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Effect of farmer's handling practices on postharvest losses of potato (*Solanum tuberosum* L.) at farm gate in Dolakha, Nepal

Rubi Kumari Sah[1,*] and Bidhan Bagale[2]

[1]*Faculty of Agriculture, College of Natural Resource Management, Agriculture and Forestry University, Marin, Sindhuli, Nepal*
[2]*Faculty of Agriculture, Central Campus, Agriculture and Forestry University, Rampur, Chitwan, Nepal*

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***Corresponding author:**
Faculty of Agriculture, College of Natural Resource Management, Agriculture and Forestry University, Marin, Sindhuli, Nepal.

Email: rubisah65@gmail.com

ABSTRACT

Purpose: The main objectives of this study were to find farmers' handling practices on postharvest losses of potatoes, to estimate the post-harvest losses from farm gate to storage level and to know how the post-harvest losses were affected by the socio-demographic factors. **Research method**: The study was conducted in Dolakha, Nepal with 100 respondents selected by simple random sampling method. A semi-structured questionnaire was used to collect the primary data and MS Excel and SPSS were used for data analysis. **Findings:** Out of the total potatoes produced, 89.73% were utilized in various forms while the remaining 10.26% were lost due to poor post-harvest handling practices and lack of adequate cold storage facility. The farmers in the study area relied on practices, such as using spades for harvesting, week-long curing, traditional home storage, sorting and grading to remove the damaged ones, use of jute sacks, and overfilling and dragging of heavy bags. The post-harvest loss was significantly affected by age, gender, land size, and farming experience of farmers whereas the literacy level, ethnicity, and religion had no impact on it. **Limitations:** Transportation was a limitation because motorable roads were unavailable due to which farmers of distant areas couldn't be included in the sampling frame. **Originality/value:** The study reported that only 3% of farmers had access to cold storage facilities and 10.26% of harvested potatoes were lost due to traditional post-harvest practices.

INTRODUCTION

The potato, scientifically known as *Solanum tuberosum* L., has been consumed by humankind for thousands of years (de Haan & Rodriguez, 2016). It is considered the world's leading non-cereal crop feeding more than a billion people daily. Moreover, it is the fourth most worthwhile crop in the world after rice, maize and wheat in terms of area or coverage of production (FAO, 2022). In Nepal, potato holds the topmost position among non-cereal crops, cultivated in 198,256 ha of land with yield of 3,410,829 Mt (MoALD, 2023). The Nepal Agricultural Research Council (NARC) recommended 12 improved varieties of potatoes, along with enhanced production techniques. These improved varieties demonstrated higher yields compared to the local varieties traditionally grown by farmers (Gairhe et al., 2017). Many farmers are not getting the expected returns from their continuous increased potato productivity due to higher postharvest losses encountered.

After harvest, produce remain metabolically active and undergoing all possible physiological processes which must be controlled to prolong the post-harvest quality (Brasil & Siddiqui, 2018). Post-harvest handling practices of any horticultural crops refer to the set of activities employed to slow the degradation process in order to maintain the quality of the produce, specifically fruits and vegetables, after they have been harvested. Immediately after harvest, activities such as trimming, cleaning/washing, sorting, grading, pre-cooling, sometimes curing, packing and packaging are performed as field/packhouse operations (Ait-Oubahou et al., 2019; Gautam et al., 2019 as cited in Gautam, 2020). These practices maintain product quality and extend the shelf life of the harvested crops. Consumers seek produce that is not only visually appealing but also firm to the touch, possesses a pleasing taste, and is nutritionally valuable (Adhikari & Aarati, 2021). The reduction of post-harvest losses has been recognized as a crucial element undertaken by various organizations to combat food insecurity (Kiaya, 2014). To minimize losses, adopting various cultural practices, implementing effective management strategies, and employing appropriate handling techniques are crucial.

