Assessment of Farmers' Perception of Post-harvest Losses of Melon during Traditional Post-harvest Processes

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ORIGINAL RESEARCH

Abstract— Post-harvest losses represent a significant challenge to global food security. Food and Agricultural Organization (FAO) suggests that one-third of all food produced globally is lost before reaching consumers. This study assesses farmers' perceptions of post-harvest losses of Melon (*Citrullus colocynthis*) with a focus on traditional post-harvest methods. Through a mixed-methods approach, combining quantitative surveys and qualitative interviews, the study evaluates the effectiveness of traditional methods in mitigating post-harvest losses of Melon. It also identifies socio-economic factors influencing farmers' adoption of these methods. Data analysis reveals that 45% of farmers experience significant post-harvest losses due to inadequate storage facilities and pest infestations. Traditional methods, while cost-effective and culturally accepted, are often insufficient in preventing these losses. The study finds that 60% of farmers rely on sun drying, which, although effective in reducing moisture content, exposes the produce to pests and weather-related damage. Additionally, 30% of respondents reported losses during threshing and cleaning due to the use of rudimentary tools. The findings highlight the need for integrated strategies that combine traditional knowledge with modern innovations to reduce post-harvest losses. These strategies could include training programs, improved storage solutions, and policy interventions aimed at supporting smallholder farmers. The study also emphasizes the importance of community-based approaches to enhance the adoption of improved post-harvest practices. By addressing post-harvest losses, this research contributes to broader efforts to achieve the SDGs and ensure a resilient and efficient food supply chain.

Keywords— Food, innovation, security, supply chain, waste

1 INTRODUCTION

Failure of all the food produced in the world to be consumed and to provide its full potential for nutrition has long been recognized as an important brake on global food efficiency and productivity (Hodges et al., 2011; Nakhumwa, 2015). More recently, concerns about population growth and the impact on the planet of unconstrained food losses and waste have been heightened by the Sustainable Development Goals (SDGs) (United Nations, 2015). The SDGs call for the world to reduce per capita food waste by 50% by 2030.

Several studies have attempted to estimate the volume of food lost in the global supply chain. The figure that is most pervasive tends to be that used by the Food and Agricultural Organisation of the United Nations of one third of all food not reaching the final consumer (Gustavsson et al., 2011). Whilst the method of measuring and valuing this loss can be disputed, the factor cost in terms of nutrition, energy, water, labour, and capital of food being produced and then not consumed is clearly vast. Consuming unsafe food could also be included in this calculation, and this would surely provide additional impetus for action by policy makers.

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Reduction in post-harvest loss offers the advantage of increasing food availability without requiring additional land, water, labour and agricultural inputs for additional production. Better post-harvest management and the associated loss reduction will also help to build resilience against current and future climate-related shocks, and reduce the need for compensatory agricultural extensification, land use change and damage to environmental services, including carbon sequestration (Stathers et al., 2013).

There have been many different definitions of post-harvest food loss and waste and ways of locating it within agricultural commodity value chains. A key element of the definitions of post-harvest losses is the attempt to address the differences between physical/quantitative, where the food is completely removed from the chain, and qualitative losses, where the food is still available, but its cumulative total value is reduced. In addition, many definitions of post-harvest losses consider the issue of lost opportunity (e.g., when, for a range of reasons, food fails to sell at its optimum possible value).

These 'economic' or 'market' losses are hard to locate and measure and so have not been the subject of extensive empirical enquiry. Three key recent attempts at defining food loss and waste include Gustavsson (2011), the World Resources Institute (Lipinski et al., 2013; World Resources Institute, 2015) and the Food and Agriculture Organization of the United Nations (Food and Agriculture Organization , 2014). One commonly adopted is that of the World Resources Institute (WRI) (Béné et al., 2015) which considers food loss to occur before products

reach consumers and food waste to be a near consumer issue of under-utilisation.

This study adopts the following definitions:
On-Farm losses: All losses during the agricultural production stage until completion of harvesting.
Post-harvest losses: Food damage or degradation of food during different stages of the food supply chain (both quantitative and qualitative); and,
Food Waste: Food losses at the near consumer stages of the supply chain.

The post-harvest system should be thought of as encompassing the delivery of a crop from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and maximum return for all involved. According to Buyukbay et al., (2011), the post-harvest system encompasses a sequence of activities and operations that can be divided into two groups:

[1] Technical activities: harvesting, field drying, threshing, cleaning, additional drying, storage, processing;
[2] Economic activities: transporting, marketing, quality control, nutrition, extension, information and communication, administration and management.

