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Ministry of Agriculture &
Farmers' Welfare

Report of Committee on Doubling Farmers' Income

Volume I

"March of Agriculture since Independence and Growth Trends"

Historical Analysis and Examination of Agricultural Production and Farmers' Income

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Document prepared by the Committee on Doubling Farmers' Income,
Department of Agriculture, Cooperation and Farmers' Welfare,
Ministry of Agriculture & Farmers' Welfare

August - 2017

Foreword

The country has witnessed a series of concerted discussions dealing with the subject of agriculture. In 1926, the Royal Commission of Agriculture was set up to examine and report the status of India's agricultural and rural economy. The Commission made comprehensive recommendations, in its report submitted in 1928, for the improvement of agrarian economy as the basis for the welfare and prosperity of India's rural population. The urban population was about 11 per cent of the whole, and demand from towns was small in comparison. The Commission notes, that communication and physical connectivity were sparse and most villages functioned as self-contained units. The Commission encompassed review of agriculture in areas which are now part of Pakistan, Bangladesh and Myanmar. The net sown area in erstwhile British India was reported as 91.85 million hectares and cattle including buffaloes numbered 151 million. Almost 75 per cent of the cultivated area was under cereals and pulses, with rice and wheat occupying 46 per cent of the net sown area. The area under fruits and vegetables was about 2.5 per cent and that under oilseeds and non-food crops was about 20 per cent. In the ensuing years, as well known, the country underwent vast changes in its political, economic and social spheres.

Almost 40 years later, free India appointed the National Commission on Agriculture in 1970, to review the progress of agriculture in the country and make recommendations for its improvement and modernisation. This Commission released its final report in 1976. It refers to agriculture as a comprehensive term, which includes crop production together with land and water management, animal husbandry, fishery and forestry. Agriculture, in 1970 provided employment to nearly 70 per cent of the working population. The role of agriculture in the country's economic development and the principle of growth with social justice, were core to the discussions. The country was then facing a high population growth rate. After impressive increase in agricultural production in the first two Five Year Plans, a period of stagnancy set in and the country suffered a food crisis in the mid-1960s. The report in fifteen parts, suggested ample focus on increased application of science and technology to enhance production.

Thirty years hence, the National Commission for Farmers was constituted in 2004 to suggest methods for faster and more inclusive growth for farmers. The Commission made comprehensive recommendations covering land reforms, soil testing, augmenting water availability, agriculture productivity, credit and insurance, food security and farmers competitiveness. In its final report of October 2006, the Commission noted upon ten major goals which included a minimum net income to farmers, mainstreaming the human and gender dimension, attention to sustainable livelihoods, fostering youth participation in farming and post-harvest activities, and brought focus on livelihood security of farmers. The need for a single market in India to promote farmer-friendly home markets was also emphasised.

The now constituted DFI (Doubling Farmers' Income) Committee besides all these broad sectoral aspects, invites farmers' income into the core of its deliberations and incorporates it as the fulcrum of its strategy. Agriculture in India today is described by a net sown area of 141 million hectares, with field crops continuing to dominate, as exemplified by 55 per cent of the area under cereals. However, agriculture has been diversifying over the decades. Horticulture now accounts for 16 per cent of net sown area. The nation's livestock population counts at more than 512 million. However, economic indicators do not show equitable and

egalitarian growth in income of the farmers. The human factor behind agriculture, the farmers, remain in frequent distress, despite higher productivity and production. The demand for income growth from farming activity, has also translated into demand for government to procure and provide suitable returns. In a reorientation of the approach, this Committee suggests self-sustainable models empowered with improved market linkage as the basis for income growth of farmers.

India today is not only self-sufficient in respect of demand for food, but is also a net exporter of agri-products occupying seventh position globally. It is one of the top producers of cereals (wheat & rice), pulses, fruits, vegetables, milk, meat and marine fish. However, there remain some chinks in the production armoury, when evaluated against nutritional security that is so important from the perspective of harvesting the demographic dividend of the country. The country faces deficit of pulses & oilseeds. The availability of fruits & vegetables and milk & meat & fish has increased, thanks to production gains over the decades, but affordability to a vast majority, including large number of farmers too, remains a question mark.

The impressive agricultural growth and gains since 1947 stand as a tribute to the farmers' resilience to multiple challenges and to their grit & determination to serve and secure the nation's demand for food and raw material for its agro-industries.

It is an irony, that the very same farmer is now caught in the vortex of more serious challenges. The average income of an agricultural household during July 2012 to June 2013 was as low as Rs.6,426, as against its average monthly consumption expenditure of Rs.6,223. As many as 22.50 per cent of the farmers live below official poverty line. Large tracts of arable land have turned problem soils, becoming acidic, alkaline & saline physico-chemically. Another primary factor of production, namely, water is also under stress. Climate change is beginning to challenge the farmer's ability to adopt coping and adaptation measures that are warranted. Technology fatigue is manifesting in the form of yield plateaus. India's yield averages for most crops at global level do not compare favourably. The costs of cultivation are rising. The magnitude of food loss and food waste is alarming. The markets do not assure the farmer of remunerative returns on his produce. In short, sustainability of agricultural growth faces serious doubt, and agrarian challenge even in the midst of surpluses has emerged as a core concern.

Farmers own land. Land is a powerful asset. And, that such an asset owing class of citizens has remained poor is a paradox. They face the twin vulnerabilities of risks & uncertainties of production environment and unpredictability of market forces. Low and fluctuating incomes are a natural corollary of a farmer under such debilitating circumstances. While cultivation is boundarised by the land, market need not have such bounds.

Agriculture is the largest enterprise in the country. An enterprise can survive only if it can grow consistently. And, growth is incumbent upon savings & investment, both of which are a function of positive net returns from the enterprise. The net returns determine the level of income of an entrepreneur, farmer in this case.

This explains the rationale behind adopting income enhancement approach to farmers' welfare. It is hoped, that the answer to agrarian challenges and realization of the aim of farmers' welfare lies in higher and steady incomes. It is in this context, that the Hon'ble Prime Minister shared the vision of doubling farmers' income with the nation at his Bareilly address on 28th February, 2016. Further, recognizing the urgent need for a quick and time-

bound transformation of the vision into reality, a time frame of six years (2016-17 to 2022-23) was delineated as the period for implementation of a new strategy.

At the basic level, agriculture when defined as an enterprise comprises two segments – production and post-production. The success of production as of now amounts to half success, and is therefore not sustainable. Recent agitations of farmers (June-July 2017) in certain parts of the country demanding higher prices on their produce following record output or scenes of farmers dumping tractor loads of tomatoes & onions onto the roads or emptying canisters of milk into drains exemplify neglect of other half segment of agriculture.

No nation can afford to compromise with its farming and farmers. And much less India, wherein the absolute number of households engaged in agriculture in 2011 (119 million) outpaced those in 1951 (70 million).Then, there are the landless agricultural labour who numbered 144.30 million in 2011 as against 27.30 million in 1951. The welfare of this elephantine size of India's population is predicated upon a robust agricultural growth strategy, that is guided by an income enhancement approach.

This Committee on Doubling Farmers' Income (DFI) draws its official members from various Ministries / Departments of Government of India, representing the panoply of the complexities that impact the agricultural system. Members drawn from the civil society with interest in agriculture and concern for the farmers were appointed by the Government as non-official members. The DFI Committee has co-opted more than 100 resource persons from across the country to help it in drafting the Report. These members hail from the world of research, academics, non-government organizations, farmers' organizations, professional associations, trade, industry, commerce, consultancy bodies, policy makers at central & state levels and many more of various domain strengths. Such a vast canvas as expected has brought in a kaleidoscope of knowledge, information, wisdom, experience, analysis and unconventionality to the treatment of the subject. The Committee over the last more than a year since its constitution vide Government O.M. No. 15-3/2016-FW dated 13th April, 2016 has held countless number of internal meetings, multiple stakeholder meetings, several conferences & workshops across the country and benefitted from many such deliberations organized by others, as also field visits. The call of the Hon'ble Prime Minister to double farmers' income has generated so much of positive buzz around the subject, that no day goes without someone calling on to make a presentation and share views on income doubling strategy. The Committee has been, therefore, lucky to be fed pro-bono service and advice. To help collage, analyse and interpret such a cornucopia of inputs, the Committee has adopted three institutes, namely, NIAP, NCAER and NCCD. The Committee recognizes the services of all these individuals, institutions & organisations and places on record their service.

Following the declaration of his vision, the Hon'ble Prime Minister also shaped it by articulating 'Seven Point Agenda', and these have offered the much needed hand holding to the DFI Committee.

The Committee has adopted a basic equation of Economics to draw up its strategy, which says that net return is a function of gross return minus the cost of production. This throws up three (3) variables, namely, productivity gains, reduction in cost of cultivation and remunerative price, on which the Committee has worked its strategy. In doing so, it has drawn lessons from the past and been influenced by the challenges of the present & the future.

In consequence, the strategy platform is built by the following four (4) concerns:

- Sustainability of production
- Monetisation of farmers' produce
- Re-strengthening of extension services
- Recognizing agriculture as an enterprise and enabling it to operate as such, by addressing various structural weaknesses.

Notwithstanding the many faces of challenges, India's agriculture has demonstrated remarkable progress. It has been principally a contribution of the biological scientists, supplemented by an incentivizing policy framework. This Committee recognizes their valuable service in the cause of the farmers. It is now time, and brooks no further delay, for the new breed of researchers & policy makers with expertise in post-production technology, organization and management to take over the baton from the biological scientists, and let the pressure off them. This will free the resources, as also time for the biological scientists to focus on new science and technology, that will shift production onto a higher trajectory - one that is defined by benchmark productivities & sustainability. However, henceforth both production & marketing shall march together hand in hand, unlike in the past when their role was thought to be sequential.

This Report is structured through 14 volumes and the layout, as the readers will appreciate, is a break from the past. It prioritizes post-production interventions inclusive of agri-logistics (Vol. III) and agricultural marketing (Vol-IV), as also sustainability issues (Vol-V & VI) over production strategy (Vol. VIII).The readers will, for sure value the layout format as they study the Report with keenness and diligence. And all other volumes including the one on Extension and ICT (Vol. XI), that connect the source and sink of technology and knowledge have been positioned along a particular logic.

The Committee benefited immensely from the DFI Strategy Report of NITI Aayog. Prof. Ramesh Chand identified seven sources of growth and estimated the desired rates of growth to achieve the target by 2022-23. The DFI Committee has relied upon these recommendations in its Report.

There is so much to explain, that not even the license of prose can capture adequately, all that needs to be said about the complexity & challenges of agriculture and the nuances of an appropriate strategy for realizing the vision of doubling farmers' income by the year of India's 75th Independence Day celebrations.

The Committee remains grateful to the Government for trusting it with such an onerous responsibility. The Committee has been working as per the sound advice and counsel of the Hon'ble Minister for Agriculture and Farmers' Welfare, Shri Radha Mohan Singh and Dr. S.K. Pattanayak, IAS, Secretary of the Department of Agriculture, Cooperation and Farmers' Welfare. It also hopes, that the Report will serve the purpose for which it was constituted.

12th August, 2017

Ashok Dalwai
Chairman, Committee on
Doubling Farmers' Income

About Volume I

The first volume of the Report of the Committee on Doubling Farmers' Income (DFI) intended to examine the growth trends in farmers' income since independence and analyse growth in associated support infrastructure (roads, electricity, irrigation, market yards, etc.). However, it is observed, that there has been no uniform methodology in the past to specifically ascertain farmers' incomes and comparable data benchmarks are thus not immediately available over long periods.

This data gap has been bridged through an analysis, that accessed various measures to infer the growth and included empirical assessments. The recent assessments by NITI Aayog and those from ICAR have been used. The need to develop a metric to monitor regularly and assess farmers' income in relation to farm output is suggested for good governance.

The evidence highlights lack of correspondence between growth in domestic production - measured as farm yield, and growth in income - a measure of monetisation of the yield. The variance could be a result of poor physical connectivity between farm and markets, low level of facilitation by the agricultural marketing system, poor resource use efficiency, inability of farmers to take risk to upsell into other markets, delay in transfer of technology from lab to farm, inherent impetus to foodgrain production vis-à-vis high value produce, inability of market structure to keep in step with production enhancements and the like. All these factors, that have been examined in this volume from a status perspective, have been addressed in the ensuing volumes of the DFI Report for resolution by suggesting suitable solutions.

Ashok Dalwai

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Doubling Farmers' Income

Volume I

"March of Agriculture since Independence and Growth Trends"

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Background

This chapter provides details of the overall performance of agriculture and allied activities and dynamics of the agricultural sector since India's independence. An overview of the structure and changes in the land holding pattern is put forth. Further, the pattern and shift of consumption preferences over time is described, to project demand of various food commodities in the near future.

1.1. Evolution of Indian Agriculture

India has been an agriculture based country. Though its share in the GDP has been declining, still a sizable population is dependent on agriculture for the livelihoods. Since this sector influences the lives of several people, attempts have been made since independence to evolve appropriate agricultural policy for producers' and consumers' welfare. It would be appropriate to examine whether agriculture can be a substantial source in the country's GDP in improving the farmers' incomes. Most of the price policies evolved so far on one hand aimed at remunerative prices for the producers as incentives for increased production and on other hand rational prices for the consumers.

The first ever commission was Royal commission (1928) constituted under the chairmanship of Linlithgow with the main aim to examine and report on the condition of agricultural and rural economy in British India and to make recommendations for agricultural improvement. The first ever committee "Food Grains Policy Committee of 1943" constituted under the chairmanship of Gregory (popularly known as Gregory Committee) was constituted mainly to focus on food availability, supplies, distribution and control price which was worsened due to the Second World War. The country faced severe food shortage problem due to lower yield levels and the problem of refugees immediately after attaining independence. Considering that, the Government appointed a committee under Thakurdas in 1947, which was also known as Foodgrain Policy Committee (1947). This committee was appointed to study the food distribution aspects, the main features of this policy were gradual withdrawal of control and removal restrictions on movements of food grains.

Subsequently various other committee like Maitra Committee (1950), Mehta Committee (1957), Venkatappaiah committee (1966) were constituted to enquire into food problems and solve the issues. The recommendations of these committees played important role in the formulation of agricultural policy subsequently.

The main policy measures in the agriculture sector were adopted in the mid-1960s. These included input minimum support prices, subsidies, public storage, procurement and distribution of food grains, and trade protection measures. During the 1960s and 1970s, widespread adoption of high yielding rice and wheat varieties occurred. The country also expanded irrigated areas, promoted increased use of chemical fertilizers and pesticides, and improved access to institutional credit. Together, all these initiatives led to considerable rise in agricultural production making India self-sufficient in food grain production at the national level.

The first comprehensive agricultural policy was brought out by National Commission on Agriculture (1976) under the chairmanship of Mr N.R. Mirdha with main thrust on production, land and water development by addressing the problems of soil and moisture conservation issues of water management. Ground water exploitation programmes were introduced for land reclamation, thrust was also on the development of animal products along with fisheries and forestry through development of animal husbandry. Development of subsidiary activities like poultry, piggery, sheep and goats were also given emphasis for increasing income. Further emphasis was also on research, education and training for promotion of agricultural and its application to field conditions. Along with the sectoral development, development of employment potential of agricultural sector was also a major concern. A committee chaired by Shri Bhanu Pratap Singh in 1990, made recommendations covering all major sectors of agricultural economy and provided the base for the first draft of agricultural policy resolution. Based on that, the first ever comprehensive National Agricultural Policy was introduced in 2000.

The National Commission on Farmers (NCF) was set up in 2004 which comprehensively studied the food situation covering mostly concerns regarding supplies for the public distribution system and the concerns related with production and productivity. Several recommendations were provided by the committee for the reforms in the Indian agriculture. Most of these recommendations were associated with land reforms, irrigation, efforts for productivity enhancement through increase in public investment in agriculture related infrastructure particularly in irrigation, drainage, land development, water conservation, research development and road connectivity. The committee also put emphasis on timely and adequate supply of credit to farmers along with the emphasis to improve food security through elimination of micronutrient deficiency and through an integrated food cum fortification approach.

However, for the first time in the history of Indian agriculture, a Committee has been set up for doubling of farmers' income in the country by 2022-23. The committee worked on holistic solutions and suggested the major reforms required in agriculture sector for fulfilling the mission of doubling. DFI Committee also considered and suggested the market reforms in a big way and increasing focus on sub-sectors of agriculture like animal husbandry, poultry and fisheries. The Committee has been holding consultations with different stakeholders, including the farmers, ICAR scientists, and professional bodies.

1.2. Trends in Agricultural Growth

Examination of the existing growth scenario becomes an essential condition for projecting the growth across various sub-sectors of agriculture. For this, the data of GDP along with value of production (VOP) of various sub-sectors and crop categories at 2004-05 prices were used. Chand and Shinoj (2012) estimated the moving decennial growth rates by fitting a semi-log trend to the smoothened data. The moving decennial growth rates were also computed in this study to examine the performance of various sub-sectors. The decennial

growth rates indicate remarkable growth 2004-05 onwards for all the sub-sectors, i.e. crop, livestock and fisheries.

Agriculture continues to be the source of livelihood for the majority of Indian population; the sector contributed about 13 per cent to the gross domestic product (GDP) of the country in 2014-15. The agricultural sector grew at the growth of around 4 per cent per year during 2004-05 to 2014-15 and the growth was quite impressive as compared to 2.6 per cent per annum during the previous decade (1995-96 to 2004-05). Chand (2014), opined that the most important factor for improved performance of agriculture, post 2004-05 period, has been the price received by the farmers caused by a number of underlying factors viz., hike given to MSP, increase in foodgrain procurement, increase in global agricultural prices and strong domestic demand for food. Maintaining such growth tempo is a virtuous challenge as the sector has multiplier effect on the entire economy. Though the industry and service sectors grew at a much higher rate during last two decades (during 1995-96 to 2004-05) (industry at 5.9 per cent and service at 7.9 per cent per annum) and 2004-05 to 2014-15 (industry at 7.9 per cent and service at 9.9 per cent per annum); agricultural sector was able to improve its rate of growth leading to reduction in the relative growth gap (Table 1.1). The agricultural exports also grew at an impressive rate of around 23 per cent during the recent decade.

