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Postharvest orange losses and small-scale farmers' perceptions on the loss causes in the fruit value chain: a case study of Rusitu Valley, Zimbabwe

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Abstract
Surveys were conducted in Rusitu Valley , Chimanimani district of Zimbabwe between 2011 and 2012 to determine orange losses and farmers' perceptions on the sweet orange (*Citrus sinensis*) supply value chain. The following data were collected using interviewer-administered Likert type questionnaires and informal interviews: orchard management practices, pest infestation, fruit handling activities, and marketing practices through. The study sample of 240 respondents was derived from two randomly selected villages in each of the four administrative wards with significant sweet orange production. The study revealed that on average a small-scale farmer in Rusitu Valley owns about 4047 m^2 (one acre) orchard with an average of 55 orange trees and that a farmer harvested 1 200 kg of oranges per tree which converts to a total of 66 000 kg of orange produce per season. The study revealed that on average a farmer lost 480 kg of oranges per tree which converts to 26 400 kg per farmer or 40% loss per farmer during the season. Based on the total number of orange farmers in Rusitu Valley, the total loss translates to 89,529,600 kg. About 54% of respondents perceived that the major postharvest losses were a result of fruit fly attack while 36% linked these losses to red weaver ants (*Oecophylla* spp.). Trapping using a mixture of methyl eugenol and malathion during the same season positively identified the African invader fly, *Bactrocera invadens*. Unavailability of appropriate storage and transport facilities were the contributing factors to major postharvest losses. Citrus production extension package with an emphasis on the control of insect pests and sustainable postharvest management should be developed to improve the capacity of the small-scale farmers in Rusitu Valley.
Keywords: Small-scale farmers, postharvest losses, pests and diseases, fruit value chain

1. Introduction

Postharvest losses in the horticultural production chain is a challenge in both developing and developed countries. In developing countries, small-scale fruit production plays an important role in income generation, poverty alleviation and in improving the nutrition and livelihood security of the rural population. The horticulture sector suffers greatly from postharvest losses. Not less than 30% losses are estimated in developing countries especially sub-Saharan Africa (Sudheer and Indira, 2007; Ladaniya, 2008; Kereth *et al*., 2013). Not only quality and quantity are affected by the postharvest losses but loss in aesthetic appeal of the fruit and consequent reduction in the market value. Postharvest losses in fruits can occur in terms of economics, quantity, quality (aesthetic appeal), and nutrition (Sudheer and Indira,2007). Postharvest losses can occur at any stage in the supply value chain hence there is need to consider the whole supply chain to determine the losses. For farmers, postharvest losses can be quantified in absolute terms for produce lost after harvest, and then calculated as a percentage based on total harvested quantity (Weinberger *et al*., 2008). Controlling and/or preventing postharvest losses is less costly as compared to producing the similar amount of the fruit loss. Postharvest management determines not only quality and safety of food but competitiveness on the market. In developing countries, the horticultural supply chains lack sustainable postharvest management systems. Major constraints of postharvest management in these countries include inefficient handling and transportation, poor technologies for storage, processing and packaging, involvement of too many diverse actors and poor infrastructure (Ladaniya, 2008).

Zimbabwe's post-independence era has been characterised by rural capacity building programmes which include the European Union's Lome Convention funding programme (Brown, 2002) that supported the Manicaland province Small-scale Coffee and Fruit projects in 1982. The projects aimed to increase household incomes through small-scale commercial production, value addition and the marketing of coffee and fruits in Honde and Rusitu Valleys in Manicaland province. In Rusitu Valley, the project transformed a number of "backyard" sweet

orange orchards into commercial orchards. This resulted in an additional set of primary actors in the Zimbabwe's orange value chain.

