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Adoption of Improved Rice Varieties among Small-Holder Farmers in South-Western Nigeria

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Abstract: The research examines the status of adoption of improved rice varieties among small holder farmers in South-west Nigeria with a view to asses the impact of technology transfer on rice production in the region. A total of 157 rice farmers selected through multi-stage sampling technique were interviewed using structured questionnaires. The results show that farmers have responded appreciably to intervention programme that promote the use of the improved rice varieties with an adoption rate of 68.7%. The mean yield of improved rice varieties (1.601 t ha^{-1}) was significantly higher than the yield of the local varieties (1.154 t ha^{-1}) with a yield advantage of 38.7%. Also ITA 150 and Ofada were the most prominent improved and local varieties, respectively. However, the mean yield (1.586 t ha^{-1}) for paddy rice in the area is still considerably low indicating that the improved rice technology is yet to have an appreciable impact on the level of productivity. However, the improved rice technology was estimated to have led to a 19.4% proportional production increase in rice production in the area. Farm size, frequency of extension contact and the yield rating of the improved rice varieties are the significant factors influencing both the decision of farmers to adopt the improved rice varieties and intensity of use ($p \leq 0.10$).

Key words: Adoption · improved rice varieties · South-western Nigeria

INTRODUCTION

Rice is the staple food in many countries of Africa and constitutes a major part of the diet in many others. During the past three decades the crop has seen a steady increase in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries [1].

The challenges faced by countries as regards rice production however differs from one country to the other in terms of population, the preference attached to the commodity in the list of household menu, natural endowment for expanded production and the productivity of the rice farms [2] quoting [3] opined that globally, annual rice production needs to increase from 586 million metric tones in 2001 to 756 million metric tones by 2030. Sources of such increase are then identified as including; increase in acreage under high yielding varieties; develop hybrid rice and super rice; evolve more appropriate and efficient crop, soil, water, nutrient management technologies and accelerate technology transfer. All these factors no doubt go a long way in defining the potential of a country for expanded rice production.

Nigeria, though naturally endowed has not been able to produce enough rice for the domestic need of her teaming population and the gap between demand and domestic supply has further been widened by decades of growing importance of the commodity among households across the length and breath of the country. This has culminated in a situation whereby domestic supply had been complemented with enormous rice import in consequence of which Nigeria has emerged as a major importer of rice [4].

The consideration of the balance of trade implication (in the midst of abundant potential for expanded rice production) of the enormous rice import had in the last two decades resulted in trade policy initiative of various regimes, culminating in import restrictions as a strategy for encouraging domestic production. Recently is the increase in import tariff on rice, which is expected to generate revenue to be used

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in funding expanded rice production programmes of the Nigerian government.

However, a continuous gap between supply and demand for rice has been projected in the country [5]. Based on projected average annual growth rate of 3.2 and 6.9% in demand and domestic supply, respectively, the gap is expected to ease off by the year 2010 assuming a substantial success in the intensive strategies lined out for expanded production.

Prominent among these strategies is the effort of research system at the development and subsequent release of improved technologies notably high yielding and disease resistant rice varieties certified suitable for the various agro ecological zones of the country.

Reports from the research institutes (based on their on-station and on-farm trials) however indicate that the technologies should lead to substantial yield increase.

This however depends on sustained appreciable adoption of the technologies at the farm level. However, rural social scientists have long maintained that adoption of improved technology and market integration are predicated on the differential possession of economic resources like land, labour and capital [6]. Added to this are other numerous socioeconomic and institutional factors alongside the physical attribute of the technology itself. Studies in innovation dissemination [7 - 9] have underscored the importance of periodic assessment of level of adoption of innovations as a means of assessing for necessary adjustment, the efficiency of institutional coordination for the dissemination of new innovations and the extent to which acceptance of new innovation is limited by both physical attribute of the technology and the socioeconomic constraints.

This research therefore examined the status of adoption of improved rice varieties and its contribution to rice production in the South-western zone of the country. Attention was also paid to the identification of the determinants of adoption of improved rice varieties in the research area.

