



## Adoption Index of Recommended Onion Production Practices and Correlation of Multivariate Factors among Smallholder Farmers<sup>#</sup>

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### ABSTRACT

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Adoption of improved technologies and agricultural practices are prerequisites for increased farm productivity. Assessing the appropriateness of potential new technologies or practices increases the likelihood of adoption or modification to suit farmers' needs; however, low farm output still persists among smallholders, attributable to several factors including poor and low adoption of modern production practices. This study therefore analyzed the index of adoption of recommended onion production practices (ROPPs) and correlation of multivariate factors among smallholder farmers in Dambatta, Kano State, Nigeria. A multistage sampling procedure was used in selecting 100 respondents for this study. Primary data collected via well-structured questionnaires were analyzed using Descriptive statistics, Adoption index and Multivariate Correlation techniques. The results revealed that the prevalent ROPPs adopted by the farmers include improved onion varieties (78%), plant spacing (69%), planting method (55%), weed management (50%) and fertilizer application (44%). Moreover, most (72%) of the farmers have low adoption index ( $\leq 0.33$ ). Further, significant correlations between multivariate factors (farm output, adoption cost and adoption index) exists and the estimated correlation coefficients for  $r_{xz}$ ,  $r_{yz}$  and  $r_{xy}$  were -0.53, 0.71 and -0.82 respectively. Subsidizing cost of adoption of ROPPs, improving access to modern production practices/technologies, agricultural credit/farm capital, extension services, adequate labour supply and tenure policy modification are recommended to ameliorate adoption constraints.

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## Introduction

The introduction of improved inputs and agricultural practices are prerequisite for increased production in particular and agricultural development in general. Onion (*Allium cepa* L.) is believed to have originated in the Middle East region which includes Iran, Afghanistan and Pakistan. It is also cultivated in the West African region both as a food and cash crop (Nisar et al., 2011). According to the United Nations Food and Agriculture Organization estimates, there are seven million acres of land in the world producing over 37 million tons of onions each year. Onion is produced in almost 170 countries of the world. China ranks first in the world with respect to onion production followed by India, USA, Turkiye, Pakistan, Iran, Indonesia, Vietnam and Myanmar (Ojo et al., 2009). Onion (*Allium cepa* L.) is a vegetable crop belonging to the family *Liliaceae* (Alabi and Adebayo, 2008). In Nigeria, onion production is concentrated in the northern region, most especially in dry tropical zones; specifically in Kaduna, Kano, Jigawa, Katsina, Sokoto, Kebbi, Plateau and Bauchi

States (Ojo et al., 2009; Nisar et al., 2011). The natural features of these regions, especially the presence of flood prone plain and river basins and above all the development of vast irrigated lands, create conditions that greatly favour the development of this crop in the area. Onions need well-drained humus and alluvial soils with high organic matter content, capable of retaining moisture during the dry season (Nisar et al., 2011). Commercial onion production in Nigeria was mainly by smallholder *Fadama* farmers particularly under irrigation in dry seasons (Ojo et al., 2009). It is therefore a major source of income for the rural farmers. Several factors influence adoption of recommended onion production practices. The identification and understanding of these factors will certainly provide valuable and significant information for policy formulation. Assessing the appropriateness of potential new technologies or practices increases the likelihood that they will be adopted, and if necessary modify them to suit farmers' needs better.

Agricultural technology or practice responds to farmers' concerns in specific ways. Any technology or practice used by farmers represents a particular way to solve one or several problems. The choice of one technology/practice over others is greatly influenced by the balance between its positive and negative characteristics; preferences, resources, and constraints that individual farmers face. Any new technology presented to farmers will either improve or substitute for the technological options they currently have. It is fundamental to identify these options and understand farmer's perceptions. Despite years of onion production in Nigeria, the yield is still very low (15ton/ha) compared to other regions with potential yields of 70ton/ha. This can be attributable to poor adoption of improved production practices by the farmers (NAERLS, 2014; Nagaraj and Katteppa, 2002). Moreover, a lot of recommended practices or technologies have been developed by Research institutes in Nigeria (Bawa and Ani, 2014; Komolafe et al., 2010; and Nagaraj and Katteppa, 2002). The recommended onion production practices (ROPPs) available in the study area include: (i) Improved onion varieties; (ii) Spacing 15cm x 20cm, 15cm x 15cm to 20cm x 20cm; (iii) Planting method (seed or sets); (iv) Weed management; (v) Transplanting (mid-June or Nov/Dec) (vi) Fertilizer application (20-25 ton/ha of farm yard manure (FYM) or 300 kg/ha NKP 15-15-15); (vii) Pest and disease control (use of *Toxipkan*, *Malathion*, *Heptactilor dieldrin*, *Parathion*); and (viii) Harvesting (onions are hand pulled and kept in shelter; bulbs are left in the shelter to cure for two weeks). However, low yields among onion farmers persist despite the availability and introduction of improved practices. The study will provide information on the index of adoption and constraints encountered in the adoption of recommended onion production practices to facilitate adjustments that improves productivity and farm income. Besides, it would help stakeholders (private and public sector) in designing policies and intervention programs that will improve the yield, income and standards of living of farmers engaged in onion production. Based on the foregoing this study analyzed the adoption index of ROPPs and the correlation matrix among smallholder farmers. It specifically identifies ROPPs available in the area, evaluates the adoption index of ROPPs, and estimates the correlation matrix of multivariate factors among smallholders.

