ASSESSMENT OF POST-HARVEST LOSSES OF YAM (*Dioscorea spp.*)IN SELECTED DISTRICTS OF KARU LOCAL GOVERNMENT AREA, NASARAWA STATE

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Abstract: The aim of this study is to introduce a method for the direct assessment of post-harvest losses in yam caused by rodents. Key informants comprising practicing yam farmers; the agriculture extension workers were selected for a Focus Group Discussion. Descriptive statistics was used to analyze the data, and the 95% Confidence Interval (CI) measured precision of respondent noted to have given a specific response. The daily yam requirements of the trapped rodents in the weight class were determined by measuring the actual amounts consumed by representative samples of captive rodents in cages. The study reveals that the major causes of post-harvest losses of yam is basically poor storage (17.7-54.7% CI) and to a lesser extent post-harvest handling of yam (10.2-24% CI). Analysis of variance shows that there is relationship between the yams sold, stored, processed and consumed, indicating increasing demand for the yam (*Dioscorea spp.*); the 10.5kg of yam lost to rodents during storage called for concern, this has resulted to both qualitative and quantitative losses. The study recommended investment in post-harvest storage processing technologies; education as well as proper method of controlling rodents that destroy yam tubers in storage.
Keywords: Post-harvest loses, yam, food security, Rodents

Introduction

Globally, about one-third of the food produced today is lost, wasted or discarded as a result of inefficiency in human-manage food chain (Hall *et al.,* 2003; Food and Agriculture Organization, 2009a; FAO, 2010), which amounts to about 1.3 billion tons per year (FAO, 2009b; FAO, 2011). In addition, 30 to 40% of the food crops produced in the world are never consumed as a result of damage, rotting as well as pest and diseases which affect crops after harvest (Tawose, 2008; Lundqvist *et al.,* 2008).

However, in Nigeria an excess of 10 million tons of grain equivalent of food per annum conservatively estimated at over ₦825 billion was reported to be lost to spoilage and wastage occasioned by the lack of post-harvest management (NIFST, 2011). Similarly, Gustavsson *et al.* (2011) conducted of a study on animal production and postharvest losses of roots and tubers in Nigeria come out with an estimate of yam produce amount to about 86,229 metric tons and about 7773.4 metric tons average loss annually. Such serial losses can hamper farmer's interest and effort in the production of food. This eventually leads to food shortage which brings about malnutrition (Bloom, 2010; Hodges, Buzby and Bennett, 2011; Bridget, 2013). The losses can occur either due to food waste or due to inadvertent losses (Weight loss; Quality loss; and Nutritional Loss) along the chain; include harvesting, handling, storage, processing, packing, transportation and marketing (Kadar, 2002; Food and Agriculture Organization (FAO), 2004; Buzby and Hyman, 2012), leading to either quantitative food losses as measured by decreased weight or volume (FAO, 1980; Bloom 2010; Buzby and Hyman, 2012), or qualitative such as reduced nutrient value and unwanted changes to taste, colour, texture or cosmetic features of food (Waarts *et al*., 2011; Buzby and Hyman, 2012) with the attendant adverse effects, both to the farmer's income and food security at large (Quested and Johnson, 2009).

There are indications that the non- availability of storage facilities to local farmers implies that farmers will always have to sell at reduced prices as they cannot keep the perishable products for an extended period of time. This has grave implications on the income of farmers and could consequently result into a rapid decline in welfare. Also, it is distressing to note that while many resources are being devoted to planting crops irrigation, fertilizer application and crops protection measures for increased productivity little is being done to minimize post-harvest losses. A reduction in post- harvest food loss could guarantee increase in food availability thereby reducing the need for food importation and consequently impact positively on the welfare of farmers (Adams, 1997; Orhevba, 2006; International Bank for Reconstruction and Development, 2011; Adesina, 2012; Food Balance Sheet Data, 2013). This is pertinent if the country is to meet its goal of food self- sufficiency by 2030.

