Research Article

Production Dynamics of Potato (*Solanum tuberosum L.*) in Surkhet District, Nepal

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Abstract

   The study sought to examine how potatoes are produced in Panchapuri Municipality, Surkhet, and randomly selected eighty farmers from the command area for analysis. The required information was obtained with the help of a pre-tested, semi-structured questionnaire and one focus group discussion. Out of the respondents, 52.4% were male, and 47.6% were female. The study discovered that only a quarter of farmers had received training, with 37.5% having access to extension services. The majority of the respondents (90%) did not practice seed treatment during cultivation, and only 10% of respondents practiced seed treatment. Although potatoes are a high-value crop, many problems were encountered during potato production and marketing. The significant problems in potato production were limited land, a lack of quality seed, fertilizer, and water, disease and pests, and the monopolistic behavior of intermediaries. Major market problems were poor road infrastructure, high transportation loss, unavailability of the vehicles on time, high cost, lack of collection centers and cold storage, less producer share and price fluctuation, micronutrients, cold storage, seed treatment, training and extension services, marketing channels, and variety. Therefore, information and training, good road and market infrastructure, proper nutrient and irrigation management, more extension services, agricultural loans and subsidies, technical and management expertise in agricultural techniques, technical expertise in disease control, and disease-resistant improved varieties should be provided to improve production and potato marketing in this region.

Keywords: Fertilizer; Monopolistic; Questionnaire; Seed Treatment; Subsidies

Introduction

   Potato (*Solanum tuberosum* L.) is a crucial food crop cultivated on 193,997 hectares (ha) in Nepal [13]. The total potato production area is 188,098 ha, and the total production is 3,131,830 metric tonnes (mt) with a productivity of 16.65 mt/ha. It is Nepal's second most important cash crop after oilseed (260,307 ha) in terms of area. After rice, maize, and wheat, potatoes are the fourth-most significant staple crop in Nepal [8]. Usually a temperate crop, potatoes can be grown anywhere between 100 and 4000 meters above sea level in Nepal [7]. Surkhet is the dominant potato producer district in the Karnali province of Nepal, with an area of production of 2,476 ha [14]. Production and productivity are 3,999 mt and 16.15 mt/ha [14]. Area, production, and yield increased by 13.94%, 67.98%, and 48.16%, respectively, to the previous year in the Surkhet district. Although area, production, and yield have increased, Surkhet fulfills only 60% of potato demand in the district, and 40% of potatoes are still in deficit during their season [4].

   Farmers opt for high-value crops over cereal crops primarily because the former can be cultivated and obtained within a shorter period (3-4 months) and offer higher yields [15]. It is an important cash crop to reduce poverty while addressing food insecurity among smallholder farmers in developing countries like Nepal [3]. Technical efficiency measurement allows for the efficient use of various inputs such as seeds, fertilizers, an efficient irrigation system, and plant protection measures, as well as aiding in the improvement of agricultural production, which improves the economy of many farmers by making farming an appealing enterprise. For potato production, most Nepalese farmers cultivate on fragmented land rather than clustered land [24]. Simply expanding the land area used for traditional potato cultivation is not an effective way to increase potato production due to labor use efficiency limitations, late availability of seed and fertilizers, inadequate knowledge of production technology, and so on [1]. The potential for increasing potato production lies in improving the efficiency and

synergy of current inputs. Technical efficiency concerns a farm's ability to generate the most output possible with a given amount of inputs [12].

The Surkhet district possesses immense potential for potato production, thanks to its diverse climate and topography. However, most farmers in the district cultivate the local potato variety. This leads to higher prices for potatoes in Surkhet due to poor transportation, road conditions, and inadequate storage facilities, resulting in increased marketing costs compared to potatoes from Dailekh. During the main production season, exporting vegetables to Indian markets was nearly impossible due to the substantial commercial scale of production. The Indian government provides numerous incentives to vegetable growers at both the state and central levels, resulting in lower prices compared to Nepal [23]. In Nepal, the marketing cost of agricultural commodities is higher due to increased transportation expenses caused by poor road conditions, inadequate transportation means, and careless handling during transportation, loading, and unloading. These factors significantly impact the profitability of vegetable farming enterprises [23]. Consequently, people are compelled to purchase potatoes at inflated prices. Given the significance of marketing efficiency in determining product profitability, this study aims to address the integration of potato markets and shed light on the challenges faced by farmers during cultivation and marketing processes [1]. Consequently, the study sought to fill the existing research gap related to these problems. The objectives of the study are to assess and analyze the dynamics of potato production in the Surkhet district, evaluate the trend of potato production in terms of area, production, and productivity, assess the constraints in potato production, and evaluate the constraints in potato marketing. This understanding will aid in the development of relevant policies, the formulation of mechanization plans, and the preparation for agribusiness activities.

