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Knowledge, Attitude and Practices of Households on Technology Adoption and Postharvest Management of Avocado, Mango and Tomato in Wondo Genet Woreda of Sidama Region

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ABSTRACT

Postharvest loss was one of the major problems in Ethiopia. Nearly about 25-45% of postharvest losses existed in Ethiopia. The magnitudes of losses were higher for perishable products like fruit and vegetables when compared from cereals and legumes. Postharvest losses for Tomato, Avocado and mango were also high in the study area. The aim of this study was to collect baseline information on knowledge, attitude and practices of households on technology adoption and postharvest management on Avocado, Mango and Tomato at Wendogent Wereda Sidama region, Ethiopia. This baseline information will be used for the purpose of intervention and evaluating the change on the farmer's practice. The area was selected based on the potentiality of production of selected commodity. From the total area 4 kebeles were selected from 12 kebeles by using production potential of Tomato, avocado and mango and the samples were distribution to all direction of the woreda. From selected four kebeles 400 household were selected based on: Population number, Land size and gender (>30%). By using total land size and population number the 400HH were divided in to four kebeles by proportional and finally their average was used as sample size. The selected household was selected for the interview by using the standard questionnaire that was pre-tested before. Kobo tool was used for collecting the data. Purposive sampling method was used to select fruit production. Data analysis was analysed using statistical software (SPSS version 22). Descriptive data analysis was computed. Tables, graphs and charts were used to display results of the research findings. The result showed that the farmers do not have knowledge on different postharvest management technology such as maturity identification, harvesting techniques, cold storage facility, and transportation and distribution channels. They were based on their traditional practice. The cause of postharvest losses was improper handling and storage. The farmers need training on different areas such as, Harvesting, Packaging, storage, transportation. the result indicated that the farmers were willing to pay for technologies to reduce postharvest lossess. These technologies were important for reduction of losses for fruit and vegetables. The finding indicated that further study was needed on the adoption and utilization of affordable postharvest technology for each selected commodity in the selected area. In addition to that the postharvest loss estimation for each commodity in the value chain was very important.

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Introduction

Post-harvest management is a system of handling, storing, and transporting agricultural commodities after harvest. For some commodities such as coffee and cocoa, post-harvest activities may include drying and fermenting as well. Tomato (*Solanum lycopersicum*) is the most popular home garden and the world's second most consumed vegetable (*Solanum tuberosum*) after potato. A large amount of tomato is not reaching the consumer particularly due to postharvest losses. Postharvest losses can be due to many variables, but in most developing countries, improper

handling, packaging, low-level technology, lack of basic equipment and facilities at collection centers, and lack of qualified workers are prevalent. In Nepal, each area has different production technologies and storage conditions, and several production pockets are located away from the market centers. Consequently, post-harvest losses are caused by various horticultural crops and development regions. Fresh fruits and vegetables, including tomatoes, are projected to have post-harvest losses of 5 to 25 percent in developed countries and 20-50% in developing countries. Fruits and vegetable losses in developed countries vary from 20-50% during post-harvest cycles. Postharvest technology is used in the manufacture, preservation, manufacture, packaging, distribution marketing,

improper handling, packaging. Any change in the amount or quality of any after-harvest product that prevents or reduces the intended consumption of the product or decreases its value is a post-harvest loss. In developing and under-developing countries, the losses are more due to lack of proper storage and transport facilities [1-4].

According to the study made in South Wollo by the postharvest loss of banana (1.5 %, 1.2% and 4.5 %); tomato (2.5 %, 2.5% and 5.9 %); mango (1.6 %, 1 % and 3.7 %) and papaya (1.5 %, 1% and 3.3 %) at farmers level, transportation and storage respectively and the major causes are pre harvest infection and injury. Furthermore, the handling and packaging material they are using are sacks in which there is no palletizing and large mass of commodity is tightly packed. The kind of transportation system is the use of pack animals and on the back of man and woman which leads to bruising during loading and unloading. In terms of market condition, most of the farmers sell their products on nearby markets and a few sells both on farm and in nearby markets. The marketing condition is unsatisfactory, discouraging mainly because higher supply of the product and middle man exploitation and the nature of the crop that makes to deteriorate fast and absence of storage structure. In other study of tomato postharvest loss, the farmer harvest when they have buyer, harvest at fully ripe stage and most still use traditional basket and sacks as their packaging material in conveying produce that leads to massive postharvest losses (62.5 %) [5,6].

The postharvest quality of avocados in general is limited by mechanical damage, soft landing, uneven ripening, chilling injury (CI), grey pulp, vascular browning and insects. The prevalence of these constraints facilitates loss in cosmetic appeal and the development of fruit decay. To extend the shelf life of avocados, fungicide applications are predominantly applied to arrest fruit decay development. Fungicides typically kill fungi by disrupting the cell membranes, deactivating critical enzymes processes, and disturbing key energy production including respiration [7].

Mango is a highly perishable fruit. The perishability of the fruit is attributed to rapid deterioration after harvest. It is also susceptible to insect-pest infestation and decay causing postharvest losses due to lack of proper pre-harvest management as well as postharvest practices. Mango has a short shelf life and is vulnerable to environmental stress especially high temperature. Considerable quantities of mangoes are being lost every year during harvesting, transport and marketing. It is reported that 35-38% postharvest losses occur due to inefficient and mismanagement of mango during its transportation, storage, and marketing. The quality and marketability of fruits are directly correlated with different factors including proper maturity stages, harvesting time and technique, postharvest treatment, handling procedures and mode of transport. The aim of this study was to assess the postharvest handling techniques in the wereda on Tomato, Avocado and Mango for reducing the postharvest losses in the district [8-11].

Material and Methods

The study was conducted at Wendogent Wereda, sidama region, Ethiopia. The area was selected based on the project goals and objective. 4 kebeles were selected among 12 kebeles by using production potential of Tomato, avocado and mango crops considered and the samples were distribution to all direction of the woreda. From selected four kebeles 400 household were selected based on: Production of the crops, Population number Land size and gender (>30%). By using total land size and

population number the 400HH were divided in to four kebeles by proportional and finally their average was used as sample size. Based on the explained assumption the distribution was done as follows for four selected kebeled in the wered. Baja Fabirka Kebele 120, Wotera Qachama Kebele 110, Aruma Kebele 70 and Yuwo Kebele 100 house hold were selected for the interview by using the standard questionnaire that was pre-tested before. Purposive sampling method was used to select fruit production and. A total of 400 sample farmers were selected from the four fruit and vegetable producing districts. The research samples included a total of 400 farmers that were selected randomly. Semi-structured questionnaire was prepared both for farmers. Data analysis was made using statistical software (SPSS version 22). Descriptive data analysis; mean, minimum, maximum values, standard deviation and percentages were computed. Tables, graphs and charts were used to display results of the research findings.

