

Red Gold in the Semi-Arid Zone: Economics and Sustainability of Strawberry Cultivation in Bhiwani, Haryana

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ABSTRACT

This paper aims to evaluate the economic viability, environmental sustainability, and marketability of a strawberry tree project in the semi-arid region of Bhiwani, Haryana, where high-value horticulture is being championed as an alternative for generating value. Reduced profitability and increased susceptibility to climate are some of the challenges affecting conventional crops in this locality, and therefore, strawberry farming seems to be one of the alternative sources of income. The research methodology was descriptive analytical, involving fifty purposively sampled strawberry cultivators in the leading farming villages of Bhiwani. Structured questionnaires were used to gather information that included production practices, costs of inputs, yield performance, marketing options and the perceptions of farmers. The research indicates that strawberry production is very lucrative, with net incomes per acre of ₹3.5 to ₹3.9 lakh, a benefit-to-cost ratio (BCR) of 8.14. Though profitability and scalability is limited by aspects of high cost of labour, lack of cold-storage facilities, institutional support, and dependency on middlemen. Farmers usually consider strawberries as a profitable harvest, and they complain about the fluctuation of prices and the lack of adequate technical assistance. This study is relevant to the growing literature on the power of crop diversification as it offers area-specifics on the effectiveness of incorporating economic, environmental, and market aspects of farms. It suggests that by focusing on policy measures, which in many ways can be based on training, infrastructure development, and the formation of co-operations, the inclusiveness, and sustainability of strawberry farming can be improved. The research has policy implications to the policy makers, rural development agencies and farmers who are determined to strengthen the agricultural systems within the semi- arid areas

Keywords: Strawberry farming practices, Horticulture, market availability, Sustainability, Profitability.

1. INTRODUCTION:

There is a historical record of the fact that agriculture is the stalemate of the rural livelihoods in Haryana, as it has been instrumental in supporting the local food system and has contributed significantly to the rural economy (Samtani et al., 2019). Over the last ten years, the tendency of crop diversification into horticulture has been getting more and more common, being predetermined by the combination of agronomic benefits and the possibility of achieving greater yields (Neri et al., 2012). The institutionalisation of the Department of Horticultural Initiatives is a relevant policy intervention to promote the growth of fruits, vegetables, and floriculture that can bring more revenue per hectare than the traditional crop systems (Tindiwensi et al., 2023). In this transitional period, strawberry cultivation is one of the leading and profitable agricultural enterprises of the state (Onken et al., n.d.). From being confined to the cooler hilly areas like Mahabaleshwar and Nainital, strawberry cultivation has spread into the plains owing to the development of more efficient production technologies, improved irrigation

systems, and enhanced market awareness (Antunes & Peres, 2013) Bhiwani district, in particular, has emerged as the microcosm for strawberry cultivation, which itself is an indicator of the alternative trend of horticulture towards high-value crops that Haryana is witnessing in its bulldozed semi-arid areas (Fachinello et al., 2011).

Geographically, Bhiwani is located at a latitude of 28.793° and a longitude of 76.140° at an altitude of about 732 feet above mean sea level (Sharma & Singh, 2009). The district has near-level to rolling topography and traditionally has been oriented to the cultivation of bajra, wheat, and cotton (Anderson et al., 1996). Bhiwani has more than 90 per cent of the total land devoted to farm needs; therefore, it is conducive for a shift-over (Cuppuri et al., 2021). The agro-climatic features of the region, which include a wide temperature range of 2°C – 45°C and average annual rainfall of 483 mm, permitted the cultivation of strawberries, particularly during the winter season, which is the most conducive time for flowering and fruit-setting (Wszelaki & Mitcham, 2003).

Thus, Innovative breeding approaches have yielded high-performing strawberry cultivars, including Camarosa, Chandler, and Sweet Charlie, that have greatly aided sustained production and greater resiliency to variations in climate (Iezzoni et al., 2020). These varieties have shown good adaptation to the semi-arid subtropical conditions of the region and are growing well in 2 to 10-acre plots on farms (Hussain et al., 2012). The cultivation of the strawberry crop has been fast integrated in the rural areas of the area like Chanana, Bapora, Dinod and Biran as an alternative crop in the classic agricultural systems due to its high returns and its growing demand in the market (Thompson et al., 2007)

Strong in the economic appeal, growers in the district are faced with a myriad of complex and interdependent problems. First and foremost, is the high cost of production where labour constitutes about 45.67 % of the total cost of production input; other costs that could attract a person are land leasing, fertiliser, pest control and setting up and maintaining irrigation facilities (Song & Forney, 2008). Although the gross yield is at an average of ₹448,000 per acre, farmers have no Minimum Support Price (MSP) thus making them vulnerable to the uncertainties of the market without formalised marketing systems (Buzby et al., 2011).

