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Assessment of Postharvest Loss of Avocado at Producers Level (Case of Wolaita and KembataTembaro Zones)

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Abstract

Current study was to estimation the post-harvest loss of avocado at the producer level using cross-sectional data obtained from 385 proportionately sampled respondents from Wolaita and Kembata Tembaro Zones, the SNNPR of Ethiopia. Descriptive and multiple regression analysis were used to estimate the amount and determinant of post harvest loss. The average post-harvest loss of avocado at the producer level was estimated at 24.1 per cent, of which 5.7 per cent was due to poor harvesting practices and 4.9 per cent to poor storage practices. Sex, education, income, training, contact with extension agents, distance from the nearest road, and off-farm income were found to be negative determinants, whereas storage accessibility and avocado harvest techniques were found to be positive determinants of post-harvest loss of avocado fruits. Post-harvest losses contribute significantly to food insecurity and create a problem for the income source of individuals and the economy of the country.

Keywords: Post-harvest losses; Avocado; Producer's; Quantity; MLR.

1. Introduction

The success of the agriculture sector is one of the primary economic pillars of Ethiopia's economy, and it has a significant impact on the country's total economic growth [1]·It is the primary activity in Ethiopia, where approximately 84 percent of the population is engaged in various agricultural activities and generates income for household consumption to sustain livelihood [2],·Horticulture crops are one type of agricultural activities in Ethiopia uses to increase income and the nutritional status of the nation [3].It is season dependant and need proper management and harvest at appropriate time and techniques otherwise results inpostharvest losses both in quantity and qualities.From harvest toconsumption quantifiable quantitative loss of products was at any point in the postharvest chain [4].· Food losses and huge economic losses result from this post- harvest loss [5]. Post- harvest losses of fruits can range in size from 5% to 35% in industrialized nations and 20 to 50% in poor nations [6].·The post-harvest phase has a significant impact on the environment, human health, and food security [7].·Ethiopia is one of the sub-Saharan African countries on the margin of severe food insecurity and poverty [8].

Fruit crops have a high humidity level and a high nutritional value, making them highly perishable. Fruit losses can result from a variety of factors, including farm operations and consumer purchased. These fruit post-harvest losses are primarily the result of incorrect handling, wrong harvesting, substandard storage facilities, inadequate post-harvest management strategies, and inadequate post-harvest infrastructure, and there are considerable output losses during these stages [9].

Tropical fruit from the Lauraceae family, the avocado (Perseaamericana Mill.) is indigenous to tropical America [10]. It is one of the most widely farmed fruits in the world to its outstanding nutritional value. Reducing postharvest losses of avocado fruits can both enhance the marketable surplus and income as well as the amount of avocado fruits that may be consumed. As a result, it might be a sustainable strategy to increase farmer income and strengthen food security standards. The production of avocado fruits in the study area for marketing purpose as well as for home consumption. From 2011E.c up to 2013 E.c the average area covered and the total output produced by are 3,038.98 hectors, and 430,783.18 quintals and 4,692.076 hectors and 690,093.29 quintals respectively for avocado produced KT and Wolaita zones respectively (ZBoARDOffice).Avocados are a source of key nutrients, including healthy fats and fiber. They also contain anti-inflammatory and antioxidant compounds and may help reduce heart disease risk. Nutritious, versatile, and delicious, avocados have become a kitchen staple in many homes around the world. It also used as well as processing industry is more prone to such losses due to high moisture content, physical injury, and attack of insect past and perishable nature. Reduction in the post harvest losses can increase the marketable surplus and hence the consumable quantity of the produce. It could be an efficient solution to increase the availability of food, reduce exploitation of natural resources, overcome hunger and improve farmers' livelihoods. Besides