There are many causes of food deterioration which leads to food waste. These include: Growth and activities of microorganisms principally bacteria, yeast and moulds; Nature activities of food (chemical and biochemical); Pests (insect, parasites and rodents); Temperature (both heat and cold); Moisture and dryness; as well as Air (particularly oxygen) and high (Fellow, 2005; Agricultural Research Service, 2008; Alexandratos and Bruinsma, 2012). Studies by Kader, (2002); Haile (2009); Buzby and Jeffery (2012); Abimbola, (2012); Chestney (2013); and Food Balance Sheet Data (2013) classified causes of food waste into two major factors: Biological and Environmental causes of loses – includes respiration rate, ethylene, production and action, rate of compositional change, temperature, relative humidity, air velocity and atmospheric composition; and socio-economic factors – include inadequate marketing system, inadequate transportation facilities government regulations and legislation, poor maintenance, lack of information and unavailability of needed tools and equipment (Regmi *et al.*, 2001; Rembold *et al.*, 2011; Save Food, 2013).

Food losses to rodents are acknowledged to be great, but quantification of this diversion from human food supplies is less than satisfactory. Lack of adequate data and appropriate survey or sampling techniques was recognized as a prime deterrent in obtaining adequate estimates of loss. Clearly, the extent of grain loss to rodents depends on the distribution, size, and species composition of the rodent populations involved. The method proposed in this study is intended primarily for use in yam stores.

The rationale for selecting*Dioscorea spp.* is the fact that it is an excellent source of carbohydrate, energy, vitamins (especially vitamin C), minerals, energy and protein levels of

3.2 – 13.9% of dry weight. It has an important excellent eating quality; it is a preferred food at social gatherings. It is often pounded into a thick paste after boiling (pounded yam) and is eaten with soup, its average consumption is 0.5 - 1.0 kg daily (Wilson 1980; Ijabo, 1989; Adejumo, 1998; Osunde, 2006; Knight and Davis, 2007; Sahore and Kamenan, 2007). Its tubers may be harvested 4-5 months after emergence (knoth, 1993; Lagegman, 1997; and Orhevba 2006). The yield depends on the size of the seed piece, and environment but normally ranges from 8-50 t/ha (Kader, 2005; International Institute of Tropical Agriculture, 2007; and Okoedo-Onemoleases, 2009).

The Two objectives of my study were to: study and analyzed the major temporal causes of post-harvest losses in yam production; and introduce a method for the direct assessment of post-harvest losses in yam caused by rodents.

Materials and Methods

Karu Local Government Area (LGA) is located on Latitude 08^0 14'N and 08^0 31'N and longitude 07^0 30'E and 08^0 E. According to 2006 population Census, Karu LGA has a population of 205,477 people, comprising; *Gbagyi, Gwandara, Gade,Hausa-Fulani,Mada, Tiv, Bassa, Koro, Yoruba* and *Ibos*.

The area has is characterized by two district seasons – the wet season last from April to October, while the dry season is experience between November and March. Annual rainfall figures rage from 1100 mm to about 2000 mm, the wettest months being July and August. Temperature is generally high during the day particularly between months of March and April, the mean monthly temperatures range between 20°C and 34°C, with hottest months being March and April and the coolest months being December and January. The soil of the study area belongs to the category of tropical ferruginous soils (Peel *et al.*, 2007). The vegetation of Karu LGA and environs lies within southern guinea savanna. This area was characterized by a high density of tree population and thick elephant grasses but due to the continue process of overgrazing and deforestation (for fire wood and agriculture) forest are few and far apart. This is due to the increase in population pressure.

Farmers in Karu LGA are predominantly subsistence. More than seventy-five percent of the population engaged in land cultivation (Agriculture). The remaining few percentage are pottery markers especially *Gbagyi*, some are black smiths, hunters, commercial drivers and *Okoda* riders because of its proximity to Federal Capital Territory (FCT) - Abuja. Others engage in exploitation of forest as the wood and timbers while others are migrants from FCT- Abuja which are mostly civil servant or workers. Major cash crops being cultivated in the study area are: yams, millet, maize, Guinea corn, beans and groundnut. Rice potatoes, vegetables, cassava are also cultivated. There is also high rate of irrigation activities especially dry season farming in most of the River basins of the study area.

