

Does Socio-Economic Dynamics Influence Crop Yield Variability?

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Abstract

This study provides an organized synthesis of the current state of an area of research on socio-economic elements that substantially impact decision-making towards crop production scheduling and the farmers' adoption of various agricultural technologies. A theoretical understanding of the findings of multiple authors on existing socio-economic factors has been reviewed exclusively in a dynamic way to ascertain the gap in findings and the most relevant aspects to provide a comprehensive scenario on socio-economic dynamics influencing crop production and to arrive at a probable recommendation therein, particularly for the zone of Northwest India for the study period, i.e., 2016-2021. The study reveals that socioeconomic factors have much evidence with comprehensive ways to influence crop yield variability. Since the majority of farmers are small and marginal, factors such as their level of education, age, awareness, perception, financial limitations, behavior, management ability, etc., have an impact on the decision-making process when it comes to crop planning. On account of their limited resources, they need more self-convinced and expertise to embrace better farm practices and strategies. In addition, societal issues, including politics, religion, the environment, and other elements, have been found to influence output and productivity. However, the study also finds some critical comments from various authors. Further, policy framework, specifically *inter alia* total subsidies, may support the farmers in improving their livelihoods to a large extent. A citation map has been presented to show the relationship between various socioeconomic factors. Besides, proper guidance and communication from agricultural scientists as well as govt. policies can motivate farmers to adopt new production technologies that could be easily affordable, environment-friendly, and economically viable. However, the study also stresses collecting more primary data for feasible intervention with socio-economic constraints.

Keywords: Farmers, crop production, socioeconomic factors, new technologies, policies, and subsidies

1. Introduction

Agriculture is the soul of India's economy. Residents of India depend on agriculture which contributes nearly 60% of their income. Population pressure on agriculture constantly rises due to the increasing demand for primary agricultural products like food, fuel, and fiber. Though agriculture is risky, the variability in crop productivity threatens food security and the country's economy¹. Much work has been done on the input side to assess their roles. However, studies on socio-economic factors in this respect have shown many dimensions with time and have limited scope for proper inference. Thus, evaluating the variability of crop production and identifying all potential socio-economic factors is essential. The climate and availability of natural resources (water, nutrition, etc.), being the primary factor influencing crop yield, has been researched extensively¹. However, little emphasis is given to identifying socio-economic factors that could provide an alternative insight that will lead to indicating socio-economic attributes that should be managed more efficiently to combat challenges associated with increasing 'demand-supply gaps' in the event of crop yield variability. Crop production has a strong relationship with some socioeconomic factors². Accessing information on socioeconomic characteristics is itself a difficult task. The availability of socio-economic data depends entirely on interactions with farmer-respondents through survey work, unlike data collection for climatic factors and natural resources, and the location of those survey areas is territorial and remote, which restricts the scope of data collection. Henceforth, this study intends to review, assess, and highlight such socio-economic factors based on their considerable impact on crop production. In particular, the review focuses on the socioeconomic causes of the decreased wheat yield in the northwest part of India in the early 2000s.

Crop production encompasses a variety of management strategies and socioeconomic factors that influence the yield of crops. No real-time data on these factors is currently available. Small and marginal farmers are solely involved in farming, operating under different soil types, climates, and socioeconomic conditions³. The scarcity of prime resources like land, capital, and labor severely reduces the efficiency of small farming systems⁴. Various obstacles, including the lack of new production methods, biophysical or geophysical rules, manual labor, marketing system, societal standards, and legislative issues, have been reported⁵. The key to production is farmer participation and their appropriate decision-making at each phase of crop production.^{6,7} Agricultural methods are becoming more capital-oriented, technology-intensive rather than labor-intensive over the past 20 years due to the release of new varieties, synthetic inputs, sophisticated irrigation techniques, and post-harvest management.^{8,9,10,11}