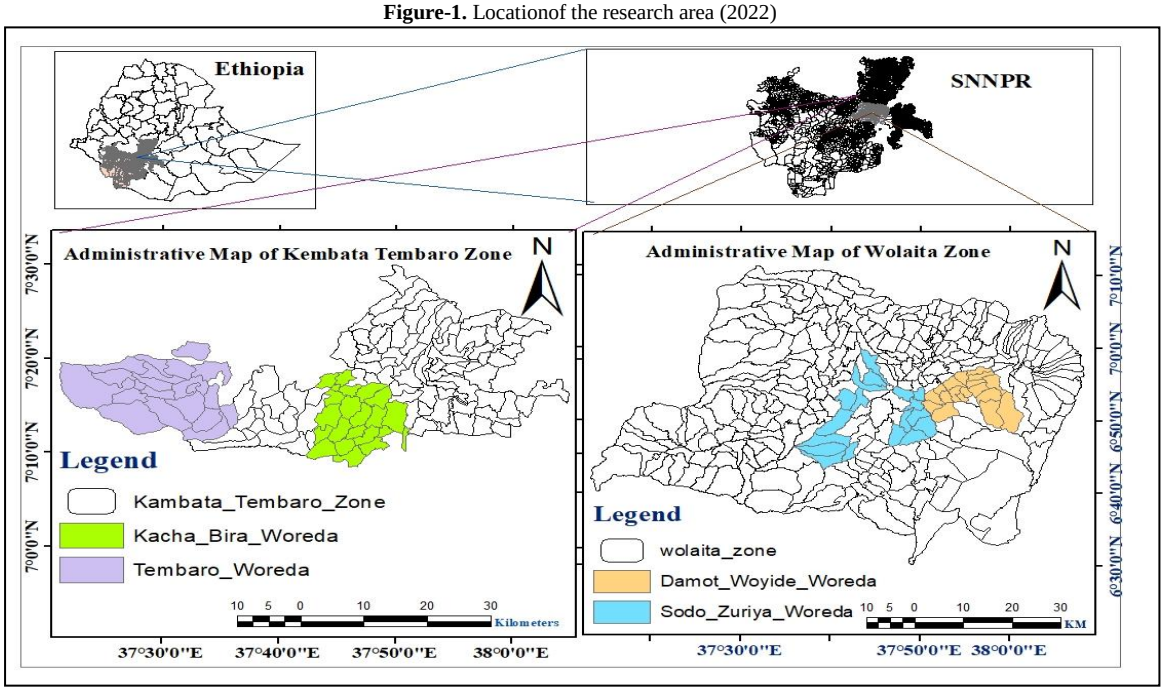
increasing productivity, it is desirable to have an efficient processing and marketing conditions in order to reduce the extent of the losses and hence the study pertains to the estimation of losses in avocado at producer's levels of farm. Post-harvest handling procedures need to for lowering the rate of avocado losses. The post-harvest management practice on avocado fruit at the producer's level does not receive enough attention. Additionally, it was shown that the respondents differed in their understanding of the right methods for care for avocado fruit. Most study done on postharvest loss was fruits combine with vegetables or two or more fruits in general manner not at specific at particular fruits [6, 9, 11, 12]. Postharvest losses in fruits vary greatly among commodities and production areas and seasons. As a fruits product moves in the postharvest chain, PHLs of fruits may occur from a number of causes, such as improper handling or biodeterioration by microorganisms, insects, rodents or birds.Causes of post-harvest loss fruits include limited availability of suitable varieties for processing, lack of appropriate processing technologies, inadequate commercialization of new technologies and lack of basic infrastructure, inadequate facilities and infrastructure, and insufficient promotion of processed.This study focuses on Postharvest loss of avocado alone; it is not incorporated with by fruits and vegetables. This is important to identify for specific commodity in postharvest practice and management as well as policy making for specified fruits. Also A few of research works have been done on avocado fruit value chain in the study area and no research was done on examine the amount of post-harvesting loss, and factors that determinates post harvest loss of avocado in the study areas. Also limited research has been conducted to asses post harvest losses of fruits with descriptive analysis and simple random with small sample respondents. Hence the study focused on the following specific objective: - (1) to compute the amount of post-harvest losses in the avocado at producers level (2) to identify factors affecting post harvesting losses of avocado fruit at the producer level.

2. Methodology

2.1. The Research Area's Description

The research was done in SNNPRin two zones, namely Wolaita and KembataTembaro Zones. Wolaita and KembataTembaro Zones are among 13 zones of Southern Nations Nationalities and Peoples Regional (SNNPR), two of them are neighboring. An administrative center for the Wolaita Zone is WolaitaSodo; Durameisthe administrative center of KembataTembaro Zone. The Wolaita Zone has a total area of 4512 km2, administratively divided into 16 woredas and 6 registered towns. According to the Central Statistical Agency's 2007 Census, this Zone has a total population of 2,473,190 people and a 4,208.64 square kilometer area.WhereasKembataTembaro Zone was subdivided into eight districts and five registered town. According to the CSA's 2007 Census, the KembataTembaro zone has a total population of 1,080,837, of which 536,676 are males and 544,161 are women. The zone has a land area of 1,355.89 square kilometers. This study was conducted in of the major avocado fruits producing area from Wolaita zone; DamotWeyde and SodoZuriyadistrcts,and from KambataTambero; KachaBira and Tembaro districts of SNNPR see figure below.

Figure-1. Locationof the research area (2022)



2.2. Source of the Data and Sampling Method

For this investigation,secondary data as well as primary data were employed. Reviewing secondary sources included looking at Central Statistical Authority, district agricultural and rural development office published and unpublished materials.In addition, websites and journals were visited to gather applicable secondary data concentrating on the study's aims.Primary data were gathered from randomly chosen growers of avocado fruits in eight rural kebeles in the study area. Structured and semi-structured questionnaires, as well as computer-assisted

personal interviews conducted by professional enumerators, were used to collect primary data. The producers of avocado fruits were chosen using multi-stage sampling techniques. In the first stage,four districts, namely DamotWeydeand SodoZuriya districts from WolaitaZones,andKachaBira and Tembaro districts from KembataTembaro zones were chosen at random from the avocado fruits producing districts of the two zones. Using a simple random sample procedure, eight avocado fruit-producing kebeles or districts were chosen from each of the four districts in the second step. 385 farm households were chosen at simple random in the third stage using a probability proportional to their combined population size.

The study used Kothari's sample size determination algorithm to determine a representative sample size for a cross-sectional household survey

$$n=\frac{Z^2}{e2}\frac{pq}{} = \frac{(1.96)^2}{0.05^2}\frac{0.5*0.5}{} = 385 \text{----------1}$$

Where n is the sample size, Z is the inverse of the standard cumulative distribution that to the levelof confidence, e is the desired level of precision, p is the estimated proportion of an attribute that is present in thepopulation and q = 1-p. The value of Z is found from statistical table which contains the area under the normalcurve of 95% confidence level.