Karu LGA is blessed with important markets across its district because of its nearness to the FCT. Some of the major markets are Karu International Market, Masaka, Mararaban-Guruku, Gitata, Gunduma, Karshi, and Uke among others. These markets generate revenue to the local government because it attract buyers especially workers from Abuja. The crops produced in this area were mostly sold in these markets only few were transported out for other towns and market.

Methodology

Sampling Technique

In other to have a better representative coverage, the study area was stratified into five (5) zones comprising Karshi I, Karshi II, Uke, Keffin-shanu/Beti and Bagaji-Agada Zones. In all fifty (50) key respondents were systematically randomly selected. Ten (10) respondents from each of these categorized zones comprising practicing yam farmers and yam seller/traders as well as the extension workers of Agriculture Department of Karu LGA for a Focus Group Discussion (FGD). The community heads in each of the farming district assisted in the purposive selection of the respondents who were judged to be conversant with the biocultural skills, ideas and historical events, since random sampling cannot perfectly cover that (Marshall and Rossman, 1999; Clissett, 2008; Robson, 2011). The grouping helped in alleviating the problem of miss-information and relocation of memories since each member of the group can complements the other in the supply of information. Information collected during the FGD include, characteristics of respondents; type of storage; causes of post-harvest losses as well as condition of yams during harvesting and storage among others. Table 1 shows the five groups of farmers interviewed. The FGD was conducted during the market days. The choice of this strategy enabled one to compare the similarities and disparities in the mode of yam cultivation and other socio-economic activities between the different groups.

Table 1: The five groups of farmers interviewed

Respondent ID	Respondent Identity	Date Conducted	Group size
1	Group leader (A) Karshi I	20/07/2016	10
2	Group leader (B) Karshi II	22/07/2016	10
3	Group leader (C) Uke	01/08/2016	10
4	Group leader (D) Keffin-Shanu/Biti	10/08/2016	10
5	Group leader (E) Bagaji-Agada	17/08/2016	10

Ethical consideration in FGD

An introductory note and concert agreement (participant information sheet) were read out to the respective respondents before the FGD. The participant information sheet emphasized that all the information given by the respondents will remain anonymous and will only be used for the research purpose, and that they may refuse to answer any of the questions and even quit the discussion at any point. The information sheet also indicated that all the information they presented would be availb1e via the final write-up document.

Method of data analysis

Data storage and processing

The information collected were transcribed and recorded in a Microsoft Office Excel Spreadsheet (Baxter and Eyles, 1997; InSites, 2007) – by "reading through the interview or focus group transcripts and other data, developed codes, coding the data, and drawing connection between discrete pieces of data" (InSites, 2007; Saldaña, 2009). This gives me the option of sorting the responses by either using the questions or the respondents' id's to assess the similarities and disparities of the respondents responses. Coding the data had assisted in reducing the data into smaller groupings (Table 2) for easy handling (InSites, 2007), the codes were derived from the questions in the questionnaire, and consequently, patterns began to emerge from the data. From the emergent pattern of information, a second cycle coding (Saldaña, 2009) was adopted in order to amalgamate some of the similar information into a broader concept.

Table 2: An Illustration of the Questionnaire Transcripts coding

ID#	Q#	Response	Code	Code Description
1	1	Xxxxxxxxxxxxxxx	OB	Second job after yam business
1	2	Xxxxxxxxxxxxxxx	PRC	Reason for yam business
1	3	Xxxxxxxxxxxxxxx	NPE	Group size
1	4	Xxxxxxxxxxxxxxx	LT	Labour division
1	5	Xxxxxxxxxxxxxxx	DOS	Business Organisation
1	6	Xxxxxxxxxxxxxxx	BP	Profit in the business
1	7	Xxxxxxxxxxxxxxx	BR	Reason for yam business
1	8	Xxxxxxxxxxxxxxx	TAX	Tax paid to government
1	9	No	YH	Yam Selling
1	10	No response	YHS	Causes of yam lossess
1	11	Xxxxxxxxxxxxxxx	TR	Mode of transporting yam from farms centers
1	12	Xxxxxxxxxxxxxxx	P.F	Distance to farms/Storage Centers
1	13	Xxxxxxxxxxxxxxx	TL	Tools used in yam harvesting
1	14	Xxxxxxxxxxxxxxx	PD	Yam pricing Strategy
1	15	Xxxxxxxxxxxxxxx	APA	Business organization in a year
1	16	Xxxxxxxxxxxxxxx	ASA	Business organization in a year
1	17	Xxxxxxxxxxxxxxx	VS	Suggestions and way forward

