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ORIGINAL RESEARCH ARTICLE

Adoption of post-harvest practices and their influencing factors: A study of ginger growers in Syangja, Nepal

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ABSTRACT

Proper ginger post-harvest practices enhance quality, extend shelf life, and ameliorate market access. Prioritizing post-harvest practices in ginger can tremendously increase the market value of ginger in Nepal. Nevertheless, this cannot be done without thorough understanding about the current adoption of post-harvest practices among farmers. So, this study was carried out to know the status of adoption of post-harvest practices in ginger, examine factors associated with adoption, identify and rank major constraints of adoption. The collection of primary data involved 80 ginger growers chosen randomly from altogether 6 wards in Galyang, Waling, and Chapakot municipalities. Data entry and analysis were performed using two software: MS Excel 2021 and SPSS Version 27. The adoption status of ginger post-harvest practices was assessed and quantified using frequency distribution. The chi-square test revealed a significant association between adoption and membership (5%), extension (1%) and training (1%). However, the association between demographic factors like age, gender, education level, experiences in ginger cultivation, and the adoption of post-harvest practices in ginger was statistically non-significant. Moreover, an independent sample t-test and indexing technique were employed. Average adoption index was computed based on which high and low adopters were categorized. Notable advantages emerged for high adopters as they cultivated ginger in larger areas ($p < 0.01$) and gained higher economic returns ($p < 0.05$). Five constraints regarding the adoption were ranked through indexing, where a poor marketing system had the highest index value of 0.83, followed by the unavailability of improved processing technologies. In contrast, labor crisis was the least ranked constraint. This study concluded that farmers still follow the traditional methods of ginger post-harvest practices, denoting significant potential for improvement. Thus, offering impactful trainings and support to farmers in line with their recommendations can be the pivotal step towards enhancing the post-harvest practices in ginger sector in Syangja district.

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INTRODUCTION

Ginger (*Zingiber officinale* Roscoe), a spice crop from the Zingiberaceae family, is a rhizome commonly used in traditional medicine and culinary practices due to its pungent taste and strong aroma (Kiyama, 2020). The primary constituents of fresh ginger, known as gingerols, undergo dehydration and transformation into shogaols, which are the leading compounds found in

dried ginger (Sang *et al.*, 2020). Ginger oil, oleoresin, ginger candy, ginger puree, ginger powder, ginger beer, and ginger paste represent some of the diversified ginger products incorporated in profuse food items (Laelago Ersedo *et al.*, 2023). Findings have shown that the Mediterranean region introduced ginger in the 1st Century from India/China (Akbar, 2020). Being the fourth largest ginger-producing country in the world, Nepal occupies 9% share of ginger production globally, meanwhile, India and China account for 35% and 19% respectively (MoICS, 2019). The total area under ginger cultivation in Nepal is 22,441 ha with a production and productivity of 287,813 metric tons and 12.83 Mt/ha respectively where raw ginger solely contributes 1.7 % to the Agricultural Gross Domestic Product (MoALD, 2023). Over 98% of Nepal's export volume is sent to India, while only a small amount of processed ginger is exported to Europe and the Gulf region (TEPC, 2019). Ginger farming provides a livelihood for many small-scale farmers in Nepal which has the potential to contribute significantly to the agricultural sector's growth.

The post-harvest practices of ginger play a crucial role in determining its quality, shelf-life, and market value. Factors like delayed harvesting, improper drying, poor storage, improper packaging, etc. exacerbate the post-harvest losses in vegetables (Leelananda *et al.*, 2021). Poor post-harvest management practice has been one of the major setbacks limiting the profitability of farmers (Poudel Chhetri *et al.*, 2023). Farmers in Syangja practice unimproved and improper storage methods of ginger which ultimately leads to rotting and sprouting of harvested ginger. Such produce doesn't fetch good prices in the market, which as a ramification has demotivated the farmers towards ginger cultivation. Despite having a favorable climate and topography for ginger cultivation, lack of technical know-how in every nook and corner of the district during postharvest handling has led to the inferior quality of harvested ginger. One of the primary obstacles that hinders farmers from adopting advanced technology for ginger is insufficient knowledge regarding high-yielding ginger varieties and the absence of technical guidance (Kumar *et al.*, 2016).