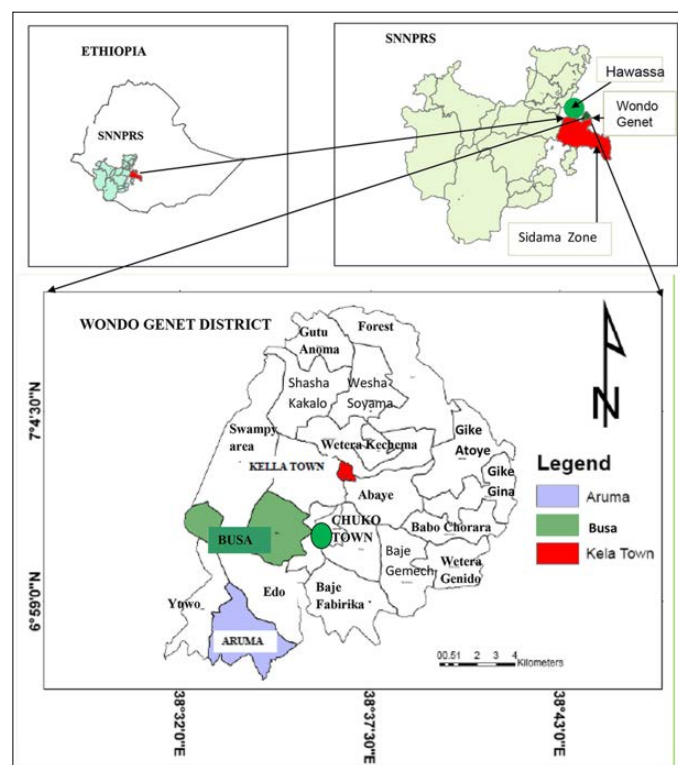


Figure: Map Showing the Study Area

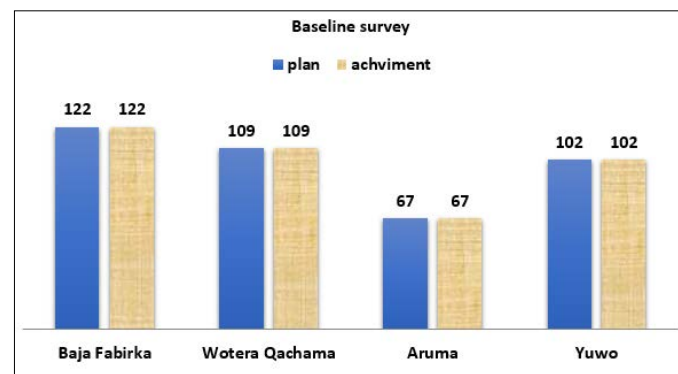
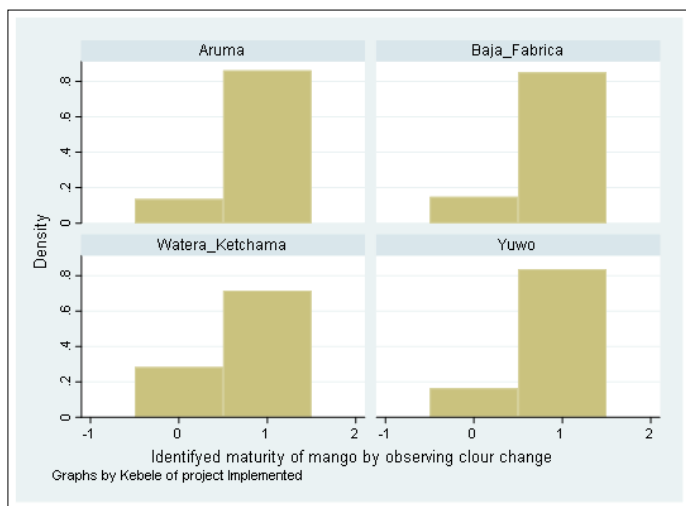


Figure: Summary table for sampling in each kebele the planned sample size and achievement

Results and Discussion

Postharvest Management

Determination of Mango avocado and tomato Maturity on the farm
 Determination of Mango Maturity on the farm



Mango Maturity by Color Change

Identified Maturity of Mango by Observing Color Change	Freq.	Percent	Cum.
NO	74	18.50	18.50
Yes	326	81.50	100.00
Total	400	100.00	

Around 81.5 % of the respondent responded that they used the color to identify the maturity of mango at farm in all selected kebeles. The rest of the respondent used others criteria to now weather the mango is matured or not before the harvest. The 18.5% of respondent used the others criteria that may bring the postharvest loss of mango.

Mango Maturity Size

Identified Maturity of Mango by Observing Size	Freq.	Percent	Cum.
NO	117	29.25	29.25
Yes	283	70.75	100.00
Total	400	100.00	

The size of the mango was one of the criteria to harvest the mango. From the total 400 respondents, 71% responded that they used the size as an identification criterion to harvest the mango. The rest of the respondents 21% was used others criteria or it might be without any identification they harvest. This is one of the factors that may bring the postharvest losses on mango as specific area.

Mango Maturity for Market Price

Identified Maturity of Mango by Observing the Market Price	Freq.	Percent	Cum.
NO	316	79.00	79.00
Yes	84	21.00	100.00
Total	400	100.00	

The market price is the driving force for the farmers to harvest mango, about 79 % of the respondent responded that they did not used the market price for the harvesting but some few of the farmers 21 % used as the criteria to harvest the mango. Once the

harvesting time was reached it is not possible to wait the market price because loses May start it, we keep the mango more time on the farm.

Mango Maturity by Market Demand

Identified Maturity of Mango by Observing the Market Demand	Freq.	Percent	Cum.
NO	332	83.00	83.00
Yes	68	17.00	100.00
Total	400	100.00	

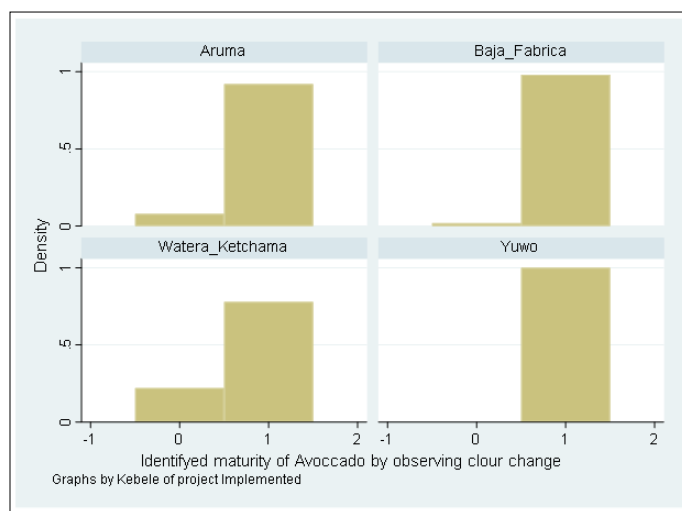
The demand on the market did not used as a criterion for harvesting of mango, as a result 83% of the farmers responded that they did not uses this as criteria for harvesting. The remained 17% used as a base to harvest the mango from their farm.

Mango Maturity by Texture

Identify Maturity of Mango by Observing Its Rough Surface	Freq.	Percent	Cum.
NO	321	80.25	80.25
Yes	79	19.75	100.00
Total	400	100.00	

From the total respondents 80% responded that they used texture or rough surface to identify weather the mango was ready to harvest or not. The rest 20% used other criteria for harvesting the mango.

Determination of Avocado and Tomato Maturity on the Farm



Avocado Fruit Color Change

Identified Maturity of Avocado by Observing Color Change	Freq.	Percent	Cum.
No	68	17.71	17.71
Yes	316	82.29	100.00
Total	384	100.00	

The color change was one of the criteria to now weather fruits are ready to harvest or not. From the total respondent 82 % of the respondent responded that they used color to identify the maturity of avocado, in this case the change of color from green to red is the optimum maturity time for harvesting but for some few varieties which are green in color even if they are matured, the delay to harvest by keeping the color change to red brings the losses at the farm level. The rest of the respondent was not used

the color change as an indicator for harvesting. This might be the cause for losses at the farm level because they are waiting some others criteria to harvest.

Avocado Fruit Size

Identified Maturity of Avocado by Observing Size	Freq.	Percent	Cum.
No	118	30.73	30.73
Yes	266	69.27	100.00
Total	384	100.00	

Out of the total respondents 69% responded that they used size for determination of the harvesting time for avocado. The size change or increment when the time or the calendar date increases the size of avocado also increases. If they are small in size this indicated the avocado was not yet matured and ready to harvest. The rest of the respondent, 31% did not used size for avocado maturity indication for harvesting. They might use the other methods or simply they harvest without any harvesting indicator. This is the factor for postharvest losses regarded to the size for avocado harvest indicator.

Avocado Calendar Date

Identified Maturity of Avocado by Observing Keeping with Calendar	Freq.	Percent	Cum.
NO	345	89.84	89.84
Yes	39	10.16	100.00
Total	384	100.00	

Out of the total respondent 90% responded that they did not use the calendar for harvesting Avocado. For perennial fruit crops and fast rotation vegetables grown in seasonal climates which are more or less uniform year to year, calendar date for harvesting is a reliable guide to commercial maturity. This means that the days from planting or days from flowering. For some crops the chronological method is refined by calculating accumulated heat units during the growing period which modulates the chronological index according to the weather pattern during the growing season. So, the majority of the farmers were not kept the avocado to stay until the date reaches to harvest. This means that they harvest early than the optimum maturity date. In this case the immature avocado was harvested and the losses existed due to early harvest before the end on the maturity time. This indicated that 90 % losses existed due to the calendar date. The remained 10% knows about the exact calendar date for harvesting avocado.

Avocado Maturity Market Price

Identified maturity of Avocado by observing the market price	Freq.	Percent	Cum.
NO	303	78.91	78.91
Yes	81	21.09	100.00
Total	384	100.00	

About the market price for determining harvesting time for avocado, 79% of respondent's did not use the market price as an indication for harvesting. This means they harvest at any time even the price of avocado was cheap, this might be as a result of the farmer do not have the technique to preserve like cold storage facility in their home or nearby. So, they sell the product in the cheaper price because the market price and the harvesting time was not inline. The rest 21% of the respondent was used the

market price as an indicator for harvesting avocado. The avocado stay on farm until the price reaches to the reasonable level of the surrounding market in the selected district of avocado producing farmers.

Avocado Maturity Form Market Demand

Identified Maturity of Avocado by Observing the Market Demand	Freq.	Percent	Cum.
NO	318	82.81	82.81
Yes	66	17.19	100.00
Total	384	100.00	

For harvesting of avocado 83% of the respondent responded that they did not experience the market demand. They harvest the without having the information about the price and the de-mand on the market, if the consumers are in need or not. As a result, the products were har-vested without the interest of the consumers or without the season of the need from the mar-cket side. This brings the product do not have the price on the market and the losses of the product existed. The rest 17% of the respondent harvest the product based on the demand from the market side.