For example, response to questions two (PRC) and seven (BR) were merged into one major idea as both the fifty (50) discussants appeared to be repeating themselves in the two questions. Through this way, similarities and differences in the different set of the emerging themes were re-organized and interpreted based on the differences and similarities of the five groups.

As for reasons offered by study, participants with respect to proper and non-proper management of yam losses were categorized into groups and ranked according to frequency of response. The precision of participant noted to have given a specific category of response was measured by computing the 95% Confidence Interval (CI) around the estimate using the following variance formula:

$$\hat{p} - z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} < p < \hat{p} + z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \ldots\ldots Eqn.1$$

Thus we reach the 100(1-α) % CI on *P*

Determination of yam losses by rodents

Count and weight method

One hundred samples of undamaged yam tubers were counted, weighted, and stored for six months from December 1st, 2015, to May 31st, 2016 in such a way that there is cross ventilation to avoid increase or rise in temperature. This provides a useful means of estimating loss at moderate infestation levels with a minimum apparatus. Equipment used includes: Balance with a range of 0.5 to 1.5 kg accurate to 0.1 g; Tally Counter; and Plastic bags. The resultant data was determined to be (700 kg). This is kept in a store of 4 m Length by 4 m Width by 3 m Height (4 m * 4 m * 3 m = 48 m^3) representing the nominal capacity of the store.

Trapping of rats and mice

During the determination of yam losses by rodents, two visits were made to the sampled yam store. First a survey of the storage facilities was made to appraise and record the extent of yam losses to rodents by identifying and evaluating thoroughly signs of rodent infestation, including burrows, excreta smears, footprints, damage to the commodity or structure and places where rodents may enter the store, tracking patches were laid approximately 200 x 300 mm at intervals along the walls of the store and besides the stacked yam tubers, especially around corners. The tracking patches were laid at the rate of approximately one per 10 tons of yam up to 5 patches. The patches were entered is a numbered sequence on the record sheet and their position indicated.

The second visit was made the next day and the presence or absence of rodent tracks on each tracking patch made by both large and/or small rodents (rat and/or mice) or by both rodents or both sizes were recorded. It then followed by setting and checking of traps at some observed locations where the rodents have access to the yam tubers for a period of 21 days which was assumed to be sufficient enough to trap all the rodents present in the sampled store. The feeding capacity of the rodents population was estimated by multiplying the number of rodents by their assumed daily food requirement and hence the current yam loss to rodents.

Equipment used were; Electric flashlight/ torch; Tracking powder (talcum or finely powdered track). A glass jar with a perforated lid provide a convenient means of dispensing the powder; Clipboard and record sheets; 200 snap traps (rat size, striking bar 70-80 mm long; (mouse size, striking bar 40-50 mm long); Spring balance (100 x 1 g); Spring balance (500 x 5 g); Blackboard chalk for marking trap locations; and a Bait.

The rodents' population was trapped out in period of 21 days, the bulk of the rodents population was caught in the first week. The correct sitting of traps is helped by knowledge of the movement patterns of the rodents. To increase and update the trapping, temporary placement of extra tracking patches was renewed regularly. The tracking patches also shows, by the absence of tracks when of the rodents have been caught.

The bait is sticky consisting crushed fruit (banana, oil palm, and melon), and sweetened dough pressed firmly into the bait hook so that rodents cannot simply lift it off but are induced to the release some lateral or downward force on the release mechanism while getting the bait. Succulent baits are used because they are particularly attractive to rodents in the dry environment of the yam store, and they are changed after few days. The traps are set as finely as possible. The trap round was checked each day; the body weight of each rodent caught for each trap is then recorded. Every trap whether it makes a capture or not, was freshly baited and reset and its position adjusted so as to increase the chance of making a capture. Attention was focused first, on trapping the large rodents present, as their number decrease gradually we switch to using the smaller traps.

