 J Hum Ecol, 36(2): 121-130 (2011)

Constraints to Sawah Rice Production System in Nigeria

C. I. Alarima[1*], C. O. Adamu[2], T. Masunaga[1] and T. Wakatsuki[3]

[1]Faculty of Life and Environmental Sciences, Shimane University, Matsue, Japan
[2]Department of Agricultural Extension and Rural Development, University of Agriculture, Abeokuta, Nigeria [3]Faculty of Agriculture, Kinki University, Nara, Japan

KEYWORDS Constraints. Farmers. Nigeria. Rice. Sawah Technology

ABSTRACT This study identified the constraints to adoption of sawah system of rice production in Nigeria. Data were collected from 124 randomly selected sawah-rice farmers. Data were analysed using correlation and regression analyses to determine the relationships between the study variables. The results showed that respondents were predominantly male (98.80%), married (98.80%) and had Quranic education (62.70%). Farm size ranged from 0.03 to 10 hectares (χ = 0.5ha), mean yield was 4.65 tonnes/ha, and mean income was $1,041.38 ($1 = ₦145.00). Production and on-farm constraints affecting sawah development were water management and flood. Major economic constraints faced by sawah farmers were lack of viable financial agencies to support production, poor capital base and non-availability of loan. Regression analysis showed that the yield of sawah was negatively related to land acquisition constraints (β=-0.34, $p<0.05$) and technological constraints (β = -0.43, $p < 0.01$). This study concluded that problems faced by farmers were interwoven in which existence of one relates with the other. Addressing these problems will lead to increase in the rate of adoption of sawah rice production technology and ultimately rice productivity in Nigeria.

INTRODUCTION

In order to increase food production and alleviate the widespread poverty in Sub-Sahara Africa (SSA), given the limited possibility for expansion of cultivable area and increase in population, there is need for a Green Revolution (GR) (Diao et al. 2008; Otsuka and Kijima 2010). GR enhances crop yield per unit of land by using high-yielding varieties, irrigation and agrochemicals such as fertilizers, pesticides and herbicides. The speed and scale with which it solved the food problem was remarkable and unprecedented, and it contributed to a substantial reduction in poverty and the launching of broader economic growth in many Asian countries. Improved cereal varieties, fertilizers, irrigation, and modern pest control methods lay at the heart of the GR (Otsuka and Kijima 2010).

Wakatsuki (2008) noted that to realize green revolution in Sub-Saharan Africa, it is essential to improve rice-growing environment by promoting lowland sawah system. This is because the sawah system utilizes the inland valleys which are reported to be high in fertility and through appropriate water management, fertility can be sustained and enhanced for rice production (Wakatsuki and Buri 2008). Among all the wetland environments, inland valley is regarded as having the highest potential for agriculture intensification and rice production. Based on the inventory data of inland valleys in West Africa, inland valley area in Nigeria for small scale irrigated sawah is between 6 to 7 million ha, which is about 7% of total land area, 10-12% of Guinea Savannah Zone and 63-74% of the Humid Forest Zone of the country (Fu et al. 2009). Sawah is a levelled rice field surrounded by banks with inlet and outlet for irrigation and drainage. The basic elements of sawah system include improved irrigated rice basins, seed-bed preparation, transplanting and spacing of seedlings, fertilizer application and most importantly, appropriate water management. Fashola et al. (2006) also reported that the 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 rice production system was introduced to the inland valley of Nigeria because it can overcome soil fertility problems through enhancing the geological fertilization process, conserving water resources, and the high performance multi-functionality of the sawah type wetlands (Oladele and Wakatsuki 2008). Sawah-based rice production took off through the establishment of a demonstration farm (1.5 ha) at Ejeti village in Bida, Niger State in 2001 (Oladele and Wakatsuki 2008). The goal of sawah rice production is development of sustainable production systems of

[*]*Corresponding author:*
C. I. Alarima
Soil and Ecological Engineering Laboratory,
Faculty of Life and Environmental Sciences,
Shimane University, 690-8504,
Matsue, Japan
Telephone:+818038745953;
*E-mail:*corneliusalarima@yahoo.com

the whole watershed, which allows intensification and diversification of the lowland production system. Studies have highlighted the potentials of sawah technology for achieving relatively high yields while effectively protecting the soil (Fashola et al. 2006; Oladele and Wakatsuki 2008). The mass adoption and sustained use of sawah technology are also important due to the resulting environmental benefits.

According to Guerin and Guerin (1994), there are several constraints to the adoption of technologies and innovations by farmers. These included the extent to which the farmer finds the new technology to be complex and difficult to comprehend; how readily observable the outcomes of an adoption are; its financial cost; the farmer's beliefs and opinions towards the technology; the farmer's level of motivation; the farmer's perception of the relevance of the new technology; and the farmer's attitudes towards risk and change. Lack of fertilizer, infestation by weeds, insect pests and diseases were the major constraints that negatively and significantly influenced the decision to adopt improved rice varieties in Nigeria (Awotide et al. 2010). Okpukpara (2010) reported that credit and availability of modern input in the rural areas appear to be the major constraining factor in adoption of modern technologies in Nigeria.

