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Opportunities and Constraints in Garden Pea (Pisum sativum L.) Production and Marketing in trans-Himalayan Ladakh: A Survey

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***Abstract*:** A survey was conducted among 354 farmers in Ladakh to identify opportunities and constraints in cultivating and marketing garden peas. In Ladakh, peas are harvested in July and August, allowing off-season production opportunities. Most farmers (99.2%) use organic inputs for pea cultivation. The majority of growers cultivate peas on a small scale, with 57.9% dedicating less than 0.05 hectares to this crop. Among the farmers surveyed, 52.8% grew peas primarily for self-consumption, while 47.2% cultivated them for commercial purposes. The main production constraints reported by the farmers included unpredictable weather conditions (34.5%), lack of access to quality seeds (29.4%), fluctuations in market prices (13.6%), challenges with water scarcity and irrigation (11.0%), and high labor costs (8.8%). Farmers also faced several marketing constraints, such as price fluctuations (39.5%), stringent quality requirements (23.4%), lack of reliable buyers (21.6%), transportation issues (8.4%), and delayed payments (5.4%). Despite these challenges, farmers have relatively easy access to the market since the overall production of peas in the region is low. However, there is a need to explore market channels outside the region to benefit fully from organic and off-season production.

***Keywords*:** Agriculture marketing, leh ladakh, off-season, organic, traditional knowledge.

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1. Introduction

Crop production in the trans-Himalayan Ladakh region is limited by three major environmental constraints: short-growing length (mid-May to mid-

September), inadequate precipitation (< 200 mm), and poor soil fertility (Dolma *et al*., 2023). Despite these challenges, vegetable farming remains vital for rural livelihoods, with crops like garden peas (*Pisum sativum* L.) gaining prominence due to their adaptability and economic potential. In Ladakh, garden pea cultivation fits the region's agro-climatic constraints. The crop has a short growth cycle of 60 to 90 days. It can thrive in marginal soils, making it a resilient choice for farmers dealing with diurnal temperature fluctuations and water scarcity (Hassan *et al*., 2020). Peas are the second most widely grown vegetable in the region, after potatoes. In recent years, they have been marketed to outside the region (Stobdan *et al*., 2018).

Off-season production of garden peas has emerged as a promising strategy to maximize agricultural output and income in high-altitude regions. For instance, Lahaul-Spiti, a neighbouring region with similar agro-climatic conditions, has successfully capitalized on off-season pea production, supplying fresh peas to lowland markets during summer months when demand is high (Meena *et al*., 2016; Sharma *et al*., 2022). This practice enhances farmer's income and reduces market competition, as off-season produce commands premium prices (Sharma *et al*., 2022). In Ladakh, the pea is harvested in July to September, thus offering off-season production opportunities (Stobdan *et al*., 2018). The potential of off-season production can be further amplified by adopting organic farming practices, which are increasingly demanded by global markets due to their environmental and health benefits (Tiwari, 2023). Organic production of garden peas reduces dependency on chemical inputs and enhances soil fertility and biodiversity, making it a sustainable choice for fragile ecosystems like Ladakh. Despite the potential of garden pea in the region, no comprehensive studies have evaluated the agronomic, institutional, and market challenges Ladakhi growers face. This gap hinders the development of targeted interventions to enhance productivity, sustainability, and equity in the region's agricultural sector.

This study seeks to address this critical knowledge gap by analyzing cultivation practices, challenges, and training needs among garden pea farmers in Ladakh. By combining field-level data with the FAO's framework for sustainable pulse intensification (FAO, 2021), this study aims to highlight the opportunities and constraints in pea production and marketing based on a grassroots-level survey. Additionally, the study explored the potential of off-season production and organic farming as strategies to enhance the resilience and profitability of garden pea cultivation in Ladakh, offering insights into similar high-altitude regions worldwide.

2. Methodology

The study involved structured personal interviews with 354 pea growers across three major valleys of Ladakh: Nubra (n=102), Leh (n=190), and Sham (n=62). Data collection took place between June 5 and September 30, 2024, using a 35-question survey to assess demographic information, farming practices, challenges, and training needs. The respondents included 158 females and 196 males. The age distribution of participants ranged from under 30 to over 80 years, with the largest group (98 respondents) being in the 51-60 age range. Educational qualifications varied significantly; the majority had no formal education (n=192), followed by 16 with primary education, 9 with middle education, 56 with high school education, 34 with higher secondary education, 45 graduates, and two postgraduates. The majority (52.4%) of respondents were full-time farmers, 24.6% were self-employed, and 22.9% were serving government employees. Face-to-face interviews were conducted to ensure the accuracy and comprehensiveness of the collected data.

