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# A preliminary study of the orange (*Citrus sinensis*) fruit value-chain in Chimanimani Rural District, Zimbabwe

**Musasa Stephen Tawanda[1]*, Musundire Robert[2], Mashingaidze Arnold Bray[2] and Makuza Stanley Marshall[2]**

[1]Directorate of Research and Resource Mobilisation, Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe.
[2]School of Agricultural Sciences and Technology, Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe.

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**The study identified the players in the sweet orange value-chain and interviewed them to quantify postharvest losses incurred along the sweet orange value-chain in Rusitu Valley. A sample of 100 farmers in Rusitu Valley was selected using a snow balling sampling technique. A Value-Chain Priority Test was conducted to determine farmers' priorities between oranges and bananas using a five point hedonic-scale. Interviewer administered questionnaires were used to gather socio-demographic data, sweet orange trading information, and farmers' perceptions on the causes and estimation of postharvest losses in the Valley. The study estimated that postharvest losses of 36%, 3% and 42% occurred; in the field, during transportation and at the market, respectively. These amounted to a total of 81% postharvest losses with an estimated monetary value of US$ 11 003 126.40. There was a significant positive association (Pearson r = 0.29, p < 0.05) between the farmers' score of pest and disease incidence in their sweet orange field and the reported postharvest losses. The present findings of the study clarified the process by which the physical flow of oranges move within the value-chain, the marketing alternatives to farmers, and constraints faced by primary actors in the chain.**

**Key words:** diseases, orange, pests, postharvest loss, production value-chain.

## INTRODUCTION

The sweet orange (*Citrus sinensis*) is a member of the citrus family (Rutaceae), along with other fruits such as mandarins, lemons, grapefruits and limes. Oranges account for the greatest value followed by grapefruits, lemons, mandarins and limes. In the pre-historic era, sweet orange was cultivated in several locations including areas now occupied by the modern China, India, Bhutan, Burma, and Malaysia (Leibbrandt, 1897; Webber, 1943). Globally, the leading producer of sweet oranges is Brazil followed by the European Union and China. In 2014, Brazil produced 17 340 MT followed by China [7 600 MT], United States [6 291 MT], and European Union [6 075 MT]. In Africa, Egypt was leading with a production of 2 570 MT followed by South Africa [1 600 MT] and Morocco [1 000 MT] (Anonymous, 2014). Orange production in Southern Africa is ranked the third

*Corresponding author. E-mail: stephenmusasa@gmail.com

regarding importance after vegetables and deciduous fruits with commercial production mainly concentrated in South Africa, Swaziland, Mozambique, and Zimbabwe (RSA, 2011).

Zimbabwe's geographic position and climate makes it ideal to produce early maturing varieties of oranges which reach the target markets earlier than neighbouring competing countries (Heri, 2000). Oranges are mainly produced in areas within or surrounding Limpopo Valley, Save Valley, Mazowe Valley, and Rusitu Valley in Zimbabwe (Dzingai, 2010). In Rusitu Valley, communal farmers benefited from the 1982 European Union's Lome Convention funding program that supported Manicaland Smallholder Coffee and Fruit projects (Brown, 2002). The program transformed a number of "backyard" orange orchards into viable commercial orchards. However, these orchards deteriorated due to depressed markets in Zimbabwe's economy from 2007 to 2009 (Chinembiri, 2009). By 2007, Zimbabwe's orange exports had declined from 78 to 42% (FAOSTAT, 2009). Zimbabwe was ranked number 35 in the world's orange-area harvested resulting in a world share of 0.3% (FAOSTAT, 2009). Musemwa and Mushunje (2011) noted a decrease in sweet orange production between 2000 and 2004, clearly indicating a huge difference in citrus management at the production levels between former commercial farmers (old value-chain primary actors) and the resettled small-scale farmers (new value-chain primary actors) who lack capital investment for pre-and post-harvest management of oranges (Chinembiri, 2009).

