



Transition of Indian Agriculture from Glorious Past to Challenging Future: A Serious Concern

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Abstract: Agriculture is different from socio-economic activities and plays a consequential role in the economic development of a nation. Beginning with the origin of agriculture, Indian agriculture availed its golden period in connection with the prosperity of farmer and farm. But due to the invasion of certain foreign emperors, glorified Indian agriculture got ruined. After independence, some efforts had been taken by Govt. of India such as the Green revolution, etc. to intensify the Indian economy. Despite increasing growth, production, agriculture faces various socio-economic and environmental challenges. Particularly, agriculture participation in GDP decreases from 67.5-14.39% from 1870-71 to 2020-21, which is an alarming signal for the nation. In this respect, there is an urgent need to take some sustainable steps incorporating in policies and planning's towards holistic welfare of agriculture.

Keywords: Ancient agriculture, Disturbing present, Green revolution, Sustainable agriculture, Vedic agriculture

Agriculture plays a significant role in the socio-economic development of a nation. In India, agriculture is considered as a backbone of the economy which incorporates sustainable socio-economic intensification. Occurring from Indus valley civilization, agriculture changed the lifestyle of early man from nomadic hunter to cultivator along with the domestication of various animals (Gupta 2004, Eagri 2011). Plants and animals were considered essential to the survival of ancient Indians, worshiped and venerated in the era known as the 'Vedic period' in Indian history. Along with cultural development, agriculture is also benefited from the wisdom and teachings of great saints. Traditional farmers established environmentally-friendly agricultural techniques and practises such as mixed farming, mixed cropping, crop rotation, and others, which are detailed in ancient Indian literature (Eagri 2011). Following then, India was the victim of invasions by foreign monarchs who came mostly for robbing and by the time commanding. In a similar vein, the East India Company arrived in India, enticed by the trade-in spices and plantation crops, and eventually governs huge swaths of the country. They take Indian agriculture as a source of revenue generation with great zeal. As a result of that much extent of revenue collection, the Indian cultivators and the villagers both were destroyed (Pandhari 2016).

Not only this, the Indian economy had been a victim of enormous exploitation in terms of natural resources (fields and forests), iron ores, gold mines, wealth, and manpower, which were subjected to intense exploitation. Due to these

atrocities, even after Independence, the Indian economy showed poor economic growth. Green and White Revolution were commencing to uplifting the agriculture sector in India along with farmer's welfare. The agricultural industry was able to produce substantially bigger quantities of food as a result of the Green Revolution, due to high-yield crops and multiple cropping methods. Operation Flood was launched in 1970 with the goal of increasing milk output, connecting milk producers and consumers, and increasing dairy farmers' revenue (OECD-FAO 2014). No doubt, these efforts increase crop productivity, which made it possible to feed the growing population. But there are several adversities that emerged due to the uncontrolled use of chemical fertilizers, synthetic herbicides and pesticides; India seems on a verge of a critical situation with facing many troubles in the socioeconomic area along with environmental hazards. India still has to face various obstacles to combat hunger. This paper, emphasize India's traditional agricultural wealth, which guides us to overcome all these problems incorporated with new technologies. Therefore, this communication is an effort to deal with the entire scenario of the Indian Agriculture system along with current challenges to overcome.