3. Results and discussion

3.1. Farm size, area under pea cultivation, and farming experience

Data on farm sizes reveal significant regional disparities in land holdings. In Nubra, 62.7% of farmers operate on small farms of <0.25 hectare (hereafter ha), indicating a predominance of small-scale farming. In contrast, in Sham, a larger portion of farmers (79.0%) have farms in the 0.25-0.50 ha range, while in Leh, 60% also fall within this size category. This suggests that farmers in Sham and Leh have larger agricultural lands. Regarding land dedicated to garden pea cultivation, 83.3% of farmers in Nubra valley allocate <0.05 ha to garden peas (Table 1). Similarly, in Sham, 77.4% of farmers dedicate the same amount. However, in Leh, only 37.9% of farmers allocate <0.05 ha, with a larger proportion (42.6%) dedicating between 0.05-0.1 ha to pea cultivation. This highlights that Leh's garden pea farming is more substantial than Sham and Nubra, where it primarily serves as a supplementary or subsistence crop.

The area dedicated to pea cultivation has fluctuated significantly across the three valleys. In Nubra, 24.5% of respondents reported an increase in their pea cultivation, 17.6% indicated a decrease, while 57.8% maintained the same area. In contrast, Sham experienced a notable decline, with 67.7% of farmers reducing their cultivation and only 6.5% expanding it. Leh saw a slight increase, with 8.9% of respondents expanding their cultivation and 10.0% reducing it.

Across all valleys, 64.7% of respondents maintained their cultivation area, 22.3% reported a decrease, and 13.0% indicated an increase (Table 1).

Table 1: Farm size, area under pea cultivation, and farming experience (% respondent)

Question/information sought	*Options*	*Valleys*			
		Nubra (n=102)	*Sham (n=62)*	*Leh (n=190)*	*Total (n=354)*
Farm size (hectare)	<0.25	62.7	17.7	27.9	36.2
	0.25-0.5	37.2	79.0	60.0	56.8
	0.55-1.0	0.0	3.2	11.6	6.8
	>1.0	0.0	0.0	0.5	0.3
Farm dedicated to pea cultivation (hectare)	<0.05	83.3	77.4	37.9	57.9
	0.05-0.1	16.6	22.6	42.6	31.6
	0.15-0.2	0.0	0.0	13.7	7.3
	>0.25	0.0	0.0	5.8	3.1
Farming experience in pea cultivation (years)	<5	5.8	0.0	10.5	6.8
	5-10	49.0	11.2	34.2	35.0
	10-20	39.2	66.1	42.6	45.8
	>20	5.8	22.5	12.6	12.4
Area under pea cultivation has __ in recent years	Increased	24.5	6.5	8.9	13.0
	Decreased	17.6	67.7	10.0	22.3
	No change	57.8	25.8	81.1	64.7
The primary reason for the increase in the area under pea cultivation, if increased	High market demand	16.0	50.0	35.3	26.1
	Improved profitability	8.0	25.0	17.6	13.0
	More yield	44.0	25.0	47.1	43.5
	Availability of quality seeds	4.0	0.0	0.0	2.2
	Improved irrigation facilities	12.0	0.0	0.0	6.5
	Government incentives or subsidies	0.0	0.0	0.0	0.0
	Other	16.0	0	0	8.7

Farmers who expanded their pea cultivation cited better yields as the main reason, especially in Leh (47.1%) and Nubra (44.0%). Higher market demand was the second most common reason for increasing cultivation area, particularly in Sham (50.0%). Other reasons for expansion included improved profitability (13.0%) and enhanced irrigation facilities (6.5%) (Table 1). However, government subsidies did not significantly influence the decision to expand cultivation.

The number of years of cultivating garden peas showed distinct regional differences. In Nubra, most farmers (49.0%) have been cultivating garden peas for the past 5-10 years, while in Sham, 66.1% have been cultivating peas for 10-20 years. In Leh, 42.6% of farmers fall within the 10-20-year category,

with a smaller portion (12.6%) having cultivated peas for over 20 years. These patterns indicated that garden pea cultivation is relatively more established in Sham and Leh compared to Nubra, where a considerable portion of farmers were relatively new to pea farming (Table 1).

3.2. *Seed Sources and Preference for Pea*

3.2.1. Seed source

Farmers in the three valleys utilized different sources for their pea seeds. In Nubra, 59.8% of farmers obtained their seeds from the government Agriculture Department, while in Sham, this figure is even higher at 87.0%. In contrast, 75.3% of farmers in Leh sourced their seeds from retail markets, indicating a more widespread availability of commercial seeds in that area (Table 2). The reliance on the Agriculture Department for seeds in Nubra and Sham suggested a more structured support system. In contrast, Leh's preference for retail markets reflects a more developed seed supply network. In comparison, 92% of farmers in Punjab procure pea seeds from private dealers, and the remaining eight percent from government agencies (Kaur *et al*., 2024).

