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From Cultivators to Consumers: Farmers in the Age of Agribusiness Corporations

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ABSTRACT

The transformation of Indian agriculture since Green Revolution through Liberalization, Privatization, and Globalization (LPG) era has significantly redefined the role of farmers. Traditionally seen as cultivators rooted in indigenous knowledge and self-reliant practices, farmers are increasingly positioned as consumers of agricultural knowledge and inputs produced by agribusiness corporations. This study analyses secondary data on agricultural production made available by the Government of India to examine the shifting trends in cropping patterns, input usage, and the growing influence of Agribusiness Corporations. The analysis reveals that the area under cultivation has declined for several traditional and less profitable crops while expanding for high-value, profit-oriented crops concentrated in irrigated regions. The seeds and inputs for these crops are largely supplied by Agribusiness Corporations through networks of Agri-input dealers. The consumption of fertilizers and plant protection chemicals has risen sharply, making India one of the highest consumers per hectare globally, despite its yield remaining below the world average. Simultaneously, export-oriented cropping patterns have contributed to environmental challenges, including increased methane emissions and worsening water stress. Crops with declining cultivation areas are increasingly being imported, despite their ecological sustainability. The data also highlight that small and marginal farmers, constituting about 86% of the total farming population, are disproportionately burdened by the rising cost of inputs, leading to deepening indebtedness and marginalization. Overall, the findings illustrate how Agribusiness Corporations have transformed farming into a loss-making venture and turned cultivators into consumers of corporate products and knowledge.

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KEYWORDS: *Small and Marginal Farmers, Agri-Input Dealers, Corporate Agriculture, Commodification of Knowledge, Input Intensive Agriculture.*

1. INTRODUCTION

Farmers are often described as a "built-in depressor" within the agrarian economy (Thorner, 1976)**.** This phenomenon reflects the imbalance between rising input costs, market volatility, and shrinking margins for farmers, who remain vulnerable to fluctuating crop prices and unpredictable weather patterns. As a result, many farmers are trapped in cycles of debt and economic insecurity, struggling to maintain sustainable livelihoods.

The Green Revolution, through HYV seeds, fertilizers, pesticides, and irrigation, raised food grain output but remained techno-centric and capital-intensive (Goswami, Bezbaruah, & Mandal, 2018, pp. 152-165). Post-1991 LPG reforms integrated Indian agriculture with global markets, allowing transnational corporations (TNCs) to dominate the Agri-input sector through hybrid seeds, chemicals, and machinery. This modernization narrative, however, increased farmers' costly dependence on external inputs often unsuited to smallholders' contexts (Madeley, 1999, pp. 26-47).

To produce food grains, vegetables, fruits etc. a large number of inputs are needed. These include seeds, fertilizers, pesticides, agricultural implements (tractors, pump sets, etc.), cattle feed, poultry feed (Ramkishen, 2004, p. 151). Agri-input dealers are seller of these agricultural inputs such as seeds, fertilizers, crop protection chemicals, farm equipment and machines, veterinary products and animal feeds. The Agri-input dealers serve as the primary and most trusted source of farm information for the farming community. Beyond providing inputs and credit, they play a significant role in transferring agricultural technology, a role valued by farmers for their accessibility and reliability (Argade, Sarkar, & Mishra, 2015).

However, it has been noted that Agri-input industries promote standardized practices such as fixed fertilizer doses, prophylactic pesticide sprays, and costly hybrid seeds regardless of crop or soil conditions. Lacking independent extension support, small farmers rely on dealers' advice, which is often exploitative, leading to higher costs and frequent crop failures (Venugopal & Kaundinya, 2014). The reduction in central government support to states for agricultural extension services has resulted in the near collapse of the public extension infrastructure. Consequently, farmers are increasingly turning to the private sector for guidance (Rao, 2003). The withdrawal of the state from agricultural extension post-1990s, the private sector including input suppliers and agri-business corporations has filled the vacuum. This shift has commercialized knowledge systems, making them profit-driven rather than farmer-centric (Venkateswarlu, 2022).

1.1. Review of Literature

(Jain & Rathore, 2023) in their study revealed that the majority of respondents obtained information about agricultural inputs primarily through dealers and retailers. Nevertheless, purchasing decisions were largely made independently by the farmers. Furthermore, most respondents reported purchasing seeds from local markets, with a clear preference for certified, high-quality, and high-yielding varieties.

(Elakkiya & Asokhan, 2021) studied the role of Agri-input dealers in Thondamuthur and Madukkarai blocks of Coimbatore district, focusing on their interaction with farmers and their influence on input use. The study highlights Agri-input dealers as central intermediaries between farmers and agri-business firms. Nearly three-fourths of farmers (73.34%) visited shops in peak seasons and 63.34% in off-seasons, relying on dealers not only for inputs but also for crop-related advice, mainly on brands (90%), chemicals (73.33%), and problem descriptions (60%). Input use showed universal pesticide adoption (100%), followed by seeds (80%), fertilizers (56%), and other inputs (26.66%). Over half of the dealers (56.70%) depended on company field assistants for pesticide recommendations, underscoring their linkage with agri-business networks. Dealers valued companies for timely delivery, credit, and support, while also advising farmers on seed rates, sowing, and agrochemical use, often in collaboration with researchers. More than half of the farmers (56.66%) applied pesticides preventively, reflecting dealers' strong influence as trusted village-level knowledge brokers.

Pesticide consumption is the highest in Maharashtra, followed by Uttar Pradesh, Punjab and Haryana in India. Agricultural Input Survey data show that in 2011-12, per cent area treated with pesticides was the highest in cotton (66.70%) followed by arhar (64.74%), jute (53.27%) and paddy (48.62%) and low in maize (25.01%) in India (Subash, Prem Chand, Pavithra, Balaji, & Suresh Pal, 2017).

(Shiva, 2016) in her famous work 'The Violence of Green revolution' revealed that for millennia, farmers preserved and shared seeds as a common resource, sustaining biodiversity and food security, but the Green Revolution disrupted this by replacing traditional diverse farming with corporate-owned HYVs and monocultures. Seeds became patented commodities, making farmers dependent on purchases and loans, while ecological balance eroded through loss of genetic diversity, pest outbreaks, soil nutrient depletion, and decline of traditional practices like pulse-based nitrogen fixation. Though HYVs boosted yields initially, they ultimately entrenched input-intensive, corporate-controlled agriculture at the cost of sustainability and food security.

(Venkateswarlu, 2022) argues that GM crops are designed to lock farmers into proprietary input systems, increasing their dependence on seed companies like Monsanto. He situates Green Revolution-II (GM Crops) within the global intellectual property regime (TRIPS) under the WTO, which undermines traditional knowledge and local seed sovereignty. It critically evaluates biosafety concerns**,** contamination of native germplasm**,** and farmers' lack of informed consent.

(Venkatesh & Nithyashree, 2014) revealed that private sector concentrated mainly on cross-pollinated and hybrid dominated crops (sunflower, 97 %; cotton, 96 %; maize, 95 %; and bajra, 90%), indicating profitability to be the major factor which could influence the selection of crops as far as private sector was concerned. The remaining high volume and low-value crops (pulses, 70%; and groundnut, 65%) were left with the public sector.

The big Agri-business corporations enters countries through joint ventures, lobbying, and patents, then consolidates control over seeds and agriculture by criminalizing seed saving, monopolizing markets, and shaping regulatory decisions. While initially promoted as tools to feed the world, Monsanto's genetically modified crops and chemical packages often deepen farmer dependency, increase debt, erode biodiversity, and create new ecological problems such as pest resistance and herbicide-resistant weeds. This reveals a business model driven more by monopoly and profit than by sustainability or farmer welfare (Robin, 2010).