Guerin (2002) highlighted three major categories of constraints that affect an innovation. The first category relates to users and includes factors such as personality, goal and objectives of using the technology, educational level, and degree of motivation. The second emphasises the characteristics of the innovation itself and issues associated with the developers of the innovation. The third area deals with the role of extension agents and the transfer process. Lack of financial capital has been cited by farmers as a major reason for not adopting beneficial technologies (Agricultural Technology Adoption Initiative (ATAI 2011). In many developing countries, and particularly in rural areas, access to financial services including credit and formal saving mechanisms is limited (ATAI 2011). Even where financial services are available, they are often highly disadvantageous to smallholder farmers. For example, within a single market, interest rates often vary according to the characteristics of the borrower and the activity being financed (Esenwa 2011).

However, none of these studies has identified the constraints faced by farmers in adoption and use of sawah technology in Nigeria. Identifying the constraint faced in the use of sawah technology will assist in the expansion of its adoption across Nigeria. Therefore, this study identified the problems faced by farmers in the use of sawah system. Specifically, the present study identified the constraints (which included land acquisition and tenure, economic, market, information and communication) and farmers' attitudes to sawah practice in Nigeria. The study further examined the interrelationships between the constraints identified.

FACTORS AFFECTING ADOPTION OF AGRICULTURAL TECHNOLOGY

Past studies have identified barriers to agricultural technology adoption. Among the barriers identified by Food and Agriculture Organization of the United Nations (FAO 2001) are large investment costs, the perceived risk of a technology, long gestation periods for the benefits of the technology to materialize, access to information and extension services, land tenure and culture and recent history. The socio-economic status such as family income, parental educational level, parental occupation and social status all affect adoption (Demarest et al. 1993). In Kenya, for instance, some of the socio-economic factors reported as constraints to technology adoption include high initial investment cost, negative image and limited private sector involvement.

Bangura (1983) argued that the best predictor of adoption was the farmers' individual goals. If there are differences in the goals of technology and the farmers' goal, achieving success by the farmers in the use of innovation will only be a mirage. The farmer's socio-economic status can also pose a threat to his/her farming activities. The characteristics of an innovation can also create a problem for the farmers. Innovations that are simple and relatively easy to understand are more likely to be adopted by the farmers than those that are complex. Bangura (1983) reported that farmers prefer to adopt innovations that satisfied their security needs, are less complex, required less time to use, and are less labour-demanding. Such innovations are easily communicated in a short time to intending users/farmers.

Kumar and Popat (2010) reported that farmers' characteristics such as knowledge, market

orientation and innovativeness influenced the adoption gap significantly. A lack of knowledge about an innovation can limit its adoption. Attitude, knowledge, skill and the personality of scientists and extension agents can also constrain the use of an innovation. Scientists have often been criticised for lacking the skills necessary for implementing their innovations. In addition, farmer's knowledge of innovation is an important factor in the adoption process. Lack of technical know-how on the use of technology by farmers can be a serious constraint to the adoption and the success of that innovation. Sawah as a package of innovation has some component elements, and mastery of its components will determine its successful adoption. Sawah components include bunds construction, puddling, flooding and flood control, levelling and smoothening, dyke construction, canal construction, seed selection, transplanting, fertilizer application, use of sand bags, water management, weed management, diseases and pest management, and nursery preparation.

The results of some research are easily observed, and are therefore easier to communicate. Innovations with a high degree of observability are more likely to be adopted. It is recognised that some innovations do not lend themselves readily to communication and this is one of the most common constraint in innovation adoption process. However, the impact of communication in human development is enormous and must be taken into cognisance in the field of agriculture where the systems that form the entity are stratified into a highly educated technology generation system (researchers), a relatively well educated technology dissemination system (exten-sionists) and a mass of technology utilization system (farmers) who have little or no formal education (Adeniji 1997). The identification and use of appropriate communication channels is important. For example, it is unlikely that the use of mass media in extension can replace personal contact between extension agents and target groups or individual farmers. If an innovation is complex and its cost and expected returns are difficult to identify, and the adoption challenges the farmer's belief, then communication from researcher to extension agent and ultimately to the farmer must be extremely clear hence the adoption faces a great problem. There is a need for continual access to information and in this regard extension agents have an important role to play as knowledge navigators.

The use of improved technologies remains a major strategy for increasing agricultural productivity and promotes food and livelihood security. Innovations may include scientific and technical knowledge, ideas, services, systems, inventions, and products. The adoption of the improved technologies requires particular biophysical conditions such as slope, soil texture which are in general well described in common manuals and relatively easy to verify (Drechsel et al. 2010). A complex situation arises from the social, cultural and economic perspectives. It is believed that the biophysical requirements are less limiting for technology dissemination than socio-economic factors. Drechsel et al. (2010) noted that the adoption of any technology is a function of the characteristics of the technology proposed, farmers' perception of its advantages and need, as well as availability and distribution of production factors. Other factors that affect the adoption of any technology are farmers' attitude towards experiments and risk, institutional support/knowledge sharing and the policy environment surrounding the technology.

