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Original Research Article

Impact of Road Conditions on Post-Harvest Losses in Tomato Production in Beledweyne District, Hiiraan Region, Somalia

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Abstract: Tomato production is an important source of income and food for many households in Beledweyne District, Hiran Region, Somalia. However, postharvest losses remain a major challenge, particularly during transportation from production areas to the main markets, so this study examined the impact of road condition on postharvest losses in tomato production in Beledweyne District, Hiiraan Region, Somalia. A descriptive cross-sectional survey design with a quantitative approach was used. Data were collected from 92 tomato farmers who supply tomatoes to the main market in Beledweyne District. The sample size was determined by using Slovin's formula with a 5% margin of error. Primary data was used through A structured questionnaire was used to collect data at the local main market in Beledweyne, where farmers bring their products. Using descriptive statistics such as frequencies, percentages, and figures, with Stata version 17. The findings indicate that postharvest tomato losses in the study area are a considerable majority of farmers reported losses ranging between 21% and 30%, and also a significant proportion experienced losses exceeding 30% of total production. The results indicated that poor road conditions are the main cause of these losses. The farmers indicate that rough and unpaved roads, long transportation distances, and frequent delays and also long travel times all negatively affect tomato quality, resulting in physical damage such as bruising, cracking, rotting, and softening. In addition to that, the study results show that postharvest losses have a serious negative impact on farmers' income, reducing profitability. All respondents agreed that also improving road condition would significantly reduce postharvest losses.

Keywords: Post-harvest losses; Poor Road conditions; Tomato transportation; Mechanical damage; Quality deterioration; Supply chain; Rural infrastructure.

1. INTRODUCTION

Tomato (Solanum lycopersicum L.) is an essential cash crop and the second most consumed vegetable crop in the world. The species originally originates from South America, the regions of Peru and Ecuador, but it was first cultivated in Mexico. (Benton, 2007). During the mid-16th century, then later it was introduced to many places in the world, like Europe, where it appeared mainly in the early herbal books. At that time it was cultivated so largely for beauty rather than fruits. It was not used for consumption purposes. At this time, consumption in countries like Italy and Spain was limited. At this time it was believed to be poisonous and was not widely recognized or accepted as a useful vegetable until around 1800. (Nicola *et al.,* 2009). Today the tomato is widely grown in many places in the world due to its importance for many, including its taste, flavor, and richness of nutrients. It can be consumed both fresh and processed. Tomatoes have many health benefits, such as well-balanced diets, as they have few calories and are a source of vitamin A, vitamin C, and also minerals. In addition to that, it provides a small amount of B-complex vitamins, including thiamin, riboflavin, and niacin (Sainju & Dris, 2006). The In 2022, tomatoes will be considered the most popular vegetable crop in the world, with a total production of 186.11 million metric tons. This production was around 68% higher than that of onions, which is the second most produced vegetable worldwide (Statista, 2024). Post-harvest losses can be defined as measurable quantitative and qualitative damages or spoilage in the post-harvest value chain caused by natural or artificial phenomena (AKAA,

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2025). Today the tomato is widely grown in many places in the world due to its importance for many, including its taste, flavor, and richness of nutrients. It can be consumed both fresh and processed. Tomatoes have many health benefits, such as well-balanced diets, as they have few calories and are a source of vitamin A, vitamin C, and also minerals. In addition to that, it provides a small amount of B-complex vitamins, including thiamin, riboflavin, and niacin (Sainju & Dris, 2006). The tomato is considered the most popular vegetable crop in the world in 2022, with the total amount of production reaching 186.11 million metric tons. This production was around 68% higher than that of onions, which is the second most produced vegetable worldwide (Statista, 2024). Post-harvest losses can be defined as measurable quantitative and qualitative damages or spoilage in the post-harvest value chain caused by natural or artificial phenomena. (AKAA, 2025).