Indian Agriculture: A Journey from Glorious to Atrocious

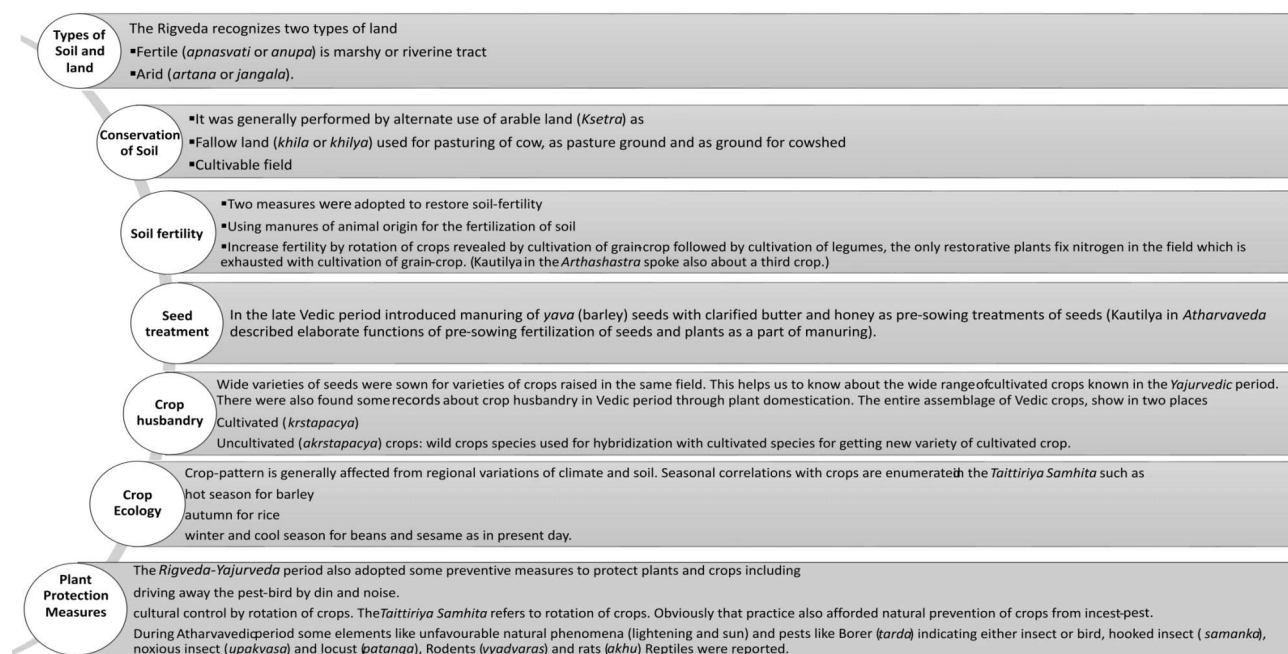
India's modern society is one of the world's oldest living civilizations. It has a long history dating back to around 9000 BC, during which the development of agriculture is intertwined as a result of early plant cultivation and domestication of crops and animals. Agricultural technology

and practices, including iron instruments, the cultivation of a wide variety of cereals, vegetables, fruits, the use of meat and milk products, and animal husbandry, are all mentioned in the Vedic writings (*Rigveda*) between 3000- 2500 B.P. (Encyclopaedia Britannica, 2019). "Agriculture in the Vedic period was thus a religio-social activity with all its ancillary aspects from soil to weather forecasts". Figure 1 and 2 show how wealthy agriculture technology was adopted by Vedic people in India, exemplifying the level of concern for socioeconomic and environmental welfare. It may be recognized as the "Golden period of Indian agriculture" in the context of welfare in every aspect starting from a farmer to country and environment too.

In the Medieval Period (200-1757CE) irrigation and crop protection methodologies were also practiced for sustained, in addition to previous agricultural practices. During 1325-51, a broad revenue system including related officials also came into existence to assess the financial aspects of the area. Mughals devised and implemented extensive agriculture management practices on a rational basis (Prashant 2011, Richards 2003). In the 14th century, the canal system of irrigation was coming into existence, which was a notable work for agriculture history. But the village headmen and peasants were charged in respect of the canal by the ruler. Overall, the peasants have to pay three major taxes, viz. land revenue (*kharaj-jiziya*), house tax (*ghari*), and the cattle tax (*charai*) (Raychaudhuri et al 1983). This can be considered as the beginning of downfall of farmer's life in every aspect,

which was directly related to the prosperity of agriculture.

In Colonial British Era (1757–1947 CE) agriculture remained more or less stationary during this period. Rather than food grains, the emphasis is on cash and plantation crops. Main focus on commerce leads the lower food crop output, widespread poverty, and farmer destitution. Policies benefited the rulers more than the ruled. During this period while the population increased the food output reduced. Furthermore, between 1600 and 1871, India's per capita Gross domestic product fell substantially. From the mid-17th century, as British living standards rose, India lagged more behind. Whereas Indian per capita GDP was more than half that of the British in 1600, it had dropped to less than 15% by 1871 (Broadberry and Gupta 2009). Under the British, the condition of the Indian peasants deteriorated steadily, though the agriculture sector had a 67.5 % share in the Indian economy at that time (History discussion 2019). Indian peasants were forced to produce cash crops including tea, coffee, sugar cane, jute, indigo, and opium, which ruined the land's fertility and made it impossible to grow any other crop. The growth of a minimum of subsistence crops resulted in the decline and destitution of Indian agriculture and cultivators. The peasant was devastated under the triple burden of the government, landlord, and moneylender. The lack of interest in agricultural development and in the utilization of modern equipment and procedures on the part of the British government also devastated Indian agriculture (Pandhari 2016, History discussion 2019).



