



## **Consequences of post-harvest losses to vegetable farmers in Tanzania**

### **A case of Singida region**

**HELVETAS Swiss Intercooperation SURVEY REPORT 2014**

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## List of abbreviations and acronyms

URT: United Republic of Tanzania

AVRDC: Asian Vegetable Research and Development Center

KUWAKI: *Kuwawezesha Wanawake Katika Kilimo*

## Executive Summary

In the Tanzania National Agriculture Policy (2013) vegetables were among the identified nine crops to promote for local and export markets in order to generate national income and increase farmers' earnings. On the other hand, vegetable production is gaining popularity in Singida region and other parts of Tanzania and farmers with access to water are increasingly allocating their land for vegetables. For example in 2012/13 season farmers in Singida region allocated more than 10% of their total arable land to vegetable production of which 44% was under tomato production. However in Tanzania losses of horticultural produce (tomatoes and onions being among them) are a major problem in the post-harvest chain leading to losses between 30 to 80%. This survey was conducted to evaluate post-harvest losses in vegetables in Singida region and assess their impact to the livelihood and income of the households. A structured questionnaire was administered in Mkalama, Ikungi, Singida town, Singida rural and Iramba districts where 200 farmers were randomly selected and interviewed.

Data collected were subjected to analysis using SPSS version 17.0 (Statistical Package for Social Sciences). The results showed that out of the 200 respondents interviewed, 67.8% were head of households with Iramba district having the highest proportion (80%). The household composition showed that most of the households had an average size of 1 to 5 irrespective of their age categories. The important finding is that in the interviewed households they have lower dependency ratio hence enough labour to work on the farm. It was found that KUWAKI project has benefited some farmers in the surveyed districts in Singida region where the highest beneficiaries were found in Singida rural (18.2%) and lowest in Mkalama (3.9%). KUWAKI outweighed other projects which were able to reach only Iramba (2.2%) and Singida Town (4.3%) districts. Furthermore, it was observed that higher numbers of farmers started vegetable production recently (1- 3 years) with most of them observed in Ikungi districts (93.3 and 25.5%) for tomato and onions production, respectively. Finally the decisions on when to harvest in all districts is largely based on crop maturity (80.9%) where rain damage, labour shortage and drought have no significant contribution to the decision. Results on post-harvest losses indicated that, post-harvest losses of (0-5%) tomatoes and onions was reported by (52%) of the famers in Ikungi district while only 15% of the respondents in Singida town reported to experience over 70% of post-harvest losses for both tomatoes and onions. Major causes of post-harvest losses in tomatoes at harvesting stage in all districts were heavy rains (41.3%) and rodents (35.4%). In Iramba district, major cause of post-harvest losses in tomatoes was said to be fungi (80%), while in Singida rural, drought has zero contribution to post-harvest losses in tomatoes. It was

revealed that lack of storage facilities (38.2%) has considerable contribution to post-harvest losses in onions from all district, with Ikungi district having high number of farmers (56.2%) reporting to be affected by lack of these facilities. Furthermore, these farmers store their tomatoes in heaps outside or inside their houses (> 30%) where Singida rural district takes the lead (83.3%) and in Ikungi district being stored in sacks (100%). Onions are mainly stored in super bags (33.3%) in Singida rural and Iramba districts, respectively while Mkalama district uses *vihenge* (40%) and Singida town uses sacks (45.5%). Findings from this study indicate that, a slight larger number of people in all districts, transport produce from farms by head (38.0%) and bicycle (35.4%), with Singida rural and Mkalama districts having more farmers transporting farm produce by head (53.8%) and bicycle (48.0%), respectively. This has might have contributed to the post-harvest losses experienced in the area. The access to electricity for household level in different districts of Singida region was high in Iramba district (45.2%) and very low in Singida town (6.1%). However, readiness to use solar power showed very positive response in Singida Town district (97.0%) followed by Mkalama district (84.6%) while the lowest was found in Iramba district (56.4%).

In order to reduce post-harvest losses it is recommended that wherever possible to introduce ox-carts as means of produce transportation to reduce losses induced by transportation. Furthermore, an introduction of affordable and environmentally friendly storage facilities is of priority apart from application of appropriate recommended pesticides.

## 1.0 Background

Agricultural commodity production in Tanzania has traditionally been dominated by few commodities which were mainly for export, namely, coffee, cotton, cashew nuts, tobacco, tea, sisal, sugarcane and pyrethrum (URT, 2013). In the Tanzania National Agriculture Policy (2013) other crops have been identified equally important in local and export markets in their ability to generate national income and farmers' earnings. Vegetables were among the identified nine crops to promote. Furthermore, in its effort of reducing the risk of dependency on traditional exports (coffee, cashew nuts and cotton), whose price recently has been declining and fluctuating widely, the Government of Tanzania has identified horticulture as one of the 'sources of growth' and prioritizes horticulture as a potential sub sector for export diversification (URT, 2013).

However, in Tanzania losses of horticultural produce (tomatoes and onions being among them) are a major problem in the post-harvest chain (Mrema and Rolle, 2002). The post-harvest losses of horticultural crops can range from 30 to 80%, in part due to a lack of awareness on good harvesting and packing practices and lack of storage facilities (AVRDC, 2012). Primary factors responsible for post-harvest produce losses include poor pre-harvest measures, adoption of poor production techniques (varieties with low shelf life, imbalanced use of nutrients, abiotic stresses, insect pest and disease infestation) (Rehman *et al.*, 2007). Other factors are non-application of pre-harvest recommended treatments/practices such as harvesting at improper stage and improper care at harvest. Post-harvest problems such as dumping produce, moisture condensation causing pathogen infestation, packaging in bulk without sorting and grading of produce, improper transportation and storage, and distant and time consuming market distribution contribute further to post-harvest losses. These losses bring low return to growers, processors and traders and the country also suffers in terms of foreign exchange earnings.

Post-harvest losses for horticultural produce are, however, difficult to measure. In some cases everything harvested by a farmer may end up being sold to consumers. In others, losses or waste may be considerable. Occasionally, losses may be 100%, for example when there is a price collapse and it would cost the farmer more to harvest and market the produce than to plough it back into the ground. There can be losses in quality, as measured both by the price obtained and the nutritional value, as well as in quantity.

Minimising wastage requires a focus on quality of the produce throughout the supply chain. Many post-harvest losses are a direct result of production management. Vegetables that are affected by weeds, insect pests and diseases, inappropriately irrigated and fertilised, generally of poor quality before harvesting or harvested past optimum maturity can never be improved by post-harvest treatments. Vegetables are living, breathing parts of plants and contain 65 to 95% water (Mrema and Rolle, 2002). Once harvested their internal food and water reserves decline over time and vegetables deteriorate and rot. Anything that increases the rate at which food and water reserves are used up increases the rate of deterioration. Acceleration of deterioration can be due to high temperature, low humidity, incorrect atmosphere and/ or physical damage.

Vegetable production is gaining popularity in Singida region and other parts of Tanzania and farmers with access to water are increasingly allocating their land for vegetables. For example in 2012/13 season farmers in Singida region allocated more than 10% of their total arable land to vegetable production (KUWAKI, 2013). Out of the total land allocated to vegetable production 44% was under tomato production. This signifies the importance of tomato in the region as food and cash crop. On the other hand, Singida region is well known for its all year round production of onions which contribute highly to the households' income. However, despite the fact that tomatoes and onions are the source of income to the poor households and Nation as a whole, their production and marketing is faced with high rates of post-harvest losses. In its effort on empowering women, KUWAKI decided to focus on the commodities which can directly benefit women of which tomatoes and onions are among them. Given the post-harvest losses facing these crops the importance of carrying out baseline survey was emphasized. Therefore, a baseline survey on post-harvest losses in tomatoes and onions was conducted in four districts of intervention namely Singida Town, Singida Rural, Iramba and Mkalama.

