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ORIGINAL RESEARCH ARTICLE



Economics of potato (*Solanum tuberosum* L.) production and marketing in Darchula district of Nepal

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ABSTRACT

The potato (*Solanum tuberosum*) is a popular root vegetable that is grown all over the world. Potato production is popular in Nepal because of its greater adaptability, high yield potential, and high demand, contributing 6.57 percent to AGDP and 2.17 percent to GDP. In Nepal, it is grown on 197,037 hectares (ha) with a yield of 13.13 metric tons per hectare and a total production of 2,586,287 metric tons. The major objective of our research was to analyze the economics and marketing state of potatoes in Api-Himal rural municipality Darchula, Nepal where a survey on potato production and marketing was conducted. A total of 60 households were randomly sampled and interviewed as the primary source of information for the research. For the residents of Api-Himal RM, there are few options for sustenance and revenue generation. The area is ideal for potato farming, and potato trading has a direct impact on rural communities' livelihoods. The B/C ratio was found to be 1.62 in the research area. The average cost of potato production was Rs. 2,67,319 while the average return was Rs. 4,32,804. The research focuses on the marketing and production of potatoes from the growers to the final customers. Low yield, insect and disease infestation, and a lack of government support are among the issues. To promote the production and marketing of potatoes, availability of improved technology, an extension of technical knowledge, efficient management of marketing channels and substantial financial support by the government as well as local bodies are recommended.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) originated in South America, is a Solanaceous starchy flowering plant, and shares the genus *Solanum*, with at least 1000 other species, including tomato and eggplant (FAO, 2009). Globally, the potato is considered the number one crop that has become a crop of the world's major economic importance (Rykaczewska, 2013). In the Himalayan area, it is regarded as the main crop (in terms of cropping pattern) by the majority of households. The potato produced in Darchula has good market recognition and is the main source of income for the people residing there. There have been few

studies that have evaluated the feasibility of potato in these places (Bajracharya and Sapkota, 2017). Its production is popular in the region because of its greater adaptability, high yield potential, and high demand, contributing 6.57 percent to AGDP and 2.17 percent to GDP, respectively. Potatoes have previously been regarded a suitable alternative for improving the nutrition and health of rural populations, as they are more productive than cereal grains and have a positive net worth than cereals. Potatoes are widely grown in Nepal, from the southern Terai at 100 meters above sea level (masl) to the northern Himalayas at 4000 meters masl. In Nepal, it is grown on 197,037 hectares (ha) with a yield of 13.13 metric tons per

hectare and a total production of 2,586,287 metric tons (MOALD, 2020). In the Terai, potatoes are used as a supplement to vegetables, however in the Hill and Mountain regions, they are a staple meal.

Potatoes are another important source of income for individuals living in the Himalayan region. For the residents of Api-Himal Rural Municipality (RM), there are few options for sustenance and revenue generation. The area is ideal for potato farming, and potato trading has a direct impact on rural communities' livelihoods. In response to rising demand and a growing number of consumers, potato planted area, production, and productivity are all expanding. Api-Himal RM is a good choice for potato production. Cultivators do not receive a premium for their produce. The price that cultivators receive and the price that customers pay are vastly different. It is necessary to conduct study in order to determine the cause.

Governmental organizations, NGOs, INGOs, researchers, students, development workers, and investors may equally find it significant. This study will present the current state of potato production and marketing in the Api-Himal Rural Municipality in Nepal's Darchula region. The findings also suggest that agribusiness operations in input markets and technical support for potato growing could be profitable. They also highlight the advantages of policy measures supporting future operations on and off the farm that will enhance the potato sector's impact on food security, revenue, employment, and food production in the coming years (Scott et al., 2019). Finally, overall variable cost was 3.3 percent due to packaging, storage, and shipping costs. Seed costs account for a considerable 42 percent of total production expenses. A gross margin of N.Rs. 15504 per ropani was reported by (Timsina et al., 2013). However, according to a study conducted in Nepal's western mid-hill region, Baglung district, the benefit-cost ratio of potato production is 1.44 (Bajracharya and Sapkota, 2017).