Private agricultural R&D has expanded under strengthened intellectual property regimes, enabling corporate dominance in seeds, traits, and crop protection. While public-private collaborations and patents foster innovation, they also intensify farmer dependency on corporations, concentrating power and narrowing autonomy in rural communities. The shift privileges technologies aligned with profitability such as herbicide-tolerant crops over agro-ecological sustainability, reinforcing input-intensive monocultures (Kalaitzandonakes & Zahringer, 2018).

1.2. Objectives

1. To analyse the changing trends in cropping patterns, input usage since Green Revolution (1970s onwards) through LPG reforms (post 1990s).
2. To compare the sources of agricultural inputs in India; the share of government and private sector agencies in the supply and distribution of agricultural inputs.

2. Research Design

The study adopts a descriptive and analytical research design based on secondary data drawn from All India Report on Input Survey (2016-17), 2021, ICAR Agricultural Research Data Book, 2022 and Agricultural Statistics at a Glance, 2023 (Department of Agriculture, 2024) to understand the pattern and use of inputs in agricultural production among Indian Farmers. The analysis employs trend analysis and comparative assessment to identify temporal shifts in cropping patterns (Food-grains), input usage in agricultural production since Green Revolution through LPG reforms.

3. Results and Discussions

3.1. Cropping Pattern (Food-grains)

All India Area under production in 1970-71 was 124.32 million hectare with 24.11% area under irrigation, which increased to 129.80 million hectares area under production with 58.99% under irrigation (Department of Agriculture, 2024).

3.1.1. Shift in Cropping Pattern

The Figure 1 and Figure 2 illustrates the change in the cropping pattern of India between the years 1970–71 and 2020–21, along with the area under irrigation for major crops such as rice, wheat, bajra, and pulses. The data highlights how India's agricultural landscape has evolved over five decades due to technological, economic, and policy changes.

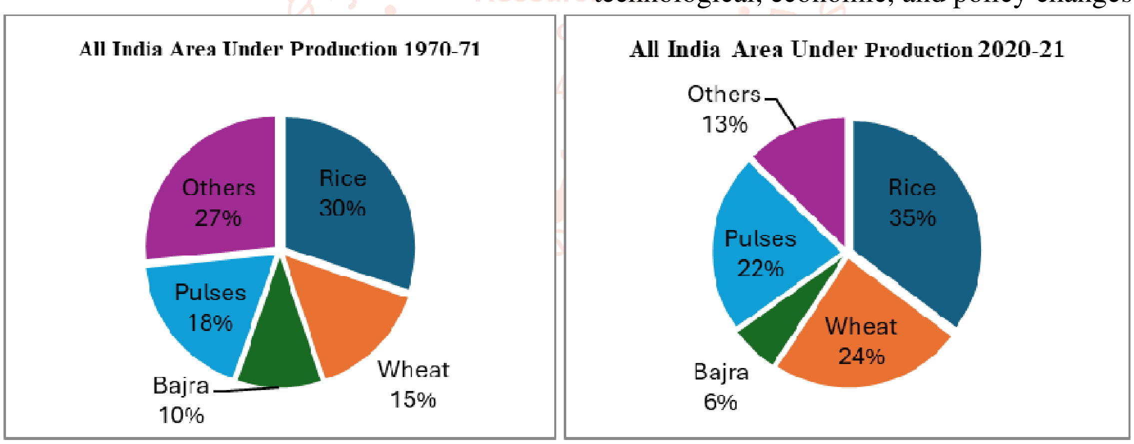

Figure 1: Distribution of crops under production for the years 1970-71 & 2020-21

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 45-75)

The Figure 1 compare the percentage share of major crops in the total cropped area for the years 1970–71 and 2020–21. In 1970–71, the major crops under production were: Rice: 30%, Wheat: 15%, Pulses: 18%, Bajra: 10%, and Others: 27%. By 2020–21, the cropping pattern had significantly shifted: Rice: 35%, Wheat: 24%, Pulses: 22%, Bajra: 6%, and Others: 13% (Department of Agriculture, 2024).

This shift reveals a clear dominance of rice and wheat cultivation, indicating the success of the Green Revolution and the subsequent policy focus on food grain self-sufficiency. The area under coarse cereals like bajra and miscellaneous crops (others) has declined substantially, reflecting a reduction in crop diversity.Meanwhile, the share of pulses increased modestly.

Area in Million Hectares

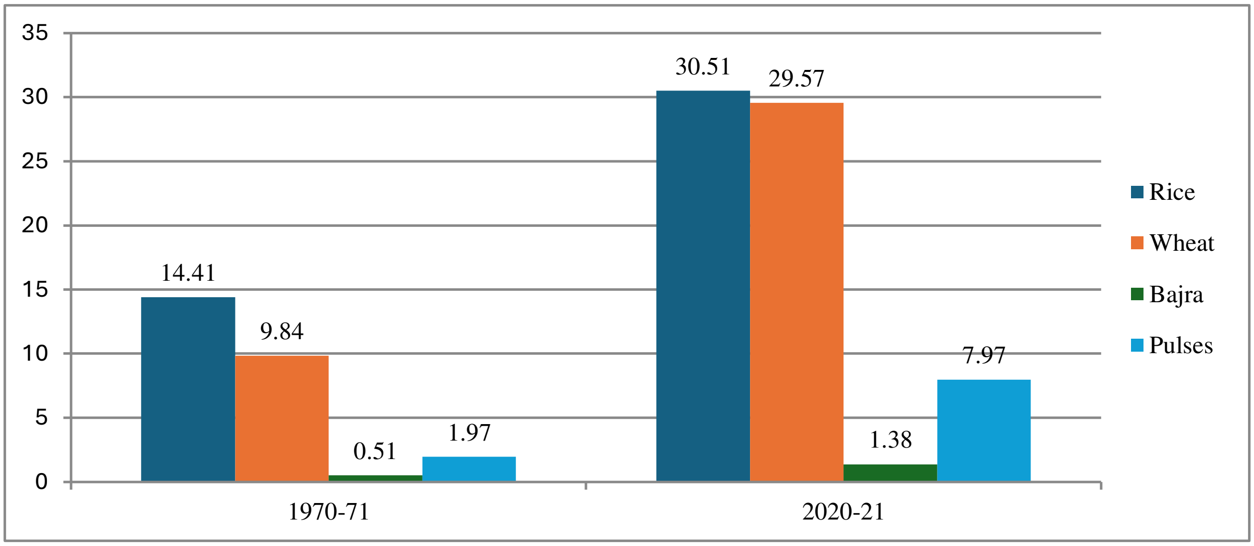

Figure 2: All India Area under Irrigation (Crop wise)

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 45-75)

The Figure 2 compares the irrigated area (in million hectares) for key crops during 1970–71 and 2020–21. The area of rice cultivation under irrigation expanded from 14.41 to 30.51 million hectares, for wheat from 9.8 to 29.57 million heactares, for bajra from 0.51 to 1.38 million hectares and for pulses from 1.97 to 7.97 million hectares (Department of Agriculture, 2024).

The data clearly shows a remarkable expansion of irrigated area, especially for rice and wheat, which almost doubled or tripled over the period. Rice increased from 14.41 to 30.51 million hectares, reflecting the crop's heavy dependence on water and government investment in irrigation infrastructure. Wheat saw a similar rise, from 9.84 to 29.57 million hectares. Pulses and bajra continue to have relatively low irrigated areas, though they also recorded slight improvements.

This pattern indicates a strong irrigation bias toward rice and wheat, leading to higher productivity in these crops but also resulting in water stress and resource imbalance in several regions. Overall, the figure demonstrates a significant structural transformation in Indian agriculture: the share of rice and wheat in the cropping pattern increased substantially, reflecting food security-driven policies. The area under irrigation expanded dramatically, showing technological progress through canal irrigation, tube wells, and groundwater extraction. However, the decline in coarse cereals and crop diversity may pose long-term sustainability concerns, including nutritional imbalance, soil degradation, and groundwater depletion.