2.3. Methods of Analyzing Data

The study employed both econometric and descriptive statistical methods, to examine the amount and determination of post-harvest loss of avocado in the study area. The sum of all these losses at various activities, such as harvesting techniques, storage, packaging materials and methods, transportation, insects, loading, and at the marketing level, is estimated to be the total post-harvest losses.Multiple linear regressions (LMLR) analysis wasemployed to determine what factors lead to post-harvest loss ofavocado fruits at producer's level. Quantity of avocado fruits post-harvest losses at percentage would be the dependent variable.

2.4. Quantitative Loss Assessment on Producer's Level

The quantity of post harvestloss would be calculated using the equation given below.

2.5. Total Loss in Avocado Fruits in %=$\underline{\text{Wrdv}}$*100

Wtv

Where, Wrdv = Weight of rejected and damaged avocado fruits sorted out in Kg

Wtv = Total weight of avocado fruits before sorting in Kg

Wrdv=Total rejected and damaged at farm level the sum of (Collection, or Harvesting, Transportation, processing, storage, insects or disease attack, and exchange before sales and consumption)

Multiple linear regression models were used to examine the relationship between postharvest loss of avocado and explanatory variables at producers level

. The general form of multiple linear regressions is:

$Y_i = f(X_1, X_2, X_3, X_4 \ldots X_k)$

$Y_i = \alpha_o + \alpha_1X_1 + \alpha_2X_2 + \alpha_3X_3 + \cdots + \alpha_kX_k + \varepsilon_i$

$Y_i$represents post-harvest loss and X_1, X_2, X_3, $X_4 \ldots X_k$represents explanatory variables that determinates of post harvest loss of avocado and ε_i is the stochastic disturbance term or error terms.

It is possible to write the function as:-

Quantity of avocado lost=$\alpha_o+\alpha_1$Sex+α_2Log_Age+α_3Log _Family size+α_4Log_Educat +α_5 LogTLU+α_6Log_ Productive avocado+α_7Access to training+α_8 Log_Income generating from avocado+α_9Log_Distance to nearest Road +α_{10} Log_Distance to nearest market+α_{11}Off farm income +α_{12}Log_ farm experiences +α_{13}Log _Extension contact per months +α_{14}Log_Total area for avocado fruits+α_{15} Log_Quantity of avocado +α_{16}Labor shortage +α_{17}Harvesting Methods+α_{18} Availability of storage + ε_i

Where α_o = intercept term.

3. Result and Discussion

3.1. Socio-Demographic Andinstitutional Characteristics of Respondent

A total of 385 respondents made up the sample. The sample ages varied from 32 to 61 years old, and their mean age was 45.95 years.The meanfamily size of sample respondents was 6.25, which was higher than the meanfamily size in the country, whichis 4.6 people per home[11]. Additionally, the sampled respondents traveled 2.8 kilometers to get to the major road and 3.07 kilometers to the nearest market center on foot (Table1).In light of this, the average length of formal education completed by sample respondents was 6.27 years.Tropical Livestock unit (TLU) per family was calculated to evaluate each household's livestock holding. A sample respondent in the study area possessed a mean of 3.08 TLU of cattle. The sample study area's average landholding size was 1.011 hectares, which is less than the 1.17 ha per household national average [13]. The typical number of times extension service was offered to sampled respondent was 2.67 day/month. The average number of years that respondents to the sample had been actively involved in farming avocado fruits producers 'production was 16.48years.Moreover, the mean annual yield quantities of avocado fruits production of the sampled household was866.90kg with a minimum of 400.00kg and a maximum of 1800.00 kg. The average unit price per kilogram 16.25birr/kg.

Table-1. Characteristics of sampled respondent (Continuous variable)

Variables	Mini	Maxi	Mean	Std. Err
Age of the respondent (Years)	32	61	45.95	6.735
Household size (Adults equivalence)	3.70	7.95	6.2466	1.05500
Education level of respondent (Grade level)	2	12	6.27	3.266
Total livestock holding(TLU)	.60	7.32	3.0843	1.33417
Land size (hect)	0.1	3.5	1.011	1.021
Number of productive avocado tree owned(Numbers)	4	7	5.89	.776
Distance from household residence to main road(KM)	.25	10.00	2.8100	1.77842
Distance from household to nearest market(Km)	.50	10.00	3.0706	1.34163
Extension agents contacts per months(Days)	1	4	2.67	0.874
Farming experiences for avocado fruits(Years)	8	40	16.48	5.898
Quantities of avocado fruits did you produce(Kg)	400.00	1800.00	866.8831	275.49794
Average unit price of avocado fruits(Birr/kg)	10.00	30.00	16.2494	4.77899

Source: Computed from survey data (2022)

Out of all survey respondents, 316 (82.1%) were headed by men, and 69 (17.9%) were headed by women among the respondent that produced avocados (table, 2). The results showed that only 9 (2.3%) of the had access to irrigation, while 376 (90.7%) did not. About8.3% of respondents had obtained services for their own credit agricultural production.Moreover, 62.3% of the sampled respondents have accessed market information for avocado fruits marketing from different sources.Additionally, 172(44.6%) of the sampled respondents were also participated in off farm activities. Consequently, the findings in the research domain showed that 69.6% of the respondents have got training access. Training in the use of marketing for avocado fruits, the adoption of post-harvest loss techniques, and post-harvest losses will improve avocado output productivity and, as a result, expand the market for avocado fruit products. Moreover 69.9 % of the sampled respondents were also access to transportation.