It is crucial to pay close attention to post-harvest operations to ensure that the end product is not only of good quality but also safe for consumption (Matthews & Jack, 2011). The current scenario not only requires solutions to maintain but also to minimize waste. It is feasible to increase production and productivity and minimize post-harvest losses of spices within a constrained time frame by implementing better cultivation and postharvest handling techniques while also decreasing any existing constraints (Hordofa & Tolossa, 2020). Traders of Nepal are hesitant to venture into the expanding ginger market because there is a shortage of processed ginger products (TEPC, 2019). Scaling of ginger processing plants is a must to establish ginger as an acknowledged export sector of Nepal. In this regard, adoption status and factors affecting adoption of post-harvest practices in ginger is studied in Syangja district to effectively address the post-harvest domain. No significant studies on ginger post-harvest practices adoption have yet been carried out in the study area. Furthermore, there is dearth of information regarding post-harvest practices in ginger sector of Syangja. Therefore, the study investigates to understand the status of farmers' adoption of ginger in post-harvest practices and provide valuable insights on constraints and opportunities to improve ginger post-harvest practices in Syangja district. This study has potential to pinpoint important areas that need further advancements and contribute to increasing the competitiveness of Nepalese ginger in the domestic and international markets. It holds significant importance for policy makers, ginger growers, and extension specialists for planning and decision-making regarding ginger production and post-harvest management. The findings of the study can aim at developing policies centered specifically to ginger growers of Syangja. Also, training modules, extension services, and other tailored interventions can be designed to promote improved post-harvest activities of ginger in Syangja district.

MATERIALS AND METHODS

Site selection, sampling, and data collection

Syangja is a hilly district in Gandaki Province, located at latitude 28°00'38.16' North and longitude 83°47'48.48' East. The altitude varies from 928m to 2266m and covers a total area of 1,164 km². The Spice Zone was established in 2019 A.D. under the Prime Minister Agriculture Modernization Project (PMAMP) in Syangja. The designated site for the study of problems and research works on the ginger sub-sector incorporated 3 municipalities of Syangja; Galyang, Chapakot, and Waling, chosen purposively. The deliberate selection of these study sites is based on their association in the Spice Zone, Syangja as a part of Prime Minister Agriculture Modernization Project (PMAMP) and presence of notable ginger growing farmers.

