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ASSESSMENT OF FACTORS PRECIPITATING POSTHARVEST LOSSES OF YAM IN ZONE A AGRICULTURAL AREA, BENUE STATE, NIGERIA

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Abstract
The study assessed the factors precipitating postharvest losses of yams in Zone A Agricultural Area of Benue State. Survey research design was adopted for the study and with the aid of semi-structured questionnaires and focused group discussion; data were collected from 204 respondents who were sampled from 1,735 yam farming households using multi-stage cluster and purposive sampling techniques. Descriptive (frequency counts, percentages) and inferential multiple regression analysis) statistics were used to achieve the objectives of the study. The findings revealed that postharvest losses of yams in the study area are precipitated by mechanical and environmental factors such as: pest attack, storage method used, disease/infections, poor transportation facility, theft, poor handling, destruction due to crisis and excessive exposure of yams to sunlight. The computed f-statistic value of 20.78 and 16.12 was significant at 1% and 5% level for mechanical and environmental factors respectively. The study therefore, concluded that mechanical and environmental factors precipitate postharvest losses of yams in the study area. It was recommended that the Government and Agricultural Aid Agencies should provide yam farmers with relevant knowledge on modern yam storage methods, including credit facility that will help them to apply these modern yam preservation methods.

Keywords: Mechanical factors, Environmental factors, Postharvest Losses, Yam

Introduction

Yam is food and economic crop of great importance to both farmers and non-farmers in Benue State, Nigeria and West Africa. The value of yam to people in these locations is underscored by its integration into the economic, social, cultural and religious aspects of their lives (Okigbo and Ogbonnaya, 2006; Verter and Becvarova, 2014). Benue State is the major contributor to the yam production capacity of Nigeria and West Africa (Phillips, Ogbonna, Etudaiye, Mignouna and Siwoku, 2013). In Benue State, 'A' Agricultural Zone is the major contributor to the yam production capacity of the State. The Zone consists of seven Local Government Areas (LGAs) which include: Kwande, Logo, Vandeikya, Katsina-Ala, Konshisha, Ukum and Ushongo. However, among these seven LGAs, the study had particular focus on Ukum, Katsina-Ala and Logo because of their leading role in yam production, with the most prominent yam markets which include: Katsina-Ala township yam market and Gbor yam markets in Katsina-Ala; Zaki Biam township yam market and Tor-Donga yam markets in Ukum; and Ugba yam market in Logo LGAs.

There is a notable high level of postharvest losses of yams in Nigeria and several studies have revealed numerous causes of postharvest losses of yams. Costa (2014) submitted in his findings from his study on strategies for reducing food losses in sub-Saharan Africa that, there are indeed, numerous contributing factors to postharvest losses. He mentioned that the lack of adequate postharvest management knowledge and equipment to implement sound crop preparation and storage practices amongst low-income farmers are the principal reasons which precipitate postharvest losses in yam. He further argued that although losses are being recorded at every stage in the supply chain, from production through retail and consumer levels, the area of highest concern (where the greatest percentage of crop losses are recorded) are pre-farm gate, where poor harvesting, drying, processing and storage of crops occurs. Current inefficiencies in postharvest management at the pre-farm gate level represent one of the largest contributing factors to food losses and hence food insecurity in Africa, directly affecting the lives of millions of small holder farming households every year and impacting enormously on available volumes of food for consumption and trade, especially in low-income, food deficit households and countries (Costa, 2014). The findings of Idah, Ajisegiri and Yisa (2007), also is in

agreement, they established that factors such as: improper postharvest sanitation, poor storage and packaging practices and mechanical damage during harvest, handling and transportation greatly enhance postharvest losses of yam produce. These factors have also been mentioned by Gernah, Ukeyima, Ikya, Ode and Ogunbande (2013) from their study on the efforts towards addressing food security challenges through agro raw materials processing. They argued that, poor condition of roads, processing and storage equipment, as well as inadequate marketing information are mostly responsible for postharvest losses in yam. These factors, they argued, are the principal reasons why over half of the food produced today is lost. The concern of this study therefore, is to find out if the precipitating factors discussed above are also responsible for postharvest losses of yams in the study area.