Table-2. Characteristics of sampled respondent (Dummy variable)

Variable	Description	No. of respondents (n=385)	Percent
Sex of the respondent	Yes	316	82.1
	No	69	17.9
Credit access	Yes	30	8.3
Irrigation access	Yes	9	2.3
Off farm activities	Yes	172	44.6
Access to market information	Yes	240	62.3
Access to transportation	Yes	269	69.9
Training access	Yes	268	69.6

Source: Computed from survey data (2022)

3.2. Post Harvest Losses in avocado fruits at Farm Level

Based on the survey results, each farmer owns an average of 7.99 avocados. The number of productive avocado trees that are productive (avocado trees that bear fruit) of the sampled respondents is therefore more important for the objectives of this study than the number of avocado trees that have been planted. The average number of avocado trees with fruit held by each producer was 5.89, and the average amount of avocado produced annually was 866.9kg. Additionally, households sold 509.5584 kg of avocados, and on an annual basis, they made an average of 5577.5455 ETB from selling avocados (table, 3). Consequently, 208.169 kg of avocado fruits were damaged or lost on average in the studied area from the total production at various processing phases.

Table-3. Avocado Fruits Utilization

	Minimu	Maximum	Mean	Std. Devi
Total number of avocado tree owned in number	6	12	7.99	0.982
Number of productive avocado tree owned	4	7	5.89	.776
Quantities of avocado fruits harvested in Kg	400.00	1800.00	866.8831	275.49794
Quantities of avocado damage or loss kg	70.00	500.00	208.1688	79.50259
Amounts of total avocado sold in Kg	150.00	1000.00	509.5584	206.89341
Income generated from avocado fruits in Birr	1000.00	15000.00	5577.5455	3347.18319

Source: Computed from survey data (2022) *1Quntal=100kg

3.3. Stage for Harvesting Avocado fruits

Avocados' harvesting stages are essential for extending their shelf life. The results in (table 4) below show that 66.2% of respondents in the sampled group in the study area say to harvest avocados when they are just ripe, 6% of them when they are still green, and 27.8% when they are fully grown. These findings imply that while fully matured

avocado fruits are easier to spoil, immature avocado are more difficult to pick and are less likely to be harmed during transit.These findings support the finding by Kadzere, *et al.* [12] that unripe fruits are more difficult to pick than ripe ones.

Table-4. Stages of avocado fruits harvesting (n=385)\

Stage of avocado harvesting (%)	Just Ripe	Full Ripened	Unripe
	66.2	27.8	6.0

Source: Computed from survey data (2022)

3.4. Avocado Fruits Harvesting Methods

Avocado fruits harvested without mechanical damage to increase the qualities of avocado. It was damaged during the harvesting process, which may have a negative impact on the avocado fruit's attractive appearance and serve as a point of entrance for post-harvest viruses that quickly cause decay during storage and transit. Below the (table5) shows that70.4% of the sampled respondent used cutter with attached bag to harvest avocado fruits. The rest 29.6% of the respondent used hand twisting, ladder and other mechanisms to harvest avocado fruits in the study area.

Table-5. Harvesting methods of avocado fruits

Methods	Frequency	Percent	Cumulative
Hand twisting	24	6.2	6.2
Cutter attached with bag on pole	271	70.4	76.6
Ladder	52	13.5	90.1
Others	38	9.9	100

Source: Computed from survey data (2022)

3.5. Avocado Fruits Packing Materials

The avocado fruit must be relocated to the shade as soon as it is harvested in order to prevent weight loss from moisture loss, which wouldhappen quickly when they are exposed to the sun. A variety of conventional packaging materials are utilized in Ethiopia to retain agricultural products, however there is a dearth of standardized fruit packaging materials [14]. In the study area, dried banana or enset leaf, carton, and plastic polyethylene were employed as avocado fruit packing materials. For packaging the avocado fruit, 68.6% of the farmers from the sampled household use dried banana or enset leaf, followed by 19% carton and 12.5% plastic boxes. Although the use of packaging materials increases the final price of avocado fruits, it usually enhances the fruit's look and quality preservation. By preventing avocado fruits from mechanical damage and unfavorable physiological changes throughout storage, transit, and marketing, avocado fruit packaging is crucial for lowering postharvest losses. Avocado fruit transportation without adequate packing exposes the fruit to mechanical damage during loading and unloading as well as while traveling on rough roads, which increases the risk of fruit deterioration.

Table-6. Packaging materials for storage

	Frequency	Percent	Valid Percent	Cumulative Percent
Dried Banana leaf	264	68.6	68.6	68.6
Carton paper	73	19.0	19.0	87.5
Plastic bag Polyethylene	48	12.5	12.5	100.0
Total	385	100.0	100.0	

Source: Computed from survey data (2022)

3.6. Producers Perceptions about Sources of Avocado Post-Harvest Loss

Avocado fruit losses happen during post-harvest handling procedures such as harvesting, picking, field storage, packaging, loading and unloading, transportation, insects, and farmer-level sales. According to the findings of the current study, postharvest loss that occurred during various operations or handling procedures, as indicated in(tables 7and 8) below was responsible for around 24.014% of the total.The present study's findings generally concur with those of other studies, who found that losses of fruits occurred in various value chains and ranged from 23 to 40% [15].As a result, a substantial portion of avocado fruit losses occur during the stages of harvest, storage, transportation, packaging, market or selling, insects, and loading. The post-harvest loss avocado fruits at the field level were estimated to be 24.01348315 % from total production of avocado fruits. This loss occurred on the farm as a result of injuries sustained when picking avocados by hand utilizing ladders and picking poles, poor packing techniques, disorganized storage facilities, unorganized transportation methods, and other factors during avocado fruit processing activities.