Source: Roy 2009, Eagri 2011

Fig. 1. Salient features of Vedic agriculture system

Pre-colonial India was self-sufficient and sustainable since it grew only two crops: rice and wheat. But colonialism introduced the concept of cultivation for the market. Although, agricultural exports from India grew at a fantastic rate and increased by more than 500% from 1859-60 to 1906-19. But Britishers, rich farmers, big Indian traders, and moneylenders reaped the lion's share of the profits generated by the export trade. This posed rural Indian communities at greater risk of damage. Further, the transition from food crops to cash crops exacerbated the disaster in famine years. Even in 1876-77, shortly before one of the century's worst famines, exports grew to stay profitable to meet Land Revenue demand. In the midst of catastrophic famine and starvation in India, it was also continued in 1897-98. The Famine Commission's reports from 1880, 1898, and 1901 provide significant evidence for examining these events, and indicating that food grains were present even during famine years and concluded that "the surplus produce of India, taken as a whole, still furnishes ample means of meeting the demands of any of the country likely to suffer from famine at any one time, supposing such famines to be not greater in extent and duration than any hitherto experienced". Thus, during the years of acute hunger, food grains were exported. These Famine Commission Reports argue that the effects of famine during British India were caused by an insufficient food supply rather than a shortage of food (Environment and Society 2019). Although, an extension of irrigation, banking sector, and agricultural

research was the major positive works to develop the agriculture sector. However, the British had played the role of administrator and collection of revenue than the welfare of India. Hence, there was no motivation to increase crop yield. Consequently, the agriculture sector was ruined through exploitation and insecure land ownership in India (Pandhari 2016).

Indian Agriculture Post-Independence: An Urge to Reclamation

In comparison to the pre-1939 period, the decline in productivity has been continued post-independence. During 1946-47 and 1949-50, the average cereal yield per acre fell from 280 to 256 Kg. India's total output fell from 0.9 metric tonnes in 1938-1939 to 0.86 metric tonnes per hectare in 1951. The studies undertaken by ICAR and the Grow More Food Enquiries were reached similar conclusions (Economics Discussion 2019). Thus, to address domestic needs, India relied on imports and food aid. As a result, economic planning was implemented in 1951, with a particular focus on agricultural growth after 1962. Following the economic reforms, the agricultural sector experienced tremendous growth, attributable to the earlier changes as well as contemporary innovations in agro-processing and biotechnology (Balakrishnan et al 2008).

Indian Agriculture: Through Green and White Revolution

The Green and White Revolution are the two key events that have changed the face of Indian agriculture. Interestingly with the usage of high-yielding seed, the Green Revolution in

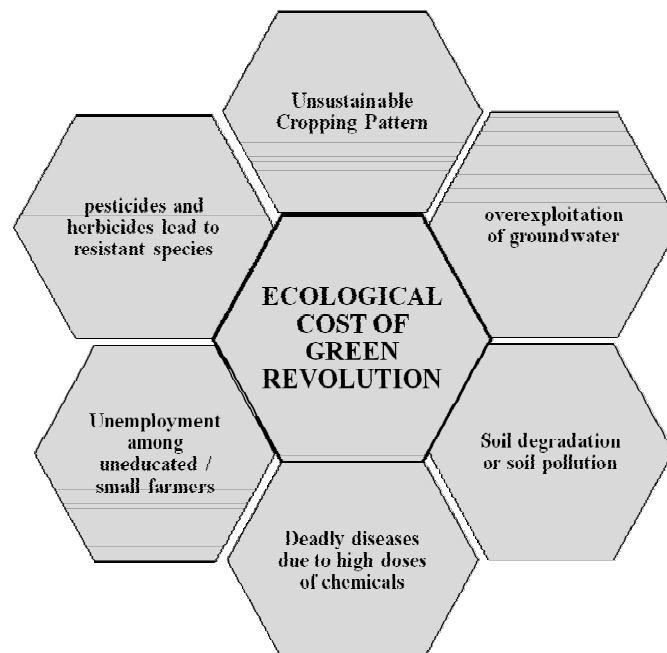


Fig. 3. Effect of green revolution on environment and farmers

the 1960s reflected in enhanced production of the country's major commodities like wheat and rice. White Revolution, which revolutionized the dairy industry with the introduction of Operation Flood in 1970, that boosted milk output and also connect customers and milk producers, and increase dairy farmers' revenue. As a result, India has surpassed the United States as the world's biggest milk producer, accounting for 22 percent of worldwide production in 2019-20, with 198.4 million tonnes estimated to be produced (Economic Times 2020, FAO 2021).