Shelf life of vegetables can be enhanced by controlled environment, modified atmosphere with low-temperature settings or use of chemicals that delay senescence and inhibit microbial decay (Colelli & Amodio, 2016). Post-harvest technology is widely acknowledged as a vital component of a comprehensive approach to agriculture in meeting the increasing global demands for food and food security. Hence the need for postharvest loss reduction (Kiaya, 2014).

The yield of potato crop in Nepal is 17.2 Mt ha^{-1} (MoALD, 2023) which is close to the global average of 20.74 Mt ha^{-1} (FAO, 2023). The main objective is to reduce losses and maintain the best possible quality for consumer satisfaction. This can be accomplished by increasing adequate storage capacity for increased potato production coupled with controlling the factors causing post-harvest losses. this study was carried out to (1) find how farmers in the Dolakha district practice the harvesting of potatoes, (2) to estimate the post-harvest losses from farm to storage level to gain an understanding of the real scenario of the post-harvest phase, and (3) to assess the effect of sociodemographic factors on post-harvest losses.

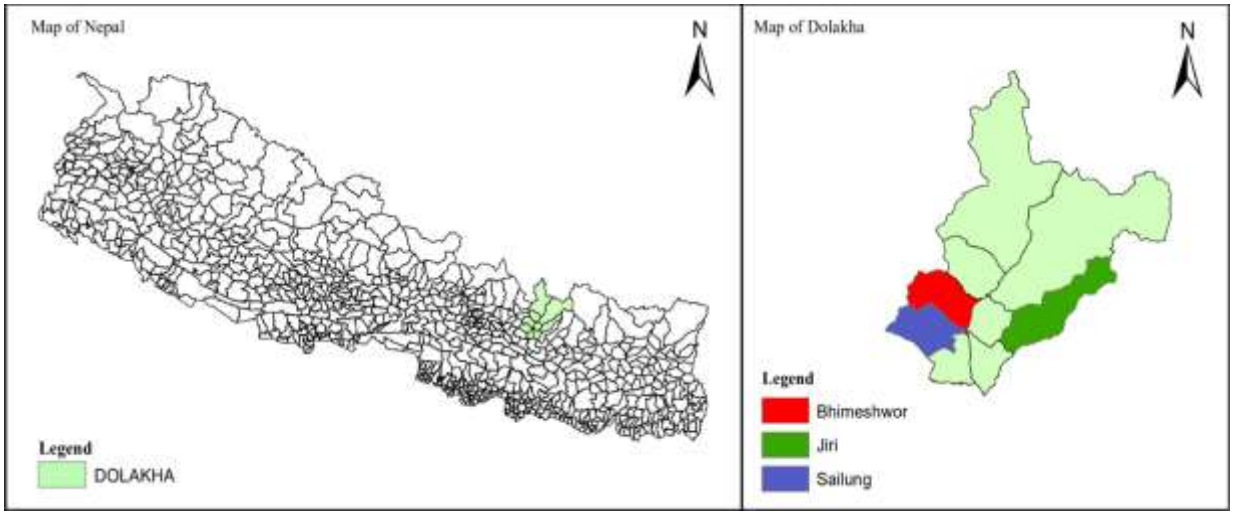

Fig. 1. Maps of Nepal and Dolakha showing study sites.

MATERIALS AND METHODS

Study area

The study area is highlighted in Figure 1. The research was carried out in the Dolakha district of Nepal (geographical coordinates of the site: 27.6693N and 86.0428E) located 1975 meters above sea level. The study area comprised wards 3, 6, and 8 of Sailung Municipality, ward 9 of Bhimeshwor Municipality, and ward 6 of Jiri Municipality. Potato farming is emphasized in these areas by the Government of Nepal through the establishment of the Potato Zone under the Prime Minister Agriculture Modernization Project (PMAMP).

Study design

A preliminary survey was carried out to collect data regarding the feasibility of the research viz. the demographic and socio-cultural characteristics of the study site. Potato growers of Sailung Municipality and Bhimeshwor Municipality were selected purposively as those areas were included in the Potato Zone by PMAMP.

