Crop Diversification and the Impact of Climate Change on the Traditional Cropping Patterns in North India

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Abstract

If India's agricultural industry is to continue growing sustainably and include land-constrained farmers inside the intensification process, there must be a shift in planting patterns. Since the COVID-19 epidemic caused millions to lose their non-farming livelihood prospects, pressure was put on agriculture, heightening the need for a shift in cropping patterns. To encourage change in the sector, it is necessary to identify the driving forces and devise effective intervention techniques to counteract them. Decentralized agricultural education, extension services, and human growth and social capitals that take into account the unique dynamics of each community will be essential to ensuring the success of the transition. As a result of climate change, the agricultural industry will no longer be viable unless effective adaptation strategies are put in place. Smallholder farmers in developing nations like India are especially vulnerable because of their lack of access to modern agricultural technology and their reliance on natural resources like rainfall.

Keywords: transition, climatic, sustainability, agricultural education, decentralized, dynamics

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Introduction

Lack of sufficient infrastructure may diminish productivity of farm investments, even while better rural connection improves the mobility of agricultural workers and boosts the production of

high-value cash crops (Amare et al., 2018). (Shamdasani, 2021). "The efficiency of agriculture mechanization, which is only approximately 40% in India compared to roughly 75% in Brazil and 60% in China, also has to be improved" (Safdar and Gevelt, 2020). In addition, building cold storage facilities helps stop price swings, which are usually the result of a supply-and-demand imbalance (Reichenbach et al., 2021). "Pulses lose 4.3-6.1% during harvesting, post-harvesting, handling, and storage; cereals lose 3.9%-6%; fruits lose 5.8-18.1%; oilseeds lose 2.8%-10%; and vegetables lose 6.9-13% (Jha et al., 2016); meanwhile, about 40% of fruits and vegetables go unsold, costing the economy around Rs. 63,000 crores annually" (Pandey, 2018).

Hence, farmers may not have sufficient motivation to alter their cropping patterns toward high-value cash crops without proper infrastructural facilities, incentives, and other assistance.

Understanding the underlying reasons and addressing them via relevant intervention measures is essential for promoting a shift in cropping patterns toward non-food grains. Accordingly, present paper addresses following 2 research questions:

a) "How have the cropping patterns changed in the state in recent years;"
b) "What role have the climatic and other factors played in influencing such changes?"

This document should prove a valuable resource for anyone working to promote sustainable intensification in the agricultural sector and adapt to the changing climate.

Recent initiatives to improve the rural economy in India via numerous national and state tier flagship programs, such the Mahatma Gandhi National Job Guarantee Act, seem to have allowed smallholder farmers to dramatically diversify their crop baskets (MGNREGA). The MGNREGA has enabled improvements to irrigation systems, which in turn have enhanced grain and pulse output (Kumar et al., 2019; Baral et al., 2021). Soil fertility and yields may see significant gains if crop rotations were modified to incorporate these nitrogen-fixing pulses (Chadha, 2010).

"The Farmer Producer Organization (FPO) and other locally based entities have also In recent years, the Indian government has tried to stabilize the prices of important food commodities by controlling exports, removing import barriers, and encouraging farmers to diversify their crops" (Economic Survey, 2021). By doing so, farmers may have easier access to markets and finance, increasing their crop options (Paudel et al., 2020). In addition to the Pradhan Mantri Fasal Bima Yojana and the Pradhan Mantri Krishi Sinchayee Yojana, the National Agriculture Market (eNAM), Mantri Kisan Samman Nidhi, and the Pradhan Mantri FasalBima Yojana are also anticipated to contribute to rural development and the expansion of the agricultural sector (Economic survey, 2020).

Adverse Impact of Green Revolution

From the start of the Green Revolution, the Indian government has encouraged the widespread use of nitrogen fertilizer,

high-yielding variety (HYV) seeds, and irrigation to increase agricultural yields. In general, the goal of such efforts has been to lessen the reliance of farmers on the weather. Farmers' responses to production risks also vary depending on factors such as the farmers' risk tolerance, their familiarity with the local climate, and the tools at their disposal.

Access to infrastructure by farmers has been studied extensively due to its effect on agricultural and rural development indicators. Adoption of technology, crop choices, farm performance, employment and earnings, land values, and poverty are all examples of indicators that have been used in the past. The impacts of climate change on agricultural methods, suitable adaptation measures, and the part played by policies and institutions have all been the subject of many scientific research.

