From Soil to Success: Reimagining Indian Agriculture

Chaitanya[1], Subrat Sharan[2]
1Delhi School of Economics, University of Delhi, New Delhi, India- 110007
[2]Department of Mathematics, Aryabhatta College, University of Delhi, New Delhi, India- 110021

Abstract- This research paper, titled "From Soil to Success: Reimagining Indian Agriculture", provides an integrated analysis of India's agricultural sector over the four major transformations that have occurred: namely, the Pre-Green Revolution, Post-Revolution, Post-Liberalization, and the existing Digital & Structural Transformation phase. Each period is analyzed in terms of socio-economic impacts, policy changes, technological innovations, and challenges facing the sector. Presenting a critical analysis of income inequalities, human capital formation, shifting patterns of demand, and the structural problems of corruption, inefficiency, and the prevalence of the practice of barter trade, this paper focuses on the multiple constraints which impede agricultural growth in India. Regression analysis is undertaken of significant variables such as land size, irrigation, infrastructure, soil health, credit access, and procurement policies with regard to their impact on the Agricultural GDP. This paper intends to provide critical information on how to reconceptualize the future of Indian agriculture using new, sustainable policy interventions addressing the core issues of the sector.

I. INTRODUCTION

For centuries, agriculture has been the backbone of India's economy—providing sustenance to millions of people while helping to earn huge amounts in foreign exchange. With its fertile soils and varied climates, it was only natural that a great diversity of crops grew on this subcontinent, making India one of the world's foremost agricultural regions for the food grains, fruits, and vegetables grown there. Despite its rich past and contribution to the economy of a country that was primarily agriculture-based until some years ago, today Indian agriculture is faced with several issues that render it either unsustainable or inefficient.

Indian agriculture remains a cornerstone of the nation's economy, engaging 54.6% of the workforce as per the 2011 Census. Despite this substantial human investment, its contribution to the Gross Value Added (GVA) has dwindled to 18.4% in 2022-23, highlighting a pressing need for transformation. Covering 54.8% of India's geographical area, equivalent to 219.15 million hectares, agriculture dominates the landscape, yet only 42.8% of this, or 141 million hectares, is under active cultivation. Remarkably, the total cropped area has surged by 66.1% from 131.89 million hectares in 1950-51 to 219.15 million hectares in 2021-22, reflecting significant expansion but also raising questions about sustainability and efficiency in land use.[1]

This paper examines the plight of Indian agriculture as it stands today, shines light on some key problems faced by it currently, and suggests solutions that could lead to a better tomorrow, ensuring transition from soil to success. This paper seeks to trace these dynamics in shaping Indian agriculture: from a history of trends and an understanding of present conditions into the possible trajectories of potential futures.

II. PHASES OF AGRI-GROWTH

Indian agriculture has always been the lifeblood of the nation, to comprehend the phases of agricultural growth, we may divide the observations into 4 simple

possibilities, all separated by the series of policy changes, and therefore the four bifurcations could be:

A. Pre-Green Revolution Era
B. Post-Green Revolution Era
C. Post-Liberalization Era
D. Digital & Structural Transformation Era

Pre-Green Revolution Era (1947-65)

Around 70% of the population was involved in agriculture on the eve of independence, the agricultural sector was backward and stagnant in nature and India faced a major problem of food insufficiencies. As a result, soon after independence, India was dependent on other nations for food supplies. Due to these reasons the structural transformation of the Indian agricultural sector was much needed.

India established the Planning Commission in 1950; the planning commission was responsible for ensuring sustainable growth trajectories for each sector of the Indian economy. The first 5-Year plan (1951-56) laid a great importance on the agricultural sector. *About 31% of total plan outlay was allocated to agriculture and irrigation*.[2] The plan laid emphasis on the land reforms, ensuring the systematic abolition of Zamindari System. The plan even initiated the two phased land ceiling programs, which specified the maximum amount of land that could be owned by the farmers (the land exceeding the limit was taken by the government and redistributed to small and landless farmers). The plan even focused on food grains production in order to reduce foreign dependence; by the end of the plan food grains production increased from *50.8 million tonnes in 1950-51 to 65.8 million tonnes in 1955-56.*[3]

The second five-year plan focused mainly on industries, *yet 20% of plan outlay was allocated to agricultural sector.* [4] The Mahala Nobis model was introduced for the backward and forward linkages of industry; many argued that Mahala Nobis model neglected agriculture whereas another section argued that the model provided the supporting role to agriculture, although this was not aggressively pursued as industries. The plan even focused on the increase in food grain sufficiency by 25%. By the end of the plan, *India saw an increase in food grains to 76 million tonnes*,[5] reflecting an improvement in agriculture but not at the desired pace. India fought two wars, with China and Pakistan, in 1962 and 1965, respectively. The wars had left India with food shortages; therefore, policy changes were urgently needed.

At the end of the phase, we had a few major problems in the agricultural sector. Traditional farming methods, lack of irrigation facilities, and inadequate infrastructure resulted in low yields. *The average yield in 1960s was 600kg/ha6*[4] The British India faced a series of food famines, notably the Bengal famine of 1943, which were predominantly rooted in the fact that the British forced Indian peasants to produce cash and export-specific crops to serve their own economy; *the mortality due to famines ranged from 10 to 30 million between 1769 to 1943*.[7] The situation continued even after independence, as a result, soon after independence, India was dependent on other nations for food supplies. The land holdings were inequitably distributed among the farmers, with few farmers having all the land. The land reforms implemented, were plagued by corruption, in fact delayed land ceiling processes helped farmers to transfer the land holdings in their name to their other family members/ relatives/friends.

Statistics at a glance:

PARAMETERS	1947	1965
Production (metric tons) *	50 million	72 million
Contribution to GDP*	50%	42%
% of Workforce*	75%	65-70%

*Ministry of Agriculture and Farmers' Welfare, GOI
Government of India, Ministry of Finance (Economic Survey).
Reserve Bank of India (RBI) Annual Report 1965-66.
Census of India, 1951 & 61*

Post-Green Revolution Era (1966-90)

The condition of agricultural sector in the late 1960s was in a dire state, therefore the policy makers introduced Green Revolution, in order to tackle the problem of food insufficiency in India. The green revolution, introduced in 1966, focused on increasing the production of the crops like wheat and rice, using high yielding variety seeds (HYVs) and modern methods of irrigation. The revolution focused on excessive use of chemical fertilizers & pesticides in

order to magnify the production. The subsidies were provided with an objective to provide incentives to farmers for the adoption of modern technology. While some claimed that subsidies were solely beneficial to wealthy farmers and put tremendous strain on the government budget, others contended that subsidies were necessary to protect small farmers and promote acceptance of modern farming practices. The revolution helped India to come out from the problem of food insufficiencies and to reduce the foreign dependency for food imports. While the production of wheat climbed from *10 million tonnes in 1964–65 to 20 million tonnes in 1970–71*,[8] the production of food grains doubled between 1967 and 1978. The Green Revolution proved to be beneficial, but benefits confined to few states as Punjab, Haryana & Uttar Pradesh. Many even claimed that the green revolution had the reverse effect of what was expected, namely an increase in farmer inequality. These beneficiaries' area was relatively well endowed with infrastructure, irrigation facilities, and land holdings, giving rise to regional disparities. Whereas the northwestern states were doing quite well, the rest of the country-notably the rain-fed areas-remained largely characterized by low productivity and poverty. *With Punjab having around 84% of its agricultural land irrigated by the 1980s, the eastern and central states had less than 20% of their agricultural land under irrigation during the 1960s and 70s.*[9]

The Green Revolution's early success rapidly waned in the late 1970s and early 1980s. Because the technologies of the Green Revolution were distinctly input-intensive, this led to soil deterioration, the depletion of groundwater supplies, and an increase in pest and disease susceptibility. The aforementioned situation was made worse by an overemphasis on monoculture, primarily with regard to wheat and rice crops, which further decreased agricultural biodiversity. Agricultural growth also saw diminishing returns during this period. Although food grain production increased, it did so at a slower rate than in the early years of the Green Revolution. Food security was seriously harmed in the 1980s as agricultural productivity development was unable to keep up with the rate of population expansion. The agrarian socio-economic divide was more pronounced in the years following the Green Revolution. The Green Revolution helped large farmers who could afford to invest in money and technology, but the majority of farmers were small & marginal farmers who could not compete in the market. On top of this, agricultural credit facilities continued to be inadequate, with a meager access provided to small farmers by the formal credit institutions. This gap was frequently filled by informal moneylenders who constantly engaged in exploitative practices and further enhanced the debt burden on the farmers who were already vulnerable. The problems of pre-green revolution era appeared to be resolved in the early 1970s but the same problems bounced back even stronger in early 80s. Therefore, the agricultural sector at the end of post-green revolution era faced multiple problems mentioned above in addition to those of pre-green revolution era.

Statistics at a glance:

PARAMETERS	1966	1990
Production (metric tons) *	72.4 million	176.4 million
Contribution to GDP*	42.5%	29.6%
% of Workforce*	70%	64%
Area Under Irrigation	18.5%	33%

*Food and Agriculture Organization (FAO),
Government of India, Ministry of Finance (Economic Survey),
Reserve Bank of India (RBI) Annual Report 1965-66,
Planning Commission of India*

Post-Liberalisation Era (1991-2010)

In late 80s, India started facing for-ex problems due to which the then Narsimha government introduced the new economic policies in 1991, these policies led to the opening of the Indian economy. One could argue that the NEP's effects on agriculture were ambiguous. On the one hand the opening up of the economy greatly expanded agricultural exports, largely benefiting the farmers. *The share of agriculture in India's total exports increased from 15.3% in 1990-91 to 18.5% by 1995-96.*[10] However, on the other hand, as a result of the economy's abrupt transition to the service sector, India now has a service-led economy. As a result, although the workforce in agriculture remained large, its share of GDP shrank dramatically. Agriculture's contribution to the GDP has declined from *50% in 1951 to 18.4% in 2022–2023*[11],

demonstrating the economy's diversification; yet, the proportion of people who depend on agriculture remains high at 54.6% (2011 Census). This has a clear implication of lower per capita productivity and lower per capita income in agricultural sector. The reforms carried out mainly focused on industry, trade & finance but they also had a profound impact on the agricultural sector. The introduction of reforms reduced the government intervention, the immediate implication of it was the gradual shift to market-led approach. The agricultural sector which was heavily regulated by price controls, subsidies & restrictions on trade, was now controlled by the market forces. The liberalisation of the economy resulted in the reduction of trade tariffs on agricultural products. The tariff on agricultural exports reduced from *113% in 1990-91 to 34.3% in 1996-97.*[12] Agricultural exports grew *from $3.5 billion in 1990-91 to $7.5 billion in 2000-01, and further to $17.5 billion in 2010-11.*[13] While the opening up of the economy presented opportunities for export-oriented goods like fruits, rice, and cotton, it also exposed domestic producers to competition from overseas markets. Therefore, the sector was exposed to challenges pertaining to lack of competitiveness and infrastructural bottlenecks.

Despite such extensive economic reforms, the agricultural productivity was still a reason for concern. *Between 1991 and 2000, the GDP of agriculture grew at an average annual rate of only 3.2% against the overall growth in GDP of 6.1%1*[24] The one reason could be a decrease in the public investment in agriculture sector, specifically in irrigation, research, and extension services. The public investment made did not keep up with the sector's expanding needs. *As a proportion of agricultural GDP, public investment in agriculture fell from 3.4% in the early 1980s to 1.9% in the early 2000s.*[15] The establishment of APMCs was meant to regulate markets and protect farmers against exploitation; but often these created monopolistic conditions leading to inefficiencies and greater transaction costs. Further, the National Agricultural Policy, 2000, was meant to achieve more than a growth rate of 4% per annum in agriculture by diverse, sustained agriculture, including technological upgradation. But as a result of inefficient implementation of policy the actual growth rate achieved during 2000-2010 was at the rate of around 2.4 percent per annum (Central Statistical Organization, GOI). Reforms in the banking sector encouraged more lending to the agricultural sector with the introduction of priority sector lending norms. Agricultural credit increased from *₹20,000 crores in 1991-92 to over ₹2.5 lakh crores by 2009-10.*[16] Access to institutional credit, however, remained biased towards large and medium farmers, while small and marginal farmers continued to depend on informal sources often at usurious interest rates.

