

Review

Crop diversification initiatives to facilitate sustainable agriculture in Haryana: A Review

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Abstract

The Green Revolution of the late 1960s allowed India to overcome a severe food shortage and achieve self-sufficiency in food grain production. However, recent trends in Haryana's agriculture have shown a significant shift towards the specialization of paddy and wheat farming. The long-term sustainability of agricultural production in terms of soil health, water resources, climate, and market dynamics are increasingly at risk due to the continuous monocropping of the rice-wheat system. This growing trend underscores the need for crop diversification to address ecological concerns. Therefore, crop diversification has become a vital strategy for ensuring the sustainability of agriculture in Haryana. This article provides a brief overview of various diversification initiatives aimed at promoting sustainable agriculture in the state. Additionally, to assess the impact of these crop diversification schemes, a study was conducted among Kinnow fruit growers in the Sirsa district of Haryana. The results support that scheme such as 'Mukhyamantri Bagwani Bima Yojana' plays a vital role in promoting horticulture as sustainable and eco-friendly source of income and Kinnow production stands out as one of the most effective methods of crop diversification in the Sirsa district of Haryana.

Keywords: Sustainable agriculture, Crop diversification, Government policies, Sirsa district, Kinnow cultivation

Introduction

Advancements in agriculture have also contributed to population growth, which in turn has placed a considerable burden on the agricultural sector. This situation necessitated a revolution in agriculture to boost crop production. The Green Revolution sought to alleviate India's food shortages by improving crop yields through modern methods such as advanced irrigation systems, the use of herbicides, fertilizers, and high-yielding crop varieties. However, while the Green Revolution achieved a substantial increase in yields, it also led to several negative consequences. The increased use of chemical fertilizers has resulted in their bioaccumulation and biomagnification in the environment and soil [1,2,3]. Prolonged and excessive use of these chemicals has led to groundwater contamination, diminished soil fertility, increased soil salinity and sodicity, and a loss of biodiversity. The presence of chemical fertilizers in food chains has also been linked to serious health issues and diseases in local plant and animal life. In Haryana, substantial progress was achieved in agricultural productivity, but this came at the expense of land and water resources. The intensive farming

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practices of the Green Revolution led to serious issues, including soil degradation, groundwater overexploitation, and soil contamination from the heavy use of fertilizers and pesticides. The conservation of land and water has become a critical concern, not just for the farmers and rural communities in Haryana, but for the entire country.

By adopting sustainable farming practices, farmers can ensure the economic viability of their land while simultaneously improving soil fertility, encouraging responsible environmental practices, and mitigating the environmental impacts associated with climate change.

Sustainable agricultural practices in India

Sustainable agriculture is a farming approach that prioritizes the use of renewable and natural resources over synthetic inputs like pesticides and fertilizers. A study conducted by Gupta *et al.* in 2021, in collaboration with the Food and Land Use Coalition (FOLU) [4], provides an overview of sustainable agriculture practices and systems (SAPs) in India. By examining agroecology, the study identifies 16 SAPs, including agroforestry, crop rotation, crop diversification, rainwater harvesting, organic farming, and natural farming. The study concludes that sustainable agriculture is relatively uncommon in India and recommends various initiatives to promote SAPs, such as restructuring government support and generating robust evidence.

The cropping pattern of Haryana

Haryana is one of India's leading states in food grain production, with wheat and paddy being the dominant crops. Typically, wheat is cultivated during the rabi season and paddy during the kharif season. The Green Revolution, which boosted wheat and rice production and prices, has influenced Haryana's cropping patterns, shaping farmers' decisions. Seeking to maximize profits, many farmers focus on growing these two crops, often at the expense of the region's traditional crop rotation practices. Among the paddy varieties, Basmati is grown on 12.8 million hectares in Haryana. The intensive cultivation of paddy is primarily driven by the Minimum Support Price (MSP) system, where the State buys crops at a predetermined price, despite the high-water usage associated with this practice. In 2019-20, the government purchased 43 lakh tonnes out of the 68 lakh tonnes of paddy produced in the state. Farmers irrigate their paddy fields between 37 and 46 times, depending on whether they use diesel or electric tube wells, as well as the level of irrigation power subsidy. This is significantly more than the recommended 15-20 irrigations.