Researchers have realized the importance of socioeconomic factors in farming and have studied their impact on increasing agricultural productivity^{12,13,14}. In addition, the decision-making of the farmers on the use of land, cropping pattern, and selection of enterprises are influenced by the choices, attitudes, and behaviors. Moreover, the farmers face different kinds of risks, such as price risk (i.e., whether they will receive a less or higher price than the minimum support price), input risk (i.e., risk of water shortage or

labor), yield risk (i.e., risk of pest and disease attack), institutional risk (i.e., govt. policy for export-import and movement of products) other risks (i.e., health issues of family members or damaged pieces of machinery)¹⁵. All these factors together affect production efficiency. This study, thus, aims to explain, summarize, and shaping outline how these factors can affect yield variability.

2. Methodology

Here, potential socio-economic factors outside the realm of natural resources (such as climate and soil) are listed that farmers encounter during the crop production period and impact crop yield. Together, these elements significantly influence the economic production of a nation. The study tries to demonstrate the relationships between socioeconomic issues and how they directly or indirectly affect agricultural yield. For the entire region of North-West India (the States of Punjab and Haryana), including outlying places, it is difficult to acquire sufficient statistics. To compile a list of all the potential factors that could be expected to have an impact on agricultural yield and production in that region, multiple multivariate articles have been studied. Due to abnormal yield variability in the early 2000s, wheat, one of the most significant crops in northwest India, has been considered for the study¹⁶. The key socioeconomic components have been represented schematically in Fig. 1.1.

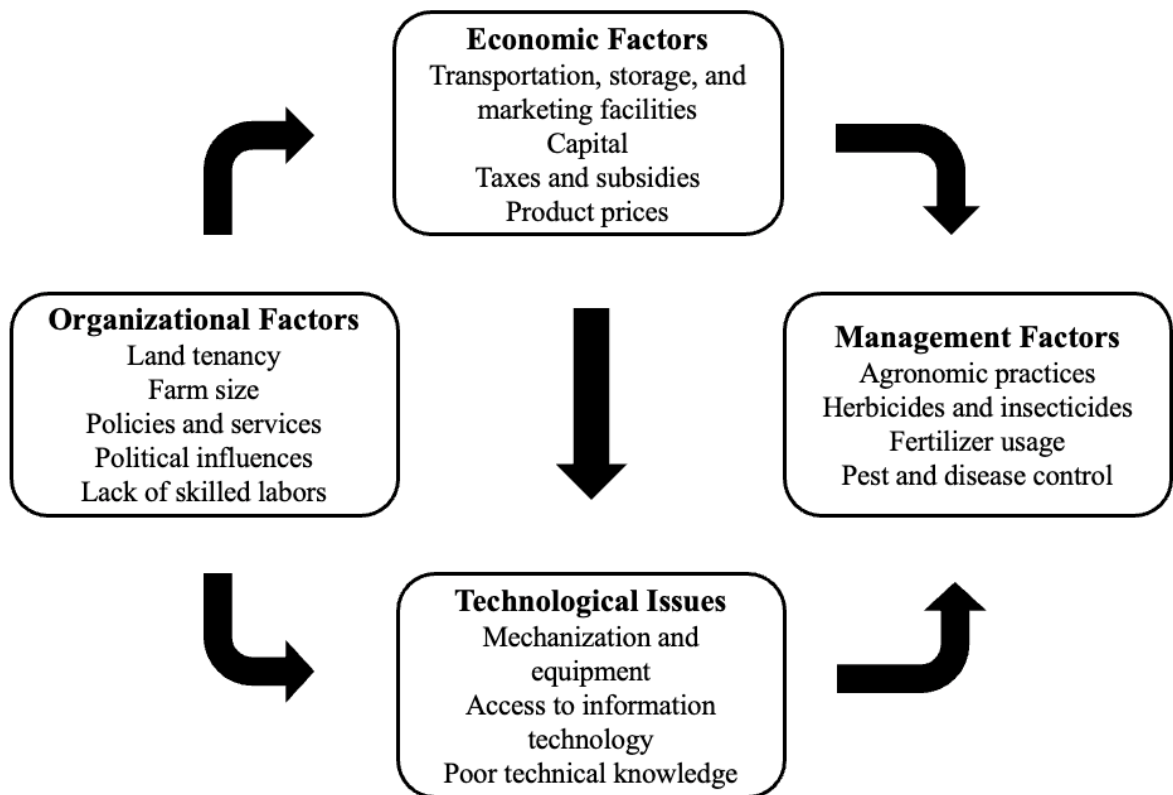


Figure 1.1. Diagram representation of the tangled socio-economic dynamics for influence wheat yield