Due to Covid-19 Pandemic, we had conducted this research within our limited budget and limited timeframe thus, the findings of our study cannot be generalized to the whole part of the district as it was conducted only on the selected area i.e., Api-Himal Rural Municipality, Darchula Nepal. No other research related to potato production and marketing was done in the study area thus, this could be a basis for future researchers in the same area. Our research may have the following shortcomings.

The samples taken from the site of the study represent only a small no. of samples i.e., 60 thus, valid statistical interference maybe difficult to meet.

The purposive sampling was taken from which the finding basically reflects the perception and experience of those respondents, which may contain respondent errors.

This research focuses on the production and marketing of potatoes from the growers to the final customers, as well as the middlemen involved in the process. The economics of two-season potato production and selling in Darchula district was the focus of our investigation. In Darchula, Nepal, we also compared and evaluated the production and sale status of potatoes across two seasons. The source of potato seed, as well as various production practices, were also recognized.

MATERIALS AND METHODS

Site selection

The study was carried out in the Darchula district of Far-Western province of Nepal covering 2322 sq. km with an elevation ranging from 357masl to 7123masl. There are 2 municipalities and 7 rural municipalities. Out of them, Api-Himal Rural municipality is one of the pocket areas for potato production. Api-Himal Rural Municipality was purposively selected for study because of higher production and marketing trends.

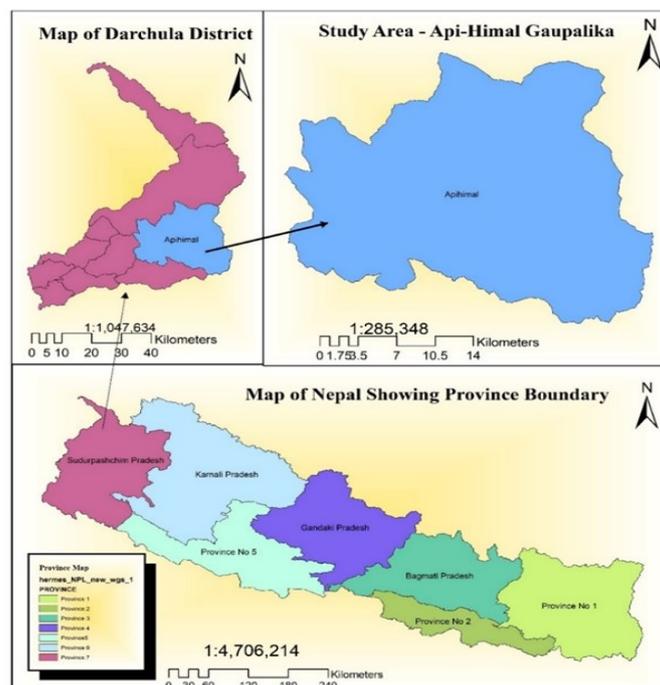


Figure 1. Study area, Api-Himal Rural Municipality Source: (Joshi et al., 2022).

Respondent selection

Agriculture Knowledge Centre, Darchula, is the principal controlling organization for potato production and commercialization in Darchula, Nepal. Hundreds of houses in the Darchula district are active in potato farming, as well as a large number of marketing agents. Individuals with at least 5 years of experience in potato production and marketing were chosen.

Sampling unit

A sample size of 60 HH from various socioeconomic backgrounds were chosen from Api-Himal RM. The sample included persons of all ages, socioeconomic statuses, educational levels, ethnicity, gender, and other characteristics. The HHs and those with at least five years of experience in production to marketing were surveyed.