3.2. Input Intensive Agricultural Production

3.2.1. Area Treated with Chemical Fertilizers and Plant Protection Chemicals (Pesticides)

Jennifer Chait includes Plant Protection Chemicals such as insecticide, herbicide, fungicide or any other chemical substance used to control pests under one name i.e. pesticides (Venugopal & Kaundinya, 2014).

Table No. 1: Percentage of Irrigated and Un-irrigated Areas Treated with Chemical Fertilizers and Pesticides for 'All Crops'

Size Groups	% of Irrigated area treated with		% of Un-irrigated area treated with	
	Chemical Fertilizers	Pesticides	Chemical Fertilizers	Pesticides
Marginal (below 1.0 ha.)	81.3	37.3	63.8	38.7
Small (1.0 - 1.99 ha.)	92.6	38.9	68.6	40
Semi-medium (2.0 - 3.99 ha.)	93.8	39.4	67.7	38
Medium (4.0 - 9.99 ha.)	93.1	38.8	60.1	31.4
Large (10.0 ha. and above)	90.5	42	40.9	23.7

Source: All India Report on Input Survey 2016-17 (Input Survey, 2021, p. 24)

The table presents the percentage of irrigated and un-irrigated area treated with chemical fertilizers and pesticides across different farm size groups in India. In irrigated areas the use of fertilizers is high across all farm sizes, ranging from 81.3% among marginal farmers to 93.8% among semi-medium farmers. The highest usage is seen in semi-medium farms (93.8%), indicating that farms of moderate size are most intensive in fertilizer use. Pesticide application in irrigated areas ranges between 37.3% and 42%. Large farms show the highest pesticide use (42%), while marginal and medium farms have relatively lower rates (~38%) (Input Survey, 2021).

In un-irrigated areas fertilizer usage is lower compared to irrigated areas, declining from 63.8% (marginal) to 40.9% (large farms). Smaller farms (marginal and small) show higher fertilizer use than large farms, suggesting that smallholders invest more in inputs even in rain-fed conditions. Pesticide use in un-irrigated areas is considerably lower overall, ranging from 23.7% to 40%. The highest usage appears among small farms (40%), while large farms use the least (23.7%) (Input Survey, 2021).

Irrigation positively influences the use of chemical inputs, with irrigated lands showing higher treatment rates for both fertilizers and pesticides. Smaller and semi-medium farms tend to use chemical inputs more intensively than larger farms. The pattern suggests that input adoption is more widespread among smallholders, possibly due to the drive to maximize yield from limited land.

Out of 105904 no. of holdings which adopted pest control method, 56876 no. of holdings opted for Chemical methods which constitute around 54% of the no. of holdings which adopted pest control methods (Input Survey, 2021, p. 62). Thus, majority of the farmers are relying on Pesticides to control pest attacks in crops. The data is shown in Figure 3 below:

Number in '000 Units

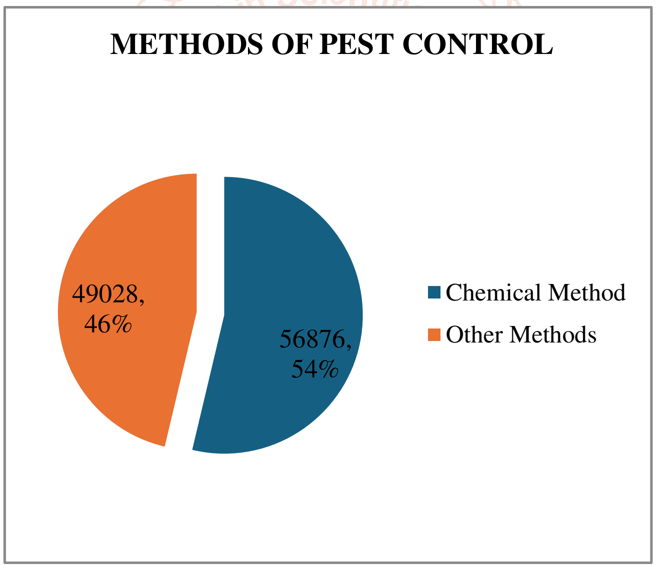

Figure 3: Usual Methods of Pest Control

Source: All India Report on Input Survey 2016-17 (Government of India, 2021, p. 62)

3.2.2 Rate of Application of Chemical Fertilizers as per Size of Holdings (All Crops)

Fertilizer application was consistently higher in irrigated areas than in un-irrigated areas. For nitrogen, the average use was 122.6 kg/ha in irrigated and 72.5 kg/ha in un-irrigated areas, with marginal holdings applying the most (151.1 and 89.0 kg/ha, respectively) and large holdings the least (90.6 and 48.2 kg/ha). Phosphorus use followed a similar trend, averaging 57.3 kg/ha in irrigated and 36.5 kg/ha in un-irrigated areas, with marginal holdings again recording the highest rates (70.3 and 42.7 kg/ha). Potash consumption was lower overall 18.6 kg/ha in irrigated and 9.6 kg/ha in un-irrigated areas and declined steadily with increasing farm size. Overall, the data indicate that smaller holdings tend to apply higher levels of N, P, and K fertilizers compared to larger holdings (Input Survey, 2021). The data is shown in below mention Figure 4 & 5:

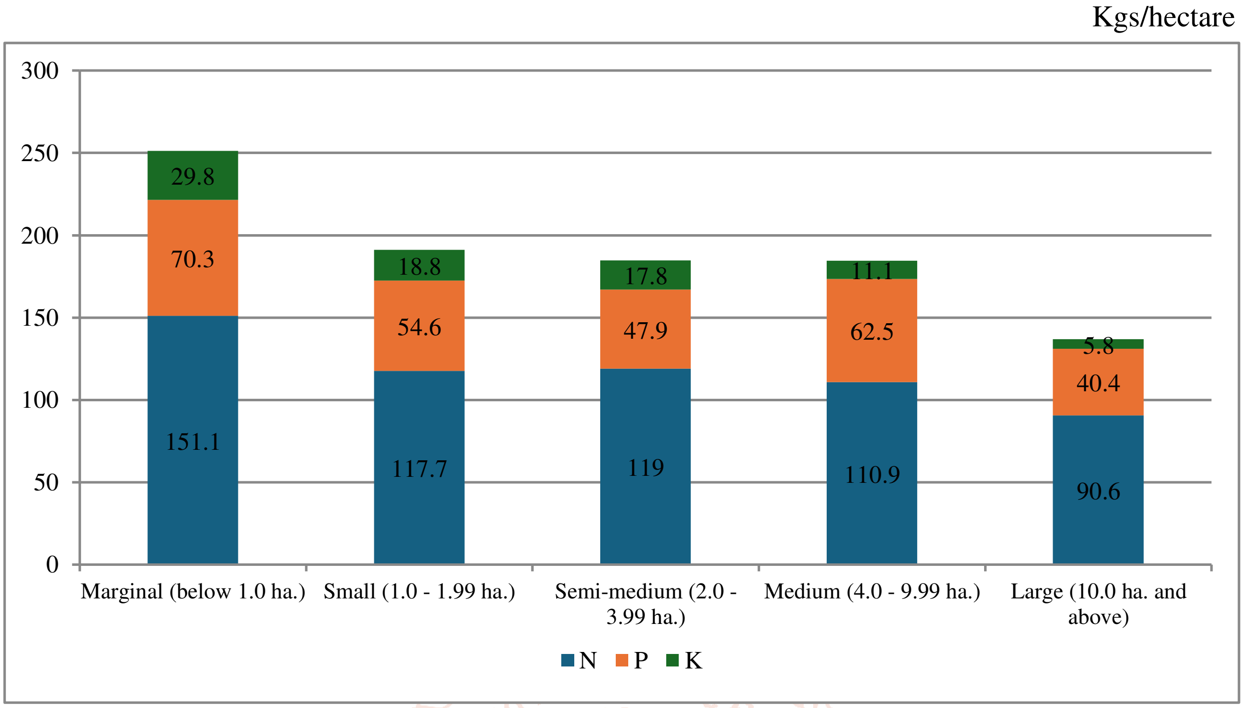

Figure 4: Rate of application of Chemical fertilizers in Irrigated Areas
Source: All India Report on Input Survey 2016-17 (Input Survey, 2021, p. 25)