MATERIALS AND METHODS

The sampling frame for present study consists of farmers growing rice under various cropping systems in the South-western zone of Nigeria. A multi-stage sampling technique was used to select a total of 200 rice farmers from two of the rice producing states of South-western Nigeria namely Ogun and Osun States. The survey was conducted between October and December, 2002.

Two ADP zones noted for extensive rice production were selected from each of the states for this research. Subsequently, 5 blocks and 10 villages were randomly selected per zone for the research. Finally, 5 rice farmers randomly selected from the list obtained from the village head were interviewed with the aid of structured questionnaires. Interviewers were selected from among the agricultural extension agents in each cell to which each of the selected villages fall with the assistance of the Zonal Extension Officer (ZEO).

However, a total of 157 of the administered questionnaires certified as containing enough information within the scope of the research were analysed for the research. The distribution across the ADP zones is as shown below.

State	ADP zones	Number of respondent
Ogun State	Abeokuta zone	39
	Ikenne	42
Osun State	Ife/Ijesa	41
	Iwo	35
Total		157

Analytical tools included simple descriptive statistics like frequency distribution, means and percentages, while adoption index was estimated for each of the prominent rice varieties gown in the area and consequently for local and improve rice varieties in the zone.

Adoption index were computed for individual farmer following Philip *et al*. [9] whereby adoption index (B_v) is given by:

$$B_v = \frac{\sum_{i=1}^{n} R_i}{\sum_{i=1}^{n} R_T}$$

Where:

B_v = The adoption rate for rice variety v,
R_i = Land area grown to rice variety v by farmer I
R_T = Total land area grown to rice by farmer I
I = (1…….n)

Similarly, proportional change in production due to adoption of improved rice variety in the research area was determined as done by Ogunsumi *et al*. [10]. The Proportional Production Increase (PPI) is thus given by:

$$PPI = \frac{\Delta Y}{Y} \times B_{vm}$$

Where:

PPI = Proportional Production Increase
ΔY = Change in Yield (i.e. Mean Yield for Improve Varieties - Mean Yield for local varieties)
Y = Mean Yield for Rice in the area regardless of variety
B_{vm} = Adoption Index for improved varieties

A model was also specified to identify the farmer, farm and variety specific variables that influence the probability of adoption and intensity of use of improved rice varieties by rice farmers in the zone. The Logit regression model was specified to identify factors that influence the probability of adoption of improved rice varieties among farmers. The model was specified as:

$$P_j = \frac{e^{(\alpha+\beta X_{ij})}}{1+e^{(\alpha+\beta X_{ij})}}$$

This is transformed into the logistic regression model by a linear function of explanatory variables:

$$\text{Logit}\,(P_j) = \alpha + \beta X_{ij}$$

Where:

P_i = Adoption decision of farmer I assuming binary form of (1) for adoption and (0) for non adoption
X_{ij} = jth predetermined (covariates) household or technology attributes
α = Constant term of the regression equation to be estimated
β = Parameters to be estimated

However, to provide the loss of information as regards the intensity of use of improved varieties, another model was specified to determine factors influencing the intensity of use of improved rice varieties after farmers might have made the choice of adoption of the technology. The model is also specified as:

$$B_{ivm} = f(X_1, X_2, \ldots\ldots X_{13}, Ui)$$

Where:

B_{ivm} = Adoption rate for improved rice varieties for farmer I and assumes 1 and 0 for the logistic model and proportion of land area grown to improved variety for the linear regression model
X_j = Socio-economic, institutional and agronomic factors as shown in Table 1
U_i = Disturbance term

Hence, the logistic model was applied to all the farmers (both adopters and non adopters) to identify factors influencing the farmers' decision to adopt or not to adopt the improved rice varieties, while the linear regression was applied only to adopters to identify factors that influences the intensity of use after farmers