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 in the developing world. In developing countries, the horticulture sector suffers greatly from postharvest losses which are estimated to be more than 30%, especially in sub-Saharan Africa (Ladaniya, 2008; Tschirley, 2011; Kereth et al., 2013). In Rusitu Valley, more than 30% orange fruit post-harvest losses were reported for the 2011/12 farming season (Musasa et al., 2013). These postharvest losses are a result of the degradation of aesthetic and market value of fruits due pests, diseases and physical and chemical deterioration (Sudheer and Indira, 2007; Watson, 2013). Fruit flies were perceived as the major cause of fruit postharvest losses in Rusitu Valley (Musasa et al., 2013). Other causes of postharvest losses in the fruit production value-chain include inadequate fruit storage facilities, poor post-harvest fruit handling and lack of access to markets (Kader, 2002; Ladaniya, 2008; Tschirley, 2011). The aim of the present study was to characterise the sweet orange value-chain and determine the nature and extent of postharvest losses at various points of the value-chain in Rusitu Valley, in Chimanimani district, Manicaland Province in Zimbabwe. Information from this study may provide insights on critical factors that need to be addressed along the value-chain to reduce postharvest losses in sweet oranges and increase profitability and investment in post harvest infrastructure and management to the benefit of smallholder producers and other players in the sweet orange value-chain in Rusitu Valley in Zimbabwe.

## MATERIALS AND METHODS

### Study site

The study area was Rusitu Valley (latitudes of 20ºS 032ºE; an altitude of about 460 m above sea level), located in Chimanimani rural district shown in Figure 1. Chimanimani rural district has a population of 133 810 and 96.2% of the district population resides in the rural areas (Anonymous, 2013). The Valley receives moderately high rainfall (>1000 mm) almost throughout the year making it suitable for horticultural production (Vincent and Thomas, 1960; Rukuni and Eicher, 2006). The soils have high agricultural productivity, which is also a characteristic of agro-ecological region I. Their particles are well graded and consolidated making them less vulnerable to erosion, enabling farmers to plough and grow crops on slopes and hilly places. The livelihood of most rural district population depends on horticulture especially fruit production. The major produced fruits are bananas, sweet oranges, naartjies and avocadoes.

### Data collection

A survey was conducted to identify the major players in the value chain and estimate the post harvest losses incurred at each point of the value chain and their causes in Rusitu Valley. Yamane's formula (Yamane, 1967) at 90% confidence interval (e = 0.1) was used to calculate the sample size of 100 farmers from the total population of 133,810 smallholder farmer households in Rusitu Valley, Chimanimani district, in Zimbabwe. A snow balling sampling technique was used to select the study sample of 100 farmers from the four sweet orange producing wards (Burns, 1994). The snowballing sampling technique was used because of the steep and hilly terrain in the Rusitu Valley that made access to a random sample extremely difficult. A Value Chain Priority Test was conducted during focus group discussion with two groups of 10 farmers per ward; to determine farmers' priorities between orange and banana production which are the major perennial fruits produced in the valley. A five point hedonic-scale was used in scoring for the priority tests; a score of 1 meaning that the sweet orange best met that criterion and a score of 5 meaning that sweet orange did not meet that criterion ranked against the other fruits. Interviewer administered questionnaire was used to gather information on: socio-demographic data, postharvest loss estimates, trading information, transportation, and attitudes towards postharvest management (Harry and Boone, 2012).

The collected data were categorised and analysed using SPSS version 20 (Field, 2011). A student t-test was used to test the significance of priority setting differences at $\alpha = 0.01$, Pearson correlation test was used to test the significance of relationship between scoring priorities for bananas and oranges at $\alpha = 0.01$ and regression analysis to test the relationship between postharvest losses and occurrence of pests and diseases was performed at $p < 0.05$. Key informant interviews and focus group discussions engaging traditional leaders and community leaders were used for fruit value chain priority settings within Rusitu Valley. Data from the key informant interviews and focus groups were synthesised and analysed for significance using student t-test computed on GraphPad Prism 6.