## Materials and Methods

### Study Area

This study was carried out in Dambatta, Kano State, Nigeria. Dambatta Local Government Area (LGA) has coordinates between latitude 12°25'N and longitude 8°35'E; with a land mass of 2732km<sup>2</sup> (NBS, 2012). It has a land mass area of 305.51km<sup>2</sup>. Average daily temperature and rainfall are 26.8°C and 700mm respectively (NBS, 2012). Most of the populations are smallholder farmers; moreover, villages that are located close to the nearby oasis irrigation project engage in the production of rice, pepper, onions, tomatoes and wheat. In addition, they rear livestock like; goats, sheep and poultry.

### Sampling Techniques

Primary data used for this study was derived through field survey, using well-structured questionnaires. Multi-stage sampling technique was employed in the selection of respondents for this study. In the first stage Dambatta Local Government Area (LGA) was purposively selected. The second stage involved the systematic random selection of four districts in the study area out of ten (10) due to the prevalence of onion production in these districts, which include Dambatta-Yamma, Dambatta-Gabas, Ajumawa and Gwarabjawa. The final stage involved the random selection of respondents from a sample frame of 1,182 onion famers compiled by the Agricultural Development Project (ADP) at the LGA in synergy with local enumerators; hence, at constant sampling proportion of 9% (0.09) a sample size of 100 onion farmers was derived and validated using Raosoft sample size calculator at 95% confidence level and 10% margin error as adapted from Onuwa et al., 2022a.

### Analytical Techniques

Data for the study were analyzed using descriptive statistics (percentages and frequency distribution), adoption index and multivariate correlation techniques.

### Adoption Index

The index of adoption of ROPPs was measured using the adoption index. Adoption index was computed for individual farmer following Saka and Lawal (2009) whereby adoption index ( $B_i$ ) is presented in equation (1) as follows:

$$B_i = \sum (R_i/R_T) \quad (1)$$

Where:

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

For this study, an index of  $\leq 0.33$  indicates low adoption, while an index of  $\geq 0.55$  indicates high adoption. Some of the recommended onion production practices (ROPPs) in the study area include: (i) Improved onion varieties; (ii) Plant spacing (15cm x 20cm, 15cm x 15cm to 20cm x 20cm); (iii) Planting method (seed or sets); (iv) Weed management; (v) Transplanting (mid-June or Nov/Dec) (vi) Fertilizer application (20-25 ton/ha of farm yard manure (FYM) or 300 kg/ha NKP 15-15-15); (vii) Pest management and disease control (use of *Toxipkan*, *Malathion*, *Heptactilor dieldrin*, *Parathion*); (viii) Harvesting techniques (bulbs are hand pulled and kept in shelter to cure for two weeks); and (ix) Storage methods.

### Multivariate Correlation

The correlation analysis was used to analyze the multivariate relationship between adoption cost (x) (₦), adoption index (y) (ratio/index) and farm output (z) (kg), where multiple correlation coefficients (R, r) are defined in equation (2), following Onuwa et al. (2022b) and Gujarat (2004):

$$R_{z, xy} = \sqrt{r_{xz}^2 + r_{yz}^2 - 2r_{xz} \cdot r_{yz} \cdot r_{xy} / 1 - r_{xy}^2} \quad (2)$$

Where:

$R_{z, xy}$  = multiple correlation coefficient between dependent and independent factors;

$z$  = dependent variable  $z$ ;

$x$  = independent variable  $x$ ;

$y$  = independent variable  $y$ ;

$r^2$  = coefficient of determination;

$r^2_{xz}$  = coefficient of determination between  $x$  and  $z$ ;

$r^2_{yz}$  = coefficient of determination between  $y$  and  $z$ ;

$r^2_{xy}$  = coefficient of determination between  $x$  and  $y$ ;

$r_{xz}$  = correlation coefficient between  $x$  and  $z$ ;

$r_{yz}$  = correlation coefficient between  $y$  and  $z$ ; and

$r_{xy}$  = correlation coefficient between  $x$  and  $y$ .

**Decision Rule:** The strength of relationships based on the correlation coefficient ( $r$ ) is expressed as follows:  $\geq \pm 0.7$  (strong linear relationship);  $\pm 0.4 - 0.69$  (moderate linear relationship); and  $\leq \pm 0.39$  (weak linear relationship).

## Results and Discussion

### Recommended Onion Production Practices (ROPPs)

Table 1 revealed the various production practices adopted by onion farmers in the study area. The significant practices adopted among onion farmers include improved onion varieties (78%), plant spacing (69%), planting method (55%), weed management (50%), fertilizer application (44%), adjustments in transplanting (31%), harvesting techniques (23%), storage methods (11%) and pest management and disease control (5%). These production practices when adopted significantly affect onion yield and enhanced the level of farm productivity. However, low adoption of onion production practices in

the study area among the respondents was observed. This result corroborates with Sabo and Dia (2009); Nagaraj and Katteppa (2002) who reported similar outcomes in their respective studies on adoption of production technologies and agricultural practices.