Avocado Maturity by Tree Physiology

Identified Maturity of Avocado by Observing the Tree Physiology (Falling of Flow)	Freq.	Percent	Cum.
NO	302	78.65	78.65
82	82	21.35	100.00
Total	384	100.00	

Physiology of the product was one of the indicators to identify the harvesting time. About 79% of the respondent do not used the physiology of avocado for determining the harvesting time. The rest 21% of the respondent used the physiology as an indicator for harvesting.

Harvesting Techniques of Mango, Avocado and Tomato Maturity on the Farm

Mango

Mango Hand picking

Harvesting Mango by Hand picking	Freq.	Percent	Cum.
NO	67	18.61	18.61
Yes	293	81.39	100.00
Total	360	100.00	

For the purpose of harvesting mango from the mothers' tree 81% of respondent used hand picking. The rest 19% used other techniques for harvesting the mango. The majority of farmers harvest by using hand, this is the factors to bring the losses and there are no technological applications for harvesting in the area for mango. For this reason, the harvesting technology should be considered to reduce the losses in mango on the selected area.

Mango Harvesting Machines

Harvesting Mango by Machines	Freq.	Percent	Cum.
NO	322	89.44	89.44
Yes	38	10.56	100.00
Total	360	100.00	

About 89 % of the respondent did not used harvesting machine for mango harvesting. This indicates that they harvest manually or by shaking the mother tree by using man power. This is some of the factors that may bring the losses for mango on the time of harvesting. Only 11 % of the respondent responded that they used some local machine for harvesting the mango from the mother tree. So, nearly the large amount of the losses on fruit and vegetables existed as a result of traditional application of the harvesting practice. This is the new area for farmers for thinking to use new harvesting technology to reduce losses during harvesting.

Mango Shaking Trees

Harvesting Mango by Shaking the Trees	Freq.	Percent	Cum.
NO	176	48.89	48.89
Yes	184	51.11	100.00
Total	360	100.00	

Harvesting of mango has many options in the selected area and some of the locally used harvesting techniques have its own side effect on the quality of harvested mango as a result of losses. About 51% of the respondent used the shaking of tree for harvesting mango. This indicated that majority of the farmers shake the tree for harvesting, this may cause the bruising and breakage of the mother tree as a result the yield of the coming years decreased because the bruising on the tree in the case of shaking. The rest 49% of the respond said that they used other ways for harvesting the mango.

Mango Beating with Long Sticks

Harvesting Mango by Beating the Tree with Long Sticks	Freq.	Percent	Cum.
NO	151	41.94	41.94
Yes	209	58.06	100.00
Total	360	100.00	

Beating long sticks for harvesting is the major practice the country for majority of fruit. Regarding the mango 58% of the respondent said that they use the beating for harvesting mango fruit from the major tree. This brings the quality deterioration and the cause for the postharvest losses the area. In the time of beating the breakage of the mango existed, which was one of the indicators for the quality losses. The rest 42 % of the respondent responded that they did not used beating long sticks for harvesting mango. They may use other techniques like hand picking or shaking of the tree.

Mango Picking Fallen Fruits

Harvesting Mango by Picking Fallen Fruits from the Ground	Freq.	Percent	Cum.
NO	272	75.56	75.56
Yes	88	24.44	100.00
Total	360	100.00	

The majority of the respondent did not pick mango from the ground after they fall on it. Around 76% responded they do not pick from the ground. This means they harvest the fruit from the mother tree by using different harvesting techniques. The rest 24% pick the mango from the ground after they fall. This is the indication for the losses because the fruit starts to fall if they are started to ripe and approached for post-harvest senescence and losses.

Avocado

Avocado Hand Picking

How do you harvest avocado	Freq.	Percent	Cum.
NO	64	17.98	17.98
Yes	292	82.02	100.00
Total	356	100.00	

For harvesting of avocado 82% of respondent responded that they user hand picking from the mother tree. The rest of the respond 18 % used other techniques for harvesting. The majority of the response showed that the traditional hand picking was the dominate practice to harvest avocado. This indicates that the stage for the harvesting was not clearly assessed and identified when they pick. Most of the time hand picking is not recommended for harvesting as a result the quality of the final product was not as intended standard. As it is known that avocado was one of commercial product for processing in the industrial park. So that the quality should be maintained to the best standard for quality processed products for export market because the oil of avocado was one of the export commodities in Ethiopia as a source of foreign currency for the country. So, the need for technology application for harvesting is mandatory rather than hand picking.

Avocado Harvesting Machines

Harvesting by using Machine	Freq.	Percent	Cum.
NO	320	89.89	89.89
Yes	36	10.11	100.00
Total	356	100.00	

The farmers responded that majority of them did not used harvesting machine for avocado. 90 % of respondent responded that they did not use any machine to harvest and they simply used hand picking. The rest 10% used different harvesting machine for harvesting purpose. The loss of avocado is due to poor harvesting techniques, which is dominated by hand.

Avocado Shaking Trees

Harvesting by Shaking	Freq.	Percent	Cum.
NO	170	47.75	47.75
Yes	186	52.25	100.00
Total	356	100.00	

52% of respondent responded that they did used shaking of the tree for harvesting purpose of avocado. The rest 48% used other harvesting methods. Majority used shaking; this is the result of breaking and bruising the mother tree. So shaking is the side of the mother tree for the temporary harvesting process.

Avocado Beating with Long Sticks

Harvesting by Beating	Freq.	Percent	Cum.
NO	169	47.47	47.47
Yes	187	52.53	100.00
Total	356	100.00	

53% of the respondent responded that they used beating with long sticks for harvesting avocado. The rest 47% used other harvesting technique for harvesting avocado. Beating with stick brings the breakage of avocado as a result the quality of final avocado was reduced.

Avocado Picking Fallen Fruits

Picking Fallen Tree	Freq.	Percent	Cum.
NO	272	76.40	76.40
Yes	84	23.60	100.00
Total	356	100.00	

76% of respondent responded that they did not pick the fallen fruit from the ground. The rest 23% pick from the ground. This is factors for losses of avocado because collection from ground brings the attack of avocado by insects and also the spoilage on the ground by dust and other foreign matter may exist.

Harvesting Time of Fruits and Vegetables

Any Time

Usually Harvest My Fruits and Vegetables Any Time of the Day	Freq.	Percent	Cum.
NO	188	49.74	49.74
Yes	190	50.26	100.00
Total	378	100.00	

The respondent was responded that about harvesting time of fruit and vegetable 50 % responded they harvest any time of the day. This indicates that the harvest in the morning, afternoon or evening. The harvesting time for fruit and vegetables was one of the factors for spoilage because immediately after harvesting they are still alive and the metabolic activity like respiration and transpiration were still active so the fast decay and senescence undergoes in this time. The remaining 50 % of respondent harvest their fruit and vegetables by their specific time of the day.

Early Morning

Usually Harvest My Fruits and Vegetables Early Morning of The Day	Freq.	Percent	Cum.
NO	219	57.94	57.94
Yes	159	42.06	100.00
Total	378	100.00	

The respond responded that about 58% did not harvest their fruit and vegetables in the morning. The morning harvesting id one of the best techniques to reduce the postharvest losses because in this time of the day the metabolic path of respiration and transpiration may be reduces as a result of low temperature of the day. So, if they did not harvest in the morning this may be the cause for the losses of the high about of the products. The rest of the respondent 42% responded that they used morning session for harvesting fruit and vegetables. But majority of the responded indicated that the losses of fruit and vegetables existed if they did not harvest in the morning on the reduced temperate of the day.

Later Morning

Usually Harvest My Fruits and Vegetables Later Morning of The Day	Freq.	Percent	Cum.
NO	303	80.16	Yes
Yes	75	19.84	100.00
Total	378	100.00	

About 20% of respondent responded that they used later morning for harvesting of fruit and vegetables. The rest 20% did not harvest the fruit and vegetables of later morning. This later morning was

also the time of relatively high temperature time, so it is not recommendable for harvesting but majority of the responses laid on this category. It may be also the factor for the spoilage of the fruit and vegetables due to the temperature of the day increment in the stated time of the day.

Early Afternoon

Usually Harvest My Fruits and Vegetables Early Afternoon of The Day	Freq.	Percent	Cum.
NO	318	84.13	84.13
Yes	60	15.87	100.00
Total	378	100.00	

The responded asked about harvesting at early afternoon, 84% responded that they did not harvest in this time of the day. This is one of the good practices of the farmers because in this time the temperate was high and it may also increase the rate of respiration and transpiration so the day and spoilage may facilitate by this increase temperature. The rest 15% responded that they used early afternoon for harvesting.