Table 1.1 Movement of Indian Economy: Trends in GDP across Sectors

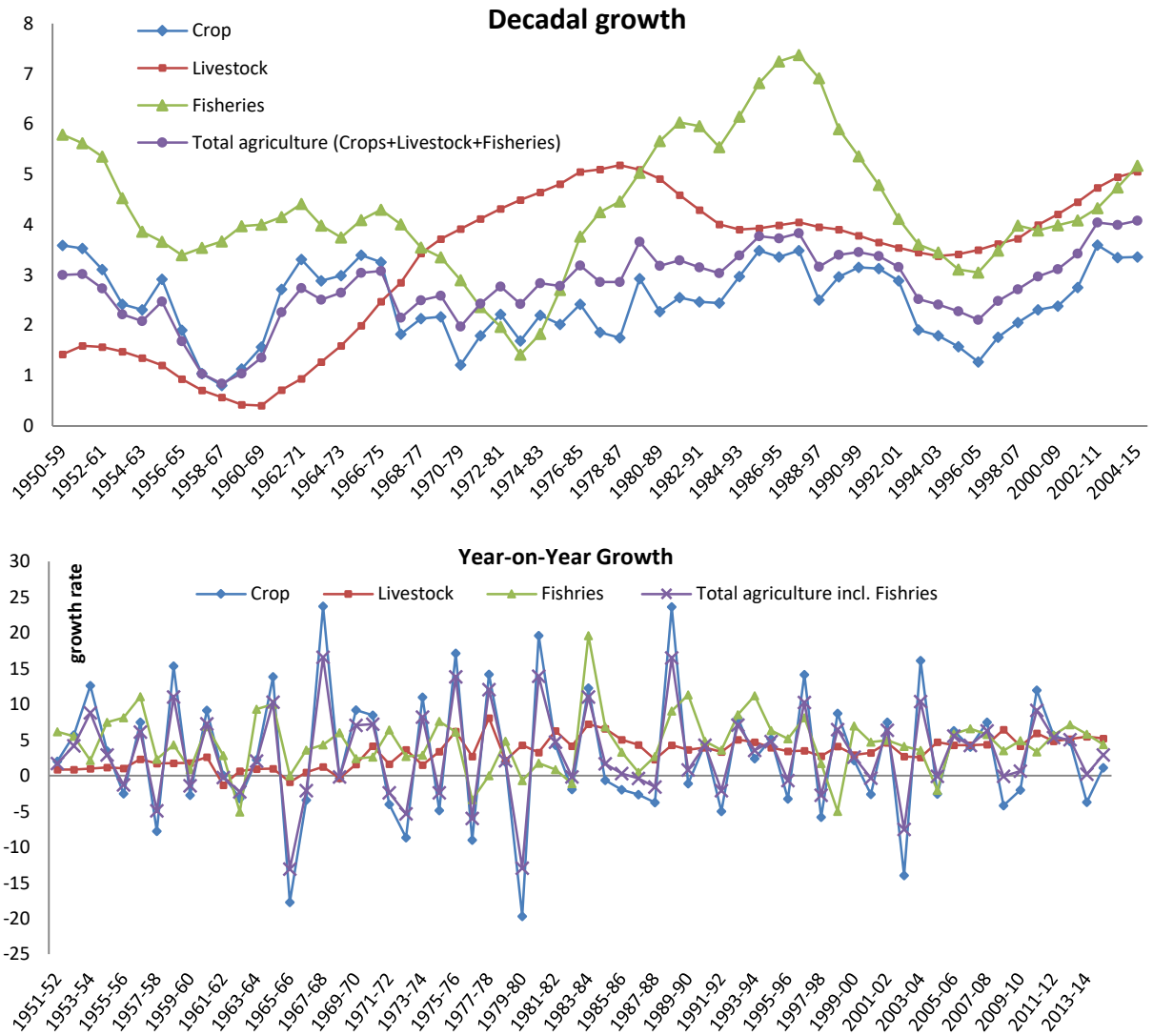
	1960-61/ 1968-69	1968-69/ 1975-76	1975-76/ 1988-89	1988-89/ 1995-96	1995-96/ 2004-05	2004-05/ 2014-15
Average GDP @2004-05 prices (Rs Billion)						
Agriculture & Allied Activities	2004	2401	3047	4116	5174	6911
Agriculture	1636	1955	2547	3473	4358	5771
Industry	725	1000	1676	2958	4773	9470
Services	1859	2517	4078	7286	13083	28991
Share of (%)						
Agriculture & Allied Activities	32.20	30.50	26.85	23.08	18.89	13.51
Agriculture	26.28	24.83	22.44	19.48	15.91	11.28
Industry	11.66	12.70	14.77	16.59	17.43	18.52
Services	29.86	31.98	35.94	40.86	47.77	56.69
GDP growth rate						
Agriculture & Allied Activities	1.04	2.24	2.47	2.76	2.28	3.72
Agriculture	0.70	2.19	2.74	2.69	2.23	3.88
Industry	5.05	3.92	5.53	5.90	4.87	8.44
Services	5.03	3.37	5.40	6.15	7.86	8.96

Source: DFI Committee Estimates

During the recent decade (2004-05 to 2014-15), crop, livestock and fisheries registered growth of 2.93, 6.11 and 5.13 per cent per annum, respectively (Fig 1.1). The pattern indicates that overall growth in agriculture moves parallel with the crop sector. The same is also confirmed from the year-on-year fluctuations in different sub-sectors. Livestock sector is growing at an appreciable and sustainable rate and is ahead among all sub-sectors. It is

remarkable to mention that livestock sector never attained a negative growth in any of the years during the span of last 34 years; the lowest growth rate attained in the sector was just one per cent in the year 2003-04. Thus, the livestock sector is likely to emerge as engine of growth of agricultural sector and can be relied upon for risk mitigation and minimizing the losses to the farmers in case of even worst outcomes from others sub-sectors. Previous studies have unanimously reported that livestock as the best insurance against agrarian distress as the sector is the source of sustained income and generates income more frequently than the crop sector.

Fig 1.1 Growth Rates in GDP across Sub-Sectors at 2004-05 Prices



Source: DFI Committee Estimates

Overall growth in agriculture moves parallel with the crop sector, which is also established from the year-on-year fluctuations in different sub-sectors. Livestock sector is growing at an appreciable and sustainable rate and is ahead among all sub-sectors. Livestock sector is likely to emerge as engine of growth of agricultural sector and can be relied upon for risk mitigation and minimizing the losses to the farmers in case of even worst outcomes from others sub-sectors.

Table 1.2 provides the existing growth rates for different crop categories based on VOP at 2004-05 prices. As far as the trajectory of growth across phase is concerned, it is evident that highest growth is observed during the recovery phase, i.e. 3.61 per cent per year during 2004-05 to 2014-15; the same is evident for almost all crop categories. Except floriculture, fruits & vegetables, condiments & spices and sugar, performance of all other crop categories was found to be decelerating and discouraging during the post-reform period (1995-96 to 2004-05).

Table 1.2 Historical Growth Rates of Crop Categories, Livestock and Fisheries in India, based on VOP at 2004-05 Prices

Crops	Pre-green revolution period (1960-61/ 1968-69)	Early green revolution period (1968-69/ 1975-76)	Wider technology dissemination (1975-76/ 1988-89)	Period of diversification (1988-89/ 1995-96)	Post-reform period (1995-96/ 2004-05)	Recovery period (2004-05/ 2014-15)
Paddy and wheat	1.53	2.49	3.34	2.20	0.40	2.40
Nutri-cereals	1.11	0.79	-0.29	-1.21	0.44	2.60
Pulses	-2.23	0.26	0.79	-0.86	0.22	2.63
Oilseeds	0.40	2.99	3.49	3.38	-0.78	1.45
Sugar	1.48	1.64	1.68	3.05	3.70	2.69
Cotton and Jute	-0.59	1.51	1.82	4.30	-0.31	5.35
Condiments & spices	0.65	3.62	4.24	3.24	4.95	5.58
Fruits & vegetables	5.44	5.16	3.08	4.07	3.38	4.85
Floriculture	4.60	5.70	3.41	5.29	10.15	6.44
All crops	1.14	2.15	2.57	2.04	1.78	3.10
Livestock	0.35	2.98	4.87	4.12	3.41	4.92
Fisheries	3.98	4.37	3.63	7.11	3.11	3.59
Overall	1.07	2.37	3.09	2.73	2.27	3.61

Source: DFI Committee Estimates

Livestock sector's performance was found to be the best during the recovery phase. Pulses achieved a growth of 2.63 per cent during the recovery phase. Fibres, condiments & spices, fruits & vegetables, floriculture performed quite well during 2004-05 to 2014-15 in the crop category. As reported, the important reason behind good performance of agricultural and allied sectors in recovery phase was remunerative price received by farmers which further encouraged production. Efforts are required at all stakeholder levels to maintain the production incentive of farmers. Improved marketing arrangements and innovations would help enhance the farmers' share in consumer rupees.

1.3. Area and Value Shares of Various Categories

Table 1.3 provides the insight of area share of different crop categories to gross cropped area (GCA) over the period of time. The period has been categorized into six phases namely Pre-green revolution period (PGR)–1960-61 to 1968-69, Early green revolution period (EGR)–1968-69 to 1975-76, Period of wider technology dissemination (WTD)–1975-76 to 1988-89, Period of diversification (DIV)–1988-89 to 1995-96, Post-reform period (PR)–1995-96 to 2004-05 and Period of recovery (REC)–2004-05 to 2010-11 as delineated by Chand and Parappurathu (2012). We have extended the recovery period up to

2014-15. The area under almost all the major crops has increased over the time period with exception of nutri-cereals and pulses, (The category of coarse cereals is now emerging as important for assured health benefits are termed as nutri-cereals now onwards. Maize, fingermillets, pearl-millets, sorghum and other small millets are covered in the category of nutri-cereals) wherein percentage area under the two crop categories has marginally declined in recovery period as compared to pre-green revolution period (Table 1.3). A continuous and significant increase in share of area to GCA under fruits and vegetables indicates that importance of these farm commodities have significantly increased at both producer as well as consumer levels. Short duration nature and growing market for horticulture crops along with quicker cash inflow from these crops are important reasons to be mentioned that have led the farmers to grow more fruits and vegetables.

Table 1.3 Area Share of Crop Categories to Gross Cropped Area (GCA)

Crops	Pre-green revolution period (1960-61/ 1968-69)	Early green revolution period (1968-69/ 1975-76)	Wider technology dissemination (1975-76/ 1988-89)	Period of diversification (1988-89/ 1995-96)	Post-reform period (1995-96/ 2004-05)	Recovery period (2004-05/ 2014-15)
Paddy and wheat	31.34	33.99	36.04	36.12	37.21	37.27
Nutri-Cereals	25.52	21.24	19.79	15.28	14.00	12.67
Pulses	14.73	13.54	13.28	12.41	11.80	12.18
Oilseeds	9.48	9.85	10.52	13.39	13.16	13.87
Sugar	1.53	1.44	1.74	1.83	2.07	2.25
Cotton and jute	5.75	5.23	4.97	4.70	5.17	5.87
Condiments & spices	1.01	1.04	1.23	1.37	1.68	1.46
Fruits & vegetables	1.90	2.27	2.96	3.68	4.37	6.48
Other crops	8.75	11.40	9.48	11.22	10.54	7.95

Source: DFI Committee Estimates

Rice and wheat still occupy more than 1/3rd share in the cropping pattern. The share of nutri-cereals has gone down substantially during last more than five decades. The signals in favour of orientation towards high value crops are clearly evident as area share of fruits and vegetables has expanded overtime.

As far as value share to total VOP is concerned, it was after early green revolution period that the decline was more pronounced in case of nutri-cereals and pulses (Table 1.4), where it declined from around 7 per cent in pre green revolution period to less than 3 per cent during recovery period.

There is a clear shift from food-grains towards fruits and vegetables, livestock products and fisheries. Due to shift in demand pattern, the farmers have also responded to market signals and gradually shifting production-mix to meet the growing demand for these commodities as indicated by increasing value share of these items over the period of time in the same table. Based on these trends it can be expected that increasing demand of high value

commodities like fruits and vegetables, livestock products and fisheries in coming years could be tapped by shift in policy focus as well as investment towards allied sectors for improving productivity, quality and efficiency.

Table 1.4 Value share of Crop categories, Livestock & Fisheries to Total VOP at 2004-05 Prices

Crops	Pre-green revolution period (1960-61/ 1968-69)	Early green revolution period (1968-69/ 1975-76)	Wider technology dissemination (1975-76/ 1988-89)	Period of diversification (1988-89/ 1995-96)	Post-reform period (1995-96/ 2004-05)	Recovery period (2004-05/ 2014-15)
Paddy & wheat	18.15	20.22	21.23	21.80	19.88	17.87
Nutri-cereals	6.90	6.25	4.97	3.85	3.02	2.74
Pulses	7.25	6.06	4.97	4.08	3.33	2.97
Oilseeds	7.07	6.93	6.33	7.84	6.82	6.71
Sugars	4.52	4.57	4.14	4.15	4.73	4.50
Cotton and Jute	2.88	2.60	2.38	2.55	2.28	3.34
Condiments & Spices	1.66	1.59	1.72	1.88	2.15	2.61
Fruits & Vegetables	10.56	13.92	14.67	14.13	16.80	18.80
Floriculture	0.25	0.35	0.37	0.36	0.61	0.93
All crops	77.14	78.20	75.36	72.19	70.01	69.58
Livestock	20.01	18.59	21.38	23.74	25.28	25.78
Fisheries	2.85	3.21	3.26	4.08	4.72	4.65

Source: DFI Committee Estimates

The value shares present a little contrasting picture as far as the value shares of paddy and wheat are concerned; the share has declined overtime despite increase in area, technological advancements resulting in productivity improvement along with the increasing price trends. The value shares of fruits and vegetables have increased substantially on account of significant area expansion, productivity improvements along with increase in prices (though being highly volatile).

1.4. Trends in Agricultural Trade

Contrary to the overall trade, India has always been a net exporter in case of agriculture despite the initial phases of attaining self-sufficiency in most of the commodities. The exports of agricultural commodities picked after 1970-71; however, a kick start was attained only after 1994-95 with launch of global trade reforms and trade integration with establishment of World Trade Organization.

Over the last 25 years since India's liberalisation, its foreign trade has expanded multi-fold and seen significant structural shifts in product as well as geographic composition. Liberalisation in trade policies related to easing of several trade restrictions, reduction in tariff levels across different products along with other trade reforms have assisted the growth of foreign trade especially in the first two decades post liberalization.

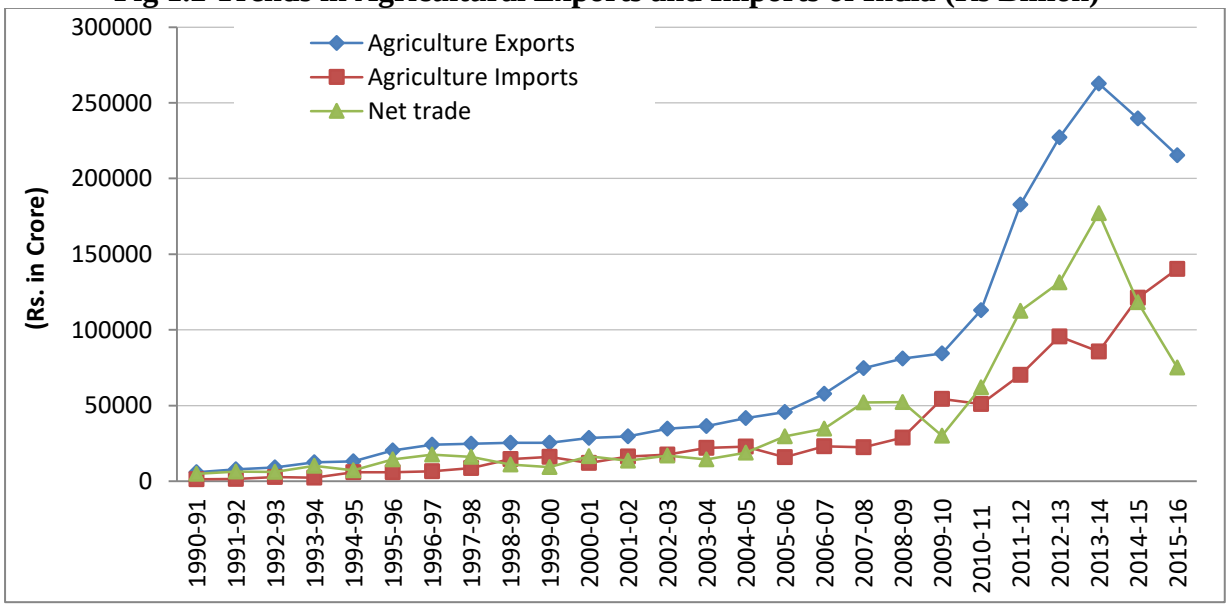
India's aggregate national exports have increased from Rs 0.32 lakh crores in 1990-91 to Rs 17.16 lakh crores in 2015-16, whereas overall imports have also enhanced from Rs 0.43 lakh crores in 1990-91 to Rs 24.90 lakh crore in 2015-16 (Table 1.5 and Fig 1.2). The composition of exports has gone substantial changes since liberalization. There is a structural shift in India's exports, away from primary, agricultural and traditional exports like textiles towards more value added manufactured and technology-based items such as engineering goods, refinery products, pharmaceuticals, etc. Overall, India's export basket is now diversified with non-traditional items and differential products are also gaining importance.

