



## **ROLE OF EXTENSION SERVICES ON POST HARVEST LOSSES AMONG WOMEN TOMATO FARMERS IN PANKSHIN LOCAL GOVERNMENT AREA OF PLATEAU STATE, NIGERIA**

**<sup>1</sup>Mukada, Y., <sup>2</sup>Murtala, N. and <sup>3</sup>Garba, A.**

<sup>1</sup>Department of Agriculture and Natural Resources, Wase L.G.A, Plateau State

<sup>2</sup>Department of Agricultural Economics, Abubakar Tafawa Balewa Unniversity,  
P.M.B 0248 Bauchi Nigeria.

<sup>3</sup>Department of Agriculture Extension and Rural Development Faculty of Agriculture,  
Federal University Dutse Jigawa State Nigeria

**Corresponding Author's Email:** yiltumukada@gmail.com, **GSM:** 08032175173

### **ABSTRACT**

The study assessed the role of agricultural extension on post-harvest losses among women tomato farmers in Pankshin Local Government Area of Plateau State. A multistage random sampling technique was employed in selecting 399 Women tomato farmers for the study. Primary data were obtained using structured questionnaires. 399 questionnaires were distributed and 340 were retrieved and used for the study. Data were analyzed using descriptive and inferential statistics. The results showed that 64.7% of the Women tomato farmers were in their active age of production and 70.3% were married with 5-9 persons per households in the study area. The results also showed that 87.9% of the Women tomato farmers had attended formal education and 12.1% attended non-formal education, while 83.2% of the respondents had 1-10 years of farming experience. The results further showed that 66.2% of the Women tomato farmers practiced mixed cropping and 67.4% had no access to credit in the study area. The findings further showed that, 25.6%, 24.4% and 20.3% of the Women Tomato farmers indicated that storage, processing and packaging respectively were the major factors that causes tomato post-harvest lost. The result also revealed that 75.3% of the Women Tomato farmers received advisory services from the extension agencies while 45.6% and 36.8% of the women tomato farmers had their information on post-harvest losses from radio and agricultural shows respectively. The findings also revealed that household size ( $P<0.001$ ), quantity harvested ( $P<0.001$ ), farm size ( $P<0.05$ ) and farming experience ( $P<0.05$ ) had significant influence on the Women tomato farmers post-harvest losses in the study area. The findings further revealed that 59.1% of the Women tomato farmers had no extension contacts. It can be concluded that the availability of cheap family labour in producing large quantity of tomatoes without adequate storage facilities and processing are the factors influencing post-harvest losses among women tomato farmers in the study Area. Emanating from the findings it is recommended that women tomato farmer should form cooperative so as to increase their access to storage facilities and inputs at lower rate. Government should employ and deploy more trained extension personnel to the study Area.

**Keywords:** Role, Extension, Services, Post-Harvest, Losses, Women Tomato Farmers.

### **INTRODUCTION**

Agriculture remains the main dependable option for the Nigerian economy as it provides all the industrial raw materials, employment opportunities and food for the ever-increasing population of human both in the rural and urban settlement (Bello *et al.*, 2022; Hamza *et al.*, 2023). Tomato is one of the most popular and widely grown vegetables



globally. It is grown throughout the world, either as outdoors or indoors, because of its wide adaptability and versatility (Hamza *et al.*, 2023; Asgedon *et al.*, 2010).

Women farmers particularly in rural areas of Nigeria have always worked and their labour plays a key role in the survival of millions of families (Adenugba and Raji, 2013). Most rural woman are the invisible farmers in Nigeria and form the backbone of rural development. The underlying facts remain that more than half of Nigeria's food is produced by woman (Adenugba and Raji, 2013).

Postharvest loss (PHL) is defined as the measurable quantitative and qualitative loss of products at any point in the postharvest chain from harvest to consumption (Kikulwe *et al.*, 2018). This leads to food losses and significant economic losses (Gross *et al.*, 2000). Nearly 40% of fruits and vegetables are lost every year due to improper handling, packaging and transportation (Vishal Sing *et al.*, 2014, Vish Wanathan *et al.*, 1999). According to Parfit *et al.*, 2010. Inadequate harvesting stage, poor cold chain system, inadequate storage facilities, limited processing knowledge, and a lack of appropriate packaging and trading facilities are the main drivers of higher postharvest loss in developing countries.