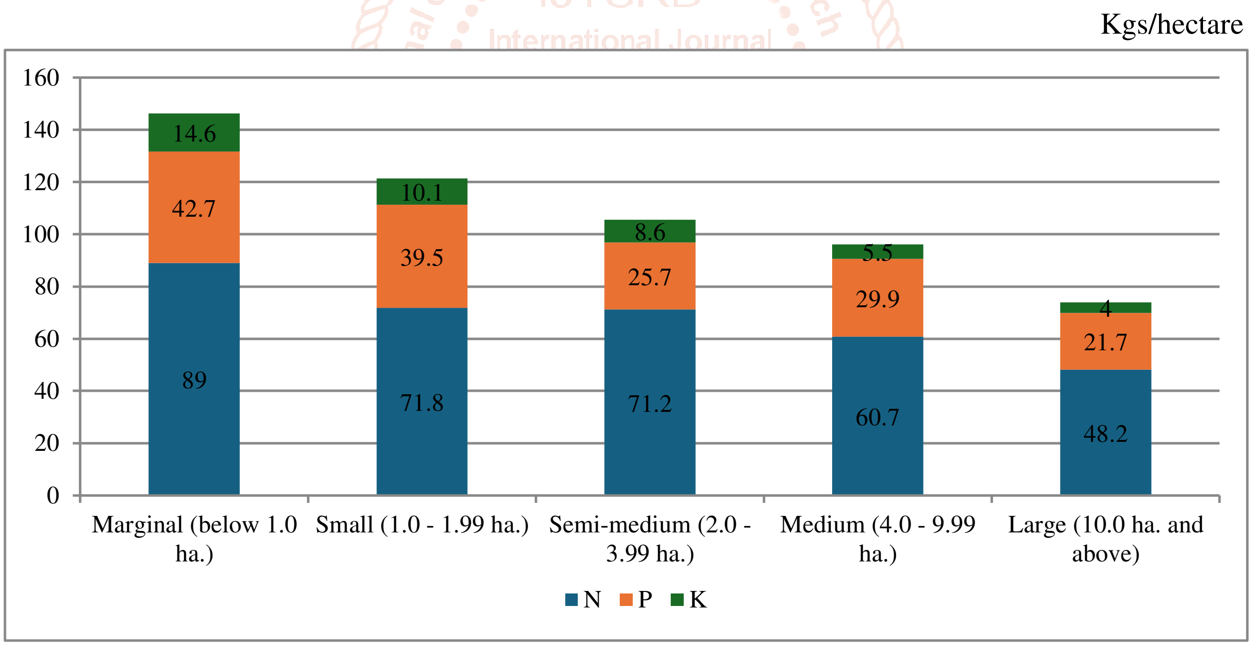

Figure 5: Rate of application of Chemical fertilizers in Un-irrigated Areas
Source: All India Report on Input Survey 2016-17 (Input Survey, 2021, p. 25)

This data reflects that small and marginal farmers use more fertilizers per unit area than large landholders. With limited land, small farmers strive for maximum productivity per hectare, prompting overuse. Overuse of fertilizers among marginal and smallholders increases input costs.

3.3. Trends in Consumption of Agri-inputs

3.3.1. Consumption of Certified/Quality Seeds

Figure 6 below, depicts the trend in the use of certified or quality seeds in India from 1995–96 to 2020–21, measured in lakh quintals. The data shows a consistent and significant increase in the consumption of certified seeds over the years. In 1995–96, consumption was 69.92 lakh quintals, which increased modestly to 91.8 lakh quintals in 2001–02 and 126.75 lakh quintals in 2005–06. A sharp rise is observed thereafter, reaching 277.34

lakh quintals in 2010–11. By 2015–16, it further raised to 304.04 lakh quintals, and in 2020–21, the consumption reached level of 421.09 lakh quintals (ICAR, 2022).

(Lakh Quintals)

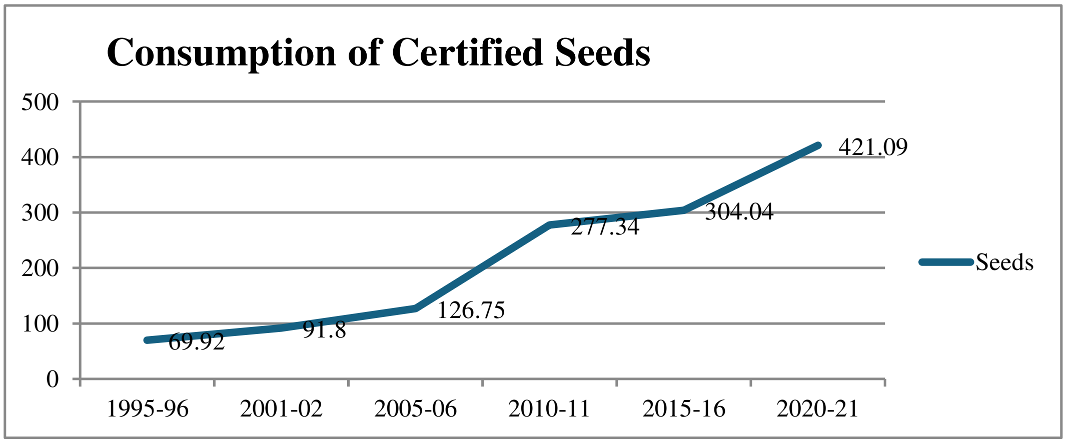

Figure 6: Consumption of Certified/Quality Seeds

Source: ICAR Agricultural Research Data Book 2022 (ICAR, 2022, p. 41)

Overall, the graph clearly indicates a steady upward trend in the adoption of certified or quality seeds post LPG reforms. Traditionally, farmers use to procure seeds from their own produce. Now farmers have to purchase seeds every year for agricultural production. These certified/Hybrids seeds boosted yields initially but they ultimately entrenched input-intensive agricultural production (Shiva, 2016).

3.3.2. Consumption of Pesticides

Figure 7 mentioned below, shows the trend in pesticide usage in India from 2001–02 to 2020–21, measured in tonnes. The data reflects a fluctuating yet overall increasing trend in pesticide consumption over the two decades. In 2001–02, pesticide consumption stood at 47.02 tonnes, it declined to 39.77 tonnes in 2005–06, indicating a temporary reduction in usage. Thereafter, consumption increased sharply to 55.54 tonnes by 2010–11, a slight rise continued in the subsequent years, with 56.72 tonnes recorded in 2015–16, and the highest consumption was observed in 2020–21, reaching 62.19 tonnes (Department of Agriculture, 2024).