Data nature and sources

The study focused on primary and secondary data collection, which were gathered from direct and indirect sources. The study concentrated mostly on the original data gathered. The primary data was gathered by conducting face-to-face interviews with HHs using a semi-structured, formal, and informal questionnaire. The information gathered was confirmed and validated through key person discussions. Various articles from reliable sources like AKC, Government Sites and Api Rural Municipality and journals including Hindawi, MDPI, Springer, Elsevier etc. were reviewed as secondary sources of data for the research.

Methods of data collection

Primary data was gathered through a discussion with the HH head or a person involved in production and sale of potatoes. Personal interviews with residents utilizing pre-printed Paper-Pen questionnaire were used to gather information about the existing environment of potato marketing, including stakeholders, different agents, and other factors impacting potato marketing and pricing. The purpose of the key person discussion was to validate and verify the data collected. Local leaders, office heads and major farmers representing the overall area were the key persons to whom the questions related to production and marketing of potatoes were asked and validated.

Questionnaires and questionnaire design

An interview protocol was created in order to acquire main data from the respondents. With the research's goal in mind, the interview schedule was kept consistent. In the interview schedule, question sequencing was extremely important, and they were arranged in a manner that the first question would create the information needed to complete the initial objective, and vice versa. The questionnaire was pretested with 20 residents of the neighboring Village Development Committee to assess its effectiveness in getting trustworthy and accurate data, and final improvements to the interview plan were made to make it more effective. To acquire information from the selected respondents, a field survey was undertaken in Api-

Himal RM, Darchula, Nepal. The researchers were directly involved in the field survey.

Data analysis methods and techniques

Primary data was gathered via a field survey and placed into an Excel spreadsheet (MS Office V. 2016). The secondary data gathered was also kept. SPSS (V.20) was used to evaluate the data that had been coded and kept. Both analytical and descriptive techniques were used to analyse the data. The results of the analysis were provided in relevant tables and figures, and the findings were interpreted using relevant literature.

Gross margin analysis

The gross margin of the potato producers in this study was calculated as;

Gross margin is calculated as Gross Return - Total Variable Cost. Where,

Gross return = Price of potato x Total quantity

Gross margin is calculated as Gross Return - Total Variable Cost. Cost of all variable items added together = the total variable cost.

Benefit cost analysis

Benefit cost analysis was done after calculating the gross return and total variable cost from the potato cultivation. Total variable cost of production was calculated by summing the variable cost items in the production process. For calculating gross return, income from the potato sale was accounted. So, the benefit cost analysis was carried out by using formula:

Benefit Cost Ratio=Discounted Benefit/Discounted Cost

Marketing margin and producer's share

Marketing margin is the difference between the farm-gate price received by the farmer and the retailer's price paid by the consumer, which was calculated as follows:

Marketing margin = Retailer's price (P_r) - Farm gate price (P_f)

Similarly, producers' share is the price received by the farmer expressed as a percentage of the retail price, that is, the price paid by the consumers. The formula below was used to calculate it.

$P_s = (P_f / P_r) * 100$

Where,

P_f = Producer's price (farm gate price)

P_r = Retailer's price

P_s = Producer's share

Problems on production and marketing

The measure was developed mostly using qualitative data. On the basis of responded frequencies, weighted indexes were calculated for the analysis of farmer's perception on the extent of production and marketing problems of the potato producers. Farmer's perception to the different production and marketing problems were ranked as 1= strongly disagree, 2= disagree, 3= undecided, 4= agree, 5= strongly agree.

RESULTS AND DISCUSSION

Household and farm characteristics

Out of 60 sample size, 56% were found to be economically active population of age group 15- 59 years. The average family size was 6.54. The study area showed the male dominated community i.e., about 65% of the respondents were male. Whereas, the other study in the same area found it to be female dominated i.e., 52% of the respondents were female (Joshi et al., 2022). The majority of the respondents had 9-12 years of schooling i.e., 41%. The average land holding was 14.75 ropani out of which, 3.50 ropani was used for potato production. Average rate of tuber/ ropani was 57.20 kg/ropani.