Agricultural extension is an innovation from the 20<sup>th</sup> century designed to stimulate agricultural development and to create incentives for farmers to adopt a new modern technology through the reduction of information acquisition costs (Alexandratos, 1995, Anderson and Feder, 2004). Extension programs have been introduced Worldwide with the objective to upgrade human capital by diffusing knowledge on production methods, optimal input use and management practices to farmers (Alene and Hassan, 2003). From nearly a million of extension workers advising farmers globally on a daily basis, the largest share of agents is located in low and middle-income countries, most notably with 70% in Asia (Bahal, 2004). Although, a number of success have been documented, critics post deficiencies in the performance of extension systems as a result of low staff morale, financial stress, poor accessibility to agricultural advance techniques, misuse of extension programs due to political connectedness or the failure to retain farmers interest in the long-term training (Agitew *et al.*, 2018, Anderson and Feder, 2004, Jones and Kondylis, 2018, Rivera *et al.*, 2002).

Over the years, tomato production in Nigeria has been facing challenges that have contributed to reduced productivity and create a gap between average quantity demand of 3 million metric tons and average quantity of tomato produced of 2.3 million metric tons. This includes about 700,000 million metric tons which contributed to high importation (NIHORT, 2020). Based on the available data, Nigeria accounts for about 68.4% of West Africa, 10.8% of Africa's total output and 1.28% of world output (Babarinsa *et al.*, 2015). Unfortunately, the country still experiences deficiency in critical inputs, lack of improved technology, low yield and productivity, high post-harvest storage losses and lack of processing and marketing infrastructure, thereby affecting the livelihood of farmers negatively. Previous studies have analyzed post-harvest losses and their effects on welfare among smallholder farmers in Nigeria (Akangbe *et al.*, 2014). However, there remains a knowledge gap on post-harvest loss and technological options to manage such losses in the context of perishable value chains especially among women farmers and roles of extension service providers in Pankshin Local Government Area (LGA) of Plateau State.

The broad objective of the study is to assess the role of extension services on post-harvest losses among tomato women farmers in the study area. The specific objective are to:

- i. describe the socio-economic characteristics of tomato women farmers in the study area;
- ii. examine the factors that causes post-harvest losses experienced by tomato women farmers;



- iii. evaluate the role of extension services in reducing post-harvest losses among tomato women farmers;
- iv. identify the types of Agricultural information disseminated by extension workers to the farmers; and
- v. determine the influence of tomato farmers' socio-economic characteristics on post-harvest losses of tomato.

## METHODOLOGY

### The study Area

Pankshin is located about 120 Kilometers from Jos, Plateau State Capital with the Local Government Area headquarters blessed with an exceptional cool climate comparable only to that of Europe; it is situated between latitude 9°19'40.29"N and longitude 9°25'52.17"E. It has area coverage of about 1,334 square Kilometer with a projected population of 279,700 at a growth rate of 3.2%. It is bounded by Mangu L.G.A to the West, Langtang North to the East, Mikang to the South East, Kanke to the East and Quanpan to the South. Pankshin L.G.A is matched alongside with Mangu, Kanke, Kanam and Bakkos LGAs as central agricultural Zone in Plateau State. Pankshin is well known for its relatively cool temperatures. Pankshin's average annual temperature is 22 °C. The range of temperatures could be hottest between April and early June. The coldest temperature can be felt in mid-November to late February, January being the coldest month. It has an average rainfall of 1,150 millimetres, while heavy rainfalls are between late June and mid-August. Farming is an important economic activity in Pankshin LGA. Vegetables such as tomatoes, cucumbers, cabbage, lettuce, carrots, green pepper, and onions are cultivated. Tomato is the major vegetable normally cultivated in the area. Cereals such as maize, millet, sorghum, accha e.t.c are also cultivated. Irish potato, sweet potato, cassava and yam are also cultivated. Other important economic activities include hunting, mining and rearing of animals' such as sheep and goats, poultry, pigs, etc.