Climate Change and its Impact on Traditional Cropping

The adoption of modern agricultural methods to boost output is hampered by fragmented landholding and small-scale farming. In addition, the lack of consistent energy for water withdrawals and water scarcity throughout the fall and spring seasons serve as roadblocks to the use of enough fertilizer to boost yields (Reddy, 2017).

Use of fertilizers has skyrocketed in the nation over the last four decades, and this has had a direct impact on food grain output. Soil fertility, crop selection, rainfall, irrigation, seed quality, and other factors all influence fertilizer use. Intensification in agriculture has risen in response to rising demand for food as well as other agricultural goods. Throughout the years 2004-2014, the forest cover varied little, but there were noticeable shifts in rainfall and humidity. Precipitation levels have risen while average relative humidity has fallen in several regions.

Environmental, institutional, technical, and economic issues all have a role. Annual precipitation average, yearly precipitation total, coefficient of variation of monthly mean temperature range, and average relative humidity are the primary environmental factors accounted for in the model. In this calculation, we take into account infrastructure variables such as the road density, the number of market yards, and the number of beneficiaries who utilize warehouse or cold storage facilities. The levels of technological intervention, such as fertilizer application, crop diversity, and water application, are accounted for in the models.

"The ratio of non-foodgrains to foodgrains is positively impacted by infrastructure-related factors (one percent and five percent, respectively) such as the number of market yards, the density of roads, and the number of beneficiaries making use of cold storage and warehouses." This indicates that the availability of infrastructure favors the cultivation of non-foodgrains over food crops. Examples of factors that might encourage diversification toward such crops include the availability of improved storage facilities and transportation networks. In a similar vein, when markets are healthy, farmers have more leverage when haggling with buyers and may save money on advertising. As a result, post-harvest

losses, especially of perishable commodities, may be reduced since goods can be disposed of at the optimal period (Rao et al., 2006).

Rainfall has no discernible effect on crop selection, whereas infrastructure elements like irrigation, fertilizer intensity, and climate features like humidity and temperature all have a beneficial effect on the adoption of non-food crops. The expansion of extension services is the result of many different initiatives, such as the push for universal education in agricultural areas and the funding of rural infrastructure. It is also crucial to improve farmers' capacity to adjust their farming strategies to the alterations in weather patterns. Nevertheless, further research utilizing primary data is needed to fully capture dynamics at the home level.

Patterns of Crop Diversification

The goal of agricultural diversification is to reduce exposure to risk while increasing the number of possible crop production options in a given location. In India, diversifying crops is often understood to mean switching from less lucrative cash crops that have been farmed historically to more lucrative cash crops. As seen with the establishment of the Technology Mission on Oilseeds (TMO) to give push on soybean production as a nationwide need for the country's requirement for less dependency on imports, policy decisions and thrust on certain crops more than a given time also make a contribution to the crop shift (diversification). Changes in crops may be prompted by better market infrastructures and other price-related supports. Farmers may benefit from agricultural diversification by growing spices and other reduced, high-value crops.

On rain-fed soils, the risk of crop failures due to drought or decreased rainfall is mitigated via crop diversification and the cultivation of a wide variety of crops. Areas with severe soil issues are also seeing a trend toward crop substitution and diversification.

With modern agricultural technology, the requirement for crop variety has increased steadily, especially since the Green Revolution of the late 1960s and early 1970s. Expenses are a major factor in this. There is increasing economic strain on India's agriculture industry. Progress in irrigation, transportation, rural market presence, and the creation and dissemination of short duration and drought resistant agricultural innovations have all contributed to the lowering of non-economic concerns in crop choice by even small farmers. As a consequence of liberalization and globalization policies, price-related economic incentives will play an increasingly bigger role in altering crop mix at both the micro and macro levels. It stands to reason that as the economy evolves, government pricing and trade policies will become more effective tools for steering farmers' area allocation decisions and bringing the changes in crop trends into harmony with the new supply and demand dynamics. In a context where agriculture is driven more by improving productivity than by area expansion, the rising importance of cost economic incentives in crop choice can also lay the groundwork for the next stage of agrarian

evolution, where growth originates more and more from valuation productions.