## **1.1 Objectives**

To explore post-harvest losses in vegetable production in respect to their impact on the livelihood and income of the households in Singida region.

### **1.1.1 Specific objectives**

- To determine the contribution of tomato and onion production to household income and livelihood,
- To audit tomato and onion production in relation to the workforce in the households, and
- To audit post-harvest losses in tomato and onion production.

## **2.0 Methodology**

The baseline survey covered a wide range of issues including demographics, economic activities and income, attitude and practices in selected issues, etc. The study interviewed randomly selected smallholder producers of vegetables in the targeted project area (Singida urban, Singida rural, Ikungi, Mkalama and Iramba districts) on selected issues. The selection criteria for the interviewee were

- a) Smallholder farmers with the plot size ranging from (0.5 – 3) acres.
- b) Smallholder farmers producing onions, tomatoes and other vegetable varieties.
- c) Smallholder farmers who sold tomato/onions three years ago.

### **2.1. Sampling Techniques and Coverage**

#### **2.1.1. Selection of Respondents**

The KUWAKI project covers 720 smallholder farmers in Singida region but larger population of vegetable producers are not KUWAKI Project beneficiaries. Using statistical formula the sample size for the set population of 2000 smallholder vegetable producers is 200 smallholder producers. Using the criteria stated above a total of 2000 vegetable producers identified and the sample size distributed proportionally. In principle, an ideal sample size of such a population of farmers depended on the characteristics of the population and comparative technique. In each district of the study 50 questionnaires (each questionnaire representing 1 household) were administered to vegetable producers. Out of the 50 questionnaires, 5 questionnaires were purposely administered to interview vegetable producers who are KUWAKI Project beneficiaries but the Lead Farmers were excluded. The remained 45 questionnaires were used to interview vegetable producers who are not KUWAKI Project beneficiaries. Therefore a total of 200 questionnaires were administered to interview vegetable producers from all 5 districts mentioned above.

#### **2.1.2 Development of the Survey Instruments**

Structured questionnaire was used to capture the data.

#### **2.1.3 Data Collection**

Data collection commenced mid May 2014 for about 6 days in selected districts in the project intervention area.



## **2.1.4 Data Analysis and presentation**

Data collected were subjected to data analysis using SPSS version 17.0 (Statistical Package for Social Sciences). The results are presented in tables, histograms and graphs in the following sections.

## **3.0 Results and discussions**

### **3.1 Households socio-economic characteristics, production and post-harvest losses facing vegetable producers in selected districts in Singida region**

Socio-economic data were collected through questionnaire administration as described in the methodology. Data collected were subjected to analysis using SPSS version 17.0 (Statistical Package for Social Sciences). The results of the socio-economic characteristics, production post-harvest losses are presented in the following Sections (3.1.1 to 3.1.12).

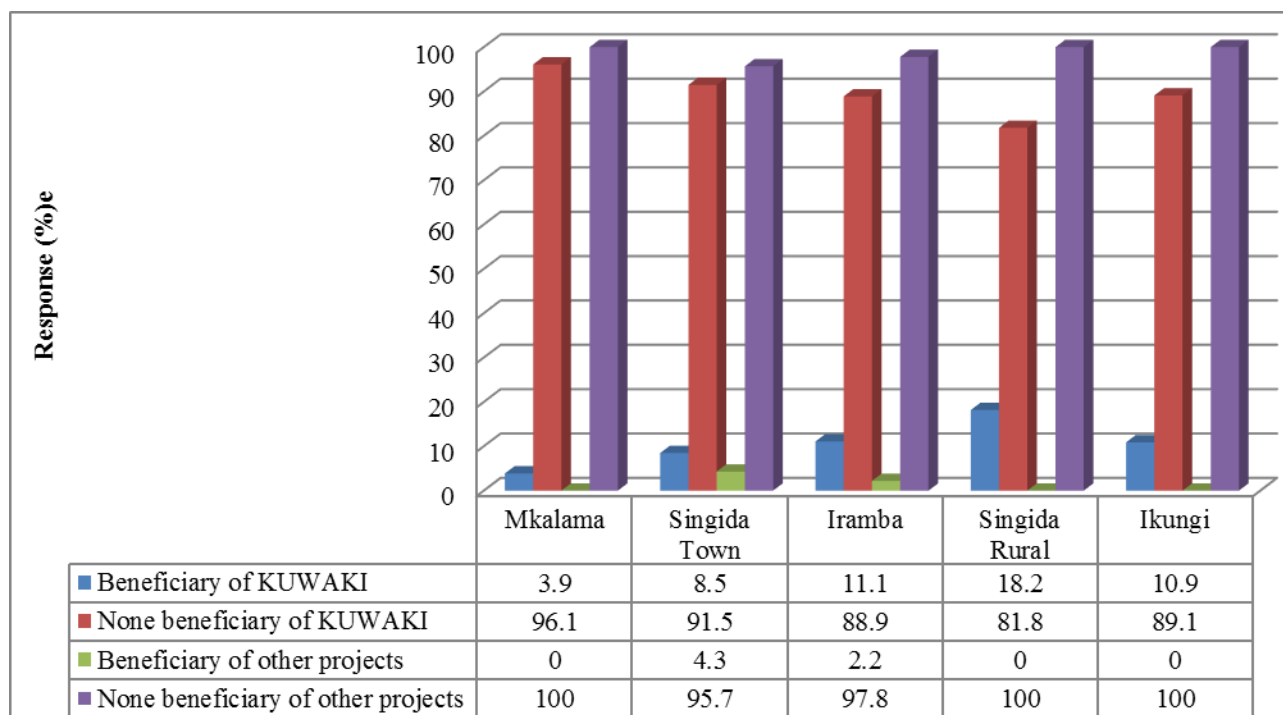
#### **3.1.1 Socio-economic and demographic characteristics of the of the households**

The main socio-economic and demographic characteristics showed that out of the 200 respondents interviewed, 67.8% were head of households with Iramba district having the highest proportion of male headed households (80%) (Table 1). Furthermore the results showed that most of the respondents were above 35 years old (54.8%) where 56.5% were male and 43.5% were female. Higher number of heads of households (64%) with age above 35 was observed in Mkalama district while in Singida town the age groups were almost equally distributed. Most of the respondents (95.4%) did not belong to any farmer group. The results show that interviewed farmers in Ikungi, Mkalama and Iramba districts did not belong to any farmer group while in Singida town and Singida rural, 13.6% and 16.7% respectively belonged to farmer groups. The trend observed in Singida town and Singida rural might be attributed to the sunflower farming and processing. In sunflower farming and processing (which is a booming business in the area) farmers have formed groups for easy access to micro credits and processing facilities.

**Table 1. Demographic characteristic of the households**

District	Head of households (%)		Sex of the head of households (%)		Age of respondent (years)		Member of farmer group (%)	
	Yes	No	Male	Female	Between 16 – 35	Above 35	Yes	No
Mkalama	76.0	24.0	82.4	17.6	36.0	64.0	0	100.0
Singida town	57.4	42.6	38.3	61.7	48.9	51.1	13.6	86.4
Iramba	80.0	20.0	60.0	40.0	37.8	62.2	0	100.0
Singida rural	72.7	27.3	36.4	63.6	54.5	45.5	16.7	83.3
Ikungi	56.5	43.5	47.8	52.2	56.5	43.5	0	100
<b>Total</b>	<b>67.8</b>	<b>32.2</b>	<b>56.5</b>	<b>43.5</b>	<b>45.2</b>	<b>54.8</b>	<b>4.6</b>	<b>95.4</b>

It was found that the KUWAKI project has benefited some farmers in the surveyed districts in Singida region where the highest proportion of beneficiaries were found in Singida rural (18.2%) and lowest in Mkalama (3.9%) (Figure 1). These results has been highly attributed to the characteristics of sample size selected for survey where on average more males were involved selected for the interview than females (Table 1). This might have caused the lower percentages of the beneficiaries as the project focus mainly on empowering women and not men. The results contradicted to the findings by the KUWAKI (2013) survey where more than 60% of the respondents said that they benefited from KUWAKI. However despite of the small out turn of the project, KUWAKI has outweighed other projects which have been implemented in the region as other projects were able to reach only Iramba (2.2%) and Singida town (4.3%) districts farmers and none in the remaining districts.



