Nat. Volatiles & Essent. Oils, 2021; 8(4): 3260-3272

NVEO
Natural Volatiles & Essential Oils

The Foremost Challenges of Post-Harvest Practices. A Case of Selected Farmers in Nkomazi South Africa

Tatsi Sisipo[1] Agholor A. Isaac[2] & Kanayo Ogujiuba[3]

[1]Masters'student: School of Agriculture, Faculty of Agriculture and Natural Sciences, University of Mpumalanga. Private Bag X11283, Nelspruit 1200
[2]Senior lecturer: School of Agriculture, Faculty of Agriculture and Natural Sciences, University of Mpumalanga. Private Bag X11283, Nelspruit, 1200
[3]Senior Lecturer: School of Development Studies, University of Mpumalanga

Abstract

Postharvest losses vary given the influence of heterogenous factors such as the degree of perishability of farm produce; ambient temperature and relative humidity which accounts for predisposing causes to incidences such as pest and diseases, level of deterioration, spoilage; incidence of rodents and birds, the span of time between harvesting and consumption of farm produce. The study evaluated the main challenges inherent in postharvest practices amongst selected farmers in Nkomazi, South Africa. Structured and semi-structured questionnaires, focus group and observations were used to solicit information on the foremost challenges associated with postharvest practices. Sample and collection of data were randomized ensuring that no group had special treatment. Mean and standard deviation were used to elucidate the degree of severity of challenges. Result indicated that socio-economic issues, technology, marketing, inadequate postharvest policy framework, and farming related challenges were found to be the primary and enduring challenges in postharvest practice. The paper justifies amongst others, the need for thorough understanding of the main factors affecting post-harvest practices, recommend the promulgation of effective measures to comprehend the gains of postharvest practice.

Keywords: Postharvest, Challenges, Losses, Food Security, Farmers, Socio-Economic Issues, Technology, Market, Policy Framework

1. Introduction

The agricultural sector has been noted as one of the sectors that can change the structural imbalance in the local economy of South Africa (DAFF, 2013). There are numerous expectations for making a considerable decrease in poverty and food insecurity through farming engagements, but the reality has been slow (Donovan & Hart, 2014). The main challenge of government is how to guarantee food security for an ever-growing population while ensuring sustainable growth. According to Food and Agriculture Organisation (2013), the anticipation is that food manufacturing must increase by 70% to address the demand for food because of world's population, which may substantially rise to about 9 billion by the year 2050. Moreover, tendencies such as the rising urban population, changes in ways of living, and nutrition; alongside climate change set significant pressure and stress on the natural resources.

Anthony (2015) argued that most people, especially in sub-Saharan African countries are found to be food insecure. This could be due to the inability to adapt to new agricultural practices and technologies that could improve their production practices. Besides, farmers, particularly smallholder farmers are losing profits and income due to postharvest losses. World Bank, (2012) asserted that postharvest losses are triggered by various factors such as damage by insect infestation, inadequate storage, and limitations in technological equipment to protect harvested produce. As a result, there is a need for new strategies to combat these problems, to ensure food availability, affordability, and safety.

In sub-Saharan Africa, post-harvest damages to fruits and vegetables vary from 30% to 80%, and this is attributed to the limitations in technology, and absence of management skills for post-harvest, like control in temperature to retain the cold chain, value adding, and packaging which triggers numerous financial and food insecurity. Armachius and Vumilia 2017; Lionel, 2015), found that poor marketing systems and inadequate access to processing technologies and maintaining the quality of the produce after harvest, results in producers not meeting the markets' fresh produce expected value. According to Weaver (2013), postharvest technology is an innovative strategy to fight hunger, increase income and improve the food security and livelihood activities of farmers. It is seen as the science employed to harvested agricultural products after harvest with the end goal of preservation, protection, quality control, improvement, processing, packaging, storage, distribution as well as marketing to achieve consumer's food and nutritive necessities. Post-harvest technologies are classified into two-primary and secondary. Primary processing entails cleaning, grading, preliminary packaging, curing, and drying, cooling, and pre-cooling, and storage while the secondary processing includes milling (flour mill, sugar mill, and oil mills). The primary purpose for processing is to increase the shelf life, and this process could contribute significantly to the transformation of the local economy and food security. Overcoming the challenges inherent in perishability of crops, enhances their nutritional value and economic value, and this is achieved through agricultural processing and value adding (Fleischer, 2011).