The increased production of wheat and rice due to the Green Revolution has negatively impacted the environment, especially the soil, vegetation, and water resources. The soil's organic matter is diminishing, and the use of chemical inputs has become more frequent [5]. This has led to the emergence of dark zones and other environmental issues. Therefore, promoting crop diversity is crucial for Haryana's agriculture. Farmers should consider their soil and water conditions before selecting crops that are best suited to these environments.

Crop diversification as a sustainable agriculture practice

As defined by Feliciano (2019), crop diversification involves transitioning from a traditionally cultivated crop or cropping system to a more profitable one [6]. This practice is a key example of sustainable agriculture. Not only does crop diversification boost the production of various crops, but it also helps mitigate risks by enabling farmers to grow a variety of crops within the same area.

Tonhasca and Bryne (1994) conducted research on the effects of crop diversification on herbivorous insects. Using a meta-analysis, they concluded that diversified crops tend to attract fewer insects. Additionally, crop diversification improves soil quality and texture. Certain crops, such as legumes, enhance soil

nutrient content by replenishing lost nutrients, thereby restoring soil fertility through their impact on the soil's biological, chemical, and physical properties [7]. Similarly, Liebman *et al.* (2001) found that crop diversification can aid in weed management and further improve soil quality. Some crops contribute to restoring depleted nutrients in the soil [8]. Qadir *et al.* (2008) also explored how crop diversification can increase productivity in salt-affected environments [9]. Rahman (2009) recommended crop diversification as a key strategy for advancing agriculture in Bangladesh [10]. Later, Lin (2011) highlighted that crop diversification is not only the most effective but also the most economical approach. Diversifying crops enhances resilience, suppresses pest outbreaks, and reduces pathogen transmission. Additionally, it can stabilize crop production. Despite these advantages, the adoption of crop diversification has been slow. To encourage its adoption, economic incentives and biotechnology strategies are necessary [11]. Acharya *et al.* (2011) conducted an economic analysis of crop diversification in Karnataka using secondary data collected over a 26-year period from 1982 to 2007. The study employed the Entropy index and linear regression analysis to assess crop diversification. The findings indicate that crop diversification also impacts production. Key factors such as irrigation, marketing, and transportation facilities, including roads, are crucial for enhancing crop diversification, as they significantly influence the extent and nature of diversification. Moreover, crop diversification can reduce the risk of crop failure due to climatic anomalies, particularly in dryland areas [12]. Diversification in agriculture contributes to increased nitrogen levels in the soil, which in turn enhances soil fertility [13]. This approach also supports employment opportunities, as farmers and their families remain engaged in various agricultural activities. One of the key advantages of crop diversification is that it provides a steady income stream, particularly beneficial for small and marginal farmers [13]. BIRTHAL *et al.* (2015) conducted a study on how crop diversification impacts poverty among Indian farmers. Their findings indicate that growing high-value crops can improve farmers' livelihoods, with those who diversify into these crops experiencing reduced poverty levels [14]. The research further explores how the degree of diversification correlates with the level of poverty. While diversification initially has a positive impact on reducing poverty, this effect diminishes over time due to various constraints. Crop diversification is an ongoing and evolving concept that involves strategies related to space, time, and value enhancement. It is driven by demand, necessity, and specific circumstances [15]. As a result, both the profitability and overall productivity, in terms of both quantity and quality, see improvement.