The objective of the study was to assess the factors precipitating postharvest losses of yams in Zone A Agricultural Area of Benue State.

Hypothesis of the Study

1. Mechanical factors do not precipitate postharvest losses of yams in Zone A Agricultural Area of Benue State.
2. Environmental factors do not precipitate postharvest losses of yams in Zone A Agricultural Area of Benue State.

Theoretical Framework

Modernization Theory

Modernization theory is a perspective with Western origin which attempts to describe the process whereby societies transform from traditional to modern societies including the characteristics of the less advanced societies. Historically, the theory is rooted in the classical works of the founding fathers of social sciences such as: August Comte, Emile Durkheim, Karl Marx, Ferdinard Tonnies and Max Weber. Ferdinard Tonnies and Emile Durkheim, for instance, wrote on the division of societies into two namely: Gemeinshaft and Gesselshaft, Mechanical and Organic solidarities, respectively (Shamija, 2006). The development of this theoretical perspective has been greatly influenced by the events that followed the Second World War, whereby, social science scholars were mandated to advance suitable arguments that would sufficiently explain the socio-economic disparities between the advanced and less advanced societies. This would offer insights into the prevailing socio-economic and political realities impeding the development of less advanced societies. Consequently, scholars such as: David McClelland (1917 - 1998), Walt Whitman Rostow (1916 - 2003), Seymour Martin Lipset (1922 - 2006), Alex Inkeles (1920 – 2010), David Apter (1924 - 2010), and recently, Gosta Esping-Andersen (2019), Stefan Kruse (2019), Ronald F. Inglehart (2021), emerged with such explanations. The thrust of modernization theory is that less developed societies lack some crucial prerequisites for development, such as: technological knowledge. The theory maintains that less developed societies do not have modern technology as found in western societies and they lack mental skills required to exercise control over their material environment to propel the process of development. This theoretical assumption has applicative relevance to this study because the use of thatched houses and barns for yam storage in the study area which include Katsina Ala, Ukum and Logo LGAs in Zone A Agricultural Area of Benue State and their seeming poor knowledge of handling yams underscores the general lack of modern technological knowledge which is responsible for postharvest losses of yams in less developed societies.

Materials and Methods

The study was conducted in three LGAs: Katsina Ala, Ukum and Logo. These are amongst the seven LGAs that constitute Zone A Agricultural Area namely: Kwande, Logo, Vandeikya, Katsina Ala, Konshisha, Ukum and Ushongo. Most of the inhabitants of the study area are farmers, while others are civil servants and traders. Survey research design was adopted for the study, whereby semi-structured questionnaire and focused group discussions were used as methods for primary data collection. The population of study consists of all yam farming households in Katsina Ala, Ukum and Logo LGAs. There seem to be lack of published statistical information on the number of yam farming households in the study area. Nevertheless, with the aid of multi-staged cluster sampling and purposive sampling techniques, the study selected 204 respondents from a sample frame of 1,735 yam farming households, which is the total number of registered yam farming households (Yam Farmers Association, 2018), drawn from the three purposively selected LGAs. Quantitative and qualitative techniques were used to analyze the data that was collected from the field. The quantitative data obtained through questionnaire was analyzed using techniques such as: frequency counts, percentages and means and multiple regression. Whereas, the qualitative data obtained through focused group discussions was analyzed by transcription. A 5 point likert scale was used to determine the mean scores for the variables that were hypothesized to be responsible for postharvest loss of yam in the study area. The variables include: storage method, distance, poor transportation, poor handling, underdeveloped market, pest attack, disease and infection, theft of yams, sprouting, destruction due to crises and excessive exposure of yams to sunlight. The scale was as follows: Strongly Agree (5), Agree (4), Disagree (3), Strongly Disagree (2), No Comment (1). A bench mark of 3.00 was established by calculating the average of the scores (5+4+3+2+1=15/5=3). Thus, any factor with a mean point of 3.00 and above was regarded as a factor that precipitates postharvest loss of yam in the study area.