Crop Diversification in the Indian Perspective

The demand for crop diversification is mostly motivated by financial incentives, and it has been on the rise ever since the introduction of modern agricultural technology, particularly during the Green Revolution of the late 1960s and early 1970s. Throughout the last half-century, India's agriculture industry has seen remarkable growth. We've gone a long way from the days of barely scraping by on scraps of food in the early 1960s to become not only self-sufficient in food grains but also sufficiently resilient to weather the terrible circumstances. The agriculture industry in India continues to struggle with inadequate infrastructure despite significant progress. Just around 36% of the farmed land has access to a reliable irrigation system.

Nowadays, sixty percent of the labor force is employed in agriculture. By 2020, it is envisaged that the proportion of the population depending on agriculture would decrease, but not proportionally, due to the growth of other sources of employment in rural regions, such as agro industries, supported infrastructure, etc. The goal is for 45–50% of the population to rely on farming by that time.

As compared to the yield achieved in agriculturally developed nations, India's productivity levels for several main crops fall short. These obstacles, in addition to widespread illiteracy, make it difficult for farmers to respond to market signals by shifting to more profitable farming patterns. Thus, they are unable to fully take advantage of the benefits brought about by the liberalization of trade. Since independence, agriculture in the nation has grown in vigor and resilience, although this expansion has been uneven among areas and crops. Nonetheless, the influence of economic liberalization policies has led to significant external pressures being exerted on India's agricultural industry. In the future, achieving lasting self-sufficiency and maintaining sustainable development with a focus on consideration of equality would need efficient and effective management of agriculture.

The Green Revolution technologies have sparked a number of trends, including an increased propensity towards crop specialization and commercialization of agriculture, both of which have socio-economic and environmental ramifications. These changes have helped increase land/labor productivity and net farm revenue, but they have also put at risk a variety of unfavorable outcomes, such as decreased farm employment and crop imbalances. Long-term agricultural productivity and development potential might be hampered by the negative environmental effects that result from changes in crop patterns, such as groundwater depletion, soil fertility loss, water logging, and salinization.

Crop Diversification Patterns in Practice

The number of crop types grown and the overall degree of dispersion or concentration in a state are both indicators of the variety there. Most northern states produce fewer crops and

are less diversified, as shown by the diversity pattern based on 30 crops. In contrast, practically all eastern and southern states are very diverse because they produce a comparatively large variety of crops.

When looking just at pattern of diversity based on area under various crop groups, most of the eastern and northern regions have bigger areas under less than two primary crops, namely wheat and rice, which explains for their higher index of concentration. In contrast, most of the land used for crops other than food is concentrated in the south and west. Time series analysis of the proportional area changes under different crop types offers a fascinating picture. The states of Haryana and Uttar Pradesh, as well as Rajasthan, Gujarat, and Bihar, have increased the proportion of their land that they devote to non-food grain crops and cereals like rice and wheat. They've shifted away from growing grains and other low-quality food staples in favor of more profitable non-food crops. Punjab, on the other hand, has decreased the share of land used for other high value quasi crops while increasing the allotment of specialist crops (rich and wheat).

Many societies rely heavily on the ecosystem services (food, fodder, and fuel) provided by agricultural systems, making their growth into a resilient area of research (Altieri, 1999). “The vulnerability of rural, agricultural communities to environmental change is exacerbated by the fact that many agriculture-based economies have very few other livelihood strategies” (Tilman et al., 2002), and that small family farms often lack the financial resources to invest in costly adaptation strategies.

In order to preserve ecosystem functions and services and save livelihoods, the research community faces the task of creating resilient agricultural systems via the use of reasonable, cost-effective techniques. So, despite severe drought or a significant decrease in rainfall, a resilient agroecosystem will continue to supply an essential function, such as food production. As the competition and failure of organisms is essential for ecosystems to operate and offer their functions, diversity may serve as the bridge between stress and resilience in agricultural systems (Heal, 2000). The key challenges connecting agro-ecosystem diversity to functional ability and resilience were laid forth by Vandermeer et al. (1998).

Conclusion

The agroclimatic conditions in India vary greatly due to the country's large size and continental nature. Regional niches for different crops have developed as a result of these differences. For a variety of agronomic, meteorological, hydro-geological, and even historical reasons, areas have historically been identified with the crops wherein they specialize. As a result of developments in biochemical and irrigation technology, the agronomic niches have shifted considerably. The general increase in crop yields and the particularly high yields of cereal grains brought about by irrigation and other advances in farming technology have enabled farmers to obtain a specific output level with reduced size, or more outcome with a specific level of area,

thereby generating the situation for inter-crop region shift (diversification) without much disruption in output level.

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