Chapter 2
Synthesis Chapter

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2.1 Introduction

As stated in Chap. 1, the study presented in this book has four pillars and each pillar builds up sequentially and progressively. It starts by evaluating the relation between per capita agricultural GDP and the twin problems of poverty and malnutrition. After establishing a strong negative relation between the development of agriculture and the twin problems, the book progresses to identify ways to ensure inclusive, efficient and sustainable agricultural growth. It does this through a detailed analysis of state wise agricultural performance to identify best practices for replication in other states. The book then builds on the fact that agricultural GDP growth is not the sole factor driving farmers' incomes; hence, there is a need to look at state wise trends in farmers' income and their composition. In its last section, the book presents an evaluation of the major programmes and schemes run by the government to support farmers. Based on the collective findings of these analyses, a new roadmap for agricultural reform has been outlined in the last section.

The biggest lessons from the analysis presented in this book are:

a. Agricultural growth can alleviate problems of poverty and malnutrition: India's agricultural sector needs to grow consistently at a growth rate of more than 4% per annum at the all India level. It needs to grow at an even higher rate in states with low existing levels of per capita agricultural GDP and that this growth is likely to help reduce the incidence of poverty and malnutrition;

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b. Three factors have historically played pivotal roles in explaining agricultural sector performance in the six studied Indian states: these are access to infrastructure (mainly irrigation and roads), diversification to high value agricultural products like fruits and vegetables, and allied activities like dairy and poultry among others, and price incentives or favourable terms of trade that reflect rising prices for agricultural commodities relative to prices in other industries. The role of inputs like fertilisers also emerged as a contributor to agricultural growth.
c. Even though at the all-India level, the growth rate in farmers' real incomes closely mirrored growth rates in agricultural GDP (for data between 2002–03 and 2015–16), there were variations in the two growth rates at the state-level. For example, in Odisha, farmers' real incomes increased much faster than the rise in the state's agricultural GDP; in Gujarat, despite higher agricultural GDP growth, farmers' incomes grew at a much slower rate. This shows a gap between agricultural GDP growth and growth in farmers' real incomes. With small, and still shrinking, average landholding sizes in India, this gap is expected to widen in the future as farmers will have to diversify their sources of income, reducing their dependence on agriculture to sustain livelihoods.
d. There is a re-think required in the way the Indian government provides support to farmers. Despite a plethora of programmes and schemes launched to alleviate farmer distress, the Indian farmer continues to suffer as many of the flagship programmes fail to deliver on their promises and set objectives. Sometimes, the problem is with the programme design, sometimes its intent; and then there are implementation gaps. All this makes a case for a fresh analysis of the farmer support environment in the country.

We expand these learning and the analysis behind it, *albeit* briefly, below. The details can be found in the respective chapters in the book.

2.2 Inter-linkages Between Agricultural Performance, Poverty and Malnutrition in India

The hypothesis is that with better agricultural performance, which should be reflected in higher per capita GDP from agriculture, both poverty and malnutrition can be alleviated especially among people living in rural areas, a majority of whom rely on agriculture-related activities for their livelihoods. International experience validates this hypothesis. This chapter evaluates and validates this hypothesis for major Indian states.

Methodology Used

In two separate analyses the linkages between (i) poverty and agricultural performance and (ii) between malnutrition (child and adult malnutrition) and agricultural performance have been studied and presented in Chap. 3.

In both cases, agricultural performance has been studied via a proxy variable. The proxy for agricultural performance in case of (i) is per capita gross state domestic product (GSDP) from agriculture and in case of (ii) it is the gross value of output (GVO) per hectare.

As agricultural performance is only one of the many factors that help alleviate poverty and malnutrition, the analysis involves two steps:

1. Identifying other variables that can affect poverty and malnutrition and understanding their linkage using a correlation matrix; and
2. Estimating the relationship among various explanatory variables including the variable that represents agricultural performance by running separate regression models

Ideally, a panel data analysis with a long time series and cross-section data at the household level should be used to test the impact that different variables have on the twin problems, but as data on both poverty and malnutrition are not collected and published regularly and is available only for particular time intervals, panel data fixed effect and random effect models had to be used. The data is pooled for 21 states across two time periods, i.e. 2005–06 and 2015–16 for the analysis on malnutrition and 2004–05 and 2011–12 for the analysis on poverty.

Results

Relation Between Agricultural Performance and Poverty (Rural)

In the statistical analysis of 21 states, a fairly strong negative correlation emerges between poverty (measured as the head count ratio or HCR) and per capita agricultural GDP (−0.6), non-farm employment (−0.68), surface road density (−0.5) and literacy (−0.58) (Table 2.1), indicating that poverty (HCR) declines with rising per capita agricultural GDP, non-farm employment, surface road density and literacy. Due to the problem of multi-collinearity between some explanatory variables, the regression results were skewed. The final results confirmed that historically, a 1% increase in per capita agricultural GDP reduced poverty by 0.73%. The impact of non-farm employment and literacy is even higher, both of which help the work force engaged in agriculture to move out to higher productivity jobs in the non-farm sector. The details can be found in Chap. 3's Table 3.2.

Table 2.1 Correlation between poverty and factors studied for their impact on rural poverty

	Poverty HCR	PCGSDPA	Non-farm Employment	Surfaced road density	Literacy
Poverty HCR	1	−0.60***	−0.68***	−0.50***	−0.58***

Note Poverty
HCR poverty head count ratio; *PCGSDPA* per capita gross state domestic product from agriculture and allied activities; non-farm employment: per cent of workers employed in non-farm activities; surfaced road density: surfaced road length as a percentage of geographical area and literacy- total literacy rates in the state;
*** significant at 1% **

Relation Between Agricultural Performance and Malnutrition

Although interlinked, malnutrition in adults differs from malnutrition in children at least when the intent is to identify ways to alleviate them. This is why the study in this section involved two separate analyses presenting the impact of agricultural performance on both child and adult malnutrition.

The econometric analysis is based on panel data on malnutrition and factors affecting malnutrition collected for two points in time—2005–06 and 2015–16—across 21 major states.

An analysis of correlation estimates for 21 states reveals that malnutrition has been strongly and negatively correlated with the performance of the agricultural sector. Interestingly, the negative relation is much stronger in the case of adult malnutrition than with malnutrition in children (Tables 2.2 and 2.3).

Other important factors significantly influencing malnutrition are literacy, toilet facilities at home, access to health care facilities (vaccination, delivery by health personnel) and child feeding practices (breastfed within an hour of birth).

To understand the relation between variables better, an analysis using the random effects model with BMI as the dependent variable and factors mentioned above as the independent variables was done.

Factors that have a significant influence on adult malnutrition are agricultural performance, literacy and delivery assisted by health personnel (Fig. 2.1a). In other models, sanitation and access to improved water also emerged as important variables.

Table 2.2 Correlation matrix of adult malnutrition and factors affecting adult malnutrition

	BMI	GVOAL/ha	Flit	Mlit	HH_Toilet	Delivery_HP
BMI	1	−0.76***	−0.72***	−0.73***	−0.65***	−0.81***

BMI average proportion of men and women with BMI below average, GVOAL/ha: gross value of output per hectare of GCA; *Flit* female literacy rate; *Mlit* male literacy rate, *HH_toilet* proportion of households with toilets within their houses; *Delivery_HP*: proportion of deliveries of new borns assisted by health personnel
**significant at 5%, ***significant at 1%

Table 2.3 Correlation matrix of child malnutrition and factors impacting child malnutrition

	IMR	Stunted	Wasted	Underweight
IMR	1			
Stunted	0.86***	1		
Wasted	0.21***	0.30	1	
Underweight	0.74	0.87***	0.68***	1
GVOAL/ha	−0.58***	−0.61***	−0.13	−0.56***
Flit	−0.87***	−0.83***	−0.32**	−0.77***
HH_toilet	−0.72***	−0.70***	−0.49***	−0.76***
Bfed_1 hr	−0.67***	−0.67***	−0.11	−0.55***
Delivery_HP	−0.83***	−0.80***	−0.17	−0.68***
Vac	−0.80***	−0.79***	−0.22	−0.67***

Note IMR: infant mortality rate per 1000 live births, stunted: percentage of stunted children in the age group 0–59 months, underweight: percentage of underweight children in the age group 0–59 months; Bfed_1hr—percentage of children born in the last five years who were breastfed in the first hour of birth, vac: percentage of children who received all basic vaccination
**significant at 5%, ***significant at 1%

Similarly, the association between agricultural performance and child malnutrition is estimated using the fixed effects model with IMR as the dependent variable and the random effects model with stunted and underweight as dependent variables (depending on the results of Hausman test).