Later Afternoon

Usually Harvest My Fruits and Vegetables Later Afternoon of The Day	Freq.	Percent	Cum.
NO	372	98.41	98.41
Yes	6	1.59	100.00
Total	378	100.00	

About 98% of respondent did not harvest the fruit and vegetables later afternoon. This is one of the good practices to reduce the losses. This time is somewhat hot and there is also the breakage of the commodity may exist. The rest of 2% harvest fruit and vegetables later afternoon.

Collection and Storage Materials

Traditional Baskets

I Use Tradition Basket Types Containers for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	74	19.79	19.79
Yes	300	80.21	100.00
Total	374	100.00	

The majority 80% of respondent used traditional basket type containers for collection and storage of fruit and vegetables. The remaining responded that they did not use this type of container for collection and storage purpose. It is indicated on the figure above majority of the used traditional ways for collection, they did not used any improved materials for collecting and storing the products. This traditional way is one of the factors for losses in the tropics due to high temperature and humidity. So, it needs the application of improved and advanced technology for storage like a king of cold storage for extending the shelf stability of this perishable fruit and vegetables as a result it improves the income of the farmers and largely the economy of the country.

Using Sacks

I Use Sack Types Containers for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	217	58.02	58.02
Yes	157	41.98	100.00
Total	374	100.00	

For collection and storage of fruit and vegetables 58% of respondent did not used sacks for the purpose but the remained 42% used for collection and storage purpose. Sacks is not recommended for fruit and vegetable because they contain high about of water as a result it may bring the bruising and damage of fruit and vegetables instead is best if they used rack for collection and storage.

Using Timber Crates

I Use Timber Crate Container for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	344	91.98	91.98
Yes	30	8.02	100.00
Total	374	100.00	

About 8 % of respondent used timber crates for collection of fruit and vegetables the other 91% did not used these materials for collection and storage purpose.

Using Plastic Crates

I Use Plastic Crate Containers for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	339	90.64	90.64
Yes	35	9.36	100.00
Total	374	100.00	

For collection purpose 91% of the respondent responded that they did not used plastic crates. The rest 9 % used this plastic crate for collecting fruit and vegetable.

Using Cardboard boxes

I Use Cardboard Containers for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	344	91.98	91.98
Yes	30	8.02	100.00
Total	374	100.00	

From the total respondent 92% did not used cardboard box for collecting and storage purpose of fruit and vegetables. The rest 8 % of the responded used cardboard box for collecting and storing fruit and vegetables in the selected area.

Using Pliable Plastics

I Use Pliable Plastic Types Containers for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	365	97.59	97.59
9	9	2.41	100.00
Total	374	100.00	

Only 2 % of respondent used pliable plastic for collecting and storing fruit and vegetable. The other respondent 98% did not use these materials for collecting and storing fruit and vegetable.

Using Rigid Plastics

I Use Rigid Plastic for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	366	97.86	97.86
Yes	8	2.14	100.00
Total	374	100.00	

From the total respondent 98% responded that they did not used rigid plastics for collecting and storing fruit and vegetable. The rest 2 % of the respondent responded that they used rigid plastics for collection and storage of fruit and vegetables in the selected area.

By Bulking

I Use Bulking for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	356	95.19	95.19
Yes	18	4.81	100.00
Total	374	100.00	

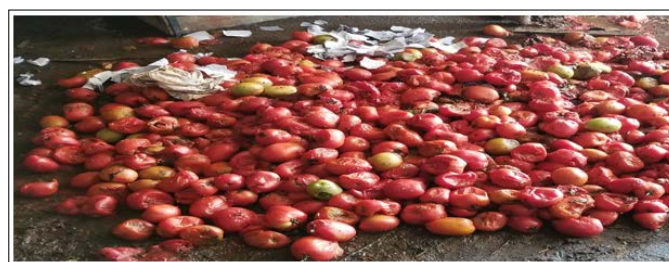
The interviewed respondent responded that about 95% did not use just bulking for fruit and vegetable collection and storage purpose. The others 5% of the responded that they used bulking for collecting fruit and vegetables.

Need Packaging

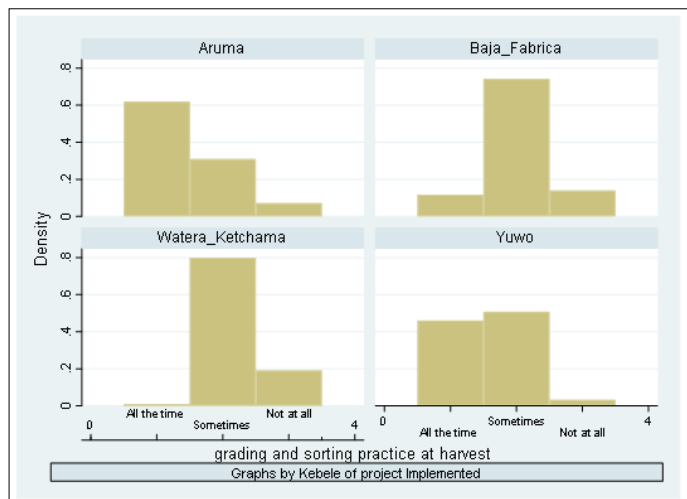
I Don't Use Any Packaging for My Fruits and Vegetables	Freq.	Percent	Cum.
NO	353	94.39	94.39
Yes	21	5.61	100.00
Total	374	100.00	

About the need and importance of packaging fruit and vegetables, 94% of the respondent responded that they do not need any packaging for fruit and vegetables in their home. The rest only 6 % need packaging for fruit and vegetables in their home after harvesting. Packaging is one of the methods to reduce the postharvest losses of perishable fruit and vegetable by reducing the entrance of any spoilage agents from the surrounding and also reduce the excess removal of water from fruit and vegetables for the surrounding environment.

Figure Show Some Postharvest Loss Indication on Tomato



Grading and Sorting Practice at Harvest



All time

I Practice Grading and Sorting All the Time at Harvest	Freq.	Percent	Cum.
NO	249	70.34	70.34
Yes	105	29.66	100.00
Total	354	100.00	

The entire respondent asked about grading and sorting of fruit and vegetables in the time of harvesting. Out of the total respondent 70% responded that they sort and grade all the time during harvesting. This practice is very important for identifying the damaged, un matured and different sized fruit and vegetables and also used for commercial purpose to categorize products based on their identity. The rest 30% of respondent responded that they did not used grading and sorting at all time. This may cause the losses of fruit and vegetable during postharvest practices, because the damaged, unripe and different sized products are harvested together and transporting for storage. This may cause the transmission of unwanted waste from unripe, damaged to the normal fruit and vegetables, if it is not sorted in the time of harvesting.

Sometimes

I Sometime Practice Grading and Sorting at Harvest	Freq.	Percent	Cum.
NO	133	37.57	37.57
Yes	221	62.43	100.00
Total	354	100.00	

From the total respondent 62% of the respondent practice grading and sorting sometimes at harvest. The rest 38% did not used this practice some times. The majority of the response indicated that sometimes based on the need they are practicing this sorting and grading. If they are not using this practice still it is one of the factors for postharvest losses in the case of fruit and vegetables. So, it is the need for practicing sorting and grading at any time during postharvest practice of fruit and vegetables.

Not at all

I Don't Practice Grading and Sorting at Harvest	Freq.	Percent	Cum.
NO	312	88.14	88.14
Yes	42	11.86	100.00
Total	354	100.00	

The respondent responded about the usage of grading and sorting at all time. About 88% responded that they are not practicing this activity all of the time but the remaining 12% responded that they are practicing this postharvest activity all of the time.

Criteria used to Practice Grading or Sorting

Size Criteria

Size of the Fruit/Bulb/Tuber	Freq.	Percent	Cum.
NO	106	29.36	29.36
Yes	255	70.64	100.00
Total	361	100.00	

The respondent asked about the criteria used for grading and soring. Majority about 71% use size for grading and soring purpose for fruit and vegetables. The rest 29% of respondent responded that they did not used size for grading and soring. They may use other criteria for sorting and grading in the case of fruit and vegetable.

Damages Criteria

Damages On the Fruits/Bulb/Tuber	Freq.	Percent	Cum.
NO	214	59.28	59.28
Yes	147	40.72	100.00
Total	361	100.00	

About 59% of respondent responded that they did not used damage as a criterion to sort fruit and vegetables but the rest 40% used this damage for grading and sorting of fruit and vegetables.

Color Criteria

Colors	Freq.	Percent	Cum.
NO	148	41.00	41.00
Yes	213	59.00	100.00
Total	361	100.00	

From the total response about 59% of respondent used color for grading and sorting fruit and vegetables. This is due to that the color of fruit and vegetables easily indicate the ripe and unripe. So, this is knowledge helps the farmers to reduce postharvest losses by harvesting the ripe by using color as an indicator for ripeness purpose. The remained 41% did not used color for grading and soring of fruit and vegetables in the case of postharvest practice.