In Africa, Poor access to roads from farm production to market in many African countries is a major problem. Most tomato production areas are located in remote rural regions that are so far from paved roads or lack good road transportation, making access to competitive markets both difficult and costly. Even where roads exist, often they are in very poor condition, further limiting efficient transportation. Good infrastructure is a major challenge in many developing countries, affecting both tomato producers and distributors over the long term (Arah *et al.,* 2014). In Ghana, 76% of farmers and traders in the Brong Ahafo Region were suffering from poor road conditions, which negatively affected their production. It was also reported that bad road infrastructure makes it very difficult to produce the tomato, and also the effect of transportation costs makes it very expensive and time-consuming to market. Yeboah (2011) found that farmers incur losses of up to 20% due to transportation delays alone (Babatola *et al.,* 2008). However, this estimate may make the true extent of losses less true, as vehicles using these damaged roads often become delayed for hours or even days, leading to even greater levels of tomato spoilage than previously reported. Using the appropriate type of transportation is also very important for successful handling of tomatoes after harvest. (Idah *et al.,*2007). In Africa most crop losses occur at the stage of harvesting, and after harvesting, post-harvest losses reach up to 20% for cereals and 40% for fruits and vegetables (FAO, 2019).

In Baledweyne District, Hiiraan, Somalia, tomato farming is an important source of income and food. It is the main market and commercial center where tomatoes from surrounding rural areas are transported and sold. However, many tomatoes do not reach the main market in good condition because of poor roads, long travel times and frequent delays. These post-harvest losses reduce farmers' income and limit the supply of fresh tomatoes. Despite that there is no previous research conducted on how road conditions contribute to these losses in Beledweyne District. Therefore, this study examines the impact of road conditions on post-harvest tomato losses in Baledweyne District, Hiiraan Region, Somalia.

2. METHODOLOGY

The study was conducted in Beledweyne District, Hiiraan Region, Somalia, which serves as the main market and commercial center for tomatoes and other agricultural crops supplied from rural areas. A descriptive cross-sectional survey design with a quantitative approach was used. The target population was 120 of tomato farmers who supply tomatoes to the main market in Beledweyne District. A sample of 92 farmers was selected using Slovin's formula, which included a 5% margin of error. A structured questionnaire was used to collect data at the local main market in Beledweyne, where farmers bring their produce for marketing. In the questionnaire, road conditions, post-harvest losses, and farmers' impact perceptions were measured as the study variables. The collected data were analyzed using descriptive statistics, such as frequencies, percentages, and figures, with Stata version 17**.**

3. RESULT AND DISCUSSIONS

3.1 socio-demographic characteristics

Table 1. The socio-demographic characteristics of the respondents are presented as showing 77.2% of the respondents were male and only 22.8% female. The results indicate that tomato farming in the study area is dominated by males. Male respondents accounted for 71 farmers (77.2%), while female respondents represented only 21 farmers (22.8%). This result shows that men play a leading role in tomato production when compared to the female. Cultural norms or home activities may contribute to the low participation of women. According to age distribution, the majority of the respondents were in the middle-age group. Farmers aged between 36–45 years constituted the largest proportion, with 61 respondents (66.30%), followed by those aged between 26-35 years, who accounted for 18 respondents (19.57%). . The respondents aged between 46-55 years presented that 11 farmers (11.96%), while only 2 respondents (2.17%) were within the 18–25 years age group. These results indicate that most tomato farmers in the study area practice tomato production mainly by economically and physically active individuals who are better able to meet the physical demands of farming and post-harvest operations. The low participation of younger farmers may be attributed to rural–urban migration or their involvement in non-agricultural income-generating activities. According to marital status 60(65.22%) were married and 29(31.52%) were single while only 3 (3.26%) were divorced, the results indicate that married farmer were the majority in the study area. The results of farming experiences show that the majority of the respondents were farmers with 4–7 years of experience, representing 48 respondents (52.2%), while those with more than 7 years of experience

accounted for 32 respondents (34.8%). and only 12 respondents (13%) had 1–3 years of experience. This result indicated that tomato farming in the study area is a long-established practice, although farmers are experienced and knowledgeable, but post-harvest losses remain a problem and are mainly due to challenges related to road conditions and transportation.