Materials and Methods

Study area

A survey was conducted in the Panchapuri municipality. The study site was purposefully selected as the Prime Minister Agriculture Modernization Project (PMAMP) has identified this area as the vegetable zone with the largest percentage of land used for and production of vegetables.
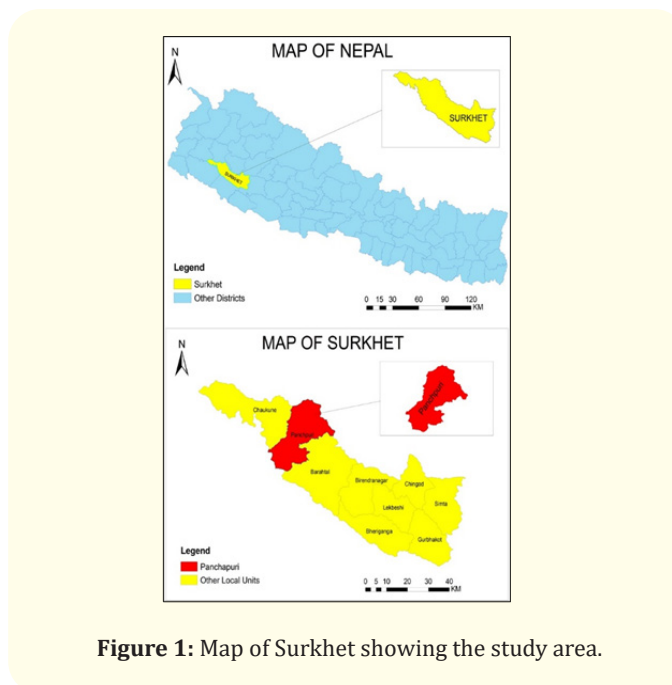
Figure 1: Map of Surkhet showing the study area.

Sample and sampling technique

80 farmers were selected out of 100 potato farmers using Slovin's formula:

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

wnere n = sample size, N = population size, and e = margin of error (5%)

Preliminary field visit

A preliminary study was carried out before the main survey to collect the study site's various socio-economic, demographic, and geophysical conditions. This information was used in preparing questionnaires and deciding on the sampling framework.

Key informant interview (KII)

KI were local resource persons, progressive farmers, social workers, senior agriculture officers, and other staff of PMAMP vegetable zone, Surkhet. KII was carried out to gather data for the survey and the area where the survey would be conducted. The information collected was reliable and contextual.

Focus group discussion

Those subjects that are difficult to understand for the farmers can be easily understood in groups. So, FGD was carried out after the survey for a validity check of the survey data. Only some people

can be in a focus group. The person should be intellectual, experienced, knowledgeable, and smart, and a homogeneous group will be preferred. A group of 6-7 people was involved, and the time was about 45-90 minutes. The FGD group was inclusive, and its operation was participatory. FGD moderators oversee everyone's participation in the group and prevent the dominance of any person or group.

Data and data types
Primary data

The primary data were collected from the study site's farmers using a semi-structured questionnaire. The prepared questionnaire was pretested, necessary corrections were made, and respondents were interviewed for data collection.

Secondary data

The secondary information was obtained through reviewing different journal articles and publications of the Department of Agriculture (DoA), Ministry of Agriculture Development (MoAD), Central Bureau of Statistics (CBS), and PMAMP vegetable zone Surkhet.