METHODOLOGY

This study was carried out in Nigeria. Nigeria has 36 states and Abuja is the Federal Capital Territory (FCT). This study was carried out in five states and the FCT where sawah is being practiced. The states are Niger, Kaduna, Ondo, Kwara, Ebonyi and Abuja (that is, the FCT). Data used in this study were collected in all the sawah sites in Nigeria namely: Bida, Zaria, Akure, Ilorin, Abakaliki and Abuja respectively from the states. A list of rice farmers in the villages where sawah system was disseminated was compiled. A total of 500 farmers were involved in sawah rice production across the states as supported by Oladele and Wakatsuki (2010). A well-structured interview guide was used to elicit information from the farmers on their socio-economic characteristics, farm characteristics and constraints. Geographical Positioning System (GPS) was also used to get readings on the distance between the farmers' fields. One hundred and twenty- four sawah farmers in the study locations randomly selected were interviewed in the course of the study due to their involvement in sawah rice production. Descriptive statistics were used to analyze the socio-economic and farming characteristics of the farmers. Correlation analysis was

used to determine the inter-correlation between the constraints and other study variables. Regression analysis was used to determine the relationships between the yield and constraints as predictor variables as shown in the equation below:

$Y = a+\beta X_1+\beta X_2+\beta X_3+\beta X_4+\beta X_5+\beta X_6+\beta X_7+\beta X_8$

Where

Y = Yield
X_1 = Land acquisition and tenure
X_2 = Production and on-farm constraint
X_3 = Economic market constraints
X_4 = Input availability related constraints
X_5 = Information and training constraints
X_6 = Technological and scientific constraints
X_7 = Attitude and perception constraints
X_8 = Total constraints

RESULTS AND DISCUSSION

***Socio-economic and Farming Characteristics of the Respondents*:** Table 1 shows the socio-economic and farming characteristics of the respondents. Majority of the respondents were male (98.9%). This implies that sawah farming in Nigeria is dominated by male farmers. The result agrees with the findings of Fu et al. (2009) who reported that sawah rice farming is being dominated by male farmers. The mean age of the respondents is 42.30 years and 65.40% fell within the productive age of 15-45 years. Most of the respondents are married (98.80%) and 62.70% of the farmers had Quranic education. These findings agree with the findings of Fu et al. (2009) and Oladele and Wakatsuki (2009). Household size of the farmers ranged between 1 and 40 persons (χ = 14). Fifty-five percent of the farmers had between 11 and 20 household size. The relative large household size could serve as a source of farm labour. According to Erenstein (2003), labour is one of the major constraints affecting several agrarian systems. The considerable large size of the farming households could reduce the labour demand. The mean size of farm devoted to sawah is 0.5ha. However, majority of the farmers have farm sizes less than 0.5 ha and the mean farmers' income is ₦ 150 000 ($1041). This implies that sawah rice production has greatly improved the standard of living of the farmer. According to CBN (2005), 70 percent of the population had income of less than $1 per day. With the adoption of sawah, this has increased considerably. Mean farmers' years of experience in rice production and sawah production are 32 and 6 years, respectively. This implied that the respondents have considerable experience in rice production and hence their experience in rice production may be of great importance in using sawah technology. According to Awotide et al. (2010), number of years of experience in rice farming influences the adoption of new technologies in rice production among rice farmers in Nigeria. Also, farmers' experience in rice production will be of great importance in developing the skills required for sawah rice production. The mean yield of rice from the sawah field is 2.5 tonnes with the majority of the farmers (77.30%) having a yield of less than 2 tonnes. In all, yield of sawah field among the sawah farmers is 4.65 tonnes per hectare. This also shows an improvement in the yield of farmers with about 1.5t/ha before the introduction of sawah technology. The average distance covered from the farmers' house to their sawah rice field 0.7km. Lowland rice farming is predominantly practiced by the farmers and they only bund their field.