Strawberries are sensitive products which are perishable and that require quick harvesting, transportation and chilling to reduce losses which take place after harvesting (Wszelaki & Mitcham, 2003). The rural infrastructure in the Bhiwani village is not enough to meet these demands, lack of transport facilities and absence of reefer facilities give the produce a high risk of spoilage during distribution (Singh et al., 2006). High percentage of the producers are still depending on intermediaries and wholesale trade thus draining profit margins and risking the exposure to fluctuating prices (Howard & Allen, 2008). In addition, the lack in technical knowledge that regards disease and pest management is quite strong. Despite the growing demand of strawberry production, farmers are still struggling to maintain the health of crops and the outbreak of diseases and pests are major issues (Heye et al., 1994). Such misfortunes are supported by poor access to extension services, frequent attendance at capacity-building events, and poor connections to research and development programmes (Metje-Sprink et al., 2019)

Another socio-economic factor impacting agricultural performance of the strawberry farmers in Bhiwani is the socio-economic profile of the farmers which includes the level of education, family size, and the availability of credit. Although most of the farmers indicated that over 75 % of their total annual earnings was as a result of growing strawberries, there remain imbalances in profitability based on landholding, as well as income brackets (Guthman & Brown, 2015). A significant number of growers emphasized on limited availability of institutional credit and formal training programmes and this is where there was a need to have fair and improved support structures (Johansson et al., 2004). This means that multi-faceted and thorough examination of the systems of strawberry production, which are cultivated locally, is needed. The present research looks into the cost

behaviour, profit opportunities, and calculation of the benefit-cost ratio (BCR) in both small and large scale to determine the economic feasibility of strawberry farming. This research is not limited to the economic perspective, but it also includes farm production behaviour and reveals the salient environmental and physical constraint and losses in the post-harvest and marketing phases. The research will focus on agronomic, economic and logistical aspects to produce practical conclusions by assessing the policy, thus contributing to the establishment of robust and lucrative horticultural production systems in Bhiwani and similar semi arid areas. The expected results will contribute to the academic discussion on agricultural diversification and sustainability, as well as give practical recommendations to the farmers, extension staff, and policy makers working to improve the livelihoods of rural people in the dryland regions of India (Hynni et al., 2025)

2. LITERATURE REVIEW

For regions of India plagued by soil health degradation, increasing water stress, and declining net returns from other horticultural or floral products, cultivating strawberries is becoming a highly profitable alternative. This crop, which was restricted for decades to hilly regions like that of Mahabaleshwar and Nainital, is now cultivated in parts of the Indo-Gangetic plains and semi-arid regions, including districts like Bhiwani in Haryana. The transition is a result of the shifting demands of the marketplace, advances in production methods, and greater interest in diversifying agriculture. (Antunes & Peres, 2013) reported the adaptation of plains in North India, utilising improved cultivars and water-saving irrigation systems, such as drip irrigation. Strawberry farming has emerged in recent years Bhiwani district of Haryana as a local innovation, institutional promotion, and feasibility of the tropical climate. The use of cultivars such as Camarosa and Chandler improved the yield and fruit quality of the crop, thus making it commercially viable for production, as reported by (Van De Velde et al., 2013). Strawberries have been confirmed in literature to provide higher economic returns to farmers than traditional cereal crops. A recent economic analysis showed potential for high net returns, with profitability influenced by factors like pest management and market premiums (Goodhue et al., 2011). From the above figures, small and medium-scale farmers can benefit from the high income-raising potential of the crop. However, this high profitability is not homogeneous and depends on such factors as the cost of inputs, closeness of market access and farmers' knowledge. Several microeconomic factors profitability of strawberry farming (Samtani et al., 2019). Illustrates these results how what land, labor, and irrigation facilities the farmer has access to, as well as the regional climate, affect his profitability. Found that labour costs account for almost half of the overall production outlay (Li et al., 2016). Given the frequent harvesting and caring for strawberries, the intensity of labour becomes an issue for small-scale growers who may lack manpower or face increasing wage bills. Marketing and post-harvest handling represent significant constraints that should not be taken lightly (Laidler et al., 2013). They observed that

perishable character of strawberries, the few attachment to commercial markets and agent exploitation were the major limiting factors to farmer income. The postharvest losses are very high because there is a shortage of cold storage facilities and there is a poor transportation network. Other farmers have also begun to sell directly to urban consumers or to local markets, but most are dependent on informal markets, whose prices are unpredictable, and whose margins are narrow. Training and extension have been the parts where policy and support services have not been given much attention.