Data analysis technique

The information collected from the survey was first encoded in the computer for data analysis. The gathered information was then examined using software such as Microsoft Excel (2010) and SPSS (version 25). A descriptive statistical analysis of the recorded data, using percentage shares, weighted and unweighted averages, and standard deviations, was used to analyze the data. As per necessity, pictures, graphs, diagrams, narrative analysis, and other inferential statements were used to sufficiently extrapolate the current production state of potatoes and severe bottlenecks in the future.

Specific objectives	Data Collection	Data analysis technique
Access the area, output, and productivity trends for potato production.	Secondary source	Descriptive statistics (graph)
To assess production constraints for potatoes.	The household survey and FGD	Indexing and ranking
To assess marketing constraints of potatoes.	The household survey and FGD	Indexing and ranking

Table 1: Specific objectives and their sources of data and analysis techniques.

Data entry, cleaning, and missing data

The collected data was entered into the MS-Excel file for analysis. The entered data was then cleaned. Data cleaning implies detecting and removing errors and inconsistencies to improve the data's accuracy. Then, the missing data on the Excel file was checked using Python, NumPy, and the missing values were filled as required for proper data analysis.

Qualitative data analysis

The qualitative data obtained from the field survey were qualitatively analyzed.

Quantitative data analysis
Descriptive analysis

A descriptive analysis was done using socio-demographic and farm characteristics. Variables like family size, sex and age distribution, occupation, education level, ethnicity, and land holding size were analyzed descriptively and presented in frequencies, percentages, means, and standard errors, together with non-parametric tests wherever applicable.

Ranking index

The scaling technique ranked farmers' perceptions of production and marketing problems. It was computed using the following formula.

Mathematically, $\Sigma\left(\dfrac{S_i f_i}{N}\right)$ [16]

where Imp = index of importance, Σ = summation, S_i = scale value, f_i = respondent's frequency, and N = total number of respondents.

Results and Discussion
Household and farm characteristics

The household and farm characteristics include gender of the respondent, family size, economically active population, education level of the respondents, land holding, and land utilization pattern.

Gender of respondent

The respondent's gender gives us information about the active person/decision-maker regarding agricultural work. The majority of respondents (52.4%) were male.

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Ethnicity

One of the crucial aspects influencing occupation is ethnicity in Nepalese society. The majority of the study's respondents (72.6%) were Brahmin/Chhetri.

Family size and economically active population

It provides information regarding the availability of labor for farming. There were 5.07 families on average, which was fewer than the average number of families in the country (5.4). Population groups between the ages of 15 and 59 that have productive capacity are considered economically active populations by the government of Nepal. The average economic population was 4.55. Therefore, it indicated that 65.75% of the population was economically active.

Age of the respondent

Regarding the age of the respondent, the average age of the respondent was 41.69. The minimum and maximum interviewee age was 20 and 70 respectively with mean age of 41.69, and standard deviation 10.61.

Variable	Frequency (n=80)	Percentage (%)
Male	42	52.4
Female	38	47.6
Total	80	100

Table 2: Population distribution of respondents by gender.

Variable	Frequency (n=80)	Percentage (%)
Brahmin/Chhetri	61	72.6
Adibasi/Janajati	13	15.5
Dalit	6	11.9
Total	80	100

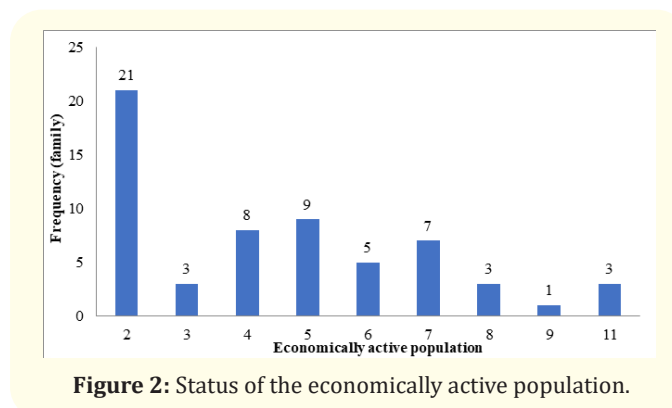**Table 3:** Distribution of population by ethnicity.

Figure 2: Status of the economically active population.