Yam losses assessment due to rodents

The numbers of body weights of the trapped rodents were recorded – divided into two body-weight classes: 50 g or less (<50 g), and more than 50 g (>50 g). The biomass (sum of the body weights) of weight is obtained. The estimate of the daily yam loss attributed to the trapped rodents is obtained by multiplying the biomass of the rodents by a factor representing the daily yam requirements of the trapped rodents.

The daily yam requirement of the rodents in the weight class determined (as a proportion of body weight) for the yam and the study area) by measuring the actual amounts consumed by representative samples of captive rodents in cages. Estimate of the annual loss is expressed as a percentage of the amount of yam actually stored of the nominal capacity of the store.

Results and Discussion

Characteristics of respondents

The study reveals that 85% of yam farming in all the zones is largely practiced by male. The mean age of a farmer is 46 and a standard deviation of 3.4 with the Coefficient Variation (CV) of 3.0% in all the zones used for this study. This implies that yam farming is dominated by male farmers and could be attributed to the nature and difficulty in cultivating yam. This is because (according to respondents) cultivation of yam is not easy as cultivating other crops. The processes involved in propagating yam consists of capital, storing of yam seed for next planting season and making of heaps are all difficult (Knoth, 1993), female cannot easily engage in the production. The study also reveals that young people (aged 30 years and below) are set with the least percentage (6%) indicating that young people venturing into farming is decreasing because of the effect of migration of youths to Abuja in search of white collar jobs. The result also supports the work of Ekunwe (2008) which reported that yam farming in Nigeria is dominated by older farmers especially between ages 41-55. Two-third (38.5%) of the interviewed yam farmers had no formal education. This may affect the use of modern technology for agricultural activities. About 65.5% with mode of 38 respondents falls under the range of primary school certificate. This shows that most of the respondents are primary school holders.

However, more than half of the respondents (53.5%) with the mode 16 years had about 11 to 20 years of farming experience. This revealed that farming experience may develop their attitude towards both cultivation and adopt suitable method of storing and maintaining yam produced. Similarly, the study also revealed that more than half (54%) cultivate both grains and yam. This implies that due to high cost of producing yam, farmers also cultivate grains, rather than yam production (Knoth, 1993). More than half of the respondents (57.6%) responded that they harvest in the month of January while only few (7.5%) harvest in the month of November.

Type of storage in the study area

Generally, the study revealed that all the yam farmers in the study area stored their yam produce in the traditional yam barn which is mostly constructed with the guinea corn stalk, sticks grass and yam vines. However, in the farm, yam are gathered in one place and covered with the yam vines. This is normally used for yam seed which are stored against next planting season. This was discovered during field study. A similar visit was also made into the yam collection centers after the FGD, where it was observed that only two groups in Karshi I and Uke wards were able to construct a modern house where the tubers are protected. It was constructed under a shade with adequate ventilation while protecting tubers from flooding, direct sunlight and pests and insects attack. The storage structure observed was like the typical barn in the humid forest zone (individual yams tied to live poles). Furthermore, the study also reveals that farmers sell most of their yams after harvest, consume more, store and process less. It was observed that the farmers mostly store seed yam for the purpose of planting next season and store little after harvesting and for a few period of time before finally sold them out.

Causes of post-harvest losses

Table 3 presents the major causes of post-harvest losses in yam. The study revealed that 36-56.5% CI of the farmers responded that poor storage of yam causes post-harvest losses. This is due to the nature and the type of storage adopted by most of the yam farmers. Most farmers in the study area used traditional method of storing yam. The yam barn are locally made or constructed which give room to micro-organisms and rodent to destroy yam tubers stored, this was identified during visit to the yam collection centers of the five zones. Other causes enumerated by the respondent are microbial attack on yam with about 25%, careless handling of yam during harvest.

