International Journal of Food Engineering and Technology
2025, Vol. 9, No. 2, pp. 65-70
https://doi.org/10.11648/j.ijfet.20250902.11

Research Article

Adaptation of an Underground Ventilated Pit for Potato Storage

Husen Bona[1, *], Teshome Wakeyo[2], Tolasa Berhanu[1]

[1]Agricultural Machinery Engineering, Oromia Agricultural Research Institute, Jimma Agricultural Engineering Research Center, Jimma, Ethiopia

[2]Agricultural Engineering, Oromia Agricultural Research Institute, Jimma Agricultural Engineering Research Center, Jimma, Ethiopia

Abstract

The potato, or Solanum tuberosum L. is a semi-perishable product. The entire potato production-consumption system depends on effective post-harvest technology and marketing due to the crop's bulk and perishability. Decomposition, deterioration, and physiological breakdown all lower potato quality and storage life. Relative humidity, air circulation, gas composition, and storage temperature all have a direct impact on these deteriorations. Maintaining tubers in their most marketable and edible state while ensuring a consistent supply of tubers for processing facilities and markets all year long is the goal of storage. The Jimma Zone in Dedo Woreda, a possible Keble for potato production, was used to store potatoes. In order to facilitate natural drainage, a dry location with a slightly raised slope was chosen. Bamboo was used to construct a horizontal ventilation system that was 2 meters long, 40 cm wide on the sides, and even in the middle of the pit. After covering the pit with rough eucalyptus poles and a board for strength, a layer of wood is applied to stop soil from slipping through. The mature, dry, healthy, and disease-free potatoes were kept in storage, while the others were left exposed and covered. The stored potato does not deteriorate or sprout for four months and twenty days.

Keywords

Perishable, Production, Shrinkage, Ventilation

1. Introduction

In intensive cropping systems, potatoes are the most productive food crop in terms of edible energy and high-quality protein per unit area and per unit of time [1]. According to [9], Ethiopia is the largest producer of potatoes in Africa, with 70% of its 13.5 million hectares of arable land suited for potato production and cultivation.

Several factors make the potato industry's contribution to the nation's income negligible. Low productivity and production, inadequate pest control, a lack of improved varieties, a lack of market, a disregard for product quality and physical damage prevention, and a lack of storage and packing facilities are the causes [7, 9]. Post-harvest losses of potato were estimated at 24% in India, 20 percent in Bangladesh, and 25% in Nepal [15].

A major contributing factor to the low potato yield in the area is the lack of suitable storage systems [4]. In-season issues also affect the product's market price and marketing strategies [14]. Due to inadequate facilities for handling and storage, a signif-

*Corresponding author: husenifnaan@gmail.com (Husen Bona)

Received: 10 July 2025; **Accepted:** 4 August 2025; **Published:** 20 August 2025

icant portion of products are wasted before they are ready for consumption and are sold for a discounted price. Average harvest and transportation-related losses of 12.45 and 11.7% were estimated in the Dedo and Seka districts respectively of Southwest Ethiopia [8]. Weight loss, rotting, insect damage, greening, and small potatoes all these factors contribute to post-harvest loss to loss in traders [13].

Modern potato seed storage facilities are unavailable, so farmers are forced to sell their produce right away at a low price during harvest [3]. Using a variety of conventional methods, farmers stored potatoes for either consumption or seed. Potatoes cannot be stored for more than three and a half months without deteriorating in these conventional storage methods [11]. Disease transmission, respiration, sprouting, water evaporation from the tubers, changes in the tuber's chemical makeup and physical characteristics, and damage from extreme temperatures, all of which are impacted by storage conditions, are the main causes of storage losses. Inadequate storage infrastructure and inappropriate post-harvest handling techniques are significant contributors to elevated postharvest losses [12].

By maintaining appropriate conditions in the store, the majority of the losses listed above can be prevented. The following factors determine the storability of potatoes before they are put into storage: growing conditions, soil type, and weather during growth, diseases before harvest, maturity of potatoes at harvest, and damage to tubers during lifting, transport, and storage [2, 5].

Proper storage stops moisture loss, rot development, and sprout growth. Additionally, it keeps the high concentration of sugars in potatoes from building up, which produces products with a dark hue. When storing potatoes, temperature and humidity are the two most important environmental factors. Also required is sufficient and unhindered airflow.