Table 1: Socio-demographic characteristics

Variables	Frequency	Percentage
Gender		
Male	71	77.2%
Female	21	22.8%
Total	**92**	**100**
Age		
18-25	2	2.17%
26-35	18	19.57%
36-45	61	66.30%
46-55	11	11.96%
Total	**92**	**100**
Marital status		
Married	60	65.22%
Single	29	31.52%
Divorced	3	3.26%
Total	**92**	**100**
Experience		
1-3 years	12	13%
4-7 years	48	52.2%
Above 7 years	32	34.8
Total	**92**	**100**

3.2 Road Condition Variables

Table 2 presented the road condition and transportation characteristics of the respondents. The results show that road quality in the study area is generally poor, as the results show that only 2 respondents (2.17%) reported very good road conditions, while 1 respondent (1.10%) reported good roads. A total of 9 respondents (9.78%) described road conditions as normal. as showing the majority of the farmers rated that the road quality as poor, with 38 respondents (41.30%) reporting poor roads and 42 respondents (45.65%) reporting very poor roads. This clearly shows that most farmers operate under unfavorable road conditions. According to the road type, only 2 respondents (2.2%) had access to tarmac roads. as Gravel and sandy roads were the most common, each used by 33 respondents (35.9%), while 22 respondents (23.9%) relied on mud roads. so while A small number of respondents (2.1%) reported using mixed road types. The results indicate that inadequate road infrastructure, with transportation relying mainly on unpaved roads, contributes significantly to post-harvest tomato damage. while according Delay frequency majority of the respondents, one of the respondents (0%) reported never experiencing delays. Only 1 respondent (1.09%) reported rarely experiencing delays, while 9 respondents (9.78%) experienced delays sometimes. so as shown the majority of farmers reported that frequent delays, with 52 respondents (56.52%) indicating that delays often occur and 30 respondents (32.61%) reporting that delays always occur. This result shows that delays in transportation are frequently experienced in the study area, which could lead to post-harvest losses of tomatoes during transportation. In terms of transport time, no respondents (0%) were able to transport tomatoes to the market in less than one hour. while Only 9 respondents (9.8%) reported that transport durations were 1–2 hours. So the majority of farmers, 70 respondents (76.1%), required 3–4 hours to reach the market, while 13 respondents (14.1%) spent more than four hours. These long transport times, combined with poor road quality and frequent delays, may likely increase physical damage, spoilage, and overall post-harvest losses.

Table 2: Road Condition Variables

Variables	Frequency	Percentage
Road quality		
very good	2	2.17%
Good	1	1.10%
Normal	9	9.78%
Poor	38	41.30%
Very poor	42	45.65%
Total	**92**	**100**

Variables	Frequency	Percentage
Road type		
Tarmac road	2	2.2%
Gravel road	33	35.9%
Mud road	22	23.9%
Sandy road	33	35.9%
Mixed road	2	2.1%
Total	**92**	**100**
Delay frequency		
Never	0	0%
Rarely	1	1.09%
Sometimes	9	9.78%
Often	52	56.52%
Always	30	32.61%
Total	**92**	**100**
Transport time		
Less than 1 hour	0	0%
1-2 hours	9	9.8%
3-4 hours	70	76.1%
more than 4 hours	13	14.1%
Total	**92**	**100**