Reformation of Indian Agriculture and Economy by Green Revolution

Agricultural output has been strong over the last three decades, and importantly food production has been able to meet the expectations of a growing population. From the mid-1960s onwards, the introduction of high-yielding seeds (such as improved wheat strains) and the increased use of chemical fertilizers epitomised what became known as the 'green revolution'. Between the mid-1960s to mid-1970s, wheat production climbed by about 150 percent, and the country became grain self-sufficient by the end of the decade. Agricultural production increased, resulting in lower food prices and higher rural incomes (Kumar, 2014). The stagnation of agriculture was reversed with the establishment of economic planning in 1951 and a special emphasis on agriculture growth, particularly after 1962. The average yield per hectare and the area under cultivation both increased steadily. The total production of crops increased as a result of this rising tendency. Food grain production grew at a slower pace of 1.4 % in 1949-50 or 1964-65, and 2.3 % in 1970-71 or 1980-81. In 1991-92, the growth rate of food grain production was regained to 2.8 % (Tripathi et al 2010). In a nutshell, India's green revolution (1967-1978) turned the country from a food scarcity to a surplus market. India has become a net exporter of food grains in the last three decades (Business Standard 2018). As a result of the Green Revolution, 5-year plans, and other government efforts in the Indian agriculture system, new opportunities, difficulties, and downsides have arisen. Figure 3 depicts the negative aspects of the green revolution.

The heavy reliance on inputs without regard for their long-term consequences has resulted in a slew of issues related to sustainability of agriculture. The agro-ecosystems are being threatened by irrational usage of chemical fertilisers, pesticides, and natural resource exploration. Soil health is depleting, water and air are polluted, and plant and animal genetic resources are eroding at an alarming rate. However, it's vital to realise that lower cereal imports did not reduce agriculture's reliance on foreign markets. Whatever gains are made in terms of reduced cereal imports are offset

by higher imports of agricultural requisites, particularly fertiliser. Prior to Green Revolution, expenditure on imports of agricultural requisites were essentially almost nil. Seven crore rupees were spent on this head in 1950-51 which is extended up to thirteen crores in 1960-61. This expenditure increased to 102 crores in 1970-71, and to 201 crores in 1973-74. Then came the spike in fertiliser prices, which resulted in an expenditure of 532.5 crores on fertiliser imports alone in 1974-75. As a result, Indian agriculture's reliance on imports had been rapidly increasing. Thus, after the Green Revolution, the agriculture sector's reliance on foreign inputs increased in a variety of ways. Previously, only food had to be imported; now, a range of inputs required to be procured. While the government had to rely on foreign countries for many of the new agricultural requirements, farmers had to depend even more on the government and the industrial sector (CPSI 2011). As a result of greater external dependence all around, the "Green revolution turning Brown".

Current Scenario of Indian Agriculture

India's agriculture industry is projected to account for only about 14% of the country's economy. However, it provides employment to 42% population. One of the major aspects which is critical for economic activity is rainfall because roughly 55 percent of India's fertile land is dependent on it. Agriculture sector's contribution to GDP has curtailed over the past few decades, as compared to the other sectors such as industry and service (Broadberry and Gupta 2009, Deshpande 2017, Balakrishnan 2021, Static Times 2021). Figure 4 depicted that, agricultural contribution in GDP was decline from 67.5 to 20.19 % during 1870-71 to 2020-21, perhaps due to lacking of suitable conditions for holistic development in terms of almost all the factors responsible for agricultural prosperity.

The services sector is the largest sector of India. In 2020-21, the services sector's Gross Value Added (GVA) is expected to be 96.54 lakh crore INR at current prices. While agriculture accounts for 20.19 percent of the economy, with a GVA of Rs. 36.16 lakh crore. But services sector has the lowest growth rate among the three sectors for the first time in 2020-21. Agriculture's performance is substantially better at current prices, as it has grown at the fastest rate of all three sectors since 2012-13 (Trading Economics 2019, Static Times 2021). Agriculture's contribution of GDP has surpassed nearly 20% for the first time in 17 years, making it the only bright point in GDP performance in 2020-21. Agriculture was the only sector to expand at a positive rate of 3.4 percent at constant prices in 2020-21, despite the fact that other sectors dropped. The share of agriculture in GDP climbed to 19.9% in 2020-21, up from 17.8% in 2019-20.

