ANALYSIS OF FACTORS AFFECTING ADOPTION OF RECOMMENDED ON-FARM PRODUCTION PRACTICES AMONG ONION FARMERS IN DAMBATTA, KANO STATE, NIGERIA

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Abstract
Low farm output continues to persist among smallholder farmers, attributable to several factors including poor and limited adoption of modern production practices and inputs. Therefore, this study analyzed the factors affecting adoption of Recommended On-Farm Production Practices (ROPPs) among onion farmers in Dambatta, Kano State, Nigeria. The study employed a multistage technique to select a sample of 100 respondents. Descriptive statistics, adoption index and Binary Logit regression model analysis were used to analyze data collected via questionnaires. The study shows that respondent's demographic factors were significant determinants of adoption of recommended production practices. Moreover, the majority (72%) of the farmers exhibited low adoption index (<0.4). Furthermore, the coefficient of determination (R^2) for the regression model was 0.748; indicating that approximately 75% of the variation in the adoption index was attributable to factors in the econometric analysis. Additionally, constraints reported by respondents significantly affected their index of adoption of ROPPs in the area. Subsidizing the cost of agricultural inputs, facilitating access to production practices and technologies, agricultural credit, capital and specialized agro-services; adopting strategies to enhance farm income, technical support and infrastructural facilities, cooperative formation, labor and land tenure adjustments are proposed to mitigate the constraints of adoption.
Keywords: Adoption index, constraints, determinants, on-farm production practices, onion farmers

Introduction

Presenting further developed inputs and agrarian practices are essentials for expanded production specifically and agricultural improvement overall. Onion (*Allium cepa L.*) is accepted to have started in the Middle East, including Iran, Afghanistan, and Pakistan. It is likewise produced in sub Saharan Africa as both food and cash crop (Mailumo and Onuwa, 2022; Nisar *et al*., 2011). Universally, more than 37 million tons of onions yearly are cultivated on 7,000,000 acres of agricultural in around 170 nations including China, India, USA, Turkey, Pakistan, Iran, Indonesia, Vietnam and Myanmar (Mailumo and Onuwa, 2022; Ojo *et al*., 2009). Onion (*Allium cepa L.*) is derived from the family *Liliaceae*; hence, it is likewise a vegetable crop (Kudi et al., 2008). In Nigeria, onion cultivation is predominant in the northern zone, most particularly in dry tropical areas; explicitly in Kaduna, Kano, Jigawa, Katsina, Sokoto, Kebbi, Level and Bauchi States (Mailumo and Onuwa, 2022). These ecological zones containing flood inclined fields, rivers and streams and irrigated farmlands; provides conducive conditions for the improvement of this crop in these areas (FAOSTAT, 2022). Onions well-drained humus and alluvial soils with high natural matter substance, fit for holding dampness during the dry season (Nisar *et al*., 2011; Ojo *et al*., 2009). Commercial onion cultivation in Nigeria was predominantly by smallholder *Fadama* farmers especially under irrigation systems in dry seasons (Mailumo and Onuwa, 2022). It is a significant source of revenue for the smallholder farmers. A few elements impact the variety in farmer's reception choices for new developments and practices in crop cultivation (Alamanjo and Onuwa, 2023). Recognizing and understanding these variables will give important and huge data to strategy definition (Alamanjo and Onuwa, 2023). Evaluation of improved and current cultivation practices and advancements improves the probability of adopting agricultural innovations, that meet smallholder farmer's particular necessities and provides solutions to the challenges encountered in cultivation (FAO, 2021; Mailumo and Onuwa, 2017).The ROPPs ought to either improve or substitute the farmer's ongoing choices; hence, distinguishing these practices and understanding farmer's insights will be exceptionally relevant.