Table 1: Socio-economic characteristics of respondents

Variables	Adopters[a]	Non adopters[a]	Total[a]	Chi - square[b]
Age range				
Less than 20 years	00 (00.0)	00 (00.0)	00 (00.0)	10.195 (0.006)*
21 - 40 years	22 (14.0)	10 (06.4)	32 (22.4)	
41 - 60 years	58 (36.9)	12 (07.6)	70 (44.6)	
Above 60 years	52 (33.1)	03 (01.9)	55 (35.0)	
Mean age	42.8	53.8	53.2	
Education				
Illiterate	13 (08.3)	17 (10.8)	30 (19.1)	45.984 (0.000)*
Educated	119 (75.8)	08 (05.1)	127 (80.9)	
Sex				
Male	116 (73.9)	24 (15.3)	140 (89.2)	1.436 (0.231)
Female	16 (10.2)	01 (00.6)	17 (10.8)	
Membership of association				
Yes	100 (87.0)	15 (13.0)	115 (73.2)	2.663 (0.103)
No	32 (76.2)	10 (23.8)	42 (26.8)	
Type of rice grown				
Upland	102 (65.0)	16 (10.2)	118 (75.2)	0.284 (0.594)
Lowland	19 (12.1)	04 (02.6)	23 (14.7)	
Upland and Lowland	00 (00.0)	07 (06.2)	07 (04.5)	
Irrigated Lowland	04 (02.6)	01 (03.7)	05 (03.2)	
Irrigated Upland and Lowland	03 (01.3)	01 (03.7)	04 (02.5)	
Cropping Systems				
Sole	70 (44.6)	17 (10.8)	87 (55.4)	0.784 (0.853)
Mixed	28 (17.8)	03 (01.9)	31 (19.8)	
Relay	06 (03.8)	01 (00.6)	07 (04.5)	
Sole and Mixed	23 (14.7)	09 (05.7)	32 (20.4)	
Source of holdings				
Inheritance	89 (56.7)	13 (08.3)	102 (65.0)	8.857 (0.031)*
Rented	29 (18.5)	12 (07.6)	41 (26.1)	
Gift	04 (02.5)	00 (00.0)	04 (02.5)	
Purchased	10 (06.4)	00 (00.0)	10 (06.4)	

Source: Field survey 2002, [a] Figure in parenthesis are percentages, * Significant at $p \leq 0.05$

might have decided to or adopted the improved rice varieties.

A pair-wise comparison of yield values given by the farmers for both local and improved varieties was done for each of the prominent rice varieties when grown with and without fertilizer as obtained using t-statistic.

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of farmers in relation to their choice of use of improved rice varieties. The results indicated that age, education, source of land holding have significant relationship with adoption of improved varieties among the farmers while sex, choice of production and cropping systems were found to have no significant relationship with farmers' adoption of improved rice varieties.

Specifically, the average age of the farmers was 53 years with 20.4% (32) been between 21 to 40 years of age while none was below 21 years of age. Also adopters of improved rice varieties were younger in age (42.8 years) than non adopters (53.9 years).

Similarly, the majority of the educated farmers (93.7%) are adopters while the majority of the illiterate farmers (53.7%) are non-adopters. Generally however, about 80.9% of the respondents are literate.

The survey also revealed that improved rice varieties were widely adopted by a larger proportion of male (82.9%) and female farmers (94.1%). About 73% of the farmers belong to one form of association or other; however, improved rice varieties were predominantly grown by both members of associations (87%) and non members (76.2%).

Production systems: The production systems adopted by farmers in rice production is also shown in Table 3. The Majority (75.2%) of the farmers engaged in rain fed upland rice production followed by rain fed lowland (4.7%). Rice was commonly grown as a sole crop (55.4%). This includes those who adopted both sole and mixed cropping, while relay cropping (4.5%) is relatively unpopular in rice production among the farmers.

Land holdings and allocation: Acquisition of farmland among rice farmers had not deviated from the age-long trend as most of the farmers (65%) acquired their farmland through inheritance while 26.1% and 6.4% acquired their land through rent and purchase respectively. However, more adopters of improved rice varieties acquired their land through inheritance (57%) than non adopters (Table 1).

Generally, average land area put to cultivation by the farmers was estimated at 11.4 ha out of which an average of 2.6 ha was put to rice cultivation. In addition, adopters of improved rice varieties were found to put more land area (1.6 ha) to rice production than non adopters (0.3 ha). Also, non adopters cultivated larger farm size to local varieties (1.4 ha) than adopters (1.0), while the average land area grown to improved varieties was 1.1 ha (Table 2).