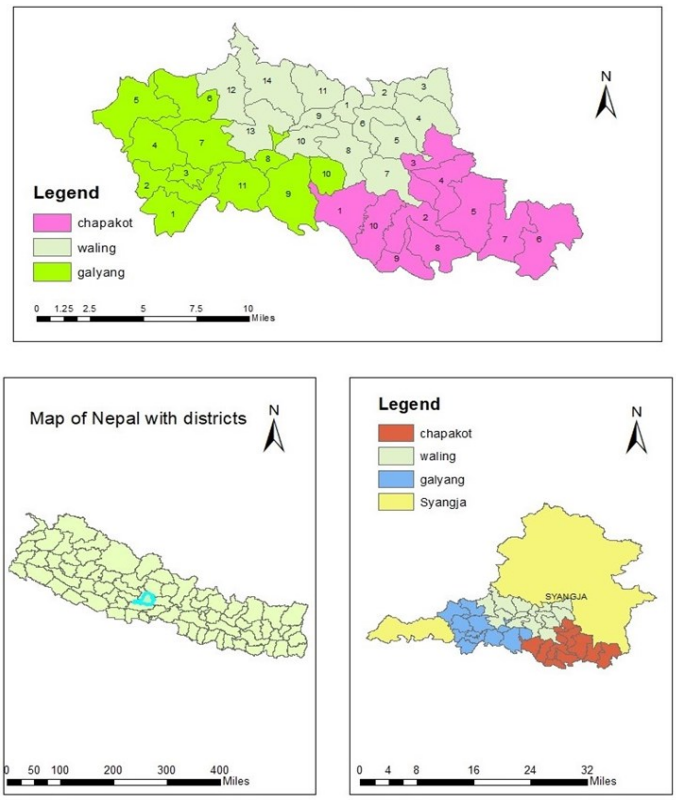

Figure 1. *Map of Nepal showing study area in Syangja district.*

The sampling frame was designed through the PMAMP Spice zone records of the listed ginger growing farmers of Galyang (Ward no. 1,7,11), Waling (Ward No. 1, 12), and Chapakot (Ward No. 8) municipalities. Out of 396 ginger growers (sampling frame) residing in the command area of Spice zone, the sample size comprised 80 farmers selected using simple random sampling technique. Household survey with the help of semi-structured, pre-tested questionnaires was carried out to collect first-hand primary data from 80 farmers. Additionally, an open structured checklist was used to carry out Focus Group Discussion (FGD) with active farmer leaders, and commercial farmers in an accessible location around the site. President of cooperatives, progressive farmers, and head of the zone committee were the key informants of the site. The information obtained from five Key Informant Interviews (KII) and three FGD was useful in verifying the information obtained from household surveys. A detailed review of available literature on the subject matter was done, which included the study of materials like Journal articles, publications of NARC, newspaper articles, records of the zone, and websites of FAO and MoALD to obtain the necessary secondary data.

In a finite population with a known population size, the sample size is determined by using Yamane's formula (Sarmah & Hazarika, 2012) given as,

$$n = \frac{N}{(1 + Ne^2)}$$

Where, n= sample size (80), N= population size (396), e= margin of error (10%)

Data analysis

The collected primary data were coded, entered, cleansed, and put forward for analysis using two software; Ms Excel 2021 and SPSS Version 27.

Chi-square test

The chi-square test is suitable for data presented as frequency counts in two or more categories i.e., nominal variables, to evaluate whether two or more categories of data are statistically independent (Das *et al.*, 2023). To study the association between two variables, Chi-square test was applied.

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where, χ^2 =Chi-square

O_{ij} = observed frequency of each ijth term

E_{ij} = expected frequency of ijth term

i = 1, 2, 3..... r

j = 1, 2, 3.....k

This was tested at 0.05 and 0.01 level of significance for different degrees of freedom.

Independent sample t-test

Independent sample t-test is used to compare the independent means of two sets of data and to test the significant difference from each other (Białowąs *et al.*, 2021).

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s^2}{n_1} + \frac{s^2}{n_2}}}$$

Where, $\overline{X_1}$ and $\overline{X_2}$ are the sample means of the two groups being compared

n_1 and n_2 are the sample sizes of the two groups being compared

s^2 is the pooled sample variance, calculated as

$$s^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$$

Where s_1^2 and s_2^2 are the sample variances for each group

Ranking technique

Constraints were listed during preliminary field visits and the 5 most frequent ones were incorporated in the questionnaire. Constraints for the adoption of post-harvest practices of ginger were ranked using a five-point scaling technique. Flash cards each with one specific constraint were provided to the farmers to ensure better comparison and comprehension. Farmers' perception of different adoption problems was ranked into very high, high, medium, low, and very low with scale value ranging from 1 to 0.2 respectively. The formula given below was used to find the severity index for adoption problems faced by farmers.

$$I_{imp} = \sum \frac{SiFi}{N}$$

Where, I_{imp} = Index of importance

$\sum$ = Summation

Si = ith scale value

Fi = frequency of ith importance given by the farmers

N = total number of farmers

Subedi *et al.* (2018) also applied the same formula to rank the problems associated with maize production in Dang district, Nepal.

Adoption index

Adoption index is a criterion used to quantify or assess the adoption of technology or practices in a given area or context. Adoption index was calculated to understand the degree of adoption of post -harvest practices in the study area. Farmers were categorized into high and low adopters based on the adoption index determined for individual farmers from the data on the extent of adoption of post-harvest practices in ginger. The adoption index was determined from adoption score which was computed by the sum of scores for adoption of 7 different ginger post-harvest practices. The Adoption Index (AI) of the farmers was measured by the index developed by Karthikeyan (1994).

$$AI = \frac{Total\ adoption\ score\ obtained\ by\ an\ individual\ respondent}{Maximum\ score\ one\ can\ obtain}$$

