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Factors Influencing Farmers' Participation in System of Rice Intensification in Bakolori Irrigation Scheme, Zamfara State, Nigeria

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Sulaiman Umar[1], Ahmed Gee Abdullahi[2]*, Doris Thomas Kudi[3], Abubakar Manuwa[4] and Rabi'u Suleiman[5]

[12345]Department of Agricultural Extension, Faculty of Agriculture/Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria,
*Correspondence and presenting author: [2]amadumaimutane@gmail.com; +2347061353848 https://orcid.org/0009-0007-0479-4863
[1]sulaimanumar@gmail.com,+2348068488698
[3]doristhomaskudi@gmail.com, +2347038254089
[4]abubakarmanuwa@gmail.com, +2348035352690
[5]rabiu.suleiman@yahoo.com, +2348033576713

Abstract

This study assessed the socio-economic and institutional factors influencing rice farmers' participation in the System of Rice Intensification (SRI) in Bakolori Irrigation Scheme, Zamfara State, Nigeria. A two-stage sampling procedure was used to select one hundred and eighty rice farmers. Data were collected using a structured questionnaire. Descriptive statistics and Tobit Regression were used to analyse the study. The results showed that the majority (92%) of the rice farmers were males, 86% were married, and 62% had less than one (1) hectare of land. While 67.4% of them had extension visits in a year and majority (96.6%) had no access to credit. The result also showed that the majority (86%) of the rice farmers participated in all the SRI practice demonstrations. The result of Tobit regression showed that age (0.014), farm size (0.016), farming experience (0.032) and extension visit were determinants of farmers' level of participation in SRI practices at 5%. It was concluded that age, farm size, farming experience, and extension visits had an influence on farmers' participation in the five SRI practices. It was recommended that there is a need for more extension activities in the study area and farmers acquire more land for improved productivity.

Keywords: Rice farmers, participation, system of rice intensification

Introduction

In Nigeria, rice is a staple food consumed in most homes. Festivities and other social functions often place a huge demand on the availability of this popular food item, hence the significant financial resources that continue to be directed toward its importation and local production scaling (FAO, 2023). Rice paddy production in Nigeria increased from 388,000 tonnes in 1971 to 8.17 million tonnes in 2020 growing at an average annual rate

of 8.74% while the total demand for rice in 2018 was about 6.4 million tons (Knoema, 2021). However, recent sectoral analysis by Pricewaterhouse Coopers (PwC Nigeria) (2024) indicates that the national demand for rice is projected to hit nearly 20 million metric tonnes by 2030, while local supply is only expected to grow to approximately 9.2 million metric tonnes. This significant shortfall reinforces the reality that domestic production continues to lag behind the rapid population growth and urbanization. Currently, annual consumption has stabilized at roughly 7.8 million metric tonnes, leaving a substantial "rice gap" that requires the country to remain a top global importer to maintain food security (FAO, 2024; USDA, 2025). Consequently, attempts have been made to improve rice production so as to meet the demands of the growing population and one such attempt, besides the Green Revolution, is the introduction of the System of Rice Intensification (SRI). SRI is a cultivation practice integrated by Fr. Henri de Laulanié, S.J. in the 1980s that increases rice yield by 100% using less water, compost manure, any rice variety and at low cost of production through six principles namely: transplanting seedlings at younger age of 8-12days; planting only single seedlings per hole; wider spacing 25 x 25 cm – 50 x 50 cm in a square pattern; increased use of organic manure; alternate wetting and drying method than flooding the field; and use of rotary weeder for weed control (Joshua et al*.,* 2025). This aims to improve rice farmers' productivity and output to alleviate their families' hunger and poverty (Adedoyin, 2025).

In Zamfara State, agriculture provides a livelihood for over 80% of the state's population. Residents are fully utilizing the venture as a source of livelihood. Rice production among smallholder farmers is hindered by various challenges, including production systems, which could be enhanced through participation in the System of Rice Intensification (SRI) (Opitz et al*.,* 2022; Issoufou et al*.,* 2023). Participation is defined as the intentional involvement of local stakeholders in development processes to ensure interventions are contextually relevant (Talsma et al*.,* 2022). Studies by Chisita et al*.* (2023) and Mugwisi (2024) views participation as the systematic engagement of community members in action-oriented scenarios that drive holistic community development. In their analysis, Chisita et al*.* (2023) emphasize that the multi-dimensional effects of community participation remain a central debate among development scholars. Key documented benefits of this engagement include: Significant improvements in the communal quality of life and environmental stewardship (Abbas et al., 2021); The socio-economic empowerment of individuals and the strengthening of community resilience (Aref & Redzuan, 2020); A heightened sense of psychological ownership and responsibility among community members (Klerkx & Rose, 2020); The reduction of social marginalization and the enhancement of collective self-efficacy, which directly ensures project sustainability (Babu et al*.*, 2024).