Taylor et al. (2008) indicate that farmers who have not undergone formal training in horticulture tend to use unnecessarily unwanted inputs such as pesticides resulting in low quality produce and straining the ecosystem. This idea is advocated by (Petrasch et al., 2019) , and their article describes the constraints of productivity and sustainability by the absence of scientific knowledge. Because of uncoordinated technical training, a number of strawberry farmers do not receive agronomic assistance of Haryana Department of Horticulture. As far as ecological adaptation is concerned, strawberries can be cultivated in Bhiwani because the winter temperatures are between 2 o C and 15 o C, and the yearly rainfall is about 483 mm (Morillo et al., 2015). Nevertheless, increasing climatic variability and the risk of out-of-season rain or heat waves may have an impact on the normal yields, and farmers will have to be more efficient in their timing and risk management. Furthermore, lastly, there is the issue of equality and inclusion (Guthman & Brown, 2015). Noted that credit is usually accessible to bigger farmers or more established farmers, training and market information as well. Although they greatly contribute to the farming and packaging, women are not consulted in decision-making and have little say because they do not own land, and they do not have access to capacity-building opportunities. Finally, literature reviews indicate that production of strawberries can be a potential alternative to economic empowerment in semi-arid lands, like Bhiwani. Nevertheless, it will be effective only in case it is cost-effective, sustainable to the environment, supported by institutions (especially in developing countries), and the market access to the development is at equitable terms. Although most research has concentrated on the profitability and production strategies, few studies have been conducted to understand the economic, environmental and market forces at the local level.

Research Gap and Study Rationale

Although the extant literature reveals that strawberry farming could be a high-value crop in the Indian horticultural industry, a very small number of studies concern the adaptation of the crop in semi-arid regions, including the Bhiwani district of Haryana. A majority of the literature focuses on the yield performance and macroeconomic returns of the crops, and thus there is a gap in the understanding of the socioeconomic aspects of adopters and their effect on the adoption process and resultant effects. Besides, specific data about farm-level activities, varietal uptake selection, and resource input use are inadequate in newly set cultivation areas. Although

found to be cost-effective, the exact economic relationships, such as costs and rents, are not yet fully understood. Moreover, the on-the-ground problems farmers encounter (climate stresses, pest difficulties and labour shortages, to the pressure of perishability, not to mention what happens postharvest) tend to receive short shrift. The role of institutional support factors (credit provision, training, and infrastructure) has not been well-studied. What we lack most is research on how profitable, risky, and sustainable strawberry farming is perceived to be in relation to traditional crops by farmers. These limitations have hampered the development of policy and support programs on a region-by-region basis. The present study aims to fill these gaps through a localized, data-driven analysis of strawberry cultivation in Bhiwani district.

3. MATERIALS AND METHODS

Study Area

This was done in the district of Bhiwani, Haryana, India. Bhiwani was located at respectively and the mean elevation of the district is about 732 ft above mean sea level. The region is semi-arid and has a sharp temperature gradient, which varies between 2 o C in winter and 45 o C in summer. The annual rainfall measures 483.0 mm. Against these agronomic and climatic characteristics that are, cool winters and low humidity Bhiwani offers a rather conducive environment in which strawberry can be cultivated.



Fig. 1. Farmer harvesting strawberries on his farm in Bhiwani District, Haryana, (India)

Research Design and Sampling

The research design used was the descriptive and analytical design whereby the primary data was collected through the structured questionnaires. The purposive sampling was used in order to pick fifty strawberry growers within the representative villages of Bhiwani, namely, Chanana, Bapora, Dinod, and Biran and the neighboring regions where a significant percentage of the land was already under strawberry production. The

sample was selected to have a wide range of farm size, level of experience, and market or infrastructure. The data were collected using face-to-face interviews whereby the respondents gave unambiguous answers and provided more qualitative data on the cultivation activities and marketing experiences.