Over the years, the rapid increases in food prices, consumer growing demand, erratic weather changes, and decline in agricultural production have necessitated the call for modification of strategies in postharvest processing and handling of farm produce (Pieters, 2014). A notable challenge and contributor to food insecurity is the postharvest losses, that manifest in form of reduction in economic value for food produced, wastage of limited resources for example, labour, soil, water, and other resources that are not renewable such as manure and energy which are utilized for food production (World Bank, 2012; FAO, 2011). Postharvest challenges occur worldwide, however, the degree of losses and the effective strategies for eradicating the problems differ according to regions. Although, numerous literatures exist on postharvest handling practices in South Africa, smallholder growers are in dearth of appropriate data on the main challenges of postharvest practices and losses. Recognising the main challenges of postharvest loss in Nkomazi, South Africa will assist to design intervention in ameliorating postharvest losses with a view of increasing food security. So, the objective of the study was to examine the socio-economic characteristics of smallholder farmers in the area and assess the challenges in adopting postharvest practices.

1.1 Statement of Problem in Context

Postharvest technology encompasses the handling practices that protect the quality of any farm produce from the period of harvest up to the time of consumption, with the main interest of reducing losses and enhance the nutritive value (Coquillard, 2014). Postharvest is important to preserve the good quality of the product such as the colour, taste, flavour, and smell. Postharvest assists to prolong the shelve life of farm produce and preserved them against insect-pests (Lopez, 2013). An appropriate postharvest system connects the farmers and consumers with the intent to reduce cost of finished produce and avoid waste. Postharvest practices contribute towards sustainability of environment by lessening excessive production, thus saving on limited soil and water resources, and safe and adequate food supply for the increasing population (Coulter and Lopez 2013; Smith 2014). The dimension of the postharvest chain includes handling, storage, packaging, processing, transportation, marketing, and consumption. These components contribute to the elevation of production in agriculture through the enhancement of farmers' earnings by raising the worth of agricultural products as well as elevation of food security and availability (Fleischer, 2011).The growth of the postharvest technology in rural areas has the potential to improve the livelihoods of farmers by making food accessible more efficiently and at a lower price. Postharvest practices impact on farm produce availability production while reducing output price variability, increase the availability of inputs, and lower their prices (Anthony, 2015). The growth of the post-production system contributes to food security by allowing pest- biological control to decrease postharvest losses, thus enhance the quantity of food accessible for consumption increases. Postharvest storage facilities assist in unlocking market opportunities for producers from and therefore generates income-earning possibilities for farmers (Aulakh and Regmi 2015).

As part of the problem statement, the identified challenges of postharvest are tabulated as follows:

Table 1

Identified challenges of post-harvest practice	**Consistent with authors**
i) Storage (inadequate packaging, transporting, and storage facilities, lack of storage facilities that lead to deterioration of product quality before it ever reaches the market. Sub-standard packaging-farmers pack their produce in plastic sacks, woven bamboo baskets and wooden crates)	Porter et.al (2016); Schejtman (2013) Mbwanaet al (2013)
ii) Poor management and training (Physical losses are primarily because of poor management, usage of poor-quality packages, uneven handling, and insufficient education concerning the requirements for conserving quality).	Nielson (2016); Armachius and Vumilia 2017); Yaren and Ucar (2012)
iii) Economic challenges (finance, inadequate purchasing power, increase cost of post-harvest equipment, high cost involved in constructing local post-harvest equipment like threshing floor, and	Meena, et.al. (2004)

high cost of repairing and fixing equipment)	
iv) Handling techniques (improper handling during loading and unloading of produce when transporting initiates mechanical injuries, which affect the market value of the products.), overcrowding of vegetables in boxes and sacks, and causing heat, physiological changes and metabolic reactions which then increases physical injury leading to microbial spoilage)	Muvhunzi, et al., (2013); Rolle and Kader (2004)
v) Awareness (Smallholder farmers' inability to make informed decisions regarding agricultural production, marketing, control of pests and diseases).	Kitinojaet.al 2011
vi) Inadequate technological know-how (poor handling of postharvest equipment and essential technologies, quality values, and food safety practices)	Gudilaet.al (2013)
vii) Handling during harvest (improper handling of produce during harvesting and transportation leads to losses and the use of cheap packaging materials' poor-quality products that the market will not accept.	Pieters, 2014; FAO (2011)
viii) The use of public transport (has been reported to cause high levels of mechanical damage as the space is not appropriate to carry people and produce)	Rolle & Kader, (2004)
ix) Timing of harvest (Harvesting of produce in hot day light causes post-harvest losses because of high temperatures and evaporation which lead to shrinkage of vegetables)	Wienberger and Genova (2006)