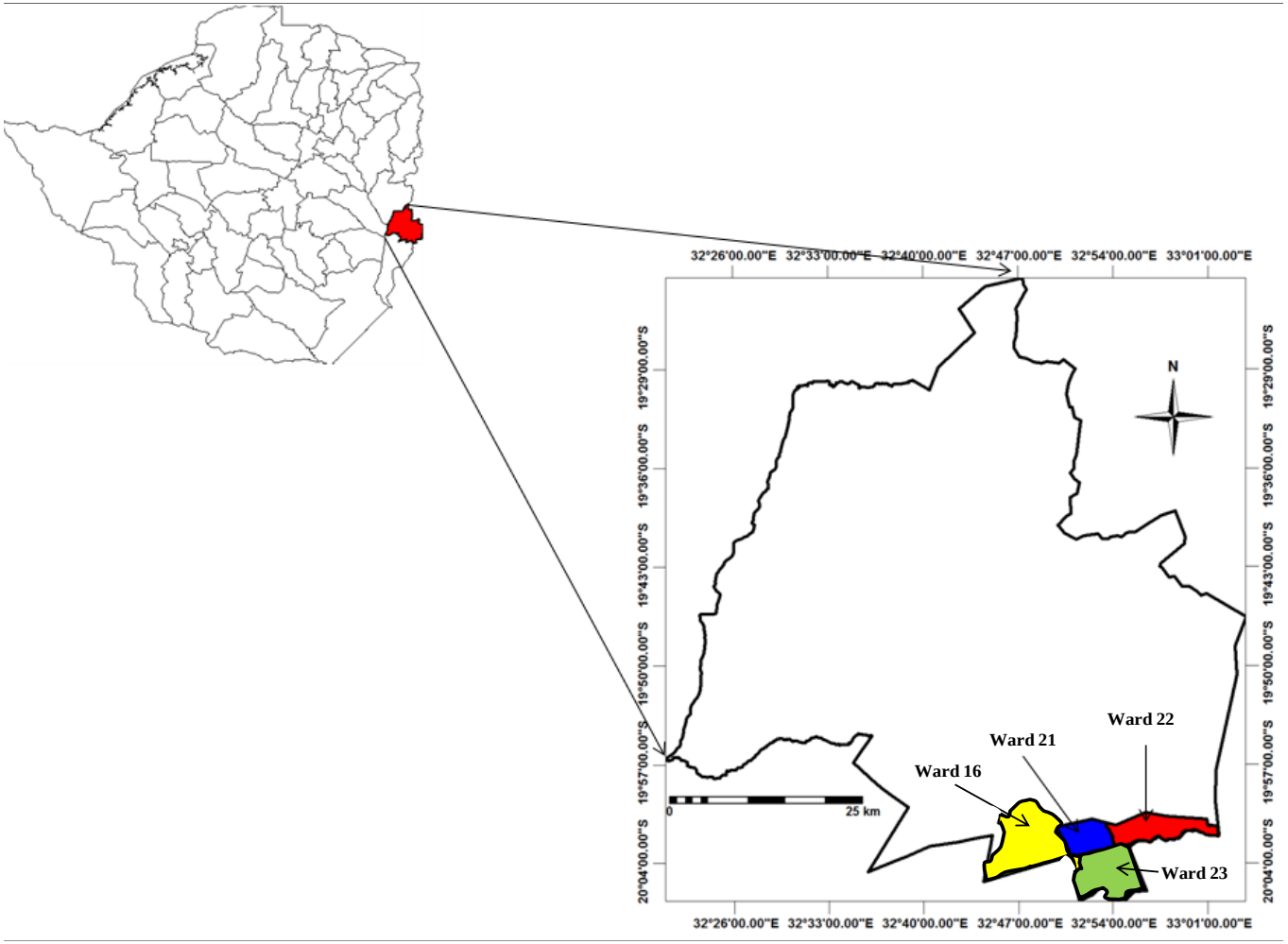


**Figure 1.** Map of Rusitu Valley wards studied, Chimanimani Rural District of Zimbabwe.

## RESULTS AND DISCUSSION

A total of 100 questionnaires were administered in the four orange producing wards (Ward 16, 21, 22, and 23) in Rusitu Valley. The respondents were derived from a total of 12 villages representing the mentioned wards and the study reflected that the villages, Muchadziya, Dzingire, Mukondomi, Muterembwe, Musareketa, and Dherudhe had a greater representation of sweet orange farmers in the Valley as depicted in Table 1. The gender representation of the study

**Table 1.** Response with respect to location (N = 100).

| Ward | Village | % Response |
|---|---|---|
| 16 | Dherudhe | 14 |
| | Zayawe | 3 |
| | Ndadzingwa | 6 |
| 21 | Gadzingo | 2 |
| | Mukondomi | 11 |
| | Dzingire | 14 |
| 22 | Matendera | 5 |
| | Muitire | 1 |
| | Muchadziya | 16 |
| 23 | Chishiri | 1 |
| | Musareketa | 12 |
| | Muterembwe | 13 |

respondents was 48% female and 51% being males. Of these respondents 61% were married, 23% widows or widowers, 7% single, and 1% divorced as shown in Table 2.

Most of the study respondents were aged above 50 years (31%) with 30% of the respondents being in the range of 30 to 50 years whilst 28% refused to reveal their age. Majority of the respondents (49%) attended secondary education, 38% primary school, 3% tertiary education and 5% never attended school at all. Thus, the majority of the farmers can read and write resulting in efficient knowledge sharing with other orange production value-chain actors such as Zimbabwe Farmers' Union (ZFU) who were perceived as important fruit production knowledge providers in the valley by 83% of the study respondents. The study revealed that 95% of farmers depend on farming as a major livelihood source and that 72% of the farmers grow both bananas and oranges as a major source of income whilst 22% grow bananas only and 3% oranges only (Table 2). The study also revealed a positive Pearson correlation ($r = 0.31$) at 0.01 significant level existed between the level of education farming as a major source of income in Rusitu Valley.