Results and Discussion

The result in Table 1 reveals several factors that precipitate postharvest losses of yam in the study area, which are categorized under mechanical and environmental factors. The mechanical factors observed include: storage method used (99%: $\bar{x}$ = 4.82), distance (48%: $\bar{x}$ =2.97), poor transportation facility (80%:

$\bar{x}$ = 4.04), poor handling of yams (89%: $\bar{x}$ = = 4.27), and underdeveloped market (82%: $\bar{x}$ = 4.09). The environmental factors include: pest attack (97%: $\bar{x}$ = 4.38), disease and infection (50%: $\bar{x}$ = 3.25), theft of yams (94%: $\bar{x}$ = 4.38), sprouting (33%: $\bar{x}$ = 2.59), destruction due to crises (94%: $\bar{x}$ = 4.5), excessive exposure of yam to sunlight (99%: $\bar{x}$ = 4.77). All the mechanical factors mentioned above except distance (48%: $\bar{x}$ = 2.97) and all the environmental factors except sprouting (33%: $\bar{x}$ = 2.59) have mean scores that were above the 3.00 mean cup-off point. This implies that all the factors with mean scores of 3.00 and above are factors that precipitate postharvest losses of yam in the study area. It can be observed that, among all the factors in both categories, the barn storage method used (99%: x = 4.82) is the most prominent factors that is responsible for postharvest losses of yam in the study area. There was a general consensus among all the 16 Focused Group Discussants in both Logo and Ukum LGAs that the most prominent factor precipitating postharvest loss of yam in the study area is the yam barn storage method which is mostly used by farming households in the area. This position was clearly reflected in the submission of a 64 year old male from Mbayam council ward in Logo LGA that:

"*We use thatched houses and barns here for storing yams. These barns can hardly stop termites and rats from entering to spoil the yams. The atmosphere here is hot from December to February and March. There is high temperature here and the thatched houses and barns in this area can become very hot for yams and this causes rot of yams on a very high scale. Many of the thatched houses and barns here don't even have good ventilation. (FGD, 2nd August, 2018*)".

This shows that thatched houses and barns are the main yam storage methods used by majority of yam farmers in the study area. These yam storage methods are traditional storage methods that lack adequate capacity to prevent pest attack on stored yams. It does not guarantee good ventilation and good temperature control within the thatched houses and barns used for storage. This has led to very high level of yam loss experienced by farmers during storage in the study area. This finding is consistent with those of FAO (1998), Opara (2003), MFCL, GMC and NARI (2004), Osunde (2008) and Adangbe, Oloruntoba, Ayanda and Komolafe (2012) that, yam barn is the principal traditional yam storage structure in the yam producing areas. That the storage method is usually incapable of ensuring good yam storage till off-season because of the high level of losses associated with it. Excessive exposure of yam to sunlight was also mentioned by 99% ($\bar{x}$ = 4.77) of the respondents as the second prominent factor that precipitate postharvest losses of yam in the study area. Although, minimal exposure of yams to sunlight, especially at the time of harvest, can help to cure yams injured and consequently prevent yam rot. However, when such exposure becomes excessive, yam rot or decay can be stimulated as the shelf-life of the yams is drastically reduced. A 61 year old male discussant from Ugbaam council ward in Ukum LGA explained how loss occurs during harvest, on account of excessive exposure of yams to sunlight by relating his experience that:

"*What I have noticed is that, if I am not around to supervise the harvest, many of my yams are always cut anyhow and left under the sun for a long time. This has made me to lose many yams over the years. (FGD, 3rd August, 2018)*".

