical Options in the Development and Management of Small Scale Irrigation. Rome, pp 45-60.

Greene, K. (1980). *Econometric Analysis.*New Jersey: Prentice Hall.849-850.

Hirose and Wakatsuki, T. (2002).West African green revolution by Sawah ecotechnology and the creation of African Satoyama systems, *http://www.humanosphere.cseas.kyotou.ac.Jp/article.php/workingpaper 61*

IRRI (2001).Terminology for rice growing environments.International rice Research Institute, Manila. 56p.

Ligeon, C., Jolly, C., Bencheva, N., Delikostadinov, S. and Puppala, N. (2013). Production efficiency and risks in limited resource farming: The case of Bulgarian peanut industry. Journal of Development and Agricultural Economics, Vol. 5(4), pp. 150-160. http://www.academicjournals.org/JDAE.

Lingard G. E., Coelli T. J. (1983). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20: 325–332.

Niser, M., (2001).Fertilizer Reform and the Determinants of Fertilizer use in Benin and Malawi. International Food Policy Research Institute. MSSD Discussion paper no.40. pp23.

Nwahia, O. C. (2020). Analysis of the cost and economic returns in rice production in Ebonyi State, Nigeria.*Indonesian Journal of Agricultural Research, 3* (3), 205 – 214.

Ogundele, O.O. and Okoruwa, V.O. (2006).Technical efficiency different differentials in rice production technologies in Nigeria AERC Research Paper 154.

Oladele, O.I., Bam, R.K; Buri, M.M. and Wakatsuki, T. (2008).Missing prerequisite for Green Revolution in Africa: Lessons and the challenges of *Sawah* rice ecotechnology development and dissemination in Nigeria and Ghana.*J. Food Ageric Environ* 8:1014-1018.

Onimawo, I. (2012). Traditional food systems in assuring food security in Nigeria. In Burlingame & B. Demini, S. (eds) Sustainable diets for biodiversity. Directions and solutions for policy, research and action proceedings of the international scientific symposium on biodiversity and Sustainable Diets United against hunger. 3-5 november 2010, FAO Rome.

Rogers, E. M. (2003). Diffusion of innovations.*Journal of Educational Technology* 5(2): 14-23.

Tiamiyu S.A., Usman, A, and Ugalahi, U.B (2014). Adopting of on-farm and Post harvest Rice Quality Enhancing Technologies in Nigeria . TROPICULTURA 32 (2):67-72

Ume, S.I., Ezeano, C.I., Eluwa, A.N. and Ebe, F. (2016). Analysis of technical inefficiency in rice production among farmers in Ezza south Local Government Area of Ebonyi State, Nigeria (application of stochastic frontier production). Archives of Current Research International 5(2),1-2.

USDA (2022), "Global food security response", West Africa Rice Value Chain Analysis Micro Report, Washington, DC.

USDA (2022), "Global food security response", West Africa Rice Value Chain Analysis Micro Report, Washington, DC.

Wakatsuki, T., Buri, M.M., Bam, R., Ademiluyi, S.Y. and Azogu, I.I. (2013). Sawah Ecotechnology: Farmers" personal irrigated Sawah systems to realize the Green Revolution and Africa's rice potential, http://www.kinki-econtech.jp/.

Wakatsuki, T., Oladele, O.I., I.I. (2014). Farmers' personal irrigated Sawah systems to realize the green revolution and Africa's rice potential, Paper presented at 151 International Conference on Rice for Food, Market, and Development (rice-Africa), Abuja, Nigeria March 3-5, 2014.

Wakatsuki, T., Otoo, E., Andah, W.E.I., Cobbina, J., Buri, M.M. and Kubota, D. (eds). (2001). Integrated Watershed Management 0' Inland Valley in Ghana and West Africa: Ecotechnology Approach. Final Report on JICA/CRI joint study project, CRI, Kumasi, Ghana and JICA, Tokyo, p. 337.

Wakatsuki, T., Shinmura, Y., Otoo, E. and Olaniyan, G.O. (1998). African based Sawah systems for the integrated watershed management of small inland valleys in West Africa. In FAO Water Report No. 17.Institutional and Technical Options in the Development and Management of Small Scale Irrigation. Rome, pp 45-60.

Warda, E. (2003). The Africa Rice Initiative (ARI): NERICA Consortium Security in Sub Saharan Africa. 40pp.