Table 1.5 Patterns and Contribution of Agricultural Trade from India

Years	Agriculture Exports (Rs. Crore)	Total National Exports (Rs. Crore)	Agriculture Exports to Total Exports **(%)**	Agriculture Imports (Rs.Crore)	Total National Imports (Rs.Crore)	Agriculture Imports to Total National Imports **(%)**	Net Overall Trade **(Rs crore)**	Net Agricultural Trade **(Rs crore)**
1990-91	6013	32527	18.49	1206	43171	2.79	-10644	4807
1995-96	20398	106353	19.18	5890	122678	4.8	-16325	14508
2000-01	28657	201356	14.23	12086	228307	5.29	-26950	16571
2005-06	45711	456418	10.78	15978	660409	3.26	-203991	29733
2010-11	113047	1136964	10.28	51074	1683467	3.41	-546503	61973
2015-16	215396	1716378	12.55	140289	2490298	5.63	-773920	75107

Source: DFI Committee Estimates based on data available in Agricultural Statistics at a Glance various issues

Fig 1.2 Trends in Agricultural Exports and Imports of India (Rs Billion)



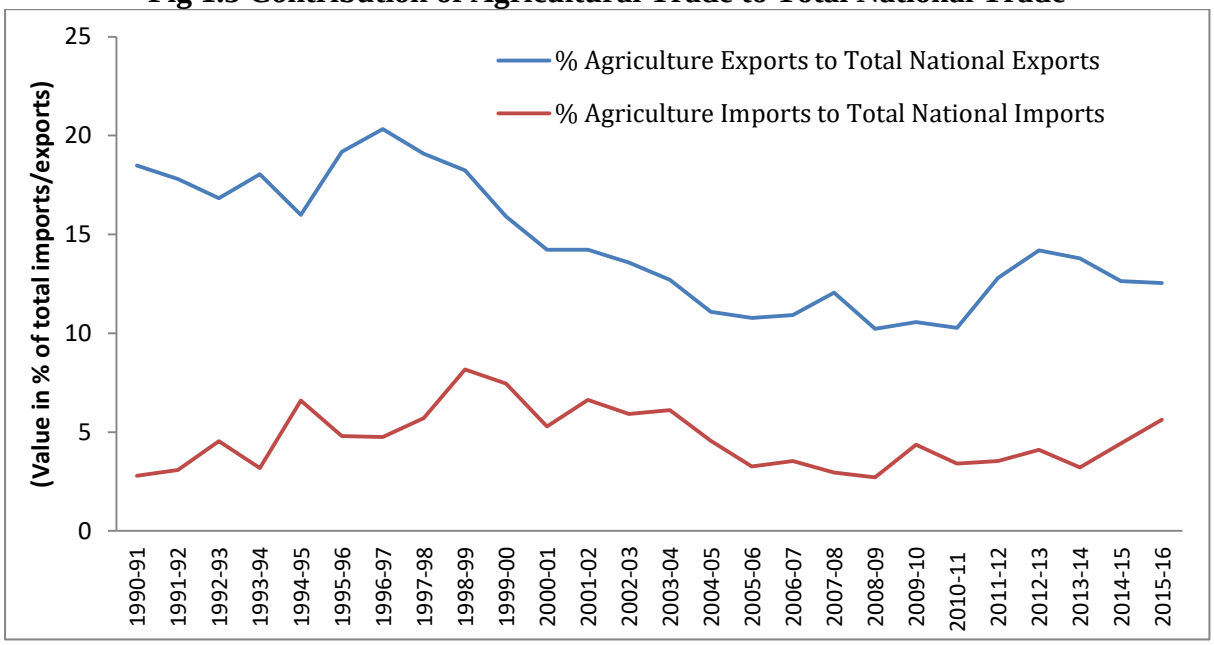
Source: Agricultural Statistics at a Glance, various issues

Agricultural exports and imports have also increased considerably during the last 25 years. Since the year 2000-01 there can be seen marked surge both in the export and import of agricultural commodities. However, since 2013-14 there is deceleration in India's net agricultural trade, primarily because of decline in the exports of agricultural commodities.

Fig. 1.3 shows the trend of agricultural exports and imports in context of overall exports to imports from India. Though the absolute agricultural trade has expanded, the share of both

the agricultural imports and exports have declined considerably in the overall trade during the last 25 years as the share of manufactured and other value added products have expanded.

Fig 1.3 Contribution of Agricultural Trade to Total National Trade



Source: DFI Committee

1.5. Prices Paid and Prices Received

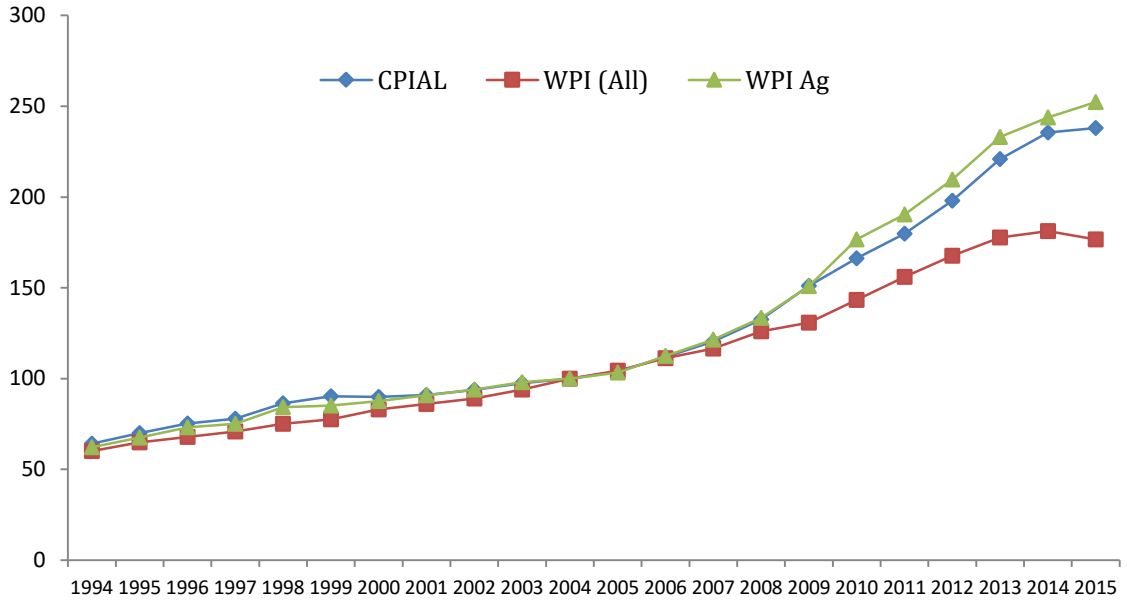
Prices determine the farmers' welfare and influence the welfare cycle on both the ways. The wholesale price indices (WPI) for agricultural commodities may be considered as representative index for the prices received by the farmers. Increase in the prices received will escalate the value of output even if the physical output remains the same.

On the other hand, changes in the consumer price index (CPI) will reflect the changes in overall expenditure and determine the cost of living. For ensuring the farmers' welfare, WPI should increase more than CPI to have a positive impact on the farmers' welfare.

CPI and WPI may diverge from each other due to many inherent problems, one, they do not follow a common base, WPI is currently available at 2004-05 base whereas CPIAL is available at 1986-87 base; second, the compositional weights vary a lot between the two series. Fig 1.4 exhibits the changes in WPI Ag, WPI (all commodities) and CPI over last 22 years. The WPI Ag index is not published by the Office of Economic Adviser; it has been derived by deducting the index of minerals (after adjustment with the category weight) from the WPI index of primary commodities.

It is noticed that the spread between the three indices remained almost stagnant till 2004-05. However, the gap expanded after 2004-05, and WPI Ag and CPI have increased at a higher rate.

Fig 1.4 Movements in Consumer Price Index and Wholesale Price Index



Source: DFI Committee Estimates based on WPI data from Office of Economic Advisor data and CPI from RBI

Prominent increase has been noticed in case of prices of agricultural commodities, such increase often leads to the inflationary situation in food commodities and affect overall well-being. This happened in the face of growing production (supply). The monthly and weekly WPI data for selected agricultural commodities exhibit severe volatility and affects the farmers' welfare.

1.6. Dependence on Agriculture

The dependence on agriculture can be assured from the fact that how many workers in the form of cultivators and agricultural labourers are employed in agriculture. Such data on agricultural workers are available in population census on decadal bases. Besides, the National Sample Survey Office (NSSO) conducts survey on employment and unemployment on quinquennial basis. Even the broad signals from the two contradict with each other.

Table 1.6 presents the data on agricultural workers in the economy except between 1971 a continuous increase has been noticed in total workers engaged in agriculture. However, the number of cultivators declined during 2001 and 2011.

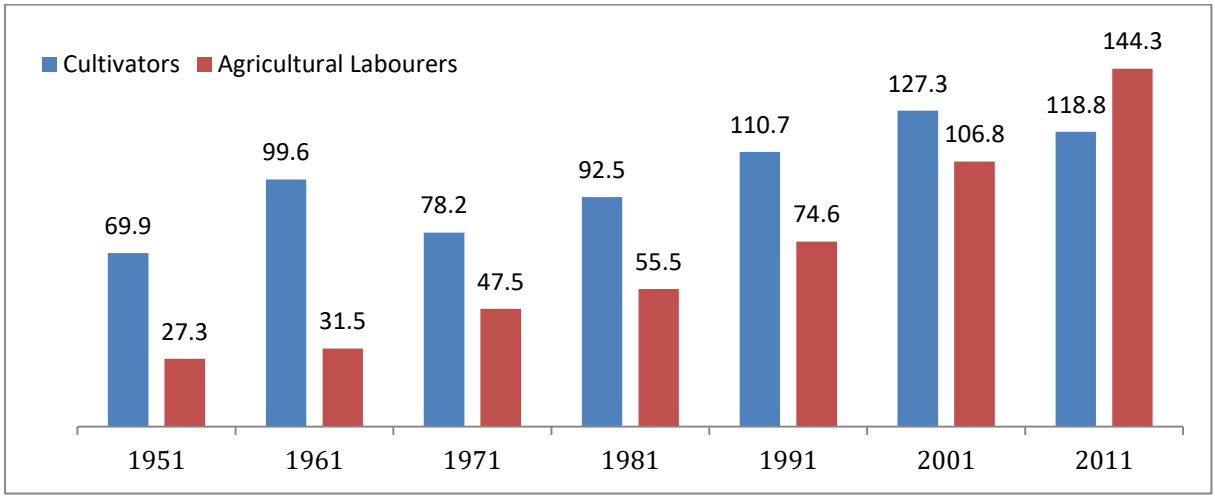
The number of agricultural labourers increased from 107 million to 144 million. Contrary to this, the numbers of agricultural labourers declined from 92.7 million in 2004-05 to 78.2 million in 2011-12 indicating that every year around 22 lakh agricultural labourers have left the sector. At the same time, the number of cultivators declined at the rate of 1.80 per cent per year during 2004-05 to 2011-12 as per NSSO survey on employment and unemployment. After 1967-71, the recent decade witnessed the negative growth in the number of cultivators engaged in agriculture (Fig 1.6), which indicates that people are moving away out of farming.

Table 1.6 Total number of workers and share of cultivators and agriculture labourers

Year	Total Workers	Agricultural Workers			Share in total workers		
		Cultivators	Agricultural Labourers	Total	Share of cultivators in total workers	Share of agriculture labour to total worker	share of agriculture workers in total worker
1951	139.5	69.9	27.3	97.2	50.11	19.57	69.68
1961	188.7	99.6	31.5	131.1	52.78	16.69	69.48
1971	180.4	78.2	47.5	125.7	43.35	26.33	69.68
1981	244.6	92.5	55.5	148	37.82	22.69	60.51
1991	314.1	110.7	74.6	185.3	35.24	23.75	58.99
2001	402.2	127.3	106.8	234.1	31.65	26.55	58.20
2011	481.9	118.8	144.3	263.1	24.65	29.94	54.60

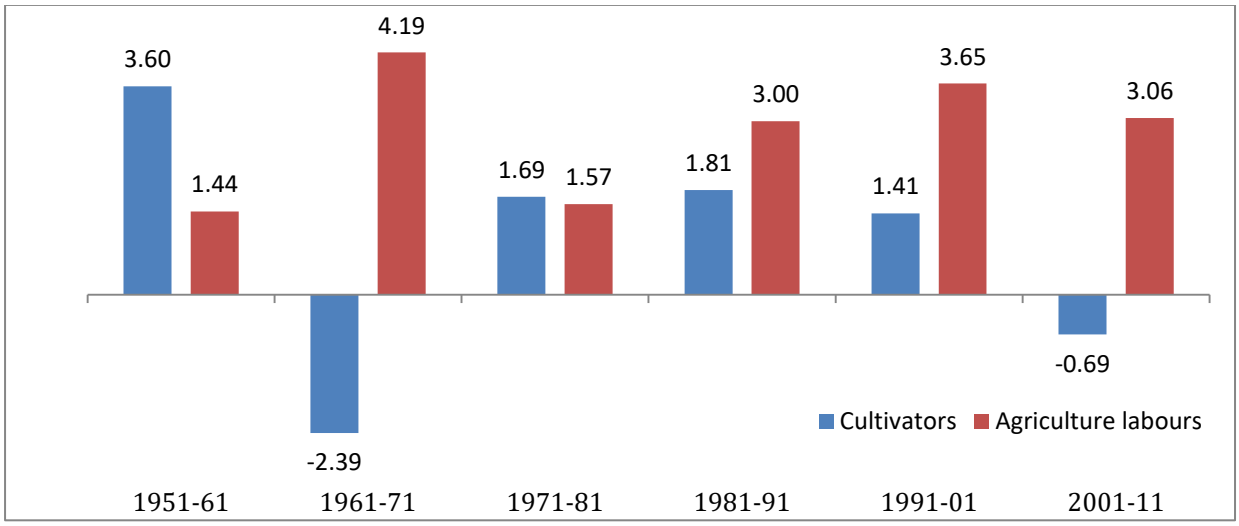
Source: Agricultural Statistics at a Glance various issues

Fig 1.5 Number of cultivators and agricultural labours in India (million)



Source: Agricultural Statistics at a Glance various issues

Fig 1.6 Compound annual growth rate of cultivators and agriculture labour



Source: DFI Committee Estimates

The available data from population census as well as NSSO clearly indicate that the interest of farming community in agriculture is declining and consequently the agricultural workers

self-employed in agriculture are leaving the industry. This reported shift is good provided the workers, who left the sector, are productively and gainfully employed in alternate sectors/industries. If such shift continues the aggregate output from the sector would be shared among lesser number of persons engaged as cultivator in agriculture and indicate enhanced gains to those who continue to work in agriculture.

1.7. Changes in Agrarian Structure

Between 1995-96 and 2010-11, the average farm size declined from 1.41 ha to 1.15 ha. Smallholders now cultivate 42 per cent of operated land and constitute 83 per cent of total landholdings (Table 1.7). This increase is most prominent in the case of marginal and small farms. However, a decline in the number of holdings with medium and large farms is noticed over the period which is a matter of concern. Fragmented and scattered holdings (as is the case of most of the marginal and small farms in India) do not allow better utilization of farm resources and technology adoption by the farmers as a result reduces the productivity. Moreover, this also hinders diversification process which is considered a key in enhancing the income of farmers.

Table 1.7 Number and Average Size of Land Holding Across Land Size Classes

	1995-96		2000-01		2005-06		2010-11	
	Average Size of Holding (ha)	**No. of Holdings (000)**	**Average Size of Holding (ha)**	**No. of Holdings (000)**	**Average Size of Holding (ha)**	**No. of Holdings (000)**	**Average Size of Holding (ha)**	**No. of Holdings (000)**
Below 0.5	0.24	48127	0.24	51254	0.23	57675	0.24	64679
0.5-1.0	0.72	23052	0.72	24154	0.71	26019	0.73	28147
1.0-2.0	1.42	21643	1.42	22695	1.38	23930	1.42	24779
2.0-3.0	2.4	9628	2.39	9549	2.36	9684	2.4	9649
3.0-4.0	3.42	4633	3.43	4472	3.38	4443	3.42	4247
4.0-5.0	4.43	2809	4.42	2627	4.38	2577	4.43	2431
5.0-7.5	6.03	3028	6.03	2829	5.97	2738	6.03	2511
7.5-10.0	8.52	1255	8.51	1122	8.45	1060	8.5	933
10.0-20.0	13.21	1142	13.16	1005	12.99	896	13.13	799
20.0 above	34.57	262	34.78	226	35.43	200	36.94	174
All classes	1.41	115580	1.33	119931	1.23	129222	1.15	138348

Source: Agricultural Census

1.7.1. Number of Holding across States

The state wise patterns of change in land holding do not exhibit significant change within a given category, except the large farm category in a few states like West Bengal, North-Eastern States and Kerala.

In most of the states, number of holding have increased in 2010-11 from 2000-01 with Bihar showing highest increase in 2010-11 as compared to 2000-01.

Other states like Uttar Pradesh, AP, Maharashtra, Rajasthan and Karnataka have also noted an increase in number of holdings; however they have not registered a sizable increase. In case of north eastern states and union territories,

Tripura has noted a highest increase from 2000-01 to 2010-11, which was followed by Nagaland. Minor increase was seen in rest of the states and union territories. However Daman & Diu, Delhi, Meghalaya and Puducherry were among some that have reported a decline in number of holding in the period.

It is clearly evident that small and marginal farmers with around 85 per cent share still dominate in number of holdings at national level.

The scenario is same across states except for Nagaland where majority of the farmers falls in medium and semi-medium category. As far as number of holdings within state is concerned, Kerala topped the list in halving highest number of small and marginal farmers (box 1.3).

1.7.2. Average Size of Holdings across States and Size Classes

Between 2000-01 and 2010-11 overall the average size of holdings has declined from 1.3 ha to 1.2 ha (Table 1.8). However, among the size classes of farmers the average size of holding have shown an increase, except in case of small farmers where it has remained constant in the period.

A sizeable increase in case of marginal, small and semi-medium farms was noted in case of Odisha where all farms have shown an increase.

An in-depth analysis of Table 1.8 brings out an interesting fact that average land holding size under large farm category was quite high in few states/UTs like West Bengal, Assam, Tripura, Kerala and A & N Islands in both the periods as compared to other states owing to the large size of institutional holdings in few districts of these states. For example, in West Bengal institutional land holding size under large farm category size was more than 500 hectares in Darjeeling and Jalpaiguri districts in the year 2010-11.

Likewise the landholding size under large farm size category was high in Wayand, Kollam, Idukki districts of Kerala, and in Hailakandi, Odalguri, Kokrajhar & Golapara districts of Assam.

Interestingly, land holding size under the same category exhibited notable change from the period 2000/01 -2010/11 in these states mainly because of change in size of institutional holdings over the period.