Shape Criteria

Shape	Freq.	Percent	Cum.
NO	189	52.35	52.35
Yes	172	47.65	100.00
Total	361	100.00	

From the total respondent about 48% used shape of fruit and vegetable for grading and sorting purpose. The rest 52% did not

used shape for grading and sorting purpose. Shape for fruit and vegetables are one of the common indicators to check whether fruit and vegetables are ripe or not but the majority of the responded indicated that they did not used shape for grading and sorting purpose.

Ripe Criteria

Ripeness stage	Freq.	Percent	Cum.
NO	331	91.69	91.69
Yes	30	8.31	100.00
Total	361	100.00	

The majority about 92% of respondent response indicated that ripeness stage was not used as criteria for grading and sorting fruit and vegetables. Over ripe or unripe is one of the important factors to cause postharvest losses for fruit and vegetables. This might be the cause of the majority losses on the farmers in the case of harvesting because they did not know about the exact ripeness period to harvest. The rest only 8% of the farmers used ripeness as an indicator for grading and sorting of fruit and vegetable.

Fruits Losses at Harvesting

Do You Have Fruits and Vegetable Losses During the Last Harvesting Season?	Freq.	Percent	Cum.
No	158	41.58	41.58
Yes	222	58.42	100.00
Total	380	100.00	

Losses during harvest in the last cropping season, majority around 58.4 % of the farmers have experienced the losses for fruit and vegetables in the past harvesting season. These losses were estimation of the losses in each year approached to more than half of the fruit and vegetables were lost in the chain of postharvest management. This showed us the need for technology for improving the postharvest management in the selected area. The other issue here was it is not in one-year loss but the figures are in each year losses.

Loss Occur at Farm During Harvest

How Much Loss Occurred at the Farm During Harvesting?	Freq.	Percent	Cum.
Less than 5%	173	49.86	49.86
Between 6 and 10%	66	19.02	68.88
Between 11 and 15%	37	10.66	79.54
Between 16 and 20%	39	11.24	90.78
More than 21%	32	9.22	100.00
Total	347	100.00	

The total losses estimation in each value chain showed the area of intervention in each postharvest activity. From the total respondent 50 % responded that the losses at the farm during harvesting were only 5%. It is assumed that the other remained number of losses occurred after harvesting. This included: transportation, storage, processing, marketing and so on.

Cause of Loss Harvesting Method

Harvesting Method Used	Freq.	Percent	Cum.
NO	132	36.87	36.87
Yes	226	63.13	100.00
Total	358	100.00	

The respondent assumed that the cause of losses for fruit and vegetable were harvesting methods. This answer assured from out of the total respondent, 63% of the responses were indicates the harvesting methods for fruit and vegetable postharvest losses were the major factor.

Cause of Loss by Improper Handling

Improper Handling	Freq.	Percent	Cum.
NO	174	48.60	48.60
Yes	184	51.40	100.00
Total	358	100.00	

From the total respondent 51% responded that the improper handling was the factor for postharvest losses of fruit and vegetable. This handling technique included the ways of harvesting, transporting, storing, marketing and processing. In all the chains the handling was the most important area to reduce the postharvest losses of fruit and vegetable. The handling techniques should be by application of different technology recommended for the reduction of losses.

Cause of Loss Unfavorable Environment

Unfavorable Environmental Conditions (Rain, Hail, Wind, etc.)	Freq.	Percent	Cum.
NO	228	63.69	63.69
Yes	130	36.31	100.00
Total	358	100.00	

Regarding the losses in line with the environmental issue of food processing like wind, rain, only 36% responded that they assume this are the factor for losses but the majority of farmers 67% responded that they did not take this is the factor for losses in fruit and vegetables. This might be the reason behind the response where the respondent were farmers and they did not have any information about the processing company environmental issue related with the losses of fruit and vegetables.

Cause of Loss Pest

Pest	Freq.	Percent	Cum.
NO	291	81.28	81.28
Yes	67	18.72	100.00
Total	358	100.00	

From the total response around 81% did not assumed that pest cause the losses for fruit and vegetable. This was majorly for cereals and legumes but for fruit and vegetable the pest might be the dominant factor for postharvest losses in the farm.

Storage of Fruit and Vegetable after Harvest

Do You Store Your Fruits and Vegetable After Harvest?	Freq.	Percent	Cum.
No	221	58.47	58.47
Yes	157	41.53	100.00
Total	378	100.00	

About the storage of fruit and vegetable after harvest 58% of respondent were respondent that they do not have storage practice after harvest. This is as a result of the farmers do not have storage facility in their own home, so they search the market for selling the product in the lost price because the harvesting season the price for commodity were decreased. If the farmers have the storage facility for extending the shelf life for perishable fruit and vegetables, they might have the high price for selling the commodity. This indicated that if, the farmers have the postharvest handling technology, the probability for having the high price high. This is the good implication for improving the living standard for poor farmers.

Store Spreading

Store Fruits and Vegetable by Spreading on Flour After Harvest	Freq.	Percent	Cum.
NO	149	53.21	53.21
Yes	131	46.79	100.00
Total	280	100.00	

Only 46% of respondent responded that they spread fruit and vegetable on floor after harvest. This is not the recommended ways for perishable products. It was also the factor from postharvest losses in the time of harvesting. The floors by itself were not clean and safe for storage and also open for any insect and rodent attack.

Store Bulk piles

Store Fruits and Vegetable by Bulk Storage in Piles	Freq.	Percent	Cum.
NO	160	57.14	57.14
Yes	120	42.86	100.00
Total	280	100.00	

Only 43% of respondent responded that they used piles for storage of fruit and vegetables. This was not the common storage practice in the area of survey. The farmers were not having awareness in these ways of storage methods that reduce the postharvest losses for fruit and vegetable. But the piles methods used for storage not for fruit and vegetables but for cereals.

Store Stacking Bags

Store Fruits and Vegetable by Stacking Bags On One Another	Freq.	Percent	Cum.
NO	231	82.50	82.50
Yes	49	17.50	100.00
Total	280	100.00	

Form using Stacking bags on fruit and vegetables only 17.5 % of the total responded that they used these bags for reducing postharvest losses for fruit and vegetable. The rest and the major figure from the respondent showed that they did not used this bag for storage. This might be the factor for high losses in the production area for fruit and vegetables.

Store Stacking Wooden Crates

Store Fruits and Vegetable by Stacking Wooden Crates	Freq.	Percent	Cum.
NO	219	78.21	78.21
Yes	61	21.79	100.00
Total	280	100.00	

From the total response only 22% of respondent used Stacking wooden crates for storing fruit and vegetable. So, the major figure from the respond not used these materials for storing fruit and vegetables.

Store Stacking Plastic Crates

Store Fruits and Vegetable by Stacking Plastic Crates	Freq.	Percent	Cum.
NO	238	85.00	85.00
Yes	42	15.00	100.00
Total	280	100.00	

Only 15% of the respondent responded that they used Stacking plastic crates for storing fruit and vegetables in selected area. The remained big figure of the response indicated that they did not have such practice on the storage area for fruit and vegetables.

Store Cold Storage

Store Fruits and Vegetable by Cold Storage	Freq.	Percent	Cum.
NO	200	71.43	71.43
Yes	80	28.57	100.00
Total	280	100.00	

The farmers asked about the using practice of cold storage for fruit and vegetables to increase the shelf life. Because the perishability of fruit and vegetables are high when we compare from another commodity. The magnitude for losses in Ethiopia for fruit and vegetables were high. From the response of respondent in the surveyed area, only 29% of the respondent used the cold storage for fruit and vegetables for storage purpose. The major figure 72% of the respondents did not have cold storage facility for fruit and vegetables. This is the major factor for post-harvest losses in selected area in particular and in Ethiopia as general. So, the need of postharvest handling technology was very crucial and important for farmers to reduce the loss of fruit and vegetables.

Store Traditional Storages

Store Fruits and Vegetable by Traditional Storages	Freq.	Percent	Cum.
NO	195	69.64	69.64
Yes	85	30.36	100.00
Total	280	100.00	

About 30% of the respondent responded that they used traditional storage for fruit and vegetables. This storage technique was the factor for postharvest losses because the farmers using the simple tradition for storage. The ways of practicing were exposed to spoilage factors in many ways.

Store Leaving Un Harvested

Store Fruits and Vegetable by Leaving Unharvested	Percent	Percent	Cum.
NO	268	95.71	95.71
Yes	12	4.29	100.00
Total	280	100.00	

Only 4% of respondent responded that they leave un harvested fruit and vegetables on farm for some times. They wait some time on farm to keep the commodity on farm storing practice.

How Long do you Store Fruits and Vegetables?