## Value chain priorities test

The Value Chain Priorities Test (VCPT) revealed that bananas were the most preferred with an average priority ranking of 2.0625 than oranges which had an average priority ranking of 2.3125 (Table 3). Though a student t-test confirmed that these priority setting differences were significant at $\alpha = 0.01$; a weak correlation ($r = 0.2828$) existed between scoring priorities for bananas and oranges and that this relationship was not significant since P (two tailed) = 0.3731 at $\alpha = 0.01$. Thus, respondents perceived that oranges were of less importance compared to bananas in Rusitu Valley and they attributed this to oranges' high fruit fly infestation rate compared to bananas. Therefore it was important to examine the production value-chain and proffer for sustainable strategies of improving orange postharvest quality and shelf-life in order to enhance orange production preference by local farmers in Rusitu Valley.

## Sweet orange fruit production value-chain in Rusitu Valley

In Rusitu Valley the core processes characterising the sweet orange fruit production-chain include; the primary production stage characterised by smallholder farmers and secondary stage characterised by informal middleman traders (Figure 2). The secondary stage of the value – chain was highly dominated by the middleman traders as shown in Table 4. The middleman traders transport the oranges to urban markets especially Masvingo, Bulawayo, Mutare, Chipinge, Gweru and Harare as shown in the geographical flow of sweet oranges from Rusitu Valley in Figure 3. The farmers perceived that these middleman traders solely rely on buying fruits from Rusitu Valley and selling them to urban markets. The study revealed that 69% of the farmers sold their orange fruits to middleman traders and that 23% sold to local vendors in the Valley (Table 4).

From the study, 71% of the respondents strongly perceived that orange losses in Rusitu Valley resulted from of pests and diseases prevalence followed by deterioration of the orange quality parameters. Pests and diseases prevalence, harvesting methods, and deterioration in quality parameters were perceived as the major causes of postharvest losses as shown in Table 5.

**Table 2.** Response with respect to demographic data (N = 100).

| | Gender | | Age | | Marital status | | Level of education | | Farming as a major source of income | |
|---|---|---|---|---|---|---|---|---|---|---|
| Response | Male | 51% | <30 | 11% | Married | 67% | Primary | 38% | Yes | 95% |
| | Female | 48 | 30 - 50 | 30% | Single | 7% | Secondary | 49% | No | 4% |
| | | | >50 | 31% | Divorced | 1% | Tertiary | 3% | | |
| | | | | | Widow | 23% | Never Attended | 5% | | |
| Std Deviation | 0.521 | | 1.194 | | 1.280 | | 0.833 | | 0.278 | |
| Variance | 0.272 | | 1.425 | | 1.639 | | 0.694 | | 0.077 | |

**Table 3.** Rusitu fruit production value chain priority test.

| Type of impacts | | Banana (Average Score) | Sweet orange (Average Score) |
|---|---|---|---|
| Poverty and sustainability | Availability of resources | 2 | 5 |
| | Potential for labour intensity technology | 3 | 1 |
| | Number of households involved in the sector | 1 | 1 |
| | Future potential | 1 | 1 |
| Structure of chain | Extent of value-adding potential | 2 | 1 |
| | Number of different value-chain actors | 5 | 4 |
| | Length of marketing chain | 1 | 4 |
| | Maturity of fruit production industry in the region | 3 | 3 |
| | Marketing potential | 1 | 1 |
| | Lack of previous research | 3 | 4 |
| | Potential for lessons learned/replication of the mechanism | 3 | 1 |
| | Production information availability | 1 | 3 |
| Average ranking | | 2.0625 | 2.3125 |

The literacy rate of farmers and middleman traders allows for better flow of product information and knowledge within the value chain. In Rusitu Valley, the middleman traders determine the prices of sweet oranges as was revealed by most of the farmers. The farmers perceived that 90% of the middleman traders were not setting prices basing on the cost of production but instead they offer very low prices thus taking advantage of the failure by farmers to handle large quantities of sweet oranges when in season. Thus, the middleman traders use the poorly developed farm infrastructure to their advantage by buying oranges at low prices.