3.2.2. Preference for pea over other crops

Farmers across the three valleys identified several key reasons for their preference for cultivating garden peas. The most common reason was the higher return per unit area; 24.5% of respondents from Nubra, 35.5% from Sham, and 48.9% from Leh cited this as a major factor. Less disease and insect pest infestation were the second most frequently mentioned reason, particularly in Sham (41.9%), while it had less influence in Nubra (25.4%) and Leh (11.1%). The higher market demand for pea and requirement of less manure and fertilizers were other significant factors.

3.3. Farming Practices

3.3.1. Crop rotation

Many farmers in Nubra (43.1%) and Sham (77.4%) incorporate garden peas into their crop rotation systems. In contrast, fewer farmers in Leh (27.9%) include peas in their crop rotation (Table 3). This implies crop rotation is more common in Nubra and Sham, where peas may be rotated with other crops to maintain soil fertility and reduce pest pressure. In Leh, a higher proportion of farmers (72.1%) do not use peas for crop rotation. This may indicate less

Table 2: Source of seed, the reason for choosing pea crop, and support received (% respondents)

Question/ information sought	*Options*	*Valleys*			
		Nubra (n=102)	*Sham (n=62)*	*Leh (n=190)*	*Total (n=354)*
Source of pea seeds	Govt Agriculture Department	59.8	87.0	24.2	45.5
	Retail market	40.1	12.9	75.3	54.2
	Contractor	0.0	0.0	0.5	0.3
	Other	0.0	0.0	0.0	0.0
Knowledge about crop variety	Yes	0.0	0.0	6.3	3.4
	No	100	100	93.7	96.6
The primary reason for choosing pea over other crops	Higher market demand over other crops	5.8	6.5	27.9	17.8
	Culinary versatility and self-preference	16.6	14.5	6.8	11.0
	Higher return per unit area	24.5	35.5	48.9	39.5
	Less disease and insect pest infestation	25.4	41.9	11.1	20.6
	Increase soil fertility	0	1.6	0.5	0.6
	Less manure and fertilizer requirements	27.4	0	4.7	10.5

emphasis on rotational farming practices in this region, potentially due to different soil conditions or farming methods. However, studies highlight the critical importance of crop rotation as a sustainable agricultural strategy for mitigating soil depletion by balancing nutrient demands, reducing pest and disease buildup through biological diversity, and improving long-term yield stability. Conversely, our study of lower adoption of crop rotation highlights the need for context-specific approaches to promote rotational practices, ensuring resilience against soil degradation.

3.3.2. Seed rate and pretreatment

The quantity of seed used per ha varies, but most farmers across all regions use between 420 to 800 kg of seed per ha. Specifically, 31.3% of farmers in Nubra use 620 to 800 kg of seed per ha (Table 3). In comparison, the recommended seed rate is 87.5-112.5 kg per ha in Punjab (Kaur, *et al*., 2024). A high seed rate is generally practiced in dry temperate regions. Farmers in the Kinnaur and Spiti Valley of Himachal Pradesh use very high seed rates, partly due to the deep and broadcast method of sowing (Kumar *et al*., 2019). However, the recommended seed rate for these valleys is 250 kg per ha

Table 3: Farming practices followed (% respondents)

Question/information sought	*Options*	*Valleys*			
		Nubra (n=102)	*Sham (n=62)*	*Leh (n=190)*	*Total (n=354)*
Practice of crop rotation with pea	Yes	43.1	77.4	27.9	41.0
	No	56.8	22.6	72.1	59.0
Seed rate (kg per ha)	< 400	0.0	1.6	6.8	4.0
	420-600	36.2	12.9	27.9	27.7
	620-800	31.3	46.7	36.3	36.7
	> 800	32.3	38.7	28.9	31.6
Seed treatment before sowing	Overnight soaking in water	0.0	0.0	1.1	0.6
	Sowing in pre-moistened soil	100	100	98.4	99.2
	Others	0.0	0.0	0.5	0.3
Sowing method	Traditional line sowing manually	100	90.3	98.9	97.7
	Hand broadcasting	0.0	1.6	1.1	0.8
	Machine assisted sowing	0.0	8.1	0.0	1.4
Soil nutrient supply	FYM	100	98.4	90.5	94.6
	FYM and chemical fertilizers	0.0	1.6	1.1	0.8
	Certified organic fertilizers	0.0	0.0	8.4	4.5
Method of irrigation	Flood	100	100	100	100
	Drip/ Sprinkler	0.0	0.0	0.0	0.0
No. of irrigation in a growing season	<8	0.0	0.0	0.5	0.3
	9-10	55.0	24.2	71.1	58.2
	11-15	45.0	72.6	27.4	40.4
	>15	0.0	3.2	1.1	1.1
Weeding in a growing season (number)	1	69.6	83.9	76.8	76.0
	2	30.3	16.1	16.3	20.3
	3	0.0	0.0	6.8	3.7
Crop harvest time	July	99.0	87.1	7.9	48.0
	August	1.0	12.9	92.1	52.0

