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Research Article

GENDER ANALYSIS OF POSTHARVEST LOSS OF PERISHABLES WITH RESPECT TO FRUITS AND VEGETABLES IN TOKE KUTAYE DISTRICT, ETHIOPIA

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ABSTRACT. The present study aimed to assess the gender analysis of Post-harvest loss of Perishables concerning fruits and vegetables in Toke Kutaye District, Ethiopia. Four kebeles were randomly selected for primary data collection. A cross-sectional-based mixed approach of sampling design was employed for data collection using open and close-ended questionnaires, focus group discussions, and key informant interviews. 360 household heads were selected for a questionnaire survey using a systematic random sampling technique. The result showed that onions, potatoes, and tomatoes take up about 41.7% of the total production in the district. About 51.1% of farmers use the local seed variety, and 71.1% do not protect their crops. The majority of the producers (63.9%) sell their produce at the proxy local markets using carts (71.7%), animals' backs (15%), and human labor (10.6%). About 64.4% of the farmers lost >15% of their total production up to the first market. The highest postharvest loss was claimed in Wajjira (34%) and Imala (28%) Kebeles. About 32.2% of the postharvest loss occurs on the field before harvesting. Diseases, insects, lack of improved variety, poor market network, and limited knowledge of postharvest handling were the major causes (40%) of the postharvest losses. Most of the pre-harvest and postharvest activities were predominantly performed by males. The logistic regression result indicated that accessing training, credit, and stored products were negative to postharvest loss and statistically significant ($p<0.05$). Accessing land, fertilizer, seed, oxen, equipment, water, benefits, and marketing of the products were positive and significant ($p<0.05$). In other words, overall control resources were negative, but it was statistically significant only for the controls over fertilizers, seed, water, and storage of the products ($p<0.05$). The regression also indicated that the decision over using money, freedom to use the money, participation, and negotiating in income generation and household expenses were negative and significant ($p<0.05$). The daily clock activities showed that females were 16 hours busy and males were 13 hours busy per day on average. The result also indicated the seasonal-based variation of activity patterns in both sexes; females are more busy than males. This calls for extensive work to minimize the gender disparity in agriculture to reduce postharvest loss.

Keywords: *Access and control, daily clocks, gender disparity; horticultural crops, postharvest handling*

INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy. The country has highly diversified agroecological conditions for producing cereals, legumes and horticultural crops [1]. More than 85% of its population is engaged in small-scale agricultural production as a major means of their livelihood. It also contributes about 50% of the country's gross domestic product (GDP), over

90% of export earnings and 73% of supplies of raw materials for agro-based domestic industries [2]. In all of these counts, horticultural crops play a fundamental role in the food security and economy of the country [3].

Ethiopia has comparative advantages in several fruits and vegetables because of its favorable weather conditions, cheap labor, and proximity to export markets such as Europe and the Middle East [4]. Despite its high potential, the country is one of the Sub-Saharan African countries poised at the edge of severe food insecurity and poverty [5, 6]. The production of fruits and vegetables is much less advanced than the other staple grains. Normally, more than 2,399,566 tons of fresh produce are being harvested by private and public commercial farms, which is estimated to be less than 2% of the total staple production [7]. Moreover, a significant amount of these products are lost after being harvested. The postharvest loss contributes to reduced profit obtained from the product and leads to food insecurity [8]. It is not only about the food loss but also the loss of human effort, farm inputs, livelihoods, and investment costs [9].

The postharvest loss occurs due to poor pre- and post-harvest management and a lack of appropriate processing and marketing facilities [10, 11]. Lack of knowledge of the proper application of cultural practices, poor awareness of nutritional values, and preference for food or adapting only to some selected types of food are also the other causes [10]. Institutional factors in terms of provision of inputs, extension services, and poor infrastructure also limit the postharvest management of the products [3]. Lack of markets to absorb the production, low price of the products, lack of coordination among producers to increase their bargaining power, and poor handling and packaging also aggravate the postharvest loss of the horticultural produce in the country [3, 12].

The socio-cultural and gender dimensions are the other underlying causes of postharvest losses of fruits and vegetables [13]. The study indicated a considerable gender gap in the postharvest management of agricultural products with a substantial postharvest loss [14]. It has also been confirmed that the involvement of women in all agricultural products, including fruits and vegetables, at all stages of the value chain has a momentous contribution to postharvest loss management [13, 15]. Thus, to promote equal access to productive resources for men and women and reduce postharvest loss, conducting a gender analysis of all agricultural products is crucial. Toke Kutaye District is one of the West Shoa Zone districts with a high potential for fruit and vegetable production. However, there is no scientific information on the impacts of gender disparity on postharvest losses of these products. Hence, this study aimed to assess the effect of gender inequality in postharvest loss of fruits and vegetables in Toke Kutaye District, West Shoa Zone, Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Toke Kutaye District, West Shoa Zonal administration, Oromia Regional State, Ethiopia, which is located 128 km away from the capital, Addis Ababa, in the west direction on Nekemte road. It is situated between the latitude of 08° 59’ 01.1’ N and the longitude of 37° 46’ 27.6’ E. The district has 31 rural peasant associations, locally called kebeles, of which 28 are fruit and vegetable producers. The district's total population is estimated to be 119,999 (59,798 of them were males and 60,201 were females). About 15,952 (13.29%) of these populations were urban dwellers [16].

Research Design, Sample Sites Selection, and Sample Size Determination

A cross-sectional-based qualitative and quantitative sampling design was employed for primary data collection. Before data collection, a preliminary survey was conducted in the study area from November 2017 to September 2018 to select the representative kebeles. A multi-stage sampling technique was used to select the study kebeles. The kebeles with high fruit and vegetable production potential areas were first identified, and four kebeles were randomly selected from the high production potential areas. The sample size of the representative respondents was calculated using the Cochran [17] formula.

$$n_o = \frac{Z^2 pq}{e^2}$$

Where N_0 - is the sample size, Z^2 - is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level, 95%, z=1.96), e - is the desired level of precision which is 0.05, p - is the estimated proportion of an attribute that is present in the population, and q is 1-p, p=0.5 and q=0.5.

Accordingly, a total of 384 households were selected. Adding 5% for unresponsiveness, the overall sample size was 403 respondents. The number of respondents from each kebele was also calculated using n*N/T, where n is the total sample size from all study kebeles, N is the total number of households in each kebele, and T represents the total number of households in the selected study kebeles (Table 1).