3. Results and Discussion

3.1. Association between socioeconomic factors

The studies of researchers and policymakers show that all socioeconomic factors are interconnected. It is also reported that organizational behavior impacts the economic, technological, and management aspects of any production activity. Of late, management consideration is found to determine crop performance strongly. Improved management practices raise the likelihood of higher levels of yields. Rich farmers can use more improved methods to upgrade their income level, whereas poor farmers cannot due to capital constraints. Since the profit margin can be very small or sometimes invisible due to uncertain climatic situations (flood, drought, forest fire, heat wave, etc.), it is challenging for poor farmers to follow managerial practices and spend more resources farming.

3.2. Organizational Factors

1. Land tenancy

Land tenancy means holding land without ownership to use, care for, and benefit from. The availability of land in India is consistently constrained by the pressure of the growing population^{1,17,18}. The span of land tenure significantly impacts crop yield and cropping patterns. According to the tenure of the land and the length of ownership, the crop type or pattern is chosen. The length of the land tenure is another factor that affects farm management plans. For instance, the term is determined by the fertility of the land in northeast India. Similarly, the land is only leased for a year or two for Jhum farming. This tenancy structure has altered since independence, but the farmers still need improvement. According to Junankar, it is possible to examine the effects of transferring ownership to tenant cultivators on agricultural output by comparing the two farmer types—"owners" and "tenants"¹⁹.

2. Farm Size

The majority of farmers in India are "marginal (36.33%) (who own or lease ~1-acre land) or "small, 30.08% (who have ~5-acre land) with land holdings ranging from 1 to 5 acres respectively²⁰. But they own only 47.34% of the total cultivated land. As a result, most of them lease land to others to cultivate and produce crops for their living. Instead of this, 275 million tonnes (MT) of food grain were produced globally in 2017–18, even though most producers lack access to the facilities and resources needed for the production process. In India, operating holdings are getting smaller on average every year. The average size of a farmer's holding, as reported by the agricultural census (2015–16), was 1.08 ha. Although in Punjab, the size was much higher (3.95 ha) during the same period.

3. Governmental policies and services

Institutional support through various government policies has played an important role in agricultural production. Change in govt. policies may affect the supply side and demand size of any production sector. Prices of inputs (seed, fertilizer, pesticide, etc.) and prices of output will be affected due to this policy change. It may also affect the degree of domestic trade (e.g., movement of commodities and sales) and international trade (e.g., tariff and quota). Govt. had developed many agencies for promoting agricultural trade in India and abroad. When the government develops some procedures and technologies to follow, it encourages the farmers to adopt those practices. This approach can improve farmers' overall socio-economic standards if appropriately implemented^{21,22,23}. A wide range of political decisions and priorities have been found to act dominantly on Indian agriculture. Conflict among different government policies also appears. Policy towards subsidies to various components and agriculture sectors influences the production decisions of farmer-producers.

4. Availability of proficient labors

Presently, young generations are drawn to information, software, and higher-paying employment²⁴, which results in a shortage of knowledgeable and skillful young farmers and has a detrimental effect on crop productivity. On the other hand, because of the high demand for farm workers, small and marginal farmers cannot afford to better techniques due to high wage rates and, thus, are deprived of good crops. A farm family is a unit of both production and consumption. Applications of the level and quality of inputs vary on a household basis, which, in turn, affects the enactment of the agriculture system to a large extent²⁶.