This post-liberalization era's increased focus on rural development through various government-initiated programs was another significant aspect. One of these, the NREGA (also known as MGNREGA) of 2005, was a significant effort to alleviate agricultural hardship by giving rural families work. As to the Ministry of Rural Development, Government of India, data obtainable in 2010, the MGNREGA program provided employment to nearly 50 million families annually. Again, though, it was unclear how much these programs would improve the agriculture industry. Productivity growth in agriculture remained sluggish, and improvement of yield continued to be dismal in large parts of the country. For example, the yield of rice, the country's main cereal crop, improved from a *mere 1,930 kg/ha in 1991-92 to 2,190 kg/ha in 2009-10.*[17] Besides, regional imbalance was heightened during the post-liberalization era because Western and Southern India benefited more from these reforms compared to Eastern and Central regions. This imbalance was fostered by the uneven distribution of resources and investments; for example, states like Punjab and Haryana were more productive than Bihar and Orissa. During the same period, farmer suicides went up alarmingly; this was more so in states such as Maharashtra, Andhra Pradesh, and Karnataka. *Over 250,000 farmers committed suicide between 1995 and 2010 due to indebtedness, crop failures, and declining profitability of agriculture.*[18] The shift towards export-oriented agriculture caused over-exploitation of natural resources, especially of water. The areas under water-intensive crops like sugarcane and rice increased and resulted in the depletion of ground water. Excessive use of fertilizers and pesticides further caused disastrous impacts on the environment, such as soil degradation and loss of biodiversity.

The ASEAN Financial Crisis of 1997 was primarily a problem for the nations in South East Asia; but it had given India a couple of bruises. It ultimately led to the

devaluation of the currencies of all the ASEAN countries, which badly impacted the agricultural exports of India to the regional markets. Devaluation of ASEAN currencies made Indian agricultural exports comparatively costlier and therefore less demanded by these markets. This had a specific effect on the export of commodity products from India, such as tea, coffee, and spices. The crisis added to global economic uncertainty, and hence investment in agriculture and associated infrastructures in India was lower. Consequently, India's agricultural exports to ASEAN nations declined by *around 5% in 1998 because of reduced demand, and intensive competition from other exporting nations whose currencies had also depreciated.*[19] *Overall growth rate of the agriculture sector in India slowed down from 5.9% in 1996-97 to 2.9% in 1997-80.*[20]

Furthermore, The Global Financial Crisis of 2008 transmitted its shocks to India's agriculture primarily through two channels: a decline in the demand for agricultural exports and a credit crunch that dried up rural financing. *Agricultural GDP growth in India, therefore, slowed down from 4.7% during 2007-08 to 1.6% during 2008-09.*[21] The world recession depressed the prices of important agricultural commodities and thus sapped farmers' incomes. *Where India's agricultural exports grew 20% in 2007-08, it grew just 6% in 2008-09.*[22] Due to the global recession, the demand for Indian agricultural export commodities experienced a fall, especially in key export markets of the United States and Europe. It included basmati rice, cotton, and spices. In the international market, the *price of basmati rice nosedived almost 15% between 2008 and 2009*,[23] thereby shrinking the earnings for farmers in India. Credit crunch during the crisis period meant that farmers could not obtain sufficient loans to buy seeds, fertilizers, and other inputs, which, in turn, had a negative effect on productivity in the agricultural sector. Domestic consumption of food remained fairly resilient, partly cushioning the crisis impact on this sector.

Therefore, like every phase, this phase showed some degree of improvement but the agricultural sector failed on various dimensions due to the persistence of problems.

Statistics at a glance:

PARAMETERS	1991	2010
Production (metric tons) *	176 million	240 million
Contribution to GDP*	29.4 %	14.4%
% of Workforce*	62.5%	53%
Area Under Irrigation	31.3%	45.3%

*Food and Agriculture Organization (FAO),
Government of India, Ministry of Finance (Economic Survey),
Reserve Bank of India (RBI) Annual Report,
Planning Commission of India*

Digital & Structural Transformation Era (2010-23)

This period was the transition phase for India's agricultural sector, which was characterised by the governmental policies of modernization, integration of technology, and economic reforms. However, all these developments created serious challenges for the farmers majorly because of demonetization, the inception of GST, and the COVID-19 pandemic. Though policy initiatives by the government promised enormous benefits, the ground reality often differed from the claims of such assertions, especially as far as small and marginal farmers are concerned. It consisted implementation of major agricultural policies such as Pradhan Mantri Kisan Samman Nidhi (PM-Kisan); Pradhan Mantri Fasal Bima Yojana (PMFBY); Agriculture Infrastructure Fund (AIF); Electronic National Agriculture Market (e-NAM).

Pradhan Mantri Kisan Samman Nidhi (PM-Kisan), initiated in 2019, aims directly at ensuring that small and marginal farmers annually receive ₹6,000 as minimum financial support in three instalments. As of early 2023, over *11 crore farmer families benefited, with the total amount disbursed reaching ₹2.24 lakh crore*.[24] The scheme had been widely hailed as one that would bring financial stability for farmers, its actual implementation was dogged by several problems that blunted its impact. The amount was universally delayed and a large number of farmers who were eligible did not find place in the genuinely needy list due to errors. Moreover, tenant farmers and landless agricultural labourers fell outside the ambit of this scheme, and hence, many of the poorest were excluded from the bracket of recipients of the intended financial assistance. *About 20% of the eligible farmers did not get any benefit,*[25] while a part of funds was distributed to ineligible beneficiaries because of inadequate verification processes.

Pradhan Mantri Fasal Bima Yojana (PMFBY), introduced in 2016, aimed at offering comprehensive crop insurance cover to farmers against loss on account of natural calamities. The government now claims that by 2023, the scheme had provided insurance coverage to *more than 70 million farmers every year and settled claims worth ₹1.2 lakh crore.*[26] Despite this huge coverage, PMFBY faced a number of problems such as one of delayed claim settlement coupled with low claim-to-premium ratio that reduced its effectiveness. In many cases, the financial succour arrived too late to be of any real use. Besides, the application process being fairly complicated dissuaded many from applying, especially the small farmers who find it too cumbersome to navigate through the bureaucracy. *Only 40% of claims were settled within the stipulated time*[27] and it is being observed that many small farmers remain either unaware of the scheme or fall outside the benefits accruing from various procedural hurdles.

AIF (Agriculture Infrastructure Fund) was announced as part of the Atmanirbhar Bharat package in 2020. It aimed at catalysing investments in the agriculture infrastructure, namely cold storage, warehouse facilities, and processing units. According to the Government, by 2023, *loans amounting to ₹30,000 crore were sanctioned, thus creating over 10,000 Agri-infrastructure projects.*[28] While the AIF had massive potential to ameliorate rural agricultural infrastructure, benefits are largely imbalanced. For small and marginal farmers-the greater chunk of agriculturists-access to these funds was beyond imagination with the stringency in loan conditions and the need to provide collaterals. Moreover, *the actual expenditure was less than estimated and stood at only ₹15,000 crore by 2023.*[29] This shortfall in funds translated into a lot of planned projects not being completed, thereby capping the real impact of the scheme on rural economies.

Another revolutionary policy implementation was Electronic National Agriculture Market (e-NAM), e-NAM was one of the most ambitious schemes launched by the Centre in 2016 with the objective of providing a single national market for agricultural produce through online integration of APMCs from all parts of the country. *It reported that more than 1,000 mandis were integrated with e-NAM, which facilitated trade worth over ₹2 lakh crore, by 2023.*[30] The initiative of e-NAM did mark a serious step towards market integration, its implementation suffered severely. Most farmers, particularly those living in areas far from urban centres, lacked the necessary digital means-for example, smartphones or uninterrupted internet access-to engage in it. Secondly, most of the transactions taking place on e-NAM were still being conducted outside of the platform, which defeats the very purpose of creating a single unified national market. Whereas, according to a study by the Indian Council for Research on International Economic Relations, only about 5% of the agricultural trade in India took place through e-NAM, which was found to be grossly inadequate due to insufficient infrastructure and general unawareness among farmers.

Demonetization of the notes of ₹500 and ₹1,000 was done in 2016 on the premise that it would contain black money, reduce corruption, and thereby gradually make the economy move toward digital transactions, including in agriculture. The impact of this policy can be termed as an 'Agriculture Short-term disruption', this sudden withdrawal of 86% of currency in circulation led to an immediate shortage of cash, particularly hitting those highly reliant on cash transactions, like agriculture. Farmers were not able to buy seeds and fertilisers or pay labourers during the crucial rabi sowing season. This led to a reduction in the sown area, which finally led to lower yields. *The agricultural growth rate declined sharply to 1.2% in 2016-17 from 5.2% the previous year-a clear indication of the sector's vulnerability to such an economic shock.*[31] Inferentially in long term, demonetisation, as a policy intervention, was supposed to nudge the agricultural sector towards digital payment systems. The transition became slow. Most rural areas lack the needed infrastructure, like internet connectivity and banking amenities, to help in digital transactions. In addition, digital literacy is quite low across the rural population, which has further hindered the pace of adopting cashless transactions. In fact, the 2018 report of NABARD found that even two years after demonetization, a meagre 10% of farmers were regularly using the means of digital payment. Hence, this vital part of the policy has been unsuccessful.

The much-publicised GST rollout in 2017 was supposed to usher in an integrated tax regime for the

Indian market, reining in the cascading impact of multiple taxes and smoothing out market mechanisms. While the reality on the ground-agriculture input cost for fertilisers is that the GST is set at 5%, whereas in the case of pesticides, it would be 12%, both below earlier taxation. This helped reduce the cost of inputs for farmers, thereby increasing their margins. However, farm machinery and equipment attracted 18% GST, against a pre-GST tax rate that was lower than this. Increased capital goods cost was thus a negative factor for farmers desiring to mechanise their operations and also specifically for financially constrained farmers. Smoothing the process of interstate trade in the country, the introduction of Goods and Services Tax has reduced transport costs and abolished taxes at the state levels. At the same time, this is equally burdensome because small traders and farmers find it very irksome to comply with the new demands of regular filing of returns and maintenance of digital records for their small-scale operations. This increases the transaction cost of their dealings and sometimes even disrupts traditional trade networks. Benefits of market integration were therefore distributed asymmetrically, the larger and more organised players gaining more than the small farmers and traders.

Now constituting the impact of COVID-19 we can foresee that the nationwide lockdown to tackle the spread of COVID-19, imposed in March 2020, had a strong impact on the agricultural supply chains. The timing of the lockdown also coincided with the peak rabi harvesting season, and so it meant a massive disruption to the movement of goods and labour. Restrictions to transport, coupled with the shutting down of markets, resulted in huge post-harvest losses, particularly for perishable commodities like fruits and vegetables. *Overall agricultural growth slowed down to 3.6% in 2020-21 from the level of 4.1% in the previous year.*[32] This shows how the sector grappled to maintain productivity amidst these disruptions. The pandemic was also blamed for a sharp contraction in demand for the agriculture produce, in particular, the high-value crops. Shutdowns of hotels and restaurants and other catering services, including consumers going back into their homes, had prices of the perishable commodities collapse. Small farmers, reliant on the sale of their products in local markets or intermediaries, bore the worst impacts. In light of a report from the Food and Agriculture Organization, one-quarter of small farmers faced income losses of more than 50% during the pandemic-the economic burden has been heavy for rural households.