### Sampling Technique and Sample Size

In the first stage, purposive sampling was employed in selecting (3) tomato farming districts in the study Area. Pankshin, Wokkos and Fier. In the second stage, simple random sampling was used to select four villages from each of those districts to give a total of (12) villages. In the final stage, Yamane's formula:-  $n = \frac{N}{1+N(e)^2}$  was used to draw a sample of 399 women tomato farmers from the study Area.

### Data Collection and Analysis

Primary data were obtained through the administration of 399 structured questionnaires. 340 were retrieved and used for the study. Data were analyzed using both descriptive and inferential statistics. Descriptive statistics such as frequency, percentage and mean while inferential statistics such as multiple regression were used to achieve the stated objectives of study.

The functional multiple linear regression model were;

$$Y = a_0 + b_0X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e \text{-----}(1)$$

Where;

Y = Quantity of fruit lost (in kg)

a = Constant

e = Error Term

X<sub>1</sub> = Farm size (ha)

X<sub>2</sub> = Quantity harvested (in kg)



$X_3$  = Age of tomato at harvest (in weeks)

$X_4$  = Age of respondent (years)

$X_5$  = Educational Background

1 = Non-Formal, 2 = Adult Education, 3 = Primary Education, 4 = Secondary Education, 5 = Tertiary Education.

$X_6$  = Household size (Number of Persons)

$X_7$  = Farming Experience (In years)

$b_1$  -----  $b_7$  = Coefficients.

## RESULTS AND DISCUSSION

### Socioeconomic Characteristics of the Tomato Farmers

The socio-economic characteristics of respondents are shown in Table 1. The results revealed that 64.7% of the women tomato farmers were within the age brackets of 20-39 years. This implies that majority of the Women tomato farmers were within their active ages of production in agriculture in the study area. This agreed with Jabil and Abdu (2012) in North and Central Zones of Plateau State Nigeria, who reported that young farmers are willing to adopt new technology like Responsible Business Conduct in Agriculture (RBC) than the older ones and they are not averse to risk. The findings also show that majority (70.3%) of the Women tomato farmers were married. This agrees with Udensi *et al.* (2011) who observed that married people were the most dominant in their study of the adoption of improved cassava varieties in Abia State, Nigeria.

The result shows that half (50.9%) of the tomato farmers had household size of 5-9 persons. This implies that tomato farmers had relatively medium size household size which could be a cheap source of family labour for tomato production in the study area. Household size is regarded as the number of people resident in the same household and sharing a common pool of household resources (Ojiako *et al.*, 2015). In adoption studies, household size is considered an important socioeconomic variable used to measure labour availability or endowment in traditional agricultural production (Baffoe-Asare, 2013).

The finding shows that 40.9% of the tomato farmers had attended tertiary levels of education, while 21.5%, 17.4%, and 12.1% of the tomato farmers had attended adult, secondary and non-formal levels of education respectively. This implies that most of the tomato farmers had attended certain levels of education which is an important factor for adopting post-harvest technologies to eradicate loss of tomatoes in the study area. This is in line with Elemasho *et al.* (2017) in Rivers State, Nigeria who reported that literacy could encourage effective use of post-harvest technologies such as RBCs technology.



**Table 1: Socioeconomic Characteristics of the Tomato Farmers (n=340)**

Variable	Frequency	Percentage	mean
<b>Age</b>			
20-29	97	28.5	37.5
30-39	123	36.2	
40-49	54	15.9	
50-59	52	15.3	
60-69	14	4.1	
<b>Marital status</b>			
Married	239	70.3	6.1
Single	46	13.5	
Widowed	14	4.1	
Divorced	41	12.1	
<b>Household size</b>			
1-4	128	37.6	6.1
5-9	173	50.9	
10-14	22	6.5	
15-19	8	2.4	
20-24	9	2.6	
<b>Educational level</b>			
Non-formal	41	12.1	0.7
Adult education	73	21.5	
Primary education	28	8.1	
Secondary education	59	17.4	
Tertiary Education	139	40.9	
<b>Farm size</b>			
0.1 – 0.5	106	31.2	0.7
0.51 – 1.00	140	41.2	
1.1 – 1.5	37	10.8	
1.51 – 2.00	57	16.8	
<b>Farming experience</b>			
1-5	167	49.1	11.8
6-10	116	34.16.6	
11-15	40	11.8	
16-20	17	5.0	