3.3. Economic Factors

1. Capital

Capital is a basic factor of production and serves as an instrument of production. Other factors of production are land, labor, management, and information. The majority of Indian farmers are suffering from capital constraints. Financial constraints refrain them from performing capital-intensive activities. Several factors, such as those affecting output, pricing, risk, and transaction, as well as the availability of and convenience of rural agricultural financing, limit farmers' access to capital. Due to creating capital, farmers go for loans or mortgages. It always remains a challenge to them to repay the loan in time due to the uncertainty of remunerative prices. As a consequence, many farmers are found to lose interest in farming. High-value crops (HVC) usually need more capital; therefore, poor farmers avoid those crops. An efficient system of irrigation is another important requirement for successful production. Thus, adopting HYV (high-yielding variety) crops, which need an assured water supply, is only possible when capital adequately supports the production system. The level of farmers' income or resources dictates their

capacity to access loans, which affects their decision on crops, farming practices, and desire to invest in sophisticated technology or crops^{27,28}. It was opined that a favorable policy regime by the govt. may be extended for private investment in agriculture (75% of total investment) and more public share in technology, infrastructure, institutional development, reforms in the institutional credit system, efficient management of public infrastructure, and building and natural resource base development²⁹.

2. Taxes and subsidies

Agriculturists in India get relief from paying income tax. The exemption is also available from capital earning from agricultural land (whether long-term or short-term)³⁰. Thus, the amount saved from this will be invested for higher production. Indian government provides agricultural subsidies and other financial support to the farmers to increase their income through high-value crop and agri-business activities. Study confirms that input subsidies have steadily increased, but public-sector agricultural investment has declined. Agricultural production is assumed to be affected by public investment in general, while subsidies are only effective in the short run³¹. However, properly implementing subsidies towards seed, energy, irrigation water, fertilizer, and low-interest crop loans is far from satisfactory. Fertilizer subsidies were raised from Rs. 1.05 lakh crore in 2022-23 to Rs. 2.30 lakh crore in 2023-24 (www.thehindu.com). The central government will pay a subsidy of 55% of the suggested unit cost to small and marginal farmers and 45% to another farmer under PMKSY (Pradhan Mantri Krishi Sinchayee Yojana) to establish drip and sprinkler system of irrigation (<https://govtschemes.in>). Gulati and Sharma³² opined that increasing agricultural investment has proved to be a better value than short-term measures like subsidies.

In India, Govt. spends 0.6 percent of GDP on net positive agricultural support for consumer benefits. Farm subsidies in India were substantially below the WTO's 10 percent standard in 1919. The net sown area under tube well irrigation grew from 22.33 thousand hectares (58%) to 29.81 thousand hectares (72%). In comparison, over the last 30 years, the coverage of the canal irrigation area has declined from 16.60 hundred thousand hectares (43.5%) to 11.60 lakh hectares (28%) (Punjab Govt: www.punjabstat.com). Punjab Govt. will have a 'new' policy this year since Green Revolution in 1966³³; using policies, different agricultural systems have evolved based on farmers' needs^{34,35}. Other policies, such as those concerning labor, immigration, or water, may not always be aimed at agricultural development. Subsidies for inorganic pesticides and disorganized irrigation systems should be reduced on sustainable ground and reduce water consumption³⁶.

3. Product prices

This is the core issue for making Indian agriculture remunerative. Price fluctuations and uncertainty remain to be the main issues of agriculture markets. But when the volume becomes large and unexpected (volatile), they can negatively impact the total food security system (www.fao.org). The living cost has

increased, but the farmer's income did not rise proportionately. The opportunity cost of agriculture to them is almost nil (no alternatives). Many farmers keep their profession hanging, creating a major threat to agriculture and economic development. Governmental regulated price policies (MSP) for selected crops are not always accessible to them. The price policy aims to ensure remunerative prices to growers to encourage higher investment in agriculture by making available food supplies at reasonable prices to the consumers.³⁷ Thus, uncertainty in price makes agricultural business riskier. The volatility of price influences the area under cultivation. However, while making decisions, farmers hesitate to invest in commercial agriculture because of the risk in returns³⁸. The socio-spatial factors also contribute to the variation in average crop prices across different markets.³⁹