**Figure 1. Beneficiaries of projects**

### 3.1.2 Household member's composition and their age distribution

The results of the analysis on the household composition show that most of the households had an average size of 1 to 5 irrespective of the age categories (Table 2). However, the highest number of the household members was shown to be at the age of 35 and above. Males had the highest proportion (82.0%) than female (75.5%) where Ikungi districts showed the highest (97.8 and 95.6%) in males and female, respectively while, Singida rural showed the lowest (33.3 and 44.4%) in male and female, respectively. In this research it was also noted that Singida rural district had higher proportion of children aged between zero and six (88.9 and 77.8%, male and female respectively). Furthermore, result showed that most of the households don't have more than 5 members irrespective of their age category with the exception of Mkalama and Singida town districts. The important finding is that in the interviewed households they have lower number of children hence enough labour to work on the farm.

**Table 2. Household members' composition and their age distribution**

Districts	Males aged 35 and above (%)			Males aged 16 - 35 (%)			Males aged 7 - 14 (%)			Males aged 0 - 6 (%)		
	0	1 - 5	>5	0	1 - 5	>5	0	1 - 5	>5	0	1 - 5	>5
Mkalama	17.6	80.4	2.0	39.2	60.8	0	56.9	41.2	2.0	56.9	41.2	2.0
Singida	17.0	83.0	0	27.7	70.2	2.1	48.9	51.1	0	59.6	40.4	0

town												
Iramba	23.4	76.6	0	40.4	59.6	0	48.9	51.1	0	53.2	46.8	0
Singida rural	66.7	33.3	0	11.1	88.9	0	44.4	55.6	0	88.9	11.1	0
Ikungi	2.2	97.8	0	44.4	55.6	0	64.4	35.6	0	71.1	28.9	0
<b>Total</b>	<b>17.5</b>	<b>82.0</b>	<b>5</b>	<b>36.5</b>	<b>63.0</b>	<b>0.5</b>	<b>54.0</b>	<b>45.5</b>	<b>0.5</b>	<b>61.0</b>	<b>38.5</b>	<b>0.5</b>
<b>Districts</b>	<b>Females aged 35 and above (%)</b>			<b>Females aged 16 - 35 (%)</b>			<b>Females aged 7 - 14 (%)</b>			<b>Females aged 0 - 6 (%)</b>		
	<b>0</b>	<b>1 - 5</b>	<b>&gt;5</b>	<b>0</b>	<b>1 - 5</b>	<b>&gt;5</b>	<b>0</b>	<b>1 - 5</b>	<b>&gt;5</b>	<b>0</b>	<b>1 - 5</b>	<b>&gt;5</b>
Mkalama	31.4	64.7	3.9	41.2	54.9	3.9	49.0	49.0	2.0	39.2	58.8	2.0
Singida town	23.4	76.6	0	27.7	72.3	0	40.4	59.6	0	70.2	29.8	0
Iramba	27.7	72.3	0	38.3	61.7	0	48.9	51.1	0	68.1	31.9	0
Singida rural	55.6	44.4	0	22.2	77.8	0	44.4	55.6	0	77.8	22.2	0
Ikungi	4.4	95.6	0	37.8	62.2	0	51.1	48.9	.0	44.4	55.6	0
<b>Total</b>	<b>23.5</b>	<b>75.5</b>	<b>1.0</b>	<b>35.5</b>	<b>63.5</b>	<b>1.0</b>	<b>47.5</b>	<b>52.0</b>	<b>0.5</b>	<b>56.5</b>	<b>43.0</b>	<b>0.5</b>

### 3.1.3 Household members working in the farm

#### 3.1.3.1 Household members working full time in the farm

It was found that in most households in the region 66.0% of the males aged 35 years and above work full time in the farm with only 0.5% not involved in the farm activities (Table 3). On average more than five males of 35 and above years from each household utilize their full time in the farm activities. On the other hand more than 50% of females and males between the age of 16 and 35 are not engaged in any farm activities. This result implies that youth in these households are running away from farm activities. This might have been caused by their involvement in other income generation activities. The results are supported by the number of youth found on the Mwanza-Dar es Salaam-Arusha highway selling various farm produce and products like onions, tomatoes, sunflower oil and groundnuts. On the other hand, some of these members might be in secondary schools or at their final years of primary education.

**Table 3. Household members working full time in the farm**

Districts	Males aged 35 and above (%)			Males aged 16 - 35 (%)			Females aged 35 and above (%)			Females aged 16 - 35 (%)		
	0	1 – 5	>5	0	1 – 5	>5	0	1 – 5	>5	0	1 – 5	>5
Mkalama	2.0	23.5	66.7	51.0	31.4	17.6	33.3	62.7	3.9	52.9	23.5	23.5
Singida town	0	27.7	68.1	48.9	38.3	12.8	34.0	59.6	6.4	40.4	46.8	12.8
Iramba	0	34.0	66.0	53.2	42.6	4.3	36.2	61.7	2.1	51.1	34.0	14.9
Singida rural	0	33.3	66.7	44.4	44.4	11.1	44.4	55.6	0	44.4	55.6	0
Ikungi	0	33.3	66.7	66.7	31.1	2.2	31.1	68.9	0	60.0	40.0	0
<b>Total</b>	<b>0.5</b>	<b>30.0</b>	<b>66.5</b>	<b>54.0</b>	<b>36.0</b>	<b>10.0</b>	<b>34.0</b>	<b>63.0</b>	<b>3.0</b>	<b>50.5</b>	<b>37.0</b>	<b>12.5</b>

### 3.1.3.2 Household members working part time in the farm

Generally the percentage of the household members not working part time (<50%) in the farm was observed to be high (>84%) in all districts and in all age categories (Table 4). The higher percentage was observed in females aged 35 and above (93.5%) while the lowest (84.4%) was from females aged 16 to 35 year. The observed trend might have been caused by the fact they don't have other competing activities for their labour when compared to the other groups. Furthermore, youth (16 – 35 years) outweighed their elders where more than 10% of the males and females, respectively with 1 to 5 members of the household members work part time in the farm. Their part time involvement in the farm activities might have been caused by the fact that the other 50% of the time is used in other income generation activities mentioned in section 3.1.3.1 or they are still at school.