***Constraints to Sawah Technology*:** The constraints to sawah development in Nigeria are presented in Table 2. The most severe constraints related to land acquisition and tenure were poor fertility of the soil (76.10%), poor road network from their farms to city centre (87.50%), and topography of the farm that results in high cost of levelling of sawah basins (84.10%). Infrastructure such as roads and irrigation plays a key role in facilitating technology adoption. Improved transportation is also associated with diffusion of technology, better use of inputs and better prices for farmers (ATAI 2011). However, accessibility, availability, conflict and land fragmentation also affect the sawah development. Land tenure security determines whether people will invest in and adopt sawah technology and can therefore be regarded as an important ingredient in adoption of sawah technology. Sawah development needs a secured land on which structures such as bund, canals and dykes should be constructed if not permanently but for a reasonable number of years. According to FAO (2001), land tenure and barriers related to land availability are major constraints to agricultural intensification. Production and on-farm constraints severely affecting sawah development were water management (86.10%) and flood (48.90%). Other on-farm constraints are drought,

Table 1: Socio-economic and farming characteristics of the respondents (N=124)

Characteristics	*Frequency*	*Percentage*	*Mean*
Sex			
Male	122	98.80	
Female	2	1.20	
Age			
15-30	27	22.00	
31-45	54	43.40	42.30
46-60	25	20.10	
>60	18	14.50	
Marital Status			
Married	122	98.80	
Single	2	1.20	
Educational Level			
Quranic	78	62.70	
No formal education	4	3.60	
Primary	15	12.00	
Secondary	23	18.10	
Tertiary	4	3.60	
Household Size			
1-10	39	31.10	
11-20	69	55.60	14
21-30	12	9.70	
31-40	4	3.60	
Farm Size (ha)			
<0.50	92	73.90	
0.50-1.00	21	17.00	0.53
>1.00	11	9.10	
Income (₦)			
<100,000	23	18.10	
100,000-200,000	71	57.80	151,110
>200,000	30	24.10	
Years of Experience in Rice Production			
1-15	30	24.10	
16-30	38	30.10	
31-45	30	24.10	32.00
46-60	23	18.10	
61-75	4	3.60	
Years of Experience in Sawah Rice Production			
1-3	32	25.60	
4-6	18	14.60	6.10
7-9	59	47.60	
10-12	15	12.20	
Yield of Sawah Rice			
0-2 tonnes	96	77.30	
2.1-4.0 tonnes	18	14.70	2.5 tonnes
4.1-6.0 tonnes	3	2.30	
>6.0 tonnes	7	5.60	
**Land Tenure*			
Own	15	12.10	
Rentals	42	33.87	
Inheritance	89	71.77	
Gift	3	2.10	
Sharecropping	2	1.61	

*Multiple responses provided
Source: Field survey

weeds, pest and diseases. Wakatsuki (2008) reported that an improvement of the natural resource management technology, especially through the improvement of water control in rainfed lowland plays a major role in increasing rice production among farmers.

The major economic constraints faced by sawah farmers are lack of viable financial agencies to support their production (70.50%), poor capital base for farming (70.00%) and non-availability of loan to support farming (69.50%). According to FAO (2001), large investment costs may discourage adoption of technology. It was estimated that one hectare of sawah field will require about ₦ 435000 ($3000) for development. Also, power tiller set used for land preparation on sawah field cost between ₦725000- ₦ 1015000 ($5000-7000) which is a high investment which the farmers cannot afford as revealed by the farmers in the course of this research . Power tiller is a multipurpose hand tractor designed primarily for rotary tilling and other operations on the farm. Getting loans and other financial incentives will definitely improve their scale of production (Ademiluyi et al. 2008).

The major information and training constraints faced by the farmers are lack of access to extension services (45.50%) and lack of technical knowledge of sawah (40.90%) especially water management. Technology generated, tried and proved useful but did not get to the end users is less beneficial. Both the technology generation system of the innovation, dissemination system (extension agents) and the farmers are needed for the effective utilization of an innovation. The farmer must know that the technology exists; he must know that the technology is beneficial; and he must know how to use it effectively. External sources of information, such as extension workers, may be particularly important for the adoption of new technologies. Therefore, the identification and use of appropriate communication channels is important (Onasanya et al. 2006). Lack of access to information and extension services by farmers would hinder adoption (FAO 2001).

A number of technical and mechanical constraints confronted sawah farmers. These include: non- availability of power tillers (79.50%) for land preparation activities, lack of skill for land and site selection (73.90%), and complexity of water management (63.60%). Farmers faced severe challenges getting power tillers for cultivation and access to fertilizers during the cropping season. Farmers are also confronted with lack of processing facilities hence they rely on locally made drums for threshing of paddy and travel

Table 2: Constraints faced by Sawah farmers (N=124)