Apart from excessive exposure of yam to sunlight during harvest which has been a precipitating factor for yam loss in the study area, many of the discussants in both Logo and Ukum LGAs submitted that the loading and off-loading of yams under the sunlight, coupled with poor storage facility in the yam market also lead to excessive exposure of yams to the heat of the sunlight which causes yam rot. This situation is reflected in the comment of a 68 year old male discussant from Mbavuu council ward in Logo LGA who noted that:

"*…….another thing is that almost all of the stores in the market are roofed with zinc. So, there is also a problem of heat that makes the yams to rotten faster, the longer they stay in those stores. (FGD, 2nd August, 2018)*".

This also underscores the fact that excessive exposure of yams to sunlight which leads to yam losses is also occasioned by underdeveloped yam market structures, indicated by 82% ($\bar{x}$ = 4.09) of the respondents. Underdeveloped yam market structure in this context refers to the poor physical condition of storage facility in the yam markets. This finding is in agreement with that of Akangbe, Oloruntoba, Ayanda and Komolafe (2012) that a lot of yam deterioration is usually as a result of lack of or poor storage facilities, which makes the yams to be exposed to extreme temperature from sunlight. The finding further agrees with that of Phillips, Ogbonna, Etudaiye, Mignouna and Siwoku (2013) that even when there are storage facilities available in the market, such stores are usually covered with zinc sheets that rather absorb heat, but do little or nothing on preventing the heat from causing yam rot. Table 1 also shows that pest attack (97%: $\bar{x}$ = 4.38) is another major factor that precipitates postharvest loss of yam in the study area. About a ¾ of the Focused Group Discussants in Ukum LGA indicated that rodents like rats are the major pests that attack their yams particularly during storage. Whereas, discussants in Logo LGA mentioned several pests that attack their yams after harvest and this is mostly during storage. The comment of a 64 year old male household head from Mbayam council ward in Logo LGA presents the details thus:

"*These barns can hardly stop termites and rats from entering to spoil the yams. Even goats……are poisonous to yam……once their teeth touch yam, particularly Ogoja yam, it dries up. Yam beetle and millipede are also part of our problem here by spoiling yams. (FGD, 2nd August, 2018)*".

This confirms the submission of FAO (1998) that, cases of rodents and vertebrate pest attack on yam do occur, especially during yam storage, and that however, such incidences of attack are not well documented in literature. Table 1 also reveals that destruction due to crises (94%: $\bar{x}$ = 4.5), which is a social environmental factor, was observed to be another major factor that is responsible for postharvest loss of yam in the study area. The study area had experienced a lot of herdsmen-farmer crises within the time frame of this study which is from 2013-2017 and the submission of virtually all of the study respondents (94%) is that these crises have led to high level of postharvest losses of yam in the study area. This result has been corroborated by the submission of a 49 year old male discussant who was a refugee from Tswarev council ward in Logo LGA. He stated that:

> "*Out of ten wards in Logo LGA, four wards which include: Tombo, Mbagber, Ukemberega/Tswarev and part of Iwuran have been displaced, due to the herdsmen-farmer crises. Some of the residences and farms are occupied by Fulani, even my house and farm. Like my brother from Mbater had said, the herdsmen usually attack, destroy and burn yams in the barn and also expose some to their cattle to eat (FGD, 2nd August, 2018)*".