**Table 4. Household members working part time (< 50%) in the farm**

Districts	Males aged 35 and above (%)			Males aged 16 - 35 (%)			Females aged 35 and above (%)			Females aged 16 - 35 (%)		
	0	1 – 5	>5	0	1 – 5	>5	0	1 – 5	>5	0	1 – 5	>5
Mkalama	94.1	0	5.9	98.0	2.0	0	94.1	3.9	2.0	96.1	0	3.9
Singida Town	93.6	4.3	2.1	78.7	17.0	4.3	97.9	0	2.1	80.9	17.0	2.1
Iramba	100.0	0	0	97.9	0	2.1	100.0	0	0	93.6	0	6.4
Singida Rural	66.7	11.1	22.2	100.0	0	0	100.0	0	0	66.7	11.1	22.2
Ikungi	68.9	28.9	2.2	64.4	33.3	2.2	80.0	17.8	2.2	68.9	28.9	2.2
<b>Total</b>	88.5	8.0	3.5	86.0	12.0	2.0	93.5	5.0	1.5	84.5	11.0	4.5

### 3.1.4 Total arable land available for production (Acres)

The average arable land in the surveyed districts was found to be less than 1 acre (47.5%) with Ikungi district having higher number of households (75.6%) (Table 5 (a)). Singida Town district was observed to have high number of households (46.8%) with arable land measuring between 1 to 3 acres. Only 13% of the respondents had >5 acres where in Ikungi none had more than 3 acres of land meaning that land scarcity is one of the constraints to agricultural production and food security in the Singida region.

The results also, revealed that in the last season 49% cultivated less than 1 acre of their arable land followed by 36.5% cultivating >1- 3 acres while only 5.5% cultivated more than 5 acres. These results are different from those found by KUWAKI (2003) where on average 5 acres were cultivated. It was expected that, given the little arable land owned by these farmers they would have utilized every bit of their land for food security and income. Out of the households who cultivated their land, more than 60% did not grow tomatoes and onions for the past two seasons leaving about 40% cultivating these vegetables (Table 5 (b)). This situation might have been highly contributed by bad weather which resulted into drought in the area hence drying most of the water sources for irrigation.

Apart from bad weather, the trends observed in both cases were highly contributed to the labour scarcity (Section 3.1.3) and poor implements owned for land preparations

and weeding. This calls for the technology and crop which can sustain these farmers. In other words valuable crops like onions and tomatoes needs to be emphasised. For these crops to sustain their life an introduction of simple irrigation technologies i.e. bore holes with treadle pumps accompanied with proper agronomic practices are of importance.

**Table 5 (a). Total arable land available for production and land cultivated last season (Acres)**

Districts	Total arable land (%)				Total land cultivated (%)			
	<1	>1-3	>3-5	>5	<1	>1-3	>3-5	>5
Mkalama	49.0	35.3	13.7	2.0	41.2	43.1	9.8	5.9
Singida town	27.7	46.8	23.4	2.1	48.9	25.5	17.0	8.5
Iramba	38.3	42.6	14.9	4.3	59.6	25.5	8.5%	6.4
Singida rural	55.6	33.3	11.1	0	55.6	33.3	11.1%	0
Ikungi	75.6	24.4	0	0	53.4	30.7	8.7	7.2
<b>Total</b>	<b>47.5</b>	<b>37.5</b>	<b>13.0</b>	<b>2.0</b>	<b>49.0</b>	<b>36.5</b>	<b>9.0</b>	<b>5.5</b>

**Table 5 (b). Area cultivated tomatoes and onion for the past two seasons**

District	Tomatoes (%)				Onions (%)			
	0 acres	<0.5 acres	0.5 - 1.0 acres	>1.0 acres	0 acres	<0.5 acres	0.5 - 1.0 acres	>1.0 acres
Mkalama	39.3	28.6	25.0	7.1	78.6	14.3	7.1	0
Singida town	67.3	19.2	9.6	3.8	78.8	7.7	7.7	5.8
Iramba	42.6	23.4	14.9	19.1	63.8	21.3	14.9	0
Singida rural	57.1	14.3	14.3	14.3	92.9	7.1	0	0
Ikungi	81.4	3.4	10.2	5.1	53.3	38.3	8.3	.0
<b>Total</b>	<b>61.0</b>	<b>16.5</b>	<b>13.5</b>	<b>9.0</b>	<b>68.7</b>	<b>20.9</b>	<b>9.0</b>	<b>1.5</b>

### 3.1.5 Experience in vegetable production farming

Results on experience in vegetable production showed that farmers had higher experience in tomato production (91%) while in onion shown to be lower (51%) (Table 6). Furthermore, it was observed that higher numbers of farmers started vegetable production recently (1- 3 years) with most of experienced in tomato production found in Singida rural district (88.9%) and Ikungi districts (93.3%). High proportion of households with an experience (1 – 3 years) in onions production were found to be in Ikungi district (64.4%) followed by Singida town (25.5%). Generally, many farmers (49%) don't have experience in onion production when compared to only 9% in tomato. The result reveals tomato has been a cash crop for some years that's why more farmers have experience (with > 12% having more than 9 years) in its production and onions are recently becoming popular cash crop in area. Onion popularity might have been induced by introduction of new varieties which don't succumb easily to diseases and its long shelf life hence reduction in post-harvest losses as compared to tomatoes.

**Table 6. Experience in vegetable production farming**

Districts	Years in producing tomatoes (%)					Years in producing onions (%)				
	0	1-3	3-6	6-9	>9	0	1-3	3-6	6-9	>9
Mkalama	7.8	39.2	27.5	5.9	19.6	52.9	9.8	11.8	2.0	23.5
SingidaTown	10.6	36.2	31.9	4.3	17.0	42.6	25.5	12.8	0	19.1
Iramba	19.1	31.9	14.9	21.3	12.8	57.4	6.4	12.8	10.6	12.8
Singida Rural	0	88.9	0	0	11.1	88.9	11.1	0	0	0
Ikungi	0	93.3	6.7	0	0	35.6	64.4	0	0	0
<b>Total</b>	<b>9.0</b>	<b>51.5</b>	<b>19.5</b>	<b>7.5</b>	<b>12.5</b>	<b>49.0</b>	<b>25.5</b>	<b>9.0</b>	<b>3.0</b>	<b>13.5</b>

### 3.1.6 Pest control and agronomic practices in vegetable production

In Table 7 the pest control measures, agronomic practices, training and agricultural advices for tomato and onions in the surveyed areas are presented. It was learnt that farmers in the surveyed districts do apply pesticides (66.6%) with no worry about fungal (early and late blights) diseases as the use of fungicides is only 11.2%. This might have attributed to the higher post-harvest losses found in these districts (Section 3.1.7.2). The use of fertilizer like booster are very minimal (20.4%) with Singida rural district taking the lead (40 %.) leading into low yields and income to farmers. The opportunity to increase vegetable production lies in the availability of water sources as more than 80%



do practise irrigation in their vegetable plots. Very few farmers (15.2%) have received training on vegetable production of which was said to be inadequate (73.1%) hence the need for more training. This has led these farmers to seek advices mostly to agro dealers where they purchase inputs as extension staffs are not enough to serve these farmers. There is need to equip farmers, extension staffs and agro dealers with the principles of vegetable production.