Several studies carried out in Assessment of Post-Harvest losses of Potato. Post-Harvest losses can occur at various stages of the supply chain, including harvesting, sorting, cleaning, handling and packing, transportation, storage, distribution, marketing and processing [6, 7]. After the potato is harvested, it is wasted every year. This lowers the values due to inadequate storage. Effective storage is one of the best ways to cut down on waste. Since potatoes are perishable, proper post-harvest handling is necessary to maximize profits. Vegetables should be stored in ways that will maximize their yield. Therefore, adapting an underground ventilated pit for potato storage is the aim of this project.

2. Materials and Methods

2.1. Materials

Wood strip, input pipe, exit pipe, elbow joints, glue, poles or other timbers, boards, brushwood, shovel, hammer & nails.

2.2. Methodology

2.2.1. Digging the Pit

A 2 m long, 1 m deep, and 1 m wide rectangular pit was prepared. Given that the walls absorb a significant amount of moisture and aid in controlling humidity, they were left to dry before being filled. A month before potato storage, the pit was ready.

2.2.2. The Horizontal Ventilation Ducts

Equally spaced between the two sides, it was set on the pit's bottom. One vent was sufficient to aerate a stack that was 1.6 meters deep, 2.0 meters long, and 2.5 meters wide. So, one vent that is two meters long and runs along the middle of the floor is enough.

Figure 1. *Horizontal ventilation ducts.*

2.2.3. The Vertical Ventilation

These vertical ventilation ducts were constructed from 12 cm diameter plastic pipes that extended 30 cm above the soil's surface when the pit was covered. To facilitate airflow through the stack, either the top was bent horizontally or an elbow joint was attached to the top. The horizontal vent at the bottom of the pit had one end of the input vertical duct attached to it.

Figure 2. *Vertical ventilation ducts.*

This guarantees that cool, dry air flows properly through the potato's storage base. It is recommended that the shorter exhaust vent protrude from the opposite end of the stack to release gases and warm air. The exhaust pipes were oriented in the opposite direction from the top of the input pipe, which helped force air through the storage pit.

2.2.4. Cover the Pit

Rough timber poles were placed over the pit for support. To stop soil from slipping through, flat boards were then placed over the poles, and then brush wood was applied. For effective insulation, brushwood was covered with soil. Reduced soil cover may make the crop more susceptible to freezing.

To make it possible to access the storage and empty the pit, a 50 cm square opening was left. Like the rest of the pit, the opening was covered with boards and the same quantity of dirt. The pit must have a roof built to leave room between the roof and the potato stack. As a result, air is drawn in and moves through the stack, trapping the warm, humid air that is quickly released when the exhaust vent is opened.

Figure 3. Covered pit after potatoes are stored.

2.3. Collected Data

Prerequisite information, especially regarding storage and environmental conditions, was gathered and documented before the potato's storage. The temperature and relative humidity of the storage and surrounding environment were measured at 15-day intervals because they are crucial factors in determining how long goods will last in storage.

The total temperature and humidity, storage temperature and humidity, and the mass of damaged, sprouted, and shrinking potatoes were gathered to calculate how long potatoes could be kept in storage without suffering significant losses.

3. Results and Discussion

3.1. At Sito Site

The respiration rate is higher and the storage life is shortened at ambient temperatures between 25 ℃ and 35 ℃ [2]. However, Sito's average-based maximum and minimum ambient temperature variations at midday are lower than recommended at 27 and 21 degrees Celsius, respectively. The shelf life of the product being stored is significantly influenced by relative humidity, air movement, and surface area, which are additional crucial factors to consider when handling the product. Here, the potato stored at midday has a maximum relative humidity of 52% and a minimum of 31%, respectively. Weight loss increase with storage duration. The trend was similar with the research conducted by [10].

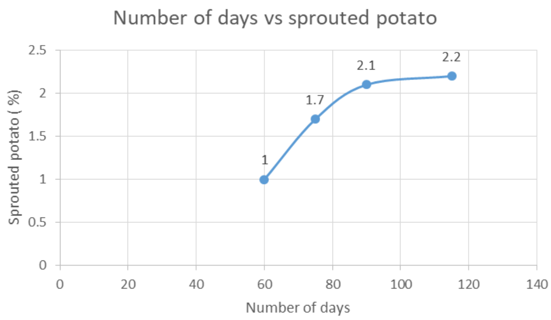

Figure 4. Number of days vs. sprouted potato at the site.