Data Collection Tools

The questionnaire for this study was developed in a structured form and pre-tested to determine its feasibility prior to data gathering. The questionnaire that resulted was subsequently adjusted based on the information gathered from the farmers and deployed to collect data from them in due course. The last instrument was designed to gather information on five critical domains. Demographic and socioeconomic variables, which include age, gender, level of education, family size, landholding size, and the frequency distribution of income. The survey collected data on varieties planted, methods of irrigation, use of fertilisers and agrochemicals applied, planting density used, and cropping cycles with respect to production environment practices. Detailed cost and income data (including input costs, rent, labour, fertilizers, irrigation, pest control, harvest levels, market prices, and total revenue) were collected over two years using field-based methods. Information was also collected on postharvest handling and marketing practices, including storage facilities, modes of transport, access to markets, and constraints encountered in the marketing of the commodity. The final section of the questionnaire investigated farmer attitudes to benefit/cost, risk, fit with climate characteristics (suitability), effect of institutional support, and whether it is better than conventional cropping systems. Responses were entered as numerical values and measured using five-point Likert scales to gauge opinions and satisfaction.

Analytical Techniques

The obtained data was analyzed using descriptive statistical methods, which included the computation of means, percentages, and frequency distribution as a result of which a complete profile of the traits of the farmers and the production patterns is provided. The economic estimation was based on the calculation of the Benefit-Cost Ratio (BCR) that was calculated through the following formula and allowed evaluating the profitability of the strawberry production under various cost and price options.

$$BCR = \frac{\text{Gross Returns}}{\text{Total Cost of Cultivation}}$$

Total Cost of Cultivation

A Likert was also applied to measure the perceptions of farmers toward constraints, risk, and profitability, the response options being between Strongly disagree and Strongly agree.

4. RESULTS

Demographic Profile of Respondents

In the current study, the sample size of the study used consisted of 50 strawberry farmers in the Bhiwani district. Demographic analysis showed that 70% of respondents were males with 30% being females; this analysis

indicates a gendered division of farm activities in the area. Most of the respondents (58%) were those between the age of 25-45 years, which suggests that the young and economically active population is more attracted to the strawberry farming practice. With regard to educational attainment, 40% of the farmers had had secondary school education, 26% university, 20% primary and 14% , with some having no formal education, completed the categorisation. These results suggest a medium degree of knowledge on nutrient-balanced management on the sampled farmers, which is presumably relevant to their learning behaviour with regard to the uptake of good cultivation behaviour. One way in which this is so is that seventy two percent of the farmers had two to five acre landholding. The other respondents owned two to ten acre holdings, which indicates that there is an increasing adoption of strawberry farming by the small and medium farmers.

In addition most of the households (76%) indicated that the annual earnings of the households were more than three-quarters of the annual earnings of the strawberries, thus supporting the saliency role of the crop in their lives.

Table 1: Socio-economic profile of strawberry farmers in Bhiwani district (n = 50)

Attribute	Category	Frequency	Percentage (%)
Gender	Male	35	70%
	Female	15	30%
Age Group	25–45 years	29	58%
	Others (below 25/above 45)	21	42%
Education Level	No formal education	7	14%
	Primary school	10	20%
	Secondary school	20	40%
	Graduate or higher	13	26%
Landholding Size	2–5 acres	36	72%
	5–10 acres	14	28%
Income Share from Strawberry	>75% household income	38	76%
	≤75% household income	12	24%

Source: Field survey

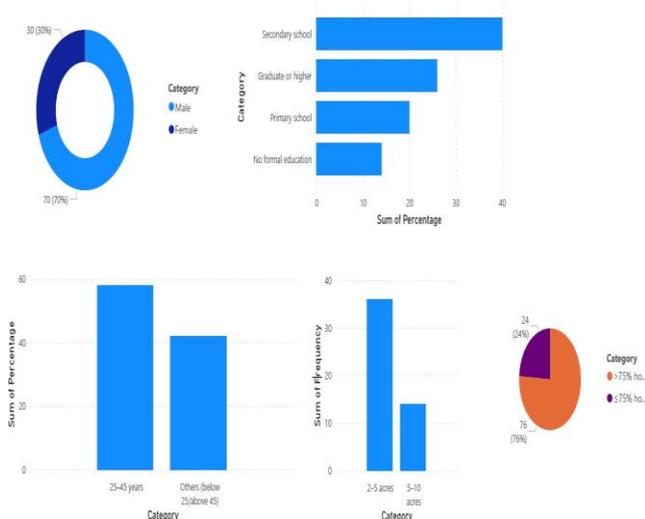


Fig. 2. Impact of Socio-economic profile on strawberry farmers

The gender distribution, shown in Figure 1, was in the form of pie chart, where 70 % of the participants were males and 30 % were females. Figure 2, in the form of a bar chart, shows the levels of education of volunteers, with about 40 % of the volunteers having secondary school education, after which a significant amount has graduate degrees or higher, and a lower amount have no formal education. Figure 3 shows the distribution of the age, which shows that the commonest age group is 25-45 years. According to Figure 4, 76 % of the respondents possess up to 75 % of the property in their households. Lastly, the second bar chart represents the land distribution of 25-50 and 50-100 whereby the former has a high frequency.