(Kumar *et al*., 2017). Pea seeds makeup as much as 27.2 to 40.3% of the total cultivation expenditure (Kaur *et al*., 2024); thus, using two to three times the recommended seed rate in the Ladakh region significantly increases the cost of cultivation. Therefore, studies are required to optimize the seed rate to reduce the cost of cultivation.

Regarding seed preparation, nearly all farmers across the three valleys (99.2%) sow their seeds in pre-moistened soil, indicating a uniform practice. A small percentage (0.6%) of farmers in Leh choose to soak their seeds overnight before sowing. This suggests that while seed preparation practices are broadly

consistent, some farmers in Leh are exploring additional techniques for seed treatment (Table 3).

3.3.3. Sowing methods

The preferred method of sowing is traditional hand sowing (line sowing), with 97.7% of farmers using this technique. A small percentage of farmers in Sham (8.1%) have adopted machine-assisted precision sowing, indicating a gradual shift towards modern and efficient techniques in this region (Table 3). Despite the emergence of some modern practices, hand sowing remains the dominant method across all valleys, underscoring the continued importance of traditional farming practices. Research in the dry temperate region of Himachal Pradesh found that a row spacing of 22.5 cm with a seed rate of 150 kg per hectare resulted in the highest pod yield (Kumar *et al*., 2019).

3.3.4. Manure and chemical fertilizer

A vast majority (94.6%) of the farmers were using only farmyard manure (FYM) as the sole source of nutrients for the pea crop (Table 3). A small section of the farmers (4.5%) used a combination of FYM and other organic sources as soil nutrients. The use of chemical fertilizers was minimal in the region. Only 0.8% of the surveyed farmers used a combination of FYM and chemical fertilizer, indicating a strong preference for organic farming. In comparison, the recommended soil nutrient for pea production in Punjab is 20 tonnes FYM, 113 kg urea, and 389 kg superphosphate (Verma, 2021). For dry temperate conditions of Himachal Pradesh, the recommended chemical fertilizer for pea production is 20 kg nitrogen, 60 kg K_2O, and 30 kg P_2O_5 (Sharma *et al*., 2015). The high cost of chemical fertilizer is a source of financial constraints to the pea growers. In Uttar Pradesh, the high cost of chemical fertilizer ranked third most financial constraints perceived by the pea growers, next to the non-availability of credit at the marginal interest rate and the high cost of hybrid seeds (Singh *et al*., 2024). Therefore, non-usage of chemical fertilizers and pesticides in the Ladakh region reduces the cost of production and aligns with sustainable agricultural practices. These findings suggest that while Ladakh's organic-focused approach aligns with sustainable agricultural practices, integrating scientific soil fertility management strategies—such as biofertilizer applications, phosphorus enrichment, and soil health monitoring—could further enhance productivity. By adapting region-specific best practices, Ladakh's farmers could improve soil fertility while maintaining the ecological integrity of their organic farming systems.

3.3.5. Irrigation

Irrigation is crucial in garden pea cultivation across the three valleys. The irrigation frequency per growing season varies significantly between the valleys (Table 3). In Nubra, all farmers reported irrigation frequencies ranging from 9 to 15 times per season, with 55% of farmers falling in the 9-10 category and 45.0% in the 11-15 category. In Sham, 72.6% of farmers reported 11-15 irrigations, while only 24.2% reported 9-10. In contrast, Leh has a wider distribution of irrigation practices, with 71.1% of farmers reporting 9-10 irrigations and 27.4% in the 11-15 category. Only a few farmers in Leh (1.1%) reported more than 15 irrigations, while no farmers in Nubra or Sham exceed this number. All valleys rely solely on flood irrigation, with no instances of drip irrigation reported. This highlights a dependence on traditional surface water irrigation systems despite the varying irrigation frequencies across the regions. However, transitioning to drip or micro-sprinkler systems can significantly enhance pea cultivation's sustainability and productivity. These methods conserve water by reducing wastage, improving yields through precise water delivery, and reducing disease risks associated with excess moisture from flood irrigation. Drip and sprinkler irrigation systems save 38 and 26% of water over flood irrigation systems (Rao *et al*., 2017). Therefore, with the increased demand for scarce natural water resources, immediate attention is required to replace conventional irrigation practices with drip and sprinklers.