Sampling procedure

A total of 100 potato growers were selected by simple random sampling technique to draw a representative sample.

Data Collection

For this study, a semi-structured questionnaire was used. The questions were written in English and aimed to accomplish the three (3) specific objectives as outlined at the detail end of the introduction in chapter one. Before the final survey, pretesting was done on 20 farmers of Ward 3, Sailung municipality.

Data analysis

Data entry, coding, and analysis were done using Statistical Package for Social Science (SPSS) and Microsoft Excel (MS Excel). Descriptive statistics namely, means, percentages, and frequencies, were used to present the results of the study regarding the three (3) specific objectives. The regression tool was used to determine the factors affecting post-harvest loss and to test the association among various dependent and independent variables.

RESULTS AND DISCUSSION

Socio-demographic characteristics of the respondents

The socio-demographic characteristics of the respondents are shown in Figure 2. Although a study done by Chauhan et al. (2022) on potato farmers in the Darchula district showed a male-domination of 65%, our study area was determined to be a female-dominated one representing 52%. The age of the respondents ranged from 21 to 79 years with the majority (31%) belonging to the age group of 26 to 35 while the average age was found to be 45.18 years (Table 1). The most respondents belonged to the Brahmin ethnic group (67%) while the least belonged to the Dalit ethnic group (3%). Respondents belonged to two religious groups, Hindu (64%) and Buddhist (36%).

The average years of experience in potato farming of the respondents was determined to be 23.87 years (Table 1). Regarding the education level, 27% of respondents lacked basic reading and writing skills and had no formal education while most of the respondents (30%) were literate with a primary level of education and a small percentage (4%) had a secondary level education. Contrasting to this, the majority of potato farmers in the Achham district, accounting for 32%, had a secondary level of education (Sapkota et al., 2019).

With a range of 0.2 to 3.56 ha, the land area owned varied considerably. The average land size of the respondents was 0.53 ha. The relatively high standard deviation of 0.45 ha indicates a considerable diversity in land ownership within the district (Table 1).

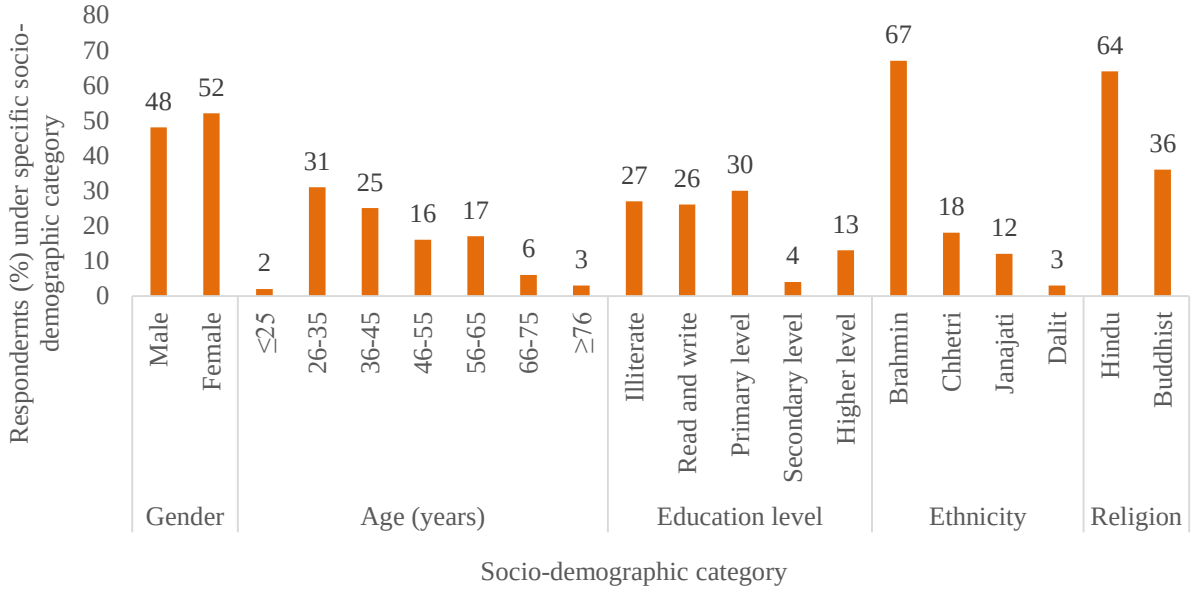

Fig. 2. Socio-demographic characteristics of respondents in the study area.