2. Materials and Method

The study was carried out in Nkomazi Local Municipality. The Municipality is one of the four municipalities in Ehlanzeni District Municipality of Mpumalanga province. It covers 17% of the geographical area, which is the smallest municipality in Ehlanzeni district. Located between the northern side of Swaziland and the western side of Mozambique; Nkomazi is noted for grains and sugar cane production. It is made up of subtropical climate with 28°c yearly average temperature and 775mm rainfall on the average (Nkomazi Local Municipality, 2016). The area is made up of three towns viz: Komatipoort, Malalane, and Marloth Park and consist of Mlambo, Hhoyi, Siboshw, Kwa-Lugedlane, Mawewe, Matsamo, Mhlaba, and Lomshiyo tribal authorities. The villages under Mawewe, Matsamo and Mhlaba Tribal Authorities were chosen for the study.

2.1 Research Design and Data Collection

The quantitative research approach was adopted for the study. The field survey that culminated to this work was carried out between March 2020 and January 2021 at household and farm level. Preceding the collection of data, a recognisance survey was undertaken to the study area to identify the ecological zoning, and mapping. Participatory appraisal tools such as the Venn diagram, transect walk was employed for this process. Prior to data gathering, the questionnaire items were pretested with only 15 respondents to ascertain the time taken to administer each questionnaire and to allow for useful modification and clarity. Primary data were collected from selected farmers using structured and semi-structured questionnaires, and field observation. Focus group discussion was used to validate some irregularities and misconceptions from respondents. The sample for the study was randomised and a total number of 330 smallholder and commercial farmers were interviewed. The questionnaire employed to gather responses were group into two sections- the socio-demographic characteristics of the farmers and assessment of postharvest challenges.

The challenges inherent in postharvest practice by smallholder farmers were assessed using the 4-point Likert scale. The ranking of the scale was continuum, fluctuating from 1-4, indicating 4=Strongly Agree, 3 = Agree, 2 = Disagree, and 1 = Strongly Disagree. Upholding the predetermined decision rule, a total mean value for challenges were adopted as follows: 1-5 = Not severe, 6-10 = Less severe, 11-15= Severe, 16-20 = Most severe. The Statistical Package for Social Science software version 27 was used and descriptive statistics which consist of the frequency, mean and standard deviation were computed. Cronbach alpha was computed for reliability and result was 0.81 and considered fit for the study (George and Mallery, 2003).

3. Results and Discussion

3.1 Demographic Characteristics of Respondents

The table 1 below indicate the demographic characteristics of farmers that were interviewed. A total of 330 respondents took part in the survey. The age distribution show that majority of the respondents were in the category of 41-50 years, which accounted for 31.8%. About 19.7% were within the age group of 51-60 years, while 13%, 7.9% and 4.8% fell in the group of 31-40 years and 20-30 years, and less than 20 years, respectively. With respect to gender, male respondents accounted for 32.7%, and female 67.3%. The marital status show that single respondents recorded 56.4%, married couples 37.9%, divorced 1.8%, and widowed 3.9%. The level of education of respondents were investigated and result show that farmers without formal education accounted for 45.5%, primary school 20.3%, secondary education 29.4%, and tertiary 4.8% correspondingly. The size of farmland cultivated recorded the highest percentage of 50.9% which shows that majority of the respondents were subsistence farmers. However, respondents who cultivated 1-5 acres, and 6-10 acres were 46.4% and 2.7%. The size of household ranged from 1-3 (25.2%), 4-7 (52.1%), and greater than 7 (22.1%). Majority of the respondents had additional income from grant (37.3%), pension (28.85), salary (17.9%) and other sources of income amounted to 16.1%. Farmers who had 16 years (40%) farm experience were in the majority. About 26% of farmers had less than 5 years farmers experience while 11-15 years and 6-10

years were 18.8% and 15.5% respectively. The percentage of farmers who had contact with extension service providers were 77.4% and respondents who had no contact with extension services were 22.6%. However, it must be acknowledged that extension services in the area remains effective.