This reveals the extent to which destruction due to crises has precipitated postharvest losses of yam in the study area. This means that destruction due to crises is a major factor that precipitates postharvest losses of yam in the study area especially within the study period. This finding confirms the report of Thomson Reuters Foundation, Stanley Foundation and Gerda Henkel Stiftung (2017) on "how herdsmen attacks on farmers threaten household standard of living". The report noted that "over 99,427 households were affected in Benue State and properties worth billions of naira destroyed. The attacks on Benue were very devastating as about 300 rural farmers were killed. Since the crises began in the North-East, Benue has lost 27% of its food output". The finding is also consistent with that of Townsend (2010) who found that crises destroys resources for food production and about 30 million people in more than 60 countries were displaced and/or had their livelihoods destroyed by crises every year through 1990s in sub-Saharan Africa, with an estimated postharvest loss valued at $52 billion. Table 1 also shows that the manner in which yams are handled has also led to postharvest losses of yams in 89% ($\bar{x}$ = 4.27) of farming households in the study area. It was observed that carelessness and/or poor knowledge of farmers about proper yam handling was mainly responsible for the poor manner in which yams are handled that has led to losses. Some of the labour force employed to help with activities such as: yam harvesting, sorting and grading do not handle the yams in a manner that will adequately protect it from injuries. Some of them even leave the harvested yams under the sunlight for a prolonged period of time. This practice reduces the shelf-life of the yams and consequently leads to easy rot or deterioration when such yams are eventually stored. This result is consistent with the finding of Dapaah (2014) who observed from his study on "postharvest losses of yam production in the Krachi-East district of the Volta Region of Ghana" that losses from yam tuber deformation or rot as a result of poor handling of yams is a common occurrence in many yam farming areas. Poor transportation facility is another factor that was mentioned by 80% ($\bar{x}$ = 4.04) of the sampled farmers as also being responsible for postharvest losses of yam in the study area. The Focused Group Discussions in both Ukum and Logo LGAs also revealed that poor condition of the road networks and the poor quality of transport facility such as: pick-up vans and trucks, jointly cause physiological damage to yams. Many of the trucks that are used in transporting yams in the study area, either from the farm to the house, farm to market or house to market are not in good condition. Some of the trucks have spoiled shock-absorbers. When such trucks that are in a poor mechanical condition are used on the existing bad roads, massive yam injury usually occurs. A 56 year old male discussant from Tswarev council ward in Logo LGA clearly described the situation when he commented that:

> "*There are no roads……even the ones that are available are very bad and many of the pick-up vans that carry yams here are not very strong. If you are not lucky, the motor can spoil with your yams under the sun, making many of your yams to rotten quickly. Some yams end up with injuries and some even crushed due to too much shaking of the van. (FGD, 2nd August, 2018)*".

The submission clearly shows that poor quality of transport facility and poor condition of road network is a major mechanical factor that precipitates postharvest losses of yam in the study area. This finding is consistent with that of Kumah and Olympio (2009) from their study of "postharvest physiology of agricultural crops" that there are usually high losses of crops attributed to poor transport conditions. The finding also confirms that of Dapaah (2014) that poor road network and poor transport facility are some of the major problems facing yam farmers. Comparatively, there are more environmental factors that precipitate postharvest losses in the study area than mechanical factors. However, on the whole, all the factors in both

categories, except for disease and infection ($\bar{x}$ = 3.25), had mean scores of 4.00 and above, which implies that these are important factors influencing postharvest losses of yam in Zone A Agricultural Area of Benue State.

Hypothesis One

The result of the ordinary least square multiple regression analysis used to test the hypothesis that mechanical factors do not precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State is presented in Table 2. Based on the magnitude of the coefficient of multiple determination (R^2), number of significant variables, signs of the regression of the entire model as indicated by the F-statistic, the Semi-log model was selected as the lead model. The value of the coefficient of multiple determination (R^2) is 0.761, which shows that 76% of postharvest losses of yam in the study area are explained by the explanatory variables included in the model. The F-ratio of the lead equation is significant at 1% (20.78)***, which implies that the model was good. Thus mechanical factors such as: storage method, poor transportation facility and poor handling of yam, underdeveloped market, were observed to be the significant factors precipitating postharvest losses of yam in the study area. Accordingly, the coefficient of storage method used in the study area was positive (2.174) and significant at 5% level. This implies a direct relationship of the storage method used with postharvest losses of yam in the study area. Therefore, increase in the use of the barn storage method would lead to increase in postharvest losses of yam. The coefficient of poor transportation facility is positive (2.300) and statistically significant at 1% level. This implies with postharvest losses of yam. Therefore, increase in the prevailing poor condition of transportation facility in the study area would lead to increase in postharvest losses of yam. The coefficient of poor handling of yams in the study area is positive (8.716) and significant at 1% level. This implies a direct relationship with postharvest losses of yam in the study area. Thus, increase in poor handling method would lead to increase in postharvest losses of yam. The coefficient of underdeveloped market in the study area was positive (0.076) and significant at 5% level. This implies a direct relationship with postharvest losses of yam in the study area. Therefore, increase deterioration of the condition of market structures in the study area would lead to increase in postharvest losses of yam. Given that the computed f-statistic value of 20.78 was significantly higher than the tabulated f-value of 9.33 at 1% level of significance and 3.11 at 5% level of significance, we therefore, reject the null hypothesis that "mechanical factors do not precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State", and accept the alternative hypothesis that "mechanical factors precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State.