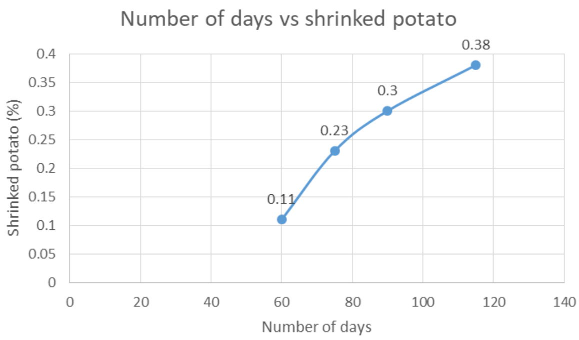

Figure 5. Amount of potato shrunk during the storage period at Sito.

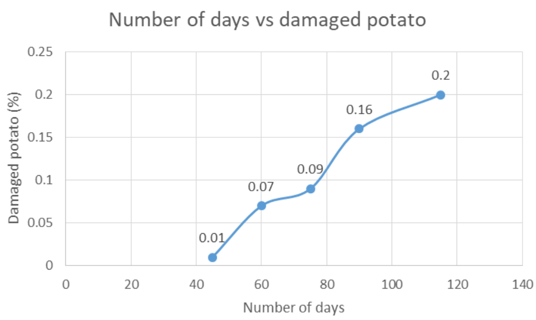

Figure 6. Amount of potato damaged during the storage period at Sito.

Decomposition, shriveling, and sprouting rates all increased with storage duration. After 150 days in storage, 7%, 1%, and 0.03% of the material sprouted, shrank, and deteriorated, respectively. Decomposition of the tubers may be primarily caused by respiration processes and injuries sustained during field transportation to storage. Ventilation was maintained throughout the storage to reduce the extent of damage.

3.2. Potato Stored Above the Ground at Ilala

Here, in Ilala, two quintals of potato tubers were kept above ground within the house. Produce deteriorates more quickly at high temperatures and relative humidity because of the increased respiration rate. The more water removed, the more weight is lost, and the more shrinkage occurs than normal. In order to create a cooler atmosphere, there is no vent or way to remove humid air. Twenty percent shrank, ten percent were damaged, and thirty-three percent sprouted after a hundred and forty days of storage.

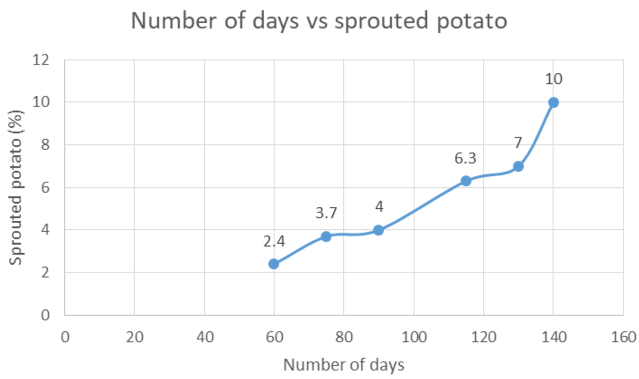

Figure 7. Amount of potato sprouts stored above the ground at Ilala.

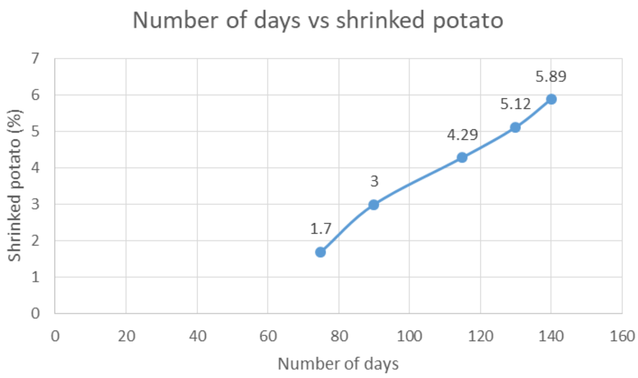

Figure 8. The amount of potatoes shrank and was stored above the ground at Ilala.