Farmers in the Valley only receive producer - trade information from traders unlike in other developing countries such as Tanzania where fruit and vegetable value-chains are well organised

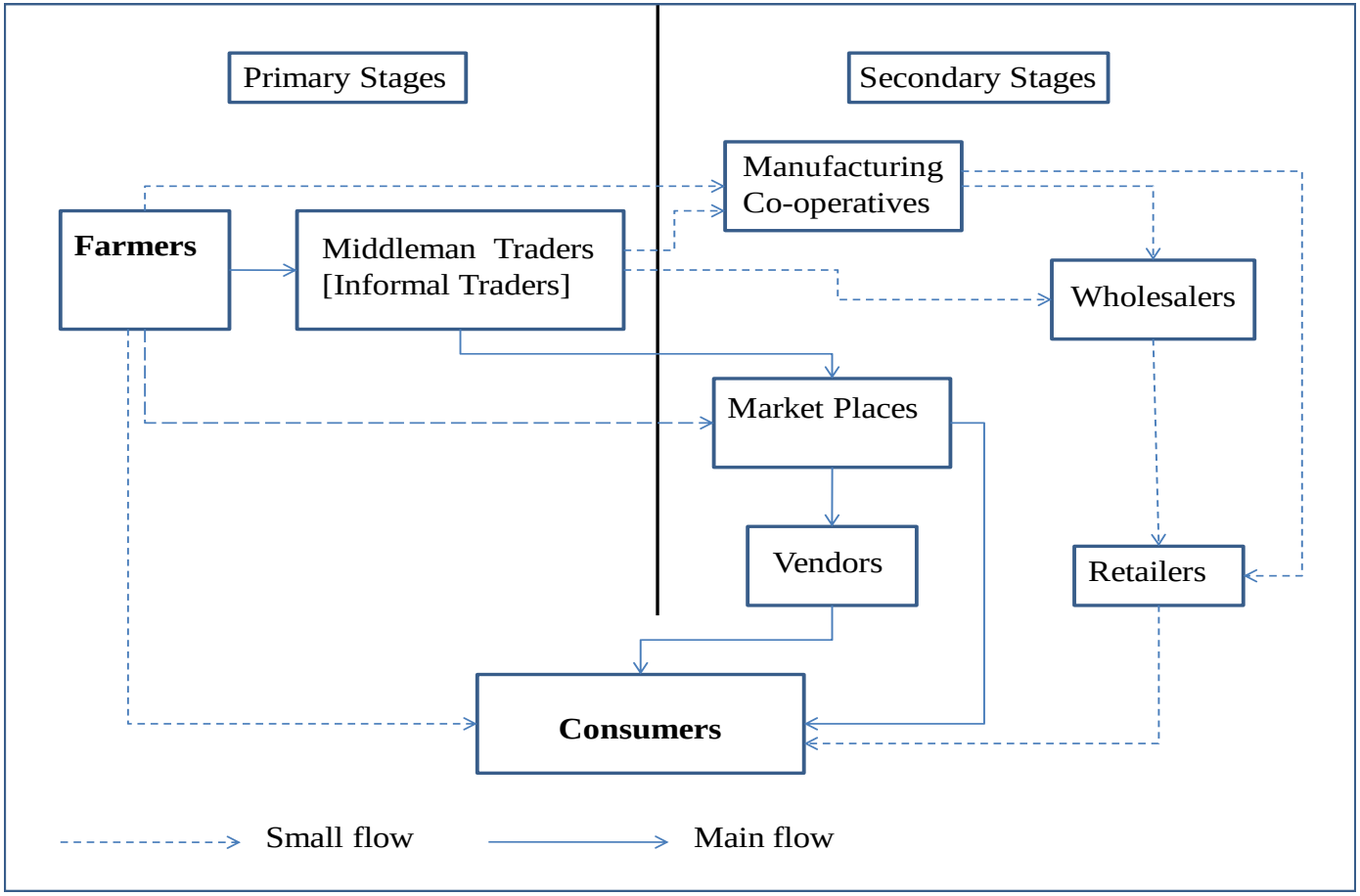


**Figure 2.** Rusitu Valley sweet orange production value chain.

and supported by different actors especially the government (Izamuhaye, 2008). As a result of this anomaly, during the 2013/2014 season 81% of the farmers sold their oranges to the middlemen traders at prices ranging from $1, 00 to $2, 00 per 15 kg pocket and 12% of the farmers sold at $3, 00 per 15 kg pocket directly to vendors within the Valley (Table 4). Therefore, the average sweet orange price in Rusitu Valley was $0, 13/kg during the 2013/2014 season which was lower than the banana price at $0, 20/kg during the same season. Though the orange value chain in Rusitu Valley was dominated by an average of 3 164 communal farmers, major flow of sweet oranges was being handled by middlemen traders. These middleman traders are not registered companies but individuals or informal traders. The dominating communal farmers lack the capacity to handle the abundant orange produce since they tend to ripen almost at once causing seasonal gluts.