Table 1.8 Average Size of Land Holding Cross States and Size Classes (Hectares)

	Marginal (<1 ha)		Small (1-2 ha)		Semi-Medium (2-4 ha)		Medium (4-10 ha)		Large (>10 ha)		All Holdings	
State/UT	**2000-01**	**2010-11**	**2000-01**	**2010-11**	**2000-01**	**2010-11**	**2000-01**	**2010-11**	**2000-01**	**2010-11**	**2000-01**	**2010-11**
All Major States												
Andhra Pradesh	0.4	0.4	1.4	1.4	2.7	2.6	5.7	5.6	16.3	15.5	1.3	1.1
Bihar	0.3	0.3	1.2	1.3	2.6	2.6	5.2	5.1	15.5	14.5	0.6	0.4
Chhattisgarh	0.4	0.4	1.4	1.4	2.8	2.7	5.9	5.7	12	16.3	1.4	1.4
Goa	0.3	0.5	1.3	1.8	2.6	2.9	5.6	6.2	23.8	24.2	0.8	1.1
Gujarat	0.5	0.5	1.5	1.5	2.8	2.8	5.8	5.7	16.9	20.9	2.3	2
Haryana	0.5	0.5	1.4	1.5	2.8	2.9	6	6.1	16.5	18	2.3	2.3
Himachal Pradesh	0.4	0.4	1.4	1.4	2.7	2.7	5.7	5.7	15.9	15.5	1.1	1
Jammu & Kashmir	0.4	0.4	1.4	1.4	2.7	2.7	5.4	5.4	21.1	22.3	0.7	0.6
Jharkhand		0.4		1.4		2.7		5.6		15.4		1.2
Karnataka	0.5	0.5	1.4	1.4	2.7	2.7	5.8	5.7	14.8	14.7	1.7	1.6
Kerala	0.1	0.1	1.3	1.6	2.5	2.8	5.3	5.3	40.9	64.6	0.2	0.2
Madhya Pradesh	0.5	0.5	1.5	1.4	2.8	2.7	5.9	5.8	15.5	15.8	2.2	1.8
Maharashtra	0.5	0.5	1.4	1.4	2.7	2.7	5.6	5.6	15.4	16	1.7	1.4
Odisha	0.5	0.6	1.4	1.6	2.7	3	5.6	6	16.5	23.7	1.3	1
Punjab	0.6	0.6	1.4	1.4	2.7	2.6	5.8	5.7	15.1	14.8	4	3.8
Rajasthan	0.5	0.5	1.4	1.4	2.9	2.8	6.2	6.1	18.2	17.5	3.7	3.1
Tamil Nadu	0.4	0.4	1.4	1.4	2.7	2.7	5.7	5.6	19.5	20.1	0.9	0.8
Uttar Pradesh	0.4	0.4	1.4	1.4	2.7	2.7	5.5	5.5	25.1	15	1	0.8
Uttarakhand	0.4	0.4	1.4	1.4	2.7	2.7	5.6	5.5	15.1	23.1	0.8	0.9
West Bengal	0.5	0.5	1.6	1.6	2.8	2.7	5.1	4.9	279	316.2	0.8	0.8
North-Eastern/Hill states												
Tripura	0.3	0.3	1.4	1.4	2.6	2.5	5.2	5.1	78.8	14.3	0.6	0.5
Arunachal Pradesh	0.5	0.6	1.3	1.3	2.7	2.8	5.8	5.5	16.1	14.9	3.7	3.5
Assam	0.4	0.4	1.3	1.4	2.7	2.7	5.2	5.2	53	68.1	1.2	1.1
Manipur	0.5	0.5	1.3	1.3	2.5	2.5	4.9	4.9	11.4	11	1.2	1.1
Meghalaya	0.6	0.5	1.5	1.3	2.6	2.8	5.4	5.7	13.1	16.5	1.3	1.4
Mizoram	0.6	0.6	1.3	1.3	2.3	2.4	4.8	5.1	13.1	15.1	1.2	1.1
Nagaland	0.5	0.5	1.2	1.1	2.6	2.6	6.2	6.2	15.8	17.6	7.3	6
Sikkim	0.4	0.4	1.4	1.2	2.7	2.5	5.8	5.4	20.7	15.8	1.6	1.4
UTs												
A & N Islands	0.4	0.4	1.4	1.4	2.5	2.6	4.3	4.3	46.8	36.9	2	1.9
Chandigarh	0.4	0.5	1.4	1.4	2.7	2.9	5.8	5.7	16.5	11.1	1.6	1.3
Dadar& Nagar Haveli	0.5	0.5	1.3	1.4	2.8	2.8	5.8	5.7	16	15.5	1.5	1.4
Daman & Diu	0.3	0.2	1.4	1.4	2.6	2.6	5.9	6.3	20.3	20	0.6	0.4
Delhi	0.4	0.4	1.4	1.3	2.9	2.7	5.8	5.6	15.3	15.1	1.5	1.5
Lakshadweep	0.2	0.2	1.3	1.4	2.6	2.5	5.5	6.1	22.3	24	0.3	0.3
Puducherry	0.3	0.4	1.4	1.5	2.7	2.9	5.7	5.7	19.5	16.9	0.7	0.7
Total	**0.2**	**0.4**	**1.4**	**1.4**	**2.4**	**2.7**	**4.4**	**5.8**	**13.2**	**17.4**	**1.3**	**1.2**

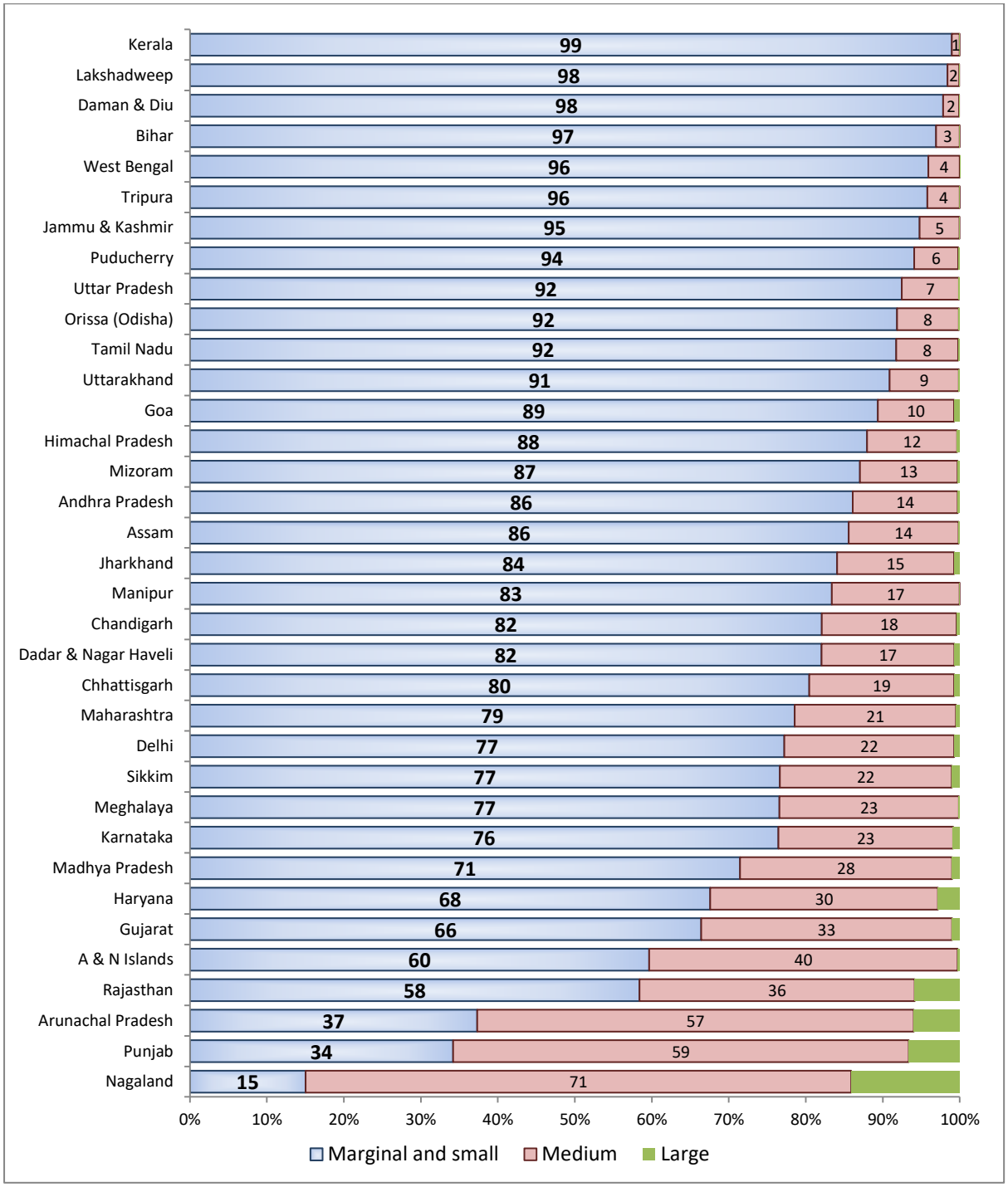
Source: Agricultural Census, various issues

Table 1.9 Number of Holding across State by Size Group in 2010-11 (No. in '000)

	Marginal	Small	Semi-Medium	Medium	Large	All Holding
All Major States						
Andhra Pradesh	8425	2918	1399	397	36	13175
Bihar	14744	948	415	81	3	16191
Chhattisgarh	2183	831	503	202	28	3746
Goa	60	10	6	2	1	78
Gujarat	1816	1429	1080	513	49	4886
Haryana	778	315	284	195	46	1617
Himachal Pradesh	670	175	85	28	3	961
Jammu & Kashmir	1207	167	64	11	1	1449
Jharkhand	1848	429	283	129	20	2709
Karnataka	3849	2138	1267	511	68	7832
Kerala	6580	180	57	12	2	6831
Madhya Pradesh	3891	2449	1655	789	89	8872
Maharashtra	6709	4052	2159	711	68	13699
Odisha	3368	919	311	64	6	4667
Punjab	164	195	325	298	70	1053
Rajasthan	2512	1511	1335	1127	404	6888
Tamil Nadu	6267	1181	502	151	17	8118
Uttar Pradesh	18532	3035	1334	398	25	23325
Uttarakhand	672	157	65	17	1	913
West Bengal	5853	980	267	23	1	7123
North-Eastern/Hill States						
Tripura	499	55	22	3	0	578
Arunachal Pradesh	21	19	34	28	7	109
Assam	1831	497	304	85	4	2720
Manipur	77	49	22	3	0	151
Meghalaya	103	58	41	8	0	210
Mizoram	50	30	10	2	0	92
Nagaland	6	20	48	78	25	178
Sikkim	40	17	11	6	1	75
UTs						
A & N Islands	5	2	3	2	0	12
Chandigarh	0	0	0	0	0	1
Dadar & Nagar Haveli	8	4	2	1	0	15
Daman & Diu	8	0	0	0	0	8
Delhi	11	5	3	2	0	20
Lakshadweep	10	0	0	0	0	10
Puducherry	28	3	1	0	0	33
All India	92826	24779	13896	5875	973	138348

Source: Agricultural census
Note: Figures are rounded off

Fig 1.7 Share of Farm Size Classes to Total Number of Holdings across States (2010-11)



Source: DFI Committee DFI Committee Estimates based on Agricultural Census, states have been sorted according to the share of marginal and small farms in all categories

The smallholders (including marginal farmer also) dominate the scene of Indian agriculture. The situation is found to be worst in states like Kerala, Bihar, West Bengal, J&K, Uttar Pradesh, Odisha, Tamil Nadu, Uttarakhand along with few NE states and UTs where the share of smallholders is found to be more than 90 per cent. Out of these, states like Bihar, West Bengal and Uttar Pradesh have higher shares of geographical pockets with lowest incomes in the country. These areas need more inclusive approach and package considering the situation of smallholders.

States like Punjab, Rajasthan Gujarat and Haryana along with few NE states and UTs have higher concentration of medium and large farms as compared to other states.

A study by Chand et al. (2011) indicates that lower the size of holding, higher was the use of inputs, crop intensity and coverage under HYVs, reflecting technology. Obviously, the greater use of these factors would result in higher productivity, and those farm categories with the higher value of these factors are also expected to realise higher productivity.

The results indicated that land productivity was inversely related to farm size class. The study concluded that agriculture productivity in marginal and smallholdings was found to be much higher than the average productivity for all size categories, however, per capita output is low on smallholdings despite higher productivity due to lower per capita availability of land.

1.8. Pattern and Shift in Consumption Expenditure

An increasing trend towards non-food expenditure is clearly visible and one would expect the trend to continue in near future. Over the past two decades, share of food in total expenditure has fallen in rural India, roughly from two-third to one-half, signalling a clear shift in expenditure behaviour.

The physical consumption quantities display consistent decline in cereals in both rural and urban India, and the declining trend holds true for pulses as well. Rather, one could observe rapid improvements in consumption of allied agricultural products, especially in urban India. Thus, a shift towards consuming staple crops and pulses to allied agricultural products could be observed in physical as well as in value terms.

Around 15 per cent of expenditure budget has shifted towards non-food expenditure. Especially, expenditure on durable goods has more than doubled, from 2.7 per cent in 1993-94 to 6.3 per cent in 2011-12 (Table 1.10).

While expenditure on fuel, light and other items have also registered consistent and marginal improvements, doubling expenditure on durable goods can be appreciated as it reflects household welfare. A more than 9 per cent increase in expenditure on other goods and services also indicate increasing preference towards non-food than the food.

One would view these changes in line with Engel's law, implying an improvement in rural living standard. By 2011-12, while difference in food and non-food expenditure shares is roughly equal in rural India, it was more than 20 per cent in urban India.

Among food groups, expenses on cereals have halved in both rural and urban India, from 24 to 12 per cent, and 14 to 7 per cent between 1993-94 and 2011-12.

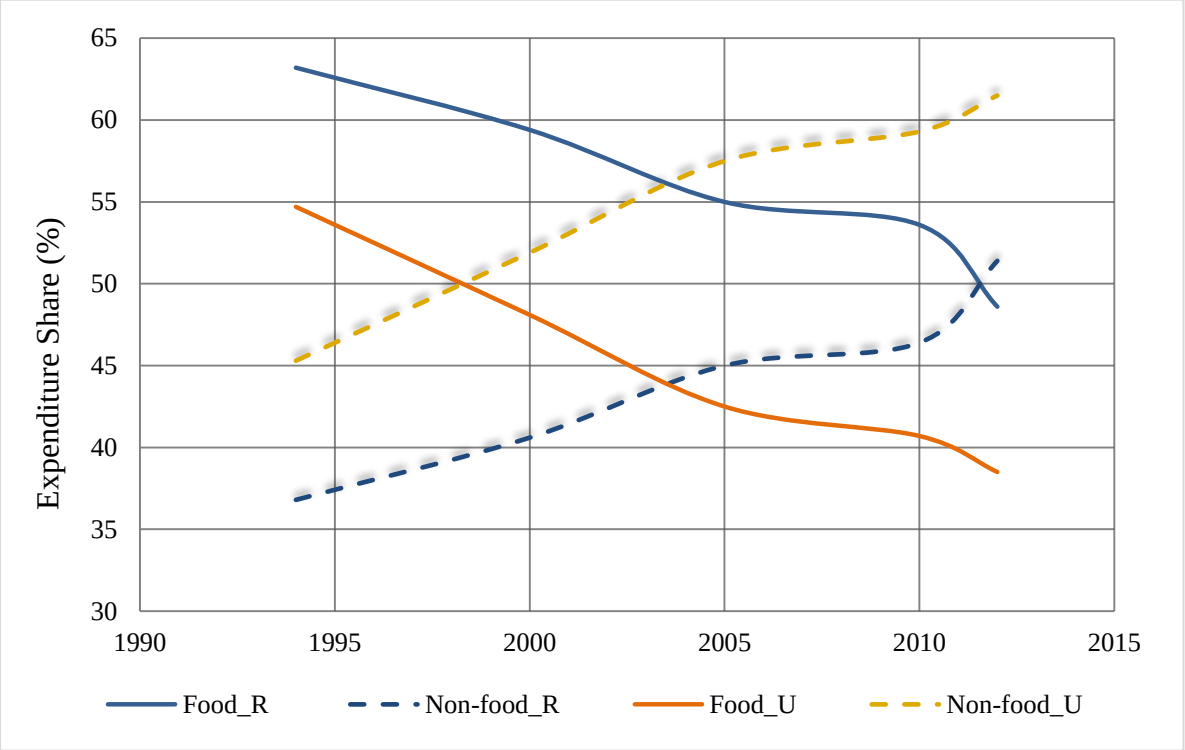
Table 1.10 Trends and Patterns in Consumption

Item group	Share in total consumption expenditure (per cent)									
	Rural					Urban				
	1993-94	1999-00	2004-05	2009-10	2011-12	1993-94	1999-00	2004-05	2009-10	2011-12
Consumption pattern of major items (Per person per month)										
Cereals (Kg)	13.4	12.72	12.12	11.35	11.22	10.6	10.42	9.94	9.37	9.28
Pulses (Kg)	0.76	0.84	0.71	0.65	0.78	0.86	1.00	0.82	0.79	0.90
Milk (Litre)	3.94	3.79	3.87	4.12	4.33	4.89	5.10	5.11	5.36	5.42
Egg (Number)	0.64	1.09	1.01	1.73	1.94	1.48	2.06	1.72	2.67	3.18
Fish (Kg)	0.18	0.21	0.20	0.27	0.27	0.20	0.22	0.21	0.24	0.25
Mutton (Kg)	0.06	0.07	0.05	0.05	0.05	0.11	0.10	0.07	0.09	0.08
Chicken (Kg)	0.02	0.04	0.05	0.12	0.18	0.03	0.60	0.85	0.18	0.24
Consumption expenditure on major categories (MPCE Value shares)										
Cereals	24.2	22.2	18.0	15.6	12.0	14.0	12.4	10.1	9.1	7.3
Gram	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Cereal substitutes	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
Pulses & products	3.8	3.8	3.1	3.7	3.1	3.0	2.8	2.1	2.7	2.1
Milk & products	9.5	8.8	8.5	8.6	9.1	9.8	8.7	7.9	7.8	7.8
Edible oil	4.4	3.7	4.6	3.7	3.8	4.4	3.1	3.5	2.6	2.7
Egg, fish & meat	3.3	3.3	3.3	3.5	3.6	3.4	3.1	2.7	2.7	2.8
Vegetables	6.0	6.2	6.1	6.2	4.8	5.5	5.1	4.5	4.3	3.4
Fruits & nuts	1.7	1.7	1.9	1.6	1.9	2.7	2.4	2.2	2.1	2.3
Sugar	3.1	2.4	2.4	2.4	1.8	2.4	1.6	1.5	1.5	1.2
Salt & spices	2.7	3.0	2.5	2.4	2.4	2.0	2.2	1.7	1.5	1.7
Beverages, etc.	4.2	4.2	4.5	5.6	5.8	7.2	6.4	6.2	6.3	7.1
Food total	**63.2**	**59.4**	**55.0**	**53.6**	**48.6**	**54.7**	**48.1**	**42.5**	**40.7**	**38.5**
Pan, tobacco, intoxicants	3.2	2.9	2.7	2.2	2.4	2.3	1.9	1.6	1.2	1.4
Fuel & light	7.4	7.5	10.2	9.5	9.2	6.6	7.8	9.9	8.0	7.6
Clothing & bedding	5.4	6.9	4.5	4.9	6.3	4.7	6.1	4.0	4.7	5.3
Footwear	0.9	1.1	0.8	1.0	1.3	0.9	1.2	0.7	0.9	1.2
Misc. goods & services	17.3	19.6	23.4	24.0	26.1	27.5	31.3	37.2	37.8	39.7
Durable goods	2.7	2.6	3.4	4.8	6.1	3.3	3.6	4.1	6.7	6.3
Non-food total	**36.8**	**40.6**	**45.0**	**46.4**	**51.4**	**45.3**	**51.9**	**57.5**	**59.3**	**61.5**
Total expenditure	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: *MOSPI, Various Reports*

As the dietary diversification is noticed, there is scope towards more nutritious consumption expenditure and nutrition-led marketing.

Fig 1.8 Shift in Consumption Expenditure (1993-94 to 2011-12)



Trends in components of non-food items remain more or less equal in rural and urban domains. Rather, while food and non-food expenditure are converging in rural sphere, urban India show a clear divergence, with a sharp fall in food expenses and a corresponding increase in non-food expenses.

While urban India shows no increase in shares among any other food groups, rural India exhibits a marginal, but gradual increase in expenses on egg, fish and meat, fruits and nuts, and beverages.