RESULTS AND DISCUSSION

Socio-demographic characteristics

Table 1 presents the socio-demographic characteristics of surveyed farmers. Most of the surveyed households were male headed. About two-thirds of the farmers belonged to the age group of 39-63 years with those above 63 years and those below 39 years having almost an equal distribution. Most of the farmers had secondary level of education whereas nearly one-sixths of the farmers were illiterate. Substantial experience in ginger farming was noted indicating ginger farming as an old business in the study area. Four-fifths of the farmers were members of agriculture related organizations representing a resilient conviction of community involvement. More than half of the farmers had not participated in training related to ginger cultivation and post-harvest practices. A considerable portion of farmers had contact with extension agents which proved proper dissemination of agricultural knowledge, skills and support in the study area. Diverse landholding was found among the surveyed farmers with wide-ranging ginger cultivation. Strikingly, a multifarious income range was observed.

Level of adoption of post-harvest practices in ginger

The average adoption index was 0.57. Resting on this value, farmers were categorized in two groups with over 60% of the farmers in the category of high adopters. Similarly, Sundresha *et al.* (2020) proclaimed more than half of the ginger farmers were part of high level of adoption.

Status of adoption of post-harvest practices in ginger

The category of adopters and non-adopters was classified by assigning arbitrary value 1 to those who adopted the selected practice and 0 to those who did not. Farmers practicing trimming, using knife or other sharp objects to remove excess, injured or injury- prone plant part were considered as adopters. More than 60% of the farmers adopted trimming. Slightly more than half of the farmers systematically grouped/ sorted their harvest based on the appearance. The process of drying ginger for 24-48 hours after harvest was taken as the criteria to separate adopters from non-adopters for sun drying. Sun drying was the most adopted practice among the seven practices as it did not require additional resources. Removal of extraneous materials like roots, attached soil, and pesticide residues through preliminary cleaning was noted. It was found that more than half of the farmers did not adopt preliminary cleaning. Use of water during preliminary cleaning was not observed. Only manual grading was followed by the farmers based on the size or color of the rhizomes. In a study by Poudel Chhetri *et al.* (2023), 100% manual grading of ginger was found in Palpa district, Nepal. Above 80% of the farmers graded ginger manually while others did not grade ginger. Black smoke-dried ginger (Gola), ginger powder, and ginger slices were prepared traditionally as value added products. Less than 10% of the farmers were engaged in ginger processing. Nearly two-thirds of the farmers followed

Table 1. Socio-demographic characteristics of ginger growers.

Gender		
Variables	**Frequency**	**Percentage**
Male	46	57.5
Female	34	42.5
Age		
Variables	**Frequency**	**Percentage**
Less than 39	13	16.25
39-63	53	66.25
Above 63	14	17.5
Education Level		
Variables	**Frequency**	**Percentage**
Illiterate	14	17.5
Primary (up to grade 5)	16	20
Secondary (up to grade 10)	35	42.5
Higher Secondary and Above	16	20
Experience on Ginger Farming		
Variables	**Frequency**	**Percentage**
Less than 5 years	21	26.25
From 5 to 14	46	57.5
Above 14	13	16.25
Institutional Involvement Indicators		
Variables	**Frequency**	**Percentage**
	Yes	**No**
Membership in organization	64	16
Participation on Trainings	33	47
Contact with Extension Agents	53	27
Farming Metrics		
Variables	**Min/Max**	**Mean ±SD**
Total land holding (ropani)	1.5/52	12.2±9.74
Area under ginger farming (ropani)	0.5/7	1.71±1.31
Income (N.Rs.)	3800/450000	41377.5±69534.41

Source: Field survey (2023)

traditional methods of storage (traditional pit, jute bags, and in-situ storage). 37.5% of farmers kept ginger in an open room, which was not considered as storage. In-situ storage was widely practiced by farmers (26.25%) followed by traditional pits (21.25%). 15% of the farmers stored ginger in jute bags.