(Tonnes)

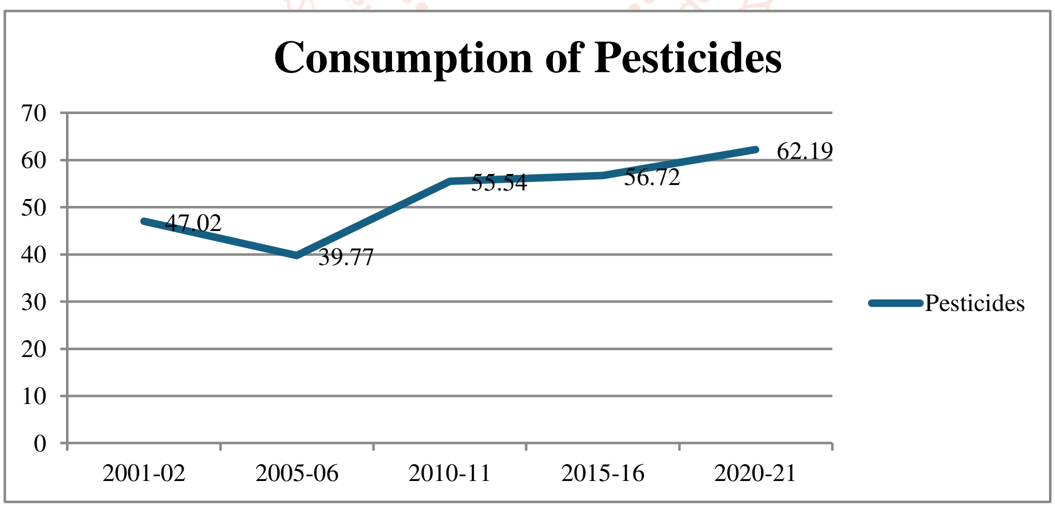

Figure 7: Consumption of Pesticides

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 287-288)

Overall, the graph indicates a gradual upward trajectory in the long term. This increase reflects the intensification of agriculture, greater reliance on chemical pest control methods, and possibly the expansion of cultivated areas using modern inputs.

3.3.3. Consumption of Fertilizers (NPK)

Figure 8 depicts the trend in fertilizer (NPK) consumption in India from 1970–71 to 2020–21, measured in kilograms per hectare. Fertilizer use rose sharply from 13.61 kg/ha in 1970–71 to 161.01 kg/ha in 2020–21. The graph shows a consistent upward trend, particularly between 2000–01 and 2010–11, when consumption increased from 90.12 to 142.26 kg/ha (ICAR, 2022). This reflects the growing intensification of agriculture and dependence on chemical fertilizers to enhance crop productivity.

(Consumption: Kg/hectare)

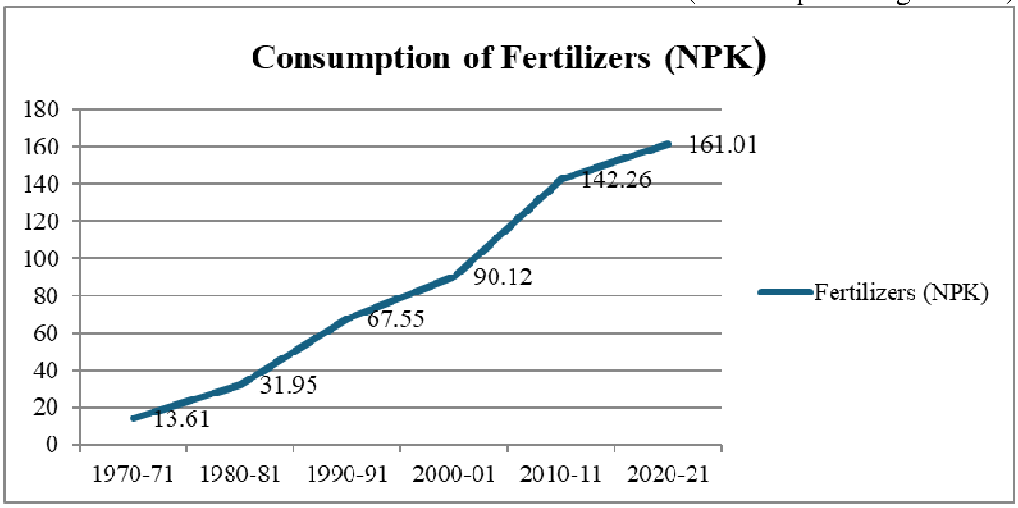

Figure 8: Consumption of Fertilizers (NPK)
Source: ICAR Agricultural Research Data Book 2022 (ICAR, 2022, p. 96)

3.3.4. Consumption of Fertilizers (NPK) for selected Countries (2019)

Kg/hectare

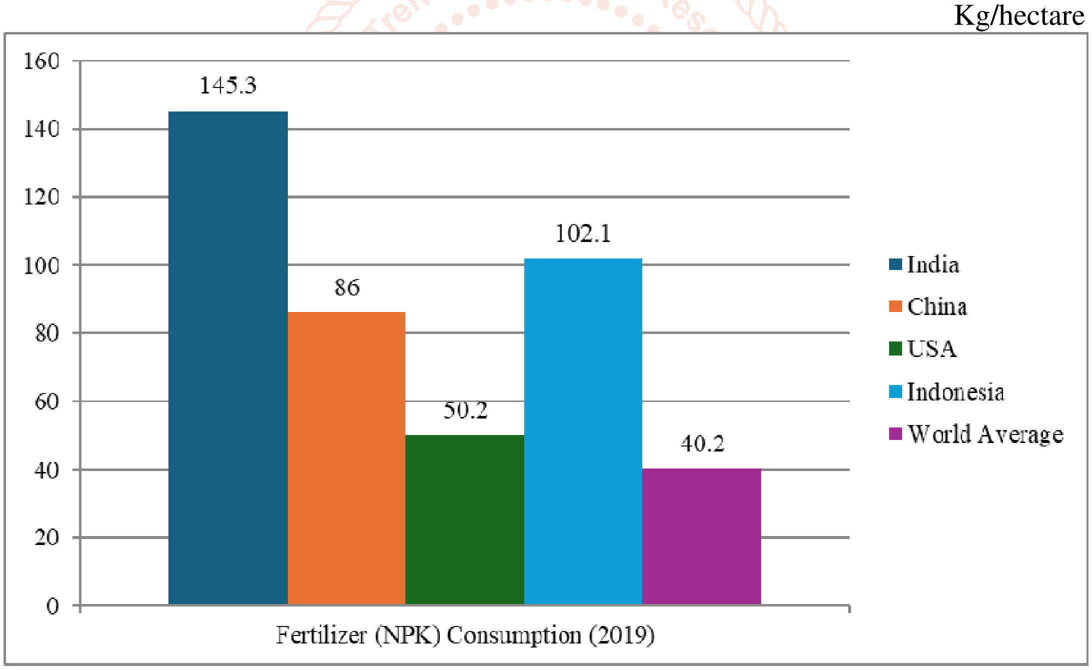

Figure 9: Consumption of Fertilizers (NPK) for selected Countries (2019)
Source: ICAR Agricultural Research Data Book 2022 (Government of India, 2022, p. 312)

Figure 9 mentioned above compares the use of fertilizers, specifically nitrogen (N), phosphorus (P), and potassium (K) across five countries and the world average, measured in kilograms per hectare. The data reveal significant variation in fertilizer consumption among countries with India recording the fertilizer consumption of 145.3 kg/ha, indicating intensive use of chemical fertilizers in Indian agriculture. Indonesia with 102.1 kg/ha, showing substantial fertilizer application, China with 86 kg/ha, reflecting moderate use compared to India. The United States had a lower consumption level of 50.2 kg/ha, suggesting more efficient or sustainable fertilizer practices. The world average was 40.2 kg/ha, much below India's figures (ICAR, 2022).