1.1 MAIN ELEMENTS OF THE POST-HARVEST SYSTEM

1.1.1 HARVESTING

The time of harvesting is determined by the degree of maturity. With melon, a distinction should be made between maturity of fruit or seedpods and seeds, for all that affects successive operations, particularly storage and preservation.

1.1.2 PRE-HARVEST DRYING

Extended pre-harvest field drying ensures good preservation but also heightens the risk of loss due to attack (birds, rodents, insects) and moulds encouraged by weather conditions, not to mention theft. On the other hand, harvesting before maturity entails the risk of loss through moulds and the decay of some of the seeds.

1.1.3 TRANSPORT

Much care is needed in transporting a mature harvest, to prevent detached grain from falling on the road before reaching the storage or threshing place. Collection and initial transport of the harvest thus depend on the place and conditions where it is to be stored, especially with a view to threshing.

1.1.4 POST-HARVEST DRYING

The length of time needed for full drying of ears and grains depends considerably on weather and atmospheric conditions. In structures for lengthy drying such as cribs, or even unroofed threshing floors or terraces, the harvest is exposed to wandering livestock and the depredations of birds, rodents or small ruminants. Apart from the actual wastage, the droppings left by these marauders often result in higher losses than what they eat. On the other hand, if seed is not dry enough, it is vulnerable to mould and can rot during storage. Moreover, if seed is too dry it becomes brittle and can crack after threshing, during hulling or milling. Lastly, if seed is too dry, this means a loss of weight and hence a loss of money at the time of sale (Koura & El-Halfaway, 2018) .

1.1.5 STORAGE

Facilities, hygiene and monitoring must all be adequate for effective, long-term storage. In closed structures (granaries, warehouses, hermetic bins), control of cleanliness, temperature and humidity is particularly important. Damage caused by pests (insects, rodents) and moulds can lead to deterioration of facilities (e.g., mites in wooden posts) and result in losses in quality and food value as well as quantity (Koura & El-Halfaway, 2018).

1.1.6 PROCESSING

Excessive hulling or threshing can also result in losses, particularly in the case of melon which can suffer cracks and lesions. The seed is not only worth less but also becomes vulnerable to insects.

1.1.7 MARKETING

Marketing is the final and decisive element in the post-harvest system, although it can occur at various points in the agro-food chain, particularly at some stage in processing. Moreover, it cannot be separated from transport, which is an essential link in the system. Figure 1 shows the stages of the post-harvest system.

2 STUDY OF POST-HARVEST LOSSES

Study of post-harvest losses covers many aspects, in view of the wide range of (a) products involved; (b) successive operations in the post-harvest system; (c) causes of losses; and (d) pests and other food parasites, not to mention; (e) physical, technical, economic and other conditions that aid and abet the action of the agents of deterioration, consequently increasing losses (Etefa et al., 2022). This has led to the enormous variety in approach and form of analysis found in reports, manuals and other works, depending on the authors' choices and aims. For example, Bourne (1997) focuses on the causes of loss, distinguishing primary and secondary causes and the places and times of loss; thus, he examines biological and microbiological causes first and is primarily interested in insects, rodents and moulds.

Similarly, a recent NRI (Natural Resources Institute) training manual (Natural Resources Institute, 2018), which does not distinguish between primary and secondary causes, starts by considering pests and micro-organisms and then moves on to losses during successive post-harvest operations.

Figure 1: Stages of the Post-harvest System

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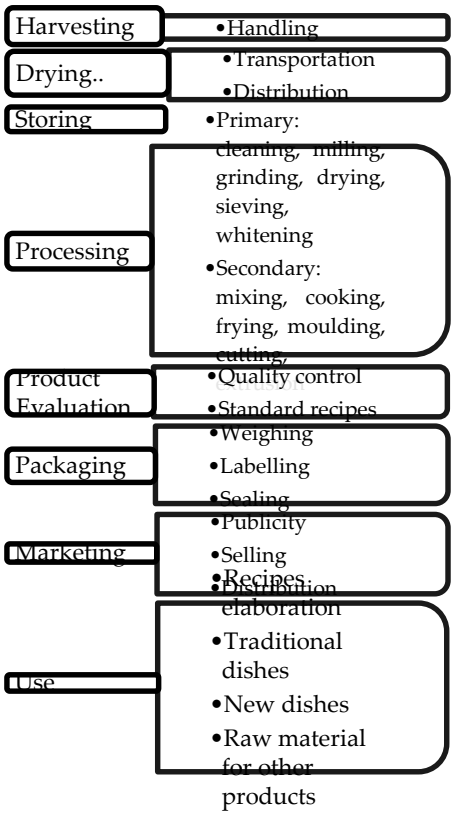

Mitiku & Gutema (2017) however, take a more selective approach, further differentiating between several categories of produce. Beginning with rice, which they distinguish from other cereals, they argue that losses for this crop are a result primarily of handling and equipment, particularly at the time of harvesting. The authors, therefore, take a close look at all the manual and mechanical operations from on-field drying through to paddy milling. Only then do they move on to a comprehensive consideration of cereals and pulses to analyse loss during storage, distinguishing small-farmer or village storage from warehouse storage and confining themselves to loss caused by insects and moulds.