Next, the government announced a host of relief measures in view of the pandemic-related economic downturn as part of the Atmanirbhar Bharat package. This was in the form of ₹1 lakh crore for the Agri Infrastructure Fund for financing post-harvest infrastructure, and also a ₹2 lakh crore credit support package aimed at ensuring adequate liquidity for farmers. *While more than 80 crore people were given free food grains under the PM Garib Kalyan Yojana and food security was ensured in the crisis, the growth rate of the sector at 3.9% in 2021-22 is still not complete.*[33] Small and marginal farmers have continued to fight the long battle of high input costs, restrained access to credit, and hanging imbalances in disrupted supply chains. *The disbursal under the Agriculture Infrastructure Fund was only ₹ 20,000 crore as of mid-2023, far below the announced ₹ 1 lakh crore.*[34] This shortfall kept the scope of developing post-harvest infrastructure inadequate, particularly in the less-developed regions where the needs were relatively more acute.

Yet, despite various large promises of improvement in farmer welfare and agricultural productivity emanating from the many initiatives, taken by the government, actual performance on the ground normally proved less favourable for farmers, and even more so for weaker sections of farming communities. The economic disruptions caused by demonetization, GST, and the COVID-19 pandemic brought underlying vulnerabilities poignantly to the fore and underlined the need to henceforth have more inclusive and resilient policy frameworks. How such reforms will be sustained over a longer period of time remains a moot question, with the sector marching with identified benefits through the minefield of modernization in an always complicating economic environment.

Statistics at a glance:

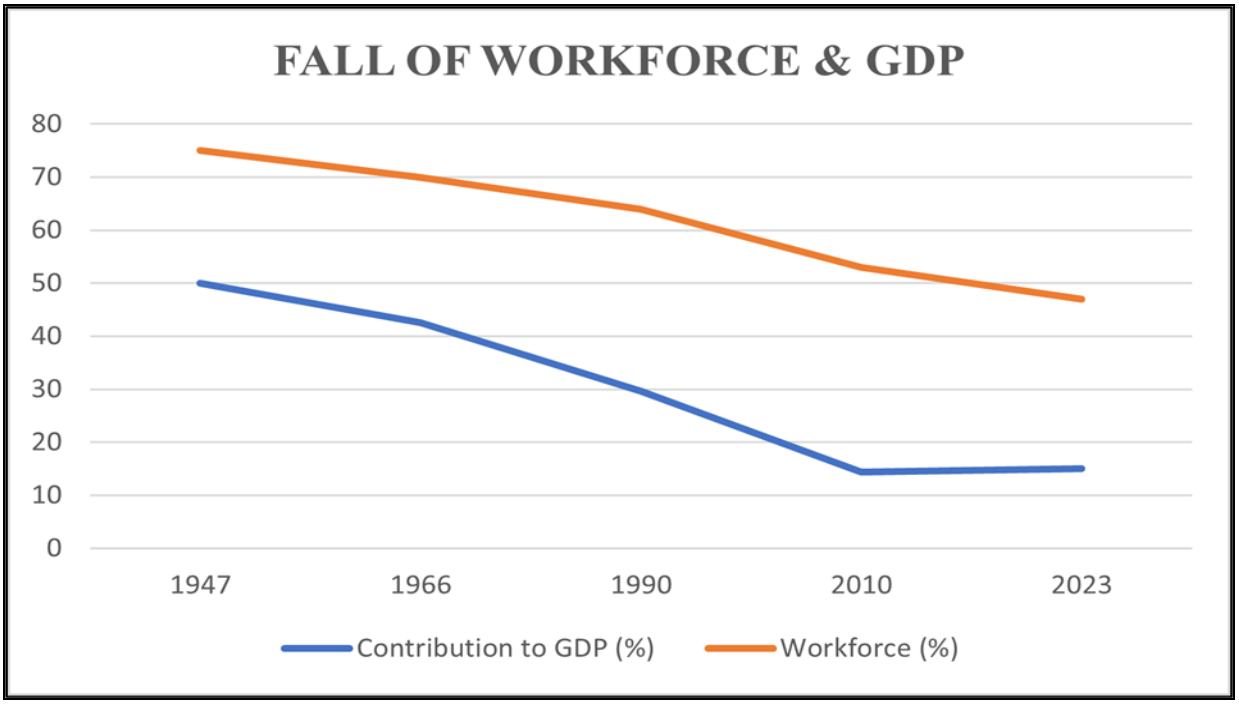
PARAMETERS	2011	2023
Production (metric tons) *	259 million	350 million
Contribution to GDP*	14.4%	15%

% of Workforce*	48.9%	47%
Area Under Irrigation	46.4%	52-55%

Food and Agriculture Organization (FAO), Government of India, Ministry of Finance (Economic Survey), Reserve Bank of India (RBI) Annual Report, Planning Commission of India

DECREASING PER-CAPITA PRODUCTIVITY & INCOME (A COMPARITIVE ANALYSIS)

PARAMETERS	1947	1966	1990	2010	2023
Contribution to GDP (%)	50	42.5	29.6	14.4	15
Workforce (%)	75	70	64	53	47



The data and the graph presented above can be understood in the following 3 stages:

STAGE-1: The Stage of Proportional Decline: From 1947 to 1966, the percentage of labour force and of GDP contribution approximately declined from 70% to 65% and from 50% to 43%, respectively, within India's agricultural sector. Both curves are nearly parallel during the period. It means that when the workforce decreased, the GDP contribution from this sector also decreased proportionally. This in turn means that in this phase, the agriculture sector did not lose any labour productivity.

STAGE-2: The Stage of Growing Divergence: Between 1966 and 2010, the agricultural workforce was only falling gradually from 65% to 50%, and, at the same time, the sector's contribution to GDP plummeted from 45% to 15%. The divergence in the two curves begins to appear in this phase. While the labour force decreases slowly, the contribution of GDP has fallen sharply, reflecting a huge mismatch. This reflects the fact that per capita income and productivity in agriculture have declined sharply in this period. The mismatch in the decline could be understood easily by observing the steeper slope of GDP contribution. As the sector was unable to keep up with the productivity improvements happening along other sectors, its relative economic importance fell, even while it continued to employ a large share of the population.

STAGE-3: The Stage of Early Sign of Productivity Recovery: Over the period of 2010-2023, the workforce continued shrinking to reach approximately 40% while GDP contribution stabilized at 15%. In this stage, although there is still a decline in workforce level in agriculture, the sector's contribution in terms of GDP stabilizes or increases slightly. This could point to the initial periods of recovery of productivity or could be due to some government interventions that raised the output levels of agriculture. This phase indicates a possible rise in per capita income and hence in productivity within agriculture; for this trend to continue, however, the process of reforms and technological changes is much needed.

III. CURRENT ISSUES PERTAINING AGICULTURAL SECTOR

The contemporary problems with the agricultural sector could be sum up in the following categories:

1) Low Agricultural GDP

2) *Socio-Economic Problems*:
   a) Human Capital Formation
   b) Income Inequalities (Inter & Intra)
   c) Changing Pattern of Demand

3) *Administrative Constraints*:
   a) Corruption and Inefficient Implementation
   b) Unorganised Agricultural Sector
   c) Existence of Barter Trade

1) LOW AGRICULTURAL GDP

Agricultural GDP is defined as the sum of the gross value of all agricultural products and related services within the economy of a country. Even today, agriculture has remained an important sector in India and provides livelihood to millions of people, mainly of rural origin. However, in the recent years, the contribution of the sector towards GDP in many states has stalled or declined, which raises a big question over the sustainability of agricultural growth. The several regions have exhibited low agricultural productivity and GDP due to some structural, environmental, and financial challenges. This decline in agricultural GDP presents some of the far-reaching fallouts, such as lower incomes of farmers, higher incidence of poverty in the rural economy, and less food. MoSPI data also points out that the share of agriculture in total GDP dropped from around 54% in the 1950s to less than 15% by 2020, even though it still engrossed nearly half of the country's workforce. That presents a paradox pointing towards structural inefficiency & it calls for deep analysis.

The problem of the low agricultural GDP is understood and quantified with the help of the multi variate regression model explained below:

Methodology: To empirically analyse which factors resulted in low agricultural GDP in the Indian states, the model based on multiple regression analysis was formed, where agricultural GDP was the dependent variable.

Objective: The model tried to identify and quantify the effects of various independent variables on the agricultural GDP of the Indian states.

Dependent Variable:

State-wise GDP of Agricultural Sector in 10 billion Rupees.

Independent Variables (Regressors):

1) State-wise Average Land Size in 100000 hectares.
2) State-wise funds released for soil health in Rupees Lakhs.
3) State-wise Electricity usage in 10 KWH.
4) State-wise Road lengths in 10000 Kms.
5) State-wise availability of Storage Capacity in 100 Kg Tonnes.
6) State-wise Cost per quintal in Rupees 1000.
7) State-wise number of Agri-Accounts in 10000.
8) State-wise number of Agricultural Loans in 10000.
9) State-wise number of Banks in Rural areas.
10) State-wise land under irrigation in 1000 hectare.
11) State-wise availability of water resources in 1000.
12) State-wise usage of fertilizers & pesticides in lakh tonnes.
13) State-wise procurement by government in Rupees 100 crores.

Results: The regression results specified the factors that actually matter the most in impacting state-level agricultural GDPs, as well as the key barriers to and opportunities for improvement. The results provide a data-driven understanding of the issues underlying in agricultural output. The model corrects for heteroskedasticity, improving the reliability of the standard errors.

Below is the screenshot of the regression results, received by using the state wise data of each variable. The explanation of each result is provided in the section that follows.

gretl: model 1

File Edit Tests Save Graphs Analysis LaTeX

```
Model 1: Heteroskedasticity-corrected, using observations 1-30 (n = 28)
Missing or incomplete observations dropped: 2
Dependent variable: GDP

                     coefficient   std. error   t-ratio  p-value
  ------------------------------------------------------------------
  const               -11.5974      2.82227      -4.109   0.0011   ***
  LandSize              0.151101    0.0467580     3.232   0.0060   ***
  SoilHealthFundsR~     0.00629347  0.00136657    4.605   0.0004   ***
  ElectricityUsage      0.0571486   0.0179243     3.188   0.0066   ***
  AvailabiltyofSto~    -0.0396185   0.00867749   -4.566   0.0004   ***
  CostofProduction     -3.75806     2.45619      -1.530   0.1483
  NumberofAgriAcco~    -0.0610902   0.00721600   -8.466   7.04e-07 ***
  AmountofAgricult~     0.0455840   0.00631447    7.219   4.43e-06 ***
  NoofBanksinRural~     0.0130884   0.00392472    3.335   0.0049   ***
  LandunderIrrigat~     0.00420131  0.000975481   4.307   0.0007   ***
  AvailabilityofWa~     0.0456028   0.00664411    6.864   7.76e-06 ***
  FPUsed                0.483127    0.135733      3.559   0.0031   ***
  ProcurementbyGov~     0.0638544   0.0193952     3.292   0.0053   ***
  ROADLENGTH            0.984528    0.129765      7.587   2.52e-06 ***

Statistics based on the weighted data:

Sum squared resid    20.67555   S.E. of regression    1.215247
R-squared            0.999532   Adjusted R-squared    0.999097
F(13, 14)            2299.924   P-value(F)            5.79e-21
Log-likelihood      -35.48474   Akaike criterion      98.96948
Schwarz criterion    117.6203   Hannan-Quinn          104.6712

Statistics based on the original data:

Mean dependent var   47.00321   S.D. dependent var    50.86704
Sum squared resid    610.2106   S.E. of regression    6.602005

Excluding the constant, p-value was highest for variable 7 (CostofProduction)
```

Interpretation of Results:

1) Land Area:
   - Coefficient: 0.151101
   - p-value: 0.0060 (significant at the 1% level)
   - Interpretation & Explanation: For every 100,000-hectare increase in agricultural land, GDP increases by 0.151 billion rupees, or Rs 151 crore, assuming everything else constant. A bigger land size has a positive relationship with the GDP in agriculture and supports the claim that fragmented land reduces efficiency.
   - Policy Recommendations: Policies on land consolidation to reduce fragmentation of land should be implemented. This would lead to an increase in efficiency in agriculture production due to economies of scale, mechanization, and optimal land use.