How Long Do You Store Before Selling Out Your Fruits and Vegetables?	Freq.	Percent	Cum.
Less than a week	240	76.43	76.43
Two to 3 weeks	53	16.88	93.31
Three to 4 weeks	12	3.82	97.13
Longer than 4 weeks	9	2.87	100.00
Total	314	100.00	

After harvesting the storage period for fruit and vegetables was asked for the farmers. Nearly about 76% of them responded that they store for less than a week in different storage ways. This is as a result they did not have postharvest handling technology for storing fruit and vegetables in good manner. So, this is one of the implications for the need of postharvest handling technology for fruit and vegetables for reducing post-harvest losses.

How Much was the Estimated Loss During?

How Much was the Estimated Loss During Storage?	Freq.	Percent	Cum.
Less than 5%	158	50.32	50.32
Between 5 and 10%	58	18.47	68.79
Between 10 and 15%	36	11.46	80.25
Between 15 and 20%	31	9.87	90.13
More than 20%	31	9.87	100.00
Total	314	100.00	

The respondent asked about the estimation of losses in storage and 50% responded that less than 5% of the magnitude of postharvest losses existed at storage.

Less value addition facility for fruit and vegetables increased postharvest loss due to the long period storage on improper storage materials and technology.



Transportation of Product from Farm to Storage

Do You Usually Transport Your Product from Farm to Storage/ Market?	Freq.	Percent	Cum.
No	165	43.65	43.65
Yes	213	56.35	100.00
Total	378	100.00	

The respondent responded that about 56% transport the product usually from farm to storage and market by using different methods. In this time the transportation was not in cold system, the product can easily get spoiled and the magnitude of postharvest losses was high. So, transportation was one of the areas that needs due attention to reduce losses for perishable fruit and vegetables.

Transport Pack Animals

Pack	Freq.	Percent	Cum.
No	165	43.65	43.65
Yes	213	56.35	100.00
Total	378	100.00	

Around 36% of respondent responded that they used pack animals for transporting fruit and vegetables from farm to different places. Pack animals did not have preservation mechanism or cold storage so, this way also brings the losses in the whole transportation system.

Transport Handy carts

Handy carts	Freq.	Percent	Cum.
NO	231	62.43	62.43
Yes	139	37.57	100.00
Total	370	100.00	

The respondent response on the usage of handy carts for transportation indicated that only 38% of the respondent used this cart for this purpose.

Transport Animal Pulled Carts

Animal pulled carts	Freq.	Percent	Cum.
NO	169	45.68	45.68
Yes	201	54.32	100.00
Total	370	100.00	

The major figure around 54% of the respondent response showed that they used animal pulled carts for transportation purpose. This major share might be the dominant factor for factor to postharvest losses in fruit and vegetables. From this transportation one of the big factors that bring the losses. The mechanism of transporting was the area it needs intervention for reducing the postharvest losses in the area.

Transportation by Vehicles

Vehicles	Freq.	Percent	Cum.
NO	309	83.51	83.51
Yes	61	16.49	100.00
Total	370	100.00	

From the total response only 16% of respondent used vehicle for transportation purpose. The rest of them used other local ways of transporting fruit and vegetables.

Transport Labor force

Labor force	Freq.	Percent	Cum.
NO	254	68.65	68.65
Yes	116	31.35	100.00
Total	370	100.00	

From the total respondent around 31% used labor force for transporting the products from place to place. This is also one of the factors to increase the postharvest losses for fruit and vegetables. No technology application was existed in the human power.

Estimated Losses Transporting

How Much was the Estimated Loss During Transportation?	Freq.	Percent	Cum.
Less than 5%	181	52.16	52.16
Between 5 and 10%	72	20.75	72.91
Between 10 and 15%	32	9.22	82.13
Between 15 and 20%	32	9.22	91.35
More than 20%	30	8.65	100.00
Total	347	100.00	

Estimation of postharvest losses on transportation, the respondent responded that, it was less than 5%. The other losses existed in other value chains.

Have you Ever Received Fruits and Vegetable Training

Have You Ever Received Any Training on Postharvest Loss preventions for fruits and vegetables?	Freq.	Percent	Cum.
No	297	78.16	78.16
Yes	83	21.84	100.00
Total	380	100.00	

About the need of training on postharvest loss preventions for fruit and vegetables, Majority of the respondent 78% responded that they did not receive any training regarding the prevention of the losses. This might be the reason for high magnitude of postharvest losses in the area. The other issue in line with low awareness on the loss's reduction technique, it also brought the farmers do not pay attention for applying the technology for loss reduction. This is the gap that needs the intervention, to improve the awareness by delivering training and also to support on the application of postharvest handling technology.

Training Need on Harvesting

Harvesting	Freq.	Percent	Cum.
NO	83	23.92	23.92
Yes	264	76.08	100.00
Total	347	100.00	

From the respondent 76% response indicated that they need training on the harvesting technique for fruit and vegetables. They were practicing the traditional harvesting mechanism and the need for improved or by applying modified technology was the need of the respondent. This might also reduce the postharvest losses for fruit and vegetables. The magnitude for losses stated from farm harvesting to the final value chain for the producers.

Training Need on Cleaning & Sorting

Cleaning and sorting	Freq.	Percent	Cum.
NO	181	52.16	52.16
Yes	166	47.84	100.00
Total	347	100.00	

Around 48% of the respondent responded that they need training on cleaning and sorting of fruit and vegetables. This was the way to remove the defect from the commodity and also to screen in the same size for further processing activity.

Training needs on Packaging & Storage

Packaging and Storage	Freq.	Percent	Cum.
NO	171	49.28	49.28
Yes	176	50.72	100.00
Total	347	100.00	

The response of 51% respondent showed the needs of training on Packaging and storage for fruit and vegetables. The packaging materials bring the postharvest loss if they are not food graded and in line with the standard by the food standardizing organization. The storage in the other hand also brings the losses due to insect and rodent attack in the storage room.

Training needs on Transportation

Transportation	Freq.	Percent	Cum.
NO	159	45.82	45.82
Yes	188	54.18	100.00
Total	347	100.00	

From the total respondent about 54% of them responded that they need training on transportation of fruit and vegetables. They assumed that the postharvest loss for fruit and vegetables were due to the factors related with inappropriate ways of transportation. The use of cold storage in the area was not well known and also the capacity of farmers to have such technology was not in line with the financial source.

Training on Postharvest Treatments

Use of Postharvest treatments (Chemical)	Freq.	Percent	Cum.
NO	229	65.99	65.99
Yes	118	34.01	100.00
Total	347	100.00	

The respondent response indicated that only 34% of the farmers used chemicals treatment for reducing postharvest loss on fruit and vegetables.

Postharvest Treatment for Preservation

Do You Use Postharvest Treatments for Preservation?	Freq.	Percent	Cum.
NO	258	68.62	68.62
Yes	118	31.38	100.00
Total	376	100.00	

In general, from the total respondent only 31% of them used treatment for preservation purpose and to reduce postharvest losses in fruit and vegetables in the survey area.

Pesticide Chemical Spray

Chemical Spray	Freq.	Percent	Cum.
NO	181	72.69	72.69
Yes	68	27.31	100.00
Total	249	100.00	

The farmers responded that only 27% from the total response indicated that they use chemical spray for pesticide reduction. They spray the chemicals on fruit and vegetables for reducing the spoilage factors like rodents, insect's mites, rats and like.

Pesticide by Cleaning

Cleaning (washing)	Freq.	Percent	Cum.
NO	200	80.32	80.32
Yes	49	19.68	100.00
Total	249	100.00	

Only 20% responded that they used cleaning to remove pesticide from the commodity. This indicates that the cleaning is not well addressed in the area for improving the quality of the product. So, the need for cleaning is very important for the quality and safety of the products well as to remove foreign materials from the harvest fruit and vegetables.

Pesticide by Curing

Curing	Freq.	Percent	Cum.
NO	157	63.05	63.05
Yes	92	36.95	100.00
Total	249	100.00	

From the total response 37% indicated that they used curing for treatment of fruit and vegetables.

Pesticide by Cooling

Cooling	Freq.	Percent	Cum.
NO	160	64.26	64.26
Yes	89	35.74	100.00
Total	249	100.00	

Only 36% of the farmers used cooling for treatment of fruit and vegetables. This is not widely used because there were no cooling facilities in the area. The farmers do not afford this technology in their home. So, the need of simple technology that support cooling is recommended such as, pot in pot and cooling chamber.

Pesticide Sorting

Sorting out	Freq.	Percent	Cum.
NO	156	62.65	62.65
Yes	93	37.35	100.00
Total	249	100.00	

Only 37 % used sorting to reduce postharvest losses in the response.