Table 2: Show the Demographic Attributes of the Respondents

Demographic characteristics of respondents (N=330)	**Freq.**	**%**
Age:		
≤ 20	16	4.8
20-30 years	26	7.9
31-40 years	43	13.0
41-50 years	105	31.8
51-60 years	65	19.7
≥61	75	22.7
Gender:		
Male	108	32.7
Female	222	67.3
Marital status:		
Single	186	56.4
Married	125	37.9
Divorced	6	1.8
Windowed	13	3.9
Level of education:		
No school	150	45.5
Primary	67	20.3
Secondary	97	29.4
Tertiary	16	4.8
Farm size:		
≤1 acre	168	50.9
1-5 acres	153	46.4
6-10 acres	9	2.7
Household size:		
1-3	83	25.2
4-7	172	52.1
≥7	75	22.7
Source of income:		

Salary	59	17.9
Grant	123	37.3
Pension	95	28.8
Other	53	16.1
Farm experience:		
≤5 years	85	25.8
6-10 years	51	15.5
11-15 years	62	18.8
≥16 years	132	40.0
Contact with Extension:		
Yes	253	77.4
No	74	22.6
Type of extension training received:		
General Production	200	60.6
Processing	75	22.7
Post-harvest training	55	16.7

The minority of farmers who were not familiar with extension services may have been residing in areas were access road maybe a problem. The respondents who had general training in farm production amounted to 60.6%. This result indicates the presence of extension services in the area. However, farmers who had training in processing and postharvest operation were 22.7% and 16.7%.

3.2 Main Challenges of Postharvest Practices in the Study Area

Table 3 show the mean and standard deviation of challenges of post-harvest practices as perceived by the respondents in the study. The finding indicated that socio-economic variables which embodies negative altitude about post-harvest, expensive infrastructures, awareness of post-harvest, timing of harvest, finance, dearth of storage facilities, and risk aversiveness were categorised as severe and summated $\bar{X}$ = 9.36 and σ = 3.08. The attitudinal disposition and awareness of postharvest pose serious challenge amongst farmers. Most farmers are not aware of inherent benefits associated with postharvest practices. Few that are aware complained of dearth of storage facilities and expensive infrastructure like amenities. This finding is consistent with the studies of Premanandh (2011); Koester (2014), found that poor infrastructure was a constraint and accounts for inadequate postharvest practices by farmers, and therefore, exacerbated grain losses. Kader (2011) posited that small-scale farming is characterized by inadequate storage facilities that lead to deterioration of farm products and quality reduction before it reaches the market for sale.

The technology related variables show a $\bar{X}$ = 7.88 and σ = 2.94 which indicate less severity. However, studies by Agholor, (2019); Ozcatalbas&Akcaoz, (2010) have shown that gender-blind technologies pose a serious challenge because it affects power relation amongst farmers and reduces

access to technology usage by women. Women in agriculture value technology that will enhance productivity, storage, and post-harvest practices, without extra labour, inconvenience, and cost.

From our survey, market challenges recorded a $\bar{X}$ = 10.08 and σ = 3.05 which imply severity of limitations. Farmers show interest in participating in post-harvest activities but are often discouraged by the size and dimension of the market. The conditions of the storage facilities in most markets differ and possibility selling a processed product is not guaranteed. The condition and management of these markets would contribute to harvested product loss during sales. The inadequate market information and the activities of speculators who appears as the third party to trade hampers post-harvest activities. In our survey, it was discovered that market speculators are ready to buy at farmgate price hence the desire for postharvest activities are seldom practiced by smallholder farmers, and this results in losses of produce. A lot of postharvest issues manifesting along the value chain include reduced quality of farm produce at the period of harvest, physical damages to farm produce during harvest, time interval between harvesting of produce and release for sale, proximity of farm to market, farmgate pricing and sale, and high cost of postharvest facilities. However, research has focused on many of these concern around postharvest microbiology and food safety to address the postharvest losses.

Finding from the study also show that extension service-related issues had a $\bar{X}$ = 4.14 and σ = 1.41. Nevertheless, the minimal challenge as indicated undermined the latent role of extension in the study area. However, postharvest research and extension is seldom acknowledged by government when developing action plan for agriculture. Appropriate information on handling techniques of postharvest equipment is provided by extension personnel, while also assisting to strengthen the link between postharvest practicing farmers to learn from each other. The reduction of postharvest losses is sustainable rather than justifying increased production to compensate for these seeming losses, as over 40% of food are lost to spoilage annually due to infestation (Kitinoja, 2011).