Adoption of improved rice varieties: The estimated adoption level of the different rice varieties identified by the farmers is shown in Table 3. The result shows that a substantial proportion of land area grown to rice was cultivated with improved rice varieties with an adoption rate of 68.7% while the adoption rate for local varieties was estimated as 31.3%.

The improved rice varieties grown by the farmers included ITA 150, WAB 189 , ITA 235, WITA 4, ITA 315, ITA 321, ITA 128, ITA 360, WAB 450.P31, WAB 450-131 and WITA 1, while the local varieties consisted of Ofada, Eleefa, Ilesa, Ode-omi, Benue local, Akure local and Mokwa. ITA 150, WAB 189, ITA 235 and WITA 4 are the prominent improved rice varieties while Ofada, Eleefa, Ilesa and Ode-omi are the local varieties commonly grown by the farmers in order of importance.

Table 2: Land allocation in rice production

State	N	Total land area (ha)	Area cultivated to rice (ha)	Percentage cultivated to rice	Average farm size grown to rice (ha)
Osun	76	695.6	194.8	28.0	2.6
Ogun	81	1086.9	207.6	19.1	2.6
Total	157	1782.5	402.4	22.6	2.6

	Land allocation by adopters and non adopters (ha)		
Land Allocation	Adopters	Non adopters	Total
Mean rice land area	1.6	0.3	2.6
Mean area to local varieties	1.0	1.4	1.1
Mean area to improved var	1.1	0.0	1.1

Source: Field survey 2002

Table 3: Adoption index for local rice varieties cultivated

	Osun		Ogun		Total	
Variety	Land area	Adoption coefficient	Land area	Adoption coefficient	Land area	Adoption coefficient
Local						
Ofada	34.2	0.1800	62.8	0.302	97.0	0.244
Ilesa	12.0	0.0630	-	-	12.0	0.030
Mokwa	-	-	1.0	0.005	1.0	0.003
Akure	-	-	0.7	0.004	0.7	0.002
Benue	-	-	0.4	0.002	0.4	0.001
Ode-Omi	-	-	6.2	0.003	6.2	0.012
Eleefa (OS6)	-	-	8.7	0.042	8.7	0.022
Total	46.2	0.2370	79.9	0.385	126.1	0.313
Improved						
FARO 44	6.3	0.0330	1.9	0.009	8.2	0.021
FARO 45	3.8	0.0200	-	-	3.8	0.010
FARO 50	6.3	0.0330	2.7	0.013	9.0	0.023
ITA 150	95.9	0.5050	100.9	0.485	196.8	0.495
ITA 235	16.7	0.0880	-	-	16.7	0.042
ITA 257	1.3	0.0070	-	-	1.3	0.003
ITA 321	-	-	5.0	0.020	5.0	0.013
ITA 360	-	-	3.3	0.020	3.3	0.008
WAB 189	-	-	16.6	0.080	16.6	0.042
WITA 1	-	-	3.3	0.020	3.3	0.008
WITA 4	-	-	4.6	0.020	4.6	0.011
WITA 12	17.6	0.0400	-	-	7.6	0.019
Total	137.9	0.7080	138.3	0.666	276.3	0.687

Source: Field survey 2002

Table 4: Average yield of prominent rice varieties

Local varieties					Improved varieties				
Varieties	N	Fertilizer	N	W. Fert.	Variety	N	Fertilizer	N	W. Fert.
Ofada	13	1.40 (0.127)^{a}	37	1.19 (0.091)^{a}	ITA 150	68	1.510 (0.074)^{ab}	15	1.58 (0.141) ^{ab}
Eleefa	-	-	15	1.09 (0.055)^{ac}	WAB 189	19	2.610 (0.028)^{d}	-	-
Ilesa	-	-	10	0.661 (0.008)^{e}	ITA 235	11	1.890 (0.185)^{bf}	4	1.79 (0.217)^{af}
Ode-omi	-	-	09	0.904 (0.035)^{g}	WITA 4	09	2.135 (0.181)^{fh}	-	-
	13	1.40 (0.127)^{a}	71	1.058 (0.022)^{b}		107	1.797 (0.041)^{b}	19	1.59 (0.016)^{a}
Mean	84	1.154 (0.007)^{a}			Mean	126	1.601 (0.006)^{b}		