A broad approach of defining an orange fruit value chain looks at the complex range of activities implemented by various actors (primary producers, processors, and traders, service providers) to bring a raw material through a chain to the point of sale of the final product (Coates *et al.*, 2011). Primary actors in Rusitu Valley's sweet orange value chain are the small-scale farmers practising farming characterized by a permaculture approach (Regmi *et al*., 2009). The small-scale farmers are reported to be facing postharvest challenges resulting in quality and quantity losses (Watson, 2013). The postharvest losses could be attributed to poor postharvest management of the fruits at peak production. Oranges are perishable and they tend to mature almost at once causing seasonal gluts; resulting in postharvest management challenges when in season (Tschirley, 2011).

The factors that affect postharvest losses vary widely from place to place and become complex as the marketing system become more sophisticated (Kereth *et al*., 2013). There are no known data on the postharvest losses in the citrus value chain of small-scale farmers in Zimbabwe. These farmers' livelihoods depend on the horticultural products but sustain considerable postharvest losses. The current study therefore investigated orange fruit losses and the causes of the postharvest losses in the citrus fruit value chain of the Rusitu Valley.

2. Methodology

2.1 Study Site

The study area was Rusitu Valley (20 ^{o}S 032 ^{o}E), located in Chimanimani district, 40 km northeast of Chipinge (Figure 1). Chimanimani district has a population of approximately 115 297 people, representing about 7.4 % of the total Manicaland province population and 96.2 % of the district population resides in the rural areas (Anonymous, 2002). Rusitu Valley has more than 70 people/km^2 and has a total of 3 164 small-scale farmers (Anonymous, 2002). It is largely composed of mountainous terrain (Mawenje mountain range) and is under the Natural Region I, which is considered the best for horticultural production. The Valley receives moderately high rainfall (>1000 mm) almost throughout the year making it suitable for citrus production (Vincent and Thomas, 1960; Rukuni and Eicher, 2006). The livelihood of most small-scale farmers is centred on fruit production especially sweet oranges, naartjies and bananas.

2.2 Research Design

An exploratory survey covering 80 sweet orange individual farmers in Rusitu Valley was first conducted in September 2011, using open-ended semi-structured questionnaires so as to obtain as much information as possible from the farmers. The exploratory study mapped out the sweet orange value chain in Rusitu Valley. The data collected included: soil nutrient supplementation, water and fruit tree management, pest and disease management. The exploratory study was complemented with key informant interviews involving local leadership. After the exploratory study, an in-depth stratified random survey covering 160 sweet orange farmers in the Rusitu Valley was conducted in April 2012. The study samples were derived from two randomly selected villages in each of the four administrative wards with abundant sweet orange production. Twenty farmers were randomly selected per village giving a sample size of 160 participants.The study aimed to ascertain the findings from the exploratory study and it had a component of assessing orange postharvest losses. Likert type questionnaires (Harry and Boone, 2012) were used to collect data leading to determination of sweet orange postharvest qualitative and quantitative losses. The Likert type questionnaire scale allowed for quantification of postharvest losses incurred by farmers during the 2010/11 season. The Likert type questionnaire also allowed for the estimation of average production of sweet oranges per year per farmer. The study was complemented by direct orchard observations and trapping of fruit flies using a mixture of methyl eugenol and malathion in the four citrus producing wards. Orchard observations were important in compiling an accurate description of sweet orange production within the Valley.

Data were analysed by looking for themes and recurring issues, and then coded immediately after the fieldwork. Data collected on orchard management were then entered into Microsoft Office Excel 2007 for the construction of graphs. The social data collected were analysed using SPSS version 16.

3. Results and discussion

3.1 Characterisation of the sweet orange supply value chain in Rusitu Valley

The results from the survey suggested that the sweet orange has a complex supply chain (Figure 2). The citrus production in Rusitu is mainly for home consumption and sale at local and other markets. Many players are involved in the marketing of the oranges. The primary producers are the local small-scale farmers who would then sell the orange produce to middlemen locally known as *makoronyera*. The middlemen supply oranges to different fruit and vegetable markets in Zimbabwe's major cities; especially Harare and Bulawayo (Figure 1). Some of the middlemen supplied fruit and vegetable markets including those in Mutare, Masvingo, and Gweru cities. Some of the farmers supply their orange produce directly to markets in Chimanimani and Chipinge, the

nearest towns to the study site. These include Kopa Musika, Rusitu Valley Jam Canners Co-operative, Chimanimani Musika, and Jopa Musika.