Willingness to Pay Postharvest Technology

Are You Willing to Pay for Technologies to Reduce Postharvest Losses?	Freq.	Percent	Cum.
Definitely, I will buy	185	48.30	48.30
Yes, depending on price	126	32.90	81.20
Yes, I can rent?	34	8.88	90.08
No, I can't pay for it	38	9.92	100.00
Total	383	100.00	

The respondent response showed that from the total of the response 48 % of the respondents were willing to pay for technologies to reduce postharvest losses. These respondents indicated that they definitely accepted to buy the postharvest handling technology for reduction of losses on fruit and vegetables. These figures were one of indication for see the probability of bringing different technology for farmers and give awareness on it for further application. The other 32% buy the technology depends on the price. The rest 9% each want to rent and the other 9% do not want to buy any technology.

Insects in the Field

Insects In the Field a Was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	53	13.59	13.59
Not	70	17.95	31.54
Moderately	123	31.54	63.08
Severe	144	36.92	100.00
Total	390	100.00	

From the respondent asked about the insect cause the postharvest loss in the field; majority 36% responded insect cause severe losses of postharvest on fruit and vegetables on the field. The other 31% responded that it is moderately, the rest 17 % and 14% responded that they did not happen and not considered as the factor for spoilage.

Insects in the Storage

Insects In Storage Was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	46	11.76	11.76
Not	66	16.88	28.64
Moderately	199	50.90	79.54
Severe	80	20.46	100.00
Total	391	100.00	

The response of the respondent showed that the insect was the factor for cause of postharvest losses in storage. From the total response the majority 51% responded was in line with this truth.

Storage for fruit and vegetables was one of the areas mostly the loss existed and this loss dominantly due to a result of insect attack.

Molds in the Field

Molds in the Field was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	40	10.36	10.36
Not	93	24.09	34.46
Moderately	160	41.45	75.91
Severe	93	24.09	100.00
Total	386	100.00	

From the total respondent 41% responded that the cause of spoilage was due to mold in the field was moderate. The rest 24 % was severe and not happened and the rest 20% was indicated not spoilage due to mold. In this responded we see that the figure was relatively moderate for mold spoilage of fruit and vegetable. This from the general truth mold was dominantly existed in low moisture foods like cereals and legumes. The response from the farmers indicates the truth of the mold in fruit and vegetables were not severe but moderately existed.

Molds in Storage

Molds In Storage was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	44	11.55	11.55
Not	85	22.31	33.86
Moderately	162	42.52	76.38
Severe	90	23.62	100.00
Total	381	100.00	

The spoilage due to mold on storage was asked about the respondent. From the total the major share around 43% indicated that the mold was moderately existed on storage. This response showed us the existed-on storage higher than the other area to spoil fruit and vegetable brought the postharvest losses in the commodity. The respondent response categorized under severe, and not happened due to mold on storage.

Rodents in the Field

Rodents in the field was cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	75	19.48	19.48
Not	84	21.82	41.30
Moderately	141	36.62	77.92
Severe	85	22.08	100.00
Total	385	100.00	

The rodents were the factor for spoilage in the field. From the total respondent 37% responded that the losses due to rodent were moderate. 22% respondent that the cause for the postharvest losses due to rodent was severe. The rest of the response indicated that the losses were not due to rodents.

Rodents in Storage

Rodents in storage was cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	69	18.11	18.11
Not	82	21.52	39.63
Moderately	148	38.85	78.48
Severe	82	21.52	100.00
Total	381	100.00	

From the total respondent 39% responded that the postharvest loss due to rodents in storage was moderate, 21% was severe and the rest of the respondent responded that they did not happen on spoilage.

Other Animals

Other animals were cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	45	11.81	11.81
Not	92	24.15	35.96
Moderately	136	35.70	71.65
Severe	108	28.35	100.00
Total	381	100.00	

The respondent responded that about 36% responded that the losses due to animals were moderate, 28 % severe and the rest of the respondent responded that the postharvest losses due to animals were not happened.

Termites

Termites was cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	65	17.29	17.29
Not	77	20.48	37.77
Moderately	144	38.30	76.06
Severe	90	23.94	100.00
Total	376	100.00	

For the cause of post-harvest loss due to termites, 38% of respondent assumed that the cause was moderate. The other 24% assumed that the cause of postharvest loss due to termites was severe. The rest of the respondent responded that the postharvest loss was not happened due to termites.

Birds

Birds was cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	35	9.54	9.54
Not	87	23.71	33.24
Moderately	143	38.96	72.21
Severe	102	27.79	100.00
Total	376	100.00	

From the total respondent 39% responded birds moderately cause postharvest losses of fruit and vegetables. The other 29% assumed that the cause of postharvest loss due to birds was severe. The remained numbers indicated that they are not the factor of spoilage for fruit and vegetables.

Theft

Theft was cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	85	23.10	23.10
Not	73	19.84	42.93
Moderately	120	32.61	75.54
Severe	90	24.46	100.00
Total	368	100.00	

From the total response 33% responded that the cause for post-harvest loss due to theft was moderate and 24% was severe. The rest of the respondent showed that the cause for post-harvest loss was not due to theft.

Weather

Weather (rainfall, wind, etc.) was cause for post-harvest loss	Freq.	Percent	Cum.
Not happened	34	9.47	9.47
Not	69	19.22	28.69
Moderately	150	41.78	70.47
Severe	106	29.53	100.00
Total	359	100.00	

From the total respondent 42% responded that the cause for post-harvest loss due to Weather (rainfall, wind, etc.) was moderate. The rest 30% responded that the weather was the severe cause for postharvest loss. The remained respondent responded that wing was not the factor for spoilage.

Spillage Damaged Storage Containers

Spillage Damaged Storage Containers Was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	33	8.80	8.80
Not	78	20.80	29.60
Moderately	163	43.47	73.07
Severe	101	26.93	100.00
Total	375	100.00	

From the total respondent 43% responded that containers were the moderate cause for postharvest losses, 27% responded that it is severe. The rest of the respondent responded that the losses due to containers were not happened.

Harvesting Method

Harvesting Method Used was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	31	8.38	8.38
Not	64	17.30	25.68
Moderately	161	43.51	69.19
Severe	114	30.81	100.00
Total	370	100.00	

The respondent responds on the methods of harvesting, 44% was responded that is where moderate and 31% said that is severe. The rest of the response showed that is not the causative factor for losses.

Cleaning Method used

Cleaning Method Used Was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	30	8.17	8.17
Not	74	20.16	28.34
Moderately	166	45.23	73.57
Severe	97	26.43	100.00
Total	367	100.00	

From the total respondent 45% responded that the cleaning methods were moderate for postharvest loss and 26% responded that severe. The rest of the respondent responded that the cause due to cleaning was not happened.

Transportation from Farm to Storage

Transportation From Farm to Storage was Cause for Post-Harvest Loss	Freq.	Percent	Cum.
Not happened	28	7.73	7.73
Not	64	17.68	25.41
Moderately	176	48.62	74.03
Severe	94	25.97	100.00
Total	362	100.00	

Transportation from farm to storage was the cause for post-harvest loss. This is evidence got from the respondent response. From the total responded 48 % responded that the cause for losses due to transportation was moderate and 26 % responded that it was severe. The rained responded response indicated that it was not the factor for spoilage.

Harvesting Stage

Significant Losses at Harvesting Stage	Freq.	Percent	Cum.
NO	106	29.28	29.28
Yes	256	70.72	100.00
Total	362	100.00	74.03

From the total response about 71% responded that harvesting stage was the factor for postharvest losses. Immature harvesting was the major factor for postharvest spoilage. There were no clear maturity identification criteria for farmers.

Sorting Stage

Significant Losses at Sorting Stage	Freq.	Percent	Cum.
NO	235	64.92	64.92
Yes	127	35.08	100.00
Total	362	100.00	

From the total response 35% responded that sorting stage was the factor for postharvest losses in fruit and vegetables.

Cleaning Stage

Significant losses at Cleaning Stage	Freq.	Percent	Cum.
NO	285	78.73	78.73
Yes	77	21.27	100.00
Total	362	100.00	

Respondent response showed that 21% answer that cleaning was the factor for postharvest losses for fruit and vegetables.

Packaging

Significant Losses at Packaging (Bagging)	Freq.	Percent	Cum.
NO	275	75.97	75.97
Yes	87	24.03	100.00
Total	362	100.00	

From the total response only 24% responded that the cause for losses was due to packaging. The rest of the responded response indicated that the cause was not related with packaging materials.

Field to Storage

Significant Losses at Transportation (Field to Storage)	Freq.	Percent	Cum.
NO	225	62.15	62.15
Yes	137	37.85	100.00
Total	362	100.00	

From the total responded only 37% responded that the cause for losses was due to field transportation.

Storage

significant losses at Storage	Freq.	Percent	Cum.
NO	267	73.76	73.76
Yes	95	26.24	100.00
Total	362	100.00	

Only 27% from the total respondent agreed that the losses were due to storage. The rest of respondent assumed that the losses were not due to storage.