Table 1. Descriptive statistics of the socio-demographic status of farmers in the study area.

Category	Minimum	Maximum	Mean	SEm±	SD
Age (years)	21	79	45.18	1.40	13.96
Household size	2	10	5.29	0.17	1.74
Experience (years)	10	60	23.87	1.07	10.80
Land size (ha)	0.20	3.56	0.53	0.045	0.45

Note: SEm± = Standard Error of mean, SD = Standard Deviation

Table 2. Average cost of production of potato per hectare in the study area.

Cost item	Average cost (NRs ha^{-1})	Contribution to total cost (%)
Seed Tuber	15,960	25.81
Land	1,573	2.54
Human Labor	25,729	41.60
Irrigation	2,249	3.63
Equipment (Mini-tiller)	11,412	18.46
Fertilizer	4,210	6.80
Insecticides	700	1.13
Herbicides	0	0
Total	61,834	100

Cost of potato production

The cost of production is one of the primary factors that significantly influence the profitability of agricultural production (Subedi et al., 2019). The total average cost of production of potatoes in the study area was calculated to be NRs. 61,834 per hectare (Table 2). The cost of labor was found to be contributing a major portion to the total cost of production followed by seed tuber cost accounting for 41.60% and 25.81% respectively. According to the study on the economics of potato production and marketing in the Darchula district, seed tuber cost occupied the major portion (33.3%) of the cost of production followed by the human labor cost (26.3%) (Subedi et al., 2019). Human labor is required for various cultivation practices like planting, weeding, earthing-up, fertilizer, weedicide, insecticide application, harvesting, and storage. The cost incurred by fertilizer and irrigation were 6.80% and 3.63% of the total cost of production which aligns with the results reported by Subedi et al. (2019) who observed the chemical fertilizers costs for 7% and irrigation costs for 1.7% . The average cost incurred on using mini-tiller was NRs 11,412. Other costs incurred are given in Table 2. It was interesting to note that there was significantly minimal use of chemical fertilizer and insecticides and no use of herbicides at all in the study area, which corresponds with the findings of Bajracharya and Sapkota (2017).

Table 3. Farmers' use pattern of potatoes in the study area.

Particulars	Average of usage pattern (Kg)	SD	Percentage (%)
Seed Tuber	1430	1299.38	15.04
Potato Sold	3828	1733.28	40.29
Family Consumption	2641	3385.50	27.79
To Relatives	628	308.90	6.60
Total	8527	6727.06	89.73
Total Production including loss	9502	4976.74	100

Note: SD = Standard Deviation

Use pattern of potato

Harvested potatoes were utilized in different ways as shown in Table 3. On average, the potato produced was 9,502 kg per hectare out of which, 89.73% was utilized in various ways which includes storing for seed tubers, selling, family consumption and gifting to relatives. The remaining 10.26% of potatoes were lost due to different factors such as suboptimal storage, cut and bruising during harvesting, damage caused by insect pests and transportation. About 27.79% of the potatoes were used by the farming families for their consumption and additionally, 6.60% were given as gifts to other people. A major portion, accounting for 40.29%, was sold during the harvesting period. This finding is in line with the work of Hossain & Miah (2009), who revealed that a significant portion of the total potato produced goes for marketing (62.04%) whereas the lowest percentage of potato produced was expended as gift to relatives (0.52%). The work from the Northern zone of Bangladesh by Hossain et al. (2014) also reported similar results on the marketing of potatoes (69.2%). Another 15.04% of the potatoes were stored traditionally at home or in cold storage as seed tuber for planting in the next season. Hossain and Miah (2009) also found that 12.73% of the potatoes were stored in cold storage, specifically as seed tuber for the next planting season.