3.2 Postharvest losses and causes in Rusitu Valley

All the farmers interviewed admitted that postharvest losses are greatly affecting their fruit produce. More than 40% of the mature fruits from the Rusitu citrus farmers is lost in-field; as a result they are not motivated and neglect their orchards as is suggested by the results presented earlier (Figure 2).About 84 % of fruit farmers in Rusitu Valley perceived that major citrus losses are occurring in the orchard, and during temporary storage (Figure 3). The study revealed that on average sweet orange farmer in Rusitu Valley harvested 1,200 kg per tree during 2011/12 season and that each farmer had on average 55 orange trees. Thus on average each farmer produced 66,000 kg of sweet oranges during the 2011/12 season. This is less than the 72,000 kg which was reported in the Business Pre-Investment study for Chimanimani Business Trust (CBT) - Fruit Processing Project in Rusitu Valley (Rukuni *et al*., 2006). The interviewed farmers perceived that on average, a farmer lost 480 kg in-field per tree during the 2011/12 season, which translates to 40% of their total yield. Based on the total number of orange small-scale farmers, about 208,824,000 kg of oranges were produced in Rusitu Valley during the 2011/12 season. During the same season, average loss for the whole valley was 89,529,600 kg which translates to an estimated monetary value of US$8, 952,960 since oranges were selling on average at US$1.50 per 15 kg pocket, in Rusitu Valley.

Several reasons were noted as contributing to postharvest losses. The causes included pests and diseases, poor production practices, poor temporary storage facilities and poor physical infrastructure (access roads, transport, communication and storage facilities). Oranges mature almost at once when in season, so farmers in Rusitu Valley harvest and temporarily store their produce under tree shades waiting for buyers, mostly middlemen (*Makoronyera*). This exposes the fruits to various adverse conditions such as fluctuations in temperature and humidity leading to deterioration in quality. The decline in market share of Rusitu Valley citrus farmers and complicated marketing chain has contributed to poor orchard management resulting in major in-field losses. From the study, more than 50 % of the interviewed farmers no longer maintain their orchards (Figure 3) citing a decrease of orange buyers in Rusitu Valley. This carefree attitude leads to poor orchard management and as a result poor quality fruit being produced.

Insect pests were also noted as another cause of the both quantitative and qualitative postharvest loss. Identified pests were: citrus black aphids, *Toxoptera aurantii* Boyer de Fonscolombe; fruit flies (Tephritidae); leaf-miner, *Agromyzidae* spp. and red weaver ants, *Oecophylla* spp. (Hymenoptera: Formicidae) (Figures 5 and 6). Amongst these insect pests, fruit flies were singled out by 54 % of the interviewed farmers as the major problem in their orchards. Fruit flies are one of the most serious insect pests of horticultural produce throughout the tropical and sub-tropical region (Mwatawala *et al*., 2004). Fly traps using a mixture of methyl eugenol and malathion were set in the four citrus producing wards and managed to trap the African invader fly (*Bactrocera invadens*). These insect pests are considered to be of quarantine importance such that its presence disrupts host fruit trade with other countries. Trade is only allowable where adequate risk management procedures have been implemented and no detections made for 12 consecutive weeks after eradication. The spread of *B. invadens* in this part of Zimbabwe could have occurred through passive expansion of the organism's distribution range or accidental introduction through movement of infested host material. In 2008 and 2010 respectively, South Africa and Zimbabwe suspended the importation of fruits from the neighbouring Mozambique due to the reports of *B. invadens* in the northern provinces of Mozambique (Anonymous, 2010). The study revealed that most small-scale sweet orange farmers do not take any measures to control the sweet orange pests, resulting in poor quality and reduced quantities of their fruit produce.