Notwithstanding years of onion cultivation in Nigeria, low yields are common (15ton/ha) contrasted with expected yields of 70ton/ha in different areas (FAOSTAT, 2022). This can be owing to smallholders' low take-up of advanced production innovation (GAIN, 2020; NAERLS and FDAE, 2014). Furthermore, several suggested practices or innovations have been developed by Research institutes in Nigeria (FAO, 2016; Bawa and Ani, 2014; and Komolafe *et al*., 2010). The accessible ROPPs in the area include (i) improved onion varieties; (ii) Spacing 15 cm x 20 cm,

including 15 cm x 15 cm to 20 cm x 20 cm; (iii) Planting methods (seeds or seedlings); (iv) Weed control; (v) Transplanting (mid-June or November/December) (vi) Fertilizer application (20-25 tons/ha of farm yard manure (FYM) or 300 kg/ha NKP 15-15-15); (vii) Pest and disease control (Toxipkan, malathion, heptactylol dieldrin, parathion); (viii) Harvesting (onions are harvested by hand using simple farm tools); and (ix) Storage techniques (harvested onion bulbs are stored in shelter facilities and allowed to cure for up to 2 weeks). Notwithstanding, low yields among onion farmers continue in spite of the accessibility and presentation of innovative management practices (World-Food-Prize, 2022). This study will give data on the adoption index, determinants and limitations experienced in embracing prescribed onion cultivation practices that improves farm efficiency and income. Also, it would help partners (private and public sectors) plan strategies and mediation programs that will work on the yield, remuneration and welfare of the farmers participating in onion cultivation. In view of the previous, this study enumerates the elements influencing reception of ROPPs among smallholder farmers and explicitly depicted the respondents' socioeconomic factors; evaluates the index of adoption of ROPPs; determines factors influencing the adoption of ROPPs; and recognizes the barriers to adoption of ROPPs.

Adoption of Agricultural Practices and Innovations among Smallholder Farmers

Mailumo and Onuwa (2022), in their study on onion production systems in Nigeria; reported that the socio-economic attributes of the farm households were significant determinants of adopting agricultural innovations that improve farm output. Smallholder farmer's demographic factors such as age, gender, household size, educational level, household income, extension contact, etc. had a positive correlation to adoption (Onuwa *et al*., 2023). However, other variables like political and environmental factors strongly influence the potential level of local participation in agricultural interventions and programs among respondents (GAIN, 2020). Onuwa and Adedire (2023) stated that the most critical factors affecting farmer's adoption behavior are their socio-economic variables. Onuwa *et al*. (2022) also posited that the inadequate technical capacity, input costs, inadequate input supply, limited access to improved technology and practices are the critical factors of adoption of agricultural innovations. Afolabi (2008) stated that income was a major indicator and determinant that influenced farmer's adoption decisions in *Fadama* farming. Sabo and Dia (2009), observed the level of awareness and poor information dissemination on the effectiveness of vegetable technology affected the level of adoption. Onuwa (2021), observed a significant correlation between farmers socioeconomic characteristics and the adoption of agricultural innovations. Furthermore, Adesope *et al*. (2012) reported that farmers' marital status and farming experience were negatively correlated to adoption of improved farming systems. Onuwa and Folorunsho (2022) reported a low adoption index for improved agricultural innovations among smallholder fames. Also, Onuwa *et al*. (2021) reported a low adoption index for soybean technology among smallholder farmers in Nigeria. Moderate levels of agricultural technology adoption have been observed among smallholder farmers (FAOSTAT, 2022). Thus, several factors affect smallholder farmer's adoption decisions for agricultural practices and innovations (e.g. Pest control, crop rotation, agro chemical application, organic farming, irrigation practices, etc.); with the primary purpose of improving farm productivity and income (FAO, 2021; GAIN, 2020; and FAO, 2016).

Research Hypothesis

H_o: There is no correlation between farmer's demographic factors and the adoption index for the ROPPs.

Methodology

Study Area

This study was conducted in Dambatta, Kano State, Nigeria. Dambatta Local Government Area (LGA) has coordinates of 12°25′N latitude and 8°35′E longitude, with a land area of 2732 km^2 (NBS 2022). The average temperature and precipitation were 26.8 °C and 700 mm, respectively (Wikipedia, 2022). Most of the LGA's residents are smallholder farmers, whose proximity to the Oasis Irrigation Project supports the production of arable crops (cereals and vegetables) and livestock (non-ruminants and poultry) (NBS 2021).