2) Scheme of Soil Health:
   - Coefficient: 0.0062947
   - p-value: 0.0004 (highly significant at the 1% level)
   - Interpretation & Explanation: For each additional unit of money (in lakhs) invested towards soil health, agricultural GDP goes up by 0.0063 billion (Rs 6.3 crore). This is

because right investment in soil health brings rich returns in the form of productivity.

- Policy Recommendations: The targeted funding for soil health schemes like the SHC scheme should be increased. Improvement in the services of soil testing by ensuring efficient funds allocation & implementation in a timely manner should be done in order to help farmers practice better sustainable agricultural practices to maintain their soils' fertility.

3) Electricity Use:
   - Coefficient: 0.0571486
   - p-value: 0.0066 (significant at 1% level)
   - Interpretation & Explanation: For each one unit increase in electricity usage per hectare, agriculture GDP goes up by 0.0571 billion (Rs 57.1 crore). The result underscores the need for not just the steady supply of electricity but also to be on the same page with the timings of agriculture related processes like irrigation. Therefore, in such cases electricity directly impacts the agricultural produce.
   - Policy Recommendations: The government must Provide uninterrupted, affordable electricity supply in rural areas for agricultural use. A good start would be to expand programs such as Deendayal Upadhyaya Gram Jyoti Yojana and scale up the construction of more solar power systems that would reduce costs for the farmers while guaranteeing reliable energy.

4) Storage Available:
   - Coefficient: -0.0396185
   - p-value: 0.0004 (highly significant at the 1% level)
   - Interpretation & Explanation: High storage capacity has a negative correlation with agricultural GDP. Every one unit increase in the storage capacity (in 100 kg tonnes) decreases agricultural GDP by 0.0396 billion or Rs 39.6 crores. The result could be explained by following arguments:
     a) It may be a pointer to lagging or over-emphasizing on storage at the cost of production efficiency.
     b) The other reason could be simply an over-reliance on storage rather than improving market access.
     c) Another argument could be that the increase in the storage capacity did not align with the increase in the agricultural production of that area, mathematically saying the increase in storage capacity might be many times more than the negligible increase in GDP.

     Therefore, we can conclude that above reasons provide enough arguments in the favour of high degree of policy ineffectiveness.
   - Policy Recommendations: The government should try to boost efficiency in the use of storage facilities through improvement in strategic use of storage facilities. Introduction of training programs on post-harvest management and encouraging private sector involvement to erect modern storage infrastructure that reduces losses and translates to market demand, could be some beneficial policy measures. The government must identify & then rectify the policy ineffectiveness of ongoing policies.

5) Road Length:
   - Coefficient: 0.984528
   - P-value: 2.52e -06
   - Interpretation: State-wise Road length is highly contributing, agricultural GDP increases by 0.9845 billion (Rs 984.5 crore) for every one unit of increase in road length (in 10000 Kms). This is because better connectivity reduces post-harvest losses as well as improves farm earnings through better market access.

6) Cost of Production:
   - Coefficient: -3.75806
   - p-value: 0.1483 (not statistically significant)
   - Interpretation & Explanation: Although the coefficient is large and negative, giving an indication of an indirect relationship between cost of production and GDP, the p-value shows that the relationship is not statistically

significant. In this case, there is lack of evidence to conclude that cost of production has a negative impact on GDP. Even after high cost of production the farmers are reluctant to reduce their production because of three reasons:

a) They have low bargaining power in factor markets; therefore, they have no other option than hiring expensive factors.
b) They do not have diverse opportunities to shift to other professions; therefore, they continue agriculture even when profits are low.
c) When the factors of production become expensive, most of the farmers often shift to manual methods of farming instead of modern FOPs. Though this manual labour driven agriculture hampers the overall welfare of a farmer but it does not impact the levels of production significantly.

All the above arguments clearly explain the reason for the insignificance of cost of production. Therefore, higher cost of production does reduce profitability but do not impact the GDP of the sector.

- Policy Recommendations: Farmers should stablish FPOs and cooperatives to bargain collectively. Through FPOs, farmers can obtain all inputs like seeds, fertilizers, and machinery at lower prices due to the pool of resources. Similarly, government support schemes on bulk procurement schemes and costly input subsidy schemes would help reduce cost pressures on farmers. Integrated rural skill development programs will provide alternative livelihood options for farmers. To develop alternative sources of income for rural and farmers agri-business and agro-processing industries should be promoted. The usage of affordable mechanization should be promoted through government subsidy on agriculture machinery and leasing models for small and marginal farmers. In addition, the development of inexpensive machinery and farmer-friendly equipment also ensure continuation of production at a level not excessively taxing the farmers physically, while at the same time improving their welfare further.

7) Number of Agricultural Accounts:
   - Coefficient: -0.0610902
   - p-value: 7.04e-07 (highly significant)
   - Interpretation & Explanation: For every additional agricultural account, the GDP drops by 0.0611 billion (Rs 61.1 crore). The above outcome may be surprising, and what it suggests is that most agricultural accounts are not being used or resources are being poorly used towards the wrong areas of finance. Moreover, we can conclude that the schemes like PM Jan Dhan Yojana were able to open the bank accounts at much larger rate, but most of these accounts are fake or remain unused & exist only for the sake of existing.
   - Policy Recommendations: The government should simplify the formal financial services and make access to such services easier, while offering education on financial management among farmers. Introduction of programs for defined credit services, subsidies, or insurance products linked to agricultural accounts would enhance the activated & continuous use bank accounts.

8) Number of Agricultural Loans:
   - Coefficient: 0.0455840
   - p-value: 4.43e-06(highly significant)
   - Interpretation & Explanation: With every unit increase of agricultural loans, the GDP goes up by 0.0456 billion (Rs 45.6 crores). The above scenario is true because access to finance is paramount for output of agriculture. So, increase in agricultural loan, increases the scope of capital investment in agriculture leading to a direct impact on GDP.
   - Policy Recommendations: Agricultural loan schemes should be expanded more. Bureaucratic barriers for the sanction of loans need to be lowered. Micro-financing schemes, suitably developed and designed for small and marginal farmers, should be

evolved to enhance their access to credit and related financial security.

9) No. of Banks in Rural Areas:
   - Coefficient: 0.013084
   - p-value: 0.0049 (significant at the 1% level)
   - Interpretation & Explanation: More rural banks contribute positively to agricultural GDP, adding 0.0131 billion or (Rs 13.1 crore) for every additional bank there is. This again highlights the role of financial infrastructure to the agricultural sector. More number of banks mean that farmers have more fair opportunities available in order to carry out basic saving- investment activity. It even shows that better banking system means better accessibility to credit financing.
   - Policy Recommendations: The government must focus on increasing the number of bank branches and banking correspondents in the rural areas. There is a need for expansion by government-led programs in rural areas by having formal finance institutions and complementing them with digital banks for quicker delivery.

10) Land Under Irrigation:
   - Coefficient: 0.00420131
   - p-value: 0.0007 (highly significant)
   - Interpretation & Explanation: For every additional hectare of irrigation, agricultural GDP increases by 0.0042 billion (Rs 4.2 crore). This is because the irrigation development really acts as a catalyst in increasing productivity particularly in those regions where the rainfall is quite erratic. It reduces the dependency of farmers on the natural rainfall, leading to more stable and higher output.
   - Policy Recommendations: Irrigation development through canal irrigation, drip systems, and rainwater harvesting should be promoted and enhanced to augment the arable land under irrigation. The government's schemes, such as Pradhan Mantri Krishi Sinchayee Yojana, should also be further strengthened so that maximum possible coverage is achieved.

11) Availability of Water Resources:
   - Coefficient: 0.0456028
   - p-value: 7.76e-06 (highly significant)
   - Interpretation & Explanation: More water resources strengths positively as with more water resources GDP goes up by Rs 45.6 crores for every unit of water resources (in thousands). Higher number of water resources is directly related to better availability of resources for irrigation purposes.
   - Policy Recommendations: Investment in water conservation techniques like watershed management, rainwater harvesting, and rejuvenation of water bodies is of utmost importance. In-order to mitigate the problem of water scarcity in agriculture implementation of policies that enhance efficient water usage, such as micro-irrigation systems, should be done.

12) Fertilizers & Pesticides Used:
   - Coefficient: 0.483127
   - p-value: 0.0031 (significant)
   - Interpretation & Explanation: For each additional unit of fertilizers and pesticides (in lakh tonnes), agricultural GDP is getting increased by 0.483 billion (Rs 483 crore), with a hidden interpretation that through balanced use of inputs increase in productivity takes place.
   - Policy Recommendations: Promotion of balanced use of fertilizers and inclusion of organic farming through schemes like Paramparagat Krishi Vikas Yojana should be ensured. Training on judicious use of pesticides and promotion of eco-friendly measures must be undertaken by the government, in order to promote productivity with sustainability.

13) Government Procurement:
   - Coefficient: 0.0638544
   - p-value: 0.0053 (significant)
   - Interpretation and Explanation: The Government procurement is also positively affecting the agricultural GDP as there is an increase in the agricultural GDP by 0.0639 billion (Rs 63.9 crore) for every additional

unit (in 100 crores) of government procurement. It highlights the importance of government interventions in stabilizing farm incomes and productivity.

- Policy Recommendations: Strengthening of the government procurement policies by expanding coverage under MSP so that additional crops would also be covered and procurement is enhanced in some of the underserved regions. Also, improving the processes for greater transparency and efficiency in these procurements and ensure on-time payments to farmers, are of great importance.

Model Overview:

- R-squared: 0.995532

This indicates that 99.55% variation in the agricultural GDP is explained by the independent variables in the model and hence, the fit is very good.

- Adjusted R-squared: 0.999097

The adjusted R-squared is slightly lower, adjusting for the number of predictors in the model, but it still is an extremely good fit.

- F-statistic: 2299.924 (p-value of F: 5.79e-21)

The F-statistic is highly high, and the p-value of F-statistic is also significant; hence, overall, the model is highly statistically significant and a good fit to the data.

2) SOCIO-ECONOMIC PROBLEMS

A) Human Capital Formation

The term "human capital formation" describes the advancement of worker health, education, and skill levels, which translates into increased productivity and economic contribution potential. Low income, low productivity, and insufficient answers to issues like market instability, technological advancements, and climate change are all results of low human capital investment. The majority of policy interventions have traditionally focused on financial incentives or physical infrastructure, whereas human capital—which is defined as one's capability, health, and technical proficiency in agriculture—is typically neglected. Even though it only makes up around 18% of India's GDP, it nonetheless employs more than 40% of the labour force, therefore, investment in human capital is essential if Indian agriculture has to reach its pinnacle.

One major stumbling block for building up human capital in agriculture is the low educational level among farmers. *Nearly 44% of the agriculture workers have never attended any form of formal schooling, while another 22% have completed only primary education.*[35] Farmers are suffering as a result of their lack of formal education since they are unable to embrace contemporary agricultural methods, comprehend the risks posed by climate change and effectively manage resources, or obtain information on market circumstances and best practices. The modern agricultural practices like precision farming, integrated pest management, and irrigation methods require some basic understanding of scientific concepts. Due to the lack of capability to understand such scientific concepts, these methods are bound to be less adopted by the lesser-educated farmers; hence missing opportunities to improve yields and reduce input costs. As per the report by the Ministry of Agriculture and Farmers' Welfare, 2020, small and marginal farmers still continue to use obsolete methods such as usage of excessive chemical fertilizers, leading to deterioration of the soil quality and decline in long-term productivity. Apart from that, digital literacy is also becoming important in agriculture as market linkages, weather updates, and government schemes are majorly communicated through online modes. Lack of information & digital literacy further reduces the potential of a farmer who is already suffering from poor formal education to reap benefits from schemes like Pradhan Mantri Fasal Bima Yojana and e-NAM. The 2022 data from e-NAM shows that only about 20% of small and marginal farmers actively participate in online marketplaces, primarily due to the digital divide.