Table 1. *Total population and sample size of the respondents from the three flower farms*

Kebele	**Total households**	**Sample size**
Birbirsa	984	45
Wajjira	2538	116
Imala	2516	115
Negafile	2735	125
Total	**8773**	**401**

Data types*, Sources and Data Collection Tools*

Primary data obtained from men's and women's household heads were used in this study. Open and close-ended questionnaires were used to collect the data. The questionnaires were prepared in English and translated to Afan Oromo to facilitate more communication during data collection. Scheduled interviews were used for data collection using the trained data enumerators.

In addition, key informant interviews (KKI) and Focus Group Discussion (FGD) were used to triangulate the quantitative data and capture the missing elements. Transporters, middlemen, agricultural officials, and academicians were engaged in the KII. Focus Group Discussions were held at each study kebele with 8 to 10 members of selected elders and model farmers. The checklist was prepared for FGDs, and the discussions were done with a moderator who is very fluent in the local language.

Data Collection Methods

First, the lists of households were taken from the study kebeles. Representative households were selected using systematic random sampling techniques. Questionnaires survey and semi-

structured in-depth interviews were used to collect data from the farmers and key informant interviews, respectively.

Data Analysis

Harvard Analytical Framework was used to analyze the gender dimensions in pre and postharvest management. Binomial Regressions were used to analyze the impacts of gender dimensions specific to the postharvest loss by controlling other factors using STATA software version 14.2. To obtain the logistic model from the logistic function, *z* was used as the linear sum of independent variable factors of the form; $Z = \beta_0+\beta_1X_1 + \beta_2X_2 +.....+ \beta_i X_i$, where the X_i are independent variables of interest and *(β's)* are representing unknown coefficients of independent variables. The specification or reduced form of the empirical model estimated is as follows:

$$Y_i = \alpha_0 + \beta_i \sum X_i + \varepsilon_i$$

Where Y_i is a dichotomous dependent variable (postharvest loss above 15% and less than 15%, specified as greater than 15% = 1, less than 15%=0); α_0 is the Y-intercept; β_i is the set of coefficients to be estimated; X_i is the set of explanatory variables hypothesized, based on theory and related empirical work, to influence postharvest loss; and ε_i is an error term.

Therefore, the model is denoted as:

$$PHL=\alpha_0+\beta_1 (LA) +\beta_2 (FA) +\beta_3 (SA) +\beta_4 (OA) +\beta_5 (EA) + \beta_6 (TA) + \beta_7 (CA) + \beta_3 (WA) +\beta_4 (TA) +\beta_5 (BA) + \beta_6 (SA) + \beta_7 (MA) + B_8 (LC) +\beta_9 (FC) +\beta_{10} (SC) +\beta_{11} (OC) +\beta_{12} (EC) + \beta_{13} (TC) + \beta_{14} (CC) + \beta_{15} (WC) +\beta_{16} (TC) +\beta_{17} (BC) + \beta_{18} (SC) + \beta_{19} (MC) +\beta_{20} (DOM) +\beta_{21} (MSFP) +\beta_{22} (FTUI) +\beta_{23} (PAN) +\beta_{24} (EMIF) + \varepsilon_i$$

Where; Postharvest loss = *PHL*, Land access=LA, Fertilizer access=FA, Seed access=SA, Oxen access=OA, Equipment access=EA, Training access=TA, Credit access=CA, Water access=WA, Transportation access=TA, Benefit access=BA, Storage access=SA, Marketing access=MA, Land control=LC, Fertilization control=FC, Seed control=SC, Oxen control=OC, Equipment control=EC Training control=TC, Credit control=CC, Water control=WC, Transportation control=WC, Benefit control=BC, Storage controls=SC, Marketing control=MC, Decision on the use of money =DOM, Money spent for purchasing =MSFP, Freedom to use income =FTUI, Participation and negotiation=PAN and Expenses made in facilitating=EMIF.

Data Reliability and Validity Test

A pilot test was conducted from November 2017 to September 2018 to evaluate the reliability and validity of the questions. Statistical Package for Social Sciences (SPSS) version 24.0 was used to test the validity using Cronbach's alpha reliability test. The Cronbach's alpha value greater than 0.70 is the acceptable cut-point of the reliability test because the internal consistency and reliability of the questions above this cut-point are considered the highest [18].

RESULTS

Socio-demographic Characteristics of the Respondents

Four hundred-three farmers (93.3% males and 6.7% females) were involved in this study. The respondents ranged from 25-60 years, with a mean age of 32.6, and most of the respondents (47.8%) fall in the age range of 30 - 40 years old. The total number of family members ranged from 5 to10 with a mean number of 5.23 per family (Table 2).

Table 2. *The socio-demographic characters of the respondents in the study area*

Item	Specific item	Frequency	Percentage (%)
Kebele	Birbirsa	46	11.40
	Wajjira	116	28.90
	Imala	115	28.90
	Negafile	125	31.10
Sex	Males	376	93.30
	Females	27	6.70
Age	<30	36	8.90
	30-40	193	47.80
	40-50	107	26.70
	>50	67	16.70
Total household members	<5	67	16.70
	5-10	316	78.30
	>10	20	5.00

The Fruits and Vegetable Produces in the Area

Onion, potato and tomato take the largest part (41.7%) of the total horticultural crops produced in the study area, whereas cabbage, carrot and mango are the least of the total produce (Table 3).

Table 3. *Fruits and vegetables cultivated in the study area*

Specific produces cultivated	Frequency	Percentage (%)
Onion, potato and tomato	168	41.70
Onion, potato, tomato and cabbage	121	30.00
Garlic, sweet potatoes and pepper	74	18.30
Carrot, orange, potato, onion, cabbage and tomatoes	13	3.30
Apple, cabbage, orange and onion	13	3.30
Onion, potato, tomato and carrot	9	2.20
Cabbage, carrot, mango	4	1.10

Seeds, Storage Methods, and Marketing System of Fruits and Vegetables

The local varieties constituted about 51.1% of the total seed varieties used in the study area. About 95% of the farmers do not store their produce, whereas 71.1% do not protect their horticultural crops (Fig. 1).

