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# Postharvest Practices and Determinants of Potato and Tomato Losses for Appropriate Interventions Design in Ethiopia

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## Abstract

Postharvest loss reduction is an important food and nutrition security strategy in developing countries like Ethiopia. In the target survey areas, postharvest losses of potato and tomato crops occur at various stages. Therefore, the present baseline survey was undertaken to identify existing postharvest practices and losses that occurred in the supply chain of potatoes and tomatoes in Arsi Zone, Ethiopia. In addition, responsible determinant factors that influence postharvest losses were analyzed. A multistage sampling procedure, through a combination of purposive and simple random sampling techniques, was adopted in the selection of districts, *kebeles*, and households. A total of 209 and 191 smallholder potato and tomato farmers were interviewed in Tiyo and Ziway-dugda districts, respectively, in 2022. Quantitative data collection was carried out online using computer-assisted personal interviewing by programming a semi-structured questionnaire in KoboCollect software for tablets. Descriptive analysis results showed that the primary causes of losses were poor storage facilities, insects, and worms as well as poor handling techniques from the perspective of the farmers. Ordinal probit regression model results revealed that during the harvest stage, working family members significantly ($p<0.01$) increased potato loss while years of schooling ($p<0.05$) and harvesting using leaf color change as a criterion ($p<0.01$) had significantly mitigated it. In storage, female respondents ($p<0.05$), land size ($p<0.05$), and lack of training ($p<0.1$) had accentuated potato loss. During transport, the household age reduced ($p<0.1$) potato loss whereas farming experience promoted ($p<0.1$) it. Similarly, during tomato harvesting, the time of harvest mitigated losses ($p<0.01$), while farming experience and lack of training increased losses ($p<0.1$). In storage, age, schooling years, sex, and training mitigated tomato losses ($p<0.05$), while only land size ($p<0.01$) accentuated it. During transport, land size ($p<0.05$) and animal-pulled carts ($p<0.1$) accentuated tomato losses. The awareness of

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the farmers on proper operation during harvesting, field handling, storage, and transportation should be increased. Suggested interventions include postharvest knowledge and skill training, simple innovative eco-friendly storages constructed using locally available materials, appropriate packaging, and simple value addition and preservation techniques.

**Keywords**: Ethiopia, ordinal probit regression model, postharvest loss, potato, tomato

## Introduction

Potato and tomato are widely produced in Ethiopia and smallholder farmers are the majority of the producers. Both crops are strategic commodities considered for ensuring food and nutrition security in the country by the government of Ethiopia at large and specifically will lead to inclusive, sustainable, and stronger agricultural value chains in the Central-Eastern Oromia region [1] where the Arsi zone is part of.

Postharvest loss reduction is among the top priorities of the sustainable development goal (SDG) and is an important strategy for food and nutrition security. It requires interventions designed based on timely and reliable statistical data [2]. Postharvest loss reduction in fruit and vegetables can compensate for the need to increase production to cope with the current growing demand in developing countries like Ethiopia. However, the lack of loss data and associated factors along the postharvest value chain stages remains a challenge to implement appropriate interventions. Generating survey data at the farm level is one way of producing reliable estimates of harvest and postharvest losses, to orient decision-making and monitor progress towards reducing food losses [3]. Research results of Shee et al. [4] showed that postharvest physical losses at different stages of the commodity value chains are influenced by socio-economic factors as well as the postharvest methods currently practiced.

Therefore, a baseline survey was conducted on potato and tomato crops in the Tiyo and Ziway-dugda districts of Arsi Zone, Ethiopia, respectively, in 2022 with specific objectives: (1) to assess socio-demographic characteristics and the extent and causes of postharvest potato and tomato losses, (2) to assess the existing harvest, postharvest handling, storage, and transport practices (3) to identify the determinant factors of producer-level postharvest losses, and (4) to identify postharvest knowledge, skills, and technology gaps and suggest appropriate scale interventions for reducing potato and tomato losses in the target areas.

## Methodology

***Sampling techniques:*** producers of potato and tomato crops were selected using a multi-stage sampling method. The first stage was a purposive selection of specific crop-growing districts and *Kebeles*. Then, a simple random sampling technique was used in selecting the respondents for the survey from each target *kebeles*.

***Approaches and methods:*** both primary and secondary data were used. The primary data collection was carried out online using the Computer-Assisted Personal Interviewing (CAPI) data collection platform, as it is a better alternative to the traditional pen-and-paper interviewing method, by programming a semi-structured questionnaire in KoboCollect software for tablets. The data collected included information on socio-demographic status, postharvest practices, and farmers' self-reported perception of their quantitative postharvest losses experienced in the previous season (2020/21).

***Analytical framework:*** the collected data were coded and analyzed using IBM Statistics SPSS version 22 for Windows. Data were analyzed by descriptive statistics and regression analysis. The

collected postharvest potato and tomato loss data were categorical and ordinal so the probit model is the most appropriate for conducting regression analysis on it [4]. On-farm loss categories that organize loss percentages into five loss categories which were built from loss percentage data collected in the respective crop surveys were used. Ordinal probit regression models were used to investigate the relationship between postharvest losses of potatoes and tomatoes and their respective explanatory variables as briefly described by Dooga et al. [5].