In their methodological work, Kikulwe et al. (2018) prefer to distinguish between storage loss and losses in other locations and of other types, leading them to divide their study into two main sections. The first section is devoted to losses connected on the one hand with pre-storage (from harvesting to drying), highlighting problems connected with maize husking and on the other hand, with industrial and domestic processing (milling, polishing, etc. and cooking). The second section is devoted to all the losses that can occur during storage, whether caused by insects, micro-organisms or vertebrates.

There is a vast dearth of research in the post-harvest losses of melon (Giwa & Akanbi, 2020). Most recent reports and handbooks pay due attention to the question of equipment in general and more specifically to small-scale mechanization, particularly as used in threshing and hulling processes of mostly cereals. For instance, the African Post-harvest Losses Information System (APHLIS) (APHLIS, 2015) provides a breadth of data on cereal grains but does not include oil seeds or melon.

A study by the Central Institute of Post-harvest Engineering and Technology (CIPHET) reported in 2015 that cumulative post-harvest losses for oilseeds in general ranges between 3 to 10% (Jha, 2015). There is every likelihood that the overall figures for sub-Saharan Africa will be higher considering that the estimates are lower than for cereal grains – 5 to 6% in India in contrast with about 13% for sub-Saharan Africa (Hodges et al., 2011; Affognon et al., 2015).

Therefore, the objective of this study is to present an overview of the current situation with regards to post-harvest losses of melon with reference to the use of traditional methods in post-harvest processes, understand the main reasons and consequences of these losses, and demonstrate approaches and practices that can contribute to their reduction.

3 METHODOLOGY

3.1 STUDY AREA

The study is carried out in Nasarawa Local Government of Nasarawa State, Nigeria Nasarawa is located at $8^0 32'$N $7^0 42'$E with an area of 5704 km^2. Economically, Nasarawa is largely based around agriculture, mainly of sesame, melon, soybeans, groundnut, millet, maize and yam. It serves as a market centre for these agricultural products.

3.2 STUDY POPULATION AND SAMPLING

The study population comprised of melon farmers in Nasarawa local Government Area of Nasarawa State. However, only those who have farmed for more than three years and were willing to be part of the study were included in the study.

The required sample size was determined by using a single proportion formula in Equation 1.

$$n = \frac{Z^2 p(1-p)}{d^2} \qquad (1)$$

Where: n is the sample size, Z is the 95% confidence interval, p *is the* expected knowledge/attitude/practice, and d is the relative desired precision.

The Z critical value for normal distribution is taken at 95% confidence level which equals to 1.96 (z value at α is 0.05, two tailed), and a margin of error of 5% (d is 0.05). It is assumed that p= proportion 60.0 % of the sample can be able to understand the questionnaire and its elements. The sample size is then found to be 369. By adding 10% of non-respondent rate, total sample size was 417. But it was observed that the average number of accessible farmers (n_0) in the study area was 57, so using correction formula in Equation 2, the sample size was adjusted to be 50.

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$$n_f = \frac{n}{1+\frac{n}{n_0}} \quad (2)$$

Where: n_f *is the* the final sample size, n *is the* sample size obtained, and n_0 *is the* the average number of accessible farmers.

3.3 METHOD OF DATA COLLECTION

This analytical study of post-harvest losses of melons is carried out using two methods: literature review and syntheses and a survey of key informants. By adopting these two different methods it was hoped that a range of post-harvest losses and important efforts to address these losses would be made.

A survey for collecting data on post-harvest losses of melon was conducted. The aim of this survey was to identify and gather information/opinion from known experts and melon farmers in Nasarawa Local Government of Nasarawa State. The survey instrument consists of a range of questions and requests for estimates of losses and where these might occur in the post-harvest processes of melon. The survey questions were divided into three sections: demographic characteristics, farmers' post-harvest activities and measure of post-harvest losses.

4 RESULTS AND DISCUSSION

Table 1 presents the demographic information of the respondents. From Table 1, it can be observed that the average age of the farmers is 38 with an average farming experience of 6 years. The average number of melon bags produced by these farmers is 10 with each bag weighing about 2700 kg.