4. Conclusion and recommendations

Postharvest quality and quantity losses of orange fruits are considered to be a major problem that affects many farmers in Rusitu Valley, Chimanimani district. The major causes of the postharvest quality and quantity losses are invasive African fruit flies (especially the *Bactrocera* spp.) and red weaver ants. More than 50% of the interviewed farmer perceived that losses were a result of fruit flies. Trapping resulted in positively identifying *B. invadens*, hence the need to develop appropriate and affordable technology for the control of insect pests especially fruit flies. It was observed that poor infrastructure (storage facilities and road networks in the Valley) and improper postharvest handling from farm to the market also accounted for the postharvest losses in the Valley. In the light of the study findings, it was considered that appropriate pre- and postharvest management be practiced to minimize postharvest quantity losses in the production value chain, especially integrated pest management, to control the invasive fruit flies and red weaver ants. There is also need for investment on advanced fruit postharvest processing technologies especially value addition to improve the fruit shelf-life.

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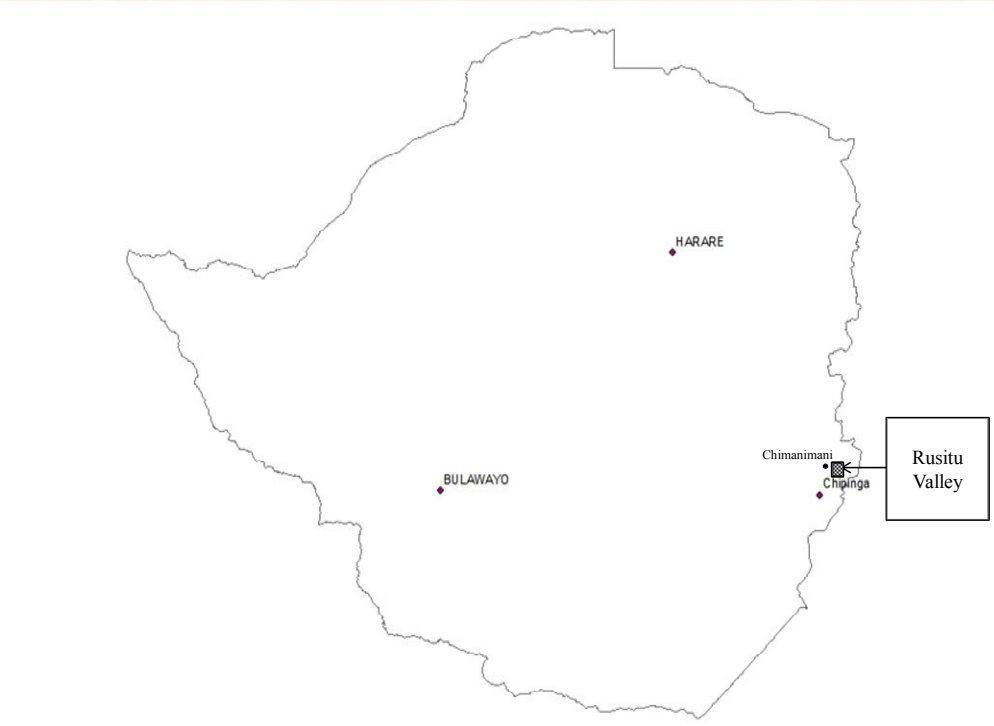