Agricultural performance holds a strong negative relation with child malnutrition (Fig. 2.1b–d). Access to improved sanitation facilities (toilet facilities and drinking water) has a strong impact on long-term child malnutrition indicators (stunted and underweight children). Other important factors influencing child malnutrition are vaccination (percentage of children in the age group 12–23 months receiving all basic vaccinations: BCG, measles, 3 doses each of DPT and polio vaccines), delivery assisted by health personnel and breastfeeding practices.

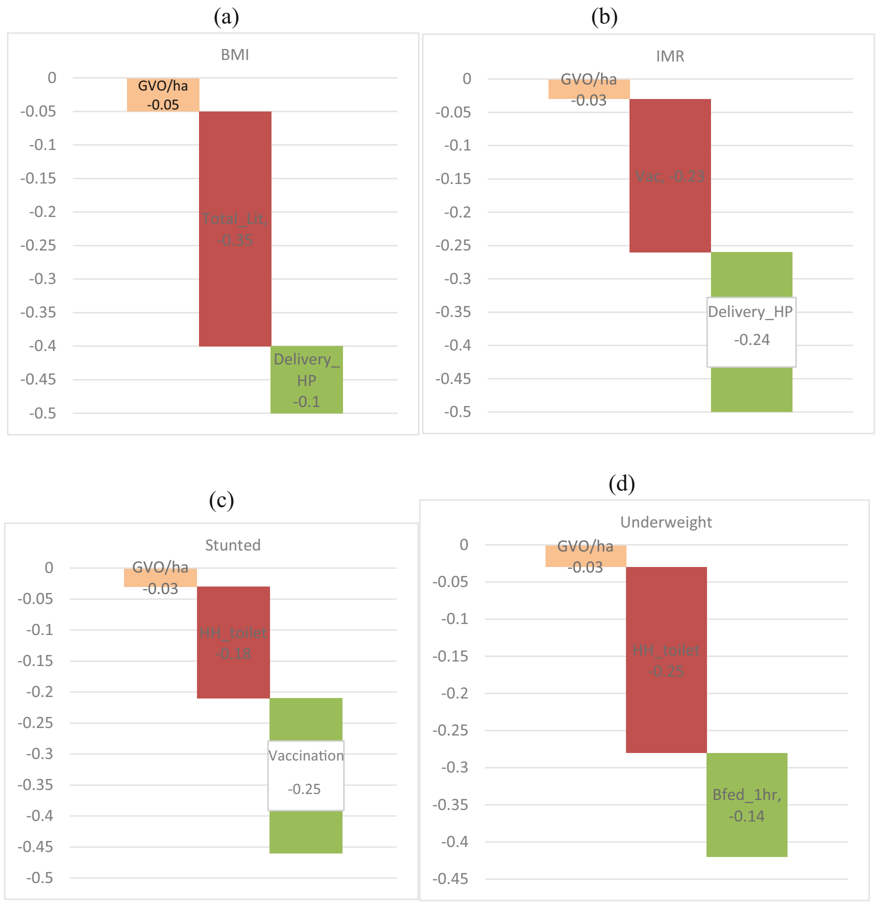

Fig. 2.1 Regression results for linkage between malnutrition and performance of agricultural GDP(GVO/ha). *Source* Based on authors' calculations

Conclusion

To sum up, agricultural performance plays an important role in reducing malnutrition and poverty in India. However, there is a likely lag in this process as it takes time for agricultural growth to manifest in terms of increased agricultural GDP on a per capita basis or per hectare basis and hence, to have an impact on malnourishment and child mortality.

2.3 AGDP Analysis of Six States

The summary presented in this section corresponds to the state Chaps. 4–9. These six chapters contain an exhaustive and thorough analysis of agriculture in six important agrarian states. These six states were identified based on the historical performance of their agricultural sector and are:

1. Punjab, Madhya Pradesh and Gujarat, categorised as high-performance states (HPS), and
2. Odisha, Bihar and Uttar Pradesh categorised as average-performance or laggard states (APS).

The initial objective of the study was two-fold: first, to undertake an analysis of each of the HPS to identify and evaluate their sources and drivers of growth, and second, evaluate the possibility of their replication in each of the APS. However, during the research, it was found that the APS states were not as average-performing or laggard as perceived earlier; in fact, they were found to be frontrunners in certain initiatives and replication of these initiatives could benefit other Indian states including the HPS states. Therefore, from the initially designed one-way learning process, the study evolved into a two-way learning process between the two sets of states.

Each state chapter includes, *inter alia,* the following:

1. A profile of the state's agricultural sector with an outline of its historical performance. This involves, *inter alia*, a study of trends and volatility witnessed in the state's agricultural GDP, the composition of and trends in the state's value of output from agriculture and allied activities, state of its infrastructure and availability and usage patterns of various agricultural inputs.
2. The growth experience of state agriculture has been studied, with focus on identifying
    a. the sources of its historical growth[1] and
    b. the drivers of this growth (estimated using a regression analysis as explained later in the section).

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[1]That is done through the following process:

a. The shares (S) of each segment (i = cereals, pulses, oilseeds, fruits, vegetables, etc.) in gross value of output of agriculture and allied (GVOA) are computed using the formula: $s_i = \frac{\mathrm{VO}_i}{\mathrm{GVOA}} \times 100$

3. Based on the above analysis, key lessons have been drawn, based on which, gaps, if any, have been identified, and implementable policy-level recommendations have been made.
4. These recommendations have then been aligned with learning from other state studies.
5. An analysis of state budgets has been presented in the end to evaluate the fiscal implications of the recommendations and the required budgetary adjustments.

This chapter gives a snapshot of the analysis presented in those six chapters individually, and then an analysis of the combined data for all six states.

2.3.1 Agriculture in Indian States

Between 2005–06 and 2017–18, while the Indian economy (measured as gross domestic product or GDP) grew at an average annual growth rate of 7.8%, its agriculture sector (measured as agriculture and allied sector gross domestic product or AGDP) grew at only 3.7% per annum. There are, however, wide regional variations masked under the national average (Fig. 2.2).

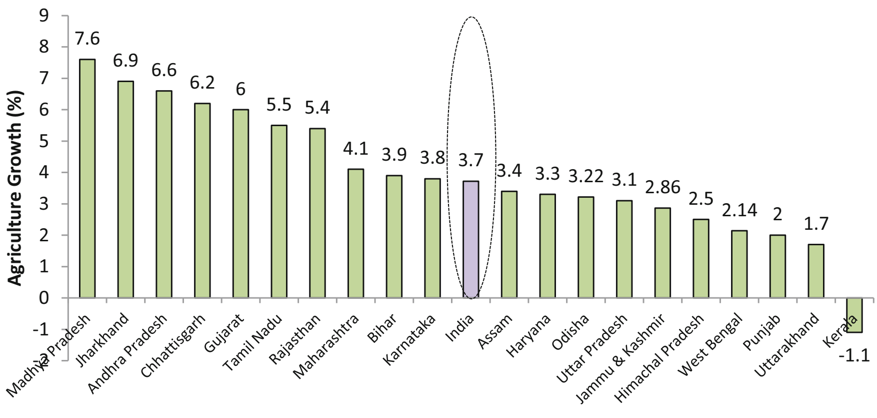


Fig. 2.2 State wise agriculture growth in the period 2005–06 to 2017–18 (2011–12 prices). *Source* Based on data from MOSPI, GOI

b. To determine sources of growth, value of output at current prices for each segment was deflated using the wholesale price index (WPI) 2011–12 = 100. The deflated value of output for a segment i in year t is given by: $D(\mathrm{VO}_i)_t = \frac{[\mathrm{VO}_i]_t}{\mathrm{WPI}} \times 100$

c. The year-on-year growth rate in GVO is then decomposed by taking the absolute year-on-year difference in GVO from each segment as a proportion of the previous years' GVO from agriculture and allied activities. The formula is: $G(i)_t = \frac{D(\mathrm{VO}_i)_t - D(\mathrm{VO}_i)_{t-1}}{D(\mathrm{GVO})_{t-1}} \times 100.$