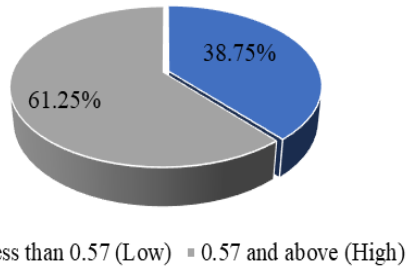

Figure 2. *Level of adoption of ginger growers (Source: Field survey, 2023).*

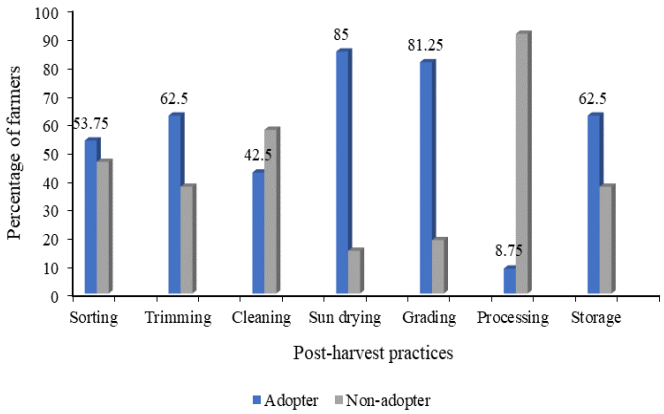

Figure 3. *Status of adoption of ginger growers (Source: Field survey, 2023).*

Table 2. Association of independent variables and level of adoption.

Variables	Chi-square value	p-value
Gender	0.007 ^{NS}	0.935
Age	0.935 ^{NS}	0.627
Education Level	2.603 ^{NS}	0.457
Family type	0.235 ^{NS}	0.628
Experience in ginger cultivation	1.107 ^{NS}	0.575
Membership in any organization	4.753**	0.029
Participation in trainings	10.012***	0.002
Contact with extension agents	10.007***	0.002

** and ***: Significant at 5% and 1% level of significance.

Influencing factors on ginger post-harvest practices adoption

Chi square test was applied to investigate the factors influencing the adoption decision on ginger post-harvest practices. The association between independent variables and level of adoption (categorized as high and low) was studied. Among the seven independent variables (Table 2) analyzed, all institutional factors- membership in organizations, contact with extension agents, and participation on trainings were found to be significantly associated with the level of adoption. In particular, membership in organizations like farmers group and agricultural cooperatives disclosed clear distinction between high and low adopters (at $p < 0.05$), conforming the conclusion provided by Kattel *et al.* (2020) where membership in organization had positive and significant impact on cleaning (at $p < 0.001$) and grading (at $p < 0.05$) in context of cardamom post-harvest practices. This may be due to the facilitation of market linkage by such organizations and dissemination of information about post-harvest practices among the members of associated groups. Participation in trainings depicted significant differences between high and low adopters (at $p < 0.01$), consistent with the outcome conveyed by Kumar *et al.* (2020). Their study found a notable linkage between training and adoption of more improved agricultural practices in most crops. Training imparts hands-on experience on practices like ginger sorting, cleaning, grading, sun drying and processing, also delivering insights into quality standards, risks during post-harvest, and market demand which ultimately boosts adoption. Furthermore, contact with extension agents was significantly associated with the level of adoption (at 1% level). Chepwambok *et al.* (2021) reported similar findings highlighting role of extension in adoption of post-harvest practices in mango and maize. Technical expertise provided by extension agents on effective post-harvest practices increases the likelihood of proficient adoption. Contrarily, the association between the age, gender, education level, family type, experience in ginger cultivation, and the level of adoption was statistically non-significant.

Mean comparison of cultivated area and income with level of adoption

Independent samples t-test was conducted to compare means of two variables- ginger cultivated area and income from sales of fresh and processed ginger with level of adoption (high and low level). The mean difference in area under ginger cultivation was statistically significant between high adopters and low adopters (Table 3). A similar finding was given by Mutungi *et al.* (2023), where households with larger farms had increased chances of adopting post-harvest practices. A wider cultivation area facilitates to opt for diversification and favors economics of scale encouraging efficient adoption. Considerable disparities were observed between income of high and low adopters (at $p < 0.05$). This may be because high adopters and likely to gain updated information about market demand and price fluctuations.

Table 3. Mean comparison of cultivated area and income with level of adoption.