Source: Field survey 2002, * Figure in parenthesis are standard errors, * Yield values with different superscripts across columns and rows are significantly different (p = 0.05), Fertilizer = Grown with fertilizer, W. Fert = Grown without fertilizer

Among the improved varieties, ITA 150 was the most prominent with an estimated adoption rate of 49.5% followed distantly by ITA 235 and WAB 189, each with adoption rate of 4.2%. Similarly, Ofada rice was the most prominent local rice variety with an adoption rate of 24.4% followed by Ilesa and Mokwa. However, there is marked variation in the spread of the local and improved varieties as more rice varieties (both local and improved) are being grown by rice farmers in Ogun State than in Osun State.

Yield differential among rice varieties: Pair-wise comparism of the yield (paddy) of the prominent rice varieties indicated that the mean yield of improved rice varieties (1.601 t ha^{-1}) was significantly higher than the mean yield of the local varieties (1.154 t ha^{-1}) amounting to a 38.7% yield advantage (Table 4). Also, the mean yield of ofada grown with or without fertilizer (1.40 and 1.19 t ha^{-1}, respectively) were significantly higher than the mean yield of all other local varieties except Eleefa while the yield of WAB 189 grown without fertilizer (2.61 t ha^{-1}) was significantly higher than the yield of all other improved varieties grown with or without fertilizer. There is however no significant difference in the yield of ITA 150, when grown with or without fertilizer. In terms of yield, the prominent improved varieties WAB 189, WITA 4 and ITA 235 and ITA 150 appeared most promising.

Given a yield differential of 0.447 t ha^{-1} between improved and local rice varieties and with an adoption coefficient of 0.687, the improved rice variety technology could be said to have contributed an estimated Proportional Production Increase (PPI) of 19.4% based on

Table 5: Description of variables included in the regression model

Variable (X_i)	Description of variables/covariates
FERTUSE	Use of fertilizer (Used = 1, Not used = 0)
PIP	Participation in intervention programme: Participation = 1, Non participation = 0
RICECULT	Land area cultivated to rice (ha)
DROUTOLE	Tolerance rating relative to local variety (Higher = 3, Similar = 2, Lover = 1)
PROCESIN	Processing quality relative to local variety (Higher = 3, Similar = 2, Lower = 1)
DSERATIN	Disease resistance rating relative to local variety (Higher = 3, Similar = 2, Lover = 1)
YLDRATIN	Yield rating relative to local variety (Higher = 3, Similar = 2, Lover = 1)
EDUCATIO	Level of education Illiterate = 0, Adult education = 1, primary school = 2, Secondary = 3, Post secondary = 4
EXTFREQ	Frequency of Extension Contact: Not at all = o, occasionally = 1, quarterly = 2, fortnightly = 3 monthly = 4 , weekly = 5
ALTINCOM	Availability of non-farm sources of income: Yes = 1, No = 0
ASOSMEM	Membership of farmers association: Yes = 1, No = 0
CREDIT	Access to credit facilities: Yes = 1, No = 0
INFOSOS	Number of sources of information on rice production identified by farmer
AGE	Age of farmer in years

Table 6: Log likelihood (Logit model) estimate of intensity of adoption of improved rice varieties

Covariates	β	Std. error	Sig. t	Wald
(Constant)	-7.187*	4.245	0.090	2.866
FERTUSE	0.063	1.144	0.956	0.003
PIP	1.659	1.553	0.285	1.142
RICECULT	3.157*	1.912	0.099	2.726
DROUTOLE	1.104	0.752	0.142	2.151
PROCESIN	0.171	0.712	0.810	0.058
DSERATIN	0.680	0.960	0.479	0.501
YLDRATIN	1.489**	0.098	0.001	20.714
EDUCATIO	0.409	0.455	0.452	0.564
EXTFREQ	0.996**	0.374	0.008	7.093
ALTINCOM	-0.610	1.947	0.975	0.001
ASOSMEM	2.160	1.441	0.134	2.246
CREDIT	-1.242	1.559	0.426	0.635
INFOSOS	-0.659	0.565	0.244	1.359
AGE	-0.025	0.058	0.665	0.188