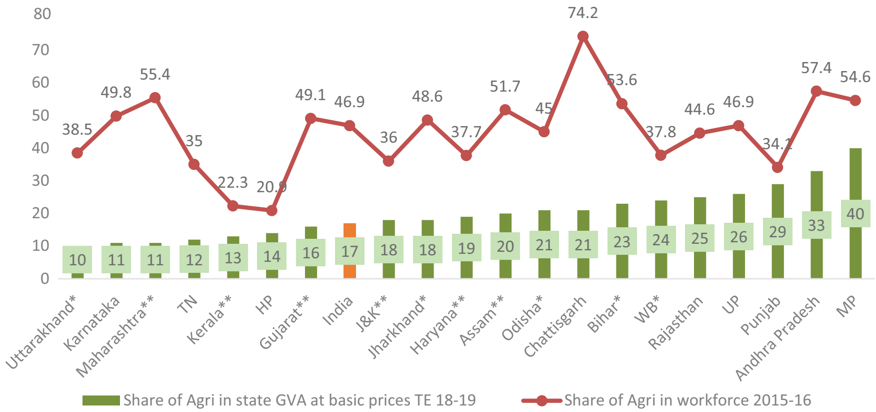


Fig. 2.3 State wise share of agriculture in GVA and share of workforce in agriculture (%). *Source* Based on data from MOSPI & Labour Bureau. *Note* *Data for TE2017–18. ** Data for TE 2016–17

During the period, Madhya Pradesh (7.6%), Jharkhand (6.9%), Andhra Pradesh (6.6%), Chhattisgarh (6.2%) and Gujarat (6%) enjoyed stupendous growth in agriculture. However, it was the low growth rates in states like Uttar Pradesh (3.1%), Odisha (3.2%), Punjab (2%) and Kerala (−1.1%) that pulled down the average national growth rate.

Punjab and Kerala are rich agricultural states, with high value per hectare—Punjab because of high rice and wheat yields as a result of the green revolution and Kerala because of its production basket that comprises mainly high value agricultural products like spices, condiments, etc. A low growth rate in these states may not be as much of an issue as low growth rates in states like UP, Bihar and Odisha will be. This latter set of states is home to a large proportion of India's agricultural workforce (together they account for 29% of the Indian agricultural workforce as per Census 2011). Low agricultural growth rates in these states are likely to affect a larger, more vulnerable section of the country, as can be seen below.

Figure 2.3 reveals that 47% of UP's workforce is employed in agriculture and the sector contributes about 26% to the state's GVA or gross value added. In the case of Bihar and Odisha, these numbers are much worse. In Bihar, about 54% of the state's workforce is employed in agriculture and the sector contributes about 23% to the state's GVA. In the case of Odisha, 45% of state's workforce is employed in agriculture, which contributes 21% to the state's GVA. This highlights how states grapple with low per capita GVA with low labour productivity and problems of underemployment. This picture is also mirrored at the all-India level, where agriculture accounts for 17% of overall GDP while engaging 47% of the country's workforce.[2]

A look at poverty concentrations shows that APS states are among the most economically vulnerable states in the country (Fig. 2.4). Forty per cent of India's poor live in these states—UP (22.2%), Bihar (13.3%) and Odisha (5.1%). The proportion

[2]In 2018–19, these numbers were 14% and 44% respectively (WDI, World Bank, 2019).

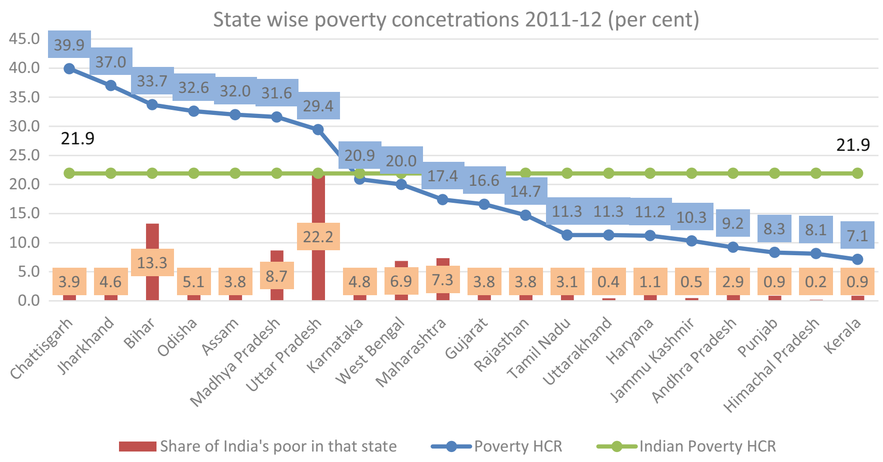


Fig. 2.4 Concentration of poverty in Indian states 2011–12 (%). *Source* Based on data from the Planning Commission, GoI

of the poor is 29.4% of the population in UP, 33.7% in Bihar and 32.6% in Odisha. This is as against the all-India head count ratio (HCR) of 21.9% (2011–12).

In conclusion, the three APS are home to a large poor population, have a greater share of their labour force dependent on agriculture with a relatively low proportion of the state's GDP/GVA coming from agriculture.

In contrast, the HPS are relatively better off with Punjab and Gujarat being among the top performers. Even though Madhya Pradesh is home to about 8.7% of India's poor and has about 32% of its population living below the poverty line, its stupendously high agricultural growth rates in the recent past has helped it secure a place in the HPS. As observed in the last section, there is a lag in the transmission of the benefits of agricultural growth in the country. Hence, even though the poverty estimates look grim for MP in Fig. 2.4 above, which used data for the year 2011, more recent data is likely to show the poverty alleviating impact of this agricultural growth.

2.3.2 Brief about the Six Focus States

We start by presenting a summary of the key parameters of the agricultural sector for each of the six states (Table 2.4).

Table 2.4 Overview of the agricultural sector in the six states

	Gujarat	Madhya Pradesh	Punjab	Uttar Pradesh	Bihar	Odisha	India
State Profile							
Population (Census 2011) in millions	60.4 (5%)	72.6 (6%)	27.7 (2.3%)	199.8 (16.5%)	104.1 (8.6%)	42.0 (3.5%)	1210.9 (100%)
Projected Population 2019 based on Census 2011 (Millions)	64.8 (4.8%)	83.8 (6.2%)	29.9 (2.2%)	233.4 (17.2%)	122.3 (9%)	45.9 (3.4%)	1353.9 (100%)
Geographical Area (m ha)	19.6 (6.0%)	30.8 (9.4%)	5.0 (1.5%)	24.1 (7.3%)	9.4 (2.9%)	15.6 (4.7%)	328.7 (100%)
Population Density (population per sq. km) (2019)	330.6	272.0	593.2	968.7	1298.4	294.5	411.9
Gross cropped area (m ha) TE 2014–15	12.6	23.7	7.9	26.0	7.7	5.1 (9.0)[b]	197.9
Gross irrigated area (m ha) in TE 2014–15 (Parenthesis gives Irrigation Ratio)	6 (47.2%)	9.7 (41.1%)	7.7 (98.5%)	20.5 (79.1%)	5.2 (68.3%)	1.5 (29%) 3.4 (38.4%)[b]	94.8 (47.9%)
Cropping intensity in TE 2014–15	122.5	153.9	189.9	156.6	144.6	115.4 166[b]	140.8
Agriculture share in Total GSDP at current prices TE 2018–19 (%)	16.3 (TE2016–17)	40	29	26	23 (TE2017–18)	21	17.6

(continued)

Table 2.4 (continued)