Constraints	*Very severe (%)*	*Severe (%)*	*Not severe (%)*	*Mean*
Land Acquisition and Land Tenure				
Accessibility	10.20	31.80	58.00	
Availability	2.30	14.80	83.00	
Fertility	76.10	12.50	11.40	
Affordability	0.00	2.30	97.70	14.61
Poor road network	87.50	2.30	10.20	
Topography	84.10	2.30	13.60	
Land conflict	5.00	15.00	80.00	
Land fragmentation	13.60	47.70	38.60	
Production and On-Farm Constraints				
Flood	48.90	39.80	11.40	
Drought	2.30	42.00	55.70	16.53
Weed	1.10	37.50	61.40	
Diseases and pest invasion	0.00	37.50	62.50	
Water management	86.10	11.60	2.30	
Labour	3.40	83.00	13.60	
Marketing and Economic Constraints				
Lack of proper market facilities	34.10	36.40	29.50	
High fluctuation in market prices	35.20	30.70	34.10	
Lack of export marketing in the area	29.50	25.00	45.50	
Glut during harvest	23.90	8.00	68.20	19.92
Small Scale of production	58.00	9.10	33.00	
Lack of capital	70.00	0.50	29.50	
Non-availability of loans	69.50	2.50	28.00	
Lack of finance agencies	70.50	0.00	29.50	
Input				
Poor varieties of seeds	44.30	46.60	9.10	
More requirement of fertilizers and manure	54.50	36.40	9.10	
Unavailability of chemicals for weed and pest control	46.60	43.20	10.20	18.23
Labour constraints	15.90	34.10	50.00	
Lack of processing facility	34.10	60.20	5.70	
Power tiller	88.60	10.20	1.10	
High cost of inputs	51.10	45.50	3.40	
Information and Training				
Lack of information needed	15.90	68.20	15.90	
Lack of extension and advice on sawah technology	45.50	44.30	10.20	16.85
Lack of practical farm demonstration	11.40	12.50	76.10	
Lack of training on sawah technology	34.10	61.40	4.50	
Lack of technical knowledge and skill of sawah	40.90	46.60	12.50	
Technology and Mechanisation				
Non availability of Power tiller	79.50	6.80	13.60	
Unavailability of technical guidance on the use of Power tiller	45.50	25.00	29.5	
Lack of skill for seed and site selection	73.90	14.80	11.40	
Lack of knowledge and skill about weed management	55.70	35.20	9.10	27.80
Power tiller operation for puddling and maintenance	59.10	11.40	29.50	
Lack of knowledge and skill about bunding	33.0	13.60	53.40	
Dyke construction	13.60	15.90	70.50	
Complexity of water management	63.60	19.30	17.00	

long distances to mill paddy rice. Power tiller is the only power-driven tool that is effectively used for sawah activities currently in Nigeria. It can be used for puddling, levelling, and transportation and can also be used as a power source for stationary machines for threshing and milling (Ademiluyi et al. 2008).

Farmers' Attitude and Perception of Sawah Technology: The result of the study however shows that farmers have positive attitude toward sawah technology. As shown in Table 3, there was no resistance from the farmers to adopt sawah technology and they have positive attitude toward it. Attitude and perceptions of the farmer who are the end users of the various activities that makes up the sawah package must be taken into account. Wossink and Boonsaeng (2003) opined that perception and knowledge is crucial

for successful research and development strategies and that many promising agricultural policies have failed because they were inappropriate to farmers need and perception. Farmers' attitudes and perception are of crucial importance to successful development strategies. Many promising agricultural innovations and supporting policies have failed because they were inappropriate to farmers' needs. It must be noted that the perceived risk of technologies may serve as a barrier to adoption. Majority of the farmers believe that sawah pose no risk to their production. Also, farmers believe that sawah rice production is profitable and worth adopting.

Table 3: Farmers' attitude and perception of sawah technology

Variables	*Agree (%)*	*Indifferent (%)*	*Disagree (%)*	*Mean*
Perception of risk	10.20	1.10	88.60	
Perception of low profitability	10.20	10.20	79.50	
Non-perception of necessity for suitable technology	0.00	26.10	73.90	7.01
Impact of beliefs and traditions	0.00	2.30	97.70	
Negative attitude towards innovation	0.00	14.80	85.20	
Farmers resistant to change	0.00	5.70	94.30	

Correlation Analysis Between Study Variables: Table 4 shows the inter-correlation between constraints to sawah technology among the farmers. There are a range of constraints that influenced the rate of adoption of innovations. The results revealed that the existence of one constraint influenced the other. Land tenure constraints were related to production constraints (r=0.52; p<0.01), input (r=0.60; p<0.01), and technical constraints (r=0.42; p<0.01). This implied that as the constraints of land tenure persist, farmers are bound to be confronted with constraints related to production, inputs and technology. Also, information constraints were related to economic (r=0.38; p<0.01), input (r=0.70; p<0.01), and production related constraints (r=0.62; p<0.01). This implies that information constraints influenced the economic, input and production related constraints of the farmers.

Furthermore, farm size of the farmers was negatively related to land acquisition and tenure related constraints (r=-0.52; p<0.01). This im-

Table 4: Correlation matrix of the study variables (N = 124)