Education level of the household head

The above pictures showed that most respondents were illiterate (56.25%), followed by literate (43.75%). Out of 43.75% literate, 68.75% were studying up to the primary level, followed by the Secondary level (14.29%) and higher level (17.14%). A farmer is more likely to use agricultural technologies if they have greater education [10]. This might be the case because someone who is educated is more likely to have access to information about technology and where and how they can get support [17].
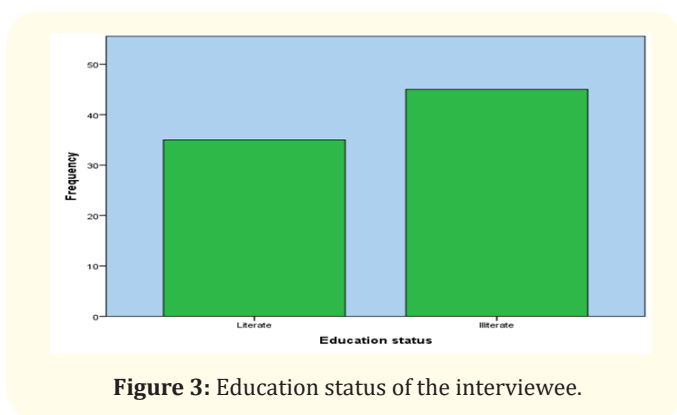

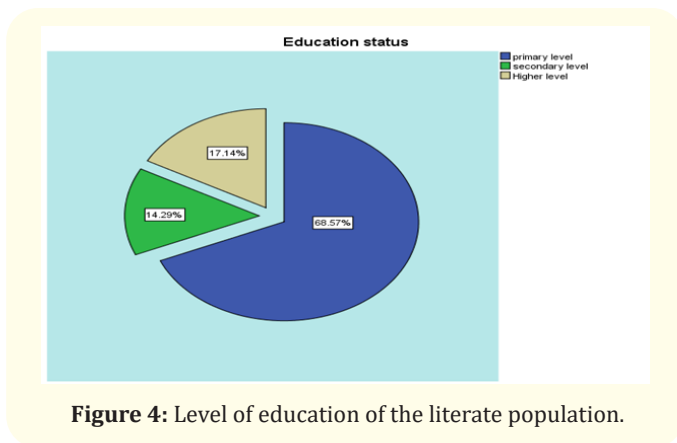**Figure 3:** Education status of the interviewee.

Figure 4: Level of education of the literate population.

Farm characteristics and productivity

The research area's agriculture productivity and characteristics are displayed in the table. The total land holding was 26.25 ha, and only 4.97 ha was used for potato cultivation. Irrigation status was also low, i.e. 2.83 ha, and this could be the reason for the low productivity of potatoes. Total potato production was 25.56 mt, and Productivity was 5.13 mt/ha, which was fairly lower than the national average (16.67 mt/ha).

The major occupation of the respondents

The respondents' major occupations were agriculture, off-farm income (Business/ service/ labor/ pension), remittance, and oth-

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ers. The majority of the respondents were engaged in agriculture (62.50%), followed by civil off-farm income (20%), remittance (16.25%), and other services (1.25%).
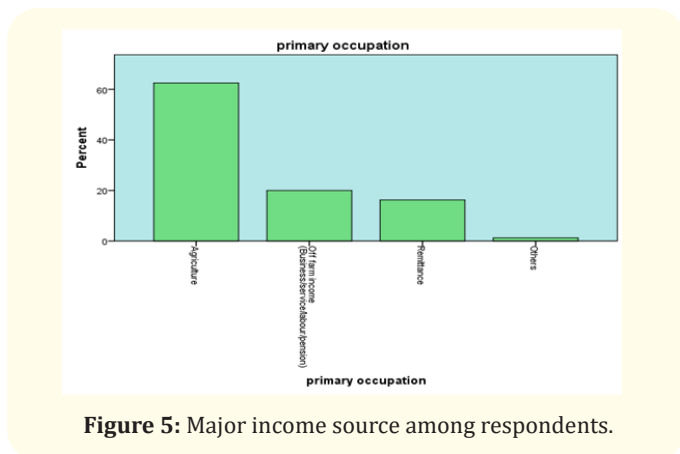

Figure 5: Major income source among respondents.

Family type

The type of family was differentiated as nuclear and joint family. However, more respondents were living in nuclear families (65%).