4. Marketing Facilities:

Marketing facilities shape the way for an efficient marketing system. Agricultural produce has typical characteristics of perishability, bulky and seasonal. Efficient marketing requires timely disposal, easy transportation, and storage facilities. The process involves multiple functions for which market infrastructure is very necessary. Infrastructure availability and utilization framework to examine the relationship between rural infrastructure and agricultural development appears to be the most priority for agricultural development. Higher infrastructure availability and utilization indices positively and significantly impacted agricultural productivity⁴⁰. Besides, demand, accessibility, the nature of produce, market size, etc., have also shaped marketing facilities. Unfortunately, due to financial constraints, many farmers cannot afford to avail facilities/services. The issue is particularly prevalent in hilly regions like Northeast India, where inadequate transportation facilities pose challenges to the farmers²⁴. Consequently, it is the practice that small farmers sell short-duration perishable vegetable crops in nearby rural markets due to the non-availability of transportation and storage facilities.

3.4. Technological issues

1. Mechanization and types of equipment

The degree of mechanization notably enhances the cost-effectiveness (including seed, irrigation, and fertilizer expenses), production, productivity, time-saving, income, and overall efficiency on various crops⁴⁰. Farm mechanization has changed from hand-drawn bullocks to tractors to automated farm equipment. These changes still needed to be accessed in many rural areas. Poor farmers are still forced to continue traditional farming, which is the cause of limited production, low crop diversification, cropping patterns, and cropping intensity. But evidence shows that technological up-gradation has got a remarkable positive response in Punjab and Haryana, and as a consequence, farmers are financially more benefitted. Northern regions like Punjab, Haryana, and parts of Uttar Pradesh have witnessed accelerated progress in mechanization. Among these, Punjab stands out with the highest farm power availability in India at 3.5 kW/ha, compared to the national average of 1.5 kW/ha.⁴²

2. Access to information technologies (ITs)

ITs help in improved production technology and efficiency, post-harvest practices, decision-making, price and weather forecasting, remote sensing and GPS location, and smart agriculture. According to a survey on internet usage across rural India in 2017, it was found that approximately 14 percent of the farmers used the internet to browse, chat and listen to songs and only 2% of farmers used apps in farming⁴³. Rural India generally demands more television, radio, and internet services. The lack of communication keeps the farmers deprived of having all this information. Govt. and different institutions and NGOs may take more initiatives to expedite the innovative extension services with traditional farmers' fairs, interactive sessions, and field days. Policy investment towards different IT media, like e-mail, mobile, Apps, etc., should be popularized. In Punjab, a majority (88%) of the farmers were daily users of ICT, 62% used smartphones, 34% used them for socializing, and 58% used WhatsApp in agriculture⁴⁴. Various other factors that affected the use of such tools in agriculture were the farmer's age, land holding size, educational qualification, and the cropping system. Thus, information technology (IT) is an integral part of remunerative farming compared to traditional farming.

3. Technical knowledge in basic agricultural subjects

Improved technical knowledge of the farmers can cope with many crop production challenges, including improved weather forecasting, reduced wastage, etc. This can enhance yields and profit margins. Interaction with agricultural scientists, extension workers, and other functionaries may improve the farmers' knowledge. Updated knowledge in basic subjects like agronomy, weed management, disease and pest management, soil health, modern irrigation methods and water management, genetics (improved crop variety), wastage management, and data maintenance for good decision-making should be shared continuously with the farmers⁴⁵. The lack of technical knowledge in implementing new technologies or practices also influences farmers' inclination to embrace them^{46,47}. Additionally, certain farmers resist adopting new technologies due to entrenched beliefs, conventions, and family traditions.