	Variables	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1.	Land acquisition and tenure	1.00											
2.	Production and on farm constraint	0.52**	1.00										
3.	Economic market constraints	0.18	0.38**	1.00									
4.	Input availability related constraints	0.60**	0.70**	0.40**	1.00								
5.	Information and training constraints	0.15	0.62**	0.20	0.54**	1.00							
6.	Technological and scientific constraints	0.42**	0.02	0.54**	0.61**	0.38**	1.00						
7.	Attitude and perception constraints	0.01	0.11	0.07	0.10	0.16	0.17	1.00					
8.	Age	0.16	0.09	0.02	0.12	0.11	0.14	0.16	1.00				
9.	Educational level	0.37**	0.09	-0.29**	-0.41**	-0.25**	-0.39**	0.03	0.51**	1.00			
10.	Household size	0.43**	0.09	0.17	0.06	0.25*	0.13	0.04	0.48**	0. 13	1.00		
11.	Farm size	-0.52**	-0.46**	-0.47**	-0.35**	0.14	0.33**	0.13	0.11	0.22*	0.32**	1.00	
12.	Yield	-0.41**	-0.18	-0.45**	-0.22*	-0.12	-0.46**	0.11	0.36**	0.53**	0.34**	0.91**	1.00

* Significant at P < 0.05; ** Significant at P < 0.01.
Source: Field survey

plies that as much as land tenure problem persists, farmers' farm size will continue to reduce. Land tenure in the study area is predominantly by inheritance (Fu et al. 2009). In this tenural system, farm land belonging to a family is shared between all the family members. As the population increases and the distribution continues from one generation to another, land fragmentation occurs. This in turn affects the size of land available to individual member of the family.

Farm size of the farmers was negatively related to production and on-farm related constraints ($r=-0.46$; $p<0.01$). The implication of this is that farm size is negatively affected by the persistence of production and on-farm related constraints. That is, due to production constraints, farmer may not be able to expand the scale of his production. A farmer facing challenges of providing farm inputs and management of the farm in terms of resources for weeding, diseases and pest control, water control and labour for farm operations may not be able to increase the size of his farm. Farm size is negatively related to economic and market and technological constraints. Farmers with limited resources such as input, labour, and machine may be constrained and may not be able to increase the size of his plot and hence have limited yield. However, household size is positively related to the farm size of the farmers. This implies that as the household increases, the farm size also increases. However, this must be subject to availability of land and other farm inputs. This may be due to the fact that the relative increase in the household size could serve as a source of farm labour.

Further, there was a negative significant relationship between input constraints and yield of farmers ($r=-0.22$; $p<0.05$). The non- availability of inputs reduced the farmers yield. Adoption of sawah technology depends on the availability of inputs such as power tillers, fertilizers, improved rice seeds and other farm inputs. Availability of these inputs will influence the level of adoption of sawah technology among the farmers and their farm output. The more available farm resources are, the greater the level of adoption and expansion of sawah technology and the non- availability of these resources pose serious threat to the famers rate of adoption. According to Mupangwa (1994) and Mapiye et al. (2006), adoption is hampered by high cost and low availability of farm inputs. The unavailability of appropriate harvest and post harvest equipment is a major constraint. Farmers rely on locally made equipments for threshing and milling of paddy. Access to improved varieties and good quality seed was cited by farmers as a major constraint.

Financial constraints have been reported by respondents as an important barrier to the adoption of changed management practices (Cary et al. 2002; Greiner et al. 2003; Byron et al. 2004). For example, Greiner et al. (2003) found that operational and financial constraints are perceived as the most important impediments to the adoption of natural resource management activities or changed practices. If the level of income available to invest in new practices is insufficient, farmers are unlikely to invest, constraining the adoption of more sustainable technologies (Webb 2004).

Regression Analysis Showing the Relationship Between Yield and Constraints: The regression model used to determine the relationships between the yield and constraints as predictor variables is shown in the equation below and the result shown in Table 5.

$$Y = 12556.16 - 0.34\,X_1 - 0.13\,X_2 + 0.13\,X_3 + 0.05\,X_4 - 0.02\,X_5 - 0.429\,X_6 + 0.22\,X_7 - 0.27\,X_8$$

The yield is inversely related to land acquisition and land tenure constraints ($\beta = -0.34$;

Table 5: Regression analysis showing the relationship between yield and constraints (N=124)

Variables	*Standardised coefficients (b)*	*t-value*	*p*	*Decision at p-value = 0.05*
Land acquisition and tenure	-0.34	-2.34	0.02	Significant
Production and on-farm constraint	-0.13	-1.06	0.30	Not significant
Economic market constraints	0.13	0.94	0.35	Not significant
Input availability related constraints	0.05	0.34	0.74	Not significant
Information and training constraints	-0.02	-0.18	0.86	Not significant
Technological and scientific constraints	-0.429	-3.597	0.01	Significant
Attitude and perception constraints	0.22	1.68	0.05	Significant
Total constraints	-0.27	-2.22	0.03	Significant

$R = 0.46$, $R^2 = 0.22$, Adjusted $R^2 = 0.13$, $F = 2.44$,
Source: Field survey

$p < 0.05$). This showed that lack of access to farm land has negative effect on yield. In most cases, land fragmentation, due to tenure system practiced limits the availability of land for sawah-based rice production. Sakurai (2005) reported that investment in water supply canals is influenced by land tenure security and that the canals enhanced yield. Farmers who have no land for production are likely to spend money that was supposed to be used for the procurement of inputs and machines for the payment of land rent. Emanating from the discussion with the respondents during the course of this study, farmers pay as much as ₦ 12000 ($83) annually as rent for an acre of land. This may increase with increase in the rate of adoption of sawah technology in Nigeria.