Table-7. Post-harvest loss of Avocado fruits at farm level in kg

	Mini	Max	Mean	Std. Deviation
Total Quantities of avocado fruits did you damage or loss in avocado fruits process (kg)	70.00	500.00	208.1688	79.50259
Loss or Damaged by harvesting stages (Kg)	.00	200.00	49.6234	29.59450
Loss or Damaged by insects	.00	80.00	18.8701	16.17640
Loss or Damaged by storage stage (kg)	.00	200.00	42.7532	24.77406
Loss or Damaged by Loading (off loading) stages (Kg)	.00	100.00	17.2909	16.75058
Loss or Damaged by packing methods(Kg)	.00	80.00	23.2078	17.66760
Loss or Damaged by marketing stages (Kg)	.00	60.00	20.9299	15.09787
Loss or Damaged by Transportation stages (kg)	.00	100.00	35.4935	21.58476

Source: Computed from survey data (2022)

Table-8: Post Harvest Losses in Avocado fruits at Farm Level in percentage

Stages	Share to the total losses (%) from total production	% of avocado fruit loss from total loss
Loss by harvesting stages (%)	5.724344569	24%
Loss by insects (%)	2.176779026	9%
Lossby storage stages (%)	4.931835206	21%
Loss by loading or off loading stages (%)	1.994606742	8%
Loss by packing stages (%)	2.677153558	11%
Loss by marketing or selling stages (%)	2.414382022	10%
Loss by transportation stages (%)	4.094382022	17%
Total loss (%)	***24.01348315***	***100.00***

Note: Percentage share of total losses = (loss / total fruit production) * 100.
Source: Computed from survey data (2022)

3.6.1. Causes of Producer-Level Post-Harvest Losses

3.6.1.1. Harvesting

Harvesting is the first step in the avocado supply chain and plays a crucial role in decisions on how to reduce waste and improve quality. The period of harvest and the methods are two crucial factors that affect losses during harvesting of avocado fruits in the research area. The findings indicate that the most important issue is the perception of losses during the harvesting phases. According to tables7 and 8, 49.62 kg, or 5.7%, of the total post-harvest loss, happened at the harvesting procedures. These are related to a study by [15] that found that severe PHL and quality deterioration of horticulture products occur in Ethiopia after harvest, and are then followed by marketing, shipping, and storage times.

3.6.6.2. Storage

Avocado fruits are collected after undergoing specialized treatments such cleaning, sorting, and packing of post-harvest fruits. 42.75 kg, or 21%, of the research area's average avocado fruit value (tables 8 and 7) were lost at the farm level due to a lack of proper storage.

Insect pests and diseases

Small, dark patches that grow to uneven, dark-brown to-black blotches as the fruit ripens are signs of the condition. Postharvest loss in the research area comprises postharvest diseases and insect pests (worm, fly, and thrimps). According to tables7 and 8, the average weight of avocado fruits lost on farms in the research area as a result of insects and dieses was 18.87 kg. At the time of the focal group discussion, insect and disease infestation, a lack of a quick market, and inadequate storage facilities were the main causes of avocado fruit losses.

3.6.6.3. Transportation

The avocado supply chain involves a lot of transportation since the fruits of the avocado have to be moved from one stage to another. 3.07 km was the typical distance traveled by the ripped, harvested avocado for the closest market. Therefore, they are using various modes of transportation, as seen in the above table where 14.5%, 62.5%, and 22.9 % of respondents said that avocado fruits are typically delivered from far places on the backs of women, animals, and men. Fruits are vulnerable to mechanical damage and heat buildup during all modes of transportation.The focus group participants said that there were lacks of access to suitable transportation, forcing farmers to harvest at a later stage of ripening and sell to local consumers even though most avocado producers in the research area use carts and human labor for transportation. Avocado fruits vibrate when traveling on bad roads, which cause losses.Out of these, 4.094382022 kg/qtl, or 17% of the total post-harvest losses, were attributable to the mode of transportation. Due to mechanical damage and product overheating are caused large amount of avocado losses.

3.6.6.4. Packing Materials

The shelf life of avocado fruits is increased and losses are decreased significantly by packaging. Therefore, incorrect packaging and the use of inappropriate packaging materials are two of the main reasons why avocado fruits

are lost at post-harvest stages. Avocado fresh produce can be damaged by poor quality packaging materials, which can also hasten the deterioration of avocado fresh produce.Fruit goods, especially perishable ones, are less likely to be damaged by a well-designed packaging strategy [16].There are a variety of conventional packaging materials used to contain avocado fruits in the study area, including banana leaves, cartons, plastic bags, and others, but there aren't many that are specified for avocado fruit packing. According to tables 7 and 8, among the average weights of avocado fruits in the study region, improper packing materials resulted in losses of 23.20 kg, or 11% of all post-harvest losses, on farms. This may be because conventional sack increased inside temperature; higher fruits injured inner fruits by compressing and piling them on top of one another during transportation; these actions intensified fruits softening and rotting.

3.6.6.5. Marketing or Selling

For market participants like farmers, wholesalers, and retailers to increase their incomes and prevent post-harvest losses of avocado fruits, a well-organized market system is necessary. However, in the study area, avocado fruits are typically sold and bought at open spaces/roadsides, plastic shelters, and houses, respectively. According to tables 7 and 8, among the average avocado fruit values in the study area, unsatisfactory marketing conditions resulted in losses of 20.92 kg, or 10%, of the total post-harvest losses.