1.8.1. Projected Demand of Food Commodities

Owing to the increasing population pressure over the years, demand for food is naturally expected to increase in coming years.

Various studies have projected the demand of food grains under alternative assumptions of income growth, distribution of income and future dynamics of rural and urban populations. Box 1.1 presents projected national demand of major food commodities for the years 2030 and 2050 as estimated in different studies.

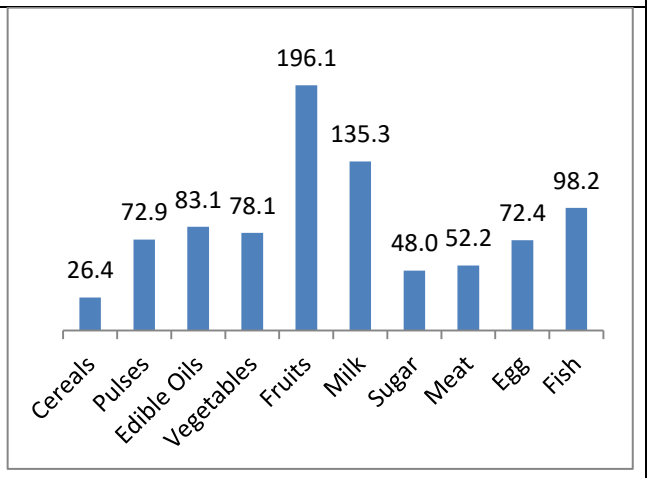
Substantial increase in the consumption of high-value food commodities like fruits, vegetables, milk, meat, fish and eggs have been projected.

Box 1.1 Projected Demand of Major Food Commodities in India

Projected Demand (million tons)

Commodities	2030*	2050**
Cereals	284	359
Pulses	26.6	46
Edible Oils	21.3	39
Vegetables	192	342
Fruits	103	305
Milk	170.4	401
Sugar	39.2	58
Meat	9.2	14
Egg	5.8	10
Fish	11.1	22

Projected Shift in demand in 2050 (% change between 2030 and 2050)



Source : *kumar et al. (2016) for projected demand in 2030*
NCAP Vision 2050 for projected demand in 2050

It is encouraging to note that the outputs have outpaced the projections due to technological improvements and better logistics. One can naturally expect that the rising food demand will be accompanied by increasing demand for its safety and quality owing to rising health consciousness of the masses. Thus, the main challenge will be to develop technologies, practices, varieties and breeds that are high-yielding as well as safe to human health.

1.9. Agriculture-Poverty Linkages

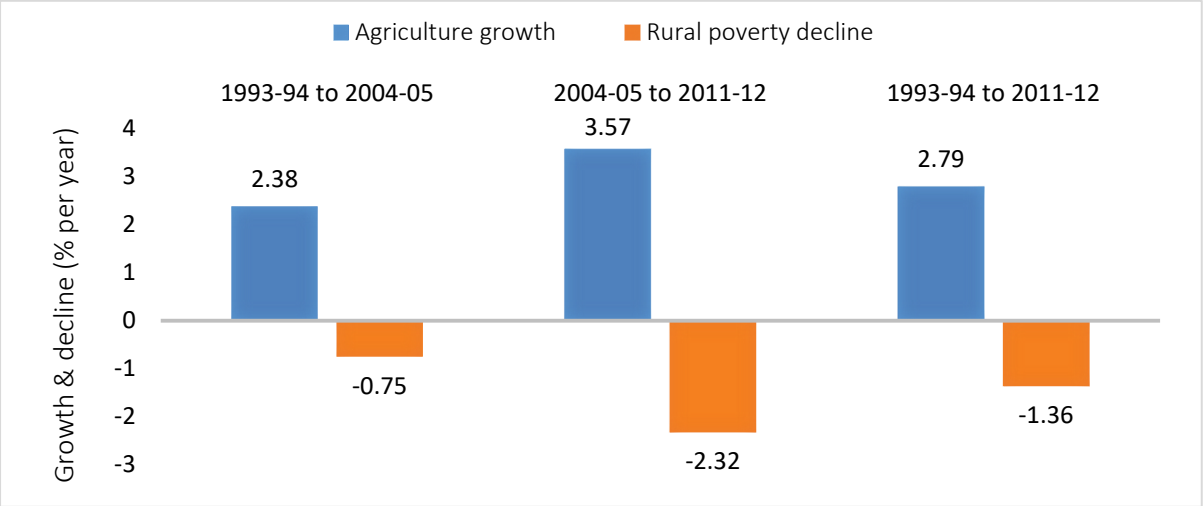
Having direct and indirect linkages with rest of the economy, agriculture sector contributes to rural prosperity through employment and income provision to the masses. Evidences suggest that the speed with which agriculture sector reduces rural poverty is at least twice than what rest of the economy does. Following a growth deceleration in post-reforms period in India, the sector has recovered its momentum since mid-2000s.

Output growth in agriculture[1] shows notable improvement since 2004-05 than the earlier period, from a 2.4 per cent growth during the pre-reforms period to a 3.4 per cent growth between 2004-05 and 2011-12 (Fig 1.9).

Rural poverty estimates of pre and post reforms period help us to understand the role of agriculture growth in rural poverty incidences. During the pre-reforms period, when growth in agriculture was relatively slow, rate of rural poverty reduction has been less than 1 per cent a year. When growth in agriculture rejuvenated, poverty decline became faster and recorded a 2.32 per cent annual decline (Fig 1.10). This positive influence is not felt at national level alone.

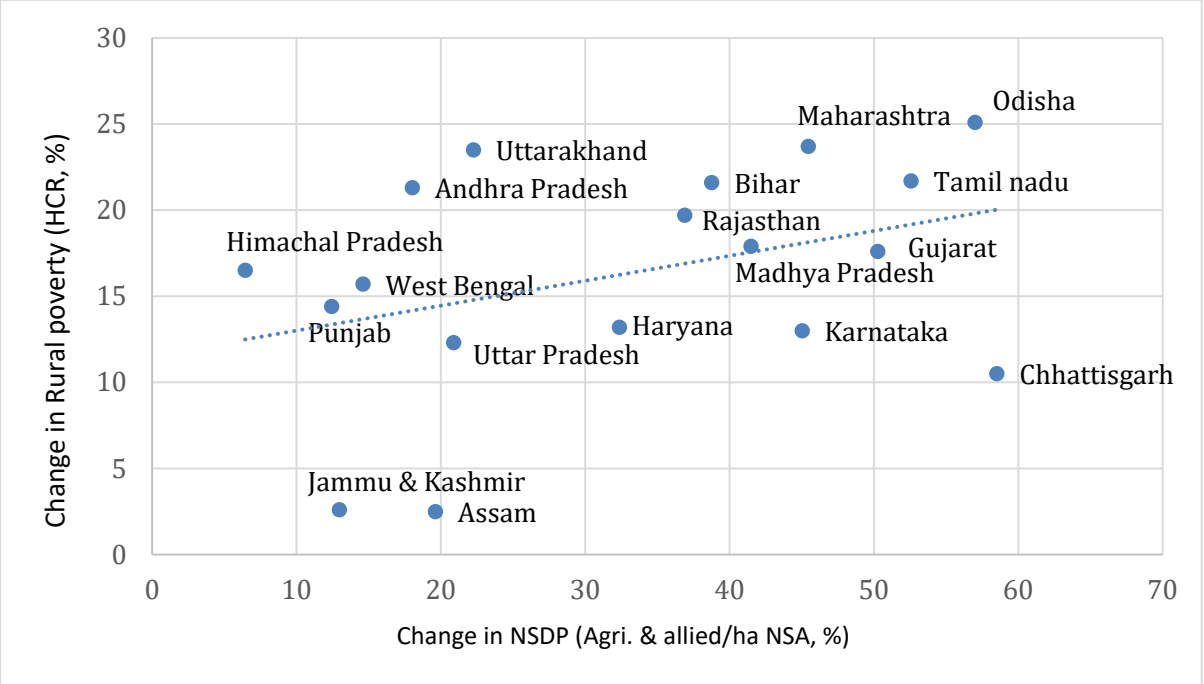
[1]Growth in value of output in agriculture and allied sector measured at 2004-05 prices.

Fig 1.9 Agriculture Growth and Poverty Decline in Rural India



Source: DFI Committee

Fig 1.10 Output change in agriculture and poverty reduction across states (2004-05 to 2011-12)



Source: DFI Committee
Note: Jharkhand & Kerala are not displayed as they were outliers.

Considerable poverty decline was felt among all states where output growth was high. Figure 1.4 plots the change in head count index against change in output growth in agriculture[2] between 2004-05 and 2011-12. Leaving few states viz., Jammu & Kashmir, Assam & Chhattisgarh, one could observe a positive relation among output change and poverty reduction almost among all states, indicating agriculture growth and rural poverty linkages.

[2] Change in NSDP (Agriculture & allied, 2004-05 prices) / ha net sown area.

1.9.1. Farm Income, Agrarian Distress and Farm Poverty[3]

It is often felt that disparity between farm income and non-farm income is rising (Chand 2008) and that those who work outside agriculture are progressing much faster than those who work in it. According to Chand et al (2015), a cultivator earned three times what a labourer earned in 1983-84. A non-agriculture worker earned three times the income earned by a farmer or his family members engaged in agriculture as their main activity.

In the next five years, there was a small decline in the disparity between farm income per cultivator and the income of a labourer. The disparity fell by 2011–12 when the income of a cultivator declined to 2.4 times the wage earnings of a labourer (Table 1.11).

In recent years the farmer's suicides have been quoted as an indicator of farmers 'distress. Also the issues related to farmer's suicides have gained lot of political attention and farmer's unrest. The studies have indicated a positive association between the agricultural growth and farmers' suicides.

However, overall value chain management is crucial to get the farmers complete benefits of enhanced output. Madhya Pradesh, a state which was being treated as role model for taking a proactive role on the strategies and framework for doubling of farmer's income in the state, is suffering from the crises related to the issues of marketing and price management.

Table 1.11 Disparities in Agriculture and Non-agriculture Income

Year	Farm income per cultivator (Rs) F	Wage earning per agricultural labourer (Rs) L	Income per non-agriculture worker (Rs) N	Ratio L:F	Ratio N:F
1983–84	4,286	1,467	12,786	0.34	2.98
1987–88	5,653	2,201	18,036	0.39	3.19
1993–94	12,365	4,784	37,763	0.39	3.05
1999–00	24,188	8,938	78,565	0.37	3.25
2004–05	26,146	10,043	106,688	0.38	4.08
2011–12	78,264	32,311	246,514	0.41	3.15

Source: Chand et al (2015)

The disparity in farm and non-farm income declined to 1:3.15; and non-agricultural worker earned 3.15 times in 2011-12 the income of a cultivator. Acceleration in growth of agricultural output and a decline in the number of cultivators from 2004–05 to 2011–12 arrested and reversed the rising disparity in the incomes of farmers and non-farmers (Chand et al, 2015).

[3] This section has been drawn from Chand et al (2015)

1.10. Annotation

The agrarian distress in the farming community has increased overtime due to a number of reasons. Chand (2016) attributed this distress to the widening disparities between agricultural and non-agricultural sectors, resulting in burgeoning gap between the incomes generated per worker from the two sectors. In another study, Chand et al (2015) reported that the growth rate in per farmer income in this period was mere 1.96 per cent, which was the lowest during 1983-84 to 2011-12. The growth rate in per cultivator income accelerated to 7.29 per cent after 2004 resulting in associated socio-economic benefits.

Price factors are becoming increasingly important in ensuring the welfare of farmers and farm labourers as consumer price index for agricultural labour (CPIAL) has risen at a faster rate than that of the price received as measured through the wholesale price indices (WPI). This may also be a reason for lowered agricultural income growth. An obvious indication is drawn from the fact that the low growth rate in farm income is concomitant with an increase in farmers' distress. Any increase in farmers' income will reduce the agrarian distress and vice-versa.

The agricultural sector being the prime sector of the economy, has received continuous attention of the policy makers and stakeholders. Earlier policies in agriculture were largely concentrated on enhancing the productivity and output, but none of the policies directly targeted at enhancing farmers' incomes. The agricultural policy focus has now clearly shifted towards making farming more directly market-led and to direct its future development towards enterprise mode, as an important contributor to the nation's economy.

The mission of "Doubling of Farmers' Income" (DFI) in India enthused and fuelled lot of energy and motivation among the stakeholders and channelled the efforts in a unified direction. Now, a holistic approach is being followed and the slogan is catching the momentum and attention of one and all. DFI goal is also concomitant to the many associated and well-thought out schemes on insurance for mitigating losses (Pradhan Mantri Fasal Bima Yojana), ensuring effective marketing through unified national agricultural marketing platform (e-National Agricultural Market), GST roll out, and improving soil health via promoting organic farming through Paramparagat Krishi Vikas Yojana, all which will contribute towards maximising the gains from farming. These programmes and schemes, implemented in true spirit, will lead to a many reforms that will revolutionise agriculture, enabling it to tap efficiently into the larger national market, be a market-led enterprise, and become a truly vibrant business sector.

To ensure that DFI mission is moving in the desired direction within stipulated time frame i.e. by India's 75^{th} independence, a systematic and scientific strategic framework is necessitated, to provide the direction to fulfil this mission. This report outlines the strategies and provides a systematic approach. The report has been organised into 10 volumes. Vol I talks about the changes in various constituents of Indian agriculture.

Key Extracts

- Overall growth in agriculture has moved in correspondent to the crop sector. Livestock sector is growing at an appreciable and sustainable rate and is ahead among all sub-sectors.
- Prominent increase has been noticed in case of prices of agricultural commodities, such increase often leads to the inflationary situation in food commodities and affect overall well-being.
- The interest of farming community in agriculture is declining and consequently the agricultural workers self-employed in agriculture are leaving the industry. This reported shift is good provided the workers, who left the sector, are productively and gainfully employed in alternate sectors/industries.
- The smallholders (including marginal farmer also) dominate the scene of Indian agriculture. The situation is found to be worst in states like Kerala, Bihar, West Bengal, J&K, Uttar Pradesh, Odisha, Tamil Nadu, Uttarakhand along with few NE states and UTs where the share of smallholders is found to be more than 90 per cent. These areas need more inclusive approach and package considering the situation of smallholders.
- Trends in components of non-food items remain more or less equal in rural and urban domains. Rather, while food and non-food expenditure are converging in rural sphere, urban India show a clear divergence, with a sharp fall in food expenses and a corresponding increase in non-food expenses.
- Considerable poverty decline was felt among all states where output growth was high. Leaving few states viz., Jammu & Kashmir, Assam & Chhattisgarh, one could observe a positive relation among output change and poverty reduction almost among all states, indicating agriculture growth and rural poverty linkages.

Chapter 2
Performance of Agriculture and Allied Sector

This chapter provides performance of agricultural and allied sector across states. The product mix of crop and livestock categories has been covered in detail. Further, a brief overview of current status of farm and non-farm income along with major sources of farm household income across states has been presented.

2.1. Growth in GSDP across states

The sectoral growth across states has been analysed using the data of gross state domestic product (GSDP). During the recent years, states like Bihar, Goa, Madhya Pradesh and Uttarakhand have shown impressive performance and grew at the rate of more than 9 per cent per year during 2010-11 to 2014-15. The trend of declining share of agriculture in total output has continued till recent times (Table 2.1). In Tamil Nadu & Maharashtra, agriculture output share in total output during TE 2014-15 is just 7 per cent and in Kerala and Uttarakhand, it is around 10 per cent. Highest share of agriculture doesn't exceed one-third of state output.

To the highest extent, agriculture in Madhya Pradesh contributes 28 per cent of its total output. In Punjab, Uttar Pradesh and Andhra Pradesh, they range between 20 per cent and 25 per cent. The pattern is not just being recorded at the said year, but has continued since past. Between TE 2006-07 and TE 2014-15, output share has declined in Bihar and Punjab by 10 per cent, from 30 per cent to 20 per cent, and from 31 per cent to 21 per cent respectively. The decline has been 9 per cent in Uttarakhand, and 7 per cent in Jammu & Kashmir, Kerala, Haryana and West Bengal. Despite of higher share than agriculture, in many of the states, share of manufacturing has also declined during this period. For example, share of manufacturing has declined from 48 per cent to 37 per cent in Jharkhand, 33 per cent to 28 per cent in Haryana and 31 per cent to 27 per cent in Karnataka. While rest of the states as well registered a decline, they were moderate, by less than 5 per cent.

Service sector has captured the momentum and compensated the decline in output in agriculture and manufacturing. During the TE 2014-15, Kerala has produced 70 per cent its output through service sector, followed by West Bengal (65 per cent), Tamil Nadu and Maharashtra (64 per cent both). To ascertain, none of the states have recorded a negative change in output share. During the period TE 2006-07 to TE 2014-15, output share has grown by more than 10 per cent in Haryana, Jammu & Kashmir and Jharkhand, and by more than 9 per cent in Uttar Pradesh, Kerala and West Bengal. Such trends and patterns clearly indicate transformation across states and increasing dependence of nonfarm sector for growth.

Output composition within agriculture sector show mixed trends. Output shares in forest sector in most of the states have not seen major changes. Fisheries sector has gradually picked up, albeit very marginally. Andhra Pradesh and Kerala have reduced their output share from crop and livestock sector. Andhra Pradesh has marginally shifted towards fisheries sector (Table 2.2). While output share in crop and livestock sector has declined by 7 per cent TE 2006-07 to TE 2014-15, output in fisheries sector has increased by 7 per cent. Kerala,

rather, has produced more from forestry than in fisheries. A decline of 4 per cent output share in agriculture and livestock has been compensated by a 3 per cent increase in fisheries. On the other hand, Jharkhand, Madhya Pradesh, Chhattisgarh and Bihar have expanded their output primarily through crop and livestock sector.

Many states like Uttar Pradesh, Kerala, Andhra Pradesh, Himachal Pradesh, Jharkhand, Madhya Pradesh, Meghalaya, Sikkim etc. have performed well in the second period where agriculture sector reported an increase in growth in GSDP. Apart from this, in few states like AP, HP, Arunachal and Sikkim, the increase in growth rate in agriculture sector surpasses the growth in manufacturing sector and in case of Sikkim service sector also. Not just agriculture reflects declining contribution but the manufacturing sector as well between TE 2006-07 and TE 2014-15. Seven out of twenty major states have reduced their output in crop and livestock sector, nine have increased.