Feliciano (2019) analyzed how crop diversification contributes to the Sustainable Development Goal of reducing poverty across various global regions, concluding that it is the most effective and affordable strategy for minimizing income uncertainties among farmers. This approach is particularly beneficial for poor farmers and those with small landholdings [6]. Kurdyś-Kujawska *et al.* (2021) conducted research in Poland, focusing on the efficiency of farmlands under crop diversification strategies. Their study emphasized the importance of these strategies in addressing climate change [16]. Sharma *et al.* (2021) explored the role of crop diversification in managing weeds and highlighted its significance in achieving Sustainable Development Goals (SDGs) 2 and 3, as outlined by the UNDP [17,18].

Indian government policies and strategies for crop diversification

The Government of India is actively promoting crop diversification as part of its initiatives to double farmers' income. For example, the Ministry of Agriculture has introduced the Crop Diversification Programme (CDP), a sub-scheme under the

Rashtriya Krishi Vikas Yojana (RKVY). This program is being implemented in the original Green Revolution States to shift paddy cultivation to alternative crops and in tobacco-growing regions to encourage farmers to transition to different crops or cropping systems.

The Mission for Integrated Development of Horticulture (MIDH) is a Centrally Sponsored Scheme aimed at fostering the comprehensive growth of the horticulture sector. It encompasses a wide range of crops, including fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa, and bamboo. Under this scheme, the Government of India (GOI) provides 60% of the funding for development programs in all states, with the exception of the North Eastern and Himalayan States, where the GOI covers 90% of the costs. State Governments contribute the remaining 40% in most states. For the National Horticulture Board (NHB), Coconut Development Board (CDB), Central Institute for Horticulture (CIH) in Nagaland, and other National Level Agencies (NLA), the GOI fully funds these initiatives. Additionally, MIDH offers technical guidance and administrative support to State Governments and State Horticulture Missions (SHMs) for initiatives such as the Saffron Mission and other horticulture-related activities, including those under the Rashtriya Krishi Vikas Yojana (RKVY/NMSA).

The Government of India allows states to address their specific needs and priorities under the Rashtriya Krishi Vikas Yojana (RKVY). Additionally, through the National Food Security Mission (NFSM), the Department of Agriculture, Cooperation, and Farmers' Welfare launched the project "Crop Intensification: Mapping and Monitoring of Post-Kharif Rice Fallow Lands using Satellite Remote Sensing and GIS Technologies for Rabi Crop Area Expansion" for the years 2016-17 and 2017-18. This initiative is being carried out by the Mahalanobis National Forecast Centre (MNCFC) in partnership with the National Remote Sensing Centre in Hyderabad.

Emphasizing the careful management of natural resources, states like Haryana have recently imposed restrictions on paddy cultivation in areas facing severe water shortages. As part of its crop diversification initiative, the government has decided to reallocate one lakh hectares of paddy fields to other crops. This decision reflects a deliberate and sometimes more stringent approach to promoting diversification, replacing more commonly grown crops with those that enhance income and sustainability. As these programs gain momentum, crop diversification could emerge as a cost-effective strategy to address ecological challenges, such as groundwater depletion and soil fertility decline, while also reducing uncertainties in agriculture and bolstering resilience against environmental changes [19].

Initiatives to promote crop diversification in Haryana

In recent years, the Haryana government has launched various initiatives and campaigns to motivate farmers to diversify into crops such as vegetables, fruits, cotton, maize, pulses, and others. One notable crop diversification program is 'Mera Pani Meri Virasat,' which aims to encourage farmers to shift to less water-intensive crops. This scheme promotes the transition from water-intensive paddy to crops like maize, pulses, fruits, and vegetables. These alternative crops offer several advantages, including nitrogen fixation, reduced production costs, decreased reliance on chemical inputs, and valuable by-products like fodder. Additionally, they provide protection from market risks associated with paddy and wheat through mechanisms like minimum support prices (MSP) and government procurement. Farmers in designated areas who diversify more than 50 percent of their paddy land will be eligible to sell their entire diversified crop yield to the government at the MSP [20].