84.21% of respondents in the study area were engaged in Agriculture. 100% of the respondents were from Chhetri ethnicity and followed Hindu religion as well.

Input procurement

Due to variances in soil types, nitrogen and moisture content, economic factors, and other environmental factors, fertilizers requirements and planting distance vary by location.(Getaneh and Laekemariam, 2021). In the research area only Compost manure was used as the source of Fertilizer for potato production. In sampled area, about 81% i.e. majority of farmers used input procurement from local available sources followed by 17% from Agriculture Knowledge Centre (AKC) and only 2% used from Agro vet.

Table 1. Household and farm characteristics of potato farmers.

Particular		Average
Sample Size (number)		60
Age (%)	<15 Years	33
	15-59 Years	56
	>59 Years	11
Average gender participation (%)	Male (%)	64.92
	Female (%)	35.08
Average years of schooling (%)	0 years	25
	1-8 years	30
	9-12 years	41
	13-16 years	4
Average household size (number)		6.54
Average land Holding (ropani)		14.75
Average potato area (ropani)		3.50
Average tuber quantity/ Ropani (kg/ ropani)		57.20
Occupation (%)	Agriculture	84.21
	Business	12.28
	Government job	3.5
Ethnicity (%)	Chhetri	100
Religion (%)	Hindu	100

Source: Field Survey (2021)

Table 2. Descriptive Statistics on attitude of Farmers towards input procurement.

Statements	Minimum	Maximum	Mean
Inputs not Available in Time	1	5	1.39
Seed centers far	1	4	1.39
Low purchasing capacity	1	5	2.19
Difficulty in transportation	1	4	3.82
Quality Seeds	1	5	2.72
Uncertified Seeds	1	5	2.81

Table 3. Descriptive Statistics on problems on potato cultivation.

Statements	Minimum	Maximum	Mean
Marginal Land	1	5	4.04
Seed Availability	1	5	2.95
Seed Germination	1	5	3.23
Irrigation facility	1	4	1.25
Labor	1	5	3.00

Attitude of farmers towards input procurement

Farmers who use current and newly developed technology more effectively, such as better adapted varieties, healthier seed tubers, botanical seed, and low-cost processing and storage, can significantly cut expenses per unit of production, primarily by boosting yield (Larkin and Halloran, 2015). The availability of high-quality improved seeds is favorably associated to the adoption of improved potatoes. Increased access to better seed, agricultural loans, and extension services could improve the efficiency of vegetable growing. According to reports, the majority of farmers obtained seed from an unofficial source, resulting in reduced yields (Subedi et al., 2019). However, according to (Ghimire, 2005; Noonari, 2016), farmers' choice of improved varieties is one of the most important elements determining crop productivity, which is influenced by a variety of factors. The five-point Likert Scale is used to rank the attitude of farmers towards input procurement which is described below:

As an interval scale, the Likert scale with five options is used. The mean is very significant. From 1 to 1.8, it means strongly disagree. From 1.81 to 2.60, it means to disagree. From 2.61 to 3.40, it means undecided; from 3.41 to 4.20, it means agree; from 4.21 to 5, it means strongly agree. In the first statement, the mean is 1.39. Hence, it means that the majority of participants are strongly disagree on inputs not available in time. The mean of the second statement is 1.39. Accordingly, the majority of respondents strongly disagree on the Seed Centre being too far. The third statement about the low purchasing capacity of people, the majority of respondents disagree on it as the mean is 2.19. The majority of respondents agreed with difficulty in the transportation of potato, and majority of respondents can't decide on low quality seed available as the mean is 3.82, and 2.72, respectively. The majority of respondents can't decide about uncertified seeds available.

Reasons for potato cultivation

The majority of potato produced is sold as soon as it is harvested. Despite the fact that large quantities of potatoes are saved for home consumption and as seed for the following season, a few producers store potato for future selling at a better price (Akello et al., 2022). The above graph shows multiple responses of respondents for 'Why potato is being cultivated in the area. The majority of Respondents produced potato for home consumption as well as for marketing. 35.08% of respondents

found it was profitable, 33.33% agreed, it was locally suited.