3.5. Management factors

Of late, issues related to farm management are assumed to be one of the basic requirements for optimum production, cost-effective and profit-maximizing farming, and, accordingly, management cost is now added to the total production price by govt. of India⁴⁸. Though small and marginal farmers do not bother it, this estimation system is followed in capitalistic agriculture. Some technical issues like optimum use of inputs (mainly seed, fertilizer, and irrigation), a scientific package of practices, application dose and methods of herbicide and pesticide, etc., involve many management practices. Efficient management practices (planning, organizing, directing, and controlling) always afford success in crop production in terms of yield and returns.

Poor management on the part of the farmers leads to poor yield as it influences other technical factors too²⁴. Besides, distance of household from main roads and input-output markets was influenced yield variability; The study also found that extent of possession of resources and management techniques significantly increased crop productivity⁴⁹. The other factors are assumed to be 'error-free' for holding adequate expertise in crop production by the Indian farmers.

3.6. Demographic, social, cultural, and environmental factors

1. Farmers' age and education

'Knowledge or level of education and farmers' age are essential demographic features to influence technology adoption and decision-making. Lack of education insists the farmers be indecisive about new technology. They might possess a highly traditional mindset or overlook environmental considerations^{27,50,51}. Consequently, very few agricultural technologies were adopted, thus, leading to low production and productivity. Expanding educational facilities in rural areas with policy priority will promote the agricultural system effectively. Old education level stands in the way of their choice and adoption of technology. The mean age of farmers in India surpasses that of other nations, which also discourages future progress of agriculture development. Generally, older people are less enthusiastic about learning or switching to improved technologies and management practices due to their traditional perception of sticking to the old ones. They avoid risks associated with adoption. Therefore, target-oriented agricultural educational programs need to be enhanced in India in conformity with other developing countries⁵², and the youth should be motivated with updated knowledge about the prospective livelihood with agricultural business.

2. Population pressure on agriculture

India's rapidly growing population demands a steady increase in agricultural production to ensure food security. In 2030, the total demand for food grain is projected at 355 million tons, with a population of 1.75 billion (approx.). It will be challenging to feed the people. Presently, India produces 323.55 million tons (2022-23), which is inadequate. India must have more than domestic demand for external purposes (export and welfare). Thus, the necessity of adopting improved technologies and management practices is much more important. To access adequate food, it is found that the nutritional quality has been deteriorating continuously due to defects in food storage and distribution systems⁵³. India had pledged to cut down hunger by half by 2015 (according to the Millennium Development Goal), but it is still awaited⁵⁴. India also contributes significantly to global food security by exporting affordable grains, spices, meat, and processed foods⁵⁵. Therefore, institutional support for finance to promote technological adoption and change of farmers' attitudes are necessary to increase food production and productivity, which, in turn, may increase farm income and reduce hunger.

3. Rural environment

Agriculture and rural development are inextricably linked. Rural development has a crucial role in agricultural development and the economy. Rural development must provide the necessary infrastructures, such as roads, markets, and storage facilities, to support agricultural production, distribution, and exchange. This, in turn, generates income and jobs in rural communities and helps to reduce poverty and inequality⁵⁶. Most rural areas are still lacking basic facilities (infrastructures and public utility goods), which require more investment urgently. Govt. has introduced Agriculture Acceleration Fund in its recent budget (2023-24) for this purpose.⁵⁷ Besides, the digitalization of rural areas will make people more aware of the commercialization of agriculture, which will lead to more production and more income from domestic and foreign markets.

4. Religion

India is home to various religions (e.g., Hinduism, Islam, Christianity, Jainism, Buddhism) and numerous culturally rooted indigenous beliefs. But it shows an extraordinary sense of cohesion among the people. Experiences show that religions restrict some people from following or adopting specific production activities. In some parts of rural areas, individuals still hold onto superstitions and steadfastly adhere to their religious convictions. At times, these beliefs can adversely impact crop production. For example, in northwest India, especially in Haryana, sunflowers were grown as a profitable cash crop during the short interval between the kharif and rabi seasons. However, the local Neelgai (a species of antelope) population, which Hindus revere like cows, multiplied rapidly and posed a serious threat to the sunflower crop. Instead of managing the Neelgai population, cultivation was limited. This practice changed the region's cropping pattern and deprived the farmers of having a financial advantage. Thus, proper education and communication without hurting people's beliefs can play a better role here⁵⁸.