Table 3: Causes of post-harvest losses

S/N	Reasons	Number of respondent	%	95% CI (%)
1	Careless handling of yam during harvest	8	15	0.7-9.1
2	Microbial attack on yam	12	23	29.3-35.1
3	Poor storage	25	50	36-56.5
4	Excessive exposure of yam to sunlight	2	5	0.4-7.2
5	Harvesting of immature yam	3	7	3.20-15.2
	Total	**50**	**100**	

Time post harvest losses occur most

Table 4 below presents the time post-harvest losses occur most. The study shows that (17.7 – 54.7 CI) respondents indicated that post-harvest losses occur most during storage. It was explained by the farmers during the FGD. The farmers stated that the more total numbers of tuber stored for a long period of time the more one recorded yam losses, 100 tubers of yam was stored and observed for about six months. Both moisture content and the weight of the yam drastically reduced after six months. Similarly, About 17 respondent (34%) with 10.2-24.8 CI responded that yams are also reduce in both quantity and quality during harvesting, this is due to Poor harvest method, uses of crude tools and poor handling of yam during harvesting. Other periods when post-harvest losses occur are during transportation, and marketing especially when there is drop in the market price of yam no farmer may be willing to sell his/her yam at that price.

Table 4 Time post-harvest losses occur most

S/N	Time	Frequency	Percentage	95% CI (%)
1	During harvesting	17	34	10.2-24.8
2	Storage	25	50	17.7-54.7
3	Transportation	7	11	9.3-23.7
4	Marketing	1	5	7.0-20.2
	Total	**50**	**100**	

Post-harvest constraints encountered by farmer

The major post-harvest constraints include lack of storage facilities (Table 5), long distance to market poor transportation, pests and lack of credit facilities. This is consistent with the findings of Said (2013). Lack of storage facilities was reported as a major constraint by the farmers (27.7-38.1 CI). Farmers responded and complained that there is an inadequate storage facility from the government and also individual, as a result, farmers are usually faced to take their produced to the market directly from the farm. Pests and diseases attack yams also recorded 19.6-23.6 CI both in the farm and storage, while about 11.5% of the respondents reported that long distance to market is another constraints to them, the least is among the constraints is the theft of the products (1.9-11.7). Other constraints are poor transportation network and insufficient capital.

Table 5: Post-harvest constraints encountered by the farmers

S/N	Constraints	Frequency	%	95% CI (%)
1	Lack of storage facilities	25	50	27.7-38.1
2	Long distance to market	6	11.5	21.8-27.6
3	Poor transport network	5	10	10.1-19.5
4	Pests and diseases	7	14	19.6-23.6
5	Low government support	4	8	2.6-13.0
6	Theft	1	2.5	1.9-11.7
7	Insufficient working capital	2	4	0.7-9.1
	Total	**50**	**100**	

Post-harvest activities of farmers

Table 6 reveals that all the farmers sell most of their yams after harvest, consume more, store and process less in all the zones used for the study. It was observed that in Karshi II, Keffi-shanu Biti and Bagaji-Agada zones, the percentage sold and consumed by the farmers is higher (45.3 46.4 and 44.6, respectively) than that stored or processed. This is because most of the farmers in these communities are peasant farmer and leave in the interior villages of the two districts. While the percentage stored in Karshi I and Uke zones is higher than the percentage consumed compare to the other zones. This is because Karshi and Uke is the two districts headquarters of the words and are having the major yam market build in them.

Table 6: Post-harvest activities of farmers

Zones	Mean % Sold	Mean % Stored	Mean % Processed	Mean % Consumed
Karishi I	38.7	29.2	18.8	22.3
Karishi II	45.3	21	16.7	36.0
Uke	39	30.6	20.3	21.6
Keffin-shanu beti	46.4	18.5	14.4	37.8
Bagaji-agada	44.6	20.7	15.5	39.1

Analysis of Variance (ANOVA) on Table 6 above determined the relationship between the yams sold, stored, processed and consumed. The hypothesis tested is:

H_O: There is no significance relationship between yam sold, stored, processed and consumed!

H_i: There is significance relationship between yam sold, stored, processed and consumed!

Base on the above, the F- calculated value is greater than F- in table (4.2881 > 2.90 at α 0.05). This shows that there is significance relationship between the yam sold, stored, processed and consumed. This finding shows that there is a high demand of yam by the people. However, this implies that any change in one or two of the variables will affect the other. For example, if there is any change in yam consumed for example may cause change in the total number of yam stored by the farmers and vise versa.