Problems of potato cultivation

Seed quality, disease and pest infestation, and irrigation availability have all been reported to have a substantial impact on productivity (Shrestha and Subedi, 2019; Timsina et al., 2013). The five-point Likert scale was used to rank the problem of potato cultivation. The table below shows the problems accordingly:

As an interval scale, the Likert scale with five options is used. The mean is very significant. From 1 to 1.8, it means strongly disagree. From 1.81 to 2.60, it means to disagree. From 2.61 to 3.40, it means undecided; from 3.41 to 4.20, it means agree; from 4.21 to 5, it means strongly agree. In the first statement, the mean is 4.04. Hence, it means that the majority of participants are agreed on the marginality of land. The mean of the second statement is 2.95, which means the majority of respondents are undecided on the unavailability of seed. The third statement about the seed germination, the majority of respondents are undecided on it as the mean is 3.23. The majority of respondents strongly disagreed with the facility of irrigation, and the majority of respondents can't decide on labor availability.

Planting system

In sampled area, it is found that majority of people i.e., 84.21% followed furrow plating system and 15.79% people followed ridge planting system.

Disease pest of potato

Potato infections spread via soil are a persistent problem in potato cultivation (Larkin and Halloran, 2015). It has also been discovered that having technical understanding of how to control illnesses, as well as adequate input and resource allocation, can assist boost potato profitability and productivity (Bajracharya and Sapkota, 2017). In sampled area, 19.3% respondents agreed on early blight infestation. Almost all the respondents had faced the problem of Late blight of Potato in the study area. White grub and red ants were also the major disease -pests of potato production in the research area. Minority of the respondents found early blight and PTM as well i.e., 19% and 44% respectively.

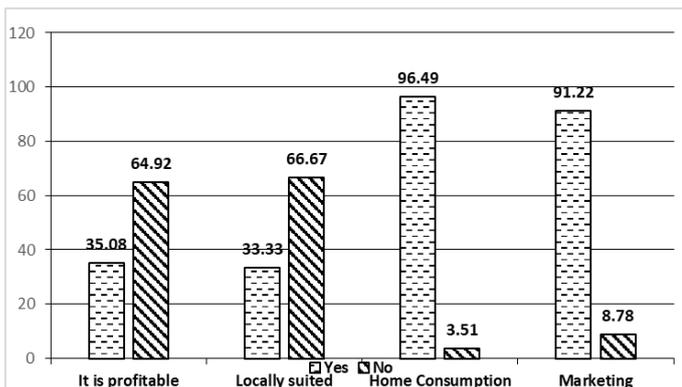


Figure 2. Reasons for potato cultivation.

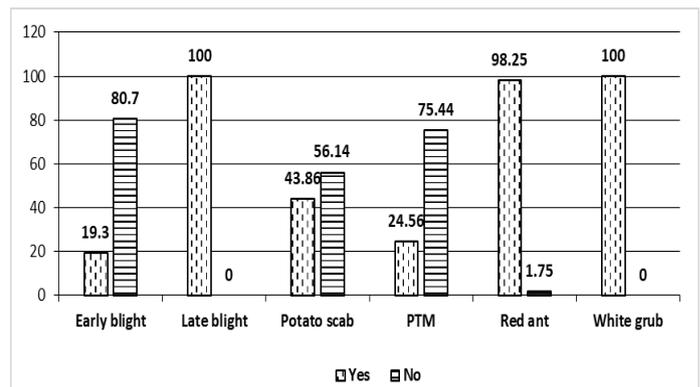


Figure 3. Disease pest of potato.

Table 4. Cost of cultivation of potato per hectare in the study area.