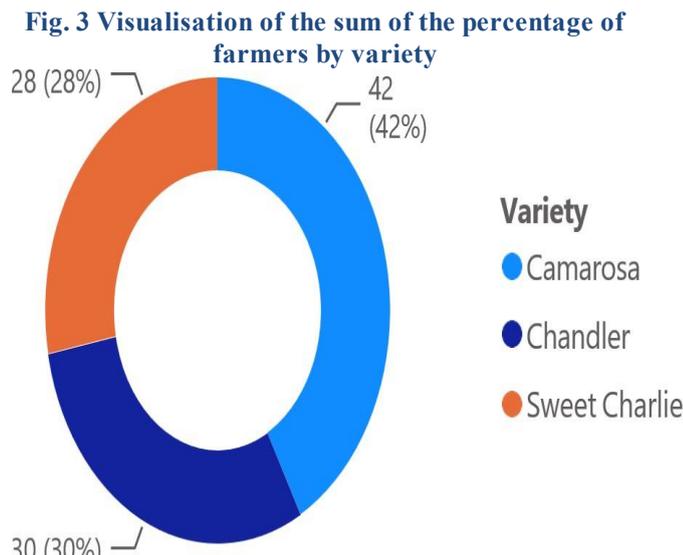
Cultivation Practices and Input Usage

The planting of strawberries in Bhiwani usually starts between September and October and the harvesting period is between December and March depending on the conditions of climatic conditions. The major cultivars are Camarosa (42%), Chandler (30%) and Sweet Charlie (28%). A preference towards agronomy has been seen in raised beds and drip irrigation combined with plastic mulching, which are practices that are considered adaptive to maximise the use of resources. Use of fertilizer was mainly inorganic, with an emerging though limited use of organic supplements like vermicomposting. Pest and disease control was said to be a big problem, with 60% of farmers experiencing regular pest infestation. Even with the high cost of inputs, 88% of the farmers were satisfied on crop performance in general

Table 2: Strawberry Varieties Grown in Bhiwani District

Variety	Percentage of Farmers (%)
Camarosa	42%
Chandler	30%
Sweet Charlie	28%

Source: Field survey



The pie chart (Fig. 3) shows the percentage of farmers growing each strawberry variety. The leading variety is the Chandler variety, grown by 42% of farmers, followed by Sweet Charlie (30%) and Camarosa (28%).

Yield and Productivity

Average yield ranged from 2200 to 3000 kg per acre, depending on variety and agronomic practices. Farms with fruit farmed from Camarosa parentage tended to have higher yields and larger fruit with better outward appearance. Variation in yield is associated with the timing of plantation along with irrigation and pest control practices.

Economic Analysis

The analysis of strawberry cultivation economics in Bhiwani district reveals a feasibility profile. Input cost analysis showed that labour was the dominant constituent, accounting for approximately 45.67% of the total cost of cultivation. Next in line were rental costs of land (at 18.36%) followed by fertilizers and chemical inputs (at 13.40%), irrigation costs (at 8.36%), and other costs such as related to transportation and packing (at 14.21%). In general, per acre average total cost of cultivation varied from ₹54,000 to ₹60,000. The farmers, however, reported gross returns of ₹4.2 lakh to ₹4.5 lakh per acre on the revenue front. The net profit came to be between ₹3.5 lakh to ₹3.9 lakh per acre after the cost of cultivation. These numbers show that strawberry production is very profitable in comparison to traditional field crops produced in the area. The Benefit-Cost Ratio (BCR) was estimated to be 8.14, confirming that the profitability of strawberry farming is sufficiently high. This holds even in the scenario of increased input prices. These results indicate that the crop has a potential profitability far higher than that of at least one of the most profitable short-cycle horticultural options currently available to the farmers of semi-arid regions like Bhiwani. (Refer to Table 3)