	Gujarat	Madhya Pradesh	Punjab	Uttar Pradesh	Bihar	Odisha	India
Average level of farmer incomes in 2015–16 (NAFIS) (INR/month)	11,899	7919	23,133	6668	7175	7731	8931
Agricultural Workforce in Total Workforce (%) (Census 2011)	49	70	35.6	59.2	74	61.8	55
Normal Rainfall (monsoon months Jun-Sep) in cm	65.8	95.2	49.2	84.6	102.8	115.0	88.8
Rural Poverty (%) (2004–05) [2011–12]	(39.2) [21.5]	(53.6) [35.7]	(22.1) [7.7]	(42.7) [30.4]	(55.7) [34.0]	(60.8) [35.7]	(41.8) [25.7]
Natural disasters: floods [2000 to 2017]				Floods: 2007 most damaging flood in history and 2017	Floods: 9 years	Floods: 15 years	
Droughts [2000 to 2017]				Drought: 2016, 2017	Droughts: 5 years	Droughts: 8 years	
Fertiliser Consumption (kg/ha) in 2014–15	131.8	75.5	218.6	163.4	175.4	55.4[b]	129.0
Power sales per hectare of gross cropped area (KWh/ha) TE 2015–16 (Parenthesis gives agricultural share in total power sales)	1087 (25.6%)	641 (38.2%)	1356 (27%)	442.8 (17.8%)	43 (3.3%)	25 (1.4%)[b]	847 (20.4%)
Road density per 1000 km^2 (2015–16)	913.9	941	2152	1707	2193	1850	1431

(continued)

Table 2.4 (continued)

	Gujarat	Madhya Pradesh	Punjab	Uttar Pradesh	Bihar	Odisha	India
Surfaced road as a share of total road (2015–16)	87.2	83	90.6	85.9	59.8	23.9[a] (2011–12)	70.6

[a]Data point given for a different year (mentioned in parenthesis) than for other states
[b]LUS data for Odisha taken from state DES

2.3.3 Land-use Pattern in the Six States

Land is one of the most important agricultural inputs. As can be seen from Table 2.4, these six states account for about 31.8% of the country's geographic area (of about 329 million ha) and about 43.9% of India's gross cropped area (of 198 million ha). With mounting pressures from urbanisation, industrialisation and climate change, the land available for agricultural activities is likely to shrink in the coming years.

An analysis of the land-use pattern of these six states reveals (Fig. 2.5) the following:

1. Punjab has the largest share of its geographic area being deployed for agricultural purposes (82%) and Odisha has the lowest (28.7%).
2. Fallow lands are a big problem in Odisha and Bihar. The share of fallow lands in total land is the highest in Bihar (10.4%) and Odisha (10%), and the lowest in Gujarat (2.1%) and Punjab (1.4%). Both Odisha and Bihar have a high proportion of fallow land because of the large number of weather-related incidents like floods, droughts and cyclones that the states are subjected to frequently. The problem of fallow lands has also become increasingly pervasive due to highly restrictive tenancy laws.

Forest and forest products are important for Odisha and Madhya Pradesh with 37.5% and 28.3% respectively of their area under forest cover.

Within agriculture, a look at the cropping pattern for the six states reveals some clear trends:

1. Cereals are the most dominant crops. The state of Punjab has the highest share of its gross cropped area (GCA), i.e. 83%, under cereals and Gujarat has the

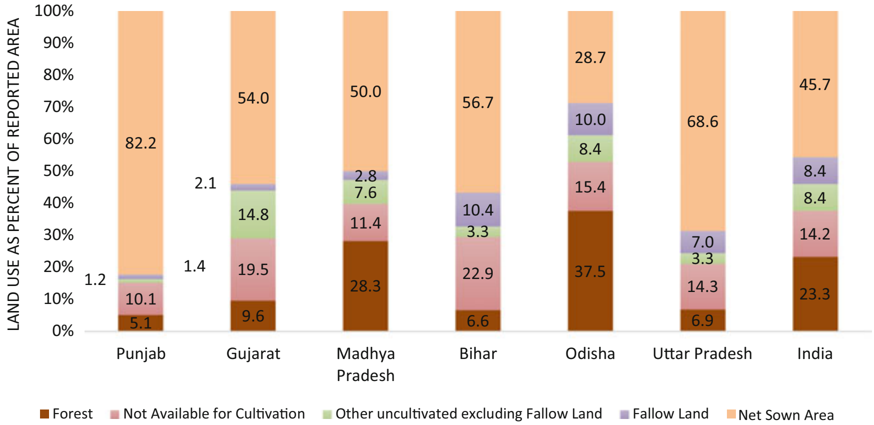


Fig. 2.5 Land use Statistics in Focus States, TE 2014–15. *Source* Directorate of Economics and Statistics, GOI. Data on Odisha state presented here is taken from Land use statistics (LUS), Government of India, which does not match the data reported by the Government of Odisha. However, we are using the GOI *Source* for all states here to make an inter-state comparison

least, i.e. 22%. On an average, only 17% of Punjab's area is left for other crops. Acreage is high under cereals in Odisha and Bihar too.
2. Gujarat has the most diversified acreage among the six states with cereals, oilseeds and cotton accounting for similar shares in the state's GCA.
3. Among the six states, Madhya Pradesh has the largest share of its GCA under pulses and oilseeds.
4. Cotton accounts for the highest share of GCA in Gujarat while sugarcane accounts for the highest share in UP.

Interestingly, the cropping pattern does not reflect the contribution a crop makes to the state's gross value of output from agriculture and allied activities. Based on the share of the value of different agriculture and allied activities calculated as a percentage of the total value of output from agriculture and allied activities (VOAA) (at current prices) (Fig. 2.6), some interesting trends emerge.

1. Barring Odisha and Punjab, livestock emerges as the largest contributor to the state's VOAA among all six states.
   a. The largest contribution from livestock is in the states of Bihar (33.8%) and UP (33%). In Odisha, the largest contribution comes from fruits and vegetables (F&V) and in Punjab, it comes from cereals.
   b. The highest contribution of cereals in a state's VOAA is in Punjab (40.9%) and the lowest is in Gujarat (6.8%).
   c. In Punjab, it may be noted that despite cereal domination, livestock is second most important contributor to VOAA. In fact it is more than that in Gujarat,

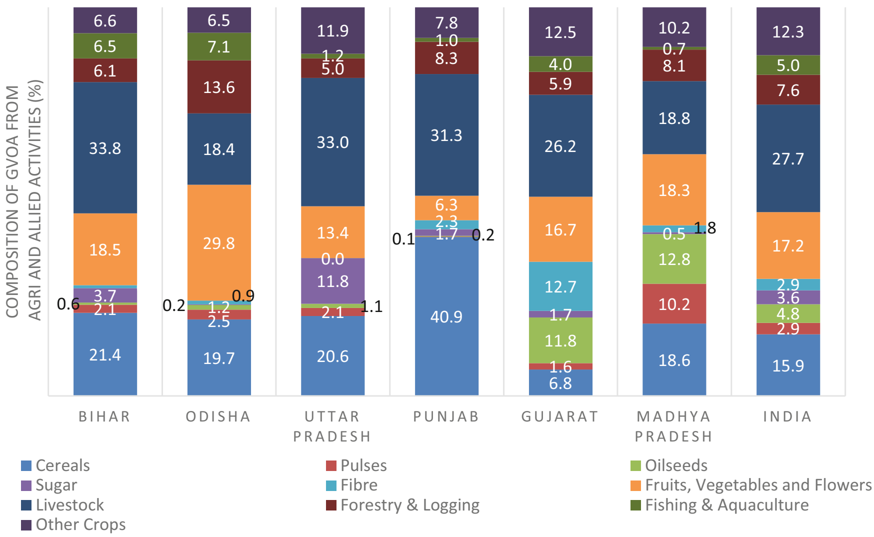


Fig. 2.6 Sector-wise shares in value of output from agriculture and allied activities TE2015–16. *Source* Based on data from CSO, Government of India, State-wise Estimates of Value of Output from Agriculture and Allied Activities

Madhya Pradesh, and even all India average. In fact livestock share in Punjab (31.3%) is pretty close to that of Bihar (33.8%) and Uttar Pradesh (33%).