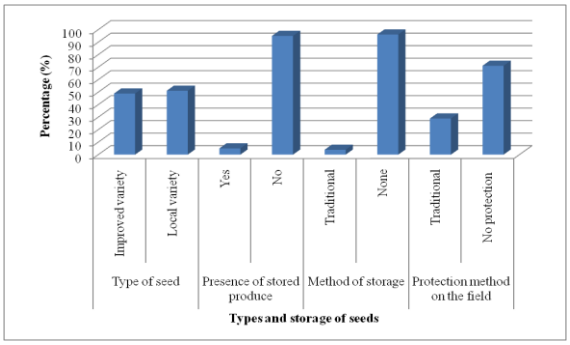

Fig 1. *The types and handling methods of seeds by the farmers in the study area*

About 98.3% of the farmers used only less than 25% of their total produce for home consumption. Similarly, 71.7 % of the farmers sell 50-75% of their total production (Fig. 2).

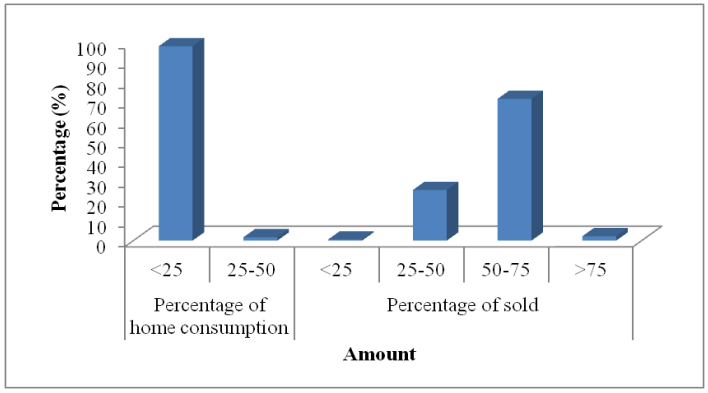

Fig 2. *The extent of horticultural crops used for home consumption and sold to the market*

About 63.9% of the total products were sold to proxy local markets and the remnant (23.9%) is sold to the retailer shops. Similarly, carts were the most widely used mode of transportation (71.7%) of the produce, followed by animal's back (15%) and human labor (10.6%) (Fig. 3).

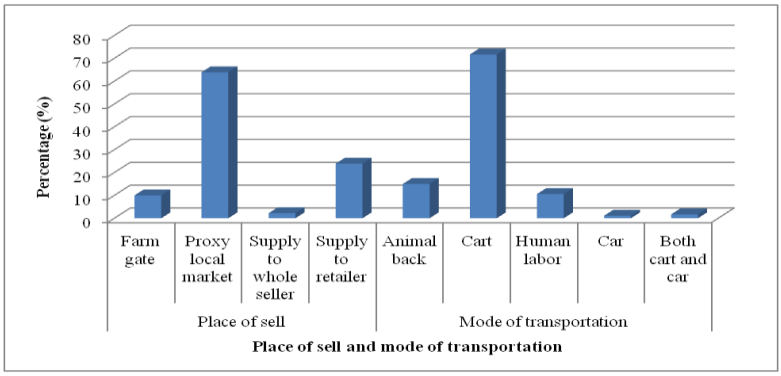

Fig 3. *Marketing and transportation of fruits and vegetables in the study area*

Postharvest Loss of Fruits and Vegetables

About 64.4% of respondents lost more than 15% of their total production up to the first market (Fig. 4).

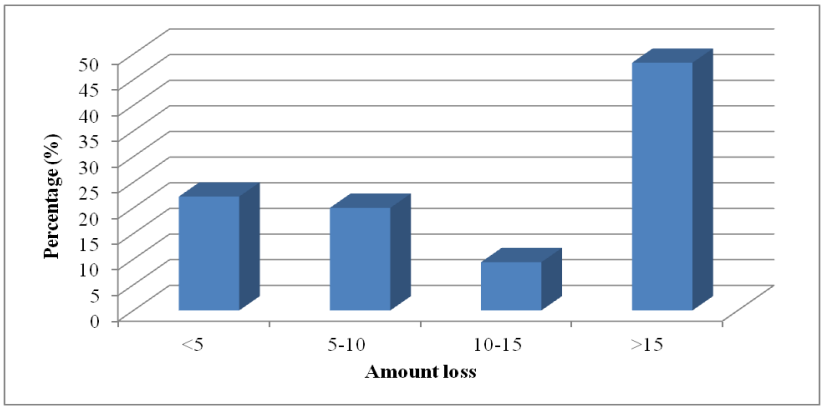

Fig 4. *The total percentage of postharvest loss of horticultural crops up to first market in the study area*

The highest postharvest loss was observed in the Wajjira (34%) and Imala (28%) kebeles, whereas the least postharvest loss was observed in Birbirsa Kebele (Fig. 5). The result showed a significant difference in postharvest loss among the study kebeles (χ^2=54.606; p=0.000).

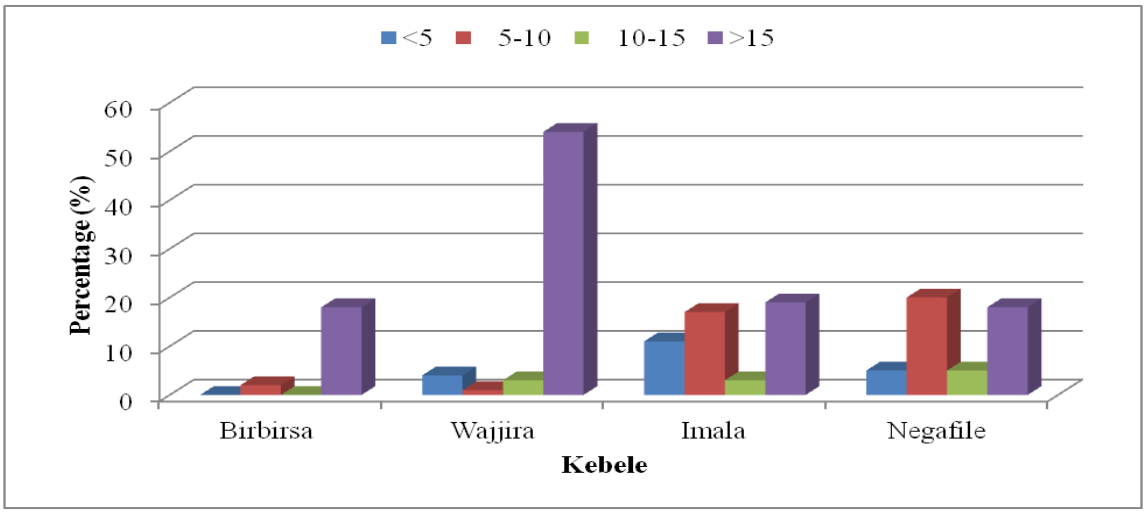

Fig 5. *The extent of postharvest loss among the study kebeles*

The Stage of Postharvest Loss and Extents of Loss at Each Stage

About 69.5% and 67.2% of the farmers agreed on a substantial postharvest loss during harvesting and on the field, respectively. Similarly, 80.6% and 98.3% of the respondents disagreed on a considerable postharvest loss during transportation and storage, respectively (Table 4).