Hypothesis Two

The result of the ordinary least square multiple regression analysis used to test the hypothesis that environmental factors do not precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State is presented in Table 3. Based on the magnitude of the coefficient of multiple determination (R^2), number of significant variables, signs of the regression of the entire model as indicated by the F-statistic, the Semi-log model was selected as the lead equation. The value of the coefficient of multiple determinantion (R^2) is 0.808, which shows that 81% of postharvest losses of yam in the study area is explained by the explanatory variables included in the model. The F-ratio of the lead equation is significant at 1% (16.122)***, which implies that the model is good. Thus environmental factors such as: pest attack, diseases and infections, theft of yams, destruction due to crises and excessive exposure of yam to sunlight, were observed to be the significant environmental factors precipitating postharvest losses of yam in the study area. Accordingly, the coefficient of pest attack (5.835) is positively related with postharvest losses of yam in the study area and significant at 1% level. This implies that pest attack precipitates postharvest losses of yam in the study area. Thus, increase in the current rate of pest attack on yams in the study area would lead to increase in postharvest losses of yam in the study area. The coefficient of disease and infection of yam (3.096) is positively related with postharvest losses of yam in the study area at 1% level of significance. This implies a direct relationship with postharvest losses of yam. Therefore, increase in the current state of disease and infection of yams in the study area would lead to increase in postharvest losses of yam. The coefficient of theft of yam is positive (2.206) and significant at 5% level. This implies a direct relationship with postharvest losses of yam; therefore, increase in theft of yam would lead to increase in postharvest losses of yam in the study area. The coefficient of destruction from crises (3.937) is positively related with postharvest losses of yam in the study area at 1% level of significance. This implies a direct relationship with postharvest losses of yam in the study area. The implication is that, increase in the present situation of destruction of yams as a result of the crises in the study area would invariably lead to increase in postharvest losses of yam in the study area. The coefficient of excessive exposure of yam to sunlight (5.317) is positively related with postharvest losses of yam at 1% level of significance. This implies a direct relationship with postharvest losses of yam in the study area. This means that an increase in excessive exposure of yam to sunlight would lead to increase in postharvest losses of yam in Zone A Agricultural Area of Benue State. Given that the computed F-ratio value of 16.122 was significantly higher than the tabulate F-value of 9.33 at 1% level of significance and 3.11 at 5% level of significance, we therefore, reject the null hypothesis that "environmental factors do not precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State", and accept the alternative hypothesis that "environmental factors precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State.

Conclusion

The study concludes that several mechanical and environmental factors such as: pest attack, storage method, disease and infections, poor transportation, theft, poor handling, destruction due to crises and excessive exposure of yams to sunlight are the factors that precipitate postharvest losses of yams in the study area. Thus, any attempt to reduce postharvest loss of yam in the study area must consider addressing these factors. Accordingly, the study recommends that the Government and Agricultural Aid Agencies, through agricultural extension agents should provide yam farmers with relevant knowledge on modern yam storage methods such as: gamma radiation and refrigeration, including credit facility that will help them to apply these modern yam preservation methods. The government should also provide good road networks and/or improve the condition of available roads in the study area to ensure safe transportation of yams and thereby, reduce the level of yam loss during transportation. Furthermore, the Local Government Authorities in the study area in collaboration with Yam Farmers' Associations should provide sufficient, quality and secured yam stores at the available yam markets in the study area to curb theft of yams and excessive exposure of yams to sunlight during transaction and at the yam loading and off-loading locations.