**Significant at: $p \leq 0.05$, *Significant at $p \leq 0.10$

-2 Log of likelihood function	= 44.096
χ^2	= 88.840*
Adjusted R^2	= 0.759
Overall Correct predictions	= 92.2%
Adopters (n = 130)	= 95.3%
Non Adopters (n = 27)	= 75.0%

Table 7: Determinants of level of adoption of improved rice varieties

Variables	Coefficient (β)	Beta Coeff.	t-statistic	Sig. t
(Constant)	0.088	-	0.82	0.414
FERTUSE	0.009	0.014	0.238	0.812
PIP	0.097**	0.166	2.535	0.013
RICECULT	0.032**	0.177	2.881	0.050
DROUTOLE	0.008	0.019	0.334	0.739
PROCESIN	0.048*	0.128	1.864	0.065
DSERATIN	0.008	0.021	0.282	0.778
YLDRATIN	0.101***	0.259	2.786	0.006
EDUCATIO	0.035**	0.173	2.238	0.027
EXTFREQ	0.021*	0.111	1.86	0.065
ALTINCOM	0.079*	0.135	1.947	0.054
ASOSMEM	0.132**	0.198	2.467	0.015
CREDIT	-0.051	-0.085	-1.071	0.286
INFOSOS	-0.008	-0.032	-0.492	0.624
AGE	-0.002*	0.112	1.945	0.054

Adjusted $R^2 = 0.737$, $F = 18.162$

*** Significant at: $p \leq 0.01$, ** $p \leq 0.05$, *Significant at $p \leq 0.10$

the ground that the average yield for rice among the farmers regardless of variety planted was estimated as 1.586 t ha^{-1}.

Factors determining adoption of improved rice varieties: The regression analysis shows the level and direction of influence of certain socio-economic and institutional factors; and the physical potentials of the improved varieties on farmers' decision to adopt improved rice varieties and intensity of use of improved varieties. The description of the factors is shown in Table 5.

The results of the Logit likelihood regression model (Table 6) indicated that the overall predictive power of the model (92.2%) and explanatory power (75.9%) are quite high, while the significant χ^2 (for $\beta = 0$) is indicative of strength of the joint effect of the covariates on probability of adoption among smallholder rice farmers in the zone.

The results also shows that the decision whether or not to cultivate improved rice varieties is determined by the size of rice farm (RICECULT), yield rating of improved rice varieties (YLDRATIN) and frequency of extension contact (EXTFREQ) which have significant positive influence. Also, the Wald χ^2 indicating the relative contribution of individual variable to probability of adoption of improved rice varieties shows that the respective yield performance of the (20.714) varieties and the frequency of extension contact (7.093) were the two most important factors determining choice of cultivation of improved rice varieties among the farmers.

However, the linear regression analysis (Table 7) indicated that after a farmer might have decided to or adopted improved rice variety, the intensity of use (adoption rate) is significantly influenced positively in order of importance by the yield rating of the improved rice variety, farmers membership of associations, size of rice farms, level of educational attainment, farmers participation in intervention programmes, availability of

Table 8: Sources of local and improved varieties

	Local varieties						Improved					
	Osun		Ogun		Total		Osun		Ogun		Total	
Sources	f	(%)	f	(%)	f	(%)	f	(%)	f	(%)	f	(%)
MANR[a]	02	2.6	03	3.7	05	1.9	11	14.5	28	34.6	39	24.8
ADP[b]	00	0.0	00	0.0	00	0.0	31	40.8	11	13.6	42	26.8
Local market	18	23.7	35	43.2	53	33.8	02	2.6	05	6.2	07	4.5
Fellow farmer	10	13.2	19	23.5	29	18.5	02	2.6	05	6.2	07	4.5
WARDA	00	0.0	00	0.0	00	0.0	05	6.5	03	3.7	08	5.1
Research Inst.	00	0.0	00	0.0	00	0.0	01	1.3	04	4.9	05	3.1
Farmers' Assoc.	01	1.3	05	6.2	06	3.8	05	6.6	06	7.4	11	7.0
Special Prog.	00	0.0	05	6.2	05	3.4	03	3.9	10	12.3	13	8.3
Input store	08	10.5	04	4.9	12	7.6	06	7.9	07	8.6	13	8.3
Buying agent	37	48.7	10	12.3	47	30.0	10	13.3	02	2.5	12	7.6
Total	76	100.0	81	100.0	157	100.0	76	100.0	81	100.0	157	100.0