Table 4. *The extent of postharvest loss at different stages of horticultural produce*

Loss	Yes		No loss	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Loss during harvesting	279	69.50	121	30.00
Loss during transporting	78	19.50	324	80.60
Loss on field	270	67.20	132	32.80
Loss during storage	7	1.70	395	98.30

Causes of Postharvest Losses of Fruits and Vegetables

Diseases, insects, lack of improved variety, limited market access, and lack of awareness were the major factors for the study area's postharvest loss of fruits and vegetables (Table 5).

Table 5. *Causes of the postharvest losses in the study area*

Causes of loss	Frequency	Percentage (%)
Diseases	41	10.3
Diseases and insects	58	14.4
Diseases, insects, lack of packaging, and lack of water for irrigation	139	34.5
Diseases, insects, lack of improved variety, lack of market, and poor knowledge	161	40
Lack of knowledge	3	0.8

Management Practices of Postharvest Loss

Farmers were using different management strategies to minimize the postharvest loss of their horticultural crops. Use of indigenous knowledge (44%), immediate transportation of the products (24.2%), and use of integrated knowledge obtained from their fore families and Developmental Agents (DAs) (20.3%) were the common management practices being used in the study area. For the farmers that temporarily store their produce, strategies such as spreading on the floor (45%) and the bed (33%) were highly used before transporting them to the markets (Fig. 6).

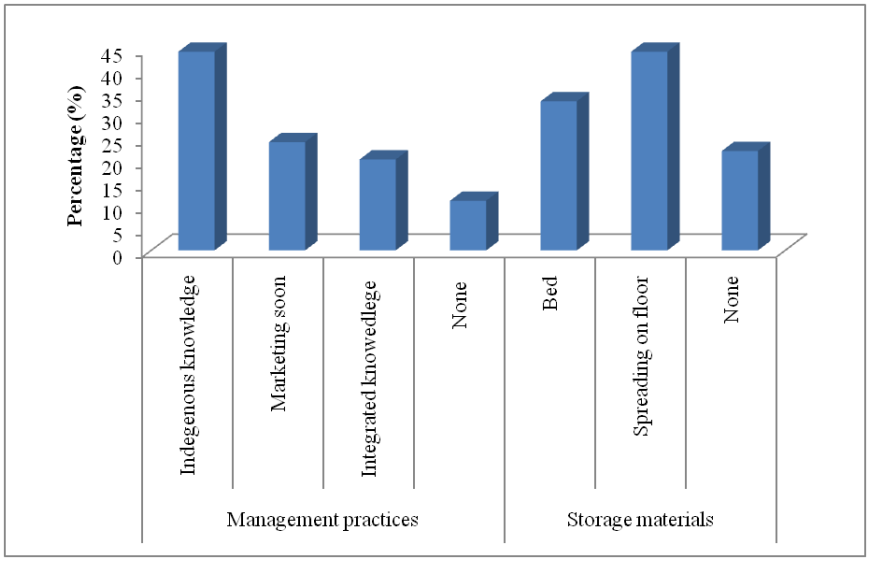

Fig 6. *The postharvest loss management practices in the study area*

Gender Analysis in Post-Harvest Loss of Fruit and Vegetable

Disparities in Gender-Based Activities in Fruit and Vegetable Production

Pre-harvesting activities such as hand tillage (27.7%), land clearance (36.7%), oxen tillage (72.8%), selection of seed varieties (75%), spraying pesticides (54.4%), watering (34.5%) and management of crops on the field (56.2%) were predominantly performed by males. However, planting or/and sowing (42.8%), application of fertilizers (38.9%), weeding (48.9%), keeping crops from pests (37.2%), and harvesting (51.1%) were performed by all family members. The postharvest activities, like transportation of the products to the first market, were predominantly done by males. The majority of the respondents agreed that there is no manuring (57.2%), trimming (51.1%), curing of roots (62.2%), pre-cooling (85.6%), sorting (61.7%), grading (59.4%), packaging (42.8%) and storing (85%) of their horticultural produces (Table 6). The result showed a significant gender heterogeneity in activities such as land clearance, hand tillage, oxen tillage, fertilizer application, manuring, pesticide spray, weeding, watering, keeping crops from pests, harvesting, packaging and transportation among the sexes ($p<0.05$).

Table 6. *Percentage of gender-based analysis of pre and post-harvest activities in the study area*

No.	Activities	Male	Female	Male and female	Female and children	All	None	Male and children	χ^2	p-vale
Pre-harvest activities										
1	Hand tillage	27.7	22.8	8.9	0.6	25	6.7	8.3	80.313	0.000
2	Land clearance	36.7	7.2	16.7	0	31.1	1.7	6.7	27.994	0.022
3	Oxen tillage	72.8	0	4.4	0.6	5	1.7	15.6	27.357	0.026
4	Seed variety selection	75	1.2	9.4	0.6	8.3	1.1	4.4	14.694	0.683
5	Planting or sowing	18.9	7.2	25.6	0.6	42.8	1.1	3.9	18.489	0.424
6	Fertilizer application	25	11.1	16.7	1.1	38.9	3.9	3.3	31.842	0.023
7	Manuring	5	21.7	5	0.6	10	57.2	0.6	55.124	0.000
8	Pesticide spray	54.4	3.9	10	0.6	15.6	2.8	12.8	39.564	0.002
9	Weeding	12.8	15.5	17.8	0	48.9	2.2	2.8	35.885	0.002
10	Watering	34.5	6.7	7.2	0.6	21.7	15.6	13.9	39.889	0.008
11	Keeping crops from pests	31.6	2.3	12.8	2.8	37.2	0.6	12.8	35.837	0.023
12	Day-to-day management	56.2	4.4	8.9	0	22.8	2.2	5.6	18.800	0.404
Postharvest activities										
13	Harvesting	22.2	2.3	17.2	0	51.1	3.9	3.3	27.457	0.025
14	Trimming	10	3.9	12.2	1.1	20.6	51.1	1.1	19.604	0.356
15	Curung of roots	6.7	2.8	8.9	2.2	17.2	62.2	0	22.590	0.093
16	Pre-cooling	2.3	1.7	3.3	1.1	6.1	85.6	0	9.470	0.852
17	Sorting	3.9	1.7	12.2	3.3	17.2	61.7	0	18.828	0.222
18	Grading	8.4	0	15.6	2.2	13.9	59.4	0.6	16.924	0.323
19	Packaging	28.3	0	9.4	1.1	13.9	42.8	4.4	28.148	0.021
20	Storing	3.9	0.6	5.6	0	5	85	0	8.283	0.763
21	Transportation to market	38.9	1.1	16.7	0	14.4	28.3	0.6	46.453	0.000