Variables	High adopter	Low adopter	Mean difference	t-value	p-value
Ginger cultivated area	2.067	1.142	1.362	3.269***	0.002
Income	55940.82	18358.06	37582.75	2.427**	0.018

** and ***: Significant at 5% and 1% level of significance.

Table 4. Constraints associated with the adoption of post-harvest practices in ginger.

Constraints	Severity of constraints					Index Value	Rank
	Very High	High	Medium	Low	Very Low		
Limited access to credit	7	10	14	21	28	0.47	IV
Poor marketing system	33	28	17	2	0	0.83	I
Unavailability of improved processing technologies	23	32	19	6	0	0.78	II
Lack of improved storage facilities	13	8	22	28	9	0.57	III
Labor crisis	4	2	8	24	42	0.35	V

Table 5. SWOT analysis of ginger post-harvest practices in Syangja.

Strengths	Weaknesses
Increased economic return	Low quality of traditionally processed dried ginger
Favorable agro-climatic condition	Low bargaining power of farmers
Suitable cash crop for small farmers	Inadequate research on processing technologies
Well established road network and efficient transportation facilities	Insufficient market information affecting appropriate pricing of the product
High demand for dry ginger in domestic and foreign markets	No proper coordination among farmers and collection centers
Opportunities	**Threats**
Export potential and growing domestic market	Serious threat of rhizome rot disease
Government policy supports ginger as high-value income generating crop	Price fluctuation throughout the year
	Higher quality of ginger produced from India and Tibet
Scope for value-added products	Lack of proper storage facilities, leading to post-harvest losses
Opportunity of increment in value of product by establishment of cleaning and processing center	

Ranking of constraints

Each problem was ranked based on the index as per the rating assigned to each constraint by the respondents (Table 4). Poor marketing system got the highest rank followed closely by the unavailability of improved processing technologies. Conversely, labor crisis was the least ranked, indicating lower severity in comparison. The majority of the farmers expressed their discontent towards unorganized market linkages resulting in low price of their products, affecting their willingness to adoption. According to the study by Muthukumar *et al.* (2020), key constraints impacting the adoption of post-harvest practices in paddy were price fluctuation, labor shortage, lack of sufficient credit, and lack of processing units in Nagapattinam district in Tamil Nadu. Similarly, in a literature review by Bisheko and Rejikumar (2023), unavailability of improved processing technologies locally was found as a barrier to adoption of post-harvest technology among small holder farmers in India.

SWOT analysis

Strengths, weaknesses, opportunities, and threats of ginger post -harvest practices in Syangja district is presented in Table 5.

Conclusion

The study underscores the crucial importance of focusing on ginger post-harvest practices in Syangja district, Nepal. Through the analysis of adoption status, the association of factors, and constraints, it is noted that many farmers still abide by the traditional methods of post-harvest activities. The study revealed that high adopters dominated in embracing post-harvest practices, distinguished by larger cultivation areas and increased income from sales, emphasizing economic benefits associated with adoption. Ginger washing practice was not observed because of lack of access to ginger washing facilities to the farmers. Institutional factors were found to be key influencer in the adoption process as the study reveals a significant association of adoption with training, extension, and membership in agriculture-related organizations. This notable association validates the scope for further improvement in this field. Therefore, impactful need-based training should be provided to keen farmers. Concerned authorities should contribute significantly to providing low-cost solar dryers to ginger growers, promoting proper ginger cleaning through ginger washing facilities. In addition, the establishment of collection, cleaning and processing centers should be done immediately to extend the market of ginger and to add value to the fresh ginger. By narrowing the disparities between modern and traditional methods, the market value and quality of ginger can be drastically improved, eventually enhancing the entire value chain at local level.

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DECLARATIONS

Author contribution statement

Conceptualization: S.A.; Methodology: S.A.; Software and validation: S.A., M.P., S.A.; Formal analysis and investigation: S.A.; Resources: S.A.; Data curation: S.A.; Writing—original draft preparation: S.A.; Writing—review and editing: S.A., M.P., S.A., D.P.; Visualization: S.A.; Supervision: K.B.T., R.L. All authors have read and agreed to the published version of the manuscript.

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