Vegetable farmers can also benefit from the 'Bhavantar Bhugtaan Yojana' (price deficiency scheme), which was previously tested in the State for four vegetable crops. This scheme ensures the purchase of vegetables like bitter melon, ladyfinger, chillies, capsicum, onion, tomato, brinjal, and bottle gourd at predetermined minimum prices, ranging from \$13.5 per kg for bitter melon to \$4.5 per kg for bottle gourd, if market prices drop too low. The payment to farmers will be made in two installments: 25% after crop verification and 75% before harvest. The incentives will be distributed exclusively through 'Direct Benefit Transfer' into the registered bank account or Aadhaar-linked account. Haryana is the first state in the country to establish minimum protected pricing for vegetables, ensuring the protection of farmers' interests. To receive benefits under this program, farmers must register with the Bhavantar Bharpayee e-Portal during harvest (<https://www.edristi.in/bhavantar-bharpayee-scheme/>).

For horticultural crops, payments will be disbursed at the time of seeding and again two months later, amounting to \$5,000. Small and marginal farmers are now required to allocate one-third of their seeded area to horticultural crops. The agricultural diversification plan also extends to tenant and leaseholding farmers. Large farmers who operate tubewells with a capacity of 50 HP or more are encouraged to avoid planting paddy, as they are better positioned to take this risk and should serve as role models for others.

In addition to these schemes, the Haryana government introduced the 'Meri Fasal Mera Byora' (MFMB) Yojana in December 2018 to enhance farmers' welfare. Through this initiative, the Haryana government provides a range of services to farmers via a single-window online portal. The portal was designed to ensure that farmers receive various state government benefits, including insurance coverage, compensation for crop losses due to natural disasters, and other financial support through different programs [21].

The Haryana State Agricultural Marketing Board (HSAMB) and the Department of Food and Supplies of the Haryana government jointly developed the 'e-Kharid' portal (ekharid.nic.in) to provide farmers with real-time information and timely payments for their crops. Through this portal, the Haryana government has tasked the State Agricultural Marketing Board with ensuring that farmers receive the Minimum Support Price (MSP) for their produce. During the Rabi season, many farmers registered on the MFMB portal to sell crops like wheat, mustard, gram, and sunflower at MSP. Additionally, to encourage the cultivation of indigenous cotton, the Haryana government will offer farmers an incentive of 3,000 rupees per acre [22,23].

The 'Baagwani Villages' program focuses on developing the on-farm infrastructure needed for the organized marketing of Fresh Fruits and Vegetables (FFV) through Farmer Producer Organizations (FPOs) and Farmer Producer Companies (FPCs). This initiative aims to establish a complete supply chain, from production through value addition to market delivery. Small farmers often struggle with the increased use of quality standards, as these typically require investments that they may not be able to afford or sustain. Given that these small and marginal farmers are part of FPOs within horticulture crop clusters in Haryana, government intervention is crucial to provide the necessary investment and support. Initially, the Horticulture Department identified 140 potential horticulture clusters, encompassing 340 'Baagwani Villages' across the state. The program has since expanded to 393 clusters, covering 1,763 villages [24].

On September 22, 2021, the Haryana state cabinet, led by Chief Minister Manohar Lal Khattar, approved the launch of the 'Mukhyamantri Bagwani Bima Yojana' (MBBY) to support horticulture farmers in the state. This scheme is designed to compensate farmers for losses caused by natural disasters and unfavorable

weather conditions, such as floods, excessive rainfall, drought, and hailstorms. The initiative also aims to increase horticultural crop cultivation and strengthen the horticulture sector in Haryana. To fund this scheme, the state government has allocated an initial amount of Rs 10 crore (Government of Haryana, Horticulture Department).

The Government of Haryana introduced the ‘Jal Hi Jeevan Hai Scheme’ to encourage farmers to diversify their crop rotations and cultivate water-efficient crops like maize and pigeon pea instead of water-intensive ones like rice, aiming to conserve water. Under this scheme, farmers will receive Rs. 200 per acre upon registration, with an additional Rs. 1800 credited to their accounts after the sowing data is verified within two months. The plan also includes the provision of free hybrid seeds. Additionally, the State Government will fully procure the diverse crops produced under this initiative.