The government related challenges were investigated and result show $\bar{X}$ = 10.06 and σ = 2.53. The relevant policy environment on postharvest practices is deficient if not totally absence as it pertains small-scale agriculture in South Africa. In our survey, the purview expectation was that farmers should be able to relate and adhere to guidelines associated with postharvest practices with respect to product handling. Our observation, reveal that products are poorly handled during transportation and thereby resulting in enormous postharvest losses. The inadequate support and the absence of post-harvest subsidy by government posed a serious challenge and was discussed extensively during our focus group discussion with farmers. Farmers asserted that even though agriculture subsidies are apportioned in some instances, the focus is usually on production and disease control but not for post harvesting practices. According to FAO, 2011, inadequate government support to producers for postharvest operations affects grain losses. Studies by Kitinoja*et.al* (2011); Thyberg, et.al 2016, asserted that postharvest losses are related to inadequate policy support and regulations in favour of small-scale farmers.

Result from out survey show that farming related challenges encompasses inadequate labour availability, access to credit, farming system practice and inadequate knowledge of pest management recorded a total $\bar{X}$ = 11.84 and σ = 3.85, indicating severe challenge as designated in the decision rule.

From our survey, farmers require labour to undertake postharvest operations. Postharvest activities require specialised skills to handle available post-harvest equipment. The general absence of labour in rural areas for agricultural activities hinder postharvest activities. Postharvest losses vary, given the influence of heterogenous factors such as the degree of perishability of farm produce; ambient temperature and relative humidity which accounts for the predisposing effects to pest and diseases, level of deterioration, spoilage; incidence of rodents and birds; the span of time between harvesting and consumption of farm produce.

Table 3

Challenges (N = 330)	**Response**	
	Mean ($\bar{X}$)	**Std dev.**
Socio-economic issues:		
Negative altitude about post-harvest	1.47	0.50
Expensive infrastructures	1.26	0.44
Awareness of post-harvest	1.21	0.41
Timing of harvest	1.26	0.44
Finance	1.33	0.47
Dearth of storage facilities	1.16	0.36
Risk averse	1.67	0.46
Total	**9.36**	**3.08**
Technology related challenges:		
Complexity of technology	1.39	0.49
Gender-blind technology	1.59	0.49
Inadequate technical know-how	1.63	0.63
Cost of procuring post-harvest equipment	2.03	0.90
Handling approach of harvested produce	1.24	0.43
Total	**7.88**	**2.94**
Marketing/Market related challenges:		
Distance from farm to market	2.39	0.63
Inadequate market information	2.66	0.55
Speculators (agents)	2.03	0.90
Market access	1.39	0.49
Transport	1.61	0.48
Total	**10.08**	**3.05**

Extension services related challenges:		
Inadequate motivation from extension	1.24	0.43
Insufficient coverage of success story	1.44	0.49
Inadequate social interaction within group of farmers	1.46	0.49
Total	**4.14**	**1.41**
Government assistance:		
Policy position	4.16	1.10
Farm training on postharvest handling	2.18	0.81
Inadequate extension service provision on the farm	1.77	0.41
Inadequate decision making on post-harvest management	1.95	0.21
Inadequate subsidy for post-harvest equipment	1.63	0.63
Total	**10.06**	**2.53**
Farming related challenges:		
Cultural perspective and attitude	2.00	0.00
Size of farmland	1.59	0.49
Access to credit	1.43	0.49
Unavailability of labour	2.62	1.16
Farming system practice	1.88	0.31
Inadequate knowledge of IPM	2.32	1.40
Total	**11.84**	**3.85**

Throughout our survey, we discovered that most farmers operated at a small scale, and realizable output is minimal and may not translate into serious postharvest operation.

4. Conclusion and Recommendation

The paper examined the inherent challenges of postharvest practice by drawing on existing literature on challenges enunciated by various authors. Findings extrapolated the postharvest constraints by farmers associo-economic issues, technology, marketing, inadequate postharvest policy framework, and farming related tasks. These were found to be the primary and enduring challenges in postharvest practice. The paper justifies amongst others, the need for thorough understanding of the main factors affecting postharvest practices, and to be able to promulgate effective measures to boost and realise the gains of postharvest practice. Through the application of policy guidelines, government

should raise awareness and training of farmers in postharvest practice. Market components should be improved, and public storage infrastructures should be supplied to assist farmers. The outstanding challenge and contributor to food insecurity is because of postharvest losses, reduction in economic value of food produced, wastage of limited resources that renewable and non-renewable. The South African government should open avenues for postharvest synergies and allow farmers form groups or cooperative to finance storage and processing facilities.