Storage losses assessment due to rodents

The biomass (sum of the body weights) of each weight class was obtained (Table 7). The estimate of the daily yam loss attributed to each class is obtained by multiplying the biomass of the rodents in each weight class by a factor representing the daily yam requirement of a rodent in that weight class and the adding together the two products.

Table 7: Summary of the numbers of body weights of trapped rodents

Class	Body Weight (g) (a)	No of Rats (b)	Mid-class a/2= (c)	Biomass of rodents (b) X (c)= (d)	Assessment of yam consumption by rodents (e)	Consumption equivalent of body weight of rodents (f)
A	< 50g	30	25	750	0.150	112.5
B	50g – 99g	54	74.5	4023	0.070	218.61
C	100g – 149g	126	124.5	15687	0.069	1113.78
D	150g – 199g	90	174.5	15705	0.068	1130.76
E	>200g	25	100	2500	0.067	182.5
				∑ = 38665		∑ = 2758.15

Sum of the body weight of rodents = 38, 665; Total estimated daily yam loss = 2758.15 g

Yam consumption equivalent of 0.070 (7%), 0.071 (7.1%), 0.072 (7.2%), 0.073 (7.3%) (World Food Logistics Organization, 2010) of body weight for rodents weighting more than 50g and 0.15 (15%) of body weight of rodents weighing less than 50 g assumed and assigned (World Food Logistics Organization, 2010, p. 112 – 113). Therefore, the estimated daily yam loss attributed to class A, was then obtained by multiplying the values of the assumed yam consumption equivalent by the body weight of each class. The total estimate for the different class, and is expressed both as absolute amount and as percentage of the amount of yam in the store and of the nominal capacity of the store. If it can be assumed that the rodents' population was reasonably stable, then the loss over a period of time can easily be calculated. Estimates of the amount loss expressed as percentage of the amount of yam actually stored, if a nominal capacity of the store and of the turnover are usually of particular interest.

Therefore, the nominal capacity of the store used for this study is:

Length (L) * Width (W) * Height (H)

L * W * H = 4m * 4m * 3m = 48m^3

The consumption equivalent of body weight of rodents (from Table 7) is, therefore:

$$\frac{2758.15}{1000} = 2.8\ kg$$

$$\frac{2.8kg}{700kg} = 0.004\ for\ a\ daily\ loss$$

Where 700 kg is the weight of the 100 sample tubers of yam;

Therefore, $\frac{0.004}{48\,m^3} = 0.0000833$

Where 48 m^3 is the nominal capacity of the stored sampled yam

Therefore, 0.0000833 * 180 days = 0.015

In summary, the total loss of yam due to rodents is estimated to be 0.015%, obtained from the 100 sampled yams (700 kg) stored and studied for six month. Finally, the total aggregate loss of yam in the study area due to rodents is 0.015 * 700 kg = 10.5 kg indicating both qualitative and quantitative yam losses.

Policy implication

The problems observed in the study area is basically more importantly lack of storage facilities, followed to a lesser extent poor transport network, use of crude implement for harvesting yam and lack of working capital. Therefore, the relevant government and agricultural agencies the Non-Governmental Organizations (NGOs); the Community Based Organizations (CBOs); as well as individuals need to strengthen their effort toward increasing food productivity by encouraging farmer to use the modern technology and materials in yam storage; this may help in minimizing post-harvest food losses hence increase in food sufficient.

Conclusion

The problem of post-harvest losses has long been recognized as one of the major factors responsible for food insecurity in Nigeria should be of utmost priority in any effort at achieving food self-sufficiency. The constraints encountered by the farmers with respect to post-harvest losses can be effectively addressed through:

i. The adequate training of farmers on investment in post-harvest yam processing storing technologies, and provision and construction of good storage facilities. The improvement of linkage roads network to keep curb losses during transit to the market.

ii. The farmers should be taught how to reduce post-harvest losses by demonstration methods, through workshops and seminars by the Agricultural extension works, the emphasis should be on rodent dis-infestation technique

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