2. In Bihar, Punjab and UP, two activities, i.e. cereal cultivation and livestock, together contribute more than half the state's VOAA. In the remaining three states, it is three crops/activities:
   a. Odisha and Madhya Pradesh: F&V, cereals and livestock
   b. Gujarat: Livestock, F&V and fibre (cotton)
3. Fishing and aquaculture makes the largest contribution in the states of Bihar (6.5%) and Odisha (7.1%). Even though Bihar is a non-coastal state, it has access to 13 rivers, and hence, has been able to develop inland fishing.
4. F&V emerges as the most important contributor in VOAA in Odisha (29.8%), Bihar (18.5%) and Madhya Pradesh (18.3%) and least important in Punjab (6.3%).
5. Pulses and oilseeds are observed to have the largest contribution in the states of Madhya Pradesh (23%) and Gujarat (13.4%).

As each of the six states have had a different historical growth trajectory (Fig. 2.2), we need to disaggregate the VOAA analysis and observe changes in each sub-segment of agriculture over time to identify the role each has played in agricultural growth to identify the sources of growth for each state.

2.3.4 Method Followed for Finding the Sources of Growth

To calculate the "sources of growth", the current value of output of each segment is deflated by the WPI series at 2011–12 prices. The decomposed year-on-year growth in the GVO from agriculture and allied activities is enumerated by taking the absolute difference in GVO from each segment as a proportion of the previous year's GVO from agriculture and allied activities. The analysis is done for the period between 2000–01 and 2015–16 (Fig. 2.7).

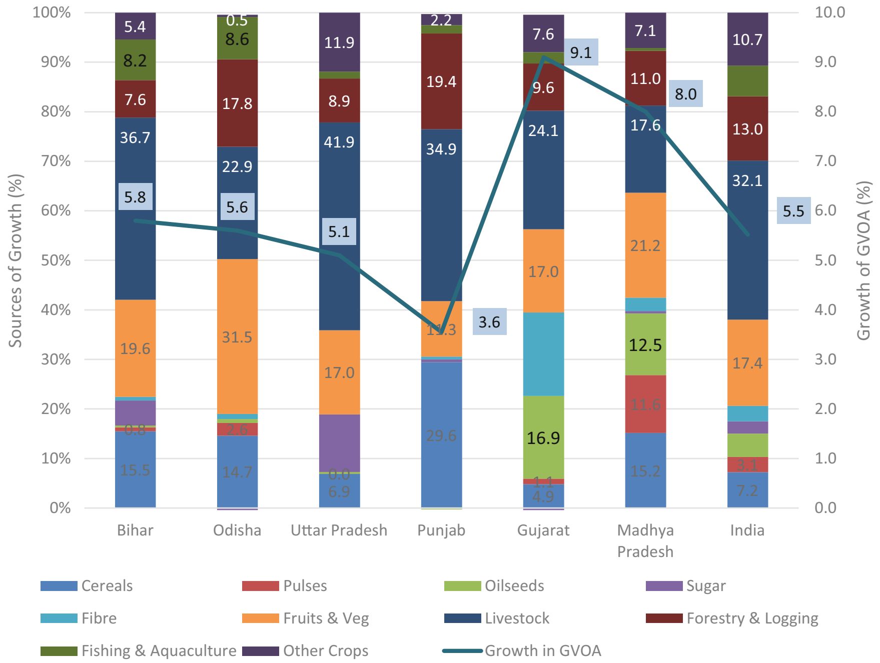


Fig. 2.7 Sources of growth 2000–01 to 2015–16 (share in growth contributed by each sector). *Source* Calculated by authors

2.3.5 Results

The analysis (Fig. 2.7) reveals interesting trends.

1. Among the six states, GVO in agriculture grew the fastest in Gujarat[3] at 9.1% on average per annum in the studied period. About a quarter of this growth came from growth in livestock, followed by the fibre and fruits and vegetables(F&V) sectors that made an equal contribution of about 17% each.
2. Madhya Pradesh with an average annual GVO growth of 8% grew the second fastest. Again, it was F&V and livestock that together explained about 39% of this growth. The contribution of cereals, oilseeds and pulses together was also about 39%.

[3]As per Fig. 2.2 in this Chapter, AGDP growth rate was highest in the case of MP but as per Fig. 2.7, the growth rate in GVO in agriculture is the highest for Gujarat. This difference is due to the difference between the studied periods in each of the figures. While Fig. 2.2 was for the period 2005–06 to 2017–18, Fig. 2.7 is for period 2000–01 to 2015–16. Figure 2.7 is the result of the statistical exercise undertaken during the 4-year research period and Fig. 2.2 is more recent and updated.

3. The lowest growth was observed in Punjab at 3.6%. About 35% of this growth was accounted for by output in the livestock sector and about 30% came from cereals.
4. Oilseeds contributed the largest to the growth in Gujarat (16.9%) and Madhya Pradesh (12.5%).
5. Pulses made a substantial contribution only in the case of MP (11.6%).
6. Sugarcane emerged an important source of growth in UP (11.6%).

Overall, it can be concluded that while Gujarat and Madhya Pradesh experienced a more diversified growth process, growth in other states centred on a few activities.

2.3.6 Drivers of Growth

From our analysis above, we now know the activities/sectors/crops that contributed to agricultural growth in the six states. In this section, we identify factors that explain the growth in these activities/sectors/crops.

The performance in agriculture and allied activities is dependent on a host of factors. These factors can be classified into various categories such as (1) physical inputs used in cultivation (seeds, fertilisers, pesticides) (2) technology (irrigation, mechanisation) (3) availability of physical infrastructure (road, electricity, cold storage, warehouses, etc.) and (4) institutional reform measures such as reform of procurement agencies, extension services and so on. However, it may not be possible to examine the effects of such a large number of variables simultaneously in a model as many of them are very closely related to each other, causing multi-collinearity. In this section, we have taken one representative variable from each of these broad areas to assess its impact on agricultural growth. Many of these explanatory variables show high correlation with each other. For example, there is high correlation between fertiliser consumption and the irrigation ratio. As far as possible, we have used different combinations of explanatory variables that are not expected to suffer from endogeneity.

To determine the drivers of growth, panel data fixed and random effect models (both time and state dummies) have been used. The panel data has been obtained by pooling data across the six states for the period 2000–01 to 2016–17. The Hausman test has been applied to find out which model (fixed or random) is the best fit for our analysis.

The results for the APS and the HPS are presented (Fig. 2.8).

Overall, two factors emerged as the main drivers of agricultural growth in any state: (i) quality infrastructure (mainly irrigation and roads), and (ii) access to markets and marketability of the produce. Additionally, for Odisha, Bihar and Gujarat, a third factor of diversification away from cereals to high value agriculture that includes, fruits, vegetables, pulses, etc., and to allied activities like dairy, poultry, piggery, etc., emerged as relevant.

2.3.7 Econometric Analysis Combining Data on Six States

To estimate the actual relation between these factors and the state's agricultural GDP, we undertook an econometric exercise based on panel data. The period of study was 2000–01 to 2016–17, that is, a period of 17 years. We had pooled data for six states for the period to conduct the regression analysis. The Hausman test was done to confirm the fixed effects model for the equation with agricultural GSDP as the dependent variable, and the irrigation ratio, road density and terms of trade between agriculture and industry as the independent variables. The result of the regression is as follows:[4]

$$\underset{}{\text{Ln\_AGSDP}} = \underset{(0.46)}{9.86***} + \underset{(0.05)}{1.121\text{Ln\_IR}***} + \underset{(0.03)}{0.22\text{Ln\_RD}***} + \underset{(0.07)}{0.28\ln\text{\_ToT}**}$$