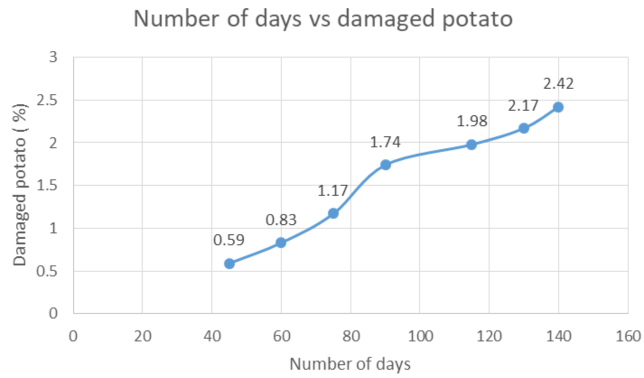

Figure 9. Amount of potato damaged stored above the ground at Ilala.

3.3. Underground Ventilated Potato Storage at Ilala

The respiration rate is higher and the storage life is shorter at ambient temperatures between 25 ℃ and 35 ℃ [2]. Nonetheless, the average-based maximum and minimum midday ambient temperature variations in Ilala were 25 ℃ and 16 ℃, respectively, and the maximum and minimum midday relative humidity levels were 20% and 54%.

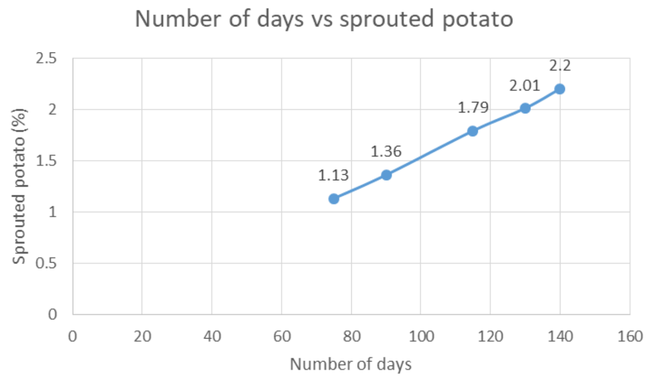

Figure 10. Amount of potato sprouts stored at Ilala.

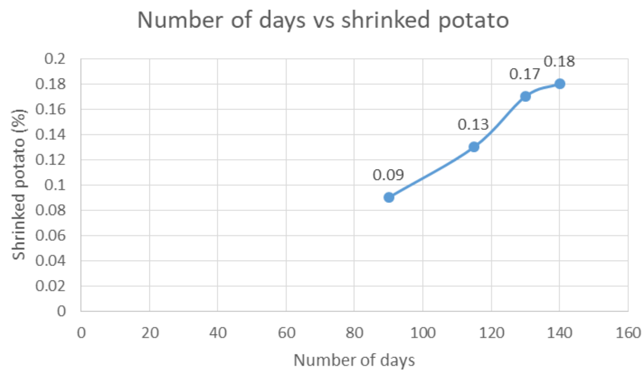

Figure 11. Amount of potatoes shrunk and stored at Ilala.

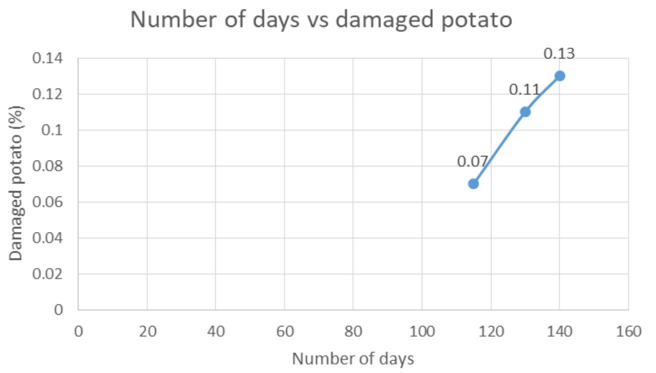

Figure 12. *Amount of potato damaged during the storage period at the Ilala site.*

Here, the temperature is dropping relative to the Sito district, and the relative humidity is rising. During the first 140 days of storage, 8 out of 49 percent sprouted, 0 out of 57 shrank, and 0 out of 31 were damaged. All potatoes that were severely shriveled and damaged were useless. You can make seed and food out of the remaining tubers. It typically brings in more money for farmers during the off-season than during the season.

4. Conclusion and Recommendation

4.1. Conclusion

Jimma zone, Dedo woreda, adopted and used an underground ventilated pit for potato storage. A dry location with a slight elevation change was chosen to allow for natural drainage. A 2 m long, 40 cm equilateral triangle with horizontal ventilation was made of bamboo and set on the pit's bottom, with the two sides evenly spaced. Plastic pipes measuring 12 cm in diameter were positioned at the pit's two ends for vertical ventilation.