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Table 1: Factors precipitating postharvest losses of yams in Zone A Agricultural Area of Benue State

Precipitating Factors	* Frequency	Percentage (%)	M‾	Decision
Mechanical factors				
Storage method	202	99	4.82	Accepted
Distance	98	48	2.97	Rejected
Poor Transportation Facility	164	80	4.04	Accepted
Poor Handling of yams	182	89	4.27	Accepted
Underdeveloped Market	168	82	4.09	Accepted
Environmental factors				
Pest attack	198	97	4.38	Accepted
Disease and Infection	102	50	3.25	Accepted
Theft of Yams	192	94	4.38	Accepted
Sprouting	68	33	2.59	Rejected
Destruction due to Crises	192	94	4.5	Accepted
Exposure of Yam to Sunlight	201	99	4.77	Accepted
Decision mean score			**3.00**	

Source: Field Survey, 2018. *Multiple response table

Table 2: Result of multiple regression analysis of mechanical factors that precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State

Variables	Linear	Exponential	Semi-log+	Double-log
Constant	29.687	1.557	0.784	1.636
	(2.047)**	(13.263)***	(1.995)**	(12.257)***
Poor Storage	-1.602	0.021	-0.861	0.265
	(4.553)***	(1.941)**	(2.174)**	(2.968)***
Long Distance	-0.560	-0.009	-0.787	-0.039
	(-0.379)	(-0.719)	(-0.060)	(-0.378)
Poor Transportation facility	2.355	0.040	29.962	-0.397
	(1.184)	(2.492)**	(2.300)***	(3.881)***
Poor Handling of Yam	-0.177	-0.004	-2.859	-0.087
	(-0.418)	(-1.089)	(8.716)***	(-1.184)
Underdeveloped Market	0.143	-0.001	0.738	-0.058
	(0.245)	(-0.203)	(0.076) **	(-0.757)
R^2	0.561	0.678	0.761	0.610
Adj. R^2	0.541	0.651	0.751	0.601
F-ratio	(5.291)***	(11.82)***	(20.78)***	(9.04)***

Source: Field Survey, 2018

******, ** and * represents 1%, 5% and 10% level of statistical significance respectively. Figure in brackets are t-values, whereas, the affirmative symbol (+) represents lead equation***

Table 3: Result of multiple regression analysis of environmental factors that precipitate postharvest losses of yam in Zone A Agricultural Area of Benue State

Variables	Linear	Exponential	Semi-log+	Double-log
Constant	29.687	1.557	0.784	1.636
	(2.047)**	(13.263)***	(1.995)**	(12.257)***
Pest Attack	-0.744	-0.010	-11.331	-0.144
	(-2447)*	(-0.817)	(5.835)***	(-1.320)
Diseases and Infections	2.797	0.016	-0.257	0.059
	(1.142)	(0.826)	(3.096)***	(0.448)
Theft of Yam	-4.119	-0.039	-23.210	-0.224
	(-3.476)***	(-4.051)***	(2.206)**	(-2.708)*
Sprouting	-0.280	-0.003	-11.289	-0.163
	(-0.854)	(-1.180)	(-1.340)	(-2.472)***
Destruction due to Crises	-0.111	-0.001	5.018	-0.020
	(-0.854)	(-0.519)	(3.937)***	(-0.485)
Excessive exposure of yam to sunlight	0.099	-0.001	3.892	0.040
R^2	(-0.283)	(-0.343)	(5.317)***	(0.583)
Adj. R^2	0.462	0.789	0.808	0.563
F-ratio	0.581	0.593	0.708	0.563
	(3.819)***	(11.16)***	(16.122)***	(4.638)***

Source: Field Survey, 2018

******, ** and * represents 1%, 5% and 10% level of statistical significance respectively. Figure in brackets are t-values, whereas, the affirmative symbol (+) represents lead equation***