Gender Analysis in Accessing the Resources

Except for training access, the result revealed that both sexes have equal access to resources (Table 7).

Table 7. *Gender-based variation in access to resources in fruits and vegetation production in the study area*

Access	Male		Female		Both	
	No	%	No	%	No	%
Land access	48	11.67	0	0	354	88.3
Fertilizer access	54	13.3	0	0	348	86.7
Seed access	43	10.56	6	1.67	359	87.8
Oxen access	60	15	0	0	342	85
Equipment access	62	15.56	0	0	340	84.4
Training access	228	55	12	2.8	174	42.2
Credit access	189	44.4	23	5.6	213	50
Water access	35	8.3	8	2.2	367	89.4
Transportation access	52	12.8	0	0	350	87.2
Benefit access	25	6.1	12	2.8	377	91.1
Storage access	62	8.9	292	42.2	340	48.9
Marketing access	38	9.4	4	1.1	364	89.4

The logistic regression analyses of our assumption made on access to resources were negatively correlated to postharvest loss and statistically significant ($p<0.05$) except for access to land ($p>0.05$) (Table 8).

Table 8. *Binary logistic regression result of the access to resources and postharvest loss*

Access	B	S.E.	Sig.	Exp.(B)
Land access	-0.421	0.235	0.074	1.524
Fertilizer access	-0.776	0.240	0.001	2.172
Seed access	-0.902	0.278	0.001	2.466
Oxen access	-0.886	0.236	0.000	2.426
Equipment access	-0.815	0.226	0.000	2.258
Training access	-0.648	0.163	0.000	0.523
Credit access	-1.063	0.188	0.000	0.345
Water access	-0.630	0.278	0.023	1.878
Transportation access	-0.677	0.240	0.005	1.969
Benefit access	-0.388	0.265	0.043	1.473
Storage access	-1.021	0.268	0.000	0.360
Marketing access	-0.812	0.282	0.004	2.252

Gender Analysis in Controlling over the Resources

Except for fertilizer and seed control, the controls made on all resources were predominantly made by male household heads (Table 9). The logistic regression assumption also indicated that the controls made on all resources and postharvest loss were negatively correlated but statistically significant for only control made over fertilizers, seed, water, training, benefit and storage of the produce ($p<0.05$) (Table 10).

Table 9. *The gender-based control over some activities in the study area*

Control	Male		Female		Both	
	No	%	No	%	No	%
Land control	348	86.70	0	0.00	54	13.30
Oxen control	221	55.00	0	0.00	181	45.00
Equipment control	229	56.60	6	1.70	167	41.70
Training control	212	52.80	4	1.10	186	46.10
Fertilizer control	188	48.30	0	0.00	214	51.70
Seed control	179	44.40	0	0.00	223	55.60
Credit control	219	54.40	0	0.00	183	45.60
Water control	342	85.00	4	1.10	56	13.90
Transportation control	348	86.70	4	1.10	50	12.20
Benefit control	306	76.10	4	1.10	92	22.80
Storage controls	279	69.40	18	4.40	105	26.10
Marketing control	318	78.90	4	1.10	80	20.00

Table 10. *Binary logistic regression results of the controls made over resources and postharvest loss*

Control	B	S.E.	Sig.	Exp (B)
Land control	-0.360	0.221	0.104	0.698
Fertilizers control	-0.502	0.221	0.023	0.606
Seed control	-0.488	0.198	0.014	0.614
Oxen control	-0.418	0.257	0.104	0.658
Equipment control	-0.141	0.284	0.619	0.868
Training control	-0.383	0.221	0.020	0.754
Credit control	-0.279	0.204	0.171	0.757
Water control	-0.460	0.218	0.035	0.632
Transportation control	-0.318	0.219	0.147	0.727
Benefit control	-0.337	0.178	0.049	0.714
Storage controls	-0.528	0.172	0.002	0.590
Marketing control	-0.204	0.190	0.281	0.815

Gender Analysis in Deciding over the Resources

The males had an immense right to decide over their money, the expense to purchase commodities, and expenses for personal uses. Similarly, males had full freedom to decide over the income obtained from the produce and other resources and in marketing and negotiating the product's price at the market (Fig. 7).

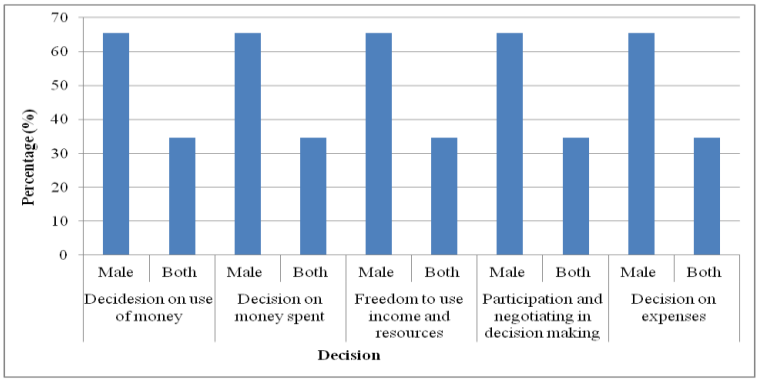

Fig 7. *Gender-based variation in decision-making on fruits and vegetables produces*

The regression analysis also revealed that the decision made over the use of money, freedom to use the money, participation, and negotiation in income generation and household expenses were negatively influencing the postharvest loss and were statistically significant ($p<0.05$) (Table 11).