2.2. What Comprises Indian Agriculture and Allied Sector?

Agriculture and its allied sector plays an important role in the Indian economy by contributing towards the gross domestic product (GDP) which is estimated in terms of Gross Value Added (GVA) using the production approach. In this context information on value of output is of utmost importance. With this in view, the contribution in terms of value of output from different sectors in the triennium 2012-13 to 2014-15 with base year of 2011-12 has been presented in charts subsequently. Agriculture & Allied Sector consists of four subsectors namely Crop sector, Livestock, Forestry and Fisheries. The share of crop sector in the total VOP from agriculture and allied activities is highest (61.31 per cent) among the other sectors as being the largest contributor. Livestock comes next with a share of 26.80 per cent in the total VOP, which is followed by forestry (7.39 per cent) and fisheries (4.50 per cent) sector.

The economic activities included in these sectors are further divided, like in case of crop sector it includes growing of field crops, plantation crops, horticultural crops, drugs and narcotics and other crops. Similarly in case of livestock it includes production of milk, meat, eggs, wool, dung, honey, silkworm cocoons etc.

The milk group contributes highest (66.6 per cent) share in the VOP from livestock sector. Meat group comprises all meats (including mutton, pork, poultry, etc.), meat products and meat by-products comprising hides and skins and other by-products. This sub sector contributes 20 per cent to the VOP from livestock sector followed by dung (6.31%), eggs (3.43%) and others (3.05%).

Table 2.1 Performance of agriculture, manufacturing and service sector across states (Rs. billion @ 2004-05 prices)

States	Agricultural Sector				Manufacturing Sector				Service Sector				Overall			
	GSDP		Growth in GSDP		GSDP		Growth in GSDP		GSDP		Growth in GSDP		GSDP		Growth in GSDP	
	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II
Orissa	187.9	233.7	3.67	0.32	289.3	464.5	9.02	3.16	364.8	705.4	10.48	5.99	841.9	1403.5	8.54	4.07
Jammu & Kashmir	77.0	86.6	1.95	-1.69	82.1	113.1	4.23	5.38	130.2	248.2	8.88	6.41	289.3	447.9	5.84	4.46
Punjab	321.2	367.9	1.98	1.38	276.7	485.0	11.55	2.13	443.5	887.0	8.47	9.43	1041.3	1739.8	7.45	5.48
Uttar Pradesh	794.2	1029.1	2.67	3.69	679.5	1004.0	7.64	1.68	1322.6	2631.9	9.50	7.91	2796.3	4664.9	7.22	5.53
Kerala	210.8	201.1	-1.46	1.59	298.3	456.4	6.80	2.53	798.4	1537.8	10.44	7.73	1307.4	2195.3	7.93	6.01
Andhra Pradesh	402.4	595.9	4.71	6.43	323.2	498.8	7.88	2.45	721.4	1376.9	9.28	7.28	1447.1	2471.6	7.73	6.05
Karnataka	329.3	477.8	5.97	2.98	564.2	863.7	7.96	2.64	952.2	1877.1	9.44	8.78	1845.6	3218.5	8.38	6.11
Tamil Nadu	277.3	347.7	4.04	1.46	793.6	1397.6	9.36	3.11	1449.4	3068.2	11.28	8.18	2520.3	4813.4	9.96	6.12
Rajasthan	336.2	511.1	5.54	1.77	437.7	813.3	8.40	6.34	613.5	1260.0	10.17	8.09	1387.4	2584.4	8.55	6.17
Chhattisgarh	111.9	183.2	5.42	5.19	229.1	403.5	9.15	6.15	178.5	369.5	10.68	7.37	519.6	956.1	8.94	6.43
Himachal Pradesh	63.7	82.8	1.88	6.53	102.2	177.6	10.23	3.63	96.3	198.3	10.12	9.35	262.2	458.7	8.34	6.52
Maharashtra	499.8	657.1	4.78	0.07	1462.6	2600.3	9.62	4.92	2774.5	5676.7	10.39	8.16	4736.9	8934.2	9.61	6.55
West Bengal	510.4	608.1	2.39	2.72	475.4	709.5	5.27	5.52	1245.9	2408.9	9.05	8.16	2231.7	3726.5	6.83	6.70
Haryana	228.8	301.4	4.01	2.25	343.5	555.2	7.32	4.56	483.5	1148.2	13.07	9.43	1055.8	2004.8	9.42	6.89
Gujarat	376.5	534.0	4.35	5.47	922.1	1698.2	10.96	4.81	1003.2	2111.8	10.93	9.44	2301.8	4343.9	9.97	7.08
Jharkhand	95.2	182.6	6.48	11.05	280.5	408.7	3.40	3.64	213.7	504.0	12.23	9.72	589.4	1095.4	7.25	7.49
Uttarakhand	54.8	71.2	2.23	3.63	88.7	279.4	19.04	11.45	140.8	362.3	16.34	7.34	284.4	713.0	14.83	8.50
Madhya Pradesh	329.7	650.5	4.28	17.99	334.1	599.9	10.64	3.42	542.1	1062.3	8.98	7.95	1205.8	2312.7	8.24	9.20
Goa	10.9	10.3	-1.80	2.49	64.7	98.1	8.36	0.66	62.5	184.2	12.22	16.79	138.1	292.6	9.52	9.84
Bihar	244.4	355.3	3.77	3.74	120.2	320.4	16.96	6.18	445.7	1064.7	9.94	13.46	810.3	1740.4	9.41	9.89
North east																
Mizoram	6.4	10.1	9.09	-0.91	5.3	8.7	10.30	2.48	16.8	35.2	11.58	6.51	28.5	54.1	10.80	4.36
Assam	139.8	179.7	3.16	3.30	143.6	199.5	2.90	6.03	271.3	487.8	8.16	7.03	554.6	867.0	5.61	6.00
Nagaland	20.7	28.9	3.56	4.25	8.8	15.5	9.25	8.99	34.5	69.5	9.49	7.63	64.0	113.9	7.64	6.91
Manipur	12.7	16.2	4.16	5.51	19.9	21.3	1.78	2.65	21.3	43.4	7.64	11.15	53.9	80.9	4.85	7.57
Arunachal Pradesh	12.4	17.9	3.51	4.38	11.4	17.4	7.93	3.62	12.4	23.6	11.23	5.63	36.1	58.8	7.73	4.62
Tripura	23.4	40.0	8.73	4.66	24.0	41.6	7.69	9.10	47.6	97.9	8.85	11.68	95.1	179.4	8.54	9.39
Meghalaya	15.8	21.3	2.04	6.99	19.0	41.4	10.75	8.34	36.1	70.9	8.93	8.77	70.9	133.6	8.02	8.34
Sikkim	3.3	5.7	3.48	12.29	5.5	35.7	35.56	9.49	10.0	17.9	9.96	6.02	18.9	59.3	19.26	8.63
All India	**5723**	**7841**	**3.52**	**4.94**	**8385**	**15538**	**8.99**	**6.78**	**16020**	**33959**	**10.00**	**9.70**	**30128**	**57338**	**8.58**	**8.22**

Source: DFI Committee Estimates based on the data from MOSPI

Note: States have been sorted by growth in GSDP for the period-II. Period 1: 2004-05 to 2010-11; Period-II: 2010-11 to 2014-15

Table 2.2 Performance of various sub-sectors of agriculture across states (Rs. lakhs @ 2004-05 prices)

State	Crops and Livestock Sector				Forestry				Fisheries				Agriculture and allied Total			
	GSDP		Growth in GSDP		GSDP		Growth in GSDP		GSDP		Growth in GSDP		GSDP		Growth in GSDP	
	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II	TE2006/ 2007	TE2014/ 2015	Period-I	Period-II
Jammu &Kashmir	61.6	71.6	2.64	-1.97	13.9	13.2	-1.49	-0.13	1.5	1.8	3.27	-1.69	77.0	86.6	1.95	-1.69
Maharashtra	391.2	517.9	5.59	-1.38	93.6	123.1	1.92	6.44	14.9	16.2	0.41	2.21	499.8	657.1	4.78	0.07
Orissa	150.2	189.1	4.07	-0.23	26.5	26.9	0.95	-0.85	11.1	17.6	4.26	8.95	187.9	233.7	3.67	0.32
Goa	7.1	6.3	-2.74	0.34	0.8	1.1	2.69	9.28	3.0	2.9	-0.80	4.70	10.9	10.3	-1.80	2.49
Tamil Nadu	238.4	298.0	4.12	1.20	17.2	21.0	1.83	3.63	21.7	28.6	5.10	2.73	277.3	347.7	4.04	1.46
Punjab	305.9	347.6	1.91	1.23	12.3	16.6	3.30	4.46	3.0	3.7	3.12	2.53	321.2	367.9	1.98	1.38
Kerala	172.0	157.0	-2.25	1.35	21.1	25.3	2.80	2.66	17.7	18.8	0.57	2.08	210.8	201.1	-1.46	1.59
Rajasthan	287.7	455.1	6.08	1.77	47.5	54.2	1.78	1.56	1.0	1.8	8.80	7.77	336.2	511.1	5.54	1.77
West Bengal	406.5	471.1	2.10	1.86	24.2	35.5	1.98	13.86	79.6	101.6	3.96	3.20	510.4	608.1	2.39	2.72
Haryana	216.8	285.1	4.00	2.16	10.7	13.2	2.58	3.07	1.4	3.2	14.70	7.27	228.8	301.4	4.01	2.25
Uttarakhand	40.7	51.9	2.14	2.52	14.1	19.2	2.46	6.76	0.1	0.1	6.84	1.14	54.8	71.2	2.23	3.63
Karnataka	280.6	405.7	6.07	2.97	41.9	59.4	4.49	3.31	6.8	12.7	10.54	2.06	329.3	477.8	5.97	2.98
Bihar	206.3	314.2	4.57	3.75	26.7	22.8	-2.00	-1.88	11.4	18.3	1.79	12.61	244.4	355.3	3.77	3.74
Uttar Pradesh	718.3	934.9	2.65	3.82	65.6	77.7	2.13	2.19	10.3	16.5	7.29	3.66	794.2	1029.1	2.67	3.69
Andhra Pradesh	319.3	432.2	4.52	3.95	20.7	26.2	2.19	4.89	62.4	137.5	6.40	15.91	402.4	595.9	4.71	6.43
Chhattisgarh	80.4	139.8	6.18	5.46	25.9	30.8	1.90	2.77	5.7	12.6	9.56	8.51	111.9	183.2	5.42	5.19
Gujarat	314.5	463.9	4.92	5.83	45.2	50.2	0.63	2.75	16.7	19.8	3.53	3.15	376.5	534.0	4.35	5.47
Himachal Pradesh	47.9	61.0	0.70	6.94	15.4	21.4	5.30	5.34	0.4	0.5	2.03	7.56	63.7	82.8	1.88	6.53
Jharkhand	72.7	150.6	6.90	12.79	20.9	27.7	3.98	2.95	1.6	4.4	18.13	12.62	95.2	182.6	6.48	11.05
Madhya Pradesh	292.8	607.6	4.61	19.43	34.1	38.5	1.58	0.91	2.8	4.3	1.47	12.85	329.7	650.5	4.28	17.99
North east																
Mizoram	3.7	7.3	14.40	-1.77	2.4	2.3	-0.57	0.43	0.3	0.5	0.97	7.01	6.4	10.1	9.09	-0.91
Tripura	19.3	27.1	6.44	1.83	2.6	8.2	18.20	9.42	1.6	4.7	16.05	15.43	23.4	40.0	8.73	4.66
Assam	118.0	147.5	2.92	2.67	13.5	19.2	4.78	4.43	8.2	13.1	3.81	9.61	139.8	179.7	3.16	3.30
Nagaland	16.2	22.5	3.16	4.41	4.2	5.9	4.58	3.70	0.3	0.5	11.15	3.46	20.7	28.9	3.56	4.25
Manipur	9.6	12.8	5.22	6.14	1.9	1.9	-0.23	-0.21	1.2	1.5	1.69	8.22	12.7	16.2	4.16	5.51
Meghalaya	11.5	16.7	2.55	9.14	4.0	4.2	1.07	-0.34	0.3	0.3	-4.65	6.17	15.8	21.3	2.04	6.99
Sikkim	2.9	5.4	4.13	13.14	0.4	0.3	-2.18	0.85	0.0	0.0	3.64	35.36	3.3	5.7	3.48	12.29
All India	**4824**	**6676**	**3.64**	**5.10**	**619**	**736**	**2.08**	**2.16**	**280**	**426**	**4.57**	**7.21**	**5732**	**7841**	**3.52**	**4.94**

Source: DFI Committee Estimates based on the data from MOSPI

Note: States have been sorted by growth in GSDP for the period-II. Period 1: 2004-05 to 2010-11; Period-II: 2010-11 to 2014-15

The forest products are classified into two broad groups' viz., (a) major products comprising industrial wood (forest and trees outside forest) which comprises of around 49 per cent of total value of output from forestry and firewood (32.28 per cent) and (b) Non-Timber Forest Products comprising 18.66 per cent of VOP in forestry.

The fishing sector comprises of (i) Inland fishing which retains highest share (59 per cent) in VOP of fisheries sector and (ii) Marine fishing contributing 41 per cent in the VOP of fisheries sector in the country.

Being the largest sector in agriculture, crop sector holds large number of contributors. Field crops including cereals, pulses, oilseeds, sugars, and fibres contributes 27.24, 4.46, 8.30, 6.24 and 6.21 per cent share respectively in the VOP from crop sector. Among the cereals, paddy and wheat alone contributes around 86 per cent share in the VOP from cereals.

Similarly in case of pulses gram, arhar and urd are the highest contributor in the VOP from pulses, while in oilseed, soybean, rapeseed & mustard, groundnut and coconut are the biggest contributor. Cotton (kapas) is the lone highest contributor with 94.45 per cent share in the total VOP from fibres.

Plantation and horticulture, including medical and narcotics contributing 3.75 per cent in the VOP from crop sector, condiment and spices 4.04 per cent and highest contributor among these is horticulture crops including fruits and vegetables contributing 25.17 per cent; the second highest in crop sectors after cereals.

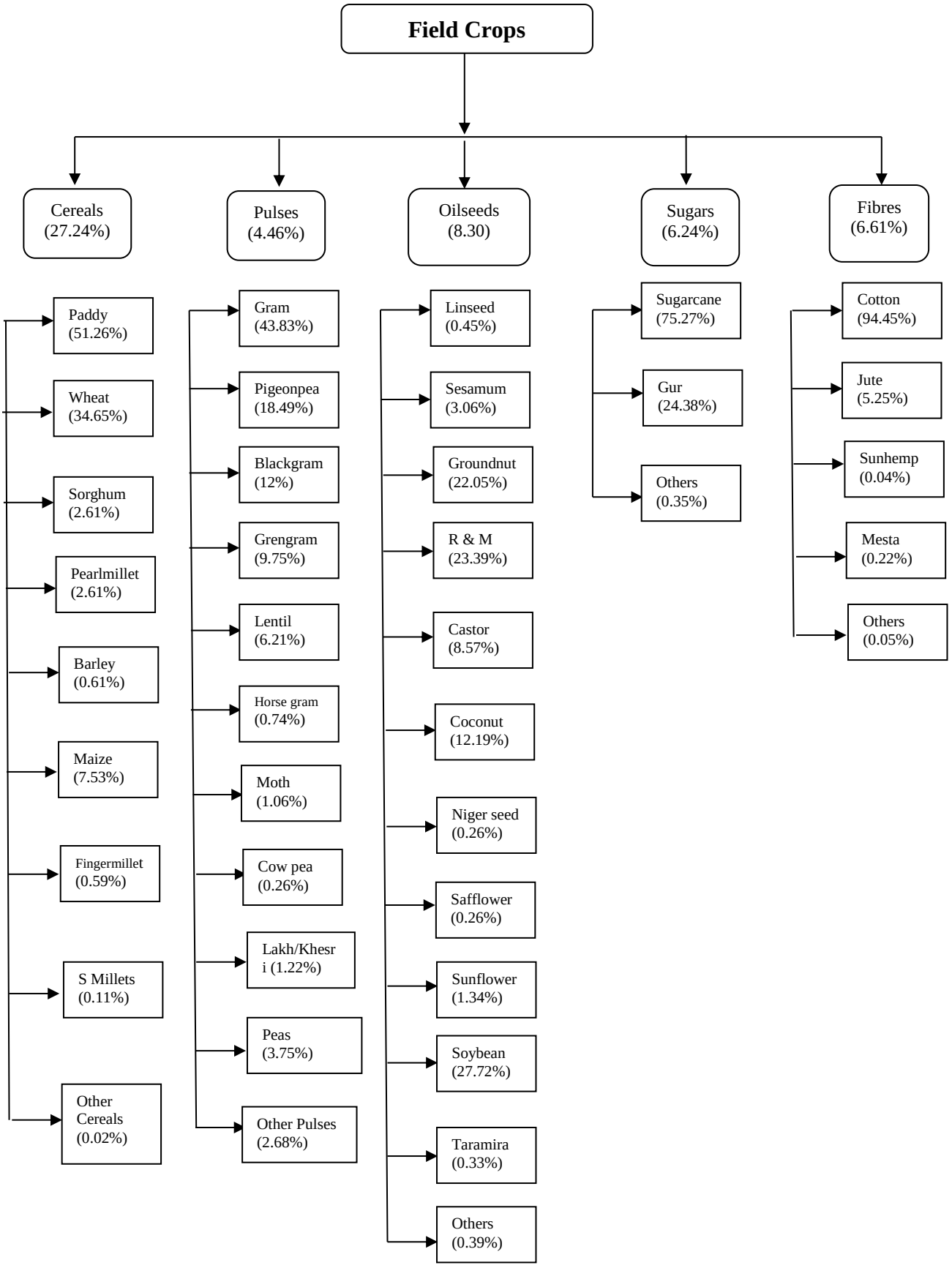
Remaining contribution in the crop sector includes other crops (8.19 per cent) including rubber, guar seed, fodder, grass, mulberry etc; by-products (5.56 per cent) and kitchen garden (0.45 per cent).