Sampling Technique

Multi-stage techniques were utilized in choosing respondents for the study. Dambatta LGA was purposively chosen in the primary stage. In the second stage, four districts (Dambatta yamma, Dambatta Gabas, Ajumawa and Gwarabjawa) out of ten (10) were methodically chosen because of the great presence of onion farmers in these districts. In the last stage, respondents were randomly chosen from a sample frame of 1,182 onion farmers compiled by the Agricultural Development Project (ADP) department at the LGA secretariat in collaboration with agricultural extension agents; consequently, at consistent sampling proportion of 9% (0.09) a sample size of 100 onion farmers was derived and validated with sample size calculator (raosoft) at confidence level of 90% and margin error of 10%.

Method of Data Collection

Well-structured questionnaires were used to collect primary data for the study.

Analytical Techniques

Descriptive statistics (percentages, frequency counts and means), adoption index and Binary Logit regression analysis were used in analyzing data collected.

Index of Adoption

The index of adoption of ROPP was computed for each onion farmer following Mailumo, S.S. and Onuwa, G.C. (2022); thus, the index of adoption (B_i) is presented in Equation (1) as follows:

$B_i = \sum (R_i/R_T)$ …….. (1)

Where: B_i = adoption index of ROPPs by i_{th} farmer; R_i = adopted ROPPs by i_{th} farmer; and R_T = number of ROPPs available to the i_{th} farmer; and i = (1……n).

For this study, an index of <0.4 represents low adoption and index of >0.55 represents high adoption. The recommended on-farm production practices ROPPs include (i) improved onion varieties; (ii) Spacing 15 cm x 20 cm, including 15 cm x 15 cm to 20 cm x 20 cm; (iii) Planting methods (seeds or seedlings); (iv) Weed control; (v) Transplanting (mid-June or November/December) (vi) Fertilizer application (20-25 tons/ha of farm yard manure (FYM) or 300 kg/ha NKP 15-15-15); (vii) Pest and disease control (Toxipkan, malathion, heptactylol dieldrin, parathion); (viii) Harvesting (onions are harvested by hand using simple farm tools); and (ix) Storage techniques (harvested onion bulbs are stored in shelter facilities and allowed to cure for up to 2 weeks).

Binary Logit Regression Model

The determinants of the adoption index for ROPPs were analyzed using Logit regression model; it specifies the relationship between the index of adoption and the explanatory variables that have an impact on this index (Gujarat, 2004). The model is expressed implicitly as follows in Equation (2):

$Y_i = \beta_0 + \beta_i X_{ij} + U_i$ …… (2)

Where: Y_i= binary variable such that; Y=1 (high adoption index) and Y = 0 (low adoption index); B_0 = intercept; *Bi*= coefficient of the estimated parameters; X*ij*= Set of endogenous factors; and U_i = error term. However, the binary logit regression model was specified explicitly in Equation (3):

$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U_i$ …… (3)

Where: Y_i= binary variable such that; Y=1 (high adoption index) and Y = 0 (low adoption index); B_0 = intercept; β_i ($B_1 - B_7$) = vector of the estimated parameters or unknown coefficients (regression coefficient); X_i = vector of the predictors (endogenous factors).The endogenous factors include; X_1 = gender (male=1; female=0); X_2 = family size (population); X_3 = farming experience (years); X_4 = level of education (years spent in school); X_5 =access to credit (yes=1, no=0); X_6 = extension contact (yes=1, no=0); X_7 = cooperative membership (yes=1, no=0); and U_i = error term.

Results and Discussion

Respondents Demographic Factors

Table 1 shows that majority (82%) of the farmers is between 30-59 years old; and the mean age was 34 years. This suggests that onion cultivation was prevalent across different age brackets in the study area. Most of the onion farmers can participate adequately in farming activities. They are also more receptive to modern cultivation practices and technology than their older counterparts. Furthermore, this is the economically active age bracket for farmers. This conforms to Onuwa *et al.* (2023) who also posited similar outcomes for farmer's socioeconomic characteristics. Also, it corroborates with Onuwa *et al*. (2021) who posited similar results on farmer's demography and adoption of farm innovations adoption. Also, 87% are men and 13% were women. This proportion suggests a large gender disparity among respondents hence a predominant population of male participants in this agricultural activity. Production of onion in the tropics is male-dominated because of the peculiarities of the most commonly used cultivation systems. Similarly, the low female participation rate may be due to socio-cultural factors in the area under study. Traditionally, the male gender expends more energy in strenuous activities than women. The religious perspective is that females are usually not allowed to participate in certain farm activities, but rather play their primary roles as housewives especially in Northern Nigeria. This is consistent with the results of Onuwa (2021). It also conforms to Onuwa and Folorunsho (2022) who posited a similar outcome on farmer's demography. Further, most of the respondents were married; hence, marital status is a factor affecting family size, as well as a proxy for the family labor required to carry out agricultural activities. This suggests that the married respondents engage in agricultural production as a livelihood activity and also to provide food for their households. Married respondents have more household population; that facilitates increased adoption of farming techniques to improve their income and standard of living. Onuwa (2021) also reported that most beneficiaries and non-beneficiaries of agricultural development programs were married. Also, Onuwa *et al.* (2022) reported similar results on farmer's demography and agricultural technology adoption.