Figure 1. Map of Zimbabwe showing the study site

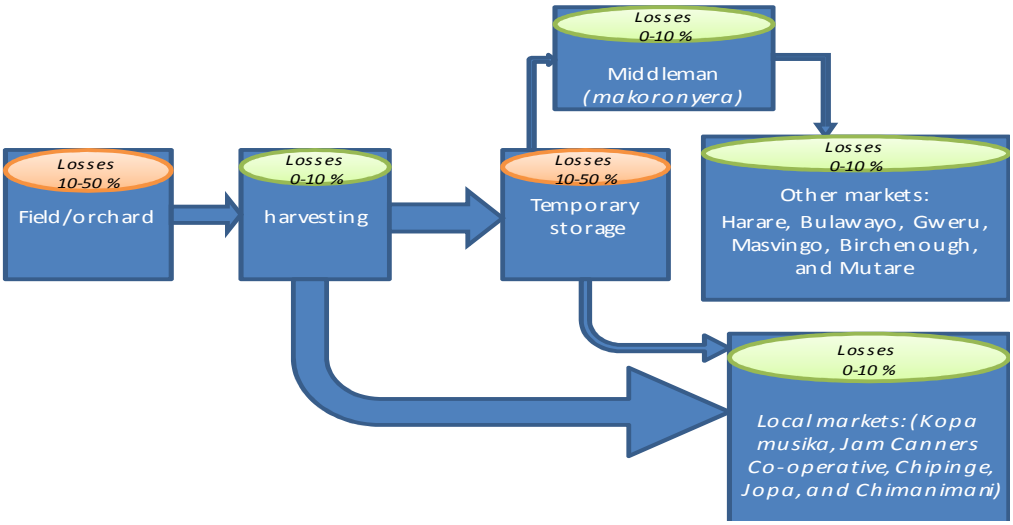

Figure 2. Rusitu Valley citrus fruit production value chain

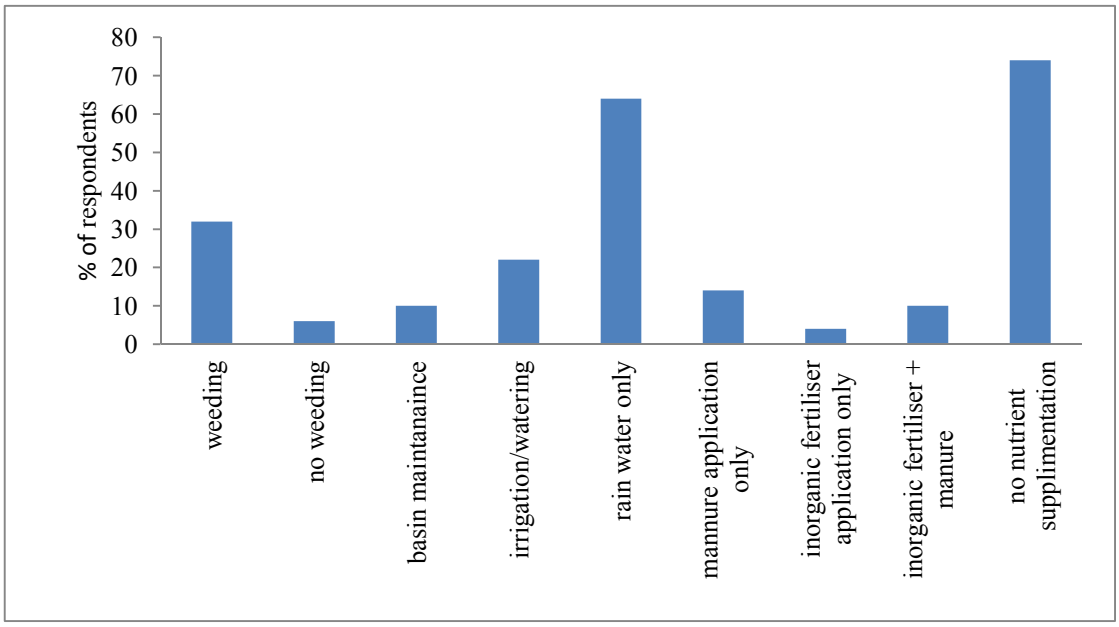

Figure 3. Percentage of respondents following specific orchard management practices in Rusitu Valley Chimanimani

Figure 4. Losses in the field resulting from poor pre- and postharvest management in Rusitu Valley