Table 3: Economic Analysis of Strawberry Cultivation per Acre in Bhiwani District

Cost Component	Percentage of Total Cost (%)
Labour	45.67%
Land rent	18.36%
Fertilisers and chemicals	13.40%
Irrigation	8.36%
Transport and packaging (other)	14.21%
Total Cost of Cultivation (₹)	₹54,000 – ₹60,000
Gross Return (₹)	₹4,20,000 – ₹4,50,000
Net Return (₹)	₹3,50,000 – ₹3,90,000
Benefit–Cost Ratio (BCR)	8.14

Source: Data based on a primary survey of 50 strawberry farmers BCR=Total Cost of Cultivation Gross Returns

It is then applied in the **Economic Analysis section (6.4, Table 3)** to assess profitability.

The data came from **primary surveys of 50 strawberry farmers** in

Bhiwani. Key economic figures per acre:

Total Cost of Cultivation: ₹54,000 – ₹60,000

Gross Return: ₹4,20,000 – ₹4,50,000

Net Return: ₹3,50,000 – ₹3,90,000

Cost components: Labour (45.67%), Land rent (18.36%), Fertilisers/chemicals (13.40%), Irrigation (8.36%), Transport/packaging (14.21%)

Gross Returns (GR)

- Gross return = **Yield × Selling Price**

Average Yield: 2,800 kg per acre (range: 2,200–3,000 kg)

Average Selling Price: ₹160 per kg (range: ₹150–170)

So:

$$GR = 2,800 \times 160 = ₹4,48,000$$

That's how the **Gross Returns (₹4.48 lakh per acre)** were obtained.

2. Total Cost of Cultivation (TC)

This is the **sum of all input costs per acre**. Farmers reported the follow Labour = 45.67% of cost

Land rent = 18.36%

Fertilizers & chemicals = 13.40% Irrigation = 8.36%

Transport & packaging = 14.21%

Reported **total cost per acre = ₹54,000 – ₹60,000** (average ≈ ₹55,000).

☞ Example breakdown at **₹55,000 total cost:**

Labour = $45.67\% \times 55,000 \approx ₹25,118$ Land rent = $18.36\% \times 55,000 \approx ₹10,098$

Fertilizers/chemicals = $13.40\% \times 55,000 \approx ₹7,370$

Irrigation = $8.36\% \times 55,000 \approx ₹4,598$

Transport/packaging = $14.21\% \times 55,000 \approx ₹7,815$ Add them = ₹55,000 (rounded).

- If yield ≈ 2,800 kg/acre and gross return ≈ ₹4,48,000, then
- Selling price ≈ $₹4,48,000 \div 2,800 = \mathbf{₹160}$ per kg

So the **Total Cost of Cultivation** comes from adding all these **input expenses reported by farmers**.

$$BCR = GR \div TC$$

Write the ratio

$$BCR = 4,48,000 \div 55,000 = 8.14$$

BCR of 8.14, meaning for every ₹1 spent, farmers get ₹8.14 in return.

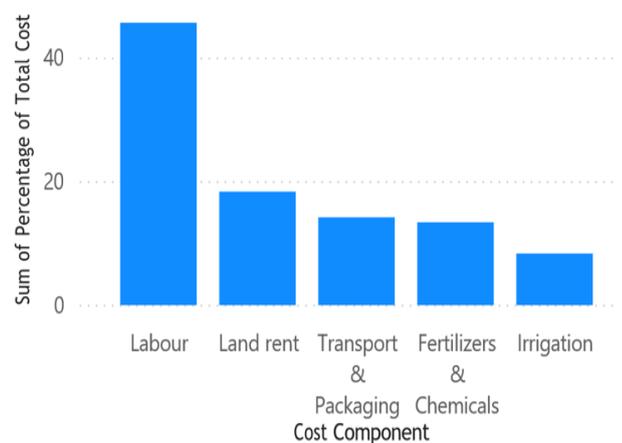


Fig. 4. Visualisation of sum of percentage of total cost (%) by cost component

The pie chart (Fig. 4.) shows the components of cost, with labor being the largest component of cost at more than 40%. Costs for land rent, transport, fertilizers, chemicals, and irrigation are much lower, and the proportion of both land rent and transport is similar.