Population	Average	Maximum	Minimum
Total (Family size)	5.07	12	2
Active population	4.55	2	11

Table 4: Family size and economically active population in respondent's family.

Variables	Value
Total land holding (ha)	26.25
Total Land under potato cultivation (ha)	4.97
Total Irrigated land (ha)	2.83
Total potato production (mt)	25.56
Productivity (mt/ha)	5.13

Table 5: Farm characteristics and Productivity.

Variety cultivated

Most respondents (77.5%) prioritized local variety followed by improved variety (22.5%). Lal Gulab and Jumli alu were two popular local varieties; Cardinal and Kufri Sinduri were two improved varieties cultivated by the farmers. Cardinal, Kufri Sinduri, TPS, Kanpure, Lal Gulab, Arun Gold, C40, Desiree, Khumal Rato, and
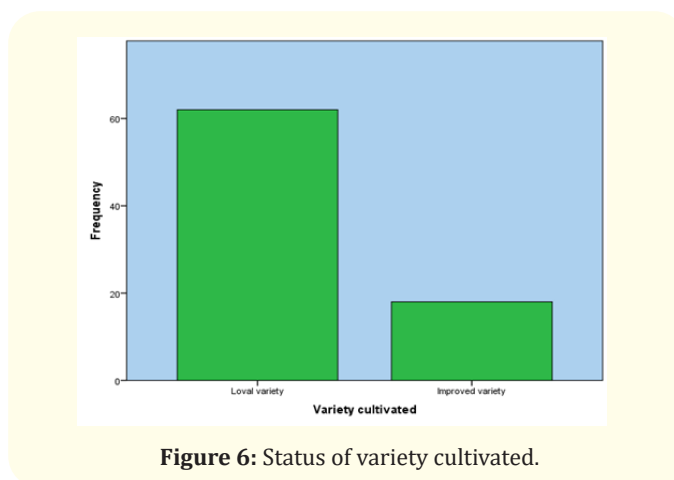

Figure 6: Status of variety cultivated.

other types of potatoes are farmed in Nepal [6,21] reported that the productivity of improved variety was superior to the local variety. This would be the reason for the low production of potatoes.

Seed treatment

The majority of the respondent (90%) did not practice seed treatment during cultivation, and only 10% of respondents practiced seed treatment. Since it is a crucial part of all crop production systems and a source of genetic resources for food and agriculture, the seed is crucial for food security and the development of rural areas. So, seed treatment helps to maintain its quality and protect it from disease and pest. Seed treatment saves the seed requirement by 50%, the most critical and expensive input for potato farming [11].
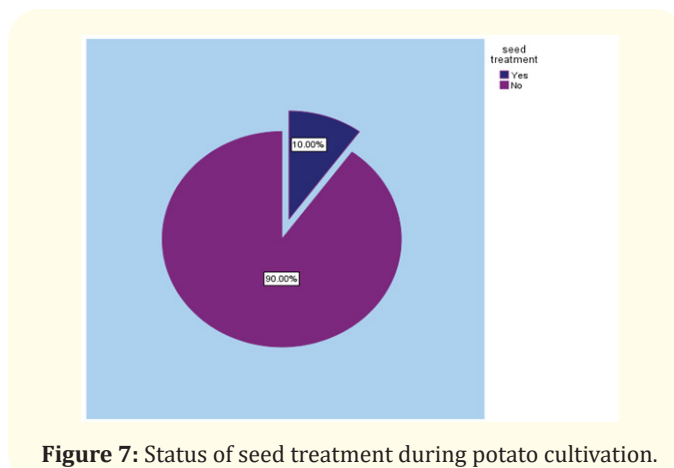