3.3.6. Weeding

Weeding is an essential aspect of garden pea cultivation, and weeding frequency varies across the valleys (Table 3). In Nubra, 69.6% of farmers performed one weeding session per season, while 30.3% conducted two sessions. In Sham, 83.9% of farmers reported performing one weeding session, with 16.1% opting for two. In Leh, 76.8% of farmers performed one weeding session, and 16.3% conducted two sessions. No farmers reported more than two weeding sessions, although a small percentage (6.8%) in Leh performed three weeding sessions. However, recent studies, such as those by Abebe (2024), suggest that increasing weeding frequency to three sessions—at 2, 4, and 6-week intervals—could optimize yields in leguminous crops. While current weeding practices in Ladakh remain effective within traditional systems, emerging challenges such as climate change and shifting growing seasons may alter weed dynamics, requiring more adaptive management strategies. Integrating modern weed management techniques could enhance productivity while reducing labor intensity.

3.3.7. Harvest time

The timing of harvesting varies significantly among the three valleys. In Nubra, 99% of farmers harvest their garden peas in July, whereas in Sham, 87.1% harvest in July. In Leh, however, most farmers (92.1%) harvest in August (Table 3). This indicates a shift in harvest timing from Nubra and Sham to a later season in Leh. The differences in harvesting months may be due to altitudinal differences in climatic variations between the valleys, with Nubra and Sham experiencing earlier pea maturity than Leh due to lower altitude. In major pea-producing states like Uttar Pradesh, Panjab, Haryana, and Madhya Pradesh, garden peas are typically grown as a rabi (winter crop) and harvested between February and April. Ladakh's unique July-August harvest positions it as a niche supplier, filling the gap between conventional rabi harvests and the lean summer period. This strategic timing enhances Ladakh's role in India's pea supply chain, boosting local incomes and strengthening food security in remote, high-altitude areas. Adopting climate-resilient practices and improved post-harvest infrastructure could further amplify these benefits, ensuring Ladakh is a key player in off-season vegetable production.

3.4. Insect Pest, Major Expenditures and Constraints in Pea Cultivation

3.4.1. Pest and disease management

Cases of pest and disease issues are minimal across the valleys (Table 4). Only a very small proportion of farmers in Leh (6.3%) reported minor yield loss due to insect pest infestations. Notably, no farmers in the valleys reported using insecticides or pesticides. In contrast, regions such as Himachal Pradesh, Uttarakhand, and the northeastern states face several pest and disease challenges that significantly impact crop yield and quality. Among the common pests, aphids (*Acyrthosiphon pisum*) feed on young vines, causing stunted growth and deformed pods, while pea weevils (*Bruchus pisorum*) infest seeds, reducing their viability. Other damaging pests include pod borers and leaf miners, contributing to further crop losses. In addition to pest infestations, garden peas are also susceptible to various diseases, such as powdery mildew (*Erysiphe polygoni*), rust (*Uromyces fabae*), and Fusarium wilt (*Fusarium oxysporum*), all of which lead to leaf damage, premature defoliation, and plant wilting, ultimately affecting productivity (Avasthi *et al*., 2023; Rajashekara *et al*., 2024). Understanding these regional variations is essential for assessing the environmental factors influencing pest and disease dynamics in pea cultivation.

Table 4: Pest infestation, major expenditures and constraints in pea cultivation (% respondents)

Question/information sought	*Options*	*Valleys*			
		Nubra (n=102)	*Sham (n=62)*	*Leh (n=190)*	*Total (n=354)*
Yield reduction due to insect infestation (%)	Nil	100	100	93.7	96.6
	<10	0.0	0.0	4.7	2.5
	11-30	0.0	0.0	1.6	0.8
Has infestation increased in recent years?	Yes	0.0	0.0	4.7	2.5
	No	100	100	95.3	97.5
Know the name of any insect pest of pea plant?	Yes	0.0	0.0	0.5	0.3
	No	100	100	99.5	99.7
Spray of pesticide	Yes	0.0	0.0	0.0	0.0
	No	100	100	100	100
Majority of expenditure in pea cultivation	Seed procurement	60.8	41.9	25.3	38.4
	Labor costs for weeding	10.8	4.8	23.2	16.4
	Labor costs for harvesting	11.8	48.4	48.4	37.9
	Fertilizers and soil amendment	0.0	3.2	2.6	2.0
	Other	16.6	1.6	0.5	5.4
The major constraint in pea cultivation	Pest and disease infestation	0.0	3.2	0.5	0.8
	Unpredictable weather conditions	6.8	1.6	60.0	34.5
	Lack of access to quality seeds	50.9	61.3	7.4	29.4
	Water scarcity and irrigation challenges	23.5	19.4	1.6	11.0
	Soil fertility issues	0.0	0.0	0.0	0.0
	High labor costs	4.9	3.2	12.6	8.8
	Market price fluctuations	7.8	11.3	17.4	13.6
	Other	5.8	0.0	0.5	2.0