<p>Tillage (krsi):</p> <ul style="list-style-type: none"> •Ploughing was generally performed with the help of oxen in teams of six, eight or twelve and also with one or two sheep. •Furrow marks were made in grid pattern: Twelve lines made by plough drawn by twelve oxen were arranged in such a way that three lines arranged vertically, three running over them horizontally and the other six made crisscross. •Mowing (<i>matyam</i>) was the post -plough operation.
<p>Cropping System</p> <ul style="list-style-type: none"> •Sowing of seeds of different kinds in grid -pattered furrows and the methodology adopted for rotation of crops. •Reaping, threshing, winnowing and storing are the post -cultivating processes, noticed from the period of the <i>Rigveda</i>.
<p>Irrigation System:</p> <ul style="list-style-type: none"> •Natural irrigation, which include rain -supported and river - supported practice. •Artificial irrigation, which includes two devices non -flowing streamlets formed out of rain water, where water was poured on arable field out of these storages by means of droni (wooden bucket) and the other, was well-irrigation. •The <i>Sutra</i> period (<i>KausikaSutra</i> and <i>Grhya sutra</i>) shows large-scale use of artificial irrigation by well and reservoir dam. Canal -irrigation is thus envisaged widely used system.
<p>Animal Husbandry</p> <ul style="list-style-type: none"> •People in general were familiar with the different breeds of cattle. Among them two were prominent: milch cattle (dhenu) and draught breed (anadvan). •Horses of Indus and Sarasvati were highly esteemed and so was also the sheep of Gandharva breed which had high food -producing capacity. •Nourishment of cattle by feeding green grass, water and barley is recommended in the <i>Rigveda</i> for increase of milk-yield. •Proper penning in two types of pen, open pasturage (gostha) and cow stall (gosala).
<p>Utilizations of animal power in agriculture</p> <ul style="list-style-type: none"> •Ploughing by oxen and sheep •Transportation of agricultural produce by carts drawn by oxen, stallions, rams and dogs •Carrying water to field • Use of animal manures •Along with breeding, rearing and tending of domestic animals, cattle diseases were given proper attention and generally cured by the application of a medicinal plant such as <i>sahadevi</i> (a variety of <i>Sida cordifolia</i> with yellow flowers).
<p>Meteorological observations in relation to Crop Prospects</p> <ul style="list-style-type: none"> •Crop prospects began to be studied in relation to seasonal rain, fogginess and dew under the influence of heavenly bodies. The <i>Rigveda</i> recognizes two seasons of rainfall summer solstice winter solstice. •The early shower was predicted from the disappearance of <i>Vrtra</i> (constellation Hydra) and the rising of two stars: <i>Ajaekapat</i> (Pegasi) and <i>Ahimbudhna</i> (Andromeda). The second of the rain was supposed to have been caused by the impact of the star <i>Apamnapat</i> (apamvatsa of later period, Virgo).
<p>Effect of rain on crops and livestock:</p> <ul style="list-style-type: none"> •The summer solstice rains were believed to produce sweet juice in corn and to increase the procreative power of cattle. •The winter solstice rains were associated with the cool season is clearly specified in the <i>Rigveda</i>

Source: Roy 2009, Eagri 2011

Fig. 2. Salient features of Vedic agriculture technology

However, although the overall economy's GVA decreased by 7.2 percent in 2020-21, agriculture's GVA grew by 3.4 percent according to the Economic Survey 2020-2021 (Down to Earth 2021).

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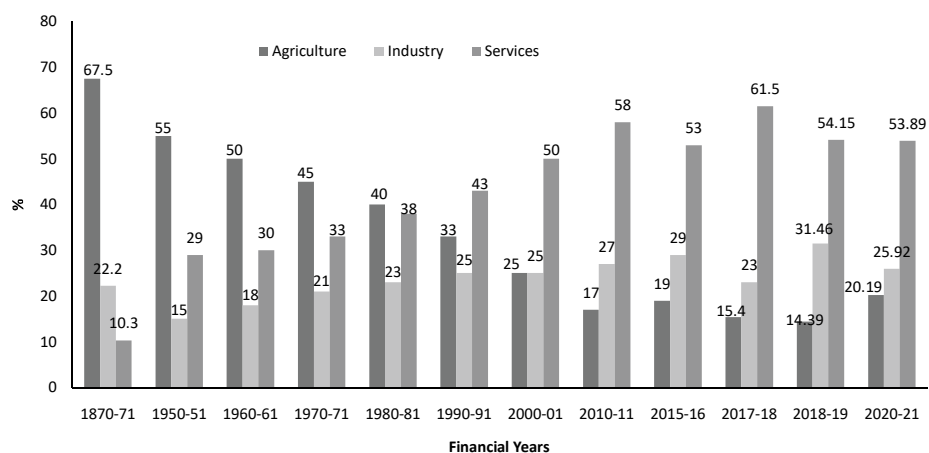
Despite declining Agriculture share, production and yield of agricultural commodities were found to be an increasing pattern from 1950-51 to 2020-21. The production showed gradual increase in pattern up to 2020-21. The agriculture yield takes a significant elevation from 522 kg ha⁻¹ (1950-51) to 2325 kg ha ha⁻¹ (2019-20). Moreover, the agriculture area has followed the pattern similar to production with 97 million ha⁻¹ in 1950-51 to 128 million/ hectare in 2019-20 (Fig. 5). Similarly, the total production of food grains increased from

50.82 million tonnes in 1950-51 to a record 303.34 million tonnes in 2020-21. The production of wheat and rice took off after the green revolution in the 1960s, and as of 2020-21, wheat and rice accounted for 109.24 & 120.32 million tonne production, respectively in the country (Fig. 6) (Deshpande, 2017, Ministry of Agriculture & Farmers Welfare 2021).