In Bakalori Irrigation Scheme, rice production is hampered by: land tenure and development; high cost of inputs such as fertilizers, improved seeds and other agrochemicals; information dissemination gap, improper management of soil and water resource and climatic factors such as soil salinity, declining soil fertility, erosion, drought and global warming which poses problems to successful rice cultivation but can be addressed by SRI technology, if it is effectively disseminated and adopted by farmers (Transforming irrigation Management in Nigeria (TRIMING)-SRI, 2021).

A significant number of studies (Bashir et al., 2022; Scripts & Thakur, 2024; Gebremariam et al., 2021; and Omotayo et al., 2023) have investigated SRI, focusing on its yield potential, adoption rates among smallholder farmers, and its comparative advantages over conventional flooding methods. These studies increasingly emphasize SRI as a 'climate-smart' intervention capable of reducing water use while increasing productivity. The TRIMING-SRI Project was tested for the first time ever at Bakolori Irrigation Scheme by the Institute for Agricultural Research, ABU, Zaria, in collaboration with National Agricultural Extension Research and Liaison Services, ABU, Zaria and National Centre for Agricultural Mechanisation, Ilorin, in 2018 using five SRI practices with the exception of rotary weeder. The enrolment of rice farmers into the System of Rice Intensification (SRI) relies primarily on a capacity building and participatory extension approach. Because SRI involves a fundamental shift in mindset, moving away from traditional, input continuous flooding to aerobic, alternate wetting and drying methods, the enrollment mechanism is collaborative rather than purely administrative (Girei, 2024; Girei and Mukaila, 2025). However, the project did not assess the level of farmers' participation, factors influencing farmers' level of participation in SRI and the constraints associated with the use of SRI practices. Therefore, it was crucial to measure the factors influencing rice farmers' participation in the SRI project in the study area. The specific objectives were to: describe the socio-economic and institutional characteristics of rice farmers; assess the level of rice farmers' participation in SRI; and determine the socio-economic and institutional factors influencing rice farmers' participation in SRI.

Methodology

The Bakolori irrigation project is located in Talata Mafara, Maradun, and Bakura LGAs and it covers 23,000 hectares of land (Mafara, 2022). The people are predominantly Hausa and Fulani, with agriculture as their main occupation. Some of the crops grown include rice, millet, maize and cowpea. The rice farmers are into rainy and dry season farming, with irrigation water supplied by the Bakolori dam. The area is one of the major rice-producing in the country and the region in particular, with irrigated lowlands, rainfed lowlands and rainfed upland (Kabir et al*.,* 2024).

This study used a two-stage sampling procedure to select the rice farmers. In the first stage, five intake areas namely N-Rice, N Central, F-Right, G-Rice and E-Down assuming the local names Dankaiwa, Rini, Tajaye, Yarkofaji and Birnin-tudu were purposively selected due to the high density of SRI participants in the areas, and security challenges and construction works that were ongoing during the testing of SRI practices. In the second stage, proportionate sampling method using random sampling technique was used to select 180 rice farmers from the five intakes representing 20% of the sample frame satisfying the central unit theorem which asserts that a sample size of at least n= 30 is large enough to ensure a normal distribution in the sampling process (Ralph-Jay, 2025). One hundred and eighty (180) questionnaires were distributed among the respondents and one hundred and seventy-eight (178) questionnaires were retrieved. Therefore, 178 served as the sample size for this study.

Table 1: Sampling procedure and sample size

Sector	Participants	Sample size (20%)	
N Rice	180	48	
N central	145	35	
F Right	275	37	
G Rice	170	38	
E Down	130	23	
TOTAL	**900**	**180**	**178**

Primary data were collected through the use of a questionnaire instrument administered to rice farmers by the researcher and trained enumerators from Zamfara Agricultural Development Project (ZADP). The instrument went through content validation by the supervisors of this study, each of whom contributed to the relevance of the variables. The secondary data on the other hand, was collected from underwent content validation by the supervisors of this study, each of whom contributed to assessing relevant journals, publications, and the TRIMING-SRI Project Data Management where necessary. Also, the internet was used for relevant information.