3.4.2. Major expenditures

The primary expenses associated with pea cultivation relate to seed procurement. This was cited as the most critical expenditure by 60.8% of farmers in Nubra, 41.9% in Sham, and 25.3% in Leh. Labor costs for harvesting (37.9%) and weeding (16.4%) were other major expenditures (Table 4). In Bundelkhand, the major costs in pea production are tractor charges (15.7%), hired labor (15.6%), seed (9.2%), and fertilizer costs (4.6%) (Khan *et al.*, 2024).

3.4.3. Major constraints

The main challenges reported by farmers varied according to the valley. Unpredictable weather conditions were a major concern for farmers in Leh

(60.0%), with Nubra (6.8%) and Sham (1.6%) being less affected. The lack of access to quality seeds was the second most significant constraint, particularly in Nubra (50.9%) and Sham (61.3%), while only 7.4% of farmers in Leh reported this issue. Market price fluctuations were also significant issues, particularly in Leh (17.4%) and Sham (11.3%), while being less impactful in Nubra (7.8%). Water scarcity and irrigation challenges were notable in Nubra (23.5%) and Sham (19.4%) but posed much less of a problem in Leh (1.6%). Other concerns, such as pest and disease infestations, were reported by only a small percentage of farmers (0.8%) (Table 4). In other states, pea cultivation faces additional challenges related to input supply, financial constraints, and ecological and market limitations. Among the technical barriers, inadequate skills for seed handling emerged as a key issue. Additionally, the unavailability of modern farming equipment in local markets restricted mechanization, making cultivation more labor-intensive. Financial constraints, particularly the high cost of high-yielding variety (HYV) seeds, further burdened farmers. Ecological and market-related challenges, including heavy frost during flowering and pod formation, inefficient and costly transportation, suppliers' low-quality inputs, and farmers' limited risk-taking ability, further hindered production and profitability (Singh *et al*., 2024).

3.5. Sources of Knowledge and Training Needs

3.5.1. Sources of knowledge

Family and traditional knowledge served as the primary source of information about pea cultivation, with 70.1% of respondents across all three valleys relying on it. This reliance was especially high in Sham, where 91.9% of respondents cited family knowledge as their primary source (Table 5). Fellow farmers and peer networks were the second most significant source of information, utilized by 28.5% of farmers. Formal agricultural extension services were rarely mentioned, with only 0.8% of respondents across all valleys citing them as a primary source of information.

3.5.2. Training needs

Farmers across all valleys were strongly interested in training programs to increase yields. In Leh, 54.2% of farmers showed interest, while 51.9% of farmers in Nubra were also interested. In Sham, 30.6% of farmers seek training (Table 5). These results highlight farmers' recognition of the potential for improving yields through better farming practices and knowledge.

Table 5: Sources of knowledge and training needs

Question/ information sought	*Options*	*Valleys*			
		Nubra (n=102)	*Sham (n=62)*	*Leh (n=190)*	*Total (n=354)*
Primary source of knowledge about pea cultivation	Family and traditional knowledge	74.5	91.9	60.5	70.1
	Agriculture extension services	0.0	1.6	1.1	0.8
	Workshops and training	0.0	0.0	0.0	0.0
	Online sources	0.0	0.0	0.5	0.3
	Fellow farmers and peer networks	25.4	4.8	37.9	28.5
	Other	0.0	1.6	0.0	0.3
Undergone any formal training in cultivation	Yes	0.0	0.0	0.5	0.3
	No	100	100	99.5	99.7
Interest in formal training to increase yield	Yes	51.9	30.6	54.2	49.4
	No	48.0	59.7	26.3	38.4
	Maybe	0.0	9.7	19.5	12.1

3.6. Marketing Channel and Constraints Faced

3.6.1. Purpose of pea cultivation

The primary reason for growing peas across the three valleys shows a strong preference for self-consumption, particularly in Nubra. A significant 85.3% of farmers in Nubra cultivate peas for personal use, while a smaller proportion (14.7%) grow them for commercial purposes. In Sham, 66.1% of farmers grow peas primarily for self-consumption, whereas the remaining 33.9% cultivate peas for sale. In Leh, the trend is reversed, with 68.9% of farmers growing peas for commercial purposes and only 31.1% for self-consumption (Table 6). This indicates that self-consumption is more prevalent in Nubra and Sham, while commercial production is more common in Leh, likely due to better market access and demand. In comparison, 89.2% of the farmers in Lahaul and Spiti in Himachal Pradesh prefer green peas to other crops because of high returns and easy marketing (Sharma, 2022).