**Table 7 Pest control, Agronomic practices, training and agricultural advices**

District	Pesticides (%)		Fungicides (%)		Booster (%)		Irrigation (%)		Training (%)		Training adequacy (%)		Agricultural advices (%)		
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Extension staff	Agro dealers	Neighbour
Mkalama	91.8	18.2	16.7	83.3	25.0	75.0	84.6	15.4	11.1	88.9	15.4	84.6	18.2	54.5	27.3
Singida town	61.8	38.2	20.0	80.0	11.8	88.2	90.9	9.1	25.0	75.0	28.6	71.4	20.7	37.9	34.5
Iramba	53.5	46.5	6.7	90.0	12.9	87.2	82.2	17.8	15.9	84.1	11.8	88.2	21.4	64.3	11.9
Singid rural	50.0	50.0	0.0	100.0	40.0	60.0	61.5	38.5	8.3	91.7	0.0	100.0	0	83.3	16.7
Ikungi	73.8	26.2	6.8	93.2	27.3	72.7	98.0	2.0	12.8	87.2	44.4	55.6	21.3	53.2	25.5
<b>Total</b>	<b>64.7</b>	<b>35.3</b>	<b>11.2</b>	<b>88.8</b>	<b>20.4</b>	<b>79.6</b>	<b>87.4</b>	<b>12.6</b>	<b>15.2</b>	<b>84.8</b>	<b>26.9</b>	<b>73.1</b>	<b>19.6</b>	<b>55.4</b>	<b>23.0</b>

### 3.1.7 Crop harvesting, post-harvest losses, and transportation

#### 3.1.7.1 Decisions and determinants of crop harvesting

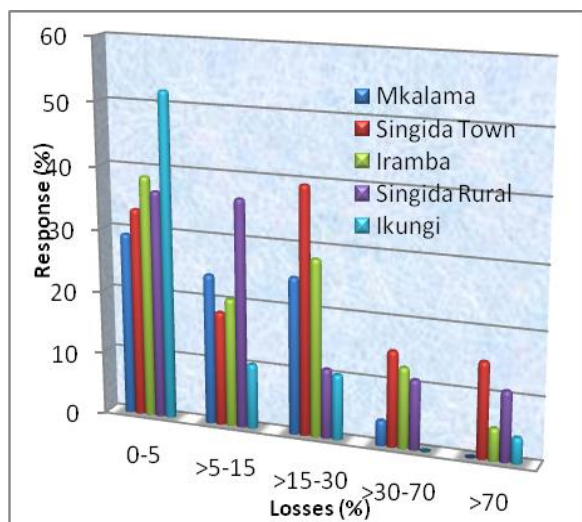
This study found that, final decisions on when to harvest tomato and onions in Ikungi district is mainly done by male (55.1%), and the major determinant being crop maturity (85.7%) (Table 8). In Iramba district, final decisions on harvesting are principally done by both (52.3%) and the central reason behind this decision is also crop maturity (90%). This study concludes that, final decisions on when to harvest in all districts is largely driven by crop maturity situation (80.9%) while rain damage, labour shortage and drought have no significant contribution.

**Table 8. Decision and reasons for crop harvesting**

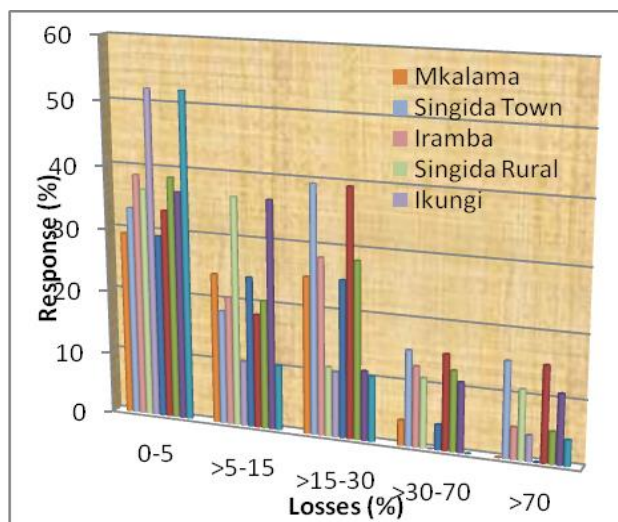
District	Final decision when to harvest (%)			Reasons for harvesting (%)							
				When matured		Fear for rain damage		Labour shortage		Drought	
	Male	Female	Both	Yes	No	Yes	No	Yes	No	Yes	No
Mkalama	40.0	28.0	32.0	76.0	24.0	23.1	76.9	0	100.0	4.2	95.8
Singida town	41.9	16.1	41.9	75.0	25.0	27.3	72.7	2.9	97.1	2.9	97.1
Iramba	36.4	11.4	52.3	90.0	10.0	14.0	86.0	0	100.0	0	100.0
Singida rural	14.3	57.1	28.6	44.4	55.6	46.2	53.8	0	100.0	0	100.0
Ikungi	55.1	14.3	30.6	85.7	14.3	2.0	98.0	0	100.0	10.2	81.6
<b>Total</b>	<b>42.4</b>	<b>19.0</b>	<b>44.0</b>	<b>80.9</b>	<b>19.1</b>	<b>16.9</b>	<b>83.1</b>	<b>0.6</b>	<b>99.4</b>	<b>4.4</b>	<b>95.5</b>

### 3.1.7.2 Post-harvest losses in tomatoes and onions at harvesting

Results on post-harvest losses at harvesting indicated that, post-harvest losses of (0-5%) for tomatoes and onions was reported by more than 20% of the famers in Ikungi district while >15% of the respondents in Singida town reported to experience over 70% of post-harvest losses for both tomatoes and onions (Figure 2 & 3).



**Figure 2. Post-harvest losses in tomatoes at harvesting**



**Figure 3. Post-harvest losses in onions at harvesting**

Major causes of post-harvest losses in tomatoes at harvesting stage in all districts were heavy rains (41.3%) and rodents (35.4%) (Table 9). In Iramba district, major cause of post-harvest losses in tomatoes was said to be fungi (80%), while in Singida rural, drought has zero contribution to post-harvest losses in tomatoes.

**Table 9. Causes of Post-harvest losses in tomatoes at harvesting stage**

District	Birds (%)		Rodents (%)		Heavy Rains (%)		Drought (%)		Fungi (%)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Mkalama	12.5	87.5	4.2	95.8	26.1	73.9	17.4	82.6	39.1	60.9
Singida town	33.3	66.7	21.2	78.8	36.4	63.6	24.2	75.8	45.5	54.5
Iramba	17.9	82.1	22.5	77.5	17.9	82.1	32.5	67.5	80.0	20.0
Singida rural	33.3	66.7	22.2	77.8	22.2	77.8	0	100.0	18.2	81.8
Ikungi	25.0	75.0	35.4	64.6	41.3	58.7	22.4	77.6	25.0	75.0
<b>Total</b>	<b>23.8</b>	<b>76.2</b>	<b>23.1</b>	<b>76.9</b>	<b>31.6</b>	<b>68.4</b>	<b>24.4</b>	<b>75.6</b>	<b>45.2</b>	<b>54.8</b>

It was found that lack of storage facilities (38.2%) has considerable contribution to post-harvest losses in onions from all district, with Ikungi district having high proportion of

farmers (56.2%) reporting to be affected by lack of these facilities (Table 10). This means that produce is just piled up outside homestead or in a room resulting into rodent's attacks or moisture build up hence accelerating rotting.

**Table 10. Causes of Post-harvest losses in onions at harvesting stage**

District	Lack of storage facilities (%)		Rodents (%)		Rotting (%)	
	Yes	No	Yes	No	Yes	No
Mkalama	26.1	73.9	26.1	73.9	9.1	90.9
Singida Town	25.8	74.2	35.5	64.5	19.4	80.6
Iramba	41.0	59.0	33.3	66.7	10.8	89.2
Singida Rural	11.1	88.9	0	100	20.0	80.0
Ikungi	56.2	43.8	20.8	79.2	4.9	95.1
<b>Total</b>	<b>38.2</b>	<b>61.8</b>	<b>26.5</b>	<b>73.5</b>	<b>11.3</b>	<b>88.7</b>

From these findings therefore, in order to minimize post-harvest losses in tomatoes appropriate fungicides in tomato production is essential. On the other hand introduction of storage facilities which are cost effective can minimize significantly post-harvest losses in onions at harvest.

### 3.1.8 Tomatoes and onions storage facilities and storage period

Observation shows that all five districts used to store their tomato produce although Ikungi district showed lower response (4.8%) followed by Mkalama district while higher percentage was in Singida rural district (66.7%) (Table 11). Contrary to tomatoes, almost all the farmers (> 85%) growing onions store their produce after harvest. The lower response showed in tomato storage compared to onions, might have been caused by the fact that tomatoes are more perishable compared to onions. So given the fact that these farmers don't have cold rooms must fear to lose their produce if stored.