Perceptions of Profitability and Sustainability

The study revealed that strawberry farmers in Bhiwani face multiple obstacles in marketing their produce and minimizing post-harvest losses. The strawberry growers from Bhiwani are confronting various challenges in marketing their produce and reducing post-harvest losses. 42% sold their harvest through local mandis (Agricultural Produce Market), 38% through intermediaries or middlemen, and only 20% sold directly to urban retailers or institutional buyers. In other words, most of the producers rely on informal markets, which usually have limited transparency and price guarantees. Farmers flagged a lack of MSP or any form of procurement guarantee as one of the major weaknesses. Moreover, there was very little or no cold storage infrastructure available, due to which the highly perishable fruit used to get spoiled within no time. In peak post-harvest season, bad rural roads connecting on top of transportation passes would further deteriorate the quality. Low bargaining power — Apart from low wages, farmers also say they have weak bargaining power, mainly because of a lack of cooperative societies or Farmer-Producer Organisations (FPOs). Post-harvest losses were projected to be 10% to 25%, depending on the season (greater losses were expected during hotter months or after off-season rainfall). All these challenges cumulatively result in a lower marketable surplus and reduced net profitability of strawberry cultivation, even though gross returns are robust.

Table 4: Marketing Channels and Post-Harvest Challenges Faced by Strawberry Farmers in Bhiwani (n = 50)

Aspect	Details / Observations
Primary Marketing Channels	
– Local mandis (Agricultural Produce Market)	42% of farmers
– Intermediaries/middlemen	38% of farmers
– Direct to urban retail/buyers	20% of farmers
Key Marketing Challenges	
– No MSP or procurement guarantee	The major cause of price uncertainty
– Lack of cold storage facilities	Leads to spoilage and short shelf life
– Transport and road delays	Reduce quality due to poor rural infrastructure
– Lack of cooperatives/FPOs	Limits collective bargaining

	and institutional support
– Post-Harvest Loss Estimates	10% to 25%, especially during hot months or unexpected rainfall

Source: Field survey

5. DISCUSSION

The results of this study are beneficial to the strawberry farmers in Bhiwani, Haryana because it defines not only the production relations but also the economic profits. These results are already consistent with the available academic literature, which argues that the development of the horticulture-based biodiversity expands the income production in semi-arid areas. Despite the popularity of the strawberry crop, there is a myriad of regulatory restrictions to the natural growth of the crop. The profitability of cultivation (around Rs 3.5 lakh per acre) is high and the benefit-cost ratio (BCR) is quite attractive (8.14), some six times the value of wheat or millets. However, the cost of production, especially the labour intensity of 46%, are still current restrictive factors. The current findings are aligned with the recent findings of (Bachhal et al., 2018), who recorded a similar level of profits in the newly opened strawberry zones in Haryana. The production of strawberries is controlled by a group of young and moderately educated farmers; however, the lack of expertise in pest control leads to the over-utilisation of chemical inputs. Global warming has exacerbated hazards like untimely rainfall and high temperatures, among other things, posing a threat to productivity. Market entry also poses a challenge because producers rely on intermediaries and local mandis and have little control over the prices. The farmers are faced with major challenges such as institutional inadequacies in extension services, cold-storage facilities and organised marketing, which hinder profit maximisation and scale growth. Government schemes have been announced, including the Horticulture Programme and other rural development schemes that are ancillary, but most of the producers are not aware of or do not enjoy their fruits. The post-harvest shelf life of strawberries is only one or two days and hence the need to have cold-storage facilities and a well-organised marketing chain to reduce losses. These concerns resonate with those, that by (Prakash et al., 2020) highlight that cold-chain infrastructure and farmer cooperatives are critical to preventing post-harvest losses and improving market efficiency. The paper also clarifies the beliefs of farmers about profit and risk. Most of them are positive about the potential of the strawberry in terms of revenue but a certain anxiety can be detected about the volatility of the market and climatic risks. This ambivalent position, in opposition to the issue of sustainability, highlight a two-fold requirement, the need of sufficient technical interventions and policy modifications that will incentivise positive action. Sections of such gaps might be partially filled in by means of price assurance schemes, pest- alert systems and aggregation through farmer-producer organisations (FPOs). Women often have to perform most of the operation of picking and packing, but again and again they do not receive training and resources,

which is why a sense of urgency to launch gender-sensitive programmes. Generally, strawberry farming offers a good source of income diversification in the semi-arid areas of Haryana although it will not be fully realized until improved policy frameworks, technical assistance, and overall market revolutionizations are realized.