4.3. Econometric Analyses

4.3. 1.Determinants of Avocado Postharvest Loss

The factors that determine avocado post-harvest losses at the producer level in the area of study were examined using multiple linear regression models. The Breusch-Pagan test, the Ramsey RESET test; the result showed that there was no serious heteroscedasticity and multicollinearity problem gives a summary of the results obtained from themultiple regression analysis. The value was logged and expressed the dependent variables as in the model, LnTLOSSA.The model fit results for factors affecting post-harvest losses along avocado fruits are as shown in (table9) given below.

Table-9. The Farm Level Factors Affecting Post-Harvest Avocado Fruit Losses

S,No	Explanatory Variables	Coefficients	Sta. Error
1	Sex of the respondent (Dummy)	-0.08401***	0.0281
2	Log_ Age of the respondent (Years)	-0.045119	0.70488
3	Log_Family size of the respondent (AE)	-0.00261	0.0450013
4	Log_Education level (Years)	-0.043848**	0.0216
5	Log_Total livestock(TLU)	0.0000144	0.0118
6	Log_Productive avocado tree(Number)	0.08944	0.06497
7	Access totraining (Dummy)	-0.13656***	0.04101
8	Log_Income generating from avocado (Birr)	-0.0924012***	0.0183054
9	Log_Distance to nearest major Road (Km)	0.0251368*	0.01423
10	Log_Distance to nearest market (Km)	-0.00559	0.022468
11	Off farm income (Dummy)	-0.07276**	0.029389
12	Log_Avocado farm experiences (Years)	-0.0326194	0.0274384
13	Log _Extension contact per months(Days)	-0.287766*	0.149307
14	Log_Total area for avocado fruits(Hec)	0.014368	0.0088837
15	Log_Quantity of avocado fruits produced(Qun)	-0.0174303	0.0726368
16	Labour shortage (Dummy)	-0.0341132	0.227235
17	Harvesting Methods (Categorical)	0.2260979***	0.0425324
18	Availability of storage (Dummy)	0.0403669**	0.0194471
	Constant	4.296625***	0.3594289
	R^2	0.7426	
	F-Values	55.43	
	Adjusted R^2	0.7292	

Source: Computed from survey data (2022)
*****, **, *:** significance level of the variable at 1% 5% and 10% level, respectively

Nine explanatory variables were discovered to explain the postharvest loss of avocado in the research area out of the 18 hypothesized variables. The regression variables sex of the respondent showed a negative relationship with postharvest loss at less than 1% significance level.This suggests that households with female heads are more likely to experience post-harvest losses for these crops than families with male heads.The coefficients of the variable show that avocado producer being a male should decrease avocado postharvest loss by 0.09 quintal. The results of [17], which came to the conclusion that there was little to no gender inequality in the growing of tomato fruits and, thus, no effect of sex on postharvest losses, are in conflict with this. The respondent's educational level had a detrimental effect on avocado post-harvest loss and was significant at a probability level of 5% or less, supporting the hypothesis. The fact that there was a decline in amount lost as education level increased suggested that quantity lost was negatively correlated with education level. According to the variable's coefficient, a one-year increase in schooling led to a 0.043848quintal decrease in the amount of avocado lost. According to the variable's coefficient,

an increase in avocado postharvest loss of 0.025 quintal occurred for every 1 km that the major road's length was increased. The coefficient of the variable revealed that an increase in a day in extension agent engagement was responsible for the reduction in avocado postharvest loss by 0.28 quintal at less than 10% significant level while other factors remained unchanged. The increase of farmer training facilities and extension assistance could hasten the effort to change post-harvest loss handling procedures and its methods. Total off farm income was statistically significant at < 5% significance level and had negatively effect on quantity of avocado postharvest loss. The result is implied that; if the amount off- farm income obtained by avocado producers increase by one Birr, then the amount of avocado fruits post-harvest loss decreases by 0.72quntals,other things are constant.Income generating from by household from sales of avocado in the production year was found to have negative influence therefore leading to a decrease in post-harvest losses among farmers at 1% significance level. It is the amount of total income (measured in Birr) generated from avocado fruits increased by one birr, the post harvesting loss decreased by 0.092 Quintals.It is obvious that income earned from avocado fruits improves the post harvestloss of by purchasing or use modernized materials for reducing post harvest losses.The coefficient of the variable demonstrated that an increase in training access was responsible for the 0.13 quintal decrease in avocado postharvest loss at 1% significant level.Another major cause of avocado post-harvest a loss to farmers was the harvesting techniques; this is statistically significant affect avocado fruits post-harvest loss at 1% significance levels of avocado producers.The result shows that if producers usedlosses attributed to harvesting methods were least at farm level at about 22 percent per season. This shows that producers generally harvested their avocado fruits on the sampled respondent are not an appropriatedmethods of harvesting; this leads to high amount of loss at storage, harvesting methods, as well as transportation. In the same layer, availability of storage system adopted by the farmers was found to have a direct relationship with PHLs of avocado fruits in the study area.Avocado post-harvest losses among farmers are increased at a 5% significance level by the absence of storage facilities to regulate temperature on matured avocado fruits. In a review of post-harvest losses in tomatoes in Sub-Saharan Africa (SSA), [19]came to the conclusion that post-harvest losses, particularly among smallholder farmers, were made worse by a lack of knowledge about essential quality standards.