3.3.5. Yield per Hectare for Selected Countries

Yield: ton/hectare

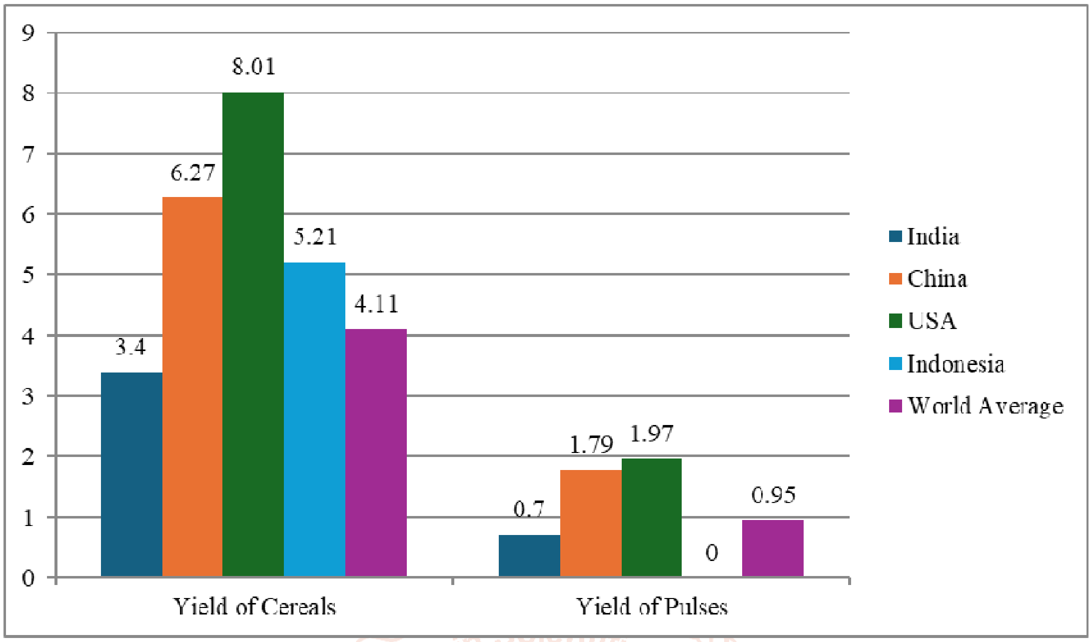

Figure 10: Yield per Hectare for Selected Countries

Source: ICAR Agricultural Research Data Book 2022 (ICAR, 2022, p. 314)

Figure 10 compares the yield per hectare of cereals and pulses across five regions: India, China, USA, Indonesia, and the World Average. For cereals, the yields are: India: 3.4 t/ha, China: 6.27 t/ha, USA: 8.01 t/ha, Indonesia: 5.21 t/ha, World average: 4.11 t/ha. India's cereal yield is well below the world average and much lower than developed nations like the USA. For pulses, the yields are: India: 0.7 t/ha, China: 1.79 t/ha, USA: 1.97 t/ha, Indonesia: (no significant data), World average: 0.95 t/ha. India's pulse yield remains below the global average (ICAR, 2022).

Overall, Figure 9 and Figure 10 shows that India's fertilizer consumption far exceeds both the world average and that of major agricultural economies, highlighting its input-intensive agricultural practices. This pattern suggests efforts to maximize productivity, but India's yield is well below the world average and much lower than major agricultural economies. It also raises concerns about soil health, nutrient imbalance, and environmental sustainability in the long run.

3.4. Share of Agri-business Corporation in Supply Chains (Seeds, Fertilizers, Chemicals)

Figure 11 mentioned below illustrate the contribution of public and private sectors to total seed availability in 2022–23. Wheat (143.54 lakh quintals) and rice (119.99 lakh quintals) dominate seed availability. The private sector plays a major role, contributing over 70 lakh quintals for rice and 109.35 lakh quintals for wheat, far exceeding public supply. For pulses, public sector (22.08 lakh quintals) contributed more comparing to the private sector (19.84 lakh quintals). Bajra had the lowest seed availability (4.33 lakh quintals), private sector playing major role contributing 3.97 lakh quintals (Department of Agriculture, 2024).

(Lakh Quintals)

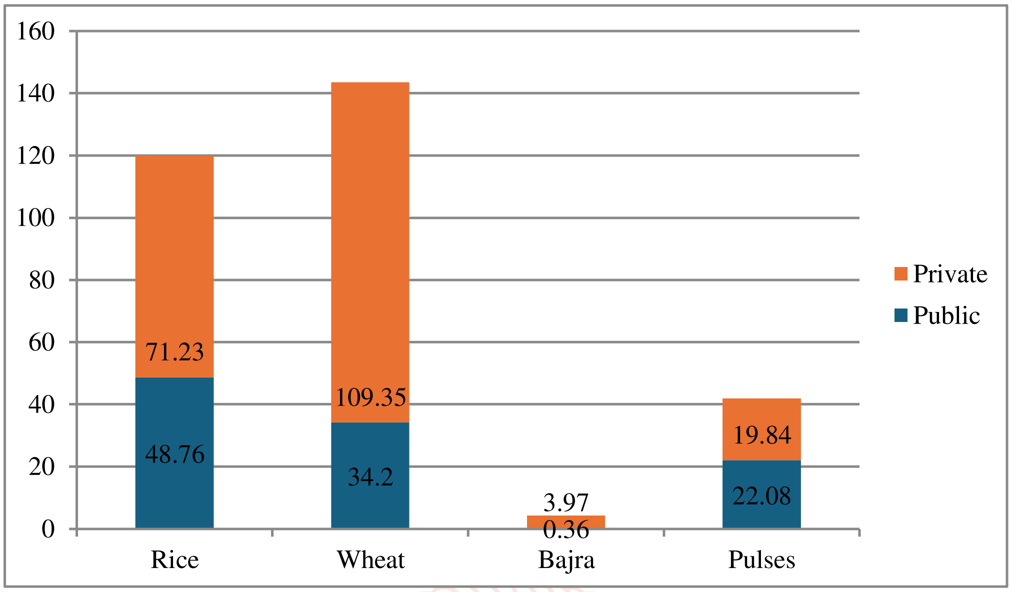

Figure 11: Availability of Certified/ Quality Seeds

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 303-305)

3.4.1. Source Wise No. of Holders Who Purchased Certified Seeds

Figure 12 mentioned below shows the number of farmers (holders) who purchased certified seeds from different sources in India. The largest number of farmers (39,154) purchased seeds from private dealers/retailers, followed by the Department of Agriculture (18,757) and co-operatives/federations (11,849). Seed corporations (6,227) and State University Farms (2,599) contributed relatively little (Input Survey, 2021).

Number in '000 Units

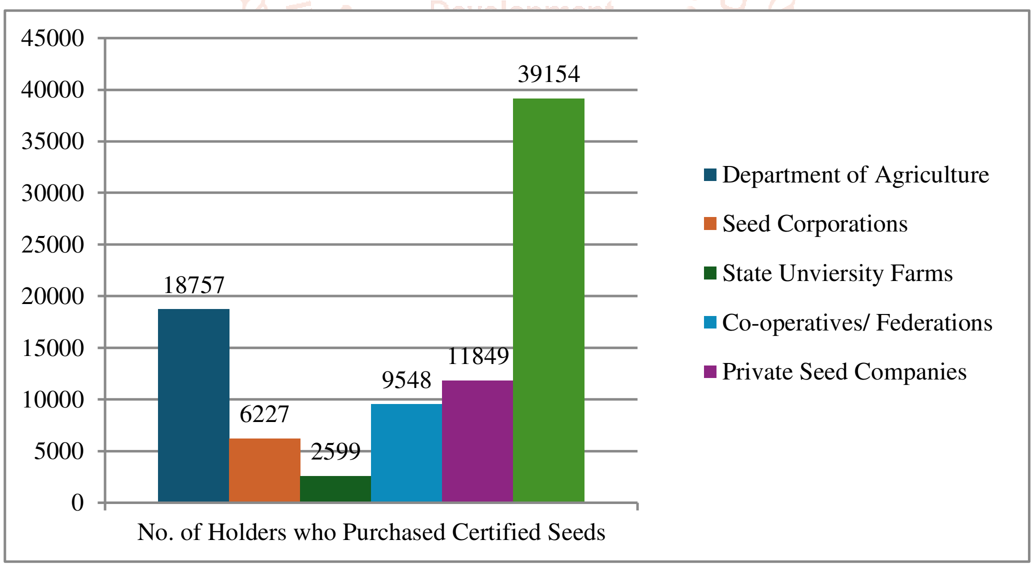

Figure 12: Source wise no. of holders who purchased certified seeds

Source: All India Report on Input Survey 2016-17 (Input Survey, 2021, p. 61)