Yield of sawah was also inversely related to technological constraint ($\beta = -0.43$; $p < 0.01$). The non- availability of power tillers, unavailability of technical guidance on the use of power tiller, lack of skill for seed and site selection, lack of knowledge and skill about weed management, power tiller operation for puddling and maintenance and lack of knowledge and skill about bunding have negative effects on the yield of farmers. However, there were positive relationships between farmers' yield and attitudes to sawah technology ($\beta = 0.22$; $p < 0.05$). This implies that farmers' positive attitude towards sawah technology has a positive effect on his commitment to sawah and timeliness of operations hence increases his yield. This may be as a result of higher yield, better water and weed control qualities of sawah as reported by Fu et al. (2009). Addressing the farmers' constraints will require a holistic approach in which all the constraints identified are addressed to improve on sawah development among the farmers.

CONCLUSION

The discussion highlighst the important constraints that must be addressed in order to improve the adoption of sawah system of rice production in Nigeria. The constraints, covering a wide array of issues included land acquisition and tenure, economics, information, communication and training, technical and mechanical constraints. The problems were found to be interwoven and influence each other. As constraints of land tenure persist, farmers are bound to be confronted with production, inputs and technology constraints. Lack of adequate information was found to be related to economic, input and production constraints of the farmers. Addressing these problems will lead to increase in the rate of adoption of sawah rice production technology and ultimately rice productivity in Nigeria.

RECOMMENDATIONS

The study recommends a reform on land by the government with appropriate legislation that will ensure effective, simplified, sustainable and successful land administration in Nigeria and give access and security on land for farmers willing to use land for agriculture especially sawah development. In addressing the credit challenge faced by sawah farmers, government should strengthen the financial base of informal institutions such as the cooperative societies in the rural communities by providing credit subsidies to them. This will encourage them to continue to offer credit delivery to rural farmers. Effort should also be made by stakeholders in rural credit schemes to increase the establishment of informal institutions in the rural areas. Government should train and deploy more extension agents to the areas where they can help train the farmers on how to best use sawah technology to improve on their rice production and for effective information communication. This can be achieved by organising on-the-job trainings for the extension agents in order to effectively train the farmers all the rudiment of sawah technology to bridge the training and information gap of the farmers. Cooperative farming should be encouraged among the farmers in order to be able to acquire farm input such as power tiller that is out of reach of individual farmer.

ACKNOWLEDGMENT

This study was supported by Japan Society for the Promotion of Science (Grant-in-Aid Scientific Research No. 19002001).

REFERENCES

Ademiluyi YS, Oladele IO, Wakatsuki T 2008. Socio-economic factors affecting power tiller use among sawah farmers in Bida, Nigeria. *Journal of Food, Agriculture and Environment*, 6(3 and 4): 387-390.

Adeniji OA 1997. Role performance of University of Agriculture, Abeokuta. In: *Research – Extension –*

Farmers – Input Linkage System in Ogun State. Post Graduate Diploma Thesis, Unpublished. Ago – Iwoye: Olabisi Onabanjo University.

Awotide BA, Diagne A, Awoyemi TT, Ojehomon VET 2010. Farm-level constraints and adoption of improved rice varieties in Nigeria. *Journal of Agriculture and Environmental Studies,* 1(2): 12-29.

Agricultural Technology Adoption Initiative (ATAI) 2011. Constraints on Adoption. From<http://atai-research.org/our-approach> (Retrieved on July 5, 2011).

Bangura AM 1983. *Farmer Motivation Patterns in Participating in Adaptive Crop Research Trials/Demonstrations in Sierra Leone.* Dissertation Abstracts, 44/03A: pp 864.

Cary J, Webb T, Barr N 2002. *Understanding Land Managers' Capacity to Change to Sustainable Practices: Insights About Practice Adoption and Social Capacity for Change*. Bureau of Rural Sciences, Canberra.

Central Bank of Nigeria (CBN) 2005. *National Economic Empowerment and Development Strategy (NEEDS) Hand Book.*

Demarest EJ, Reisner ER, Anderson LM, Humprey DC, Farquhar E, Stein SE 1993. *Review of Research on Achieving the Nation's Readiness Goal.* Washington, D.C: U.S. Department of Education.

Diao X, Headey D, Johnson M 2008. Towards a Green Revolution in Africa: What would it achieve, and what would it require? *Agricultural Economics,* 39: 539–550.

Drechsel P, Olaleye A, Adeoti A, Thiombiano L, Barry B, Vohland K 2010. Adoption Driver and Constraints of Resource Conservation Technologies in Sub-Saharan Africa. From<http://westafrica2.iwmi.org/pdf/AdoptionConstraints-Overview.pdf.> (Retrieved on November 25, 2010).