Frequency, mean and standard deviation while the inferential statistic used is Tobit Regression. The descriptive statistics was used to analyze data used to achieve objectives i and ii. Tobit Regression was used to achieve objective iii.

This model was used to achieve objective iii: to determine the factors influencing rice farmers' participation in SRI.

$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + U$;

Where:

Y_i= Level of participation (index of SRI practices carried out by rice farmers)

1. Transplanting at 9 – 15 days
2. Transplanting 1 seedling per hill.
3. Transplanting dimension of 25 x 25 cm – 50 x 50cm
4. Use of compost at 10 – 15t/ha and complementary mineral fertilizer at 1/3 – ½.
5. Alternate wetting and drying at water depth of 2 – 4cm.

The index score is calculated as: $\frac{3 \text{ Adopted practices}}{5 \ Total \ practices} = 0.60 \ 0r \ (60\% \text{ participation intensity})$

X_1 = Age of the farmer (in years)

X_2 = sex of the farmer (Male = 1, Female = 0)

X_3 = Marital status (Married= 1, Single = 2, Divorced = 3)

X_4 = Farm size (In hectares)

X_5 = Household size (Number of individuals)

X_6 = Educational level (no formal education= 0, primary education= 1, secondary education= 2, tertiary education= 3)

X_7 = Farming experience (Years)

X_8 = Cooperative membership (years spent)
X_9 = Extension visit (Number of extension visits per year)
X_{10} = Access to credit (actual amount received in naira)
β_0= Constant
β_1 - β_{10} = Regression coefficients
U = Error term

Results and Discussion

Institutional Characteristics of Rice Farmers

The result in Table 2 shows that 93% of the rice farmers were members of cooperative societies. This shows that most of the rice farmers belonged to one cooperative society or the other. The finding is similar to that of Kabir *et al.* (2024) who reported that 86.7% of the respondents were members of farmers' association. Their membership to a cooperative society provided easy access to information during the farming season. The mean extension visits was 3.0 while the minimum and maximum extension visits were 1 and 9 respectively. The result also shows that 70% of the rice farmers visited extension agents for 1-5 times a year. This indicates that majority of the rice farmers had extension visits. Ugwuoti et al. (2026) also found a significant proportion of the farmers to have extension visits. This could mean that rice farmers with frequent extension visits had access to necessary information and technicalities needed for better yield. The result reveals that most (96.6%) of the rice farmers had no access to formal credit. It was gathered that the minimum and maximum credit received were N20,000 and N300,000 respectively. However, those who had no access to credits stated that they financed their farm through personal saving (39%), sales of farm produce (36%), and family members (23.8%). This shows that there were poor or absence of credit facilities in the study area. This finding is in line with Attamah et al. (2023) who found poor access to credit among farmers. The implication is that lack of or inadequate access to credit could hinder rice farmers' production capacity.

Table 2: Institutional characteristics of rice farmers

Institutional Characteristics of Rice farmers	Frequency	Percent	Mean	Min.	Max
Membership of cooperative society					
No	13	7.3			
Yes	165	92.7			
Rice farmers' years of membership					
<5	39	23.6			
6-10	41	24.8			
11-15	43	26.0			
16-20	33	20.0			
21-25	10	6.1			
26-30	1	0.6			
>30	2	1.2			
Number of times extension agents visited rice farmers in the last farming season					
No visit	32	18.0	3.0	1	9
1-5 visit a year	120	67.4			
6-9 visit a year	26	14.6			
Number of times rice farmers visited extension agents in the last farming season					
Not visited	53	29.8	1.3	1	5
1-5 visit a year	125	70.2			
Received credit in 2019					
No	172	96.6			
If yes, amount received					
20,000-100,000	4	66.7		20,000	300,000
101,000-300,000	2	33.3			
If no, indicate how you financed your farming					
Personal savings	67	39.0			
Family members	41	23.8			
Sale of farm products	62	36.0			
Credit and thrift associations	2	1.2			

Farmers' Participation in SRI

The result in Table 4 shows that 93% of the rice farmers participated in the transplanting at 9 – 15 days, transplanting 1 seedling per hill had 96%, and transplanting dimensions of 25 x 25 cm– 50 × 50 cm had 87%. This showed that the majority of the rice farmers participated in all the SRI practices demonstrated. This result is in line with Badiru et al.