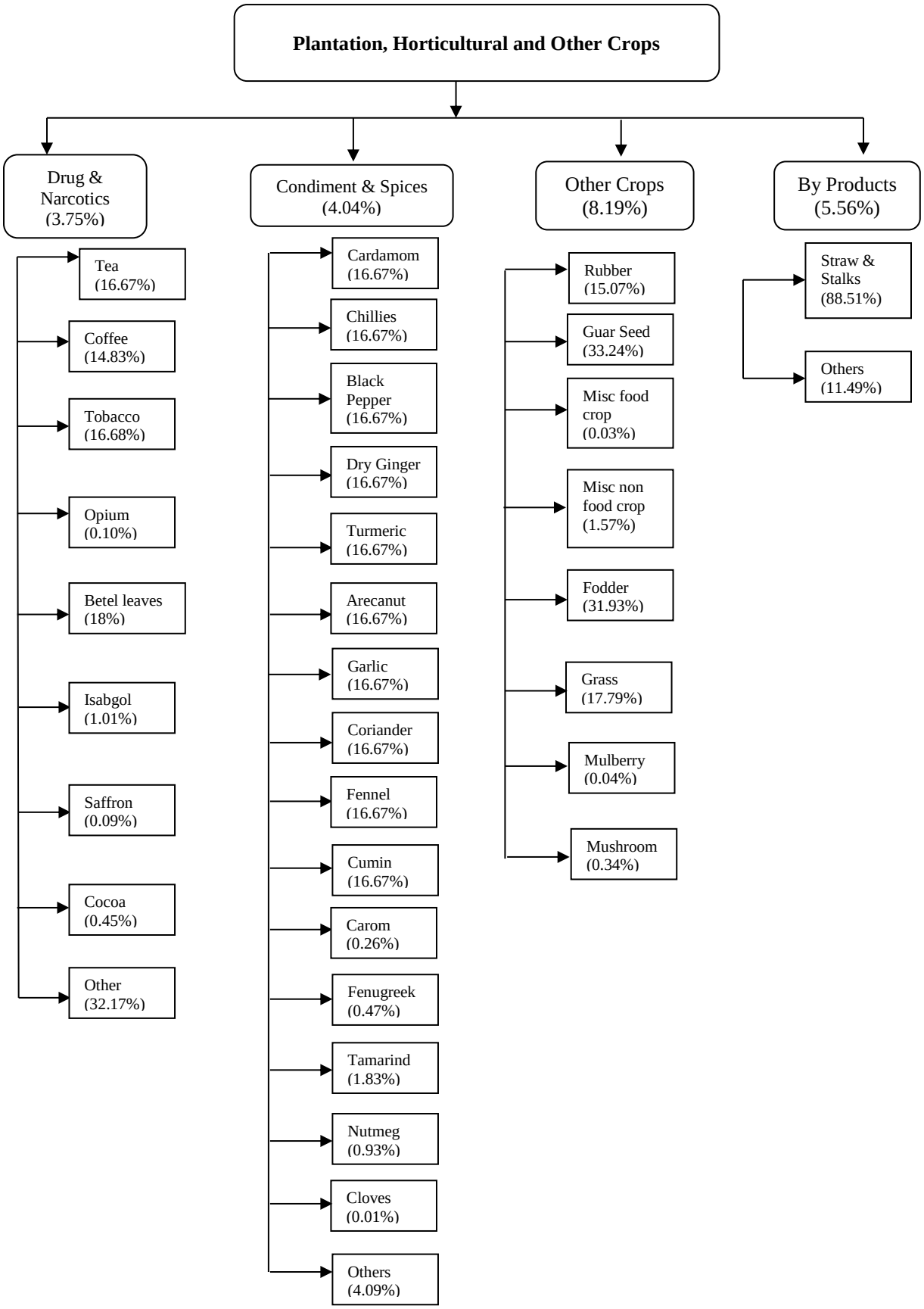
India is the land of diverse agro-ecologies and produces a number major and minor agri-based commodities. Box 2.1 provides the total production of all major agri-commodities in India.

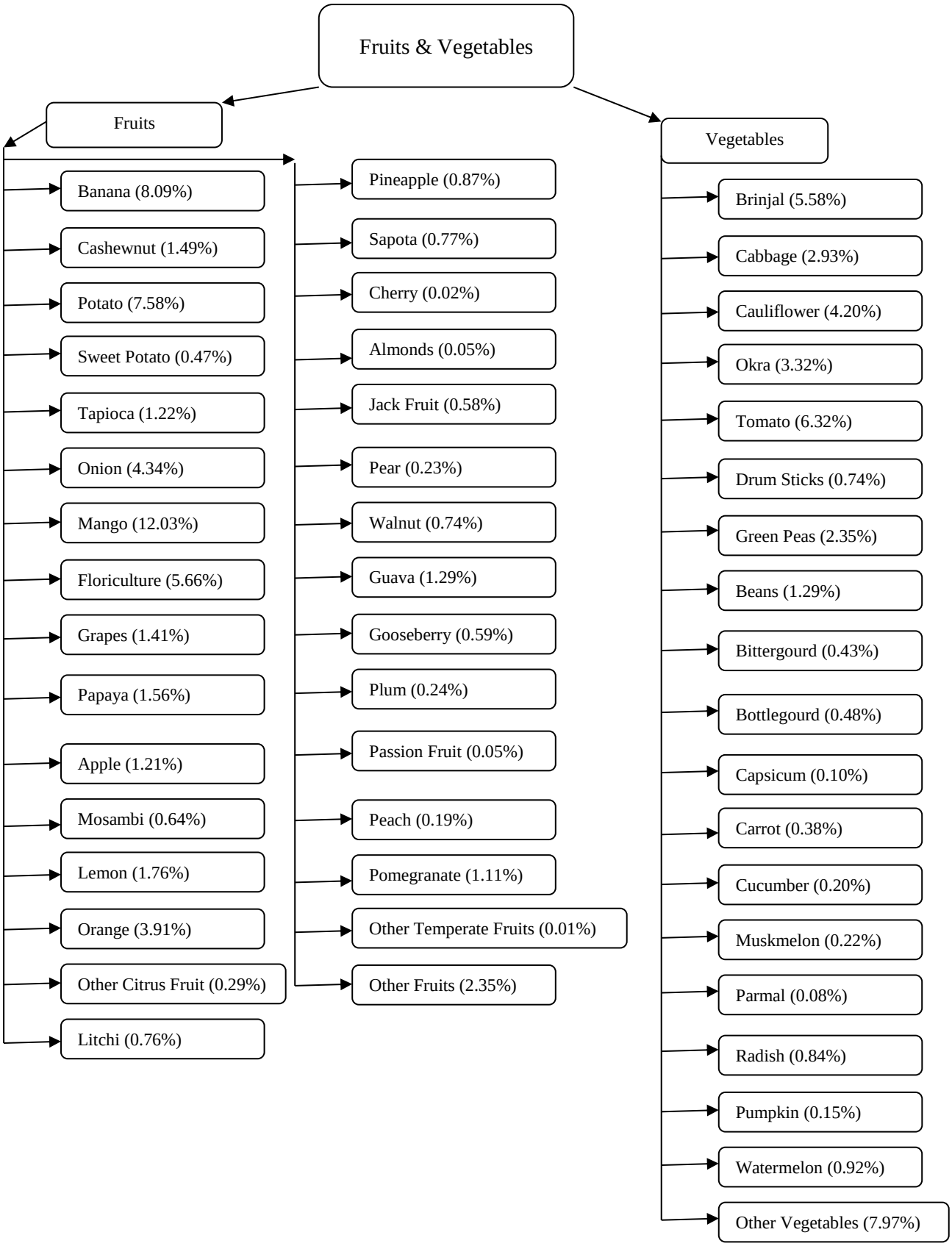
Currently, the country produces approximately 1.13 billion tonnes of agricultural produce. However, the commodities vary in terms of their importance for food, feed & fodder, clothing along with being used as, raw and intermediate products for industry.

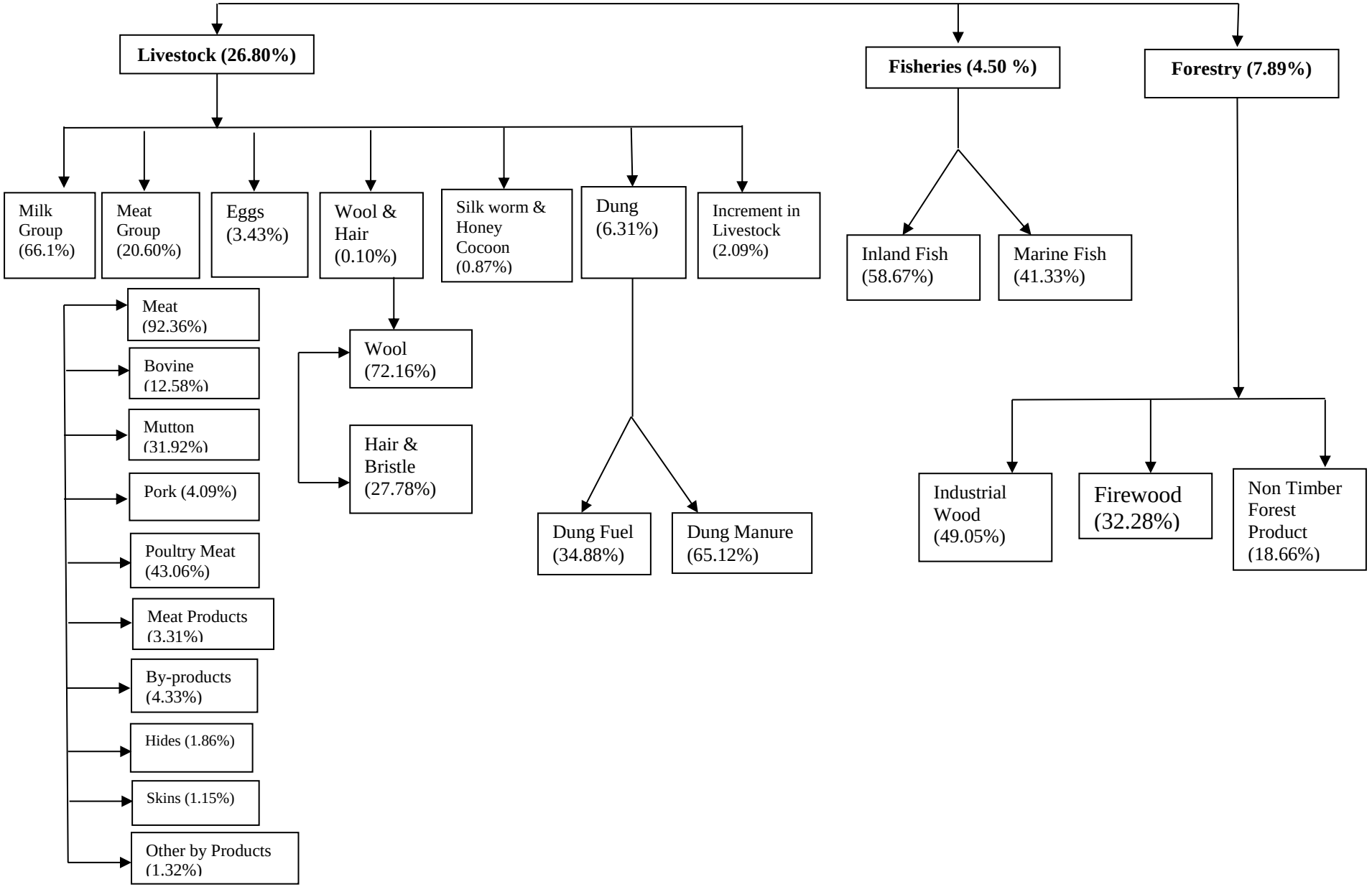
Box 2.1. Volumes of different commodities produced in India, TE 2014-15, (000 Tonnes)

Cereals							
Paddy 105790	Wheat 91961	Sorghum 5423	Pearl millet 9059	Barley 1732	Maize 23564	Finger Millet 1873	Small Millets 417
Pulses							
Gram 8564	Pigeonpea 3002	Black Gram 1876	Green Gram 1431	Lentil 1062	Horse Gram 229	Moth 300	Peas 4176
Oilseeds							
Linseed 148	Sesamum 743	Groundnut 7270	Rapeseed & Mustard 7396	Castor Seed 1853	Coconut 14862	Niger Seed 92	Safflower 104
Sunflower 494	Soybean 12300						
Sugar and Jaggery							
Sugarcane 351891							
Fibres							
Cotton 34976	Jute 10681	Sunhemp 619	Mesta 568				
Indigo, Dyes & Tanning Material Drugs & Narcotics							
Tea 1180	Coffee 316567	Tobacco 220	Opium 345	Saffron 1	Cocoa 15		
Condiments & Spices							
Cardamom 21	Chillies 1467	Black Pepper 56	Dry Ginger 699	Turmeric 997	Arecanut 659	Garlic 1312	Coriander 433
Fennel 91	Cumin 465	Carom 21	Fenugreek 111	Tamarind 197	Nutmeg 13134	Cloves 1	
Fruits							
Banana 28485	Cashewnut 750	Mango 18320	Grapes 2630	Papaya 5311	Apple 2182	Mosambi 3878	Lemon 2770	Orange 3346
Other Citrus Fruit 970	Litchi 564	Pine Apple 1764	Sapota 1526	Almonds 11	Jack Fruit 1612	Watermelon 1883	Muskmelon 831	Pear 305
Walnut 237	Guava 3620	Gooseberry 1222	Plum 501	Passion Fruit 118	Peach 96	Pomegranate 1293	Strawberry 5	Other Fruits 5875
Vegetables								
Potato 44969	Sweet Potato 1149	Tapioca 6583	Onion 18381	Cabbage 8719.3	Cauliflower 8129	Okra 6135	Tomato 17783	Green Peas 4176
Radish 2401	Beans 1614	Bittergourd 839	Bottlegourd 1912	Capsicum 168	Carrot 1062	Cucumber 666	Pumpkin 637	Other Vegetables 25791
Other Crops								
Rubber 777567	Guar Seed 3023	Mushroom 34	Floriculture 1565					
Livestock								
Milk Group 138810	Meat 6291	Eggs 413	Wool 47					
Fisheries								
Inland Fish 6260	Marine Fish 3422							


Field Crops
Cereals (27.24%)
Pulses (4.46%)
Oilseeds (8.30)
Sugars (6.24%)
Fibres (6.61%)
Paddy (51.26%)
Wheat (34.65%)
Sorghum (2.61%)
Pearlmillet (2.61%)
Barley (0.61%)
Maize (7.53%)
Fingermillet (0.59%)
S Millets (0.11%)
Other Cereals (0.02%)
Gram (43.83%)
Pigeonpea (18.49%)
Blackgram (12%)
Grengram (9.75%)
Lentil (6.21%)
Horse gram (0.74%)
Moth (1.06%)
Cow pea (0.26%)
Lakh/Khesri (1.22%)
Peas (3.75%)
Other Pulses (2.68%)
Linseed (0.45%)
Sesamum (3.06%)
Groundnut (22.05%)
R & M (23.39%)
Castor (8.57%)
Coconut (12.19%)
Niger seed (0.26%)
Safflower (0.26%)
Sunflower (1.34%)
Soybean (27.72%)
Taramira (0.33%)
Others (0.39%)
Sugarcane (75.27%)
Gur (24.38%)
Others (0.35%)
Cotton (94.45%)
Jute (5.25%)
Sunhemp (0.04%)
Mesta (0.22%)
Others (0.05%)

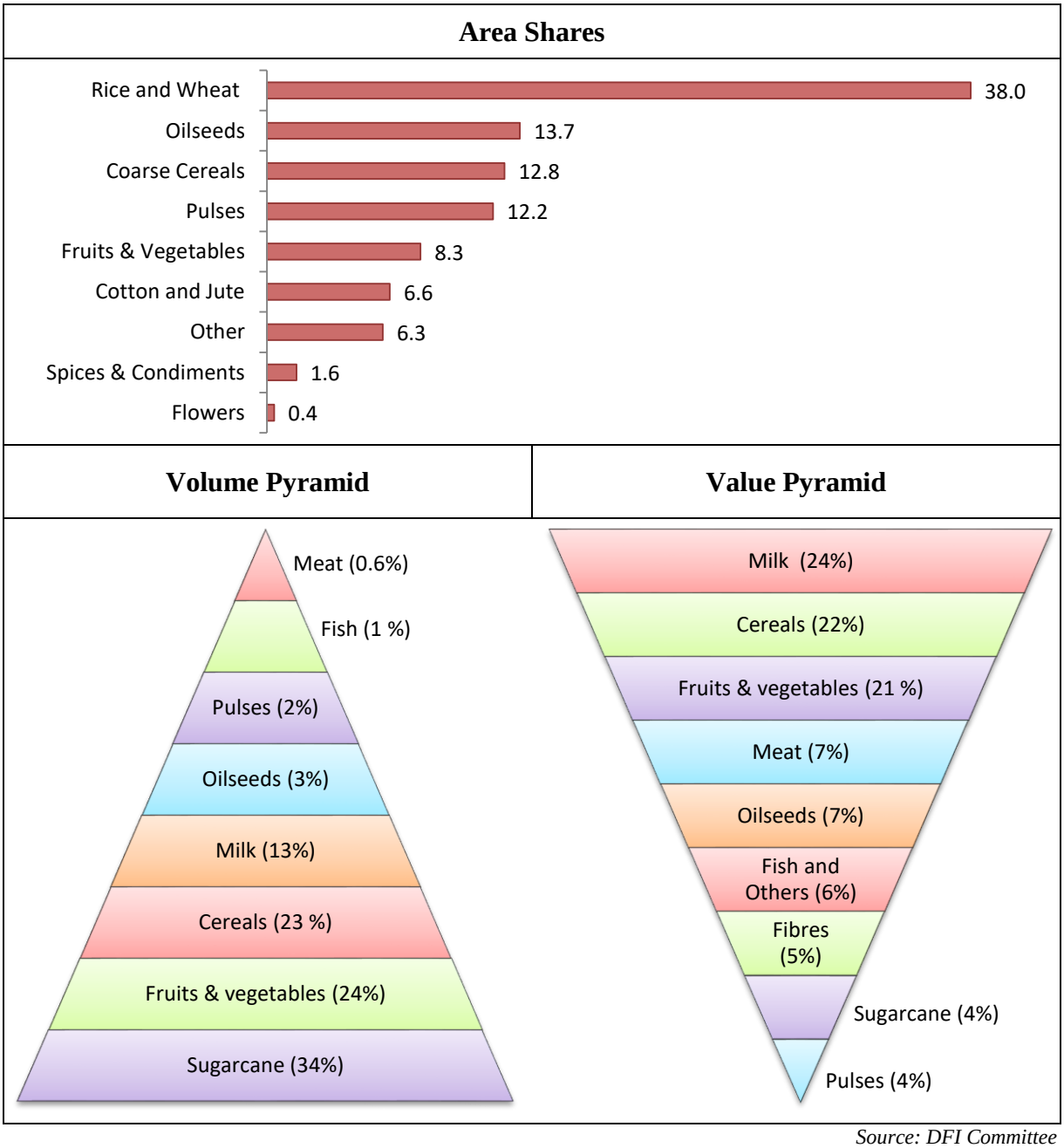

Plantation, Horticultural and Other Crops
Drug & Narcotics (3.75%)
Tea (16.67%)
Coffee (14.83%)
Tobacco (16.68%)
Opium (0.10%)
Betel leaves (18%)
Isabgol (1.01%)
Saffron (0.09%)
Cocoa (0.45%)
Other (32.17%)
Condiment & Spices (4.04%)
Cardamom (16.67%)
Chillies (16.67%)
Black Pepper (16.67%)
Dry Ginger (16.67%)
Turmeric (16.67%)
Arecanut (16.67%)
Garlic (16.67%)
Coriander (16.67%)
Fennel (16.67%)
Cumin (16.67%)
Carom (0.26%)
Fenugreek (0.47%)
Tamarind (1.83%)
Nutmeg (0.93%)
Cloves (0.01%)
Others (4.09%)
Other Crops (8.19%)
Rubber (15.07%)
Guar Seed (33.24%)
Misc food crop (0.03%)
Misc non food crop (1.57%)
Fodder (31.93%)
Grass (17.79%)
Mulberry (0.04%)
Mushroom (0.34%)
By Products (5.56%)
Straw & Stalks (88.51%)
Others (11.49%)