The ministry releases five estimates of food grain production at various stages of crop growth, India's food grain production is expected to increase by 2% in the 2020-21 crop year to an all-time high of 303.34 million tonnes, due to higher output of rice, wheat, pulses, and coarse cereals (Business Standard August 2021). Furthermore, food grain output in 2020-21 would be 24.47 million tonnes greater than in the preceding five years (2015-16 to 2019-20). Rice production is expected to reach a new high of 120.32 million tonnes in 2020-21 that is 7.88 million tonnes greater than the average production of 112.44 million tonnes over the previous five years. Similarly, wheat production also exceeds the average wheat production of 100.42 million tonnes by 8.81 million tonnes and is expected to reach a new high of 109.24 million tonnes in 2020-21 (Economic Times 2020, Business Standard, August 2021, Ministry of Agriculture & Farmers Welfare, 2021). The Indian government is continuously working for the welfare of farmers through the implementation of various schemes (Balkrishna et al 2020).

Challenging Future of Agriculture in India

Nonetheless, the Green Revolution was a huge success. From being a net food importer in the 1950s, India has changed dramatically over the last four decades: India has produced a record 303.34 Mt of food grains in 2020-21, up from 82 Mt in 1960-61, owing primarily to a large increase in rice and wheat output. Higher output, on the other hand, has had consequences. However, the agricultural sector's



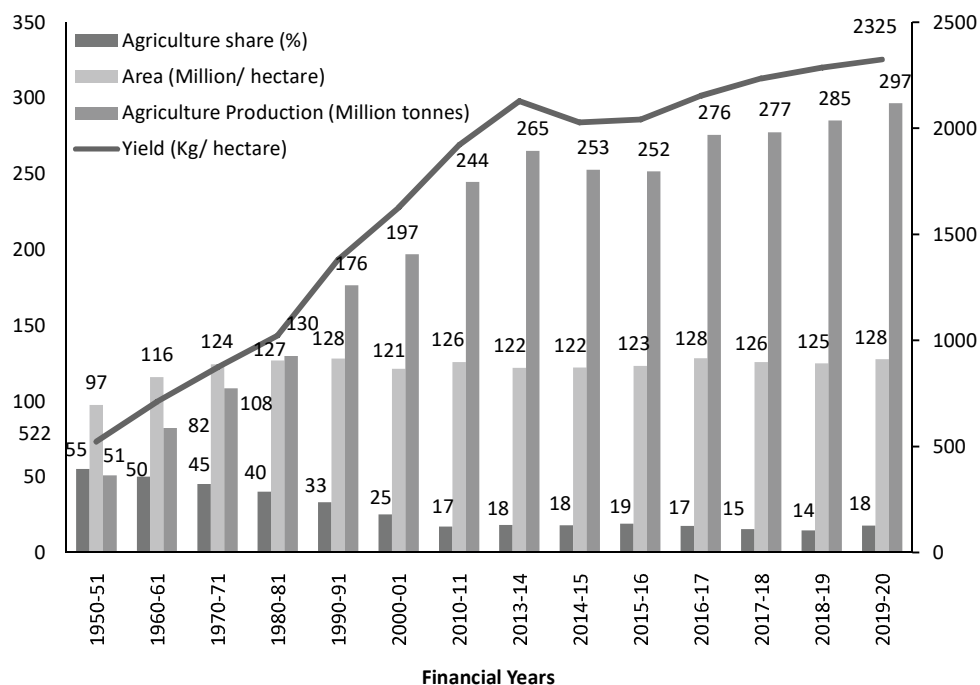
Source: Ministry of Statistics and Programme Implementation (2018-2019), Planning Commission, Govt. of India (2004-05 series) and Statics Times

Fig. 4. Sector wise contribution to gross domestic product (GDP)

growth has been erratic in recent years (Kodidala 2018). Yield gains were unevenly distributed throughout the country, owing to the Green Revolution spreading primarily in favourable locations.