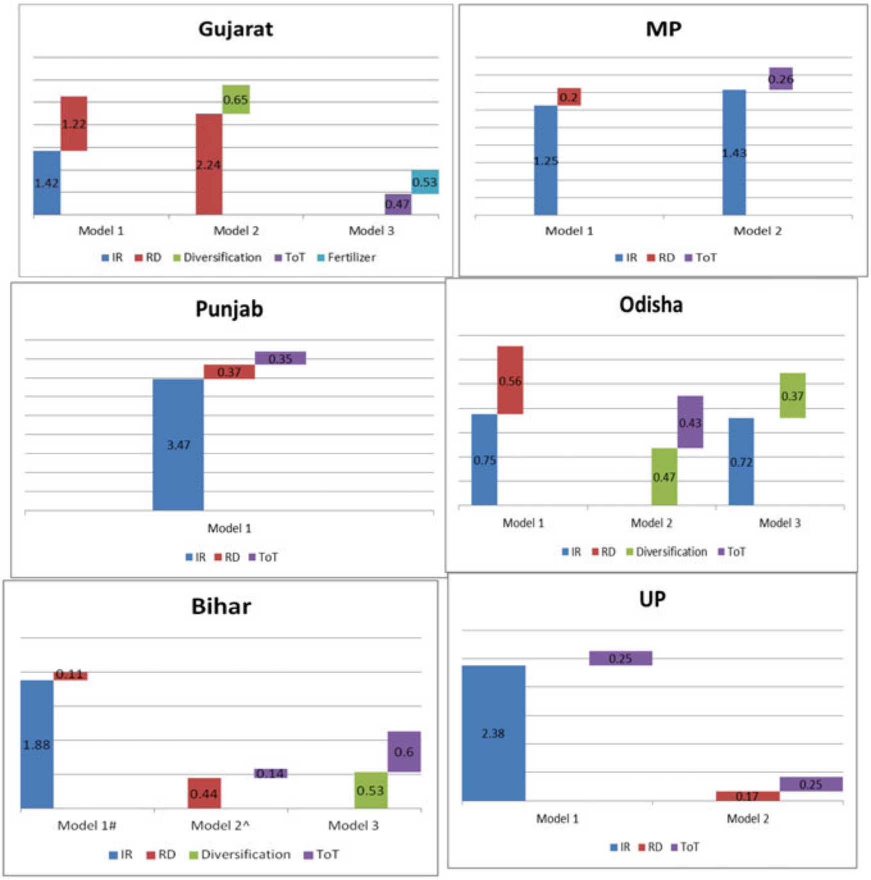
$N = 102$
R square:
Within $= 0.81$
Between $= 0.14$
Overall $= 0.20$

Note Ln_GSDPA = log of GSDP from Agriculture (dependent variable); Ln_IR = log of Irrigation ration; Ln_RD = log of total road density; Ln_ToT = log of Terms of Trade between Agriculture and Industry

The impact of irrigation, roads and ToT are found to be significant in the model with irrigation having the strongest impact on agricultural GDP. The results indicate that a one per cent growth in the irrigation ratio increases agricultural GSDP by 1.12%. Similarly, a one per cent increase in the terms of trade in favour of agriculture leads to a 0.28% increase in agricultural GSDP. So, econometrically, it is recognised that supply of water, road infrastructure and price incentives are necessary for agricultural development.

The quantum of rainfall is pretty low and uncertain in many parts of the country. Hence, providing irrigation facilities is essential for cultivation. With the use of HYV seeds and fertilisers, irrigation facilities become necessary in the production process. Once the produce is ready to be marketed, roads play an important role in agricultural development by providing connectivity to even far off areas, especially for perishable produce that needs to reach the market on time. The third most important factor is price incentives. A higher return on cultivation encourages farmers to invest more, which raises agricultural GDP, which in turn augments farmers' income. A robust marketing infrastructure and procurement facilities guarantee that farmers get remunerative prices for their produce.

[4]Numbers in parentheses are standard errors.



Note: Regression periods: 2000–01 to 2015–16 for Gujarat, MP, Odisha; 2001–02 to 2014–15 for UP, 2001–02 to 2015–16 for Bihar and 1970–71 to 2015–16 for Punjab. Abbreviations: IR: irrigation ratio, RD: Road a Density, ToT: terms of trade for agriculture. Other variables are diversification to high value agriculture and fertiliser consumption. All variables have high R square value of above 75 per cent. Note: Separate model numbers reflect results from separate econometric models. # In Model 1 of Bihar, Road Density is not significant. ^In Model 2 of Bihar, Terms of Trade is not significant

Fig. 2.8 Summary of the econometric results from state studies

2.4 From Agricultural GDP to Farmers' Incomes

Historically, India is a country that is known to have suffered immensely because of floods, droughts, cyclones and other weather vagaries, sometimes all in the same year. To feed its huge population, the country had been a net importer of food at least until the late 1960s. The situation changed gradually after India's green revolution in the late 1960s and 1970s, when high-yielding varieties of wheat and rice seeds were imported and planted in India, resulting in bumper production. Together with support from a robust and revamped agricultural extension system and marketing

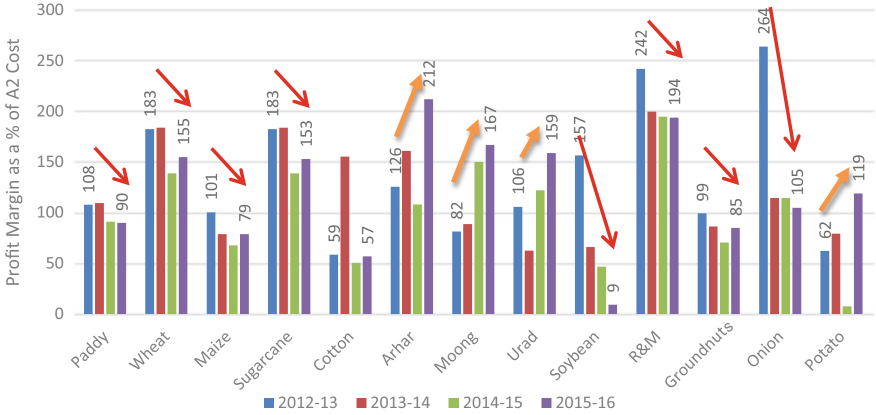


Fig. 2.9 Trends in profitability (over A2 cost) of important crops in India. *Source* Based on data from DES, GOI. Note: trends are estimated as weighted average of major producing states

infrastructure, including government procurement, there was a sustained increase in production over the years that enabled India to become a net exporter of food to the world.

If traditionally an Indian farmer suffered more due to production losses, today he suffers additionally from price risks especially in the years of bumper production. Therefore, the problem of the Indian peasantry is not as much of tonnage today as it is of imperfect and inefficient markets and its related infrastructure.

It may be noted that after 2013–14, the margins of profitability over paid out costs (Cost A2) have been falling on most of major crops in India (Fig. 2.9). And if one works out these margins over full comprehensive cost that includes imputed rent on owned land and imputed interest on owned capital, the margins of profitability become negative for many crops.

Historically, when India suffered immensely due to volatile production, it was right for policies and the policy makers to focus on increasing production. Today, as a result of access to quality inputs and technology, India has been able to produce surpluses in the case of most crops with the notable exception of edible oils. The question before policy makers today is that of the sustainability of these surpluses, which is predicted to suffer on two accounts: (a) the unpredictable impact of climate change and (b) falling margins of profitability that act as a disincentive to farmers to undertake further investment.

While the country's agricultural research and development division is working to resolve the risks associated with climate change, it is the second issue of market and price risk that the policy makers must immediately and urgently focus on.

There is need for increased focus on the value of the produce that is created, which means that the earlier focus on agricultural GDP has to be shifted to a greater focus on a combination of higher tonnage and higher value realisation for that produce.