Figure 11 and 12 indicates that private dealers and companies are the main suppliers of certified seeds to farmers. This confirms that private agencies dominate the certified seed market, serving more than twice as many farmers as public institutions. This applicable for other inputs like fertilizers and pesticides, evident from the study of (Elakkiya & Asokhan, 2021), which highlights Agri-input dealers/retailers as central intermediaries between farmers and agri-business corporations.

The findings are also in accordance with findings of (Venkatesh & Nithyashree, 2014). The private sector concentrated mainly on cross-pollinated and hybrid dominated crops, indicating profitability to be the major factor which could influence the selection of crops as far as private sector was concerned. The remaining high volume and low-value crops like pulses were left with the public sector (Venkatesh & Nithyashree, 2014).

3.5. Export-Oriented Production

3.5.1. Import and Export of Rice and Pulses

Figure 13 mentioned below compares India's import and export of rice (in '000 tonnes) for both Basmati and non-Basmati rice over time. Exports (other than Basmati) have shown a steep rise, reaching 17,792.14 thousand tonnes in 2022–23. Exports of Basmati rice remained stable between 4,000–5,000 thousand tonnes. Imports of both Basmati and non-Basmati rice have remained negligible, showcasing India's self-sufficiency in rice production (Department of Agriculture, 2024).

(Quantity: '000 tonnes)

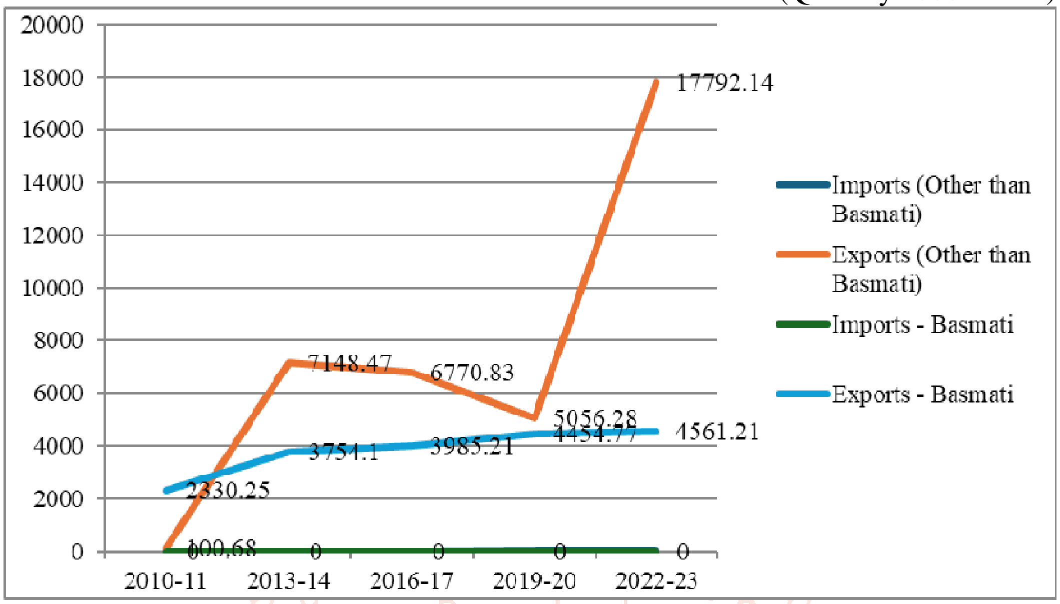

Figure 13: Import and Export Quantity of Rice

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 204-215)

Figure 14 below, presents India's import and export trends for pulses (in '000 tonnes). Imports peaked at 6,609.49 thousand tonnes in 2016–17, reflecting domestic shortages, but later declined to 2,496.17 thousand tonnes in 2022–23. Exports have remained relatively low but show a recent rise to 762.67 thousand tonnes in 2022–23 (Department of Agriculture, 2024). Overall, the data suggests that India continues to be a net importer of pulses.

(Quantity: '000 tonnes)

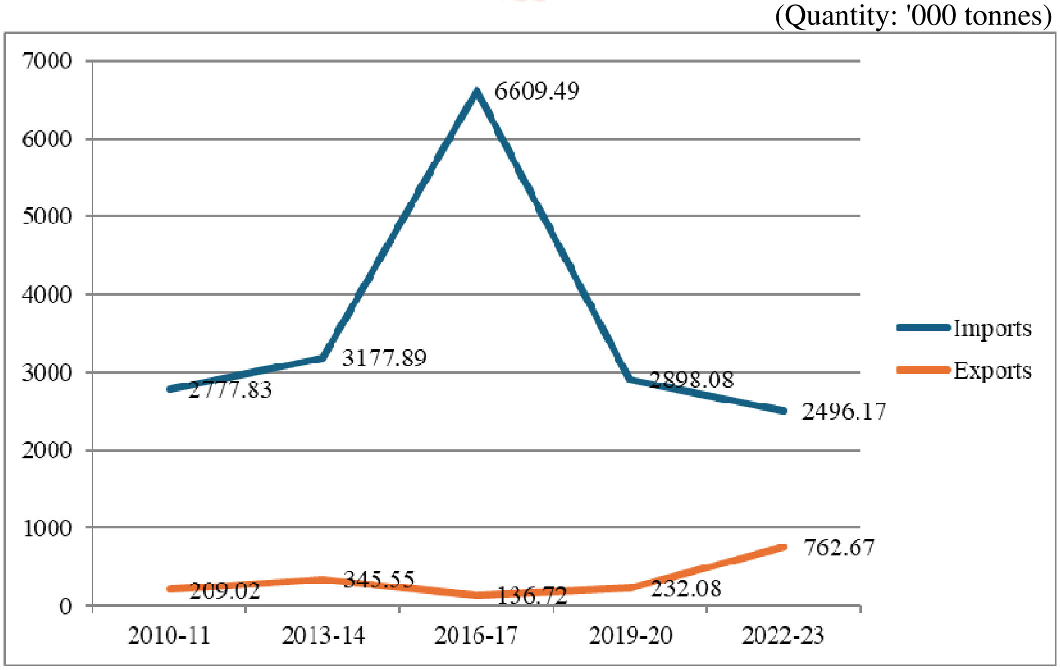

Figure 14: Import and Export Quantity of Pulses

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 204-215)

This trend signifies India's transformation to one of the largest exporters of rice, driven by enhanced productivity, irrigation coverage. However, India remains net importer of pulses, which require less water and emit minimal methane, making them climate-resilient crops compared to rice. Exporting rice, therefore, indirectly means exporting virtual water, as India is sending abroad vast quantities of water embedded in rice production. (Gowri & Shivakumar, 2021) water footprint of Indian rice exports International trade in rice during 2018-19 resulted in a total virtual water transfer of 24354 Mm^3 per year. In contrast the pulses requires only one-fourth to one third of the water used for rice, which evident from the cropping pattern in India.