5. Acknowledgement

The authors wish to acknowledge and express our profound gratitude to the University of Mpumalanga for giving ethical clearance for this study and MsTatsiSisipofor her assistance in gathering the data. Our heartfelt appreciation also goes to Mawewe, Matsamo and Mhlabatribal authorities in Nkomazifor their unalloyed cooperation in responding to our questionnaires.

References

Agholor, AI. (2019). Gender Gap in Sub-Saharan Africa, Reminiscence of Rural Extension and Advisory Services: Delineation, Challenges and Strategies. South African Journal of Agricultural Extension. Vol.47 (3) 2019: 46-60.

Anthony, S., (2015). Crop Postharvest: Science and Technology. Livelihood diversification and Natural. Food and Agriculture Organization of the United nation, 28 April, pp. 345-352.

Aulakh, J. &Regmi, A., 2015. Post-harvest Food losses estimation: development of consistent methodology. Greener Journal of Agricultural Sciences, 20(12), pp. 56-59.

Armachius, J. &Vumilia, Z., (2017). Postharvest management of fruits and vegetables: A potential for reducing poverty, hidden hunger, and malnutrition in sub-Saharan Africa. Journal of Cogent Food and Agriculture, 3(1):34-40.

Coulter, N. & Lopez, W., (2016). Post-harvest losses, Technology and Employment: The case of Rice in Bangladesh, Bangladesh: Westview Press.

Coquillard, M., 2014. Post-harvest technology and processing for Small-scale production. 2nd ed. Amsterdam: University of Greenwich Press.

DAFF, Department of Agriculture, Forestry and Fisheries., (2013). A strategic plan for Agriculture, 2013/14- 2016/17, Pretoria: DAFF publishers.

Donovan, O. & Hart, M., (2014). Assessment of rural development: a 20-year review of economic and social sector programs, Cape Town: Human Sciences Research Council.

Food and Agriculture Organization., 2013. Addressing post-harvest technology and Processing, Pretoria: Food and Agriculture Organisation (FAO).

Food and Agriculture Organization., 2013. Addressing post-harvest technology and processing, Pretoria: Food and Agriculture Organization (FAO).

Food and Agriculture Organization., 2011. The effect of post-harvest technology in promoting food security in South Africa, Port Elizabeth (PE): Food and Agriculture Organization Press.

Food and Agriculture Organization of the United Nations, (2011). Global Food Losses and Food Waste—Extent, Causes and Prevention, Food and Agriculture Organization of the United Nations: Rome, Italy, 2011.

Fleischer, C., 2(01). Contract framing and out-growers' schemes in East and Southern Africa. Journal of Agricultural Economics, 15(11):503-508.

George, D. &Mallary, P. (2003). SPSS for windows step by step: A simple guide and reference.11.0 update (4th ed.). Boston: Allyn& Bacon.

Gudila A. Kereth, Monica Lyimo, Hadijah A. Mbwana, Richard J. Mongi1 and Carolyne C. Ruhembe. (2013). Assessment of Post-harvest Handling Practices: Knowledge and Losses of Fruits in Bagamoyo District of Tanzania, Food Science and Quality Management.11(1):1-10

Kaminski, J.; Christiaensen, L. (2014).Post-harvest loss in sub-Saharan Africa—What do farmers say? Glob. Food Secur. 2014, 3, 149–158.

Kitinoja, L.; Saran, S.; Roy, S.K.; Kader, A.A.(2011). Postharvest technology for developing countries: Challenges and opportunities in research, outreach, and advocacy. J. Sci. Food Agric. 2011, 91, 597–603.

Koester, U. Food Loss and Waste as an Economic and Policy Problem. Inter-economics, 2014, 49, 348–354

Lionel, K., 2015. Non-traditional vegetable crops and Food Security among Small-scale farmers in Guatemala, Baltimore OH, USA: Johns Hopkins University Press.

Lopez, Q., 2013. The impact of post-harvest practices on food availability in Benin. Journal of Agricultural and Applied Economics, 4(5):657-658.

Meena, M. S., Prasad, M. and Singh, Rajbir (2009) Constraints perceived by rural agro- processors in adopting modern post-harvest technologies. Indian Research Journal of Extension Education, 9 (1):1-5.