**Results and Discussion**

Harvesting of potato and tomato crops at an appropriate stage of maturity and time of day is important for long-term storage and transport to distant markets. The maximum percentage of farmers harvested based on color change in potato leaves and by observing tomato leaf and/or fruit color change. The produce harvesting stage needs to be based on the intended market i.e. the preference of the local consumers, farmer nearby market, distant market, or long-term storage plan. With regards to harvesting time, the majority of respondents (69.9%) harvest their produce in the mornings whereas 19.6% of respondents harvest at midday.

The majority of potato farmers (40.7%) used a combination of storage methods: spreading on flour, traditional storage, and delayed harvest. Among respondents, only 5.8% of farmers had traditional storage structures. Delayed harvest (5.8%) is one of the on-farm storage methods employed by farmers in the district. The most common one, however, is storing harvested potatoes by spreading them on the floor of a storage room before transportation with a response rate of 40.1%. Whereas, only a few (3.66%) respondents practice storage for tomatoes with the most common one being storing harvested tomatoes by spreading them on the floor of a storage room before transportation with a response rate of 42.8%. Postharvest potato and tomato production in the target areas lacks proper storage methods such as cold storage and proper packaging materials such as plastic crates. The primary mode of transportation of potatoes and tomatoes in the study areas to the markets was by loading them on pack animals like horses and donkeys with 45.4 and 23% response rates, respectively. All respondents experienced potato and tomato loss during transport to market.

Bad weather (rainfall, wind, etc.) (35.4%), molds in the field (26.3%), insects in the field (23%), and harvesting methods used (15.8%) were major factors for producer-level potato losses. Similarly, the highest moderately severe threats that contributed to producer-level potato loss in the target area were from the harvesting method used (34.4%) and other animals (34%). The major causes of tomato losses were insects in the field, molds in the field, rodents in the field, birds, weather (rainfall, wind, etc.), and harvesting methods used with 19.9, 29.32, 24.61, 30.89, and 19.37% respondents reporting it as sever causes of loss, respectively. The aggregate mean loss between harvest and transport to market was 15-46% and 15-51% for potatoes and tomatoes, respectively. Elevated losses during harvesting and storage in the areas are likely to reflect poor handling and storage practices. In addition to these, the majority of the respondents didn't receive postharvest training for potatoes and tomatoes with response rates of 62.2 and 67.54%, respectively. Farmer respondents (with a 49.8% response rate for potatoes and 87% response rate for tomatoes) need training on overall postharvest aspects.

Moreover, the results of analysis using the probit link function in the ordinal regression model estimation reveal that self-reported perceptions of the level of quantitative postharvest losses (perceived at five categories for both produce) at different stages of farmer level value chains were influenced by socio-demographic variables and postharvest factors in the target survey areas. During the harvest stage, working family members significantly ($p<0.01$) increased potato loss while years of schooling ($p<0.05$) significantly reduced loss. In addition, harvesting using leaf

color change observation as a criterion had significantly ($p<0.01$) mitigated it. In storage, female respondents ($p<0.05$), land size ($p<0.05$), and lack of training ($p<0.1$) had accentuated potato loss. During transport, the age of household reduced ($p<0.1$) potato loss whereas farming experience promoted ($p<0.1$) it. Factors like farmer's age, inappropriate time of harvest, and lack of grading/sorting activities were significant ($p < 0.05$) determinants of postharvest tomato loss. During tomato harvesting, the time of harvest mitigated losses ($p<0.01$), while farming experience and lack of training increased losses ($p<0.1$). In storage, age, schooling years, sex, and training mitigated tomato losses ($p<0.05$), while only land size ($p<0.01$) accentuated it. During transport, land size ($p<0.05$) and animal-pulled carts ($p<0.1$) accentuated tomato losses.

**Conclusions and Outlook**

The survey provided factual baseline information on the aspects and impacts surrounding the producer-level postharvest operations such as harvesting, field handling, packaging, postharvest treatments, storage management, transport, and marketing activities. These findings are particularly useful to the policymakers and other developmental stakeholders to capitalize on the various determinants found to influence the respective crop losses. To reduce the existing losses, farmers' awareness should be increased concerning each stage by providing adequate training, to use proper operation during harvesting, field handling, storage, and transportation. The study recommends the need for stakeholders' intervention focusing on postharvest knowledge and skill capacity building while including young and women. Suggestions include crop-specific postharvest training, demonstration of simple innovative eco-friendly storage facilities using locally available materials (ventilated storage construction for potatoes and zero energy evaporative coolers for tomatoes), appropriate packaging (such as reusable plastic crates) and transport methods, and simple value addition methods (such as potato drying using indirect solar dryers, potato flour processing for fortifying local cereals, tomato sauce/paste/ketchup, tomato indirect solar drying).

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