Post-harvest handling practices

The distinctive approaches for post-harvest handling practices adopted by the farmers of Dolakha district are shown in Table 4. It was found that almost all the respondents (100%) relied on the manual method for harvesting i.e. use of spades since a mechanical harvester was not available in the study area. Post-harvest curing {essentially a wound-healing operation to replace the damaged periderm (outer-most/cork layer) prior to storage} in shade for a week, was found to be adopted by 59% of the respondents. The practice of cold storage was rare (3%). The reason behind this might be the limited availability and accessibility of cold storage facilities as only one cold storage plant was available in the study area and it too was limited in size. Accessibility to this cold storage was challenging for most farmers due to its considerable distance from their individual farm locations. To remove the damaged potatoes during the storage period, a routine check every 15 days was practiced by 55% of respondents. Prior to packaging, it was found that almost all the respondents performed sorting to sort out the pest-infested and rotten potatoes and then graded them based on shape and size. For marketing, the primary choice of farmers was found to be jute sacks for containment. It was found that all the respondents (100%) practiced overfilling during packing and dragging of jute sacks during loading and unloading. Maremera (2014) reported that inadequate storage facilities and improper handling practices lead to higher post-harvest losses.

Table 4. Farmers' handling practices of potatoes in the study area.

Practices	No. of respondents
Harvesting by Spades	100
Curing for a week	59
Traditional method of storage	97
Cold storage	3
Dragging	100
Overfilling	100
Checking of stored potatoes at 15 day intervals	55
Sorting and grading	100
Use of jute sack for packaging	100

Table 5. Average loss of potato at different stages of post-harvest operation in the study area.

Category	Average loss (kg)	SD	Average loss (%)	Percentage of total production
Rejected During Sorting	321.2	145.53	32.96	3.38
Cut Potato	157.35	73.38	16.15	1.66
Rotten Potato	144.9	82.52	14.87	1.52
Curing Loss	101.55	41.04	10.42	1.07
Pest damage	92	45.07	9.44	0.97
Transportation Loss	79.5	35.7	8.16	0.84
Potato Remained in Soil	77.9	34.52	7.99	0.82
Total	974.4	457.76	100	10.26

Note: SD = Standard Deviation.

Table 6. Effect of socio-demographic factors on post-harvest losses in the study area.

Regression variable	Regression coefficient	p-value	Standard error
Intercept	βo	0.01	243.01
Gender	0.03	0.05	53.27
Age	0.11	0.01	2.29
Education level	-0.03	0.15	25.29
Ethnicity	-0.07	0.17	38.09
Religion	0.06	0.40	57.67
Land size	0.75	0.00	3.40
Experience	-0.16	0.05	2.52
No. of observation		100	
R^2		0.48	
F (100,7)		14.09	

Losses at different post-harvest operations

Basically, physical, biological, and environmental factors which include extreme temperatures, mechanical injuries, pests, and pathogens are responsible for causing post-harvest losses (Clark et al., 2004; Degebasa, 2020). The losses can occur during harvesting, cleaning, sorting, grading, other handling operations including packaging, transportation, storage, distribution and processing (Degebasa, 2020). The post-harvest losses of potatoes at different stages of post-harvest operations in the study area are shown in Table 5. On average, total post-harvest losses incurred comprised 10.26% of total production. Potatoes were manually harvested using spades due to which 1.66% of the harvest showed cuts and bruises. As a result, those potatoes became unfit for marketing. Harvested potatoes were then cured under the shade. The average loss due to curing was found to be 1.07% which was higher than the findings of Hossain and Miah (2009) i.e. 0.88%.