3.6.2. Proportion of harvest for commercial purposes

Among farmers who grow peas for commercial purposes, the majority in all valleys reported selling most of their harvest. In Nubra, 93.3% of farmers sell between 76-100% of their pea harvest, reflecting a high degree of market orientation. In Sham, 71.4% sell a similar proportion of their harvest, while 67.9% of farmers in Leh also sell most of their pea harvest. This suggests that

Table 6: Marketing channel and constraints faced

Question/information sought	*Options*	*Valleys*			
		Nubra (n=102)	*Sham (n=62)*	*Leh (n=190)*	*Total (n=354)*
The primary reason for pea cultivation	Self-consumption	85.3	66.1	31.1	52.8
	Commercial purpose	14.7	33.9	68.9	47.2
Percent of harvest sold (%)	<25	0.0	0.0	0.0	0.0
	25-50	6.7	0.0	13.7	11.4
	51-75	0.0	28.6	18.3	18.0
	76-100	93.3	71.4	67.9	70.7
Primary market channel	Local retail market	73.3	38.1	9.2	18.6
	Whole seller	0.0	57.1	87.0	75.4
	Directly to army	0.0	4.8	1.5	1.8
	Directly to hotels/restaurant	26.7	0.0	2.3	4.2
Farmer's selling price (Rs/kg)	<30	13.3	0.0	16.8	14.4
	31-40	46.7	33.3	57.3	53.3
	41-50	20.0	57.1	24.4	28.1
	>50	20.0	9.5	1.5	4.2
Gross income from pea cultivation (Rs per 0.05 ha)	Nil	85.2	66.1	31.1	52.8
	31000-40000	6.8	14.5	36.3	24.0
	41000-50000	5.8	17.7	16.3	13.6
	51000-60000	1.9	1.6	9.5	5.9
	>60000	0.0	0.0	6.8	3.7
The major factor influencing sales decision	Price offered	20.0	47.6	73.3	65.3
	Consistency of demand	6.7	4.8	10.7	9.6
	Proximity to market	26.6	0.0	0.8	3.6
	Volume of purchase	0.0	4.8	4.6	4.2
	Reliability of payment	33.3	42.9	8.4	14.4
	Personal relationship	13.3	0.0	2.3	3.0
	Other	0.0	0.0	0.0	0.0
Satisfaction with current markets	Highly satisfied	0.0	0.0	0.0	0.0
	Satisfied	0.0	19.0	14.5	13.8
	Neutral	0.0	52.4	30.5	30.5
	Dissatisfied	100	28.6	43.5	46.7
	Very dissatisfied	0.0	0.0	11.5	9.0
Interest in exploring new markets or sale channels	Yes	100	38.1	70.2	68.9
	No	0.0	4.8	2.3	2.4
	Not sure	0.0	57.0	27.5	28.7
Major constraints faced in marketing	Price fluctuations	33.3	42.9	39.7	39.5
	Delayed payments	0.0	0.0	6.9	5.4
	Transportation issues	20.0	38.1	2.3	8.4
	Lack of reliable buyers	0.0	9.5	26.0	21.6
	Stringent quality requirements	33.3	9.5	24.4	23.4
	Other	13.3	0.0	0.8	1.8

when peas are cultivated on a commercial scale, they are primarily marketed with minimal retention for self-consumption.

3.6.3. Primary market

The primary channels for selling garden peas differ significantly across the valleys. In Nubra, 73.3% of farmers sell their peas to local retail markets, while 26.7% sell to hotels or restaurants. In contrast, farmers in Sham predominantly sell through wholesalers, with 57.1% using this channel. A substantial portion (87.0%) of farmers in Leh also sell peas to wholesalers. Additionally, some farmers in Sham (4.8%) and Leh (1.5%) sell directly to the army, reflecting the varying market dynamics in these regions (Table 6). These differences indicate that Nubra has a more localized market for peas, whereas Sham and Leh benefit from larger, more commercial markets through wholesalers. Farmers get easy access to the local market since the overall production of garden pea is low in the region. However, market channels outside the region must be explored to benefit from organic and off-season production.