Furthermore, these farmers store their tomatoes in heaps outside or inside their houses (> 30%) where Singida rural district takes the lead (83.3%) and in Ikungi district being stored in sacks (100%). Onions are mainly stored in super bags (33.3%) in Singida rural and Iramba districts, respectively while Mkalama district uses *vihenge* (40%) and Singida town uses sacks (45.5%). Some few farmers in Iramba district (7.7%) store their produce in plastic barrel which might result into moisture build up leading in rotting. The results imply that the storage facilities available in these areas cannot sustain storage of tomato and onion produce for long time to wait for the better market price. This calls for an introduction of good and cheap storage facilities for these farmers.

**Table 11. Types of facilities used to store tomatoes and onions**

District	Storage (%)		Types of tomato storage facilities (%)				
	Yes	No	<i>Vihenge</i>	Sacks	Plastic barrel	Super bags	Heaped in the house or outside
Mkalama	13.0	87	50	0	0	33.3	16.7
Singida town	36.7	63.3	18.8	6.2	0	31.2	43.8
Iramba	28.6	71.4	7.7	7.7	7.7	46.2	30.8
Singida rural	66.7	33.3	0	0	0	16.7	83.3
Ikungi	4.8	95.2	0	100	0	0	0
District	Storage (%)		Types of onions storage facilities (%)				
	Yes	No	<i>Vihenge</i>	Sacks	Plastic barrel	Super bags	Heaped in the house or outside
Mkalama	85.6	14	40.0	0	0	20.0	20
Singida town	100	0	27.3	45.5	0	27.2	0
Iramba	90	10	25.0	0	25.0	33.3	16.7
Singida rural	100	0	0	16.7	33.3	33.3	16.7

The observation showed that most respondent store tomatoes and onions between 1 to 2 days (51.2, 46.4%, respectively) followed by 3 to 4 days (22 and 38.7%, respectively) (Table 12). In Singida town (83.3%) and Singida rural districts (100%) they cannot store their tomato produce beyond 1 to 2 days and this might largely been contributed by the

fact that the store them in heaps outside or inside their houses as was indicated previously in Table 11. Onions in all districts can be stored mostly up to 4 days.

**Table 12. Storage period for tomato and onion**

District	Tomato (%)					Onion (%)			
	1-2 days	3-4 days	5-6 days	7-8 days	>10 days	1-2 days	3-4 days	5-6 days	>10 days
Mkalama	83.3	0	0	16.7	0	57.2	28.6	0	14.3
Singida town	29.4	35.3	29.4	5.9	0	50	37.5	12.5	0
Iramba	45.5	27.3	9.1	0	18.2	41.6	41.7	8.3	8.3
Singida rural	100	0	0	0	0	33.3	66.7	0	0
<b>Total</b>	<b>51.2</b>	<b>22</b>	<b>17.1</b>	<b>4.9</b>	<b>4.8</b>	<b>46.4</b>	<b>38.7</b>	<b>6.5</b>	<b>6.5</b>

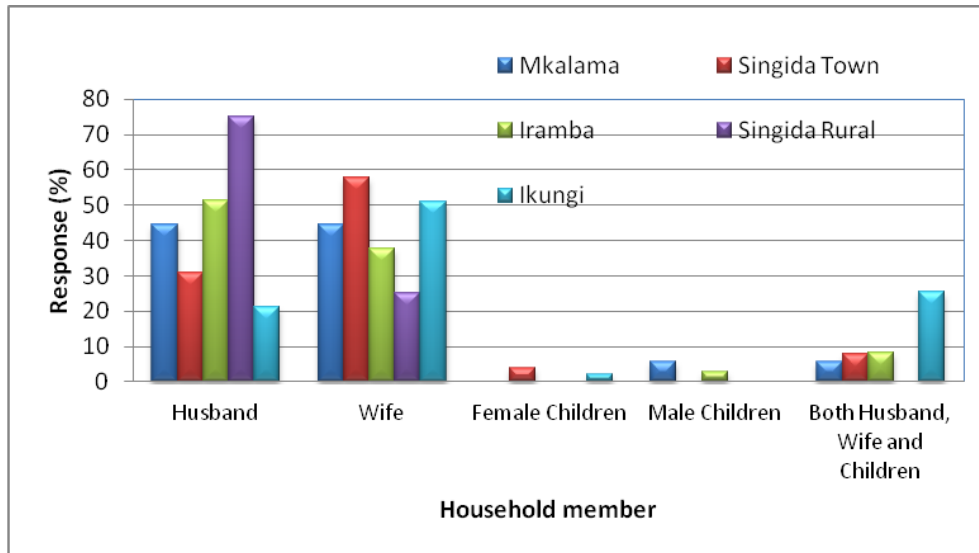
### 3.1.9 Means of transport of produce from farm to homestead

Findings from this study indicate that, a substantial proportion of people in all districts, transport produce from farms by head (38.0%) and bicycle (35.4%), with Singida rural and Mkalama districts having more farmers transporting farm produce by head (53.8%) and bicycle (48.0%), respectively (Table 13). Ox-cart (18.2%) and motorcycle (17.8) follows after head and bicycle transportation. It was further revealed that, power tillers are not used as means of transporting farm produce except in Iramba (7.3%) and Ikungi (12.5%) districts. Tractors were also reported not to be used to transport produce in Singida rural and Singida town but in Mkalama (4.2%), Iramba (2.4%) and Ikungi (6.2%). The means of transport observed might have been contributing to post-harvest losses after harvest as they might lead into physical injuries which can allow pathogen to easily infect the produce leading to rotting and deterioration. Wherever possible we highly recommend an introduction of ox-carts as means of produce transportation to reduce post losses induced by transportation. On the other hand an introduction of ox-carts will reduce the time on which the produce will remain in field hence reducing in-situ post-harvest losses.

**Table 13. Means of transportation of produce from farm**

District	By head (%)		Bicycle (%)		Power tiller (%)		Tractor (%)		Ox-cart (%)		Motorcycle (%)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Mkalama	19.2	80.8	48.0	52.0	0	100	4.2	95.8	20.8	79.2	29.2	70.8
Singida Town	44.1	55.9	29.4	70.6	0	100	0	100	5.9	94.1	14.7	85.3
Iramba	30.2	69.8	34.1	63.4	7.3	92.7	2.4	95.1	24.4	75.6	22.5	77.5
Singida Rural	53.8	46.2	18.2	81.8	0	100	0	100	27.3	72.7	0	100
Ikungi	45.8	54.2	37.5	62.5	12.5	87.5	6.2	93.8	19.0	81.0	14.6	85.4
<b>Total</b>	<b>38.0</b>	<b>62.0</b>	<b>35.4</b>	<b>64.6</b>	<b>6.0</b>	<b>94.0</b>	<b>4.4</b>	<b>95.6</b>	<b>18.2</b>	<b>81.8</b>	<b>17.8</b>	<b>82.2</b>

Household members participating in transporting farm produce in Singida rural and Singida town are mainly husbands (75%) and wives (58%) respectively (Fig. 4). In case where transportation of produce from the farm was left to female and male children only about 2% were found to be involved in Ikungi and Iramba districts. The results implies that if we want to introduce affordable technology which can reduce drudgery on produce transportation, then husbands and wives in the tomato and onions farming families must highly be involved from the beginning.