3.5.2. The Impact of Export

Table No. 2 Calculated data for Methane emissions (in kilotonnes) from Rice Cultivation

Region/ Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
India	4524.55	4645.70	4513.11	4658.99	4656.25	4580.25	4559.14	4620.79	4661.15	4608.99	4757.59	4895.77
USA	512.03	370.67	379.46	349.71	415.44	364.73	438.66	336.26	412.18	350.85	422.94	352.40
EU	235.64	236.65	224.49	211.87	210.21	214.49	219.21	217.29	205.38	206.32	210.71	201.34
China	5246.67	5278.92	5292.98	5323.65	5323.32	5406.59	5399.92	5400.13	5302.17	5214.45	5282.95	5255.06
Russian Federation	56.25	58.02	53.65	52.91	54.75	55.69	57.07	51.98	50.45	53.39	54.86	52.17
World	24384.00	24456.01	24376.25	24572.26	24373.78	24066.02	24223.98	24496.59	24479.00	23977.17	24375.12	24506.16

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 407)

Table No. 2 presents the methane emissions from rice cultivation for major rice-producing regions like India, USA, EU, China, and the Russian Federation from 2010 to 2021. India and China are the two major contributors, consistently recording the highest emissions. In 2021, India emitted 4,895.77 kilotonnes (20%), while China emitted 5,255.06 kilotonnes (22%), together account for two-fifths of global methane emissions from rice farming. USA, EU, and Russia (52.17 kilotonnes) contribute marginally, with emissions below 500 kilotonnes each. The global total methane emission from rice cultivation stood at 24,506.16 kilotonnes in 2021 (Department of Agriculture, 2024).

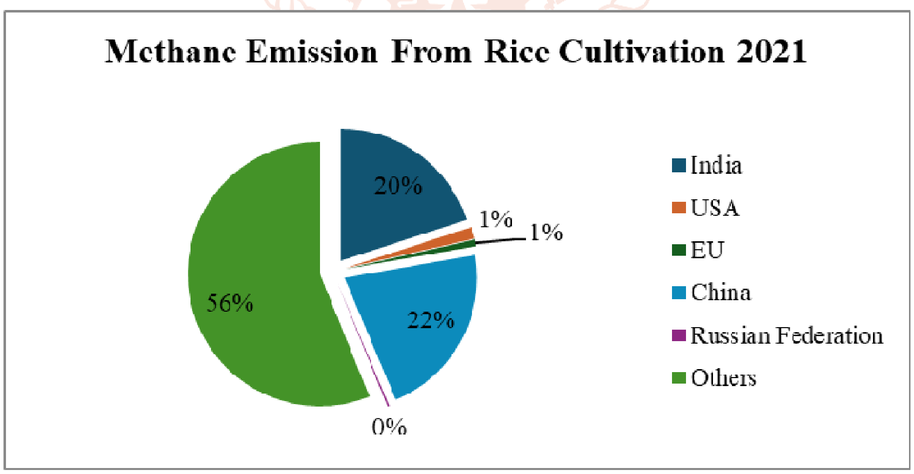

Figure 15: Methane Emission from Rice Cultivation 2021

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 407)

Figure 15 mentioned above, represents the percentage contribution of different countries to total methane emissions from rice cultivation in 2021. This data highlights that India and China are the primary contributors to global methane emissions from paddy fields due to their large-scale rice cultivation.

Hence, while rising rice exports strengthen India's agricultural trade balance, they simultaneously increase the country's contribution in methane emission, posing challenges for climate commitments.

3.6. Farmer Indebtedness

Table No. 3 Percentage Distribution of Indebted Agricultural Households by Size-Class of Land Possessed

No. of Holdings: '000 Number

Size Group	Marginal (upto 1.0 ha of land)	Small (1.01 to 2.00 ha)	Semi-Medium (2.01 to 4.00 ha)	Medium (4.01 to 10.00 ha)	Large (>10.00 ha)
No. of Holdings (2015-16)	100251 (68.45%)	25809 (17.62 %)	13993 (9.55%)	5561 (3.80%)	838 (0.57%)
Indebted Holdings	62.7%	20.2%	12.0%	4.5%	0.6%

Source: Agricultural Statistics at Glance 2023 (Department of Agriculture, 2024, p. 386-388)

Table No. 3 provides the distribution of agricultural households by landholding size and their corresponding levels of indebtedness. Marginal farmers (up to 1 ha) form the majority, with 68.45% of holdings and a high indebtedness rate of 62.7%. Small farmers (1.01–2.00 ha) make up 17.62% of holdings, with 20.2% indebtedness. Semi-medium and medium farmers have lower shares (9.55% and 3.8%) and much lower indebtedness (12.0% and 4.5%). Large farmers (>10 ha) constitute only 0.57% of holdings, with 0.6% indebtedness (Department of Agriculture, 2024). The data reflects that small and marginal farmers, who form the bulk of Indian agriculture, are also the most indebted. A clear inverse relationship exists between land size and indebtedness i.e. smaller landholders are far more indebted than larger ones. Nearly four out of five indebted farm households belong to the marginal or small farmer category.

Marginal and small farmers possess tiny operational holdings, often below the economically viable scale. To sustain livelihoods, they tend to maximize yield per hectare, leading to high input intensity (evident from Table No. 1, Figure 4 and Figure 5). As evident from Figure 11 and Figure 12 above, the share and supplies of inputs in the hands of private sector, increases their cash requirements, forcing many to take credit or loans.

Conclusion

The analysis of agricultural trends since Green Revolution through LPG reforms in India reveals a profound structural transformation in the farming sector that has gradually shifted farmers from being self-reliant cultivators grounded in indigenous knowledge systems to consumers of corporate technologies, inputs, and advisory services (Shiva, 2016). The cropping pattern data clearly indicate a growing dominance of rice and wheat, reflecting the long-term influence of the Green Revolution. However, this expansion has come at the cost of crop diversity, with coarse cereals and pulses witnessing a steady decline. The irrigation data reinforce this bias, showing irrigation coverage concentrated to rice and wheat belts (Department of Agriculture, 2024).

Fertilizer application patterns (Figures 4 & 5) demonstrate that marginal and small farmers apply far higher quantities of chemical inputs per hectare than large farmers. This reflects a structural compulsion to maximize yields from limited holdings, leading to input overuse, fostering dependency on external credit and purchased inputs. The All India Report on Input Survey (2016–17) provides strong evidence (Figures 11 & 12) of the growing penetration of private agribusinesses in the input supply chain. Private dealers and input firms have become the dominant intermediaries between farmers and markets, dictating cropping choices through proprietary seeds, chemical fertilizers, and pesticides (Venkatesh & Nithyashree, 2014; Elakkiya & Asokhan, 2021).

The excessive use of chemical fertilizers (Figures 9 & 10) has made India one of the world's highest consumers per hectare, yet yields remain below the global average. While the other agricultural economies yields more with less consumptions of chemical fertilizers. This imbalance signals diminishing returns to input intensification and long-term threats to soil health and environmental sustainability. At the macro level, India's growing rice exports (Figures 13 & 14) underscores India's integration into global agribusiness circuits but with hidden environmental cost, the export of virtual water and the escalation of methane emissions (Gowri & Shivakumar, 2021). Meanwhile, the decline in pulse cultivation underscores a neglect of climate-resilient crops that demand fewer inputs and emit less greenhouse gases.

In sum, the findings demonstrate that agribusiness corporations have not merely supplied inputs but reconfigured the very logic of cultivation, transforming farming into a capital-intensive and debt-driven enterprise, where cultivators have become consumers within the global agribusiness regime. The path forward must involve reclaiming seed sovereignty, promoting sustainable cropping systems, and re-centering policy around farmer welfare and ecological resilience rather than corporate profit.

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