Average family size was 10.3 people; majority (52%) had family size comprising ≤9 people; which imply availability of labour supply from household members for agricultural activities. This conforms to Onuwa *et al*. (2023) who reported that large household sizes provide and contributes to labour

supply for agriculture and other household activities. This finding corroborates with Adesope *et al.* (2012) who also reported that large household size provides labor supply used to undertake agricultural and other domestic operations. In addition, mean level of education of the respondents was 8.2 years; majority (55%) attained primary education (≤6 years); secondary education (7-12 years) (31%), while 14% attained tertiary education (≤13 years); suggesting that the farmers had basic understanding of the consequences of adopting the ROPPs, suggesting that majority of the respondents are literate. High literacy levels among respondents facilitate better technology adoption; knowledge and skillset development. The respondents' educational level is required to explain the observed strengths and weaknesses; management ability and adoption of modern practices and innovation. Thus, the respondents in the area are expected easily adopt new production practices and adopt technology in their agricultural activities to increase farm productivity. This corroborates with Komolafe *et al*. (2010), who found that highly educated farmers are willing to adopt and use new technologies. This conforms to Onuwa and Adedire (2023) which showed that literacy and educational levels facilitate uptake of agricultural innovation; the benefits of adoption of modern practices and innovation; and its consequences are easily processed by the literate farmers. Further, average farm experience was 11 years; most (51%) of the respondents have farming experience of ≤9 years, farming experience of 10-19 years comprised 39%; 10% have ≥20 years' experience in farming. Farming experience is an indication of ability to make informed decisions in the allocation of resources and overall farm management. The study was conducted in an agrarian community, where majority of the onion farmers had extensive experience in farming activities; which provides agricultural information and knowledge on agricultural practices and technologies that improves farm output Onuwa *et al*. (2021). Also, Komolafe *et al*. (2010) reported that several years of agricultural experience improves farm efficiency.

Moreover, most (75%) respondents had no credit access. Agricultural credit helps farmers to augment their meager farm capital for the acquisition of farm assets (technology, practices and inputs). Its availability could determine the extent of production capacity; credit access provides the farmers with the means of expanding and improving their agricultural activities. This result therefore is an indication that most of the onion farmers lack adequate financial capacity to adopt the production technology/ practices that boost their level of farm productivity. This finding conforms to Matata *et al*. (2010) who also posited similar results. Also, most (81%) of the respondents had no contact extension with extension services, while 19% had extension contact. Extension contact in the study area was inadequate and in most cases unavailable, thus mitigating agricultural information dissemination. Extension contact enhances farmer's ability for resource use efficiency through adoption of improved agricultural innovations and recommended practices. The frequency of contact with extension services improves farmer's access to technical and institutional support. This corroborates with Adesope *et al*. (2012) who reported that poor delivery of extension services affected adoption of recommended technologies among farmers; improved contact facilitates production technology adoption. In addition, most (68%) do not belong to a cooperative while those who were members of cooperatives constituted 32%. The implication is that most of the respondents have no structured medium or platform through which exchange of ideas and information diffusion on production technology/practice can be shared. Cooperative membership avails opportunities for information sharing on improved production technology and current trends in agricultural production (Onuwa and Adedire, 2023). This conforms to Maiangwa (2008) who reported that farm cooperative members derive more benefits comparative to individual farm units. Additionally, the average farm size is 1.63 ha; most respondents (66%) have farm size ≤1.9 ha, 25% scale from 2.0 to 4.9 ha and 9% scale from ≥5.0 ha. This shows that majority of the onion farmers had small farm holdings; hence, a predominance of subsistence onion cultivation in the study area. This mitigates attainment of commercial and mechanized production. Smallholdings and land fragmentation dates back to prevailing land use practices in the area. This conforms to Onuwa *et al*. (2022) and Ajayi *et al*. (2008), who posited similar results in studies on correlation of farm size and technology adoption.