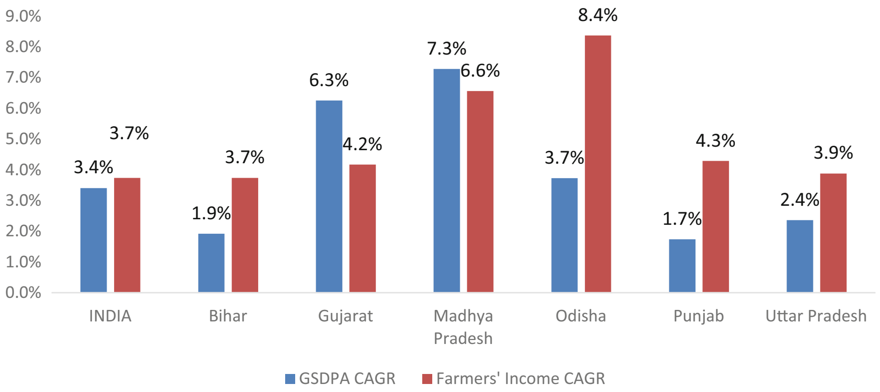


Fig. 2.10 CAGR of GSDPA and Farmers' Income (FY) between 2002–03 and 2015–16. *Source* MOSPI, NSSO and NABARD. Note: Growth rates are estimated as CAGR of terminal values of GDP from agriculture and allied activities and farmers' income for years 2002–03 and 2015–16

Comparing historical growth rates achieved by agricultural GDP and levels of farmer incomes reveals some interesting trends (Fig. 2.10). Between 2002–03 and 2015–16, real incomes of farmers grew at 3.7% per annum and agricultural GDP grew at about 3.4% per annum. It may not be wrong to say that both growth rates followed each other closely in these years. At the state level, however, the two growth rates differed (Fig. 2.10).

In the case of our six states, despite higher AGDP growth, farmers' incomes have failed to rise as fast in Gujarat and MP (to some extent). Contrarily, farmers' incomes have risen sharply in Odisha, Punjab, UP and Bihar despite a not-so-impressive AGDP performance.

But how does a gap arise between two important variables measuring a farmer's eco-system? While this may be explained by outlining accounting procedures,[5] but what may be at the core of the situation would be- the farmer's small and shrinking size of landholding. Due to the small size of his farming landholding, farmers are forced to diversify their income sources by looking beyond agriculture to augment their household incomes. Farmers sometimes work on other's farms in return of wages and sometimes they undertake non-farm businesses to support their families.

An average Indian farm size is 1.08 ha (Agricultural Census 2015–16) and it has been shrinking over the decades (it was 2.3 ha in 1970–71) (Fig. 2.11).

India has about 146 million landholdings and 68.5% of these are marginal holdings, i.e. less than 1 hectare and the average landholding size of this category is much

[5]Some parts of this disconnect between AGDP and farmer income trends may be explained by the way the data for each is segregated and analysed. Certain sources of incomes like wages and salaries that agricultural households made from, for example, working in schools, tuition centres, etc., will be counted as income from services and not towards agriculture; hence, even though an agricultural household earned that income, it does not get reflected in the GDP from agriculture. This and many more data issues raise the need to look at both agricultural GDP and level of farmers' incomes as variables to monitor and target if one wants to alleviate poverty in the country.

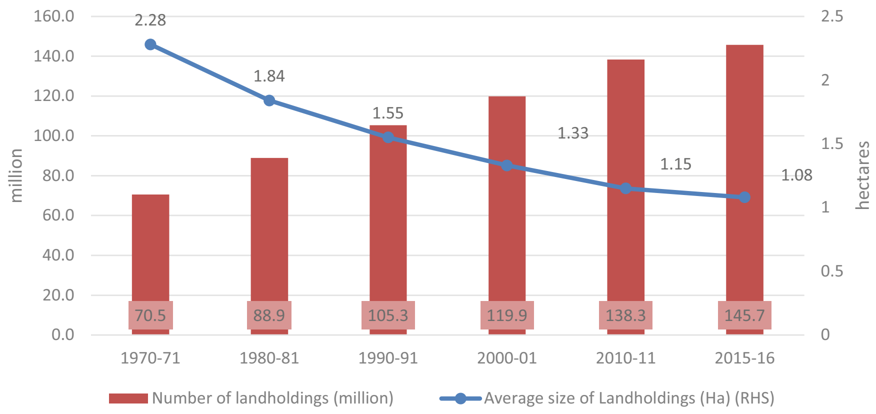


Fig. 2.11 India's operated area under agriculture: size and number of holdings. *Source* Data taken from Agricultural census of various years

smaller at 0.38 ha. In addition, about 17.7% of Indian landholdings are categorised as small, i.e. they are between 1 and 2 ha and have an average size of 1.41 ha. Thus, about 86% of Indian landholdings are less than 2 ha and fall under the category of small and marginal landholdings or farmers (SMF). They together operate on about 47% of the country's 157 million hectares of operated area.[6]

As incomes from such small farms are not enough to sustain families, farmers diversify their sources of income through dairy farming, by working as labourers on others' farms or even outside the farms (non-farm) and operating small businesses like barber shops, among others. As the landholding size falls, one would expect a more diversified income portfolio. These diversified activities may not all be accounted for as part of the country's agricultural GDP. While some may be counted towards manufacturing GDP, others may be added to the services sector's GDP.

What are the sources of farmer incomes? In this section, we will detail the following:

1. The level of farmers' incomes in the country and inequality in incomes between states
2. The structure of farmers' incomes and trends.

2.4.1 Source of Data

Since the year 2000, data on Indian farmers' incomes is available for three years: 2002–03, 2012–13 and 2015–16. The 2002–03 and 2012–13 surveys were conducted

[6]According to the Agricultural Census 2015–16, operated area includes both cultivated and uncultivated areas, provided part of it is put to agricultural production during the reference period. This is different from the net sown area, which refers to the actual acreage under crops in that year and gross cropped area, which includes the double cropped area.

by the NSSO. The 2015–16 survey was conducted by the National Bank for Agriculture and Rural Development (NABARD), and it is called the NABARD All India Financial Inclusion Survey (NAFIS).

2.4.2 *Composition of Incomes*

GoI's National Sample Survey Office (NSSO) profiles an average Indian farmer and identifies the actual sources of income. According to the NSSO's Situation Assessment Survey 2012–13, an average Indian farmer has four major sources of incomes: (i) *income from cultivation* (includes income from the production of field crops and plantation/orchard crops); (ii) *income from livestock* (includes receipts from the sale of milk, egg, live animals, wool, fish, honey, hide, bones, manure etc.); (iii) *wages and salaries* (includes income from working on others' farms and outside farms as well as salaries from working in the construction sector and wages received under MGNREGA) and (iv) *income from non-farm activities* (receipts from the sale of prepared food, refreshment and drinks, earnings from goods and passenger traffic, communication charges receivable from customers (STD/courier, fax, etc.), receipts for educational activity (like tuition fees, examination fees, capitation fees, etc.).

In the 13 years between 2002–03 and 2015–16, these incomes grew at an average CAGR of 11.8% at current prices. With the consumer price index for agricultural labourers (CPI-AL) growing at 8.1%, the CAGR for farmers' real incomes works out to be about 3.7%. Breaking up the farmer incomes into its four components, the sharpest growth in CAGR has been observed in the case of incomes coming from livestock as they are estimated to have increased annually at 17.1% (in nominal terms) in the 13 years.

A summary of an average farm household's nominal and real incomes are presented (Fig. 2.12).

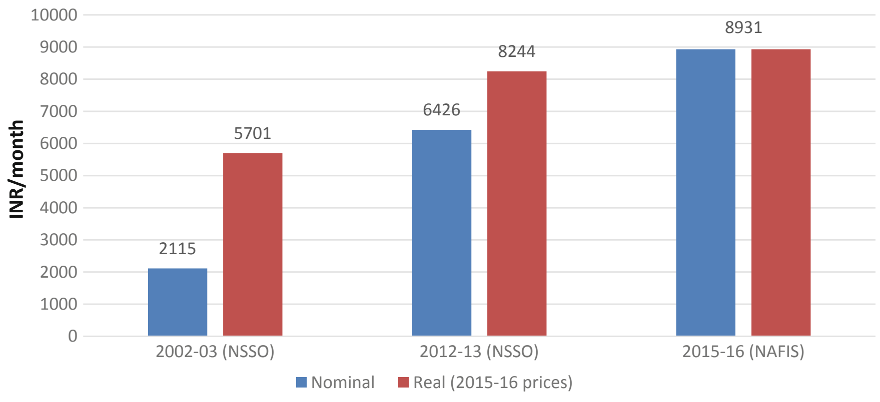


Fig. 2.12 Average farmer income level (INR/month). *Source* Based on data from NSSO and NAFIS

From analysis of data on farmer incomes, some very interesting facts emerge and are presented in the Chapter on Farmers' Incomes. Some of those facts can be found below.