In the conventional approach of storage, farmers regularly monitored stored potatoes at an interval of 10 to 15 days to sort out those that had damaged from pest infestation or decaying of those that had signs of bruising and cutting. However, in this method, farmers' lack of technical knowledge and capability to maintain the proper temperature and humidity results in the loss of potatoes due to disease and pest damage (Hossain & Miah, 2009). Throughout the storage period, the rotten potatoes accounted for 1.52% of the overall harvest whereas those lost due to pest damage accounted for 0.97%. Before transporting them to the market, farmers performed sorting and grading of potatoes based on shape and size, during which a major portion i.e. 3.38% of potatoes were discarded for their unmarketable smaller size, normally not preferred by buyers/consumers. The average loss due to transportation was found to be 0.84% and the potatoes unintentionally left unharvested under the soil at the time of harvesting was estimated to be 0.82% of the overall or total harvest.

Effect of socio-demographic factors on post-harvest loss of potato at different stages of the post-harvest operations

Table 6 represents the results of the linear regression model for determining the effect of socio-demographic factors on post-harvest losses of potatoes in the study area. The influence of sex was found positive and significant at 5% level of significance. This finding indicates that male-dominated households were likely to experience more post-harvest losses as compared to female-dominated households. The post-harvest loss was positively influenced by the age of farmer and was statistically significant at 5% level of significance indicating that younger farmers faced less loss as compared to older ones.

Both farming experience and education level of farmers had a negative effect on post-harvest loss but only the influence of farming experience was significant at 5 % level of significance. Experienced farmers exhibit good knowledge and successful integration of post-harvest handling technologies among other farmers (Tadesse et al., 2018). Regarding the losses, the experience that the farmers had accumulated over the years proved to be more significant and might have compensated for the gap in education.

The effect of religion and ethnicity of respondents on post-harvest loss was found to be non-significant at 5 % level of significance. However, land size for potato production was notably significant at 1% significance level showing a positive correlation with the post-harvest loss. This indicated that for every 1% increase in the size of land, the potato loss would be increased by 7.49%.

CONCLUSION

The post-harvest losses of potatoes occur at different stages of post-harvest operation. Around one-tenth of produced potatoes are lost in the Dolakha district because of improper harvesting and poor post-harvest handling practices. Insect damage, the absence of cold storage and poor handling practices like prolonged curing, overfilling of potato sacks, dragging of heavy bags, and improper sorting and grading lead to a considerable loss in quantity. Farmers mainly cultivate potatoes for commercial purposes followed by family consumption and then for storage as seed tuber for the next season. The post-harvest loss was significantly affected by age, gender, land size, and farming experience of farmers whereas the literacy level, ethnicity, and religion had no impact on it.

Conflict of interest

The authors have no conflict of interest to report.

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REFERENCES

Adhikari, B. & Aarati, G.C. (2021). Post-harvest practices of horticultural crops in Nepal: Issues and management. *Archives of Agriculture and Environmental Science, 6(2),* 227-233. https://doi.org/10.26832/24566632.2021.0602015

Ait-Oubahou, A., Brecht, J. K., & Yahia, E. M. (2019). Packing Operations. *Postharvest Technology of Perishable Horticultural Commodities,* 311-351. https://doi.org/10.1016/b978-0-12-813276-0.00009-2

Colelli, G., & Amodio, M. L. (2016). Factors Affecting Quality and Safety of Fresh-Cut Fruits and Vegetables, In *Fresh-Cut Fruits and Vegetables*, 255–282. CRC Press. https://doi.org/10.1201/9781315370132-19

Bajracharya, M., & Sapkota, M. (2017). Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal. *Agriculture & Food Security*, *6*(1). https://doi.org/10.1186/s40066-017-0125-5

Brasil, I. M., & Siddiqui, M. W. (2018). Postharvest Quality of Fruits and Vegetables: An Overview, In *Preharvest Modulation of Postharvest Fruit and Vegetable Quality*, 1–40. Academic Press. https://doi.org/10.1016/b978-0-12-809807-3.00001-9