Table 11. *Binary logistic regression results in the decision over resources and postharvest loss*

Decision	B	S.E.	Sig.	Exp.(B)
Decision on the use of money	-0.370	0.108	0.001	0.691
Freedom to use income and resources generated	-0.370	0.108	0.001	0.691
Participation and negotiating in income generation	-0.370	0.108	0.001	0.691
Decision on the expenses	-0.370	0.108	0.001	0.691

Focus Group Discussion

Gender-Based Daily Activities Clocks of the Farmers

The results obtained from FGD also revealed that both sexes were engaging in different activities, which varied based on the cultural, social, and biological differences between the two sexes. The daily clock activities showed that females were performing the routine care and maintenance of the household works and its members, including childcare, food preparation, fetching water, fuel collection, home-gardening, tending animals, and housekeeping. They were also involved in agricultural activities such as crop cultivation, sowing, weeding, fertilizer application, harvesting, storage, looking after livestock, and other associated activities like milking, milk processing, fodder collection, and household duties. Men were, however, involved in the public domain activities like farming, marketing, looking after livestock, etc. Generally, females were highly frantic in their daily life with heavy workloads. They wake up early in the morning and sleep later than males. They have much less leisure and sleep time than men. On average, females were **16** hours, and males were **13** hours busy daily (Figure 8A & B).

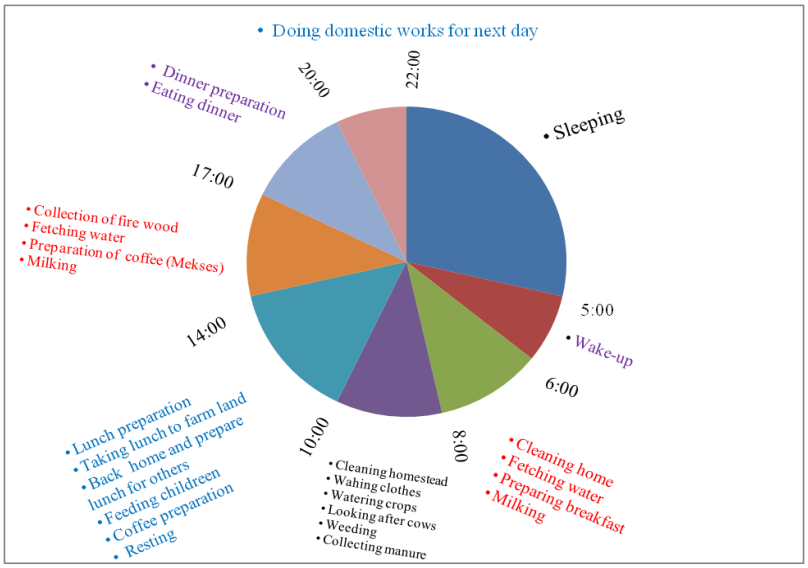

Fig 8A*. Daily activities clocks of the females in the study area*

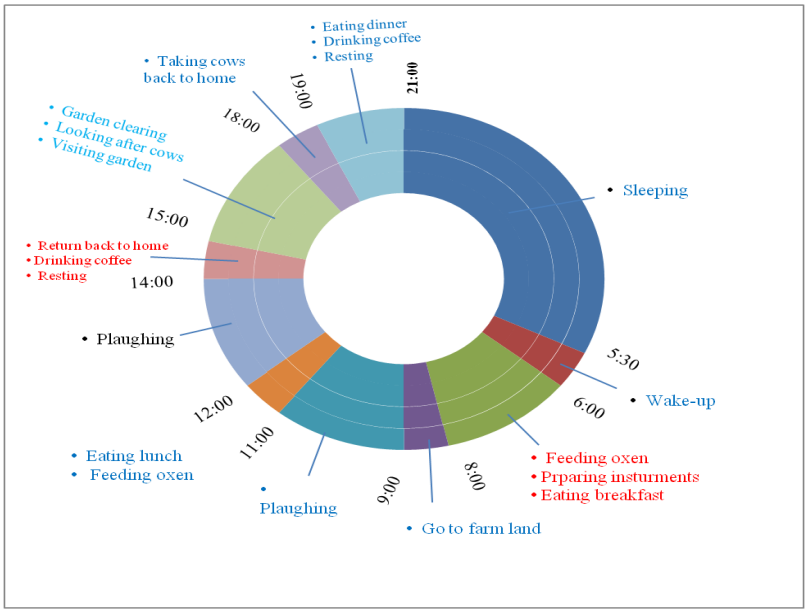

***Fig 8B**. Daily activities clocks of the males in the study area*

Gender-Based Seasonal Calendar of the Farmers

The farmers are also involved in seasonal activities, from land preparation to harvesting and marketing the produce. The result indicated the seasonal-based variation of activity patterns among the two sexes. Generally, the role of females in farming activities was more or less equivalent to males, but females have many additional duties at home than males in all seasons (Figure 9A & B).