Cost item	Quantity (Rs)	Contribution to total cost (%)
Tuber cost	68,817	25.74
Cost of land preparation	39,194	14.66
FYM	50,100	18.74
Planting cost	23,620	8.84
Weeding cost	60,300	22.56
Harvesting cost	25,288	9.46
Total cost	2,67,319	100

Table 5. Major Marketing problems of potato.

Statements	Minimum	Maximum	Mean
Transportation	1	2	1.02
Middle man	1	3	2.09
Low price	1	3	1.67
Influence of Indian market	1	3	2.82
No support from local government	1	3	1.23
Low market demand	1	3	2.40

Special practices before and after potato harvest

Dehauling practice was not followed by any of the respondents. 98.25% of the respondents followed drying, 96.49% respondents followed sorting, 50.88% respondents followed cleaning and 1.75% respondents followed packaging practices.

Storage facilities

Potato postharvest management is critical not only for reducing postharvest losses, as well as for ensuring its health and nutritional quality (Musita et al., 2019). 68% of the respondents followed pit storage and 32% of the respondents followed room storage for storing potato.

Cost of cultivation of potato per hectare

Seeds accounted for the majority of the cost of production (33.3 percent), followed by human labor (26.3 percent), FYM (12.3%), chemical fertilizers (7%), irrigation (1.7 percent), micro-nutrients (0.8 percent), and pesticides (5.2 percent) (Subedi et al., 2019).

Bara was discovered to have the lowest cost of producing potatoes per kattha of land (NRs. 4,427), followed by Kailali (NRs. 6,290), and Jhapa (NRs. 6,833), and the gross return obtained from potato production in 1 kattha of land was highest in Kailali (NRs. 14,400.5), followed by Bara (NRs. 9,632.2) (Subedi et al., 2019). The average cost incurred in potato production was Rs. 2,67,319. The cost incurred in tuber was Rs. 68,817 which is around 26% of all the production cost. The weeding cost accounted about 23% of the total cost of production. The cost incurred in land preparation was Rs. 39,194. Other cost incurred are given in the Table 4.

Comparative analysis of cost of production and returns/ Benefit-cost analysis

In the Accham district, the average benefit cost ratio of potato

production was 1.47, with gross revenue of small-scale farms (NRs. 382483.601/ha) (Bharati et al., 2020). In Bajhang district, the per ha total income from potato was determined to be NRs. 268,047, with a B/C ratio of 1.44, and low output and productivity was owing to disease infestation on standing crop (Bajracharya and Sapkota, 2017). The average cost of potato production was Rs. 2,67,319 while the average return was Rs. 4,32,804 and the B/C ratio was found to be 1.62 in the research area. According to a study on the economics of potato cultivation in Taplejung, the benefit-cost ratio is 2.9 (Timsina et al., 2013). This research found that the average cost was 2,67,319 Rs/ha however, the average return was 4,32,804 Rs/ha. The Benefit-cost ratio for potato production was found to be 1.62 in the study area.

Trend of potato production and marketing

Because of agronomic, organizational, and marketing issues, outputs are still low (Schulte-Geldermann, 2017). Furthermore, it has been claimed that a lack of quality seeds, combined with a lack of other inputs (such as fertilizer and farm machinery), has reduced output (Gauchan, 2017). The graph below shows the area of potato cultivation which was in decreasing trend over last 5 years. Similarly, the amount of potato sold was in increasing trend upto 2074 BS which may be due to suitable climate or less infestation of disease and pest but production trend was diminishing from 2074 to 2077 BS which may be due to decrease in production area, severity of disease and pest infestation.