Chauhan, B., Joshi, D., Banjade, D., Bhatta, B. D., Awasthi, P., Paneru, M., Shrestha, M., & Chand, P. B. (2022). Economics of potato (*Solanum tuberosum* L.) production and marketing in Darchula district of Nepal. *Archives of Agriculture and Environmental Science*, *7*(3), 393–401. https://doi.org/10.26832/24566632.2022.0703013

Clark, D., Klee, H., & Dandekar, A. (2004). Despite benefits, commercialization of transgenic horticultural crops lags. *California Agriculture*, *58*(2), 89–98. https://doi.org/10.3733/ca.v058n02p89

Degebasa, A. C. (2020). Prospects and challenges of postharvest losses of potato (*Solanum Tuberosum* L.) in Ethiopia. *Global Journal of Nutrition and Food Science*, *2*(5). 1-10. https://doi.org/10.33552/gjnfs.2020.02.000550

de Haan, S., & Rodriguez, F. (2016). Potato Origin and Production. *Advances in Potato Chemistry and Technology*, 1–32. Second Edition. Academic Press. https://doi.org/10.1016/b978-0-12-800002-1.00001-7

FAO. (2022). Retrieved from: https://www.fao.org/statistics/en

FAO. (2023). FAOSTAT. Retrieved from: http://www.fao.org/faostat/en/. Date of access: October 29, 2023

Gairhe, S., Gauchan, D., & Timsina, K. (2017). Adoption of improved potato varieties in Nepal. *Journal of Nepal Agricultural Research Council*, *3*, 38–44. https://doi.org/10.3126/jnarc.v3i1.17274

Gautam, D. M. (2020). Postharvest Handling and Storage of Vegetables. In *Comprehensive Insights in Vegetables of Nepal* (pp. 1601-1608). Nepal Academy of Science and Technology.

Gautam, D. M., Bhattarai, D. R., & Acharya, U. (2019). *Postharvest management of horticultural crops in Nepal*. Paper presented at 10th National Horticulture Seminar, Kirtipur, Kathmandu, February 7-9.

Hossain, M. A. & Miah, M. A. M. (2009). *Post-Harvest Losses and Technical Efficiency of Potato Storage Systems in Bangladesh.* Bangladesh Agricultural Research Institute (BARI), Farm Machinery and Postharvest Process Engineering Division. Bangladesh: USAID.

Hossain, M. A., Zomo, S. A., Ullah, A., Rahaman, S. M. S., & Sarkar, M. D. (2014). Production and Grower Preference of Potato in Northern Zone of Bangladesh: Scenario from Shibgonj, Bogra and Kalai, Joypurhat. *Journal of Bioscience and Agriculture Research*, *1*(2), 93–101. https://doi.org/10.18801/jbar.010214.11

Maremera, G. (2014). Assessment of vegetable postharvest losses among smallholder farmers in Umbumbulu area of Kwazulu-Natal Province, South Africa. *University of KwaZulu-Natal*.

MoALD. (2023). Statistical Information on Nepalese Agriculture.

Sapkota, S. C., Raj Rokaya, P., Acharya, H., & Uprety, S. (2019). An Economic Analysis of Potato Production in Achham District of Nepal. *International Journal of Horticulture & Agriculture*, *4*(2), 1–9. https://doi.org/10.15226/2572-3154/4/2/00131

Subedi, S., Ghimire, Y. N., Gautam, S., Poudel, H. K., & Shrestha, J. (2019). Economics of potato (Solanum tuberosum L.) production in terai region of Nepal. *Archives of Agriculture and Environmental Science*, *4*(1), 57–62. https://doi.org/10.26832/24566632.2019.040109

Tadesse, B., Bakala, F., & Mariam, L. W. (2018). Assessment of postharvest loss along potato value chain: the case of Sheka Zone, southwest Ethiopia. *Agriculture & Food Security*, *7*(1). https://doi.org/10.1186/s40066-018-0158-4

Kiaya, V. (2014). Post-harvest losses and strategies to reduce them. *Technical Paper on Postharvest Losses, Action Contre la Faim (ACF)*, *25*, 1-25.