Mbwana, H, Mongi, R &Kereth, G., (2013). Assessment of postharvest handling practice knowledge and losse of fruits in Bagamoyo district of Tanzania. Journal of science and Quality management 11(7):361-399.

Muvhunzi, S., Gatsi, W. &Muzari, W., 2013. The impacts of technology adoption on smallholder agricultural productivity in Sub-Saharan Africa: A Review. Journal of Sustainable Development, 8(5):205-235.

Nkomazi Local Municipality, 2016. Annual Report 2016/2017 - Nkomazi Local Municipality Available: https://www.nkomazi.gov.za. Accessed: 12/06/202

Nielson, M., 2016. The Economic benefits of Postharvest handling practices and the impact of post-harvest losses in generating income, Columbia: Short-run Press.

Ozcatalbas, O. & Akcaoz, H., (2010). Rural women and agricultural extension in Turkey. J. Food Agric. Environ., 8(1):261-267.

Pieters, X., 2014. Postharvest technology and processing, New Jersey: Blackbird publishing

Porter, S.D., Reay, D.S. (2016). Addressing food supply chain and consumption inefficiencies: potential for climate change mitigation. Reg Environ Change 16, 2279–2290 (2016).

Rolle, R. & Kader, A., (2004). The role of post-harvest management in assuring the quality and safety of horticultural produce, Rome: FAO.

Warren, A. & Wood, L., (2013). Food safety training and evaluation of handwashing intention among fresh produce farmworkers. International Journal of Food Control, 12(8), pp. 437- 448.

World Bank, (2012). Missing food: the case of postharvest grain losses in sub-Saharan Africa.,Washington DC: The International Bank for Reconstruction and Development/The World Bank.

Schejtman, H., (2013). Role of Post-harvest technology on Food Security. India Journal of Agricultural Economics, 5(5), pp. 65-73.

Simona, RR; Borzellecab,JF; DeLucac, HF; &Weaver.CM 2013. Food and Chemical Toxicology Review. Safety assessment of the post-harvest treatment of button mushrooms (Agaricusbisporus) using ultraviolet light

Smith, L., (2014). Impact of Post-harvest Research, Washington, DC: International Food Policy Research Institute.

Thyberg, K.L.; Tonjes, D.J. (2016). Drivers of food waste and their implications for sustainable policy development. Resour. Conserv. Recycl. 2016, 106, 110–123.

World Bank, (2012). Missing food: the case of postharvest grain losses in sub-Saharan Africa.,

Washington DC: The International Bank for Reconstruction and Development/The World Bank.

Wienberger, K. & Genova, 2006. Postharvest loss in the supply chain for vegetables: the case of chili and tomato in

Vietnam, Ho Chi, Vietnam: FAO.

Yaren, H. &Ucar, M., 2012. The hygiene training of food handlers at a teaching hospital.

African Journal of Food, Agriculture, Nutrition and Development, 41(8), pp. 305-325.

Kang, A. N. A. H. A. T., et al. "Herbicides are escalating severe public health problems but unavoidable for food security." International Journal of Medicine and Pharmaceutical Science 6 (2016): 1-12.

Farooqui, Noria, and NaushadulMullick. "Domestic and International Food Security: Issues and Challenges." International Journal of Food Science and Technology (IJFST) Vol 6 (2016): 1-4.

Ukpe, E. M. M. A. N. U. E. L., and S. M. F. D. S. Mustapha. "Agricultural knowledge management: a case study of Nigeria cassava production process." Journal of Agricultural Science and Research 3 (2016): 11-16.

Jha, B. K., and AsitChakrabarti. "Back yard poultry farming as a source of livelihood in tribal village: an economic appraisal." International J. Agric. Sci. and Res 7.1 (2017): 267-274.

Chakraborty, Samarpan, and DebabrataBasu. "Homestead Gardening: An Emerging Venture Towards Achieving Food Security & Nutritional Security-A Study of Selected Areas of West Bengal." International Journal of Applied and Natural Sciences (IJANS) ISSN (P) (2018): 2319-4014.

Youssef, Samy Ismail Abdelgawwad Mohamed, and Mohamed Said Rowihil. "Impacts Of Climate Change On Oceans And Coasts, Basic Physical And Chemical Phenomena Influence On Biological Processes And Fish Stocks While Considering The Challenges And Prospects For The Maritime Industry." International Journal of Applied and Natural Sciences (IJANS) 4.2 (2015): 47-56.