A case study: Impact of crop diversification schemes on ground level in Sirsa district, Haryana.

To assess the impact of the ‘Mukhyamantri Bagwani Bima Yojana’ (MBBY) and other crop diversification efforts, an analysis of the horticulture sector’s progress in Haryana was conducted. Haryana, with its favorable agro-climatic conditions, is a leading producer of horticultural crops. The cultivation of fruits and vegetables significantly contributes to livelihoods, offering a crucial income source for many rural families and aiding in poverty reduction. By creating job opportunities and potentially boosting farmers’ incomes, fruit and vegetable farming plays a key role in sustaining livelihoods. Furthermore, the cultivation and trade of these crops contribute to economic growth by generating employment in farming as well as in the wider agricultural supply chain, including processing, marketing, and retailing. Thus, the horticulture sector is essential for ensuring livelihood security for farmers in the evolving agricultural landscape [25,26,27,28].

In 1966-67, horticultural land in Haryana accounted for just 0.42% of the total cropped area, but this figure increased to 2.94% by 2000-01. By 2019-20, the area dedicated to horticultural crops had expanded to 478,444 hectares, representing about 7.07% of the total cultivated land [29].

In Haryana, fruit crops play a significant role among horticultural crops. The increase in per capita income, combined with the effects of urbanization and globalization, has led to noticeable changes in fruit consumption across households of different economic backgrounds. In 1991-92, fruit crops occupied 2.87 million hectares in Haryana, producing 28.63 million tonnes with a productivity rate of 9.96 tonnes per hectare. By 2022-23, this area had expanded to 6.9 million hectares, resulting in a production of 101 million tonnes of fruits and an enhanced productivity of 14.64 tonnes per hectare (Figure 1, Statistical Abstract of Haryana, various issues).

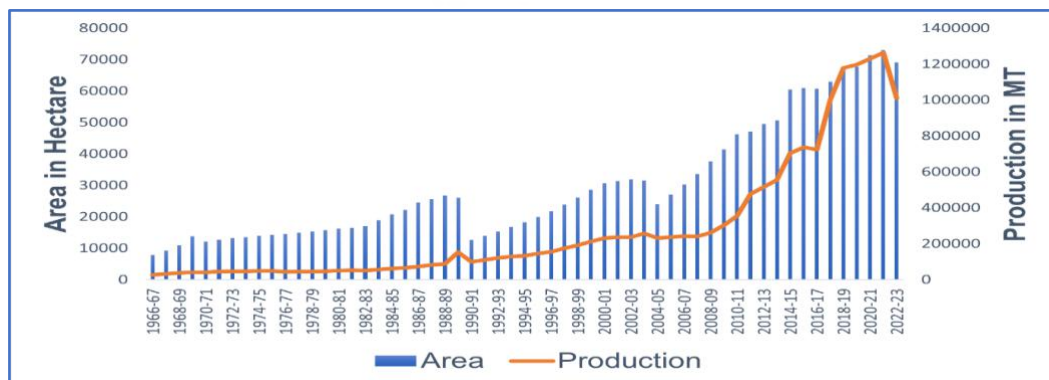


Figure 1: Graphical representation of cropping pattern of fruit crops in Haryana since 1966-67 to 2022-23

Among the primary fruit crops in Haryana, Kinnow stands out as the most widely cultivated, both in terms of area and total production. It dominates citrus fruit cultivation in the state. In 1991-92, Kinnow farming covered 3,189 hectares, expanding to 5,041 hectares by 2005-06, according to horticulture data from that period. By 2014-15, the area had grown to 19,499 hectares with a production of 302,065 metric tons. By 2022-23, Kinnow cultivation had further expanded to 23,920 hectares, yielding 470,852 metric tons (Department of Horticulture, Sirsa, Haryana).