3.7. Citation map

Initially, a flowchart of the relationship between the factors and yield is shown (Figure 3.2) to provide a clear picture of the objective of this study. Then a citation map has been developed to depict the schematic relationship among all the socio-economic factors affecting crop production, as evident from the linkages that connected these parameters. The institutional factors include different government policies, which determine crop production input costs. So, this factor influences farmers' economic well-being (taxes, subsidies, and product prices), choice of crops, and management practices. Based on financial needs, farmers use technologies that influence yield and the overall efficiency of the system. Small and marginal farmers are found to use inferior technologies and low-cost resources (seeds, manures, fertilizers, pesticides, and fungicides) in farming due to low levels of funds. The inadequate financial positions of the farmers and the absence of productive investment are assumed to be the most important influential factors for productivity and production⁵⁹. Figure 3.3 employs arrows to depict direct

relationships. Indirect connections among the factors are omitted in this illustration to maintain clarity in the citation map. Additional factors are excluded from the citation map as they are independent and challenging to establish direct connections with. This approach is made from the findings of a literature review due to the non-availability of ample field data and statistical analysis.

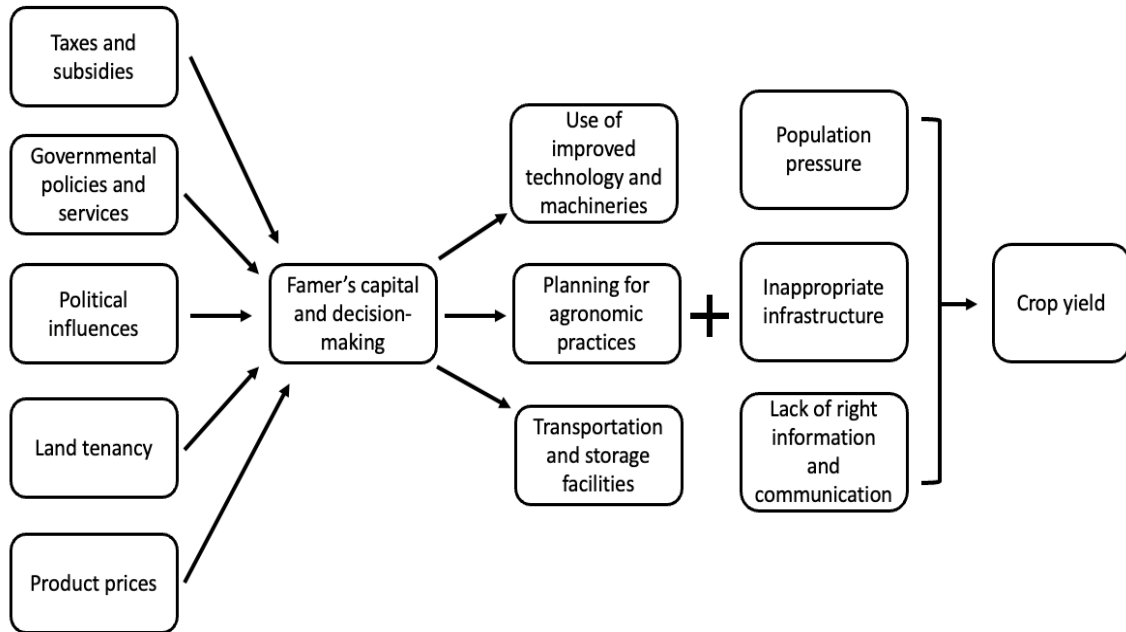


Figure 3.2. Relationship between socio-economic factors and crop yield

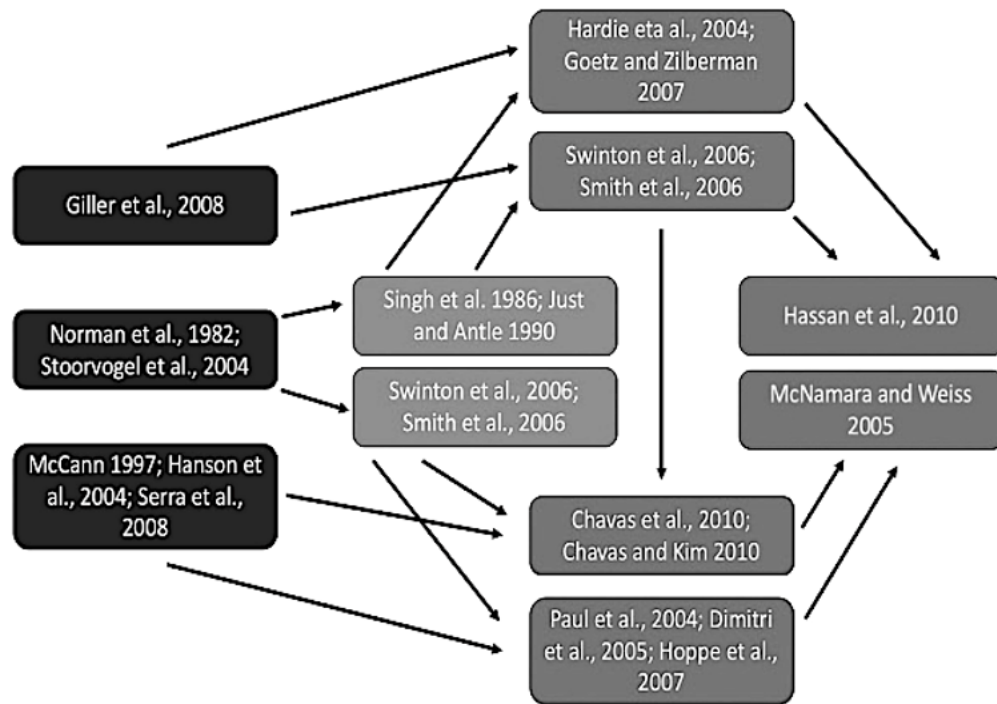


Figure 3.3. Relationship among socio-economic factors based on cited literatures

4. Conclusions