While there have been some efforts in India in the direction of enhancing skill development through initiatives such as the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), such initiatives have not emphasized agriculture to a considerable extent. *Only 7% of the agricultural labour has received formal skill training. This is far away from other sectors as manufacturing and services report over 25% of its workforce as formally trained.*[36] The absence of skilling results in a labour-intensive farming model, which is dominantly unable to raise its productivity curve. The mechanization is very low in the country as

only about 40% of the farms are using modern machineries like tractors and harvesters compared to 95% usage level seen in the US and other developed nations.[37] Mechanization not only enhances productivity but it also reduces the drudgery of farm labour. A factor that deters widespread adoption of mechanisation is that the Indian farmers are usually unskilled in operating and maintaining such modern machinery. In addition, skills such as post-harvest management, value added processing, and efficient water usage are grossly underdeveloped. The *post-harvest losses account for 20 percent of the total food production,*[38] due to poor practices in post-harvest handling, storage, and transportation. All these are the areas where improvement can definitely be massively enhanced by targeted skill development programs.

Health is one of the critical contributors to human capital. In rural areas access to healthcare is still very poor, and most of the agricultural working groups reside there. About *35% of the agricultural workers have chronic malnutrition*,[39] and healthcare access is sporadic in many rural regions. Poor health undermines the physical and cognitive capabilities of farmers and hence impinges directly on farm productivity. Nutritional deficiencies, TB, respiratory problems, and waterborne diseases are commonly found among the rural agricultural workers. This is the health burden that exacerbates rural poverty and reduces labour efficiency. The healthy farmer is bound to make better farming decisions, manage risks more effectively, and work more productively. They also cannot recover from physical injury or illness in the absence of reliable healthcare facilities in rural India. This, in turn, is causing prolonged absenteeism during the peak seasons of agriculture. Even for the flagship health program of the government, Ayushman Bharat, the utilization rate seems low in rural areas. It can be concluded that rural households are less likely to avail services related to Ayushman Bharat because of low awareness and low density of healthcare providers in far-flung areas. Thus, this becomes a kind of vicious cycle, where poor health reinforces low productivity and perpetuates poverty.

Human capital development can be more or less observed from looking at technology adoption in the agricultural sector as well. While digital platforms, advanced technologies involving drones, satellite imagery, and IoT-enabled sensors have been introduced to revolutionize farming, their reach is constrained due to inadequate education, digital skills, and technical knowhow amongst farmers. On the other hand, the Agriculture Skill Council of India estimates that even very simple technologies, such as mobile applications for weather forecasts or market prices, reach less than 15% of the farmers. With the introduction of platforms like Kisan Suvidha and eNAM, the government has facilitated market linkages and real-time information; but due to limited digital literacy and technical skills farmers are unable to use facilities. One such example is the adoption of precision agriculture-wherein the judicious use of inputs like water and fertilizer is optimized with the help of data analytics and satellite imagery. Only *5-7% farmers in India have so far integrated precision agriculture into their practice.*[40] Whereas in developed countries, over 40% use such technology in the quest for sustainable crop productivity improvement.

Indian farmers depend on indigenous knowledge, which is very helpful but cannot help in addressing the modern-day problem of climate variability and resource depletion. Climate change and market fluctuations have increased the challenges in human capital formation in Indian agriculture. Certainly, in a world when the weather is getting quite arbitrary; information, skills, and technologies that would adapt farmers are needed. *Still only 12% farmers had received knowledge on climate-resilient crops and farming techniques in 2021*.[41] For instance, millets are more drought-resistant and less input-intensive, but the farmers lack the technical know-how in their cultivation, processing, and marketing, hence millets are not being adopted on a wide scale. There is also market volatility, especially after globalization. Indian farmers are increasingly being exposed to fluctuations in international prices for which they are ill-prepared to respond. While the OECD-FAO Agricultural Outlook projects that Indian agricultural exports are growing at 7% per year until 2025, but participation in these markets requires very strict adherence to standards of quality and a certification process. Most farmers in India lack such training; hence the smallholders cannot meet such requirements and are eventually dwarfing their integration into global supply chains.

Policy Recommendations: There is an urgent need to make policy intervention in order to improve the rural human capital and to ensure the continuous &

sustainable growth in agriculture. One effort could be concentrated on integrating agricultural education at schools in rural areas. Interventions like Agri-Clinic and Agri-Business Centers (ACABC) Scheme for rural practical training and skill development should be upscaled. The program to increase the digital skill literacy of farmers should be enhanced so as to empower farmers on how to go about the online platforms and the new technologies. This comes in by appointing a trainer in every area whereby, in case the farmer is unable to understand the technology, the children/family members should be involved so that the knowledge could be transferred efficiently. The government shall invest in co-operate programs with major aggrotech firms and agribusiness companies in order to ensure the development of skills among farmers within the agricultural sector. Such a venture may possibly equip farmers with precision agriculture, supply chain management, and other sustainable means of farming so that a skilled workforce emerges to enhance productivity. This would further help the private partners, too, because once the adaptation of modern methods has been initialized through such programs, their sales or benefits would increase. Programs like Ayushman Bharat should focus on outreach in rural areas so that health services reach the farm workforce. Mobile health units integrated with advocacy would further increase access to health and decrease the burden on the health of the agricultural community. Therefore, in order to promote better health, it is mandatory to implement the ongoing policies effectively to the rural part of the world. Other major steps could be technological usages in agriculture for education through mobile learning, apps, and bridging knowledge gaps. Projects such as Digital Green show that farmers are willing to adopt new farming techniques if the content is conveyed in local languages and on easy-to-use platforms. In that light, human capital formation in agriculture is among the most critical but long-overlooked part of India's development strategy. Farmers will become more productive and resilient and integrated with the world value chains only by investment in education, skills, health, and technology. At its core, closing the gaps in human capital, in order to ensure preparation for rising competitiveness within a climate-impacted world, shall be basic to the very sustainability and profitability of Indian agriculture.

B) Income Inequalities (Inter & Intra)

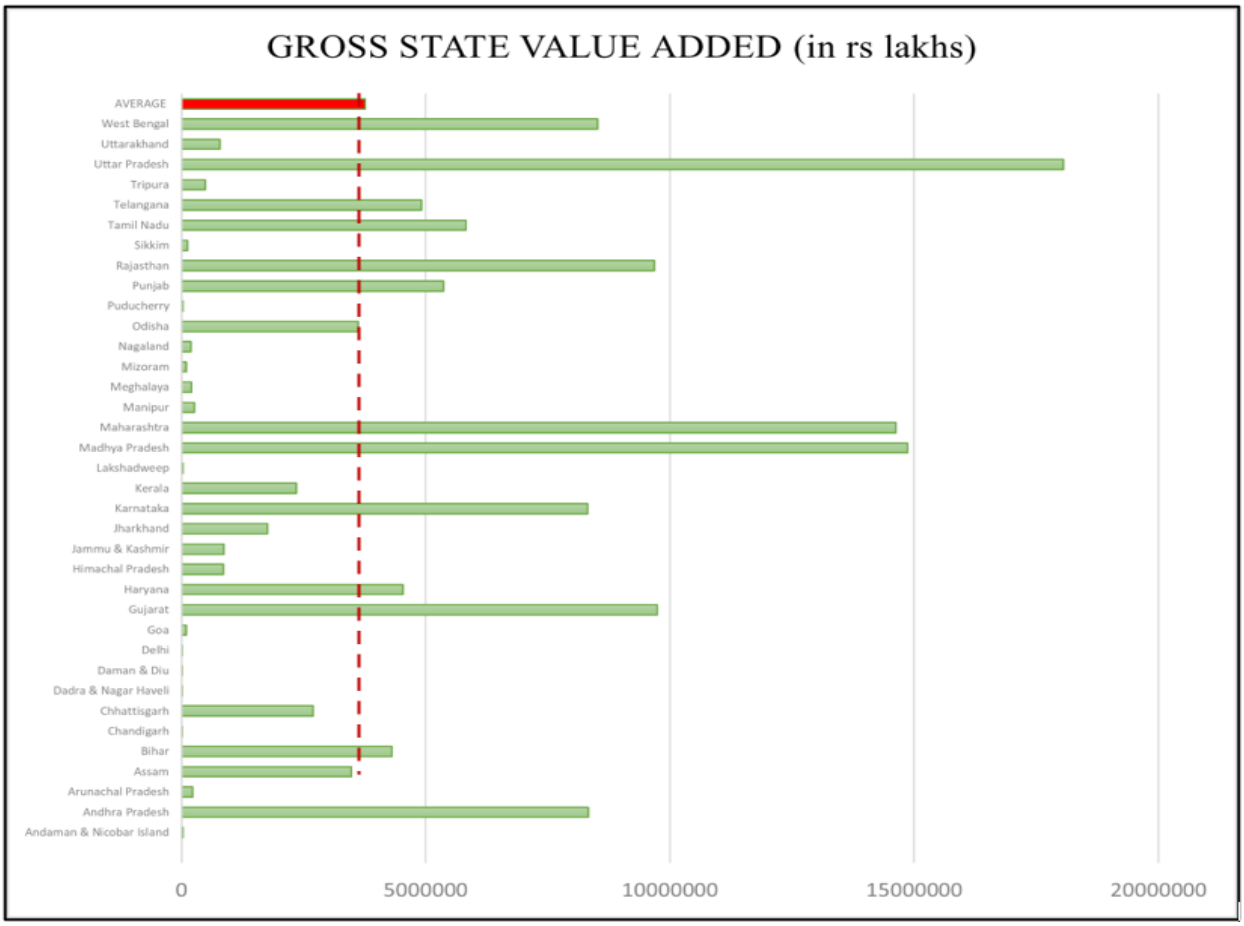
Income disparity in agriculture is an issue of utmost significance for India, responsible for social instability, poverty, and retarded rural development. A sector employing almost 40% of the workforce contributes to only approximately 16-18% of the nation's GDP. This current scenario clearly indicates that there are wide disparities not just between agriculture and other sectors (Inter-Sectoral Disparities), but also within the agricultural sector itself (Intra-Sectoral and Inter-State disparities). These inequalities have extensive repercussions in terms of inequitable access to factors of production, market opportunities, technology, and governmental support. With the unfolding of agriculture within the dimensions of globalisation, technology, and climate change, these inequalities are deteriorating further.

Inter-Sectoral Disparities: The chasm between agriculture and the rest of the sectors in the Indian economy has only been increasing in the last couple of decades. Agriculture has contributed to the GDP in a steadily decreasing trend, while the services and industry sectors are on a groove upwards. Agriculture accounted for about *31% of GDP in 1990-91; as of 2020-21, its share fell to around 16%*.[42] This is in a direct contrast with the service sector, which now holds over 55% in contribution to GDP and employs far fewer people. This difference is further underlined by the wage gap between agricultural and non-agricultural workers. The average monthly earnings of *agricultural workers stood at ₹9,750 against ₹17,000 for non-agriculture workers*.[43] This represents a whopping 74 percent disparity in wages, which manifests as one of the economic reasons people have to abandon farming in order to seek better prospects in urban areas, hence exacerbating rural poverty. It is partly because of low productivity in agriculture due to limited mechanization, underinvestment in technology, and generally poor infrastructure. Whereas the capital investment is higher in the non-agricultural sectors, agriculture has remained under-capitalized. In fact, *capital investment per worker stands at ₹50,000 in agriculture, while that in manufacturing is ₹2.5 lakh*.[44] This skewed investment results in stagnation in agricultural incomes relative to other sectors.