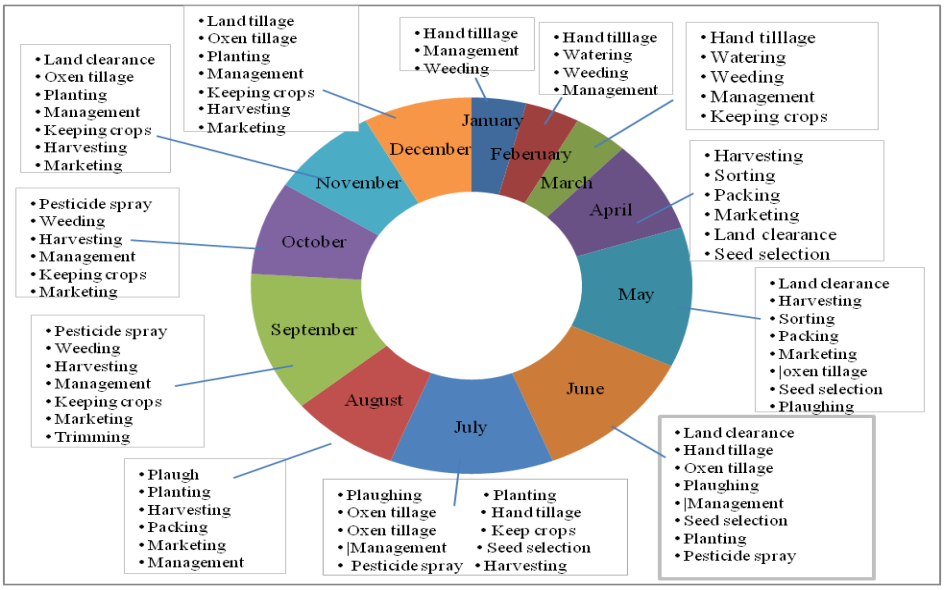

***Fig 9A.** Seasonal based activities of male farmers*

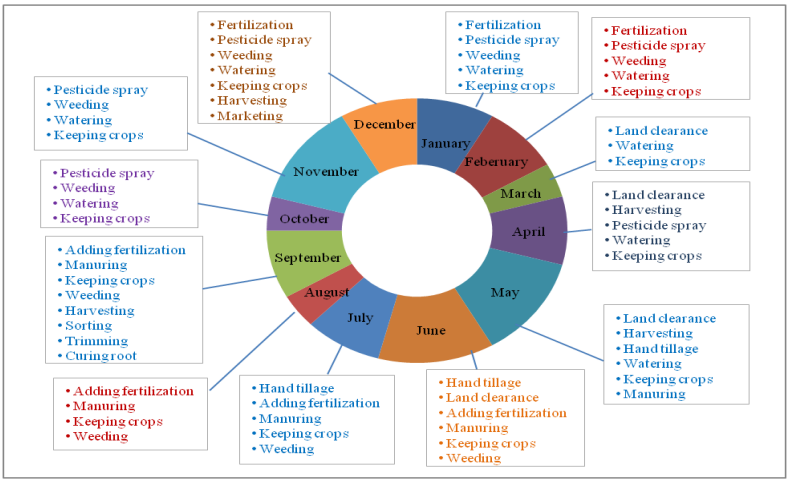

Fig 9B. *Seasonal based activities of female farmers*

DISCUSSION

The Fruit and Vegetable Produce in the Area

Ethiopia is well known for its diversity of indigenous food plants, including fruits and vegetables cultivated in home gardens [19]. The production system is, however, traditional and poorly supported by scientific methods [20]. The horticultural products obtained in the present study were characterized by a mixed production system with the highest percentage of onion, potato, and tomato produce (41.7%), mainly cultivated using irrigation (Table 2). This is associated with the favorability of the area for irrigation. The study done in some parts of the western (Dendi, Ambo, Toke Kutaye, Cheliya, Ilugelan) and southwestern (Woliso, Wonchi) Shewa zones also indicated similar types of horticultural crops cultivated in the areas [21]. The studies conducted in different parts of the country also showed similar types of produce [22, 23, 24, 25].

Types of Seeds, Storage Methods, and Marketing System of Fruits and Vegetables

The use of the local varieties of seeds in this study area could be attributed to the lack of improved varieties because only a few governmental and non-governmental organizations are supplying the improved seeds. Even for the available improved seeds, farmers have financial constraints to purchase the seeds. Thus, they are limited to using local varieties with lower productivity and prone to diseases and insects at a reasonable price. The studies also indicated the scarcity of improved seeds of fruits and vegetables in most parts of the Ethiopia Zone [21, 26]**.**

Most of the farmers had no stored produce and did not use any storage methods due to financial constraints and a lack of awareness of the importance of the storage method. Thus, they immediately sell their produce to the nearby markets cheaply. Lack of field storage facilities is also a common problem in almost all parts of the country, causing a significant postharvest loss before arriving at the first markets [16, 27]. Kasso and Bekele [23] also reported that farmers use resident houses to store their horticultural crops in the Dire Dawa area temporarily, and a few people store them under big trees and caves or bury them under the soil.

In the present study, only a few farmers (1.7%) use a high amount of their total produce (25-50%) for home consumption. Rather, they sell it and purchase other staples because fruits and

vegetables are comparatively expensive. Demissie et al. [28] also reported that fruits and vegetables are not widely consumed in Ethiopia due to poor feeding habits and perceptions. Moreover, there is a wrong perception that monotonous diets consisting of cereals and legumes are adequate and superior in their nutrition quality. Many studies also confirmed that economic factors and perception are among the most important constraints for horticultural crop consumption among the poor farmers in Ethiopia [1, 21, 22].

Postharvest Loss of Fruits and Vegetables

Postharvest loss of fruits and vegetables is a major challenge for many farmers (30 to 50% of total loss) in developing countries [28, 29]. In the present study, the total estimated loss up to the first market exceeded 15% of the total production for most farmers (Fig. 3). This could be due to factors such as poor pre-harvesting activities, harvesting techniques, postharvest handlings, diseases, pest animals, etc. This is comparable with the reports made in the Dire Dawa area (20 to 50%) [24], and north-western Ethiopia (15 to 30%) [25]. Muhammad et al. [30] also reported 5-20% and 20-50% of postharvest loss of fruits in the developed and developing countries, respectively. The highest postharvest loss observed in Wajjira (34%) and Imala (28%) kebeles (Fig. 4) could be associated with the high dependence of the areas on irrigation and their long distance from the markets**.** The study also indicated that distance from the market negatively correlates with postharvest loss [31]. The result is similar to the report of Hailu et al. [22] from the Ejere District.

The Stage of Postharvest Loss, Extent, Causes, and Management Strategies

The present finding also revealed that most of the farmers (61.1%) faced high postharvest loss on the field with a very small loss during harvesting and no loss during transportation and storage (Fig. 6). This is highly accompanied by diseases and insect pests, shortage of improved seeds, inadequate market access and limited knowledge on the handling of products on the field (Table 4). The studies also indicated that poor pre-harvest handling practices cause a substantial postharvest loss of perishable crops [32]. Our finding is analogous to the report of Kasso and Bekele [24], Hailu [21], and Rahiel et al. [26]. In contrast, Bantayehu and Bizuayehu [25] reported a high postharvest loss during harvesting due to a lack of improved harvesting and collection technologies. The difference might be allied with the variation in the harvesting and handling techniques on the field and after harvesting [26].

The farmers of the present study area use different traditional management strategies like harvesting at the appropriate age and time, occasionally spreading the product on the floor or on the bed before marketing and transporting the produce quickly without storing it. Similarly, farmers in different parts of Ethiopia use similar cultural practices to reduce postharvest loss of horticultural crops [26, 29].