3.6.4. Farmer's selling price

The farmer's average selling price of garden peas varies across the valleys. In Nubra, 46.7% of farmers received Rs 31-40 per kg, while 20% earned Rs 41-50 per kg. Farmers in Sham generally received higher prices, with 57.1% earning Rs 41-50 per kg and 9.5% reporting prices above Rs 50. In Leh, 57.3% of farmers received Rs 31-40 per kg, with 24.4% receiving Rs 41-50. The higher price brackets in Sham and Leh suggested larger-scale commercial production and better market access in these regions than in Nubra. The farmer's average selling price of green peas stands at Rs 48.25 per kg, which is comparable with that of Himachal Pradesh (Rs 43.8-46.6 per kg) (Thakur *et al*., 2023).

3.6.5. Marketable surplus and economic returns per unit area

The survey data revealed significant differences in the economic outcomes of pea farming across the valleys. A substantial number of farmers grow pea for self-consumption, resulting in no marketable surplus: 85.2% of farmers in Nubra, 66.1% in Sham, and 31.1% in Leh. In contrast, some farmers reported earnings between Rs. 31,000 and Rs. 40,000 (24.0%), with a few achieving yields greater than Rs. 60,000 per 0.05 ha (3.7%) (Table 6).

3.6.6. Factors influencing sales decisions

Farmers across all valleys primarily consider the price offered when deciding where to sell their peas. In Leh, 73.3% of farmers prioritize price, followed by

47.6% of farmers in Sham. In Nubra, 20.2% consider price to be the deciding factor. Other considerations include payment reliability, consistency of demand and proximity to the market. In Nubra, 26.6% of farmers value market proximity, while in Sham and Leh, this factor was less significant. Personal relationships with buyers were meaningful for 13.3% of farmers in Nubra, but this was not a consideration in Sham or Leh. These insights underscore the importance of pricing and market reliability in selling decisions, with local proximity and relationships playing a more significant role in Nubra. Similarly, in other hilly states like Himachal Pradesh, factors such as farm income, farming experience, distance to markets, and access to market information significantly influence farmers' choice of marketing channels, ultimately impacting their marketing performance and livelihoods (Thakur *et al*., 2023).

3.6.7. Satisfaction with current markets

Satisfaction with current markets varies widely across the valleys. In Nubra, 100% of farmers expressed dissatisfaction with market conditions, while 28.6% of farmers in Sham reported dissatisfaction. In Leh, 43.5% were dissatisfied, with 11.5% expressing strong discontent. This high level of dissatisfaction may stem from price fluctuations, unreliable buyers, and delayed payments. On a more positive note, 19.0% of farmers in Sham and 14.5% in Leh reported being satisfied, indicating that some farmers in these valleys find their market access acceptable.

3.6.8. Interest in exploring new markets

There was significant interest in exploring new markets and sales channels, particularly in Nubra, where 100% of the farmers expressed interest. In Sham, 38.1% were interested, and 70.2% of farmers in Leh were keen on exploring new sales avenues. This desire for new markets reflects a dissatisfaction with existing channels and an acknowledgment of the need for more reliable and profitable market access. One promising opportunity lies in India's growing demand for organic off-season peas. With increasing consumer preference for organic produce, premium urban markets, high-end retail chains, organic food stores, and direct-to-consumer platforms offer potential sales channels. Institutional buyers such as hotels, restaurants, organic food exporters, and government procurement programs focused on sustainable agriculture could expand market opportunities for farmers producing organic off-season peas.

3.6.9. Constraints in marketing

Farmers across all valleys face common challenges when selling their peas, with price fluctuations being the most prevalent issue. In Nubra, 33.3% of farmers reported challenges with price fluctuations, while 42.9% in Sham and 39.7% in Leh faced similar difficulties. The stringent quality requirement was another challenge, with 33.3% of farmers in Nubra and 24.4% in Leh citing this issue. Farmers in Sham reported fewer concerns about quality (9.5%). Lack of reliable buyers was the third most (21.6%) cited constraints in marketing. Transportation issues affected 38.1% of farmers in Sham but were less problematic for Nubra (20.1%) and Leh (2.3%). Delayed payment was notable challenges for farmers in Leh (6.9%). The three major constraints farmers encounter in marketing pea crops in Himachal Pradesh are lack of market consultancy service, high commission charges, and vehicles not being available in time (Thakur *et al*., 2023).

Conclusion

The study highlights the potential for off-season and organic pea production in Ladakh. At present, pea cultivation is minimal, with 57.9% of farmers allocating less than 0.05 hectares to peas, mainly for their consumption. This limited production faces numerous challenges undermining productivity and profitability, including unpredictable weather, inadequate access to quality seeds, water shortages, high labor costs, fluctuating market prices, and a lack of reliable markets. Targeted interventions are essential to overcome these barriers. Improving seed availability, offering training in modern cultivation techniques, and enhancing market connectivity can make a substantial difference. By implementing these strategies, we can significantly improve the sustainability and profitability of pea farming in the region, creating a more secure future for farmers and the local economy.

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