The survey revealed that orange fruit tree

**Table 4.** Sweet orange tree owned/farmer and orange prices for 2013/14 season (N=100).

| | Orange trees owned/farmer | | Orange buyers | | Orange prices (US$) | |
|---|---|---|---|---|---|---|
| Response | <50 | 77% | Middleman | 68% | <1 | 1% |
| | 50 - 100 | 14% | Local Vendors | 28% | 1-2 | 80% |
| | 101 - 150 | 7% | Cooperatives | 2% | >2 | 6% |
| | >50 | 2% | | | | |
| Std deviation | 0.699 | | 1.44 | | 0.568 | |
| Variance | 0.489 | | 2.075 | | 0.323 | |

**Table 5.** Perceptions of farmers on the major causes of postharvest losses in Rusitu Valley (N=100).

| Perceived causes of losses | Strongly agree (%) | Agree (%) | Indifferent (%) | Disagree (%) | Strongly disagree (%) | Std Deviation | Variance |
|---|---|---|---|---|---|---|---|
| Pests and diseases | 71 | 27 | 2 | 0 | 0 | 0.506 | 0.256 |
| Transportation to the market | 13 | 35 | 16 | 35 | 1 | 1.102 | 1.215 |
| Harvesting methods | 11 | 68 | 1 | 20 | 0 | 0.916 | 0.838 |
| Farming and marketing practices | 31 | 62 | 3 | 4 | 0 | 0.682 | 0.465 |
| Deterioration in the sweet orange quality parameters | 49 | 40 | 3 | 8 | 0 | 0.87 | 0.758 |

population in the Valley reduced from 2011/2012 season's 174 020 to 145 544 trees during the 2013/2014 season. The study also highlighted that orange fruit production capacity per tree reduced to 700 kg from the 2011/2012 season's 1200 kg/tree as most of the farmers (71%) now owned trees less than 50 in their orchards (Table 4). Pests, diseases, and tree aging were noted as the major causes of reduction in the production capacity and quantity of sweet oranges (Table 5). Basing on the total number of sweet orange farmers the study revealed that a total of 101 880,8t of sweet oranges were produced in Rusitu Valley during the 2013/2014 season. Of this produce 36% deteriorated in the field, 3% during transportation, and 42% at markets. Thus, the total postharvest losses in this value chain amounts to 81% of the total produce (82 523,448t of sweet oranges with a monetary value of US$11 003 126.40). The study also revealed that a positive correlation ($r = 0.22$, significant at the 0.05 level (2-tailed)) existed between the varieties farmers grow and the total postharvest losses incurred during the 2013/2014 season.

Farmers who grow both Navel and Late Valencia varieties incurred more postharvest losses than farmers growing Navel variety only. The median for farmers who grow both Navel and Late Valencia varieties is higher (Figure 4, Graph a) than those of the rest of farmers reflecting that farmers growing the two varieties incurred greater losses during the 2013/2014 season. The lower quartile for farmers growing Navel, Late Valencia, and other varieties is actually larger than the rest of farmers, which means that there is more variability in the lower 25% of their postharvest scores than the other farmers. The box plots in Figure 4 show that the range of postharvest losses amongst farmers was different during the 2013/2014 season. In Figure 4, Graph a is showing an asymmetrical distribution of postharvest loss scores, Graph b resembling the distribution postharvest losses with respect to orange varieties, and in graph c the p-p plots are showing that the postharvest losses do not follow a normal distribution. It can be concluded that the variability of postharvest losses with respect to orange varieties grown by communal farmers in Rusitu Valley do not follow a normal distribution.