Figure 7: Status of seed treatment during potato cultivation.
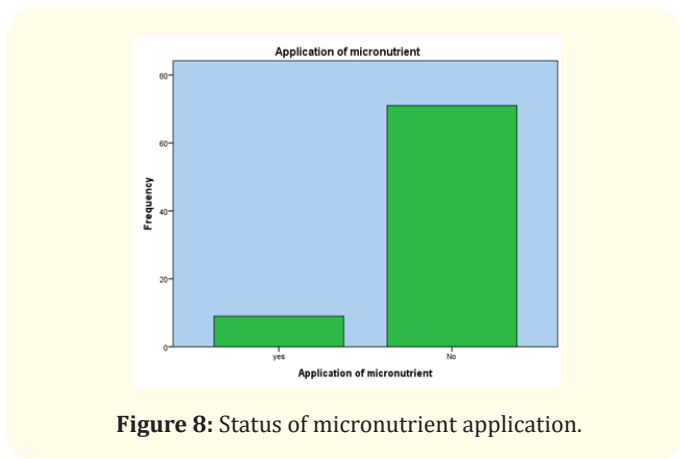
Micronutrient application

Figure 8: Status of micronutrient application.

The studies found that the majority of respondents (80%) did not supplement NPK fertilizer with micronutrients. The application of micronutrients such as boron, sulfur, manganese, and zinc has a large and essential impact on certain potato parameters. According to findings from several scientists, combining various micronutrients with NPK is the best nutrient management technique for getting higher tuber yield, good quality of tuber, and economic return [20]. Furthermore, it is reported that soil application of soil micronutrients can help boost potato yield and ensure nutritional concerns [18]. Yet, the survey found that the majority of respondents (80%) did not supplement NPK fertilizer with micronutrients.

Market and marketing characteristics

Market and marketing characteristics include accessibility to cold storage, extension services, and attitude toward the middleman.

Training and extension services

Just one-fourth of farmers had access to training, and only 37.5% to extension services, as per the survey. stated that limited availability of quality seeds, storage problems, poor extension services, and training directly affect the Production and marketing of potatoes. Those with access to substantial service and training had a higher chance of successfully growing potatoes on a wide scale [5].

Cold storage

The study found that the majority of farmers (88.3%) required access to cold stores. However, only a few (11.7%) of the respon-
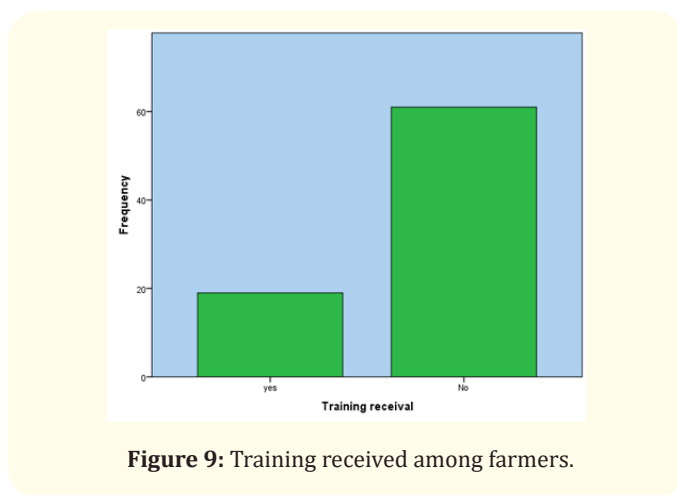

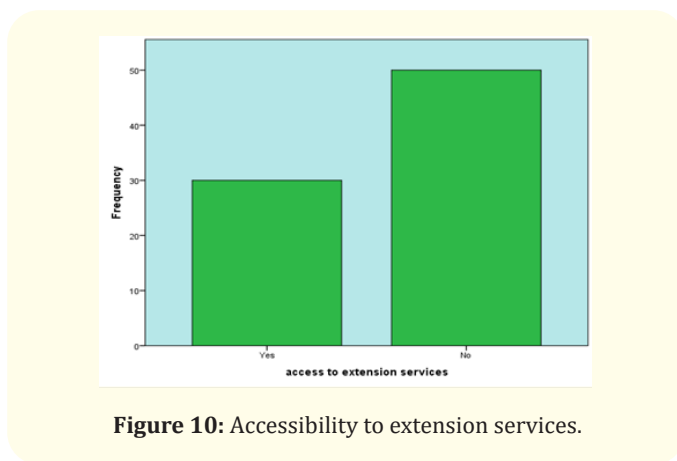**Figure 9:** Training received among farmers.