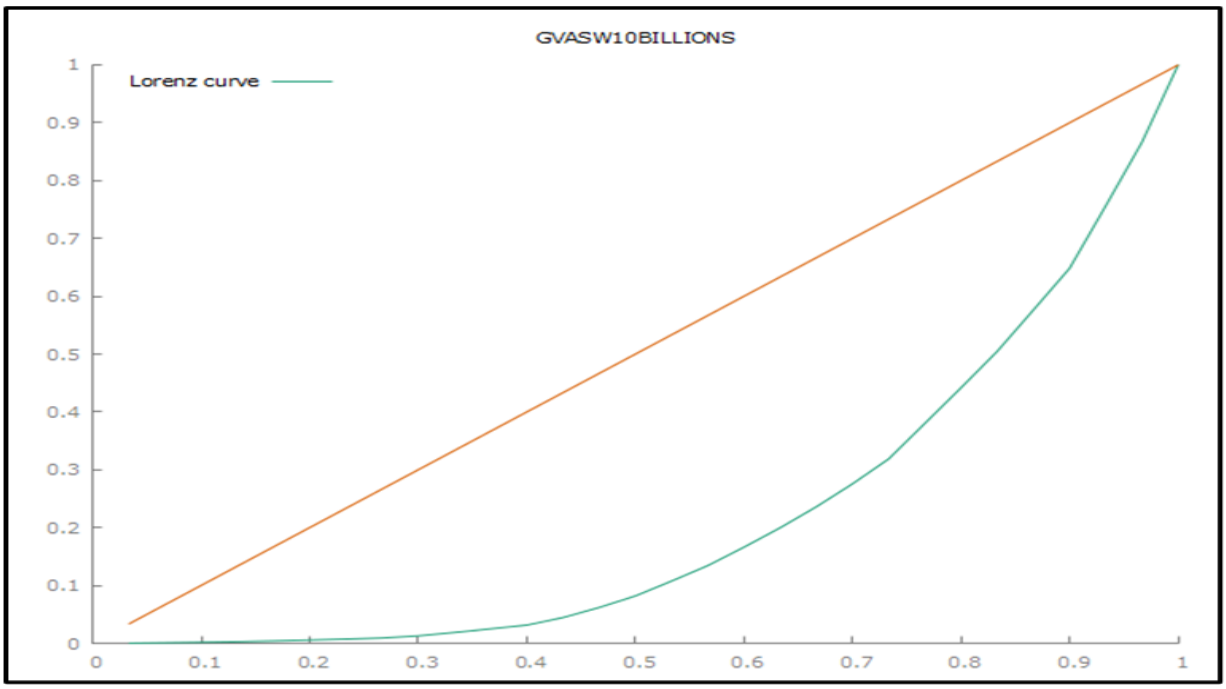
Inter-State Disparities: Significant regional disparities in agricultural income also contribute to inequality

within the sector. More specifically, states such as Punjab, Haryana, and Maharashtra have gained from past investments in irrigation, mechanisation, and policy support during the Green Revolution and are way ahead of states like Bihar, Odisha, and Jharkhand in terms of average farm incomes. This is reflected in the average per-month earnings of a household from farming activities, which stands at *₹23,133 per month in Punjab, while the figure for Bihar is ₹7,175 per month.*[45] This disparity is mainly due to the unequal distribution & availability of agricultural infrastructure, and access to inputs like fertilizers, good-quality seeds, and irrigation facilities. *In Punjab, more than 95% of cultivable area is irrigated, and hence can support multiple cycles of cropping, while the irrigated area in Bihar is only 36%.*[46] The ensuing productivity levels for wheat in Punjab stand at more than 4,500 kg/ha against less than 2,500 kg/ha for Bihar. Also, it is only the high-income states that are better positioned, in terms of access to markets and value addition, to bring about diversification by farmers into high-value crops such as fruits, vegetables, and horticulture. Farmers in the poorer states get locked up in the lower-value staple crop production trap from where they cannot rise upward through the ladder due to defects in the levels of infrastructure, market linkages, and training. *The value added of agriculture accounts for close to 25% of rural income in states such as Gujarat and Tamil Nadu, but only about 8% in states such as Bihar and West Bengal.*[47]

In all Indian states and union territories, the GVA of 13 states, such as Uttar Pradesh, Telangana, Tamil Nadu, Rajasthan, Punjab, Madhya Pradesh, Maharashtra, Karnataka, Haryana, Gujarat, Bihar, West Bengal, and Andhra Pradesh, is above the national average. Contrarily, the GVA of 22 states/UTs, like Uttarakhand, Odisha, Kerala, Jharkhand, Delhi, and Assam and others, are below the national average. The results are based on the state wise GVA of agricultural sector and reflects a huge degree of intra state inequalities.



NOTE: The graphs for the better characterization of the same is provided below.



Intra-Sectoral Disparities: The most obvious form of inequality in the farming sector is the inequalities across categories of farmers. Small and marginal farmers, holding less than 2 hectares of land, *constitute more than 86% of the farming population*.[48] These small and marginal farmers hold about 47% of the total cultivable land, while large farmers, constituting less than 1% of the farming population, own about 10% of the land. This unequal distribution of land is one of the strong drivers of income inequality within agriculture. The income disparity between small and large farmers on average is such that the *monthly income of a small farmer would be about ₹6,500 while the large farmers earn excess of ₹23,000 a month*.[49] This gigantic chasm is due to economies of scale enjoyed by large farmers who have invested in mechanization, irrigation, and high-value crops, while small holders are confined to subsistence farming. Larger farmers have better access to credit, allowing them to make investments in productivity-enhancing inputs. *About 63% of agricultural loans flow to medium and large farmers,*[50] although a majority of the farming population consists of small holders. The meagre flow of credit to the smallholders leads to inadequate input application, poor yields, and persistence of poverty. Besides, the small farmers are largely kept out of the more modern agricultural supply chains since there is a demand for consistent quality and scale. For example, the dairy sector is one of the largest agricultural sub-sectors in India and, by convention, is dominated by cooperatives and large private sector players. Small farmers can't meet their volume and quality requirements, so eventually, they end up selling their products through traditional channels at low prices. *The large dairy farmers realize a net profit margin, which was 45% higher than those realized by small farmers, mainly because of better access to inputs, markets, and technology.*[51]

Another dimension of intra-sectoral disparity lies in the differential access to government subsidies and support schemes. Since big farmers work on a bigger scale and are better connected with governmental schemes, they can gain significantly from the subsidy on fertilizers, irrigation, and electricity. For example, under PM-KISAN, where ₹6,000 was distributed annually to the farmers, only a few smallholders benefited because most of them were not able to prove the ownership of land which was mentioned in the documents to receive such funds. Another inequality within this sector is the wages of the land owning and landless agricultural workers. Around 55 percent of the rural labour force consists of landless workers, according to NSSO (2019), who are paid much lower wages than land-owning farmers. *While the average wage for a day of an agricultural worker is ₹ 312, the average earnings of a small landholding farmer can be as high as ₹ 500 a day after putting together*

farming income and subsidies.[52] Inheritance laws and increasing population have, over time, reduced the average size of landholdings, hence reducing economies of scale. The dominant small and marginal farmers in this sector have structural problems of accessing credit, inputs, and technology, which singularly or collectively promote a vicious cycle of poverty since the smallholders cannot invest in productivity-enhancing practices. Though the government has framed a few policies like PM-KISAN and crop insurance with the motive to reduce income disparity, benefit disbursal in large areas has been biased towards big farmers. *The large farmers are 1.7 times more likely than small farmers to receive agricultural subsidies because of better access to documentation and networks.*[53] In this way, it further widens income inequalities within the agricultural sector. Small farmers have limited resources and capacity to handle extreme weather events like drought, flood, and erratic rainfall. The World Bank, 2020, estimated that farmers in rainfed areas were usually poorer, with crop failures because of climate change leading to a decline in income of 30% in the past ten years, while irrigated areas only suffered a 10% decline.

Policy Recommendations: Small and marginal farmers face countless structural impediments that make productive farming a highly infeasible vocation for them and, therefore, a very low-paying occupation. This gap, therefore, has to be complemented by a strategic intervention aimed at providing the critical inputs required by them for improvement in farming practices and enhancing their earnings. One of the critical challenges small farmers faces is limited access to institutional credit. While the Kisan Credit Card scheme is specifically devised to provide the required short-term credit for crop production, most small farmers do not have the required documents to access this. Scaling this up to cover small farmers, including tenant farmers and sharecroppers, would allow them to invest in inputs such as seeds, fertilizers, and irrigation equipment that raise yields. Greater flow of institutional credit will reduce dependence of small and marginal farmers upon high-interest loans availed from informal sources.

The small holders in general get excluded from modern technologies because of high cost and lack of knowledge. The Sub-Mission on Agricultural Mechanization (SMAM) government initiatives need to be more responsive to marginal farmers by ensuring availability of small tractors, harvesters, and irrigational systems at an economical cost. Group-based schemes such as those, which would allow small farmers jointly buy or lease equipment in order to be able to gain from mechanization without having to make large investments on their own.

Small farmers do not generally have direct access to the markets and hence have to sell their produce at lesser prices to intermediaries. Initiatives like e-NAM, aimed at integrating the agricultural market across the country, need to be expanded and made more inclusive. Small farmers need training in the use of digital platforms among other things, with a view to providing them with storage and transportation facilities to cut post-harvest losses and improve their bargaining position.

Agricultural infrastructure is distributed in a grossly asymmetrical manner: states such as Punjab, Haryana, and Maharashtra have benefited more from irrigation, storage, and transportation facilities. This is one of the reasons for the agriculturally unequal productivity of states and farm incomes. The states of Bihar, Jharkhand, and Odisha are particularly deprived in irrigation coverage, with less than 40% of their cultivable land having been irrigated as of 2021. Accordingly, Pradhan Mantri Krishi Sinchai Yojana (PMKSY)- which essentially takes up the cause of improving irrigation infrastructure-should focus on these backward regions. Promotion of schemes like micro irrigation (drip and sprinkler), minor rainwater harvesting structures, and efficient water management practices should be further enhanced. Farmers in the relatively underdeveloped states need rural connectivity such as road facilities, cold storage and processing centres to reach the markets. *In the case of states like West Bengal and Assam, where perishable crops such as fruits and vegetables are grown, 30% is lost after harvest due to lack of cold storage infrastructure.*[54] The schemes like the Pradhan Mantri Gram Sadak Yojana (PMGSY) by the government should be directed towards ensuring better last-mile connectivity even in the countryside of lagging states. Improved rural roads, according to a World Bank report, 2020, could lower transport costs by 25%, thereby enabling farmers to sell their produce at better prices. Also, cold storage increases the shelf life of

perishables, enabling farmers to avoid distress sales and bargain for better prices. Most agricultural research institutions and extension services are concentrated in the relatively better-off states. For equity reasons, the government needs to take its Krishi Vigyan Kendra (KVKs) to backward regions so that small farmers in these regions are informed of the latest farming techniques, pest management strategies, and climate-resilient crops.

Small farmers, particularly in the rainfed areas, continue to bear a disproportionate impact of climate change as droughts and floods recur with greater frequency and intensity. Though under climate-smart agriculture, practices for mitigating these risks exist; however, these practices will have to be scaled up among the most vulnerable farmers. Promotion of climate-resilient crops such as millets, sorghum, and drought-tolerant varieties of staple crops among small and marginal farmers may be encouraged. The National Mission for Sustainable Agriculture should promote agroforestry, integrated pest management, and other soil conservation techniques. There is a requirement for insurance against weather-related hazards through schemes like the Pradhan Mantri Fasal Bima Yojana, which should be made increasingly inclusive in nature. In the existing form, high premiums and complicated application procedures cause the benefits of the program to be skewed in the direction of large farmers. The government can subsidize insurance premiums for small and marginal farmers with the simplification in procedures for claim settlements to ensure wider coverage.

This calls for investment by the government in highly efficient early warning systems and real-time weather data information, which should be extended to farmers through mobile applications, SMS, and radio broadcasts. This will ultimately enable the small farmers to make informed decisions on the best time to plant or harvest to reduce unnecessary losses in case of sudden weather changes. The farmers receiving timely weather information are able to *reduce their climate-related losses by 20-30%.*[55] This would certainly help in the improvement of farm management in climate-sensitive regions. Subsidies on fertilisers, electricity, and irrigation are given in kind today. These normally lead to leakages and overuse of the subsidised commodity. Shifting them to DBT, like in the case of PM-KISAN, would mean that small farmers get cash subsidies directly into their account, with the capacity to make rational choices on the use of inputs, thereby economising on them and ensuring better farming practices. The subsidies should be calibrated in line with farm size, with the lion's share of the subsidy going to small and marginal farmers. In that way, it would reduce the current skewedness where large farmers, due to the scale of operations, capture a disproportionate share of government support. The small farmers, which is over 80% of the farming population, receive only 30% of the agricultural subsidies. A fairer distribution of subsidies would help in levelling up the playing field and contribute to reduce income disparity in the sector.