Whom to sell

Farmers who marketed their product directly to customers received a bigger share of the consumer's price while those who marketed their produce through agent (Karki et al., 2020). Furthermore, over a quarter of farmers (27.3%) said they sold their products to local markets and collectors, while only 3%

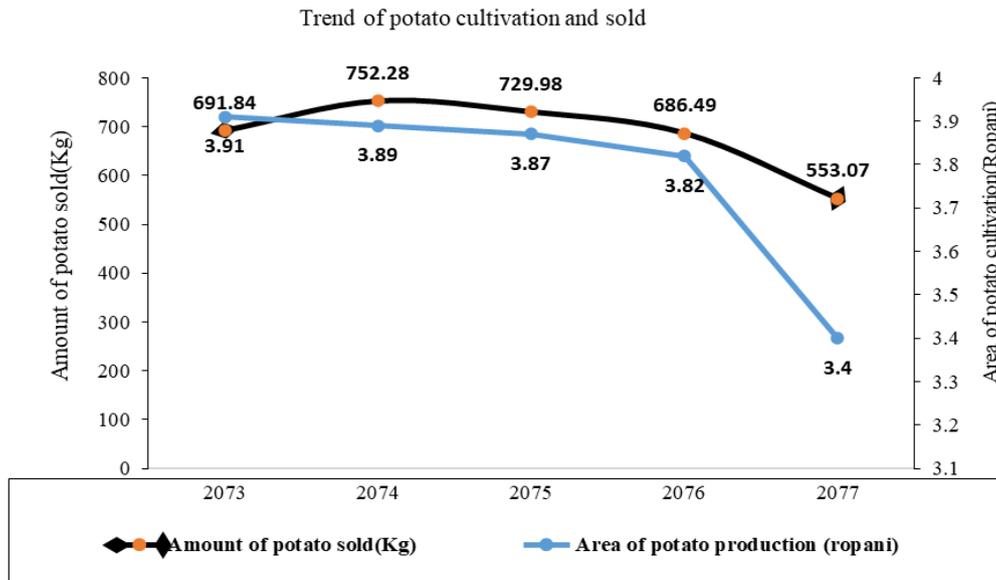


Figure 4. Trend of potato cultivation and sold.

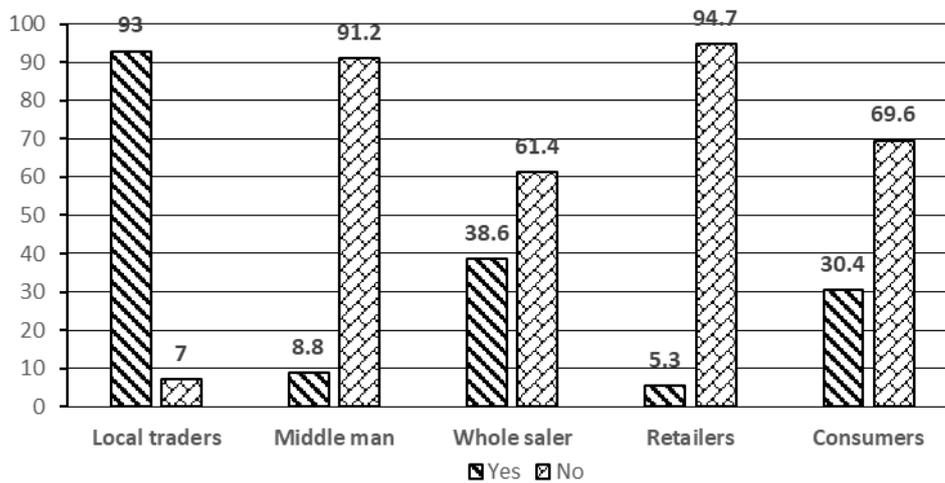


Figure 5. Whom to sell.

said they sold to cooperatives, farmers groups, or the District Agriculture Development Office. The quantity sold, availability to market information, and distance to the nearest market have all been demonstrated to have a direct relationship with market channel choice selections (Kaguongo et al., 2014). The graph below shows that 93% of total respondents sold potato to local traders, 8.8% respondents sold potato to middle man, 38.6% respondents sold potato to wholesaler, 5.3% respondents sold potato to retailer and 30.4% respondents sold potato to consumer directly.