Transportation

significant losses at Transportation (storage to market)	Freq.	Percent	Cum.
NO	266	73.48	73.48
Yes	96	26.52	100.00
Total	362	100.00	

From the total response only 27% agreed that the losses for fruit and vegetables were due to transportation to the market for storage.

Marketing Loss

significant losses at Marketing	Freq.	Percent	Cum.
NO	331	91.44	91.44
Yes	31	8.56	100.00
Total	362	100.00	

Only 9% from the total responded that the losses were existed on the market.

Post-Harvest Loss at Different Stage Tomato

Variable	Obs	Mean	Std. Dev.	Min	Max
Kg tomato lost Sorting	163	15.718	47.952	0	500
Kg tomato lost Packaging	161	12.062	43.634	0	500
Kg tomato lost Trans to storage	161	12.556	43.999	0	500
Kg tomato lost Trans to market	163	14.191	44.099	0	500
Kg tomato lost Storage	158	14.403	46.607	0	500
Kg tomato lost Trans to market	139	13.939	48.778	0	500
Kg tomato lost on Marketing	143	10.506	45.688	0	500

Avocado

Variable	Obs	Mean	Std. Dev.	Min	Max
Kg avocado lost harvest	300	16.018	53.907	0	500
Kg avocado lost Sorting	282	6.514	42.113	0	500
Kg avocado lost Packaging	284	6.508	42.014	0	500
Kg avocado lost Trans storage	288	6.965	41.825	0	500
Kg avocado lost Trans market	283	5.484	30.11	0	500
Kg avocado lost Storage	265	5.68	31.48	0	500
Kg_avocado_lostTrans2market	240	7.589	44.648	0	500
Kg_avocado_lost_Marketing	238	7.879	46.4	0	500

Mango

Variable	Obs	Mean	Std. Dev.	Min	Max
Kg mango lost harvest	254	10.926	46.628	0	536
Kg mango lost Sorting	247	5.124	32.542	0	500
Kg mango lost Packing	239	4.967	33.078	0	500
Kg mango lost Transept	246	5.591	32.826	0	500
Kg mango loss market	244	6.06	33.001	0	500
Kg mango lost Store	233	5.918	33.69	0	500
Kg mango lost Marketing	210	2.955	10.767	0	100

Training on Postharvest Loss Prevention

Have You Ever Received Any Training or Other Information on Postharvest Loss Prevention	Freq.	Percent	Cum.
No	304	79.37	79.37
Yes	79	20.63	100.00
Total	383	100.00	

From the total respondent 79% of the farmers responded that they did not receive any training or other information on postharvest loss prevention. The farmers did not have any information and awareness about the postharvest losses of fruit and vegetables due to many factors.

The farmers asked about the reason of they not participated on any training, from the total responded nearly 39 % of the farmers responded that they do not have any idea about the losses and the impact of the losses on the total livelihood. The rest of the response showed that they have many reasons for not taking the training for reducing postharvest losses of fruit and vegetables.

Training on Harvesting

Postharvest Operation Training Need on Techniques of Harvesting	Freq.	Percent	Cum.
No	69	17.69	17.69
Yes, I Need to train	321	82.31	100.00
Total	390	100.00	

From the total respondent 82% responded that they need training on postharvest operation and techniques of harvesting. This included the whole chain from harvesting indicators, transportation, storage, processing, distribution and marketing of the commodity. This approach was very important for prevention of losses starting from farm to fork approach.

Training on Packing

Postharvest Operation Training Need on Techniques of Packing	Freq.	Percent	Cum.
No	75	19.43	19.43
Yes, I Need to train	311	80.57	100.00
Total	386	100.00	

The respondent from the total responded showed that 81% need training on postharvest operation on techniques of Packing. So, the need of farmers on packaging was very important to reduce postharvest losses because packaging was one of the techniques to reduce postharvest losses of fruit and vegetables.

Training on Transportation

Postharvest Operation Training Need on Techniques of Transportation	Freq.	Percent	Cum.
No	74	19.37	19.37
Yes, I Need to train	308	80.63	100.00
Total	382	100.00	

From the total respondent 81% responded that they need training on transportation as one of the means to prevent postharvest losses of fruit and vegetables. This is as a result of there was no cold storage when transporting commodity from one place to the

other place. The farmers did not use any transportation that have the preservation facility inside, so the loss of fruit and vegetables during transportation was high.

Training on Cleaning

Postharvest Operation Training Need on Techniques of Cleaning	Freq.	Percent	Cum.
No	78	20.42	20.42
Yes, I Need to train	304	79.58	100.00
Total	382	100.00	

From the total respondent 80% responded that they need training on techniques of cleaning as postharvest operation. This operation was very important to remove foreign materials come from field and it causes the problem on postharvest handling practice of fruit and vegetables.

Training on Moisture Measurement

Postharvest Operation Training Need on Techniques of Moisture Measurement	Freq.	Percent	Cum.
No	116	29.90	29.90
Yes, I Need to train	272	70.10	100.00
Total	388	100.00	

From the total respondent 70% responded that they need training on moisture measurement to reduce postharvest loss of fruit and vegetables. The importance of moisture adjustment was, it was one of the factors for spoilage of commodity as a result of microorganism and enzymatic activity can be actively facilitated when there was moisture content in the commodity.

Training on Mold Identification and Control

Postharvest Operation Training Need on Techniques of Mold Identification and Control	Freq.	Percent	Cum.
No	107	27.65	27.65
Yes, I Need to train	280	72.35	100.00
Total	387	100.00	

From the total respondent 72% responded that they need training on mold identification and control. Mold was one of the factors to bring the problems on postharvest handling of fruit and vegetables. So, reduction of mold attack on fruit and vegetables was one of the important steps to prevent losses and increase the shelf life of fruit and vegetables.

Training On Use of Pesticide

Postharvest Operation Training Need on Techniques of Using Pesticide	Freq.	Percent	Cum.
No	87	22.48	22.48
Yes, I Need to train	300	77.52	100.00
Total	387	100.00	

From the total respondent around 78% responded that they need training on techniques of using pesticide for preventing postharvest loss of fruit and vegetables. They wanted the application of pesticide on reduction of spoilage factors such as insects, rodents, mites and so on. So, the appropriate ways of application were very

important to reduce the spoilage factors.

Training on Pesticide Handling and Safety

Postharvest Operation Training Need on Techniques of Pesticide Handling and Safe	Freq.	Percent	Cum.
No	85	22.02	22.02
Yes, I Need to train	301	77.98	100.00
Total	386	100.00	

About 78% of respondent response showed that they need training on Pesticide handling and safety for postharvest operation. The pesticide handling was the major problem in developing country if it is not handled properly. The residue after application brings the chemical hazards and cause health related problem for consumers when they consume fresh fruit and vegetables with the chemical residue in the product.

Training on Proper Storage

Postharvest Operation Training Need on Techniques of Proper Storage	Freq.	Percent	Cum.
No	77	20.32	20.32
Yes, I Need to train	302	79.68	100.00
Total	379	100.00	

From the total respondent 80% responded that they need techniques of Proper storage of fruit and vegetables. The storage was the factor for spoilage if it is not well managed. In this case the king of cold storage was very important and the farmers need training on it. Stored fruit and vegetable were highly susceptible for spoilage due to factors such as, moisture content, temperature, respiration, transpiration and microorganisms. So, the need of managing properly was very crucial to reduce the postharvest management of fruit and vegetables.

Training on Marketing

Postharvest Operation Training Need on Techniques of Marketing	Freq.	Percent	Cum.
No	79	21.01	21.01
Yes	297	78.99	100.00
Total	376	100.00	

From the total respondent 79% responded that they need training on techniques of Marketing for fruit and vegetables. This included the search of marketing place, distribution and linking with different cooperatives.

Conclusion

The baseline information indicated that, farmers faced a problem on postharvest handling of Tomato, Avocado and Mango indicated that there were huge losses in the study area. The farmers did not have any awareness and practice on Technology Adoption and Postharvest Management of Avocado, Mango and Tomato. From the total respondent majority of them did not have cold storage technique for preservation purpose of these perishable products. The needs of farmers on different technology were high and showed interesting result. The farmers were also highly motivated and willing to pay for postharvest management Technology. Regarding the need of training for postharvest management and

technology adoption, the farmers were showed interest for getting training and utilizing available technology.

Recommendations

- ✓ Further study was very important on lose estimation with monetary value for the selected commodity.
- ✓ The need on specific technology was very important based on specific commodity.
- ✓ Arranging the farmers in different cooperative and supplying different technology for adoption was very crucial for the next step for improvement.
- ✓ Utilizing locally available and low-cost postharvest management technology was very important for the farmers.

Data Availability

The data are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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