C) Changing Pattern of Demand

Consumption patterns in both urban and rural India have changed significantly over the past two decades. This transformation has been driven by rising incomes, improved access to markets, and changes in consumer preferences of late-modern consumerism that is drifting more towards processed, packaged foods, milk products, and fruits. This growing demand for such products has led to a reduction in the intake of conventional staple foods like cereals, pulses, and coarse grains that have conventionally constituted the backbone of India's agricultural production. This rising demand pattern poses a multidimensional challenge before Indian agriculture, more so when the government policies are not in tune with these changes. The new face of consumerism in India is the growing demand for packed and processed food items. It is more visible in urban parts but with improved market access and change in lifestyles, it has begun to percolate to the rural areas too. Convenient foods like instant meals, snacks, and beverages are growing popular among the urban consumers. With increased disposable incomes and a time constraint on food preparation, the attraction towards processed and packaged foods has increased significantly. *The packaged food market in India is expected to register 10-12 percent annual growth in the near future-as a serious dent in raw, unprocessed food products.*[56] Value addition has replaced rice, wheat, and pulses in the urban diet. The fallout of all this is an increasing imbalance between what the agriculture produces and what the modern consumer is demanding. For example, while government procurement policies

focus big time on wheat and rice, these are seeing a relative decline in diets in urban centres. While villages were traditionally isolated from these changes, better connectivity and infrastructure have brought about a rapid change in rural consumption patterns, too. With better connectivity and increased outreach of retail chains, even packaged foods, dairy products, and fresh fruits are widely available in the most far-off regions. *The packaged foods are seeing 14 percent rural growth over the last five years.*[57] This is higher than the growth seen in urban centres. The improved consumption pattern has consequently reduced demand for staple foods from their natural sources. A recent survey by ICAR, in fact, revealed that rural households are buying more of processed snacks, soft drinks, and dairy products than a decade ago. Such changes have the potential to cause a mismatch between demand and supply because these traditional crops become less important in the diet of rural households as well.

Other key features of evolving consumer demands are the increasing demand for dairy products, fruits, and vegetables, impelled by rising health consciousness and nutrition awareness. This transformation is affecting the demand structure of Indian agriculture. In fact, milk and its products, such as curd, cheese, and yogurt, are highly nutritious and have become essential commodities for both urban and rural households. *The demand for dairy products has increased at a rate of 7% annually, and India's per capita milk consumption is 406 grams per day (as of 2022), compared with 180 grams per day in the 1990s.*[58] This indicates that there is a continuous rise in the demand for dairy products, hence the need for agricultural focusing to shift to the production of dairy. As such, a shift in consumer preference has resulted in disproportionate attention to dairy instead of staple crops. Farmers previously growing cereals increasingly shift to livestock farming, especially in states like Punjab, Haryana, and Gujarat, where the returns on dairy farming are comparatively higher. This transition has wide ramifications for agricultural policy that remains focused on traditional crops. *There has been a 15-20% increase in the consumption of fruits and vegetables over the past decade*.[59] This trend follows from growing awareness of the benefits that come with a balanced diet, further supported by the government's push for nutrition through initiatives like the Poshan Abhiyan. In fact, the increasing demand for horticulture produce finds no reflection in the present agricultural policy framework, which still gives undue emphasis on cereal production. Horticulture today contributes more than 33% to the agricultural GDP, but government procurement and subsidies are still disproportionately allocated to cereals. This aberration can produce distortions in supply creation and render the farmers ill-equipped to act upon the relevant market signals.

Growth of rural roads, e-commerce, and organized retail has brought rural consumption closer to urban consumers. Government-sponsored programs such as Pradhan Mantri Gram Sadak Yojana (PMGSY) have ensured last-mile connectivity, which in turn has been leveraged by FMCG players to access even the most remote rural markets more efficiently. All this is due to the fact that food products, starting from packaged snacks right up to fresh dairy and fruits, are entering their circles with increasing market infrastructure and connectivity. This trend poses a risk to traditional agriculture since it is not responding fast enough to the changed demand patterns.

The trend has picked up only faster with the rise of e-commerce platforms like Amazon, Blink It, Zepto, and Big Basket in India. *The rural online shopping has grown 40% over the last five years.*[60] Rural consumers increasingly shifting toward packaged foods disorganize local agricultural markets. Production cycles and cropping patterns of farmers remain tuned to traditional demand, and farmers cannot adapt to such changes in the short run. The MSP regime continues to be a single most important factor in dictating the cropping pattern in India. However, MSPs are tuned to a small set of crops-wheat, rice, and a few varieties of pulses-which is facing declining shares in consumer demand, particularly in urban areas. Cereals like rice and wheat dominate the MSP scheme of the government, which has already become misaligned with the current consumption pattern. Despite large-scale procurement by FCI, consumer demand for these staples has failed to keep pace with such purchase. For example, rice consumption per capita fell from 85 kg/year to 72 kg/year in urban areas between 2000 and 2020, while wheat also registered a similar decline in the same line of consumption. This suggests that government procurement is increasingly being targeted toward crops whose demand in the

domestic market is falling. This, therefore, means that the MSP regime is distortionary in the markets and encouraging farmers to continue with the crop for which the demand is shrinking, instead of diversifying to higher-value crops like fruits, vegetables, or even dairy farming. MSP should be dynamic with the newer consumption patterns and incentivizing production of such crops which are in increasing demand, like fruits, vegetables, and pulses. It is hence high time to revise the MSP framework in order to include diverse types of crops and ensure equal support to the horticulture and dairy sectors. With no MSP reform, farmers would remain mired in growing crops that are becoming increasingly irrelevant for the market.

Policy Recommendations: A set of well-sequenced policy reforms will be needed for adequately ensuring that Indian agriculture meet the changing consumption patterns. Reforms will have to be aimed at the alignment of agricultural production with consumer demand, improvement in market infrastructure, and benefits to farmers. The MSP regime is biased toward cereals like rice and wheat, which no longer represent the millennial consumption pattern. Upgradation of the MSP system in a way that it would encourage farmers to produce commodities which are in high demand, such as fruits, vegetables, pulses, and dairy products. Similarly, MSP coverage needs to be expanded towards horticulture crops, pulses, and oilseeds due to emerging demand for such commodities domestically and internationally through a multi-crop MSP mechanism which would be region-specific based on the local demand pattern and agro-climatic conditions. This would provide an incentive to farmers to produce other crops in order to meet the changing market trends.

The increased demand for dairy products, fruits, and vegetables needs to be addressed by promoting crop diversification. Farmers, particularly those reliant on monoculture crops, must be encouraged and incentivized to switch over to high-value crops. The government should launch a "National Crop Diversification Mission" aimed at promoting horticulture, dairy farming, and other high-value crops in the states predominantly focused on cereals. This should be in the form of subsidies for inputs such as seeds, fertilizers, and equipment, specifically required for horticulture and dairy farming. Training programs should also be a part of the mission so that the farmers learn the modern ways of horticulture and animal husbandry. Similarly, since the demand for perishable items like dairy, fruits, and vegetables is increasing day by day, proper cold storage and logistics facilities are needed to address the issue of wastages so as to ensure that these products reach the consumer, especially in rural areas. This may also involve the creation of a PPP model for developing cold storage, refrigeration, and supply chain logistics infrastructure in rural areas. Tax incentives and subsidies through the government to companies will encourage investment in cold chain infrastructure. Accordingly, the government can also create a rural cold storage fund in NABARD for easy access to financing in order to construct such storage.

The government should encourage the setting up of agro-processing units in rural areas to meet the emerging demand for packaged and processed foods. This will bring value addition at locations near to the site of production and the consequent benefit to the farmer and the rural economy. It may take the shape of agro-processing clusters in rural areas and incentives for small and medium enterprises to set up food-processing units near farming hubs. In this case, it would be the absolute duty of the government to provide financial assistance, infrastructural support, and skills imparting through the Pradhan Mantri Formalization of Micro Food Processing Enterprises (PMFME) scheme. The clusters should be used to process fruits, vegetables, and dairy products into packaged foods, juices, and dairy products.

While modern consumerism is now tilting towards junk or processed foods, there should be a counter-balancing awareness creation on the benefits of pulses, coarse grains, and millets. Being nutritious and resilient to climate change, this could be recommended that nation-wide campaigns under Poshan Abhiyan for advocacy regarding nutritional values of the locally available traditional foods along with packaged products should be initiated. Besides, the coordination between schools, local governments, and NGOs in conducting awareness programs in rural as well as urban areas by stressing the health benefits from millets, pulses, and coarse grains could yield some encouraging outcome. The government should encourage their inclusion in public distribution systems and midday meal schemes as well.

3) Administrative Constraints

A) Corruption and Inefficient Implementation

Corruption and inefficiencies have been a persistent issue in the Indian agricultural sector, affecting everything from subsidy distribution leakages, loan disbursement delays, and inefficiencies in crop insurance to procurement issues in the MSP system. These broader systemic issues, already discussed in this paper many a times, are compounded by a less-discussed yet equally damaging problem, that is localized corruption within decentralized governance structures. This includes village-level functionaries, Panchayats, and district officials in the implementation, who introduce additional layers of corruption and inefficiency to the policy and therefore access to such central schemes becomes singularly tough for their beneficiaries. Decentralized governance, meant to bring administration closer to people, more often results in local power brokers and politically connected individuals manipulating the distribution of government benefits. In most of the cases, Panchayat leadership and local officials are more influential in the selection of farmers regarding subsidies, loans, or insurance claims. The result, is undue tilted towards politically aligned farmers while small and marginal farmers are deprived of benefits. In some cases, the loan waiver and subsidy announcements by central or state governments have been disbursed only with approval by local officials, only after receiving bribes or the approval is given only in selective cases of politically favored groups. This really distorts the structures of schemes-like the Kisan Credit Card and PM-KISAN-aimed at supporting all eligible farmers. This type of decentralized corruption, distortion in the policy implementation process, and inequity in access to government resources become causes for the further increasing inequality gap between the different farmer groups. Another main challenge has to do with the multitude and conflating of administrative responsibilities at local, state, and central governments. Agricultural policies, such as the MSP procurement system or crop insurance claims under PMFBY, have always used multi-tier approaches to approval, inspection, and verification. This being a fairly decentralized process, loopholes are left for corruption wherein each layer of bureaucracy adds to an opportunity for rent-seeking. Farmers in rural and backward areas may have little knowledge of these administrative processes and hence may easily be exploited. Local authorities might distort information about crop losses, falsify records, or delay the processing of claims, and all that does not only give a financial burden but also demolishes the trust of farmers in the government. By the time such issues reach the central authorities, they have already caused damage at the grassroots level, which is hardly rectifiable. Decentralization also creates information asymmetry, in which local farmers may be uninformed of their rights, or the true value of subsidies, or the criteria for accessing government programs. This opens the way for corrupt officials to charge indirect "fees" for facilitating access to programs that are designed to be free. Where tracking systems are not transparent, farmers usually have no right to challenge such exploitative practices. Schemes like the Public Distribution System, which would deal with subsidized food grains, are often mangled by village-level distributors. Beneficiaries complained that they were receiving either poor-quality grains or less quantity than allocated while the rest was bled on to the black market by the local officials themselves.

Policy Recommendations: Against this backdrop, the blockchain-based governance structure would ensure that agricultural benefits accrue in a more transparent and tamper-proof manner. Using blockchain technology, every transaction whether related to loan release, subsidy, or procurement of crops, could be recorded right in real-time and accessed by farmers and central authorities simultaneously. Records of all such transactions would thus be beyond the realm of local functionaries to manipulate for purposes of delaying payment, for instance. This would, in turn, make the farmers' access to their entitlements in real time and hence reduce the scope for corruption in the process of effective implementation of government schemes at the grassroots level.