Figure 10: Accessibility to extension services.

dents had accessibility to cold storage and stored potatoes to sell in the off-season (Figure 11). Potato is mainly a seasonal crop. Around 90% of potatoes are grown during the winter, but because demand for them is year-round, cold storage is required to control market supply. [6] identified that access to cold stores among Nepalese farmers was poor, i.e., 10% percent, so one of the key approaches could be to help the farmers to construct cold stores so that they could warehouse their produce in flush and send it to the market in lean period.

Attitude of farmer toward middleman

The majority of respondents had a favorable opinion of intermediaries. Poor roads, far markets and they take their full product at a time might be the reason. Farmers have perceived the positive role of intermediaries as an institution that facilitates the sale of agricultural products, lender of farming inputs, and cash loans [22].
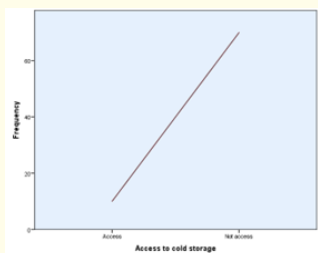
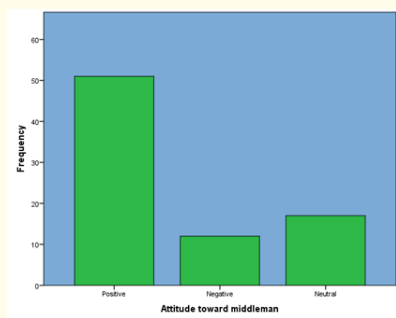**Figure 11:** Accessibility to cold storage.

Figure 12: Farmer attitude toward middleman.

The trend in potato production

A significant crop in our country is the potato, but production and productivity are very low compared to our neighboring countries. In the Nepalese context, overlooking the trend of the previous seven years, the production area of potatoes has suffered from a certain fluctuation over the years. However, for the past seven years, production has significantly expanded, and productivity has become steady.
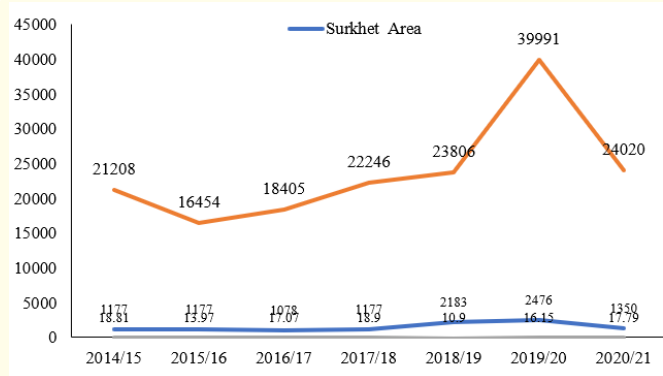

Figure 13: Trend of potato production in Nepal from 2014/15-2020/21.
Source: [14].

Figure 14: Trend of potato production in Surkhet from 2014/15-2020/21.
Source: [14].

Figure 14 depicts the original series' observation, and shows an increased production during the period 2014/15-2020/21. There was a certain swing in the production area and production of potatoes. The highest production during the period was 39,991 mt in the year 2019/20, and the minimum was 16,454 mt in 2015/16. Despite a rise in the area and volume of potatoes produced, Surkhet's productivity could have been higher. In the Surkhet district, overlooking the trend of the previous seven years, the production of potatoes has suffered from a certain fluctuation. There were 1,350 hectares of land under cultivation, producing 24,020 tons [14]. There was an increasing trend in production area from 2014/15 up to now but an initially decreasing trend from 2014/15 to 2015/16 and not much significant increase in productivity up to now, which might be due to faulty production practices, quality seed tubers, and knowledge on improved production technology.