The study, thus, reveals that socio-economic factors have got much evidence with comprehensive way to influence the crop yield variability. While examining the reviews of many authors, the broad issues like organizational, economic, technological, management and demographic factors have appeared dominantly along with the socio-economic factors. The important socio-economic constraints that have been identified in the analysis include land tenancy system, farm size, skilled (young) labour, capital (agricultural credit), market and product price, farm mechanization, access and knowledge of information technology (IT), farm subsidies, management of resources, farm risk, awareness, age of the producers, population, rural development, govt. policy and religion and they are found to be linked with socio-economic perspectives of India agricultural system. Assessment on qualitative and, to some extent, quantitative analysis of these factors show that all these factors eventually affect the agricultural production, productivity and financial benefits of the sector. Many studies also find that socio-spatial attributes also have unique role in shaping the yield variability of crops in India. Findings

also confirm that the factors responsible for yield variability with special reference to socio-economic components are not independent. They are tied up with each other directly or indirectly. In this context, an effort has been made to demonstrate these relationships with citation map for the information as derived from various sources and authors. Reduction of communication gap between farmers and scientists has been advocated for good adoption of consistent production enhancing technology. To conclude, it may be stated that socio-economic issues can be thoroughly considered while examining their impacts of yield prospective of agricultural crops in India. Govt. may take more pro-active agricultural policies on all broad issues as stated above to reduce the crop variability which, in turn, will increase the level of production, productivity and return. However, more feasible studies on assessing these factors will be ascertained after on collecting data from the farmers directly to provide a better insight and condition of the current situation for further intervention.

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