**Source:** Field Survey, (2022)

### Factors Causing Tomato Losses

The results on Table 2 revealed that 25.6%, 24.4% and 20.3% of the Women tomato farmers indicated that storage, processing and packaging were the major factors causing tomato loss. This agreed with Idah *et al*, (2007) reported that farmers in Nigeria use woven baskets from palm fronds to package their tomatoes for sale to customers. He reported that the inside of the baskets have sharp edges which cause mechanical injuries to the fruits. The oversized nature of the baskets also results in excessive crushing forces acting on the fruits located at the base of the basket (Hurst 2010). This results in bruising and crushing of the fruits which breaks the resistant of the fruits to the introduction of disease causing pathogens.

The result shows that 49.2% of the Women tomato farmers harvest their tomato at turning/firm fruit stage. This implies that, the tomato farmers harvest their tomato at early stage which helps to reduce post-harvest loss in tomato production in the study area. This is in line with Moneruzzaman *et al* (2009) and Orzoklek *et al*. (2006) that farmers targeting distant markets must harvest their tomatoes in a matured green state. This will not only give



the producers ample time to prepare the fruits for the market but also prevent mechanical injuries during harvesting.

About 51% of the Women tomato farmers who harvested their tomato when the tomato is already soft and fully red respectively. This agreed with Toivonen (2007), Watkins (2006) and Reid (2002) that fully ripened tomatoes are susceptible to injuries during harvesting resulting in shorter shelf life. This may be the reason why there are high level of losses in tomatoes harvested at fully ripened stage in the study area. This implies that the tomato farmers harvest their tomato at early stage which helps to reduce post-harvest loss in tomato production in the study area.

The results revealed that 32.6%, 29.4% and 28.5% of the Women tomato farmers harvest 21-30 baskets, 31-40 baskets and 41-50 baskets of tomato per day. This implies that most of the Women tomato farmers were relatively medium scale farmers with good quantity of tomato harvest per day, with 0.5 – 1ha hence the need for post-harvest losses eradication in tomato in the study area.

The findings revealed that majority (59.1%) of the Women tomato farmers use farm family members for harvesting, sorting and grading. This implies that most of the Women tomato farmers use family members for harvesting, sorting and grading which gives more chances and reduction of post-harvest loss in tomato production in the study area. This agreed with Kitinoja (2008) that tomatoes are harvested by manual picking instead of mechanical picking in most developing countries, in harvesting, care is taken to avoid mechanical damage which can be an entry point for disease causing pathogens.

The finding shows that most (88.2%) of the Women tomato farmers agree that the quality, size and grades of tomato have different prices. This agreed with Beckles (2012) who reported that the physiological maturity of the fruit at harvesting stage has a major effect on the quality, care must be therefore be taken as to when to harvest the fruit in order to attain the best quality as best quality of the fruit attract consumers as well as price.



**Table 2:** Opinion of Tomato Farmers on Factors Causing Tomato Loss (n=340)

Variables	Frequency	Percentage
<b>Main factors causing tomato loss</b>		
Sorting/grading	28	8.2
Packaging	69	20.3
Storage	87	25.6
Transportation	14	4.1
Handling	41	12.1
Agro-processing	83	24.4
Inadequate markets	18	5.3
<b>Time and method of tomato harvest</b>		
Turning stage/firm fruit	167	49.1
Already soft	82	24.1
At full red stage	91	26.8
<b>Quantity of tomato harvest per day in baskets</b>		
11-20	18	5.4
21-30	111	32.6
31-40	100	29.4
41-50	97	28.5
51-60	14	4.1
<b>Type of labour used</b>		
Farm family members	201	59.1
Hired labourers	139	40.9
<b>Price changes due to quality size and grades</b>		
There is change	300	88.2
There is no change	40	11.8
<b>Methods of packaging for transport</b>		
Plastic buckets	83	24.5
Small baskets	46	13.5
Fibre sacks	98	28.8
Woven wooden/stick baskets	100	29.4
Others (Basins)	13	3.8
<b>Type of storage facilities</b>		
Floor	170	50.0
Small huts	32	9.4
Poly nets	69	20.3
Sacks	69	20.3
<b>Market reliability</b>		
There is reliable market	156	45.9
There is no reliable market	184	54.1