aProblem in production

The study found that various issues restricted farmers in the work area from growing potatoes. With an index score of 0.77, diseases and pests were ranked first in the index ranking. It was followed by limited land with an index value of 0.69, low-quality seed with an index value of 0.59, lack of fertilizer and water with an index value of 0.51, and monopolistic behavior of middleman with an index value of 0.48, which is shown in table 7 below. As per [2], the main constraints on the production of potatoes in Asia and Pacific regions were a lack of suitable varieties, technical constraints, disease, and pests, lack of post-harvest technology, unreliable and inexpensive supplies of high-quality seed, poor farmer-to-market connections, indiscriminate use of pesticides and fertilizers. In de-
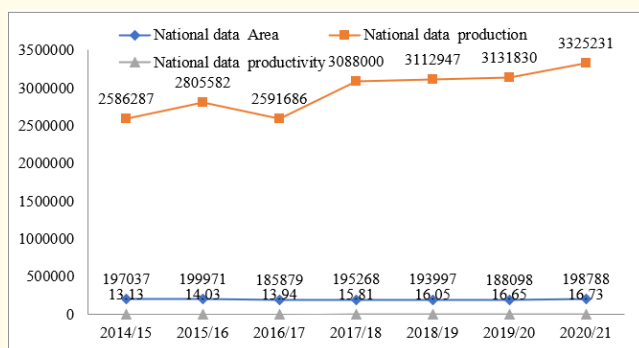
veloping countries like Nepal, small-scale farmers do not have easy access to quality seeds leading to significant reductions in yield [9].

Problems	Index	Rank
Disease and pest	0.77	I
Low-quality seed	0.59	III
Lack of fertilizer and water	0.51	IV
Limited Land	0.69	II
Monopolistic behavior of middleman	0.48	V

Table 7: Problem in potato production.

Variable	Index	Rank
Poor road infrastructure	0.70	I
High transportation loss	0.47	IV
Unavailability of the vehicle on time	0.61	III
High cost	0.67	II

Table 8: Transportation problem.

Variable	Index	Rank
Lack of collection center and cold storage	0.74	I
Less producer share	0.73	II
Price fluctuation	0.50	III

Table 9: Marketing problem.

Market problem

According to the field survey, poor road infrastructure ranked first with an index of 0.70. It was followed by high cost with an index value of 0.67, unavailability of the vehicle on time with an index value of 0.61, and high transportation loss with an index value of 0.47. Table 8 shows major problems related to transportation. Lack of a collection center, less producer share, and price fluctuation were the main marketing-related problem shown in Table 9 below. Lack of collection centers and cold storage were ranked first with an index value of 0.74, followed by less producer share with an index value of 0.73 and price fluctuation with an index value of 0.50 [19] revealed that high transportation costs, poor road infrastructure, lack of proper grading, long-distance market access, long marketing channel, delayed payment, scare cold storage places, monopoly of middlemen, and price fluctuation were the main market problems of vegetables.

Conclusion

The study revealed that the majority of respondents (77.5%) favored the local potato variety, while 22.5% preferred the improved variety. Total potato production was 25.56 mt, with a productivity of 5.13 mt/ha, which was significantly lower than the national average of 16.67 mt/ha. This lower productivity could be attributed to the superiority of the improved variety over the local variety. Notably, only a small percentage (10%) of respondents practiced seed treatment, while the majority (90%) did not. Similarly, around 80% of respondents did not supplement NPK fertilizer with micronutrients. Regarding storage, although 88.3% of farmers expressed the need for cold stores, only 11.7% had access to them for storing potatoes during the off-season. The demand for potatoes throughout the year necessitates cold storage to manage market supply. Disease and pests ranked first (index score of 0.77) in terms of challenges, followed by limited land (0.69), low-quality seed (0.59), lack of fertilizer and water (0.51), and monopolistic behavior of middlemen (0.48). Poor road infrastructure (0.70), high costs (0.67), unavailability of vehicles on time (0.61), and high transportation losses (0.47) were identified as key challenges in transportation. Lack of collection centers and cold storage ranked first (0.74) among marketing challenges, followed by a lower producer share (0.73) and price fluctuations (0.50). In order to enhance potato production and marketing in this region, it is essential to provide a range of resources and support. These include access to information and training, well-developed road and market infrastructure, effective nutrient and irrigation management practices, increased availability of extension services, provision of agricultural loans and subsidies, technical and managerial knowledge in agricultural techniques, expertise in disease control, and the introduction of disease-resistant improved potato varieties. Further research should investigate the reasons behind the preference for the local potato variety, address the low productivity compared to the national average, and explore strategies to promote seed treatment and micronutrient supplementation. Additionally, efforts should be made to improve access to cold storage facilities and aim for broader scope and rigorous data collection methods.

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