Majority of the farmers strongly agreed with the perception that postharvest losses incurred on

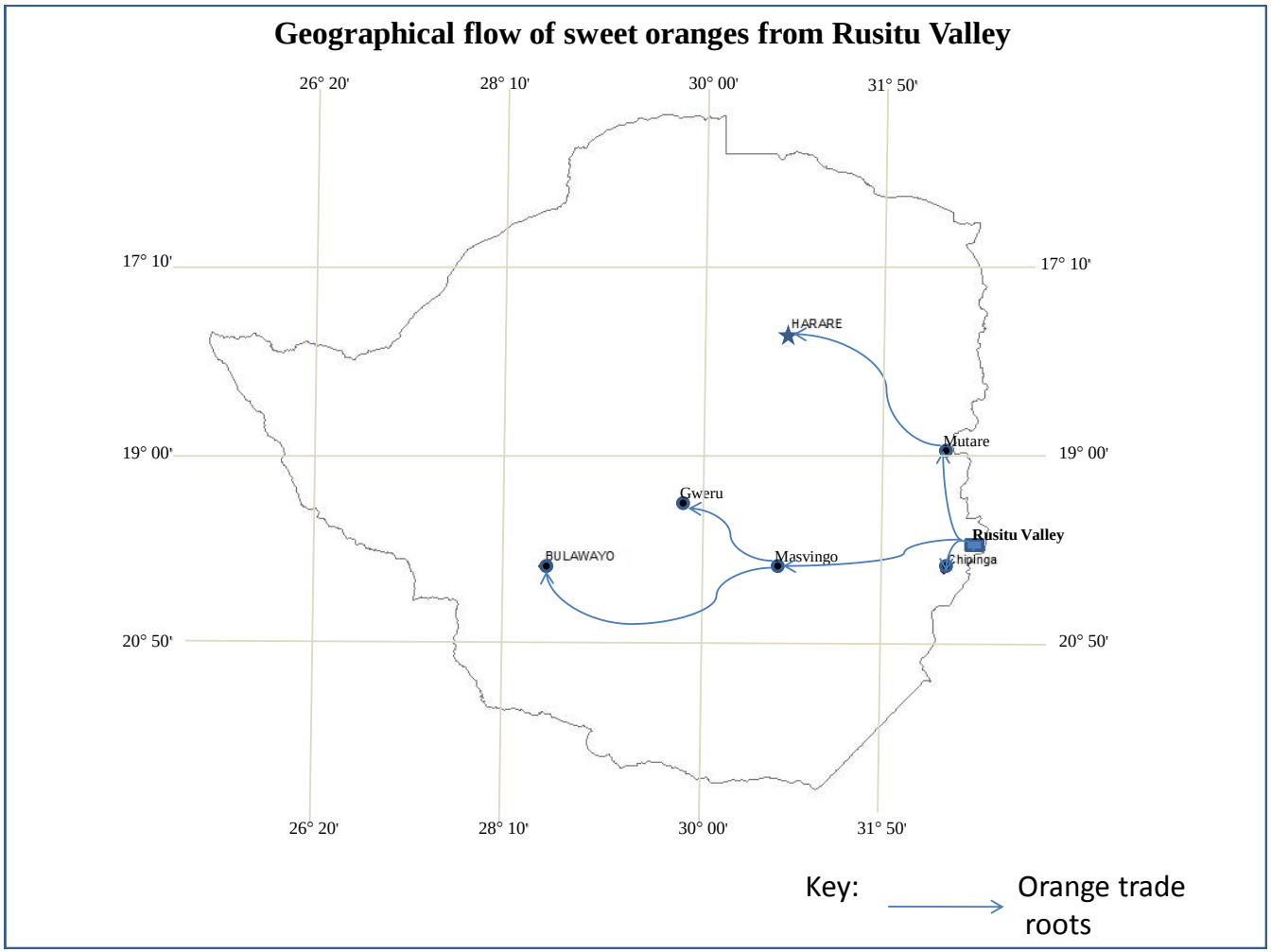


**Figure 3.** Sweet orange trade routes.

sweet orange production during the 2013/2014 season were caused by pests and diseases, followed by deterioration in orange quality parameters (Table 5). A regression analysis on the relationship between postharvest losses and prevalence of pests and diseases confirmed that correlation existed ($r = 0.29$) and was significant at $p < 0.05$. The regression analysis also established that prevalence of pests and n diseases accounts for 8.5% ($R^2 = 0.085$) of the total post harvest losses thus there are other variables that are contributing to postharvest losses in Rusitu Valley.