5. Conclusion and Recommendation

The objective of this research work was to identify the factor that led to PHL in avocado fruit at the producer's level in the Wolaita and KembataTembaro Zone of Ethiopia's SNNPR. To improve the welfare of farm households, smallholder farmers must decrease post-harvest losses. The average number of avocado fruits lost after harvesting at the farm household head was 0.24. This suggested that the average loss from the production of all avocado fruits was equal to 24% of the total amount produced. This demonstrated that a substantial percentage of the yield of avocado fruits were lost.

The results of econometrics analysis found that sex, training on avocado management system and income generating from avocado fruits were significantly and negatively related with avocadoPHLs for small -scale farmers (P< 0.01). But avocado harvesting methods significantly and positively affects post-harvest loss from small avocado fruits producers (P< 0.01).Beside the education level and off farm income level of the household head were variables which significantly and negatively related with avocado fruits PHLs for small scale farmers (P< 0.05), were as availability of the storage at household level have significantly and positively affected avocado fruits PHLs for small scale producers (P< 0.05. Also distance to nearest road significantly and positively affects PHLs for small avocado fruits producers (P< 0.1) and number of days extension contact per months significantly and negatively affectsPHLsfor small avocado fruits producers (P< 0.1).This study comes to the conclusion that more than one-fourth of the overall production of avocado fruits was lost throughout the post-harvest and consumption phases. Avocado fruits quantity loss is determined by physical and natural, institutional and demographic factors.

The following suggestions for policy changes are developed based on the study's findings to decrease avocado fruit postharvest losses.

- Since avocado fruit growers rarely use the usual post-harvest handling techniques, such as washing, grading, packaging, and shipping, the state of avocado fruit post-harvest management in the research area turned out to be poor. In order to minimize losses, the Ministry of Food and Agriculture, through its extension agent, be supposed to step up the training it offers to growers of avocado fruits, particularly women.
- To reduce mechanical damages, roads connecting farms with markets need to be repaired. The Municipal and District Assemblies and private sector investors in the study area should improve the road infrastructure linking farms to market centers to reduce transport losses.
- Post-harvest losses contribute significantly to food losses and give a serious hazard to the society's and the nation's main source of income. The reduction of post-harvest losses is not given enough focus by academics, the government, and researchers. The administration arrangement being practiced and the existing policy are also not helpfully for to overcome the problem. Highly government interference and coordination activities are, important for successful and sustainable controlling of the post harvesting losses of fruits.

6. Data Availability

All the necessary data are included in the manuscript. If additional data are required, the corresponding author can be contacted.

Conflicts of Interest

The authors declare that they have no conflicts of interest

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Author Contributions

Abera: -conceptualized, investigated, wrote the original draft, did the review and editing, software for analysis and interpreted the data; Wrote the paper. Berhanu and Lemma: - supervised and validated along with methodological work. All authors have read and agreed to the published version of the manuscript.

Reference

[1] FAO, 2014. *Food and agriculture organization ethiopia country programming framework*. Addis Ababa: Office of the FAORrepresentative in Ethiopia to AU and ECA.

[2] Central Statistical Agency, 2019. *Agricultural sample survey: Crop and livestock product utilization survey*. Addis Ababa, Ethiopia.

[3] EHPEA Ethiopia Horticulture Producers and Exporters Association, 2013. "Ethiopian investment commission database of licensed projects; embassy of Ethiopia in China; All Africa."

[4] Kikulwe, E. M., Okurut, S., Ajambo, S., Nowakunda, K., Stoian, D., and Naziri, D., 2018. "Postharvest losses and their determinants: A challenge to creating a sustainable cooking banana value chain in Uganda." *Sustainability*, vol. 10, pp. 2381-19.

[5] Gross, R., Schoeneberger, H., Pfeifer, H., and Preuss, H. J., 2000. "Four dimensions of food and nutrition security: Definitions and concepts." *SCN News*, vol. 20, pp. 20–25.

[6] Hailu, G. and Derbew, B., 2015. "Extent, causes and reduc-tion strategies of postharvest losses offresh fruits and vegetables–A review." *Journal of Biology, Agriculture and Healthcare*, vol. 5, pp. 49–64.

[7] Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., and Searchinger, T., 2013. *Reducing food loss and waste. Working paper, installment 2 of creating asus-tainable food future*. World Resources Institute.

[8] FAO, 2019. *Reducing food losses through improved postharvest management in Ethiopia. Final eval-uation of phase 1*. Rome, Italy: Food and Agriculture Organi-zation of the United Nations.

[9] Kasso, M. and Bekele, A., 2018. "Post-harvest loss and quality deterioration of horticultural crops in Dire Dawa Region Ethiopia."

[10] Griesbach, J., 2005. *Mango growing in kenya, world agroforestry centre, nairobi world agroforestry centre (ICRAF)*. Nairobi, Kenya, Internet: Nairobi, Kenya. Kul Graphics.

[11] Aujla, K. M., Abbas, M., Mahmood, K., and Saadullah, S., 2007. "Marketing system of fruits, margins and export potential in Pakistan." *Pakistan Journal of Life and Social Sciences*, vol. 5, pp. 34-39.

[12] Kadzere, I., Watkins, C. B., Merwin, I. A., Akinnifesi, F. K., Saka, J. D. K., and Mhango, J., 2006. "Harvesting and post-harvest handling practices and characteristics of Uapaca kirkiana (Muell. Arg.) fruits."

[13] CSA, 2014. *Agricultural sample survey 2013 / 2014, report on area and production of major crops, statistical bulletin 532* vol. 1. Addis Ababa, Ethiopia.