**Source:** Field Survey, (2022)

The results revealed that half (50%) of the Women tomato farmers use floor to store tomato, while 20.3% each use poly nets and others to store tomato, only 9.4% of the Women tomato farmers use small huts to store tomato in the study area. This agreed with Olayemi *et al.*, (2010) who reported that farmers in developing countries do not have the capacity to install cooling system technologies on their farms but have therefore improvised other cooling systems. This implies that the Women tomato farmers use a free ventilation facility to



store tomato which helps to reduce post-harvest loss, it also indicates that tomato farmers had several forms of storing tomato to reduce post-harvest losses in the study area.

The results revealed that 54.1% of the Women tomato farmers indicated that tomato market was not reliable. This implies that tomato market fluctuates over time which could in some cases result to increased post-harvest loss of tomato, this shows that post-harvest losses were not only attributed to the perishability nature of the crop but also poor market or purchasing power by consumers in the study area. This agreed with (Ofori Sarpong (2001), that market availability is a big challenge facing most tomato producers in developing countries especially those in Africa.

### **Role of Extension Services on Post-harvest Losses**

Extension service is an important component in agricultural production which helps to educate farmers on improve production technologies and innovation in agricultural production especially among vegetable farmers in the study area. The results from Table 3 revealed that 75.3% of the Women tomato farmers received advisory services from the extension agencies, 19.1% have no access to the agricultural extension services, 3.2% received technical services while 2.4% had facilitation services. The finding agrees with Kidane and Worth, (2017); Mapiya *et al.*, (2021) who stated that most agricultural extension agencies provide advisory services such as advice, information and other support services to farmers to improve the productivity of their crop and animal production.

The results from Table 3 reveals that 45.6% and 36.8% of the Women tomato farmers had their information on post-harvest losses from radio and agricultural shows. This implies that the Women tomato farmers had various sources of information on tomato post-harvest in the study area. Farmers commonly use multiple information sources to increase their knowledge about agriculture technologies (Toma *et al.*, 2018).

The result also shows that majority (59.1%) of the Women tomato farmers had never had extension contacts, while 32.6% and 8.2% of the tomato farmers had monthly and quarterly extension contacts in the study area respectively. This implies that Women tomato farmers had little access to extension contacts which could affects their knowledge on technologies of reducing post-harvest losses of tomato. On the other hand majority (59.1%) of the Women tomato farmers had no extension workers in their area, while 40.9% of the Women tomato farmers had 1-3 extension workers in the study area, which implies that there are few extension workers for tomato producers in the study area. According to Lowenberg-DeBoer and Erickson, (2019), the added value of an innovation or technology needs to be demonstrated and made visible. Information sources create awareness among farmers and increase their knowledge about the attributes of the technology in question.



**Table 3:** Role of Extension services on Tomato Post-harvest losses (n=340)

Variables	Frequency	Percentage
<b>Types of agricultural extension services provided</b>		
Technical services	11	3.2
Facilitation services	8	2.4
Advisory services	256	75.3
None	65	19.1
<b>Source of information on post-harvest losses</b>		
Extension agent	14	4.1
Radio	155	45.6
Posters and leaflets	28	8.2
Agricultural shows	125	36.8
Family and neighbors	18	5.3
<b>Frequency of extension contacts</b>		
Monthly	111	32.7
Quarterly	28	8.2
Never	201	59.1
<b>Number of extension workers in the area</b>		
1-2	139	40.9
3-4	103	30.3
None	98	28.8

**Source:** Field Survey, (2022)

### **Type of Information Disseminated**

The result on types of agricultural information disseminated through agricultural extension to women tomato farmers is presented in Table 4. The result shows that 20.9% of the tomato farmers used information on sources of agricultural credit, 17.4% used information on improved seeds varieties and 15.0% used information on fertilizer type, dosage, time, method of application. Also 12.4% of the tomato farmers used information on preservation, processing and storage of tomato produce using new post-harvest technology. Based on the responses, it could be said that available agricultural information obtained from extension workers in the study area were adequate and capable of reducing post-harvest loss of tomato.