3.3 Post-Harvest Loss Variables

Table 3 presented post-harvest loss variables shows tomato percentage losses variable show that post-harvest losses are high among the respondents in the study area. The results show that none of the farmers reported losses in the range of 0.5%, indicating that post-harvest losses is high problem. As shown in the results, the majority of the respondents experienced losses between 21% and 30% (47.83%), followed by those who reported losses of 11–20% (34.78%). In addition to that, 11.96% of the farmers lost more than 30% of their tomato production and 6-10%(5.43%) which is the smallest. So this results in strongly indicating that a large share of tomatoes is lost before reaching the market, which affects farmers' income as a whole. The main causes of losses, as shown by the results, are largely related to transportation. Poor condition was reported by 73.91% of the respondents, making it the most important cause of tomato losses, as the results show that long distance to market was mentioned by 22.83% of respondents. In addition to that, only a small number of farmers reported poor packaging (2.17%) and poor vehicle condition (1.09%), showing that road quality and distance are more problematic causes of postharvest losses in the study area. According to the effect of vibration, all respondents (100%) agreed that vibration affects tomato quality during transportation, so these results strongly indicate the seriousness of the problem, especially when tomatoes are transported on rough roads. Finally, the type of damage shows that bruising was the most common reported damage (30.43%), followed by cracking (28.26%) and rotting (27.17%). Softening accounted for 13.04%, while only 1.1% of respondents experienced all types of damage. These damages are mainly related to the poor transportation system in the study area.

Table 3: Post-Harvest Loss Variables

Variables	Frequency	Percentage
Tomato Percentage Losses		
0–5%	0	0%
6-10%	5	5.43
11–20%	32	34.78%
21–30%	44	47.83%
Above 30%	11	11.96%
Total	**92**	**100**
Main Causes of Losses		
Poor road condition	68	73.91%
Poor packaging	2	2.17%
Long distance	21	22.83%
Poor vehicle condition	1	1.09%
Total	**92**	**100**
Effect of vibration		
Yes	92	100%
No	0	0%
Total	**92**	**100**

Variables	Frequency	Percentage
Damage Types		
Bruising	28	30.43%
Cracking	26	28.26%
Rotting	25	27.17%
Softening	12	13.04%
All of the above	1	1.1%
Total	**92**	**100**

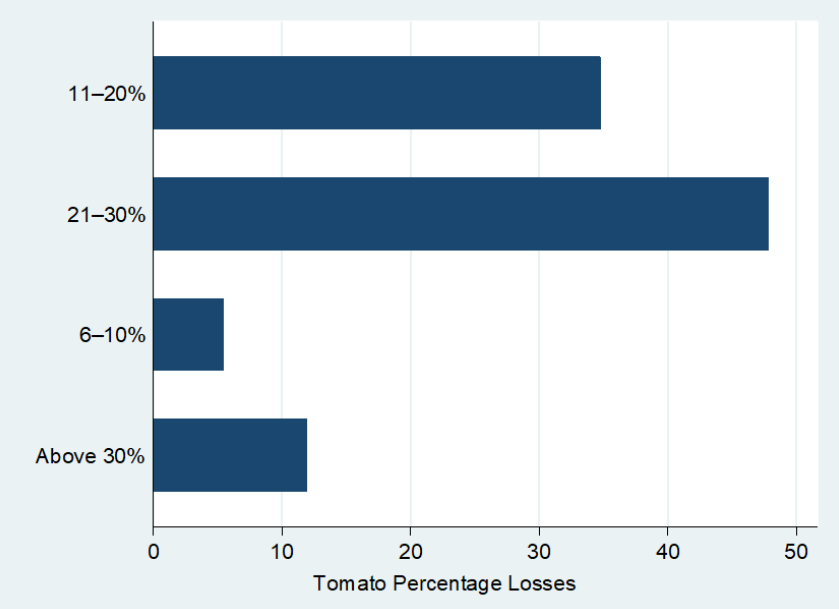

Figure 1: Tomato Percentage Losses

Figure 2: Post-harvest tomato damage observed at the main market in Beledweyne District (photograph taken by the authors).