Erenstein O 2003. Smallholder conservation farming in the tropics and sub-tropics: A guide to the development and dissemination of mulching with crop residues and cover crops. *Agriculture, Ecosystems and Environment,* 100: 17–37.

Esenwa AO 2011. *Contribution of Formal Financial Institutions to Cassava Processing in Benue State, Nigeria*. Master's Thesis, Unpublished. Abeokuta: University of Agriculture Abeokuta.

Fashola OO, Oladele OI, Aliyu J Wakatsuki T 2006. Dissemination of Sawah Rice Technology to Farmers Cultivating Inland Valleys in Nigeria. Proceedings of the Asian Pacific Extension Network, 6-8th March 2006, Australia.From<http://www.regional.org.au/au/apen/2006/Refereed/5/3223_fashola.html#topofpage> (Retrieved on December 22, 2010).

Food and Agricultural Organization (FAO) 2001. FAO Rice Conference 2001. From <www.fao.org.> (Retrieved on November 25, 2010).

Fu RHY, Maruyama M, Oladele IO, Wakatsuki T 2009. Farmer's adoption and propensity to abandoned adoption of sawah-based rice farming in inland valley of Central Nigeria. *Journal of Food, Agriculture and Environment,* 7(2): 379-382.

Greiner R, Stoeckl N, Stokes C, Herr A, Bachmaier J 2003. *Natural Resource Management in the Burdekin Dry Tropics: Social and Economic Issues.* A Report for the Burdekin Dry Tropics NRM Board, CSIRO, Townsville.

Guerin F 2002. Overcoming the constraints to the adoption of sustainable land management practices in Australia. *Technological Forecasting and Social Change,* 65: 205–237.

Guerin LJ, Guerin TF 1994. Constraints to the adoption of innovations in agricultural research and environmental management: A review. *Australian Journal of Experimental Agriculture,* 34(4): 549 – 571.

Kumar GDS, Popat MN 2010. Assessment of adoption gaps in management of aflatoxin contamination of groundnut (*Arachis hypogaea L.*). *The Journal of Agricultural Education and Extension*, 16(3): 309 – 319.

Mapiye C, Mupangwa JF, Mugabe PH, Chikumba N, Poshiwa X, Foti R 2006. A review of forage legumes research for rangeland improvement in Zimbabwe. *Tropical Grasslands,* 40: 145-149.

Mupangwa JF 1994. Fodder production in small-scale and communal sectors of Zimbabwe. In: C Mutisi, J Madsen , T Hvlepund , M Gomez (Eds.): *Proceedings of the Workshop on Integrated Livestock/Crop Production in the Small-Scale and Communal Farming Systems in Zimbabwe,* Held at Faculty of Agriculture Hall, University of Zimbabwe, 26-28 January 1994.

Okpukpara B 2010. Credit constraints and adoption of modern cassava production technologies in rural farming communities of Anambra State, Nigeria. *African Journal of Agricultural Research,* 5(24): 3379-3386.

Oladele OI, Wakatsuki T 2008. Social factors affecting wetlands utilization for agriculture in Nigeria: A case study of sawah rice production. *Rice Science,* 15 (2): 150–152.

Oladele OI, Wakatsuki T 2009. Effect of land tenure on the adoption of sawah rice production technology in Nigeria and Ghana. *Journal of Agricultural Science and Technology,* 3(10): 47-53.

Oladele OI, Wakatsuki T 2010. Sawah rice eco-technology and actualization of green revolution in West Africa: Experience from Ghana and Nigeria. *Rice Science,* 17(3): 168-172.

Onasanya AS, Adedoyin SF, Onasanya OA 2006. Communication factors affecting the adoption of innovation at the grassroots level in Ogun State, Nigeria. *Journal of Central European Agriculture,* 7(4): 601-608.

Otsuka K, Kijima Y 2010. Technology policies for a green revolution and agricultural transformation in Africa. *Journal of African Economies,* 19(suppl 2): 60-76.

Sakurai T 2006. Intensification of rainfed lowland rice production in West Africa: Present status and potential Green Revolution. *Developing Economies*, 44 (2): 232-251.

Wakatsuki T 2008. Materialization of African rice green revolution by sawah eco-technology (in Japanese). In: M Matsuzono , H Nawata , S Ishida (Eds.): *Human Development of Africa: Practice and Cultural Anthropology.* Tokyo: Akashi Shoten, pp. 1-27.

Wakatsuki T, Buri MM 2008. General concept of sawah system. In: M M Buri, R N Issaka, T Wakatsuki (Eds.): *The Sawah System of Rice Production*. CSIR-Soil Research institute, Kumasi, Ghana, pp. 6-27.

Webb T 2004. Understanding Behaviour: Social and Economic Influences on Land Practice Change. *Discussion Paper for Land Management Practices Information Priorities, Classification and Mapping – Towards an Agreed National Approach,* Canberra.