(2024), who reported that 51.9% of the respondents had a high level of participation in Farmer Business School activities in Osun State. The implication is that participation of the majority could lead to adoption by the majority, increased productivity and eventually an improved livelihood status.

Table 3: Distribution of rice farmers based on SRI practices participated

SRI Practices participated		%
Transplanting at 9 – 15 days		93.3
Transplanting 1 seedling per hill		96.1
Transplanting dimension of 25 x 25 cm – 50 x 50cm		87.1
Use of compost at 10 – 15t/ha and complementary mineral fertilizer at 1/3 – ½	97	54.5
Alternate wetting and drying at water depth of 2 – 4cm	136	76.4

*Multiple responses were allowed

Socio-economic and Institutional Factors Influencing Farmers' Level of Participation in SRI

Table 6 presents the socio-economic and institutional factors influencing farmers' participation levels in SRI in Zamfara State. The estimated coefficients of the tobit model, the standard error, p-value and marginal effects are also presented. The likelihood ratio (-451.052) indicates that the variables included in the model were jointly significant in influencing farmers' participation levels in SRI. The result shows that extension visit (0.034), farming experience (0.032), farm size (0.016) and age (0.014) were statistically significant determinants of farmers' level of participation in SRI.

It was found that extension visit was a positive ($\beta = 0.034$) and significant ($p = 0.001$) determinant of farmers' level of participation in SRI at $p< 0.01$ level of probability. This shows that the more the farmers had extension visit, the more they participated in SRI. The marginal effect of 0.60 indicated that farmers with more extension visit could more likely participate in SRI by 6 %. This result is in line with Kaloi et al. (2021) who reported that farmers who had significant extension visits had better chances to be aware of various management practices that they could use to increase production. The implication is that the chances of participating in SRI could greatly increase for farmers with more extension visit. Farming experience was positive ($\beta = 0.032$) and significant predictor of farmers' level of participation in SRI at $p< 0.05$ level of probability. The result shows that the more experience in rice farming, the more participation in SRI. The marginal effect of 0.26 indicates that farmers with rice farming experience would likely participate in SRI by 2.6%. This is in line with Kaloi et al. (2021) who found that there was positive relationship between farmer experience and adoption of SRI. The implication is that the more the years of famers' experience the more likelihood to participate in future interventions.

Farm size was positive ($\beta = 0.016$) and significant determinant of farmers' level of participation in SRI. This shows that the larger the farm size, the more farmers participate in SRI. The marginal effect of 0.06 shows that possession of a large farm increases the possibility of participation in SRI by 0.6%. This result is in line with Mhango (2024) who

reported that owning more farmlands was correlated with the adoption of agricultural technologies. The implication is that if farmers with larger farms participated more in SRI, there could be more bumper harvests and higher yields. It was found that the age of farmers was a positive (β= 0.014) and significant determinant of farmers' level of participation in SRI. This implies that the increased age of farmers increases the likelihood of participating in the SRI. The marginal effect of 0.08 showed that an increase in farmers' age increases the probability of more participation by 0.8%. This is in line with Mhango (2024) who found that age was positively related to farmers' participation at 1% level of probability. It can be said that older farmers would tend to stick to farming as their occupation for many years and would work hard, participating in any agricultural programme to improve their output and general livelihood.

Table 4: Socioeconomic and institutional factors influencing farmers' level of participation in SRI

Variables	Coefficient	Std. Err.
Age	0.01472*	0.02000
Sex	-0.31837	0.23224
Marital status	-0.01030	0.02341
Farm size	0.01672*	0.02123
Household size	-0.03255	0.05332
Educational level	0.11237	0.10942
Farming experience	0.03201*	0.02310
Cooperative membership	-0.01013	0.02113
Extension visit	0.03427*	0.01124
Access to credit	0.00521	0.00215
Sigma	1.22324	0.05145
Number of observations = 178		
F (17, 658) = 7.01		
Prob > F = 0.001		
Pseudo R2 = 0.071		
Log pseudo likelihood = -451.052		

NB: * P ≤ 0.05, Std. Err. = Standard Error,

Farmers' socio-economic and institutional characteristics had no significant effect on the level of participation in the system of rice intensification. Table 6 shows that the likelihood ratio (-451.052) was significant, which indicated that the variables included in the model were jointly significant in influencing farmers' level of participation in SRI.

Conclusion and Recommendations

Extension visits, farming experience, farm size and age were the significant factors influencing farmers' level of participation in SRI practices. There is a need for more extension activities in the study area so that farmers can acquire more land for improved rice production.

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