B) Unorganized Agricultural Sector

India's unorganized agricultural sector is mostly disadvantaged on account of high fragmentation in the labour laws and lack of any income tax collection. These are entrenched features of the informal organization of the sector, which have far-reaching ramifications in both economic and manpower terms.

Agriculture is the sector that employs more than 40% of the workforce in India. However, it largely remains unorganized and informal, with workers lacking formal contracts, job security, and access to social benefits. *About 90% of the workforce engaged in agriculture is informal*.[61] This has contributed to the fragmentation of labour laws, as agricultural workers are often excluded from the protection afforded by various national labour regulations. Most agricultural workers fall outside the purview of acts such as the Industrial Disputes Act, 1947, and the Minimum Wages Act, 1948, which are meant to regulate employment terms, wages, and dispute resolution. While the Unorganized Workers' Social Security Act, 2008, seeks to offer some coverage to informal workers, its implementation in agriculture has been inadequate, leaving a large portion of the workforce without significant labour rights. The lack of consistent labour protections has led to varying employment practices across different states and regions. For instance, minimum wage laws are either not enforced or inadequately implemented in many rural areas, causing wages to fluctuate without regard to workers' welfare. This fragmentation creates disparities in working conditions, limits worker mobility, and perpetuates income insecurity in the agricultural sector.

Another significant issue in the agricultural sector is the minimal contribution of agricultural incomes to India's tax revenue. According to Indian law, agricultural income is largely exempted from income tax under Section 10(1) of the Income Tax Act, 1961. This exemption was originally designed to protect the livelihoods of small farmers, but it has inadvertently led to substantial revenue losses for the government. In 2019, the Finance Ministry estimated that agricultural tax exemptions cost the government over ₹50,000 crore annually, with a significant portion of this being due to misuse by wealthy entities. The National Sample Survey Office (NSSO) data shows that the majority of farmers in India earn below the taxable income threshold. According to the NABARD All India Rural Financial Inclusion Survey 2016-17, the average monthly income of an agricultural household was around ₹8,931. As most small and marginal farmers (comprising around 86% of the total farmers) earn low incomes, the government justifies the tax exemption on the grounds of poverty alleviation.

However, the exemption of tax on agricultural income has also opened avenues that are sometimes misused by rich individuals and companies to show agricultural income as untaxed. There were cases of misclassification of income from non-agricultural sources as agricultural income to evade taxes. This misuse results in revenue leakages and makes it difficult for the government to monitor real income levels in agriculture. Moreover, as the sector does not involve any formal transactions, therefore the distinction between the rich and poor farmers are unclear. As a result, many rich farmers who should be the tax contributors, often hide their actual income and conveniently enjoy the benefits of tax exemption.

Policy Recommendations: The Government should formalise agricultural employment through contract farming models and farmer producer organizations. These institutions can act as an intermediary agency, ensuring proper labour contracts, thus giving the labourers decent wages, social security benefits, and legal protection under labour laws. The second key measure is the strict enforcement of the Minimum Wages Act in rural areas to narrow the gap in wages. State governments should monitor the wage practices in the agricultural sector more effectively, along with creating mechanisms for reporting violations of wage payment, where local self-governing bodies such as panchayats must play a crucial role in its implementation.

A progressive agricultural income tax system could also be instituted to close the gap in revenue collection while protecting the small and marginal farmers. The model would be such that, only the incomes above a threshold would fall under the ambit of taxation and those that are below the threshold would remain fully exempted. This would end incongruous situations of rich farmers getting undue exemption from taxes and 'fudging' agricultural income with an escape route from paying taxes.

Finally, the improvement in formalisation & collection of the data related to agricultural incomes and employment is useful for the reform of labour laws and taxation policies. For example, with satellite imagery, GPS, and blockchain technology, most agricultural production could become more transparent, and hence

traceable, while at the same time enhancing the monitoring of labour conditions and fairer taxation. The systematic records of a framer's income could also be facilitated by ensuring the formal transactions in the sector. The unorganized agricultural sector of India needs reforms in providing formal employment with enforcement of labour laws and presentation of just tax policies. This will definitely protect the workers and add to fiscal contribution, benefiting both the workers and the general economy.

C) Existence of Barter Trade

Barter trade is, however, a common yet generally overlooked part of the Indian agricultural economy. While modern methods of payments have scaled and formal markets have increased in large parts of rural India, barter transactions still are a very vital part of economic exchanges, particularly among smallholder farmers and marginal communities. They quite often exchange goods and services for labor instead of cash, especially in regions with limited access to formal banking and market infrastructures. The problem reflects deeper structural issues of the rural economy, such as financial exclusion, poor infrastructure, and low liquidity. Besides, barter exchange in many rural areas also extends to services and equipment. Farmers barter the availability of agricultural machinery. One farmer may have a tractor that the other farmer needs, while the other farmer has a tube well or perhaps labor. This type of resource-sharing arrangement could be mutually beneficial, especially for the small and marginal farmers who cannot afford to own expensive equipment in an outright manner. In States like Punjab and Haryana, where agricultural mechanization has reached a relatively advanced level, a farmer may offer tractor services during ploughing or harvesting seasons to get irrigation from the tube well from a neighboring farmer. This system allows both parties to minimize costs, particularly when formal credit for buying equipment is not easily accessible. *About 25-30% of small farmers in northern India still rely on informal equipment-sharing arrangements against barter, suggesting that non-monetary transactions do have some relevance.*[62] Barter trading is more common in economically marginalized regions characterized by limited access to cash and a dearth of financial institutions. The majority smallholder farmers struggle with low crop yields and volatile market prices; hence, they rely on barter for goods and services. A study by NABARD estimates that 15 to 20% of rural households are into bartering, especially in inaccessible areas, like in the tribal parts of Odisha and Jharkhand. Here, goods like seeds, fertilizers, and manual labor are often exchanged in lieu of cash. Here, a farmer may exchange some amount of rice or pulses to take seeds or farm implements in return. This form of trade provides immediate solutions to the farmers for temporary shortages in cash or inputs, by allowing the sharing of risks.

Barter trade exists because of market failures in rural areas. Poor road connectivity, a lack of transportation, and no storage facilities for perishables are some important factors to place the farmers far from formal markets. These often lead to high transaction costs that reduce the farmer's abilities to earn profit from their produce. This has led to the emergence of barter arrangements where farmers do not try to sell their produce in far-away markets but rather try to meet their immediate needs within their communities. In states like Madhya Pradesh, for example, farmers who grow fruits and vegetables are often found sharing these perishable crops with their fellow farmers who may be found within the same region in exchange for livestock or other goods that could be longer-lasting. In fact, with a lack of cold storage and an expensive transportation facility to urban areas to transport their goods, it is perceived that bartering works much better.

Policy Recommendations: The government should pursue policy actions on financial inclusions through mobile banking, rural credit cooperatives, and microfinance schemes directed towards rural households. Programs such as Pradhan Mantri Jan Dhan Yojana (PMJDY) would contribute to scaling up access to formal banking services and reduce reliance on barter among marginal farmers. Investment in rural infrastructure, primarily roads, transportation, and storage, would improve access to formal markets. It would result in the reduction of dependence on the local barter system, especially for those crops which are perishable. It would also help farmers to relocate their produce to a market where they receive good prices for them. Strengthening agricultural cooperatives would help farmers to gain access to modern farm equipment, like tractors and tube wells, without having to resort to barter. Cooperatives allow farmers to access group for buying of machinery and inputs, making such equipment more available to

small-scale farmers at a reduced individual cost, and access to resources in a more formal way. Under the Digital India initiative, promotion of digital payment systems in rural markets would enable farmers to move out from barter and into cash or digital transactions. Training and access to easy platforms for digital transactions can facilitate the integration of even marginal farmers into the formal economy.

IV. CONCLUSION

The findings of this paper suggest that the Indian agriculture sector is quite complex and yet to face a conjunction of legacy issues with emerging demands. Regression analysis reveals that infrastructural inadequacies, inefficient irrigation systems, fragmented holding, and credit constraints leads to low agricultural GDP across the states of India. Evolving consumption patterns and the mismatch of government procurement policies with market demands are other problems the sector faces. The sector remains hamstrung by structural inefficiencies and corruption that arrest the effective implementation of numerous government schemes and policy reforms. A holistic approach is required to re-imagine Indian agriculture- one that not only addresses production-related challenges but also focuses on creating a demand-driven, farmer-centric model. Developing rural infrastructure, improving soil health, and access to agriculture credit, and moreover, modernizing procurement policies are all critical measures. Further, digital instruments should be further utilized towards an agriculture ecosystem that proves more resilient and productive. This entails a growth that has equity with time, fostering sustainable long-term change, by incorporating bodies of government, private enterprises as well as farmer cooperatives.

REFERENCES

[1] Report by Department of Agriculture and Farmers' Welfare
[2] Planning Commission, First Five-Year Plan Document
[3] Agricultural Statistics at a Glance 2022", Ministry of Agriculture & Farmers Welfare
[4] Planning Commission, First Five-Year Plan Document
[5] "The Economic History of India 1857-1947" by Tirthankar Roy
[6] "Indian Economic Surveys" by the Ministry of Finance
[7] "Late Victorian Holocausts" by Mike Davis
[8] Agricultural Growth in India: Role of Technology, Incentives, and Institutions" by Ashok Gulati, Kavery Ganguly & FAO Reports
[9] Reports and data published by ICAR on state-wise agricultural productivity during the Green Revolution
[10] Directorate General of Commercial Intelligence and Statistics (DGCIS), "Economic Survey of India 1996-97"
[11] "Indian Economic Surveys" by the Ministry of Finance
[12] World Bank, 1999
[13] Ministry of Commerce & Industry, Government of India
[14] Reserve Bank of India, 2000
[15] Government of India, Planning Commission
[16] Reserve Bank of India, 2010
[17] Department of Agriculture & Cooperation, Government of India
[18] National Crime Records Bureau, Government of India
[19] Ministry of Commerce & Industry, Government of India. (1999), India's Trade Performance During 1997-98
[20] Ministry of Agriculture & Farmers Welfare, Government of India. (1998), Annual Report 1997-98
[21] FAO. (1999), Impact of the Asian Financial Crisis on Agriculture. FAO Corporate Document Repository
[22] World Bank, (2009). India: Impact of the Global Financial Crisis. Washington, DC: The World Bank.
[23] Ministry of Agriculture & Farmers Welfare, Government of India. (2010). Annual Report 2009-10
[24] Ministry of Agriculture & Farmers Welfare
[25] CAG Report 2022
[26] Ministry of Agriculture & Farmers Welfare
[27] A report by the Centre for Science and Environment
[28] Ministry of Finance
[29] Parliamentary Standing Committee Report 2023
[30] Ministry of Agriculture & Farmers Welfare

[31] Economic Survey of India 2016-17
[32] Economic Survey of India 2020-21
[33] Ministry of Finance
[34] PIB, GOI
[35] NSSO 2019
[36] According to the latest estimate released in 2022 by the Agriculture Skill Council of India
[37] FAO, 2021
[38] NITI Aayog (2020) report on agricultural modernization
[39] NFHS-5 (2020-21)
[40] Food and Agriculture Organization, 2021,
[41] Indian Council of Agricultural Research, ICAR
[42] RBI 2022
[43] PLFS (2021)
[44] according to a report by CRISIL (2021)
[45] NABARD All India Rural Financial Inclusion Survey of 2018
[46] As per the records of NITI Aayog 2021
[47] According to the FAO report of 2021
[48] Agriculture Census, 2015-16
[49] NSSO Situation Assessment Survey of Agricultural Households (2019)
[50] According to Reserve Bank of India (2020)
[51] A study by ICAR-National Dairy Research Institute, 2020
[52] PLFS 2021
[53] Data from the Comptroller and Auditor General
[54] ICAR, 2021
[55] According to FAO, 2020
[56] According to Nielsen's Consumer Trends 2022
[57] According to a report by Kantar Worldpanel
[58] According to the NDDB
[59] According to a Nielsen India Report of 2022
[60] According to the NABARD Rural E-Commerce Report (2022)
[61] According to the NABARD Rural E-Commerce Report (2022)
[62] The PLFS 2020-21