Table 1: Distribution according to the Respondents Demographic Factors

Variable	Mean	**Frequency**	**%**
Age:			
≤29		7	7
30-59		82	82
≥60	34.7	11	11
Gender:			
Male		87	87
Female		13	13
Marital Status:			

Married		74	74
Single		26	26
Household Size:			
≤9		57	57
10-19		32	32
≥20	10.3	11	11
Level of Education:			
Primary (≤6 years)		55	55
Secondary (7-12 years)		31	31
Tertiary (≥13 years)	8.2	14	14
Farming Experience:			
≤9		51	51
10-19		39	39
≥20	11.1	10	10
Farm credit access:			
Access		25	25
No access		75	75
Extension Contact:			
Contact		19	19
No contact		81	81
Cooperative Membership:			
Non-member		68	68
Member		32	32
Farm Size:			
≤1.9 ha		66	66
2.0-4.9ha		25	25
≥5.0ha	1.63ha	9	9

Source: Field Survey (2020)

Adoption Index of Production Practices

Table 2 revealed that most (72%) of the onion farmers have low adoption index (<0.4); while, 28% have high index of adoption (≥0.55). In the study area, Different onion production technologies are accessible; however, low and unsatisfactory adoption index for these technologies was reported; hence, low yields across various farm units was prevalent. In the region, poor farm output among smallholders was due to poor agricultural innovation (Alamanjo and Onuwa, 2023). Thus, identifying the factors affecting the adoption of production technologies and practices becomes very pertinent (Mailumo and Onuwa, 2022; Adesope *et al*., 2012; and Saka and Lawal, (2009).

Table 2: Distribution according to the Index of Adoption of Production Practices

Index of adoption	**Frequency**	**%**
Low index (<0.4)	72	72
High index (>0.55)	28	28

Source: Field survey (2020)

Factors affecting the Adoption of Recommended On-Farm Production Practices (ROPPs)

The regression analysis presented in Table 3 shows the determinants of adoption of ROPPs. The Log-likelihood ratio (X^2) was significant (P<0.0051); implying that the regression result significantly explains the cause and effect relationships. Additionally, the coefficient of the regression analysis (R^2) was 0.7482, suggesting that 75% variation in the index of adoption is attributable to factors in the regression model. Omitted variables and the stochastic error term explained the remaining 25%.

Household size: household size coefficient (0.431) was significant and positive at 5% (p<0.05) level, implying that farm labour requirements for onion production and particularly adoption of ROPPs was relatively supplied by household members; and as such, this factor facilitates the adoption of production technology among smallholder farmers. This corroborates with (Adesope *et al*., 2012) who reported a similar outcome.

Farm experience: Farm experience coefficient (0.261) was significant and positive at 5% (p<0.05) level, implying that the years of experience improves farmers access to agricultural information and technology transfer. This conforms to Onuwa *et al*. (2023) and Matata *et al*. (2010) who posited similar results on adoption of modern agricultural innovations.

Education level: Education coefficient (0.524) was significant and positive at 5% (p<0.05) level,

implying that educational level of the farmer's affects agricultural technology adoption, required to enhance farm efficiency and yield. This result conforms to Onuwa *et al*. (2022) who posited a similar outcome on production technology determinants.

Farm credit access: The coefficient of farm credit access (-0.358) was significant, but negative at 5% ($p<0.05$) level, suggesting a reversed relationship with the probability of the farmers adopting any option of the ROPPs; and as such, policies need to be implemented to improve access to farm credit and avail farmers additional farm capital required to acquire farm assets; and particularly for the adoption of agricultural innovations that improves farm productivity. Its availability could determine the extent of production capacity; farm credit access provides the farmers with the means of expanding and improving their agricultural activities. This result conforms to (Adesope *et al*., 2012) who posited a similar outcome in a study on production technology determinants.