Source: Field survey 2002, f = Number of respondents, a = Ministry of Agriculture and Rural Development, b = Agricultural Development Project

alternative sources of income, processing quality of the rice variety, age of the farmers and frequency of extension contact. These rather show that more factors determine the continuous or increased use of the improved rice varieties than the decision to adopt or not to adopt at the initial stage.

Other factors like farmers use of fertilizer in rice production, drought tolerance and disease rating attributes of the improved varieties, access to credit facility and number of sources of information were found to have no significant influence on intensity of use of improved varieties.

The f-statistic however indicated that all the variables jointly have a significant influence on the level of adoption of improved rice varieties. Also, 73.7% (R^2-value) of the variation in the level of adoption is accounted for by variations in the explanatory variables.

Sources of seed: Table 8 indicated that while the ADPs (26.8%) and Ministry of Agriculture (24.8%) of the respective states are the most important sources of improved rice seeds, farmers obtained the seed of the local varieties notably from local markets (43.2%) and fellow farmers (23.5%).

Policy implication and recommendation: The main aim of present research is to analyze the adoption behaviour of smallholder rice farmers in South-western Nigeria through the determination of the level of adoption of various improved rice varieties grown in the region and the identification of factors that determines the decision to adopt and followed the by level of investment on improved rice technology.

The research has clearly shown that farmers are responding appreciably to intervention programmes that promote the cultivation of improved rice varieties in the region with an adoption rate of 67%.

However, the average yield for the research area (1.601 t ha^{-1}) has indicated that the improved rice technology is yet to have an appreciable impact on productivity as the yield is still considerably low and not far from the national yield value of 1.50 t ha^{-1} for 1996 [5, 11]. It was also shown that the improved varieties that have a better yield potential on farmers' field (e.g. WAB 189, WITA 4 and ITA 235) are yet to be appreciably adopted by the farmers despite their high premium performance even when grown without fertilizer. The research also indicated the possibility of having an increase in yield potential of the local varieties by the use of fertilizer input which has been demonstrated to be an important determinant of level of yield of cereal crops especially. It was also discovered that the varieties with the higher yield potentials were the latest set of varieties introduced to the farmers.

Bearing the problem in distribution system for fertilizer in mind. It is glaring that an enhanced adoption of the improved rice varieties despite fertilizer shortage still has the potential of raising the productivity of the nation's rice farms.

The empirical result also indicated that the choice and intensity of adoption of improved rice varieties are jointly influenced by the size of rice farms, yield of improved rice varieties and frequency of extension contact. However, other factors like participation in intervention programmes, processing quality of the rice variety, level of education of farmers, availability of alternative income, membership of farmers association and age were found to influence the level of use of the improved rice varieties.

This thus underscores the importance of institutional support that would provide for increased individual farmer's or group participation in intervention programme that promote the cultivation of improved rice varieties for sustained adoption.

Such intervention programmes, targeted at younger farmers because of the indirect influence of age on adoption should include on-farm and demonstration trials, agricultural shows and promotional activities for improved rice varieties while more efforts should be given towards ensuring a wider and effective coverage for extension services. This may be in the form of recruitment of more extension staff complemented with regular routine training to update their technical skill. Although, input stores and farmers association appear to be closer to farmers in terms of input supply, the distribution of the sources of rice seed did not indicate that these opportunities are been well explored. Efforts should therefore be made to further strengthen these channels for regular and timely supply of improved seeds to farmers.

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