Furthermore, high-yielding rice and wheat varieties led to mono-cropping in some areas, increasing sensitivity to biotic and abiotic stressors (e.g., droughts and pests). The earth's natural resources are depleting. Farmers produce a range of crops in traditional farming, which often has a big supply of unique genotypes. People who use Green Revolution farming techniques plant fewer crop varieties in favor of high-yielding ones. Crop genetic diversity is lost as a result of this form of agriculture. Only ten varieties of rice varieties are cultivated in 75% of rice fields in India. When compared to the 30,000 rice types grown 50 years ago, this is a dramatic decrease. Traditional crops have the most gene variety, and as they become scarce, those genes become extinct. These losses in genetic variety can be seen all across the world in places where the Green Revolution farming methods were applied (Sciencing 2018). High-yield varieties are known to involve high costs in terms of energy, soil fertility, environment, and financial implications. This technology is inefficient in terms of energy utilization when compared to older technologies. These types are also extremely responsive to fertilizer and water inputs, resulting in fast groundwater table depletion. Water scarcity for agriculture has reached crisis proportions, particularly in

Western Uttar Pradesh, Punjab and Haryana. The upper layer of groundwater in Punjab has been depleted; therefore, farmers' input costs increased due to using the advanced machinery to retrieve water for irrigation. Thus, in Punjab and Haryana, the cultivation of water-intensive paddy is promoted. According to the Economic Survey 2018-19, irrigation uses over 89 percent of groundwater. Furthermore, crops like paddy and sugarcane utilize more than 60% of India's irrigation water, limiting water availability for other crops (Kumar 2014, Sidhu et al 2021). Post-harvest loss is another emerging issue in Indian agriculture. The post-harvest supply chain in India is disjointed, with weak infrastructure and considerable wastage. Supply chain inefficiencies are causing significant losses. Every year, agricultural production is projected to be lost worth Rs. 500-600 billion due to a lack of suitable post-harvest infrastructure and poor supply chain management. Because of insufficient storage and transportation facilities, over 30-40% of horticulture produce is wasted each year. In 2011, the FAO released a report on global food losses and waste, claiming that roughly one-third of all food produced for human consumption is lost or wasted (FAO 2011). These predicaments lead to Food Insecurity. India's population was 1.21 billion people in 2011, up 364 million people in the prior two decades, according to the 2011 census. Despite the addition of 94 million people to India's population over that time period, this progress was made, demonstrating faster



Source: Ministry of Agriculture & Farmers Welfare, 2021, Directorate of Economics & Statistics. 4th Advance Estimates

Fig. 5. Yearly pattern of agricultural components in terms of share, area, productivity, and yield

success in eliminating food insecurity. However, with about one-quarter of the world's food-insecure people within India, improving the country's nutritional condition remains a significant challenge (UNICEF 2015).

A poignant fact emerging after all above-mentioned circumstances is Farmer's Suicide. Over 300000 Indian farmers have committed suicide since 1995. Suicides in the agriculture sector declined 32% in 2016 from 2007, the lowest over the last decade. The highest number of farmer suicides was recorded in 2004 when 18241 farmers

committed suicide over the last 16 years. Among farmers, indebtedness and crop failure was the major cause of suicide (India News 2017, India spend 2018, OECD-FAO 2014).

Possible Solutions to Combat Current Issues in Agriculture

The works highlighted in this context shows, that there is an urgent need for balanced development in the three main areas such as economic, social, and environmental. These areas play a significant role in the development of a prosperous country. To overcome the above-said