Table 1: Demographic Characteristics of Respondents

Item	Characteristics	Response
Gender	Male	37
	Female	13
	30 and below	12
Age	31-40	18
	41-50	10
	51 and above	10
Level of Education	Primary	4
	Secondary	30
	Post-secondary	16
	5 and below	3
Farming Experience	6-10	35
(Years)	11-15	10
	16 and above	2

Of the four post-harvest activities (coring, washing, drying, shelling) shown in Table 2, 4% of the respondents utilized machines in the coring process and 4% use machines in washing. However, none of the respondents use mechanized method of drying and about 44% of the respondents use machines to shell their melon. Most respondents affirmed that they are often too poor to employ improved methods of melon processing using mechanized tools. In this respect, an agricultural mechanization policy would need effective targeting regarding farming activities and types of farmers for which different forms of mechanization efforts could be directed.

Table 2: Post-harvest Processing Methods

Post-harvest processes	Methods	
	Traditional	Mechanised
Coring	48	2
Washing	47	2
Drying	50	0
Shelling	28	22

Although, the respondents affirmed that shelling using machines is often faster, majority of them complained of the loss of seed quality as compared to the traditional method of using hands. Seed damages often occur when the physical properties of melon seed are not implemented in the design consideration of melon of the shelling machine. Neglecting these properties in design often has a detrimental influence on machine efficiency and might lead to product losses. Furthermore, the respondents affirmed that there are losses in the use of traditional methods of processing, but they could not ascertain the quantity.

Table 3. presents common constraints to reducing post-harvest losses which may be common for melon and per step of post-harvest as identified by the respondents.

As can be observed from Table 3, innovations can make a difference in post-harvest losses. Evidence from various sources indicate that adoption of the practices and technologies can significantly reduce post-harvest losses in melon (Affognon et al., 2015; Ayodele & Salami, 2006; Giwa et al., 2010; Osunde & Kwaya, 2012; Asoiro et al., 2018; Giwa & Akanbi, 2020). Therefore, it is pertinent to develop technologies that can help in reducing post-harvest losses in melon during some of the post-harvest processes.

Table 3: Constraints to Reducing Post-harvest Losses

Post-harvest step	Causes
Harvest	i.Inadequate knowledge about technology and of post-harvest among farmers. ii.Inadequate knowledge on post-harvest management and poor harvesting methods. Pressure for money makes farmers harvest the crop when it still has high moisture content iii.Poor training materials (trainers, equipment, etc.)
Field drying	Lack of training in post-harvest for agricultural extension officers
Washing	i.Cost is too high for farmers ii.Cost of processing equipment iii.Lack of availability of cheap, locally made, technologies

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Further Drying	**i.**Climatic changes, lack of knowledge by farmers and extension **ii.**Lack of local technical solutions for drying when rains are late **iii.**Lack of training in post-harvest for agricultural extension officers
Shelling	i.Cost is too high for farmers ii.Cost of processing equipment iii.Lack of availability of cheap, locally made, technologies iv.Lack of training in post-harvest for agricultural extension officers v.Low use of technology vi.Poor practices, use of hired labour
Sorting/ Grading	i.Labour intensive ii.Cost is too high for farmers iii.Lack of price differential that does not give incentive iv.Lack of training in post-harvest for agricultural extension officers
Storage	i.Availability and accessibility (up-front costs) of improved storage options and knowledge of how to properly store ii.Cost is too high for farmers iii.Lack of information and non-availability of hermetic storage bags, ineffective storage structures iv.Low investment in storage and not being aware of storage structures which can reduce losses v.Proper training is not widely available, proper structures are needed
Marketing	i.At the start of the marketing season there is a glut on the market due to oversupply. This takes farmers a long time to dispose of their grain. Meanwhile grain losses are incurred ii.Commodity staying long at the markets iii.Lack of market information

5 CONCLUSIONS

This background paper has attempted to present an overview of the current situation with regards to post-harvest losses of melon with reference to the use of traditional methods in post-harvest processes. The results revealed that majority of farmers do not use machines for the post-harvest processing of melon due to factors such as cost and inadequate knowledge about technology among farmers. When they do utilize machines for shelling, the machines were not efficient as some of the shelled seeds are damaged. Making post-harvest mechanization more accessible and effective is likely to reduce post-harvest losses. Nevertheless, mechanization must overcome a past littered with poorly designed machines with low efficiencies. Proper consideration of the seed properties needs to be inculcated in the design of the machines to avoid seed damage.

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