In respect of the role of agricultural information disseminated to the farmers in reducing tomato post-harvest losses in the study area, it was revealed that 70.9% of the tomato farmers have benefited from agricultural extension service especially agricultural information on post-harvest losses of tomato. The finding agrees with Akanda and Roknuzzaman (2012) assertion which revealed that the most significant purpose for agricultural information is for advancement of agricultural production. Information on Post-harvest losses will educate the farmers to manage as well to reduce post-harvest losses of tomato.



**Table 4:** Farmers Opinion on the Types of Agricultural Information Disseminated through Agricultural Extension (n=340)

Variables	Frequency	Percentage
<b>Type of information disseminated</b>		
Land preparation	21	6.2
Improved seed varieties/method of controlling pest and disease	59	17.4
Sources of credit	71	20.9
Marketing information on farm produce and prices	23	6.8
Improved method of weed control	18	5.3
New post-harvest technology	42	12.4
Fertilizer type, dosage, time, method of application	51	15.0
Irrigation (time, number and method)	17	5.0
Harvesting time and methods	26	7.6
Spacing and planting dates	12	3.5
<b>Role of the information disseminated in reducing tomato post-harvest loss.</b>		
Beneficial	241	70.9
Not beneficial	99	29.1

**Source:** Field Survey, (2022)

### **Influence of Socioeconomic Factors on Post-harvest Losses**

The result from Table 5 reveals the socioeconomic factors influencing tomato post-harvest losses. The result revealed that the coefficient of quantity of tomato harvested was positive and significant ( $P < 0.01$ ) as a factor influencing tomato post-harvest losses. This implies that the higher the quantity of harvest the higher the post-harvest loss in tomato production, this could be attributed to inadequate storage facilities for tomato in the study area. The result also shows that the coefficient of household size was positive and significant ( $P < 0.01$ ) as a factor influencing tomato post-harvest losses. This implies that the higher the household size the higher the post-harvest losses in tomato which could be attributed to the availability cheap family labour in producing large quantity of tomato without adequate storage facilities.

On the other hand the findings shows that the coefficients of farm size and farming experience were negative and significant ( $P < 0.05$ ) as factors influencing post-harvest losses in tomato production. This implies that increase in farm size and farming experience could result to decrease in post-harvest losses in tomato production in the study Area. As the farm size increases, the Women tomato farmers get familiar with factors causing post-harvest losses and how to manage and reduce the loses. While higher years of experience, give farmers experience and strategies of reducing post-harvest losses in tomato production. Hassan *et al.*, (2019) found a negative and significant relationship between farm size and awareness of ICT, which means that with the increase in farm size the awareness of farmers on the use of ICT decreased.



**Table 5:** Socioeconomic Factors Influencing Postharvest Losses of Tomato

Variables	B	Std. Error	Beta	t	Sig.
Constant	1.289	.424		3.043	.003***
Farm size	-.061	.026	-.165	-2.339	.020**
Quantity harvested	.125	.042	.193	2.988	.003***
Age of fruits	-.049	.042	-.195	-1.171	.242
Age	-.001	.002	-.036	-.564	.573
Educational level	-.012	.026	-.056	-.470	.639
Household size	.013	.004	.174	3.054	.002***
Farming experience	-.014	.007	-.216	-2.004	.046**

## CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that the availability of cheap family labour in producing large quantity of tomato without adequate storage facilities and processing are the factors influencing post-Harvest losses among women tomato farmers in the study Area. One of the key findings is that there is significant relationship between the socio-economic characteristics of the farmers and post-harvest losses of tomato. The study therefore recommends that:

- Women tomato farmers should form and join cooperatives so as to increase their access to storage facilities and inputs at lower rates.
- Government should employ and deploy more trained extension personnel to the study area to educate the farmers on post-harvest losses of tomato.
- Government and NGO's should assist in providing storage facilities and inputs to women tomato farmers in the study area.
- Extension workers should make deliberate efforts in disseminating information to improve the level of awareness of postharvest loss of tomatoes among the Women tomato farmers.
- Information literacy training programme should be organized for Women tomato farmers to enable them navigate and evaluate information on post-harvest losses by the government.