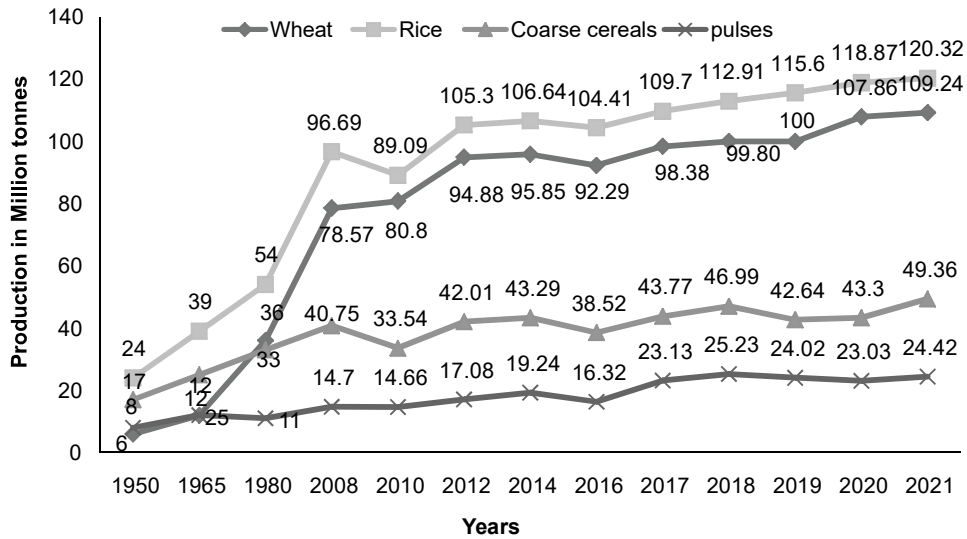


Fig. 6. Production of wheat, rice, pulses, and coarse cereals

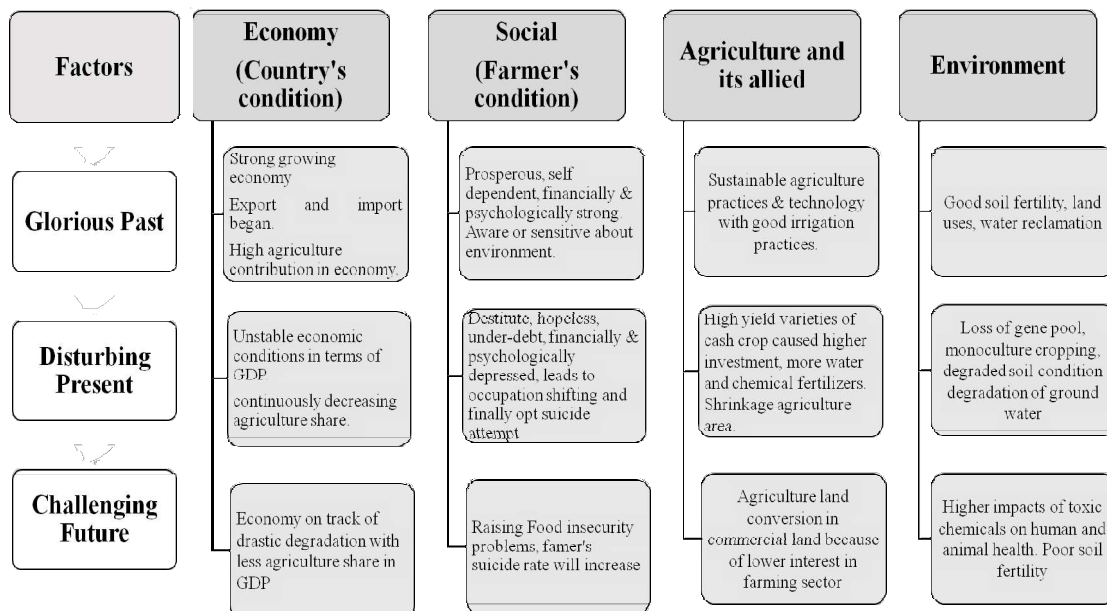


Fig. 7. Analytical vision on Indian agriculture scenario

challenges, there is a need to bring a structural change in the agriculture system with certain effective and efficient measures:

- To overcome the disturbing present situation, there is a need to introduce a transparent system that contains the availability and traceability of agriculture input and output.
- Re-adoption of traditional agriculture practices with sustainable new techniques. Mistakes committed in the past need to be rectified after an in-depth analysis of reasons for failure.
- Farmer income can be boosted up only by connecting agriculture with the advanced technology with transparent mapping, availability, and traceability system from crop to consumer. This will have to contend with all of these challenges over time to succeed in achieving sustainable change.
- Advanced technology should be adopted by analysing its pros and cons in terms of long-lasting economic, environmental as well as social impacts.
- Traditional agriculture knowledge practices and methods should also be incorporated in adopting advanced technology with more emphasis on sustainable agriculture.
- Eradicate the gap between the research & reality needs to be overcome to accomplish the objective. Overall, it can be summarized, that sustainable agriculture seeks interrelation between economy, social factors, and environment.

CONCLUSION

For lifting up the declined share of agriculture and allied sectors in the Indian economy; gearing up for the projected negative consequences of loss in biodiversity, gene pool, variety, and nutrient value in terms of crop and soil; providing food security and food safety; feeding rapidly growing populations; accessing sustainable technologies that are beneficial for farmer and farm in every aspect, strategic planning is quite necessary. There is a need to not only focus to improve the farmer's income but also point to a target to boost agri-based manufacturing growth in rural India.

AUTHOR CONTRIBUTIONS

AB: conceptualized and supervised the study; GS and NS drafted the manuscript and analyzed the data; NR, AK, and VA done review and editing.

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