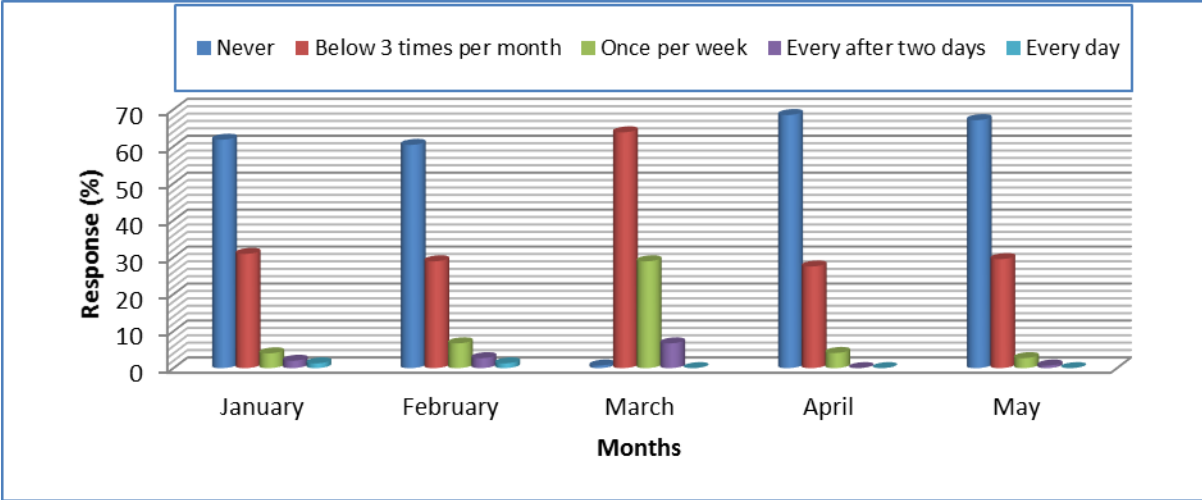


**Figure 4. Households member involved in transportation of produce from farm**

### 3.1.10. Household food shortage and purchasing power distribution per year

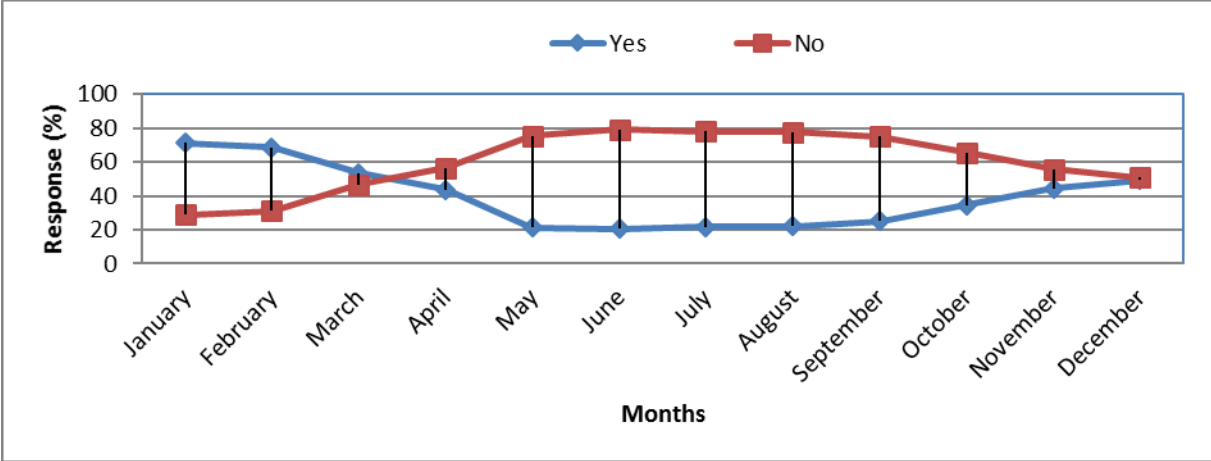
In this community very few households (<5%) purchases food every day and in March >60% purchase food for at most three times a month (Figure 5). It was found that more than 58% of the households do not purchase food in the months of January, February, April and May. Purchasing food for at most three times a month was about 30% in the months of January, February, April, and May, whereby once a week was about 30% in the month of March. In March most of the households (>60%) were food insecure buying food at least 3 times per month compared to the rest of the months. Food purchasing goes down in the months of April and May as farmers will start harvesting their crops hence increasing food security in the households. Some farmers face food shortages as they did not store their food produce due to lack of storage facilities (Section 3.1.7.2) or they sell sold some of their food to get money for their own alternative expenditures.





**Figure 5. Frequency of buying food in the households**

The purchase of vegetables (including onions and/or tomatoes) in this community was high in the months of January and February (70%) and decrease (20%) in May to September which later increase to about 50% for the remaining months of the year (Figure 6). Production cycle of vegetables especially onions and tomatoes is a function of weather conditions especially water supply and temperature. On the other hand December to February is the rain season for Singida region and during this wet period there is high disease and pests pressure especially for vegetable. This might have made some of these farmers to shy away from onions and tomatoes production due to high production costs hence leading into increased purchase of vegetables in their households.



**Figure 6. Vegetables (onions and tomatoes) purchase during the year**

### **3.1.11 Annual household income**

Household income and their sources are presented in Table 14 (a). The results showed that most of the household income (93.5%) come from vegetable selling with some (31.2%) getting extra income from selling other crops and very few (6.5%) obtaining extra income from employment. Most of the households earn bellow Tshs 100,000/= followed by those earning Tshs >100,000-500,000/= with very few (13%) earning more than Tshs 1,000,000/=. This means that many families are living below poverty line which is less than on dollar per day. These results implies that as most of the households are depending on vegetable sells in order to increase household income and improve their livelihood an investment in vegetable production is very essential.

It is encouraging to learn that most of the households (92.1%) involved in vegetable production do sell their produce after harvesting to generate income (Table 14 (b)). On the other hand it is discouraging to learn that of the 69.9% is sold either at farm gate or homestead with only 45.1% being taken to market. The situation might have contributed to the lower income realized annually in the most households. There is a need of forming farmers marketing groups if we want improve income and livelihoods of these farmers.

**Table 14 (a). Sources of household income**

District	Employment (%)		Selling vegetables (%)		Selling other crops (%)		Annual earnings from vegetable selling (Tshs)			
	Yes	No	Yes	No	Yes	No	<100,000 (%)	>100,000-500,000 (%)	>500,000-1,000,000 (%)	>1,000,000 (%)
Mkalama	16.0	84.0	73.1	26.9	29.6	70.4	53.6	28.6	7.1	10.7%
Singida town	0	100.0	81.2	18.8	21.2	78.8	50.0	25.0	7.7	17.3
Iramba	5.3	94.7	83.3	16.7	42.1	57.9	25.5	42.6	12.8	19.1
Singida rural	0	100.	54.5	45.5	0	100.0	71.4	21.4	0%	7.1
Ikungi	8.5	91.5	89.4	10.6	36.2	63.8	39.0	52.5	1.7	6.8
<b>Total</b>	<b>6.5</b>	<b>93.5</b>	<b>81.0</b>	<b>19.0</b>	<b>31.2</b>	<b>68.8</b>	<b>43.0</b>	<b>37.5</b>	<b>6.5</b>	<b>13.0</b>

**Table 14 (b) Vegetable selling**

District	Selling vegetables (%)		Selling points (%)		
	Yes	No	Farm gate	Market	Homestead
Mkalama	88.0%	22.0	46.2%	46.2%	7.7%
Singida town	93.3%	6.7%	47.6%	33.3%	19.0%
Iramba	94.3%	5.7%	44.8%	34.5%	20.7%
Singida rural	85.7%	14.3%	75.0%	25.0%	0%
Ikungi	93.0%	7.0	41.3%	21.7%	37.0%
<b>Total</b>	<b>92.1%</b>	<b>7.9</b>	<b>45.1%</b>	<b>30.1%</b>	<b>24.8%</b>

### **3.1.12 The accessibility and uses of electricity and solar power in the households level in Singida Region**

The access to electricity in different farming household in Singida region was very high in Iramba district (45.2%) and very low in Singida town (6.1%) as indicated in Table 15. On the other hand Ikungi, Mkalama and Singida rural had 39.6, 25 and 8.3% respectively. These results were contrary to the expectations as Singida town district was supposed to take the lead. The reason behind might be that most of the agriculture in urban and peri urban is practised by the poor people while in the rural areas is their main economic activity.