[14] Bereda, S., 2016. *Effect of harvesting, handling and storage techniques on quality and shelf life of avocado fruits in sidama ethiopia. Msc thesis*. Ethiopia: School of Plant and Horticultural Sciences, College of Agriculture, Hawassa University. p. 72.

[15] Ban_Jaw, T., 2017. "Imed pub journals review of post-harvest loss of horticultural crops in Ethiopia, its causes and mitigation strategies of post-harvest loss horticultural crops in Ethiopia." *Journal of Plant Scienceand Agricultural Research*, vol. 2, pp. 1–4.

Appendix 1

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. vif
```

Variable	VIF	1/VIF
HARVMETHOD41	6.59	0.151686
TRingonav~13	6.02	0.166213
OFFINCO20	3.61	0.277000
log_EDULEVL7	3.14	0.318681
log_DISHO~17	2.66	0.375810
log_QUNTA~26	2.16	0.462613
log_DISHO~16	2.07	0.483316
log_INCOA~14	1.98	0.503992
sex1	1.96	0.509076
log_Age2	1.80	0.555194
LABSHORT31	1.73	0.577399
AVILASTORA53	1.59	0.629544
log_AVOCD~24	1.41	0.710304
log_Famile~4	1.27	0.784396
log_TOTAR~25	1.24	0.804641
log_ProdA~12	1.24	0.807752
log_TLU10	1.24	0.809367
log_EXEC~231	1.16	0.860976
Mean VIF	2.38	

Source: Computed from survey data (2022)

Appendix 2

```
. reg log_TLOSSDA96 sex1 log_Age2 log_Familesiz4 log_GradLev7 MarSta8 log_TLU10 log_ProdAVOTR12 TRingonavocdo13 log_INCOAVOCDOFR14 log_DISHOMKT16 log
> _DISHORoad17 OFFINCO20 log_EXECONTMO231 log_AVOCDFRMEXP24 log_TOTAREAVOCADO25 log_QUNTAVOCDOPRO26 AVILASTORA53 LABSHORT31 HARVMETHOD41
```

Source	SS	df	MS		
				Number of obs	= 385
				F(19, 365)	= 55.43
Model	24.0120066	19	1.26378982	Prob > F	= 0.0000
Residual	8.32168033	365	.022799124	R-squared	= 0.7426
				Adj R-squared	= 0.7292
Total	32.333687	384	.08420231	Root MSE	= .15099

log_TLOSSDA96	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
sex1	-.0840149	.0281014	-2.99	0.003	-.1392753	-.0287545
log_Age2	-.045119	.0704881	-0.64	0.523	-.1837316	.0934936
log_Familesiz4	-.0026101	.0450013	-0.06	0.954	-.0911036	.0858833
log_EDULEVL7	-.0438483	.021685	-2.02	0.044	-.0864912	-.0012054
log_TLU10	.0000144	.0184742	0.00	0.999	-.0363145	.0363434
log_ProdAVOTR12	.08944	.0649755	1.38	0.170	-.0383321	.2172122
TRingonavocdo13	-.1365606	.0410104	-3.33	0.001	-.2172062	-.055915
log_INCOAVOCDOFR14	-.0924012	.0183054	-5.05	0.000	-.1283982	-.0564041
log_DISHORO16	.0251368	.0142303	1.77	0.078	-.0028467	.0531203
log_DISHOMK17	-.0055905	.022468	-0.25	0.804	-.0497731	.038592
OFFINCO20	-.0727675	.0293896	-2.48	0.014	-.1305611	-.0149739
log_AVOCDFRMEXP24	-.0326194	.0274384	-1.19	0.235	-.0865761	.0213373
log_EXECONTMO231	-.0287766	.0149307	-1.93	0.055	-.0581374	.0005841
log_TOTAREAVOCADO25	.0143682	.0088837	1.62	0.107	-.0031013	.0318378
log_QUNTAVOCDOPRO26	-.0174303	.0368726	-0.47	0.637	-.089939	.0550783
LABSHORT31	-.0341132	.0227235	-1.50	0.134	-.0787982	.0105718
HARVMETHOD41	.2260979	.0425324	5.32	0.000	.1424594	.3097364
AVILASTORA53	.0403669	.0194471	2.08	0.039	.0021248	.0786091
_cons	4.296625	.3594289	11.95	0.000	3.58982	5.00343

Source: Computed from survey data (2022)

Appendix 3

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of log_TLOSSDA96

         chi2(1)      =     0.19
         Prob > chi2  =   0.6635


. ovtest

Ramsey RESET test using powers of the fitted values of log_TLOSSDA96
       Ho:  model has no omitted variables
                 F(3, 364) =      1.44
                  Prob > F =      0.2315
```

```
linktest
```

Source	SS	df	MS	Number of obs	=	385
				F(2, 382)	=	460.29
Model	22.8513353	2	11.4256676	Prob > F	=	0.0000
Residual	9.48235168	382	.02482291	R-squared	=	0.7067
				Adj R-squared	=	0.7052
Total	32.333687	384	.08420231	Root MSE	=	.15755

og_TLOSS~96	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	-.4747966	1.04833	-0.45	0.651	-2.536017	1.586424
_hatsq	.2385959	.1695172	1.41	0.160	-.0947077	.5718994
_cons	2.263841	1.611796	1.40	0.161	-.9052625	5.432944

Source: Computed from survey data (2022)