Sirsa district is the top producer of Kinnow in Haryana, contributing 74% of the state’s total output and covering 52% of the cultivation area. Following Sirsa, the districts of Bhiwani, Hisar, and Narnaul also play significant roles, as depicted in Fig. 2 (Department of Horticulture, Sirsa, Haryana).

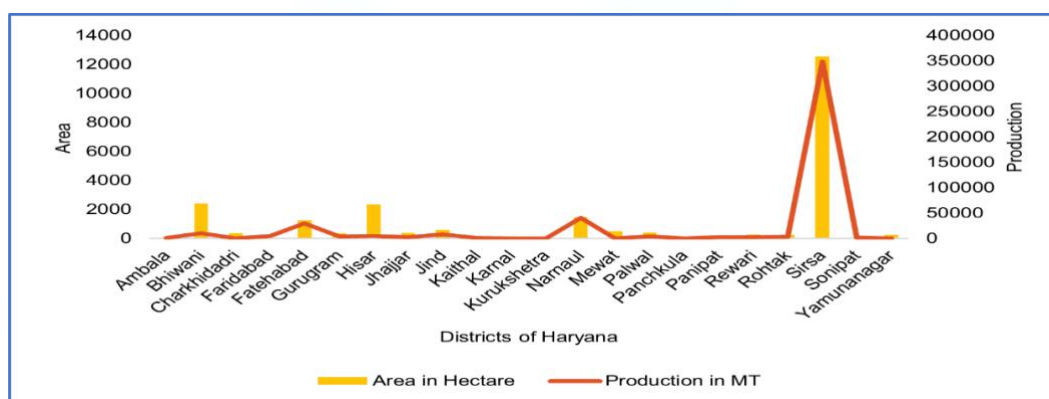


Figure 2: Area and production of Kinnow in different districts of Haryana (2022-23).

A study was conducted among Kinnow fruit growers in the Sirsa district of Haryana, analysing both primary and secondary data to track trends in the area, yield, and productivity of Kinnow. The area dedicated to Kinnow cultivation in Sirsa has significantly increased from 5,905 hectares in 2008-09 to 12,548 hectares in 2022-23. During this same period, production rose from 36,831 MT to 348,290 MT, leading to a productivity increase from 6.24 MT/ha to 27.81 MT/ha over the fifteen years. This growth in Kinnow orchards has been driven by the promise of higher assured income, thanks in part to the successful implementation of the ‘Mukhyamantri Bagwani Bima Yojana’ (MBBY) and other crop diversification initiatives [30]. As a result, a significant portion of the district’s population is now engaged directly in farming or in related activities such as retailing, processing, and marketing Kinnow. These shifts in cropping patterns and livelihood strategies have introduced new socio-economic dynamics for local farmers, and the steady expansion of Kinnow orchards has improved the socio-economic lifestyle of cultivators and traders in the district.

At the same time, Kinnow growers faced significant challenges, including a lack of processing and storage facilities, insufficient post-harvest management, inadequate marketing infrastructure, and a shortage of high-quality planting materials [31,32,33,34]. Therefore, it is crucial to invest more in essential infrastructure, such as transportation, grading, cold storage, and warehousing, as well as in marketing and providing training and extension services to Kinnow farmers. Additionally, increasing awareness among producers about government

schemes that promote horticulture and crop diversification, along with assisting them in securing funding for new technologies, can further enhance Kinnow production and support sustainable livelihoods in the Sirsa district.

Conclusion

The increasing trend of rice-wheat monocropping raises ecological concerns, making crop diversification a crucial strategy for sustaining agriculture in Haryana. Interventions are designed to encourage farmers to adopt diversified farming practices. The study found that schemes promoting crop diversification had a positive effect on farmers' adoption rates. Providing sufficient incentives and timely compensation is likely to further enhance the effectiveness of these programs among farmers. Additionally, the horticultural sector plays a vital role in providing farmers with a stable income. In the Sirsa district of Haryana, Kinnow production stands out as one of the most effective methods of crop diversification.

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