Figure 2:

shows tomatoes that were damaged during transportation to the main market in Beledweyne District due to poor road conditions. Rough and unpaved roads expose the produce to repeated vibration, shocks, and long travel times, resulting in bruising, crushing, and skin damage, which accelerate quality deterioration and increase post-harvest losses. This damage reduces market value and shortens shelf life, directly affecting farmers' income**.**

Figure 3: Tomatoes showing cracking and bruising observed at the main market in Beledweyne District due to poor road conditions (photograph taken by the authors).

3.4 Impact of Road Conditions

Table 4 presented the results of how roads affect postharvest losses. The majority of respondents (69.57%) indicated that road conditions have a very high effect on losses, while 22.83% reported a high effect. Only 7.6% of the respondents perceived the effect as moderate, and none reported low or no impact. These results indicated that poor road conditions are a major factor or problem contributing to tomato losses in the study area. According to the income impact, the results show that post-harvest losses of tomatoes have a serious effect on the farmers' income in the study area. Most of the respondents (60.87%) reported that the impact on income is very high, while 30.43% indicated a high impact. Only 8.70% of the respondents experienced a moderate impact, and none reported low or no impact. This result indicates that tomato losses significantly reduce farmer income and threaten their livelihoods. finally According to farmers' perception of road improvement, all respondents (100%) agreed that improving road conditions would reduce post-harvest tomato losses; the results show the importance of road improvement as a solution to post-harvest losses.

Table 4. Impact of Road Conditions Variables

Variables	Frequency	Percentage
How roads affect losses		
Very high	64	69.57%
High	21	22.83%
Moderate	7	7.6%
Low	0	0%
No impact	0	0%
Total	**92**	**100**
Impact on income		
Very high impact	56	60.87%
High impact	28	30.43%
Moderate impact	8	8.70%
Low impact	0	0%
No impact	0	0%
Total	**92**	**100**
Perception of Road Improvement		
Yes	92	100%
No	0	0%
Total	**92**	**100**

4. CONCLUSION

This study examined the impact of road conditions on postharvest losses of tomatoes in Beledweyne District, Hiiraan Region, Somalia. The results of the study show that postharvest tomato losses are high in the study area, and most farmers reported that they are losing between 21% and 30% of their tomato production, while some other farmers experienced losses

of more than 30% before the produce reached the main market. The findings indicate that poor road conditions are the main cause of these losses. Rough and unpaved roads, long transportation distances, frequent delays, and long travel times cause tomatoes to be subjected to strong vibrations during transportation, so the results show tomatoes also have problems with physical damage such as bruising, cracking, rotting, and softening. So all respondents confirmed and agreed that vibration during transport negatively affects tomato quality. This study also found that postharvest losses have a strong negative impact on farmers' income, as shown by the results. Most farmers agreed that these losses greatly reduce their income. In addition to that, all respondents agreed that improving road conditions would significantly reduce post-harvest tomato losses. Finally, poor road infrastructure is a major factor contributing to post-harvest tomato losses in the Baledweyne district. So improving road conditions would help reduce losses, increase farmers' income, and improve the tomato marketing system in the area.

5. RECOMMENDATION

Based on the findings of this research, the following recommendations are highlighted.

1. The government and development partners should prioritize and improve rural feeder roads linking tomato production areas to the main market in Beledweyne to reduce transportation delay and post-harvest losses.
2. Measures should be taken to reduce transportation time from farms to markets through improved road connectivity and transport services in the study area.
3. Farmers should use appropriate transport vehicles and avoid overloading in order to minimize mechanical damage during tomato transportation.
4. Proper handling and stacking practices should be adopted during loading and unloading to reduce bruising, cracking, and crushing of tomatoes.
5. Agricultural extension services should provide regular training to farmers on post-harvest handling and packaging techniques to improve tomato quality and reduce losses.
6. The establishment of local collection and aggregation centers near production areas is recommended to shorten transportation distance, improve handling conditions, and enhance market access for farmers.

Conflict of Interest

The authors declare that no conflicts of interest

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