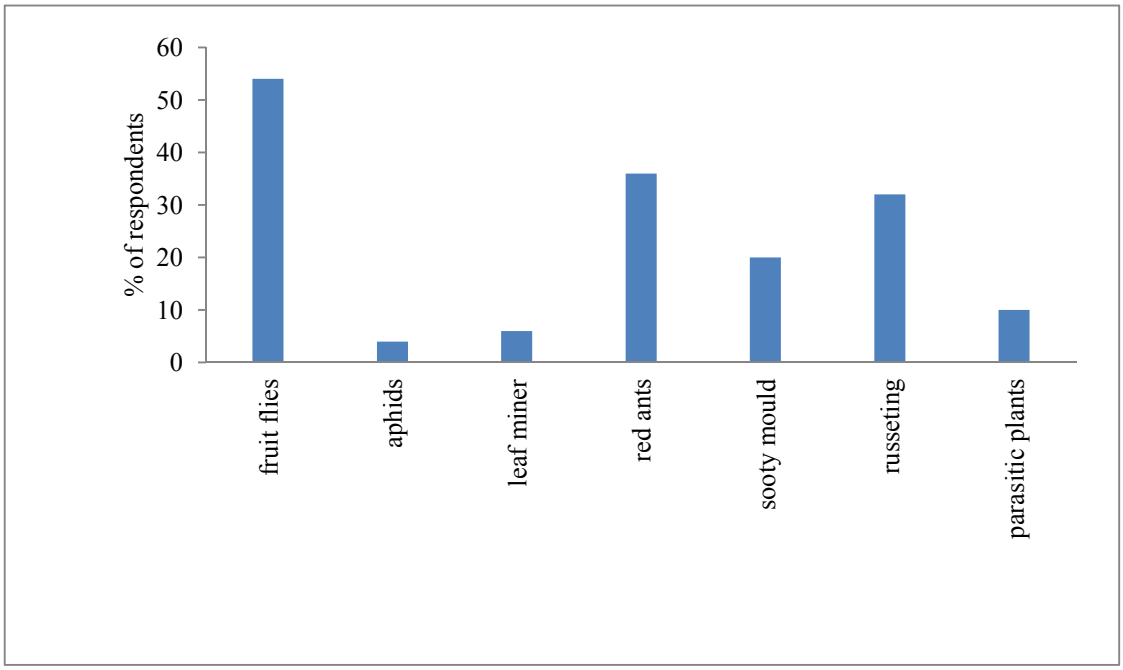

Figure 5. Common sweet orange pests in Rusitu Valley, Chimanimani

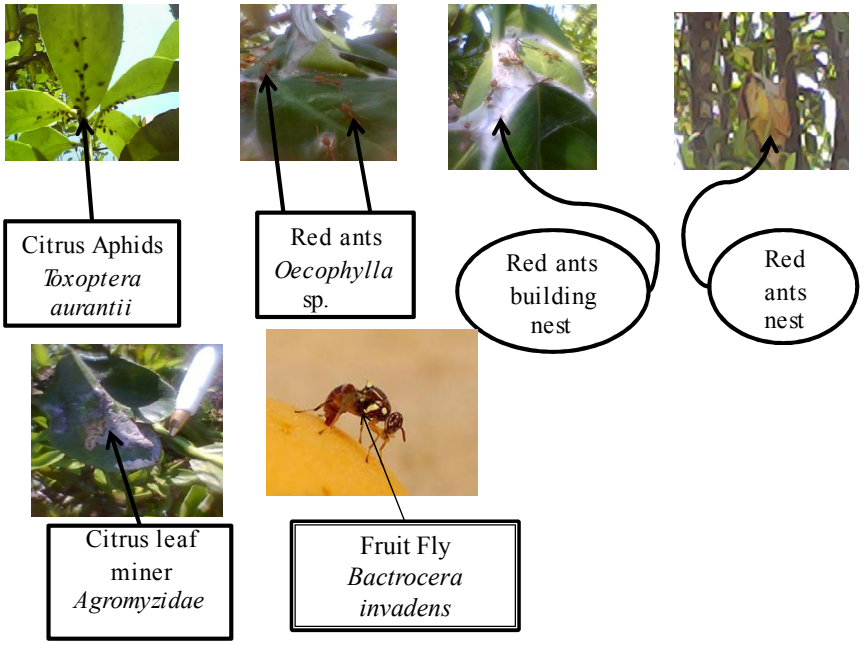

Figure 6. Some common citrus insect pests in Rusitu Valley

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