Furthermore, access to solar power as an alternative source of energy in the household level was very high in Mkalama district (41.7%) and very low in Singida rural (16.7%) (Table 15). On the other hand, readiness to use solar power showed very positive response in Singida town district (97.0%) followed by Mkalama district (84.6%) while the lowest was found in Iramba district (56.4%). Frequent power cut-off and availability of solar power facilities may have contributed to high use of alternative power source. The knowledge, income and availability of solar power facilities are the main challenge to the use of solar energy in this region.

Farmers reported different advantages of solar energy in Singida region (Table 15). In Iramba District farmers reported that solar power energy is cheaper (68.2%) compared to electricity while in Mkalama district said the advantages are it's readily availability (25%) and the reduce use of kerosene in household (50%). The use of solar energy was categorized differently in this region where in Mkalama district it is mainly used for Mobile phone charging (53.5%) while in Singida rural for both Mobile phone charging and television (35.7%). The combination of mobile phone charging, television use, radio, and lighting was high in Singida town (28.9%) and low in Iramba district (10.6%). Lighting alone using solar energy was low in Singida town (9.6%), this may be caused by availability of electricity whereby solar power being used in time of power interruption only. Singida rural had 28.6% of the households using solar power for lighting alone which is the highest compared to the rest of the districts. This implies that most of the households in the Singida rural district don't have access to electricity so they use an alternative source of energy such as solar power and kerosene.

**Table 15. Access and uses of electricity and solar power in the households**

District	Access to electricity (%)		Access to solar power (%)		Readiness to use solar power (%)		Advantages of solar power use (%)			Uses of solar power (%)			
	Yes	No	Yes	No	Yes	No	Cheaper	Reduce kerosene use	Readily available	Mobile phone charging	Mobile phone charging, TV	Mobile phone charging, TV, Radio, lighting	Lighting
Mkalama	25.0	75.0	41.7	58.3	86.4	13.6	25.0	50.0	25.0	53.5	14.3	17.9	14.3
Singida Town	6.1	93.9	18.2	81.8	97.0	3.0	44.2	38.5	17.3	38.4	23.1	28.9	9.6
Iramba	45.2	54.8	33.3	66.7	56.4	43.6	68.2	21.3	8.5	48.9	23.5	10.6	17.0
Singida Rural	8.3	91.7	16.7	83.3	75.0	25.0	57.2	21.4	21.4	14.3	35.7	21.4	28.6
Ikungi	39.6	60.4	18.8	81.2	66.7	33.3	60.3	17.3	22.4	43.1	13.8	19.0	24.1
<b>Total</b>	<b>29.2</b>	<b>70.8</b>	<b>28.8</b>	<b>71.2</b>	<b>74.4</b>	<b>25.6</b>	<b>52.7</b>	<b>28.9</b>	<b>18.4</b>	<b>38.3</b>	<b>19.9</b>	<b>24.4</b>	<b>17.4</b>

#### 4.0 Conclusions

The main objective of this study was to explore post-harvest losses in vegetable production in respect to their impact on the livelihood and income of the households in Singida region. The results obtained led into the following conclusions.

- (i) Most farmers in the region don't belong to any farmer groups which hinder these farmers to access credit facilities.
- (ii) In 2013/14 season 49% of the farmers cultivated less than 1 acre of their arable land followed by 36.5% cultivating >1- 3 acres while only 5.5% cultivated more than 5 acres. The trend observed was highly contributed to labour scarcity and poor implements owned for land preparations and weeding.
- (iii) Generally, more farmers (49%) don't have experience in onion production when compared to only 9% in tomato. The result reveals tomato has been a cash crop for some years that's why more farmers have experience (with > 12% having more than 9 years) in its production and onions are recently becoming popular cash crop in area.
- (iv) The purchase of vegetables (onions and/or tomatoes) in this community for the year round was high in the months of January and February (70%) and decrease (20%) in May to September which later increase to about 50% for the remaining months of the year.
- (v) Major causes of post-harvest losses in tomatoes at harvesting stage in all districts were heavy rains (41.3%) and rodents (35.4%). In Iramba district, major cause of post-harvest losses in tomatoes is fungal infection (80%), while in Singida rural, drought has zero contribution to post-harvest losses in tomatoes.
- (vi) Lack of storage facilities (38.2%) has considerable contribution to post-harvest losses in onions in all districts, with Ikungi district having high number of farmers (56.2%) reporting to be affected by lack of these facilities.
- (vii) Some few farmers in Iramba district (7.7%) store their produce in plastic barrel which might result into moisture build up leading to rotting.
- (viii) Transportation of the produce from farms is done mainly by head (38.0%) and bicycles (35.4%), followed by ox-cart (18.2%) and motorcycle (17.8). This might have significant contribution to the post-harvest losses due to the possibility of injuries leading to pathogen infections and reduced shelf life.
- (ix) The access to electricity in different farming households in Singida region was very high in Iramba district (45.2%) and very low in Singida town (6.1%). On the other hand, access to solar power as an alternative source of energy in the household level was very high in Mkalama district (41.7%) and very low in Singida rural (16.7%). However, farmers showed very positive response to solar

power use in Singida town district (97.0%) followed by Mkalama district (84.6%) while the lowest was found in Iramba district (56.4%).

## 5.0 Tentative recommendations

Based on the conclusions made from the study the following recommendations are given as a strategy to improve vegetable production.

- (i) Farmers must be sensitized to form or join farmer groups. Creation of awareness on the advantages of farmer groups is very essential in this region.
- (ii) In order for the farmers cultivate more land there is a need to introduce technologies to reduce drudgery which are affordable, easy to use and readily available to farmers. These technologies can include ox-ploughs, ox-weeders and rippers, to name a few.
- (iii) Due to the fact that most of the farmers don't have experience in onion production, there is a need for training vegetable farmers in this aspect for sustainable and increased production.
- (iv) In order to reduce tomatoes post-harvest losses at harvest in Singida region rodent control is essential accompanied with synchronization of season to avoid losses caused by heavy rains. In Iramba district an extra intervention is needed to control fungal attack through the use of proper fungicides recommended for tomatoes.
- (v) Onions post-harvest losses can largely be reduced by introduction of simple storage facilities common in the areas such as *vihenge*.
- (vi) Storage of onions in plastic barrel must be discouraged as it might result into moisture build up which leads into rotting.
- (vii) Whenever possible establishment of central collection and storage centre with cold rooms can highly reduce post-harvest losses especially in tomatoes. These centers can be owned by farmer groups.
- (viii) Wherever possible we highly recommend an introduction of ox-carts as means of produce transportation from farm to reduce post losses induced by transportation. On the other hand an introduction of ox-carts will reduce the time during which the produce will remain in field hence reducing in-situ post-harvest losses.
- (ix) Given the high costs of electricity and readiness of the farmers to use solar power, it is recommended that efforts must be put in availing solar power facilities to farmers at affordable cost.
- (x) Agriculture micro-credit schemes for farmers must be introduced to all farming communities so as farmers can access credits to buy various farm inputs and implements.

## 6.0 Literature list

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