## REFERENCES

- Adenugba, A. O., & Raji-Mustapha, N. O. (2013). The role of women in promoting agricultural productivity and developing skills for improved quality of life in rural areas. *Journal of Engineering*, 3(8): 51-58.
- Agitew, G.S. Yehuala, A. Demissie, and A. Dagnew (2008). "Technological gaps of Agricultural extension: Mismatch between demand and supply in North Gondar zone, Ethiopia." *Journal of Agricultural Extension and Rural Development*, 10: 144-149.
- Akanda, A.K.M. & Roknuzzaman, M.D. (2012). Agricultural Information Literacy of Farmers in Northan Region of Bangladesh. Retrieved from [www.iiste.org/journal/index.php/IKM/articledownload/---12663](http://www.iiste.org/journal/index.php/IKM/articledownload/---12663)
- Akangbe, J. A., Ogundiran, T. J., Komolafe, S. E., Ifabiyi, J. O., & Ajibola, B. O. (2014). Tomato farmers adoption level of postharvest value addition technology and its constraints in Surulere Area of Oyo State, Nigeria. *Journal of Agriculture and Social Research (JASR)*, 14(1): 91-97.
- Alene, A.D. and Hassan, R.M. (2003). Measuring the impact of Ethiopia's new extension programme on the productive efficiency of farmers" In proceedings of the 25<sup>th</sup> international conference of Agricultural Economists (IAAE), 16, 22.



- Alexandratos, N. (1995). World agriculture: Towards 2010: FAO study, Food and Agriculture Organization of the United Nations, Rome, Italy.
- Anderson, J.R. and Feder, G. (2004). "Agricultural extension. Good intentions and hard realities," *The world Bank Research Observer*, 19: 41-60.
- Asgedom, S., Struik, P. C., Heuvelink, E., & Araia, W. (2010). Opportunities and constraints of tomato production in Eritrea. *African Journal of Agricultural Research*, 6(4): 956-967.
- Babarinsa, F. A., Omodara, M. A. & Okanlawon, S. O. (2015). Preservation of mature green tomatoes using controlled atmosphere storage under tropical conditions. *Journal of Stored Products and Postharvest Research*, 6(9): 72-76.
- Baffoe –Asare (2013). Socioeconomic Factors influencing Adoption of Codapep Cocoa Hih-tech Technologies among small holder farmers in central Region of Ghana: *Journal of Experimental Agriculture International*, 3(2): 245 -250.
- Bahal, R. (2004): Agricultural Research and Extension Systems: World wide study of Human Financial Resources, Concept Publishing Company.
- Beckles D.M. (2012). Review: Factors affecting the postharvest soluble solids and sugar content of tomato (*Solanumlycopersicum* L.) fruit. *Postharvest Biology and Technology*, 63(1): 129–140.
- Bello, O. G., Ehien, A. E., Makinta, U., & Nasiru, A. (2022). Capacity Building Needs Of Farmers On Post Harvest Storage Of Tomato In Jigawa State, Nigeria. *Journal of Agriprenurship And Sustainable Development*, 5(1): 103-114.
- Elemasho, M. (2017). Farmers Perception of Adoption of postharvest technologies of selected crops in Rivers State Nigeria. *International Journal of Agricultural research Innovation and Technology*, 7(2): 2258 – 3329.
- Gross, R., Schoeneberger, H., Pfeifer, H., Preuss, H.J. (2000). Four dimension of food and nutrition security: Definitions and concepts. *SCN News* 20: 20-25.
- Hamza, A., Gumi, A.M. and Aliero, A.A. (2023). Potential of neemleaves on preservation of selected elementalcompositions in two tomato cultivars from Sokoto, Nigeria. *Journal of Biore Environmental Science*, 2: 14-20.
- Hassan, N. (2019). Firm-Level Political Risk: Measurement and Effects. *SSRN Electronic Journal*.
- Hurst, W. C. (2010). Harvest, Handling and Sanitation Commercial Tomato Production. Handbook B 1312. CAES Publications. University of Georgia. URL:
- Idah, P.A., Ajisegiri, E.S.A. and Yisa, M.G. (2007). Fruits and Vegetables Handling and Transportation in Nigeria. *AU J.T.* 10(3): 175-183.
- Jabil, E. and Abdul, S. (2012). Farmers perception of adoption of post-harvest technologies of selected food crops in Rivers State Nigeria, *International Journal of Agricultural Research Innovation and Technology (IJARIT)*, 7(2): 22-26.
- Jones, M. and Kondylis, F. (2018). Does feedback matter? Evidence from agricultural services," *journal of Development economics*, 131: 28-41.
- Kidane, T. T., & Worth, S. H. (2017). Different agricultural extension systems implemented in Africa: A review. *Journal of Human Ecology*, 55(3): 183-195. <https://doi.org/10.1080/09709274.2016.11907022>
- Kikulwe, E. M., Okurut, S., Ajambo, S., Nowakunda, K., Stoian, D. & Naziri, D. (2018). Postharvest losses and their determinants: A challenge to creating a sustainable cooking banana value chain in Uganda. *Sustainability*, 10(7): 23-28.
- Kitinoja, L. (2013). Innovative Small-scale Postharvest Technologies for Reducing Losses in Horticultural Crops. *Ethiopian Journal Applied Science and Technology*. 1: 9- 15.