1. The share of income from cultivation and livestock fell between 2002–03 and 2015–16—from 50% (in 2002–03), it first increased to 60% (in 2012–13) and subsequently fell to 43% (in 2015–16).
2. By 2012–13, while the share of income from cultivation rose (from 46% in 2002–03 to 48%), that of income from wages and salaries fell (from 39% to 32%). By 2015–16, while the share of income from cultivation fell to 35% that from wages and salaries increased to 50%.
3. Income from the non-farm sector is the smallest component and has grown the slowest.
4. The share of income from cultivation also increases as landholding size increases. Smaller landholder households earned most of their income from livestock and through wages and salaries.

2.4.3 Farmers' Income in Indian States

There is wide variation in average agricultural household incomes across states (Fig. 2.13). According to NABARD's NAFIS, the highest farmer incomes (monthly basis) were earned by Punjab farmers (Rs. 23,133 per month), followed by Haryana (Rs. 18,496/month), Kerala (Rs. 16,927) and Gujarat (Rs. 11,899). Low incomes were earned by farmers in the eastern Indian states of Odisha (Rs. 7731), Bihar (Rs. 7175), Jharkhand (Rs. 6991) and the southern state of Andhra Pradesh (Rs. 6920); the lowest incomes were earned by UP farmers (Rs. 6668/month).

Figure 2.13 presents the average monthly farmer income levels in different Indian states. The darker the green colour gets, the higher the average level of income. In states with dark red colour, farmers earn very low levels of incomes. As can be seen from the map, these states are Uttar Pradesh, Bihar, Jharkhand, West Bengal, Odisha and Andhra Pradesh and, according to Census 2011, these states are home to close to 40% of Indian farmers.

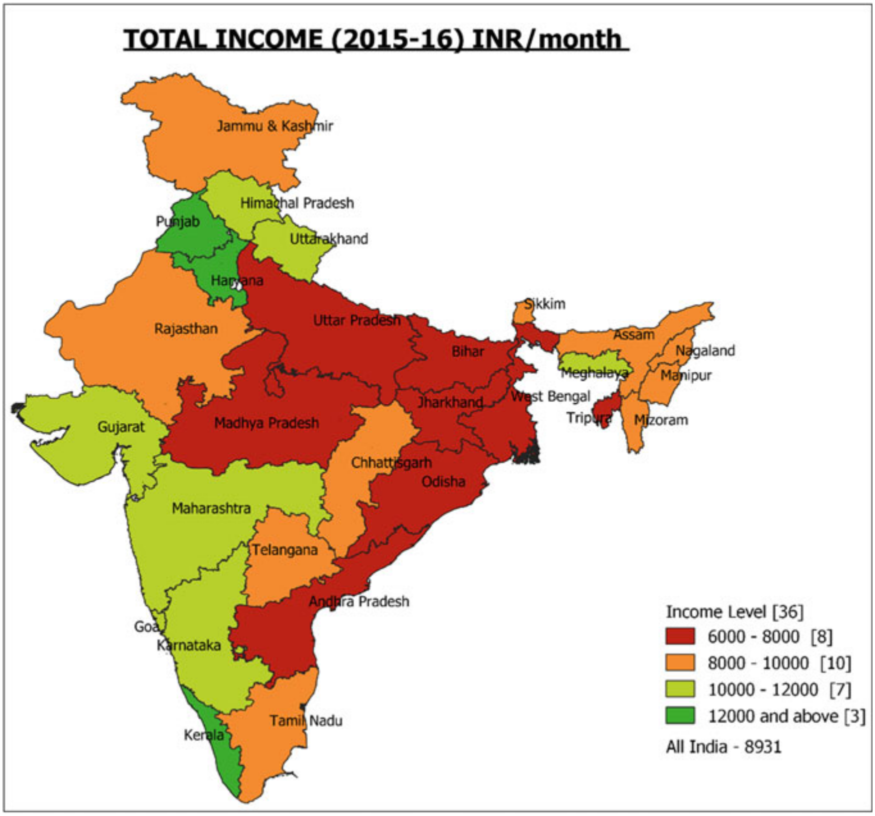


Fig. 2.13 Farmers' average monthly incomes in major Indian states: 2015–16 (INR/month). *Source* Created by authors from NAFIS data

2.4.4 Conclusion

Going forward, the policies and programmes governing Indian farmers need to be aligned to the objective of improving farmers' incomes, where improving price realisation is as important as increasing and diversifying production. To improve farmers' welfare, the focus should also be on creating opportunities for getting greater value from the produce.

2.5 Analysing Policies and Programmes

Ever since PM Modi became India's Prime Minister in May 2014, there have been some interesting developments in Indian agriculture.

1. Cyclicality in prices of most agricultural products –After rising in 2014, the prices of most crops started spiralling downwards. A fall in global prices magnified this downward trend as it adversely affected the price competitiveness of Indian products, leading to a further crash in prices domestically;
2. Five consecutive years of lower than normal rains—In its 118 years of recorded rainfall history, India had never faced five consecutive years when monsoon rains fell short of its long period average. This happened in the five years since 2014–15. Underground water levels in several states fell, their water reservoirs dried, and the agriculture sector suffered a cumulative loss over these five years as 51% of the country's GCA depends on rains for irrigation and monsoon rains are about 75% of the annual rainfall in the country.
3. Promotion of policy-level innovations—These include programmes like the PM-KISAN that makes an unconditional cash transfer into the bank accounts of all landowner farmers. This transfer is a top-up on the existing input and price support that farmers have been getting over the years. Due to the Lok Sabha elections in 2019, several state governments resorted to farm loan waivers.

In this Section, we summarise our analysis of some of the biggest schemes/announcements and evaluate them for their effectiveness in alleviating farmers' problems.

The major schemes and initiatives analysed are the National Food Security Act, 2013, agricultural marketing reforms such as eNAM, APLM, PM Aasha, MSP as cost plus 50%, *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY), *Pradhan Mantri Fasal Bima Yojana* (PMFBY) or crop insurance scheme, *Pradhan Mantri Kisan Samman Nidhi* (PM-KISAN) and farm loan waivers.

An analysis of these schemes (presented in detail in the relevant chapter) reveals that most were inefficiently implemented and marred by design or implementation gaps. In particular, the results were as follows: (a) because of their limited reach, schemes like farm loan waivers and procurement under MSP (PM Aasha) emerge as inefficient solutions; (b) Despite being the right solutions, implementation lags and errors and a siloed approach to reforms have rendered schemes like e-NAM, soil health cards and PMFBY less effective; and (c) unconditional cash transfer to farmers under PM Kisan is a unique opportunity but involves colossal fiscal implications and, in the current situation, when payments under the scheme are in addition to existing input subsidies, the fiscal burden will only snowball, squeezing scarce fiscal resources and adversely affecting public investments in and for agriculture.

What does all this mean? On one side, the Indian Prime Minister promises to double real incomes of farmers by 2022 and, on the other, schemes and programmes designed to deliver on that promise fall short in terms of performance and delivery. If India wants an overall GDP growth rate of about 8%, it cannot do so sustainably without ensuring that its agricultural sector grows at least by 4% per annum. But even a 4% annual growth rate in agricultural GDP cannot double farmers' incomes by 2022. It requires a much higher growth rate, may be 13–15% per annum for the next three years, which is impossible for the agriculture sector. In any case, it seems that doubling farmers' incomes cannot be achieved by 2022, but it may be possible over a somewhat longer period, perhaps between 2025 and 2030. To ensure this, the experience of fast-growing agricultural states like Madhya Pradesh and Gujarat and upcoming states like Odisha, UP and Bihar may be worth studying. A statistical analysis of the growth story of each of these states revealed that most growth in the agricultural sector will come from: (i) diversification to high-value agriculture (tantamount to a movement away from cereals like paddy and wheat), (ii) investment in roads and irrigation and (iii) access to efficient and more remunerative markets to get the best prices for farmers. The central and state governments should focus on these factors. Apart from this, it is imperative that the government acts as a facilitator and enabler of reforms by providing a stable and predictable policy environment for farmers and others in the value-chain to flourish.

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