Gender Analysis in Postharvest Loss

Gender-Based Variability of Activities in Fruits and Vegetable Production

Gender-based analysis is highly important to determine the effectiveness of postharvest loss reduction strategies and interventions. The studies indicate that socio-cultural backgrounds reflect the gender role differences in the food value chain, postharvest management, and how resources and benefits are successively shared among the gender [33, 34]. There are five main categories of gender-based constraints in agriculture which includes limited access to knowledge

and information, limited participation and decision-making, limited access to finance, limited access to inputs and resources, and work burden and time poverty of females [34, 35].

The predominance of males in most of the pre and post-harvest activities of the present study (Table 9) might be associated with the culture-based gender roles, which favor males in accessing, controlling and deciding over all of the resources. Females are mostly responsible for reproductive tasks, marketing the smaller quantities of products and purchasing the smaller food and non-food items for consumption. Kasso and Bekele [23] also reported that males are dominant in farm work in the Dire Dawa area except in a few activities. The role of males and females in agriculture is also 59% and 41%, respectively in Ethiopia [36].

Accesses and Controls over the Resources

Women have a high level of participation in agriculture in all parts of the world, but there is a significant gender disparity in accessing the resources [36, 37]. Our result also revealed that all resources were equally accessed by both sexes except for access to training and storage, which agrees with the report made from the Dire Dawa area [23]. The less training access to females in this study might be due to the fewer training opportunities available for females in agriculture, and this is in agreement with the report of Blackden et al. [36] in the SSA region. In another way, the predominance of females in access to storage might be because of a norm that considers females can handle and store fertilizers and seeds with more care than males [38].

The results also revealed that access to all resources was negatively correlated with postharvest loss and statistically significant ($p<0.05$), indicating that equally accessing of the resources by both sexes is less likely to cause highly postharvest loss. This is because when they have equal opportunity to access the resources, both of them sense equal responsibility in the postharvest management [39]. According to Shee et al. [35], rural women have very limited access to farming, facilities, technologies and markets as a consequence of higher food losses. Similarly, postharvest management is underperformed in SSA countries because women have limited access to resources and opportunities in agriculture [40].

Power and agency is the other most important factor in postharvest management [35]. Customs and traditions are the major factors determining who does what in the family, who is the decision-maker and who controls and owns the family resources [41]. Our finding also demonstrated that males dominated the controls made over the resources except for fertilization and seeds (Table 8). Similarly, fertilizing and planting the horticultural crops are mainly the role of females and children, and male household heads are responsible for land preparation in many parts of Ethiopia [42]. The assumption of the binary logistic regression model revealed that the engagement of both sexes in controlling the resources is less likely to cause high postharvest loss, which confirms the necessity of females in decision-making over the resources to reduce postharvest loss. This is because when the controls over resources are dominated by males, females do not feel the ownership of the resources and the profits obtained from the resources [43]. Moreover, when the benefits obtained from the resources and credits are dominated by males, females sense the unprofitability and do not care for the postharvest loss [15]. Similarly, the controls made over resources in agricultural activities are mainly performed by males with high post-harvest loss in other agriculture [41].

Decision Making on the Resources

Inter-household dynamics and power relations have a major role in determining the decision-making power of the family members in agriculture [35]. Despite their paramount role in

agriculture, rural women have however a very specific role in decision-making and these constraints affect their ability to fully contribute to and benefit from postharvest loss reduction [34, 35]. In this study, males are the decision-makers on the resources and benefits (Figure 7). The regression also revealed that the decisions made over the resources and profits were negatively correlated to postharvest loss and statistically significant ($p<0.05$) indicating that the engagement of both sexes in the decision-making causes the less likely of high post-harvest loss, which in corroboration with the report of Maliro and Kandiwa [44]. O'planick and Garloch [37] also reported similar results in other parts of Ethiopia. The study made in Kenya also showed that males are decision-makers over the sale of produce, storage and money that accrue from the sale of agricultural produce [33]. In contrast, Quechua women farmers in Peru are key decision-makers, deciding which plant varieties meet specific nutritional needs, what crops to sell and what crops to consume [45].

Daily Activities Clock and Seasonal Calendar

In the present study, both sexes were performing different activities, which varied based on the daily and seasonal based patterns. Both the daily and seasonal-based calendars revealed that females are too busy with both farm and homestead works (on average females were **16** hours busy and males were 13 hours busy per day). Thus, they have very small leisure time during their daily and seasonal times. According to Nzioki and Kandiwa [33], rural women often manage complex households and pursue multiple livelihood strategies such as producing crops, tending animals, processing and preparing food, working for wages in agricultural or other rural enterprises, collecting fuel and water, engaging in trade and marketing, caring for family members and maintaining their homes. Many of these activities are not defined as "economically active employment" in national accounts, but they are essential to the well-being of rural households. Lal and Khurana [41] also reported that women comprise around 43% of the workforce in agriculture worldwide in addition to their homestead works. Female participation in agriculture is also about 41% in Ethiopia [36]. They also play a pivotal role in postharvest activities [13]. The works typically assigned to the women are arduous, time-consuming and repetitive, and are often carried out around the home. This double or triple role creates time and energy constraints, and can significantly influence food loss [13, 34]. This generally constrains their ability to fully contribute to growth and poverty reduction. Similarly, in the Center Province of Cameroon, men's mean total weekly labor time is 32 hours, whilst for women; it is more than 64 hours, which is almost comparable with our finding [36]**.** Generally, large-scale comparative studies have demonstrated that gender inequalities are costly and inefficient, and improving gender equality in agriculture contributes to food security by reducing post-harvest loss [46].

CONCLUSION

The present study indicates that fruits and vegetables are the most widely cultivated agricultural produce in the area, where onion, potato, and tomato take the largest part of the total produce. Despite this, there is a significant postharvest loss of the products due to inadequate transportation access, storage facilities, improved variety, market access, knowledge and biological factors like insects and diseases. In other ways, there is a significant gender role disparity in the fruits and vegetable production, harvesting and handling with an implication of high postharvest losses. Mainly, females are less dominant in accessing, controlling and decision-making in most of the pre and post-harvest activities. The extent of the postharvest loss

was highly associated with the gender role disparity in agricultural activities. This calls for extensive work to ensure gender equality in the production of these horticultural crops for sustainable management of the postharvest losses and meet the food security in the study area.

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