- Lowenbery-Deboer, B. E. (2019). Setting the Record straight on Precision Agriculture adoption. *Agronomy Journal*. **111**(4): 1552-1569.
- Mapiye, O., Makombe, G., Molotsi, A., Dzama, K., & Mapiye, C. (2021). Towards a revolutionized agricultural extension system for the sustainability of smallholder livestock production in developing countries: The potential role of icts. *Sustainability*, **13**(11): 58-65.
- Moneruzzaman, K. M., Hossain, A. B. M. S., Sani, W., Saifuddin, M., & Alenazi, M. (2009), Effect of harvesting and storage conditions on the post harvest quality of tomato (*lycopersiconesculentum* mill) cv. roma VF. *Australian Journal of Crop Science*, **3**(2):113-121.
- NIHORT (2020). *Remaining 700, 000 metric tons quantity of tomatoes required to meet national demand*. Workshop training organized by Institute for Critical Stakeholders in tomato and Telfaira production and value addition held in Abuja. Retrieve from <http://www.vanguardngr.com>.
- Ofori-Sarpong E. (2001) Impact of climate change on agriculture and farmers coping strategies in the Upper East region of Ghana. *West Afr. J. Appl. Sci.* **2**:21-35.
- Olayemi, F. F., Adegbola, J. A., Bamishaiye, E. I. and Daura, A. M. (2010). Assessment of post- harvest challenges of small scale farm holders of tomatoes, bell and hot pepper in some local Government areas of Kano state, Nigeria. *Bayero Journal of pure and Applied Sciences*. **3**:39-42
- Orzolek, M. D., Bogash, M. S., Harsh, M. R., Lynn, F., Kime, L. F., Jayson, K. and Harper, J. K. (2006). Tomato Production. Agricultural Alternatives Pub. Code # UA291. Pp. 2-3.
- Parfitt, J., Barthel, M., Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical transactions of the Royal Society Biological science*, **36**(1): 3065-3081.
- Reid, M. S. (2002). Maturation and maturity indices .University of California, Agriculture and Natural Resources Publication 3311, Oakland.
- Rivera, W., Qamar, M. K., Van Crowder, L. (2002). “Agricultural and rural extension worldwide: options for institutional reform in the developing countries.” Tech. Rep.
- Toivonen, P. M. A. (2007). Fruit maturation and ripening and their relationship to quality. *Stewart Postharvest Reviews*, **3**:1–5.
- Udensi, E. (2011). Adoption of Selected improve cassava varieties among small holder farmers in Abia State. *Journal of Food Agriculture and Environment*, **99**(1): 329 – 335.
- Vishal Singh, M. D. Hedayetulla, P., Praveen, Z. and Jagmohan, M. (2014). Postharvest Technology of fruits and vegetables: *An overview journal of post-harvest Technology*, **2**(2): 124-135.
- Vishwanathan, R., Thangavel, K., John Kennedy, Z. and Kailappan, R. (1999). Post-harvest losses of tomato in Tamil Nadu. *Kisan World*, **26**(1): 19-25.
- Watkins, C. B. (2006). The use of 1-methylcyclopropene (1-MCP) on fruits and vegetables.