Major Marketing problems of potato

In a sampled area, the major marketing problem were transportation and lack of support from local government as the mean were 1.02 and 1.23, respectively. Similarly, the medium problems were presence of middle man, low price and low market demand as mean were 2.09, 1.67 and 2.40 respectively. Influence of Indian market was found to be normal problem as the mean was 2.82.

Index of major players in determining price in the study area

In a sampled area, the local collectors were in 1st rank in determining the price of potato. Similarly, district traders, wholesalers, AKC and others held 2nd, 3rd, 4th and 5th place respectively.

Credit supply situation

All of the respondent felt very difficult for accessing credit from Banks, Financial company, cooperatives, local money lender and AKC.

Support from Organizations

On an average majority of farmers got supports from PMAMP, Darchula i.e., 23% i.e., 77% of the farmers got support from AKC Darchula.

SWOT analysis

SWOT Analysis is a powerful analytical tool used in developing full awareness of all the controllable and non-controllable factors that help in Farm-Business decision making. Here is the result as given by the respondents.

Strengths

Api-Himal RM is greatly suited for the production of potatoes as the agro-climate is highly favorable. The research area is completely organic as, the farmers have no idea about chemicals and pesticides, all the goods produced here is 100% organic. The farmers utilize only local resources which minimizes the cost of production. The interest of farmers is growing towards potatoes as its demand is high and fetch higher price. Since, farmers use FYM only, it helps to maintain soil health and protects the natural health of microorganisms of the soil. Healthy soil also produces healthy crops. Organic products fetch higher price in the market and also provides employment opportunities to the women of the village.

Weakness

Most of the farmers lack proper cultivation methods of potatoes. Almost all the farmers lack the knowledge about disease pest management so, they suffer from heavy loss due to diseases. There is no government subsidy to compensate their loss due to disease and pests. Skilled manpower or Agriculture professionals are very far from the reach of the farmers. Inadequate supply and access to quality inputs, nutrients, organic fertilizers, bio- insecticides and bio-pesticides. Poor local market opportunities and infrastructures. Lack of motorable road and effective storage facilities and skills. Problem of irrigation is also one of the major weakness.

Opportunities

There are many small farms in the region. So, the farmers themselves could fulfill the labor demand that shows the employment opportunity. There is increasing local awareness of benefits of potato production. If their products are exposed to distant markets, it would fetch very higher price. Demand of the potato is high and also fetches higher price than other produce. If Bio-insecticides and IPM training were given to the farmers, they would harness the production to optimum. Governmental support in policy programs for trainings and subsidy.

Threats

Disease pest infestation is decreasing the production regularly and the day might come that farmers may not grow potatoes any longer, if the disease infestation continues. Increasing migration of rural work force towards the cities and the outside the country for the better employment opportunity. Farmers are shifting towards Yarshagumba collection and animal husbandry rather than potato production.

CONCLUSION AND POLICY IMPLICATIONS

The Benefit cost ratio was found to be 1.62 with an average return of Rs. 4,32,804/ha. Indian market influenced a lot in marketing of potato produced here. The major problems observed were irrigation, marginal land and disease-pests infestation. The major marketing problems observed in Api-Himal RM were transportation, low price of potato and no support from local

government. Local collectors were the major players in determining the price of potato tubers. Majority of farmers used potato seed from locally available and followed furrow planting system and pit storage structures. Establishment of collection center and creating a favorable marketing environment for all the organically produced products is a must here. Supplying of improved seeds to the villagers and establishing agro vets will surely increase the potato production in the study area. Development of more efficient technology and proper guidelines and trainings to the needy farmers to control disease and pests will result in better yield. Provision of effective storage facilities and related skills will prolong the post-harvest life of potatoes. Transportation facilities is must for enhancing the overall agri-business environment for produced goods. Regular monitoring by agriculture professionals is very crucial. Provision of necessary rewards for those who produce more potatoes would increase people's interest in potato production.

Conflict of Interest

The Authors declare that there is on conflict of interest for the publication of the manuscript.

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