6. CONCLUSION & POLICY RECOMMENDATIONS

Growing strawberries in the semi-arid agricultural region of Bhiwani, Haryana, is a suitable and profitable diversification initiative. Empirical data indicate that the profitability of strawberry farming is very high with an average net returns of 3.5 to 3.9 lakhs per acre with a benefit-cost ratio of 8.14 which is considered to be very strong to propagate plants onsite. These financial indicators show that strawberries are better in terms of income than traditional cereals including wheat and bajra. Besides the proven profitability, investigation has shown that farmers have been able to engage improved cultivars along with improved resource-use technologies such as drip irrigation systems and plastic mulching. This uptake represents a rising trend in the use of accuracy farming methods with the aim of maximizing efficiency when it comes to water use or crop defence in water-scarce regions. Although significant progress has been made, some underlying systemic issues still exist. The most notable of these are high costs of labour inputs and high crop management processes, perishability of the produce after harvesting, poor cold-chain systems, absence of formal training, and insufficient institutional support. Also, the enigma of the informal marketing channels subjects farmers to price fluctuations and limits their bargaining capacity. This opposition explains why there is a need to have strong indicators that depict a paradox; on the other hand, most of smallholder farmers portray enthusiasm on benefits they get economically by producing strawberries, but they are careful as they lack technical support systems and organised marketing systems. Results can be described as an urgent need of multi-dimensional policy responses that can improve productivity and market resilience, access to training and social inclusion at the same time. This paper, therefore, suggests a combination of specific policy measures to enhance the profitability, sustainability, and inclusiveness of strawberry production in the Bhiwani area. The urgent needs are all-inclusive technical training and extension services. It is necessary to implement village-level training on the topics of climate-resistant agroforestry practices, combined pests and disease control methods, modern postharvest methods, and efficient input utilization. Furthermore, training field-level horticulture extension workers to help farmers adopt best production practices. Secondly, cold chain and postharvest infrastructure need to be established. More decentralized cold storage facilities and improved refrigerated transport would help reduce postharvest losses, as strawberries are perishable. Public-private partnerships could also be a viable option when government projects are insufficient.

Third, there is a need to promote and consolidate further Farm Producer Organizations (FPOs). These forms of

organizations facilitate the group mobilization within the area of input sourcing, supplier bargaining, and formation of indirect connection with the urban markets and institutional buyers. Lastly, the use of the minimum support price (MSP) or traction-price systems is mandatory. Without MSP of horticultural goods, the farmers have the option of reducing their market risk in price guarantees by using forward contracts or floor-price commitment options. Also, institutional credit and crop insurance should be increased. Small-scale farmers would face less financial and climatic pressure due to tailored credit lines in priority-sector lending programs in horticulture and weather-linked insurance covers. Another important point highlighted in the study is the need to use a gender-inclusive model of horticulture. Many women engage in the strawberry production by themselves, but they have no access to training and credit, and owning land. Special initiatives to overcome such differences would increase productivity and social equity. Furthermore, the adoption of sustainable inputs, including integrated nutrient management (INM) and integrated pest management (IPM) will also promote long-term soil health and minimize environmental degradation, especially in crops that consume a lot of inputs like strawberries. Together, these measures will be able to transform strawberry farming in Bhiwani into a scalable, climate-resilient livelihood opportunity that is more economically inclusive.

The findings of the study provide consumer information which can be used in policy formulation of horticulture and rural development programs on a state level.

7. LIMITATION

Although the study has come up with some useful information on economic and environmental as well as marketing aspects of strawberry cultivation in Bhiwani, it is not free from limitations. First is the small sample size of only 50 farmers, who, even though purposively selected for representativeness to the district as a whole, they may not fully

represent on-the-ground situation in the entire district or other districts undergoing horticultural transition. Secondly, the study was only established for one cropping season, limiting the possibilities to include inter-annual changes in yield, market price, pest incidents and climatic conditions that may affect profitability and sustainability.

Moreover, dependence on self-reporting of data especially for income, cost and perception based answers may bring recall bias or subjective estimation though ground verification was made wherever it was possible. Furthermore, even though the study used a combination of quantitative and qualitative methods, geospatial or time-series data were excluded from the analysis which could have added value to environmental analysis. Finally, it is not clear the extent to which policy awareness, access to government schemes and extension services were considered in detail due to a gap that still exists in our knowledge of how state-level interventions affect farm level outcomes, and can therefore be subjected future research. However, they provide a good initial

benchmark and can be used to inform more detailed analyses of high value horticultural systems within semi-arid areas

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