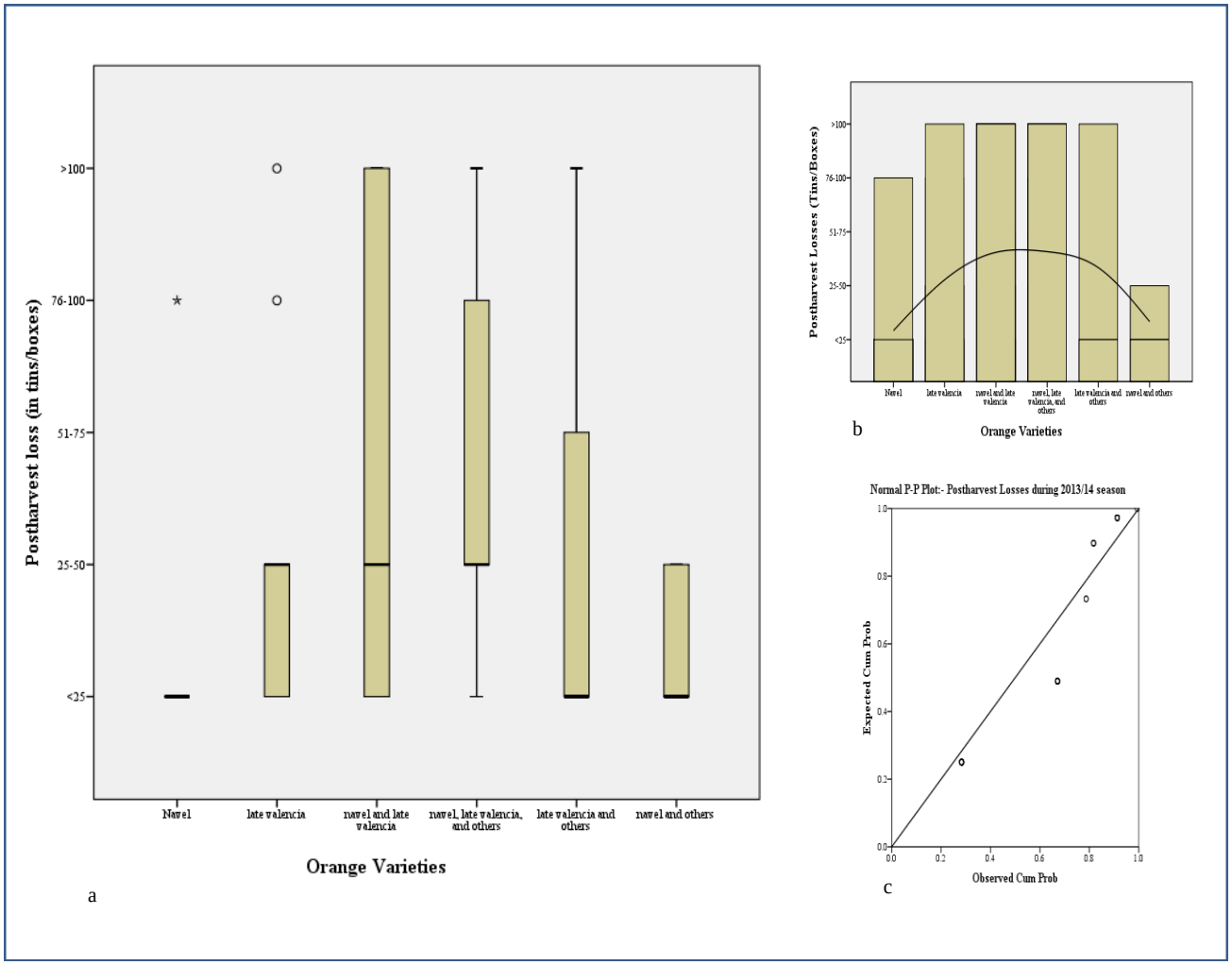


**Figure 4.** Sweet orange varieties and postharvest loss distribution tests for postharvest losses.

These variables include harvesting methods, farming and marketing practices, deterioration in quality parameters, and transportation of sweet oranges.

## CONCLUSIONS AND RECOMMENDATIONS

From the study, the main flow of oranges is distributed through informal middleman traders who transport produce to urban market places where there are poor storage facilities hence huge losses amounting to 42% of the total produce are incurred. Farmers in Rusitu Valley are forced to

sell their orange produce to informal middleman traders at prices below the production costs, since the farmers lack capacity and market information to handle the seasonal gluts of sweet oranges.

The study also revealed a decline in the quantity of Rusitu Valley orange produce and an increase in postharvest losses; resulting from poor postharvest management and prevalence of pests and diseases. The distribution of postharvest losses was greater for farmers who own both Navel and Late Valencia varieties compared to farmers owning Navel variety only. It can be concluded that reduction in these postharvest losses improves the livelihoods and development of Rusitu Valley communities. In light of the study findings, it was suggested that the main flow of oranges should be distributed through registered collection agents linked to the manufacturing industry. There is also need for investment on proper postharvest management within the orange value chain especially in assisted value addition technologies since all the actors are lacking investment capital.

## Conflict of Interest

The authors have not declared any conflict of interest.

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