### Index of Adoption of Production Practices

The result in Table 2 reveals that most (72%) of the farmers have low adoption index of  $\leq 0.33$ ; while, 28% have high adoption index of  $\geq 0.55$ . Moreover, it was evident that several technologies for improved agricultural technologies for onion farming are available in the area; however, the index of adoption of these technologies was very low and not satisfactory. This trend was responsible for the existing low farm productivity of this crop in the area; as observed in previous studies (Bonabana- Wabbi, 2002). It is well known that in sub-Saharan Africa low agricultural productivity by smallholder farmers have been attributed to poor adoption of improved agricultural technologies. Therefore, identification of factors hindering adoption/uptake of improved agricultural technologies is pertinent and particularly critical to agrarian communities (Adesope et al., 2012; Bonabana- Wabbi, 2002).

### Correlation of Multivariate Factors

Table 3 revealed that the result of the correlation analysis was significant at 5% level of probability. This suggests that a significant correlation between multivariate factors (output, adoption cost and adoption index) exists. The estimated correlation coefficient between  $x$  and  $z$  ( $r_{xz}$ ) was  $-0.53$ ; which suggests a moderate and inverse linear relationship between the factors. This implies that as adoption cost increases technology adoption decreases and consequently overall farm output declines.

Table 1. Distribution Based on Production Practices Adopted

Production practice	Frequency*	%	Ranking
Improved onion varieties	78	78	1 <sup>st</sup>
Plant spacing	69	69	2 <sup>nd</sup>
Planting method	55	55	3 <sup>rd</sup>
Weed management	50	50	4 <sup>th</sup>
Fertilizer application	44	44	5 <sup>th</sup>
Adjustments in transplanting	31	31	6 <sup>th</sup>
Harvesting techniques	23	23	7 <sup>th</sup>
Storage methods	11	11	8 <sup>th</sup>
Pest management and disease control	5	5	9 <sup>th</sup>

Source: Field Survey, 2020; \* = Multiple response

Table 2. Distribution based on the Index of Adoption of Production Practices

Adoption index	Frequency	%
Low adoption index ( $\leq 0.33$ )	72	72
High adoption index ( $\geq 0.55$ )	28	28

Source: Field survey, 2020.

Table 3. Correlation Coefficient Matrix

Factors	Farm Output (z)	Adoption cost (x)	Adoption index (y)
Farm Output (z)	1.00		
Adoption Cost (x)	$-0.53^*$	1.00	
Adoption index (y)	$0.71^*$	$-0.82^*$	1.00

Source: Field Survey, 2020; \*Correlation coefficient ( $r$ ) is significant at 5% level (2-tailed).

The estimated correlation coefficient between  $y$  and  $z$  ( $r_{yz}$ ) was 0.71 which suggests a strong linear relationship between the factors. This implies that as the adoption index increases the level of farm productivity (output) tend to also increase. The estimated correlation coefficient between  $x$  and  $y$  ( $r_{xy}$ ) was -0.82, which suggests a strong and inverse linear relationship between the factors. This implies that as adoption cost increases the index of adoption of ROPPs among the farmer's declines. The implication of these findings is that adoption of ROPPs tends to increase the level of farm productivity in the study area and hence improve agricultural sustainability. Furthermore, the cost of production practices determines farm level adoption. Thus, this result corroborates with Matata et al. (2010) and Yasin (2003) who also evaluated the correlation of similar multivariate factors in their respective studies on adoption of production practices and technology among farmers.

### Conclusion and Recommendations

This study analyzed the adoption index of ROPPs and the correlation of multivariate factors among smallholders. The findings revealed that there were several ROPPs available in the study area; however, adoption of these production practices was relatively low. Moreover, a low index of adoption of ROPPs among respondents in the study area was very prevalent. Furthermore, a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index) exists; thus, positive correlates facilitate agricultural sustainability. Based on the foregoing, this study recommends the following: Formulation and implementation of policies that subsidizes cost of adoption of production practices/inputs, through public-private sector interventions; and as such, enable smallholders adopt more options of ROPPs. Also, adoption of measures that improves smallholder farmer's access to modern production practices/inputs, agricultural credit and farm capital. In addition, improvement of extension service delivery systems via establishment of agro service centers; to facilitate technology transfer and agricultural sensitization programs in the study area. Further, adequate farm labor supply is pertinent to facilitate production technology adoption and utilization for sustainable agricultural production. Moreso, tenure policy modifications are required to mitigate land fragmentation; and as such, improve expansion of farm holdings to facilitate agricultural commercialization among smallholders in the study area.

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Author A and Author B designed the study, managed the literature searches, handled the computation of the statistical analysis and wrote the protocol and first draft of the manuscript. Author A and Author B also read and approved the final manuscript.

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