Rough eucalyptus poles and boards are used to support the pit, and then a layer of wood is applied to keep soil from slipping through. The mature, dry, disease-free, and undamaged potatoes were kept in storage, while the remaining ones were left exposed and covered. The potato remains in storage for four months and twenty days with minimal loss.

4.2. Recommendation

Preparing an underground ventilated pit for storing potatoes required careful attention to detail. The pit must be completely covered to prevent light and rain from getting into the storage, and ventilation must be used carefully to prevent significant losses or complete damage to the potato tubers. For small and medium-sized farmers, it can therefore be suggested that any seed potato storage is a suitable remedy for potato losses.

Abbreviations

HVD Horizontal Ventilation Duct
VVD Vertical Ventilation Duct

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Alam, A. and R. S. Devnani. 1979. Equipment for the production, handling, and storage of potatoes. In Kishore, H.: Post-harvest technology and utilization of potato. Proceedings of International Symposium, The International Potato Center, Region VI, New Delhi and Central Potato Research Institute, Simla.

[2] Amrat Lal Basediya, D. V. K. Samuel & Vimala Beera," Evaporative cooling system for storage of fruits and vegetables: A review", Journal of Food Science Technology, Volume 50(3), 2013, pp. 429-442, https://doi.org/10.1007/s13197-0110311-6

[3] Anonymous 1985. Zero energy cool chamber. Research Bulletin No. 43, IARI. New Delhi.

[4] Arora, C. P. 2000. Refrigeration and air conditioning. 2nd Edition. Tata McGraw-Hill Publishing Company Limited, New Delhi.

[5] ASAE. 1994. ASAE Standards, 41st Edition. ASAE, St. Joseph, MI.

[6] Degebasa, A., 2020. Prospects and Challenges of Postharvest Losses of Potato (Solanum Tuberosum L.) in Ethiopia. Global Journal of Nutrition and Food Science, 2, Pp. 1-10. https://doi.org/10.33552/GJNFS.2020 .02.000550

[7] FAO (Food and Agriculture Organization) and Ethiopian Statistics Service. Report on pre-and post-harvest crop losses pilot survey (2021-2022). Rome and Addis Ababa. 2023. https://doi.org/10.4060/cc3937en

[8] Kuyu, C. G., Tola, Y. B., and Abdi, G. G., 2019. Study on post-harvest quantitative and qualitative losses of potato tubers from two different road access districts of Jimma zone, South West Ethiopia. Heliyon, 5(8). PMAMP 2022. (2022). Retrieved from https://armis.pmamp.gov.np /about-us

[9] Oliy, G. B. and Adunya, A. T., 2018. Adaptation and Evaluation of Ware Potato Storage in Horo and Jardega Jarte Districts of Horo-Guduru Wollega Zone of Ethiopia. *International Journal of Scientific and Research Publications*, *8*(8), pp. 74-80.

[10] Paudel, N., Upadhyay, K., Subedi, G., Simkhada, R., Aryal, S., Rijal, A., and Thapa, B., 2023. Postharvest Loss Assessment of Potato Genotypes under Ordinary Storage Condition in Dhading and Tanahun District of Nepal.

[11] Principles of Potato Storage, International Potato Center (CIP), http://cipotato.org/resources/publications/manual/principles-of-potato-storage

[12] Sah, R. K., and Bagale, B., 2024. Effect of farmer's handling practices on postharvest losses of potato (Solanum tuberosum L.) at farm gate in Dolakha, Nepal. Journal of Horticulture and Postharvest Research, 7(Issue 1), Pp. 59-68. https://doi.org/10.22077/jhpr.2024.6913.1342

[13] Sujana Lohani, Sushil Awasthi, Astha Thapa Giri, Bipana Chaulagain, Lekha khadka, Chandra Bhusal (2024). Assessment of The PostHarvest Losses of Potato in Banepa Municipality of Kavrepalanchok District. Agribusiness Management in Developing Nations, 2(2): 88-95.

[14] Tadesse, B., Gebeyehu, S., Kirui, L. and Maru, J., 2025. The contribution of the potato to food security, income generation, employment, and the national economy of Ethiopia.

[15] Upadhyay, K., Paudel, N., Aryal, S., Simkhada, R., Bhusal, B., and Gautam, I., 2020. Storability of potato varieties under ordinary storage condition in Panauti, Nepal. Sustainability in Food and Agriculture, 1(2), Pp. 51-57.