Extension contact: Extension contact coefficient (-0.297) was significant and negative at 5% ($p<0.05$) level, suggesting a reversed relationship with the probability of the farmers adopting any option of the ROPPs. Thus, strategies should be adopted to increase contact with extension services for farmers, thereby improving exchange of agricultural information and technology transfer that boosts the yield levels per farm unit (World-Food-Prize, 2022).

Membership of cooperative: The coefficient of membership of cooperative (-0.457) was significant and negative at 5% ($p<0.05$) probability level, suggesting a reversed relationship with the probability of the farmers adopting any option of the ROPPs; hence, farm cooperatives avails its members opportunities for exchange of agricultural information on modern innovations and updates on current trends in agricultural production. This result is in line with Onuwa and Folorunsho (2022) and Maiangwa (2008) who also reported a similar outcome on factors affecting the adoption of agricultural innovations. Thus, an improvement of these negative factors *ceteris paribus*; increases the respondent's likelihood to adopt more ROPPs, required to boost their farm output.

Table 3: Factors affecting the Adoption of ROPPs

Variable	Coefficient	Standard error	T-ratio
Constant	0.788	0.312	2.53**
Gender (X_1)	0.486	0.432	$1.125^{n.s}$
HH size (X_2)	0.431	0.172	2.506**
Experience (X_3)	0.261	0.101	2.584**
Education (X_4)	0.524	0.195	2.687**
Credit access (X_5)	-0.358	0.13	-2.754**
Extension (X_6)	-0.297	0.174	-2.626**
Cooperative (X_7)	-0.457	0.118	-2.517**
Log-likelihood(X^2)	0.0051**		
Pseudo R^2	0.7482		

Source: Field survey (2020); ** = significant at 5% ($p<0.05$), $^{n.s}$ = not significant

Adoption Constraints of Recommended On-Farm Production Practices

Table 4 shows the barriers encountered by farmers in adopting ROPPs in the study area. These barriers to technology adoption among smallholders include inadequate capital (91%), technology cost (83%), low farm income (78%), poor input supply (66%), inadequate extension service's (52%), poor credit access (41%), inadequate technical expertise (39%) and poor infrastructural facilities (23%). These factors resulted to limited adoption of the recommended on-farm production practices by the respondents. This conforms to Mailumo and Onuwa (2022) who posited similar constraints in studies on agricultural technology adoption. Similarly, Onuwa *et al*. (2021) and Kudi *et al.* (2008) stated that Nigeria's agricultural sector was significantly affected by poor technology adoption, inadequate input supply, poor extension services, expensive and complex technologies.

Table 4: Distribution according to Barriers Encountered in the Adoption of the ROPPs

	Constraints	Frequency*	%
1.	Inadequate capital	91	91
2.	Technology cost	83	83

3.	Low farm income	78	78
4.	Poor input supply	66	66
5.	Inadequate extension service's	52	52
6.	Poor credit access	41	41
7.	Inadequate technical expertise	39	39
8.	Poor infrastructural facilities	23	23

Source: Field Survey (2020); *Multiple Response

Conclusion

This study examined the factors affecting the adoption of ROPPs among onion farmers in Dambatta, Kano State, Nigeria. The demographic factors of the farmers affected the adoption index for the ROPPs. Despite the different types of ROPPs available to the respondents, a low index of adoption index was reported; with inverse effects on the quantity of farm yield. Additionally, the factors in the regression model had significant effects on the index of adoption of recommended on-farm production practices. Based on the above, this study recommends improved access and adequate supply of modern agricultural innovations, farm credit and capital; to facilitate the adoption of more ROPPs; policy development and implementation that subsidizes adoption cost of ROPPs; Further, improving extension services by establishing agricultural contact offices that facilitates the exchange of information on agricultural innovations. Moreover, policy formulation that ensures higher remunerative farm income and provides technical support for sustainable production is pertinent. Provision of infrastructural facilities is very vital. Additionally, cooperative formation, adequate supply of agricultural labor and modification of land policies, facilitates technology intensification for agricultural sustainability and the scaling-up of agricultural land for commercialization purposes.

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