Fruits & Vegetables
Fruits
Vegetables
Banana (8.09%)
Cashewnut (1.49%)
Potato (7.58%)
Sweet Potato (0.47%)
Tapioca (1.22%)
Onion (4.34%)
Mango (12.03%)
Floriculture (5.66%)
Grapes (1.41%)
Papaya (1.56%)
Apple (1.21%)
Mosambi (0.64%)
Lemon (1.76%)
Orange (3.91%)
Other Citrus Fruit (0.29%)
Litchi (0.76%)
Pineapple (0.87%)
Sapota (0.77%)
Cherry (0.02%)
Almonds (0.05%)
Jack Fruit (0.58%)
Pear (0.23%)
Walnut (0.74%)
Guava (1.29%)
Gooseberry (0.59%)
Plum (0.24%)
Passion Fruit (0.05%)
Peach (0.19%)
Pomegranate (1.11%)
Other Temperate Fruits (0.01%)
Other Fruits (2.35%)
Brinjal (5.58%)
Cabbage (2.93%)
Cauliflower (4.20%)
Okra (3.32%)
Tomato (6.32%)
Drum Sticks (0.74%)
Green Peas (2.35%)
Beans (1.29%)
Bittergourd (0.43%)
Bottlegourd (0.48%)
Capsicum (0.10%)
Carrot (0.38%)
Cucumber (0.20%)
Muskmelon (0.22%)
Parmal (0.08%)
Radish (0.84%)
Pumpkin (0.15%)
Watermelon (0.92%)
Other Vegetables (7.97%)


Livestock (26.80%)
Fisheries (4.50 %)
Forestry (7.89%)
Milk Group (66.1%)
Meat Group (20.60%)
Eggs (3.43%)
Wool & Hair (0.10%)
Silk worm & Honey Cocoon (0.87%)
Dung (6.31%)
Increment in Livestock (2.09%)
Inland Fish (58.67%)
Marine Fish (41.33%)
Meat (92.36%)
Bovine (12.58%)
Mutton (31.92%)
Pork (4.09%)
Poultry Meat (43.06%)
Meat Products (3.31%)
By-products (4.33%)
Hides (1.86%)
Skins (1.15%)
Other by Products (1.32%)
Wool (72.16%)
Hair & Bristle (27.78%)
Dung Fuel (34.88%)
Dung Manure (65.12%)
Industrial Wood (49.05%)
Firewood (32.28%)
Non Timber Forest Product (18.66%)

The agricultural commodities stand at different positions in volume and value status. This gives an idea about the importance of a commodity and helps in identification of potential of the particular commodity. Box 2.2 provides the segregation of different agricultural commodities on the basis of their volume and value shares. It is identified that sugarcane occupying largest position (first place) with 34 per cent share in volume is placed at 7th place in value pyramid with 4 per cent share. However, cereals position has increased from 3rd place at the volume pyramid to 2nd place at the value pyramid. Higher switching of position is seen in case of meat and milk. Respectively from 0.6 and 13 per cent in the volume pyramid, meat and milk have reached to 7 and 24 per cent in the value pyramid, which indicates their importance in the agriculture sector.

Box 2.2 Area, Volume and Value Pyramid

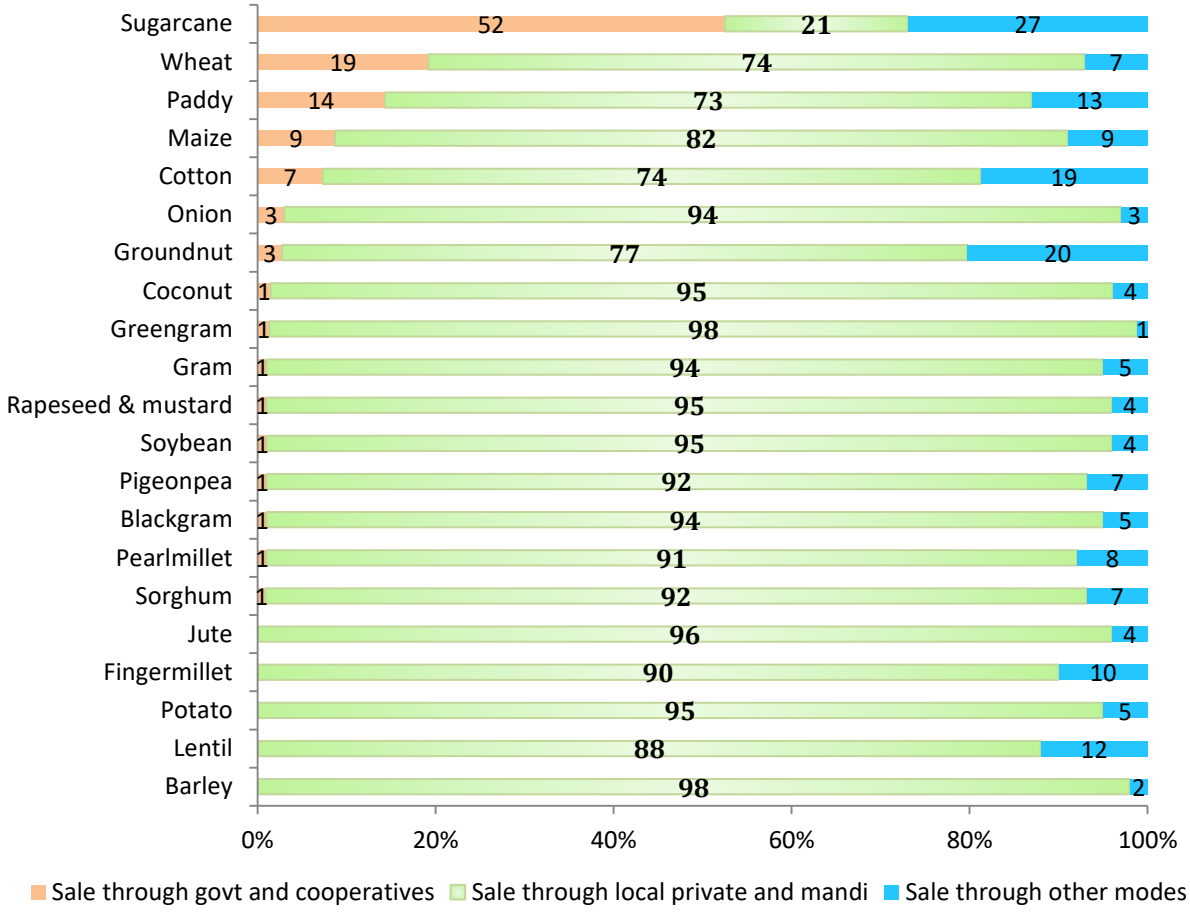


Source: DFI Committee

2.3. Marketing Interventions in what is Produced

Marketing played the prime factor in assessing the agricultural situation in India. Major problem faced by farmers is where to sell his produced in the market so that he can get remunerative prices. In this context role of agency for sale has prime importance and choosing between the agencies is governed by several factors; price offered, being the prime one. So, in the above context, crop sold through various modes by the farmers is shown in Fig 2.1 As it is observed, majority of sale is being done through local private and mandi in almost all of the crops and only few are being sold through government and cooperatives. This raises a question on the procurement scenario in India, as major crops like paddy and wheat whose procurement is well governed and monitored through FCI also shows a lower sale through government and cooperative agency in the country. Only in case of sugarcane, majority of sale is done through government and cooperative agencies while in all other crops it is through local private and mandi.

Fig 2.1 Sale of different commodities through various agencies



Source: DFI Committee Estimates based on NSSO (2014)

Price policy plays a pioneer role in the economic development of a country. It is an important instrument for providing incentives to farmers for motivating them to go in for production oriented investment and technology. The agricultural price policy in India is basically aimed at intervening in agricultural produce markets to influence the level of fluctuations in prices and price-spread from farm gate to the retail level (Government of India [GOI] 2010). India's

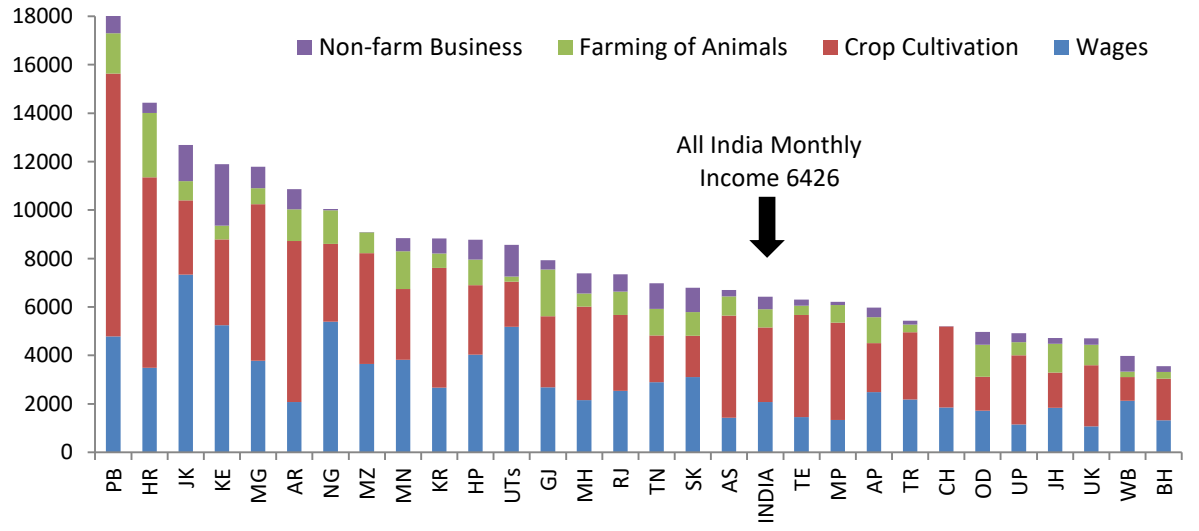
agricultural price policy includes three main types of administered prices: support, procurement, and issue price. The support price is generally announced at sowing time, and the government agrees to buy all grain offered for sale at this price. These prices guarantee to the farmer that, in the event of excessive production leading to oversupply in the market, prices of his produce will not fall below the support price. Support prices generally affect farmers' decisions indirectly, regarding land allocation to crops. The areas to be sown, however, depend upon the actual prices farmers realized for the previous crop and their expectations for the coming season.

Procurement of food grains at MSP is carried out by Food Corporation of India (FCI). FCI operates however, in only selected states and selected districts which had surplus of food grains initially. The quantity to be procured is determined by the government's needs for disbursements under the public distribution system. The role of the Food Corporation of India (FCI) has evolved over time, from being an agency to procure food grains and distribute to states for the operation of the public distribution system (PDS), in recent years it has become a device of maintaining the Minimum Support Prices by procuring whatever is offered.

2.4. Farm Households' Income: Major Sources at State Level

Box 2.3 provides income estimates and sources of income across states. The share of income derived from crop cultivation is relatively higher in Punjab, Haryana, Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Uttarakhand; while the least is noticed in case of Jammu & Kashmir, Tamil Nadu and West Bengal. It is difficult to demarcate and identify different categories on the basis of sources of income. Even the composition of different sources of income in the best performing state, viz. Punjab and the least performing state, viz. Bihar is quite similar. The income from farming of animals occupies larger share in Haryana, Gujarat, Odisha, Jharkhand and Andhra Pradesh; while least is observed in Kerala, Chhattisgarh, Karnataka and West Bengal.

Box 2.3 Categorisation of States on the basis of Income (monthly)



Source: DFI Committee Estimates based on NSSO (2014)

It is surprising to note that Chhattisgarh derives total income only from crops and wages; thus, the state needs special consideration in terms of preparation of strategic plan of the state. As far as non-farm and wages & salary as alternate sources of income are concerned, states like Kerala, Jammu & Kashmir, Himachal Pradesh, Tamil Nadu and West Bengal earn maximum from these two sources. As these states are special states in terms of the typology i.e. the states fall into either hilly or coastal typology and thus being dominated by specialised horticultural and fishery products. Thus, farmers rely on alternate sources to ensure their livelihood. Again, these states need special attention and separate strategic framework is required for doubling of income.

2.5. Current Status of Farm and Non-Farm Income across States

Chand et al (2015) provided the farm income details for the income earned by a cultivator, per unit of net sown area per household/holding along with the income earned by a labour. Between 1983–84 and 2011–12, the real farm income per cultivator deflated by CPIAL (base year 2004–05) rose 2.7 times, from Rs 16,103 to Rs 42,781; In 2011–12, a cultivator earned an annual income of Rs 78,200 at current prices; while one hectare of net cultivated area generated an income of Rs 80,800 to a farmer (Table 2.3).

The farm income in real terms increased at the rate of 3.67 per cent per year between 1983–84 and 1993–94. The annual growth rate of the income of farmers accelerated to 5.36 per cent after 2004-05. The growth figures measured on the basis of different denominators like per cultivator, per holding or per hectare of NSA basis also appeared promising in 2004-05 to 2011-12 as compared to the previous period i.e., 1993/94 -2004/05. An impressive growth in farm income on per cultivator basis in 2004-05 to 2011-12 was mainly due the decline in number of cultivators from 16.7 crores in 2004–05 to 14.6 crores in 2011–12.

Table 2.3 Real and Current Farm Income and Wage Earnings of Agricultural Labour

Year	Per cultivator	Per hectare net sown area	Per holding	Wage earning per labourer
Real income				
1983–84	16,103	14,798	22,603	5,513
1987–88	17,030	16,770	22,298	6,630
1993–94	21,110	21,345	27,147	8,168
1999–00	26,875	26,437	31,325	9,931
2004–05	26,146	30,755	34,103	10,043
2011–12	42,781	44,176	44,688	17,662
Income at current prices				
2011–12	78,264	80,817	81,753	32,311
Growth in farm income				
Period	Total	Per Cultivator	Per Holding	Per Hectare of NSA
1983-84 to 1993-94	3.67	2.74	1.85	3.73
1993-94 to 2004-05	3.30	1.96	2.10	3.38
2004-05 to 2011-12	5.36	7.29	3.94	5.31

Source: Chand et al (2015)

A decent growth in farm income requires some cultivators moving away from agriculture along with high growth in output and favourable prices for farm produce as has been also opined by Chand et al. (2015). This again emphasized the need of employment in non-farm sectors and income from wages and salaries to reduce the income disparities and promotion of inclusive growth.

Key Extracts

- States like Bihar, Goa, Madhya Pradesh and Uttarakhand have shown impressive performance and have grown at the rate of more than 9 per cent per year during 2010-11 to 2014-15. The trend of declining share of agriculture in total output has continued till recent times. Not just agriculture reflects declining contribution but the manufacturing sector as well. Despite of higher share than agriculture, in many of the states, share of manufacturing has also declined during this period.
- Service sector has captured the momentum and compensated the decline in output in agriculture and manufacturing.
- The share of income derived from crop cultivation is relatively higher in Punjab, Haryana, Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Uttarakhand while income from farming of animals occupies larger share in Haryana, Gujarat, Odisha, Jharkhand and Andhra Pradesh. Surprisingly Chhattisgarh found to derive total income from crops and wages; thus the state needs special consideration for preparation of strategic plan for agricultural sector.
- As far as non-farm and wages & salary as alternate sources of income are concerned, states like Kerala, Jammu and Kashmir, Himachal Pradesh, Tamil Nadu and West Bengal earn maximum from these two sources. As these states are having special typology i.e. the states fall into either hilly or coastal typology, agriculture in these states are dominated by horticultural and fishery products. Again these states need special attention and separate strategic framework for doubling income of farmers.
- As moving away from agriculture has been reported as an important factor for impressive growth in farm income, the diversification in the sources of income like employment in non-farm sectors and earnings from wages and salaries, should be the policy focus of the government if doubling of farm income is stated objective.

Chapter 3
Technology and Cultivation Practices

This chapter exhaustively covers technology and cultivation practices followed across states. The chapter emphasizes the issues and exigency of yield gaps and contribution of total factor productivity (TFP) bridging this gap. Apart from that, the chapter provides detail description of regional use pattern of various inputs like irrigation, seed, fertilizer and credit; and brings out the role and importance of technology and infrastructure in enhancing the farmer's income and meeting the objective of doubling farmer's income within the stipulated time.

3.1. Managing Yield Gaps

There exist huge yield gaps in agricultural sector. A study by Planning Commission estimated these yield gaps between 6 to 300 per cent in cereals, 5 to 185 per cent in oilseeds and 16 to 167 per cent in sugarcane (Planning Commission, 2007). Such gaps exist at two levels—one, between the best scientific practices and the best field practices and second, between the best field practices to the average farmer practices and these gaps are caused by a number of environmental factors. If these yield gaps are addressed through proper scientific and management interventions, there can be significant gain in output.

If we examine the production portfolio of the country, rice and wheat are the staple crops of India and are extremely important in terms of food security of majority of the population in different regions in the country. Rice is grown throughout the country under different agro-climatic conditions. The total domestic demand for rice is estimated to be 113.3 million tonnes and requires 28-29 per cent yield enhancement to achieve 2.65 tonnes per hectare average yield for the year 2021-22 (Kumar et al., 2009). Considering the limited scope for area expansion under rice cultivation, the National Food Security Mission was launched in 2007-08 to enhance the production of rice, wheat and pulses. Despite many technological breakthrough especially in rice and wheat crops, the crop yield realized at farmers' field remain considerably lower than the demonstration yields. Table 3.1 provides the yield gaps for rice and wheat across major producing states of the country. The average state yield in all the producing states is much lower than the experiment station yield; however, the magnitude of yield differential varies across states.

The yield gap (percentage difference between state average yield and average potential yield of rice) was found to be higher in Madhya Pradesh (57.6%), followed by Chhattisgarh (53.4%), Maharashtra (49.7%), Odisha (45%), Assam (43.7%), Karnataka (39.5%), Haryana (35.3%), U.P. (34.1%), and Tamil Nadu (32.5%). Subsequently, yield gap (%) in these states was also found to be higher than that of the national average (30.8%). Thus, it means that these states having a higher potential yield as compared to the existing average yield have realized more than 31 per cent of yield potential of rice as expressed by experimental yields given in Fig 3.1. If these yield gaps are addressed, it would significantly contribute in the mission of doubling farm income of India by 2022-23.

The average yield gap (i.e., differences between the state average yield and average experimental yield) of wheat, three states namely Haryana, Punjab, and West Bengal

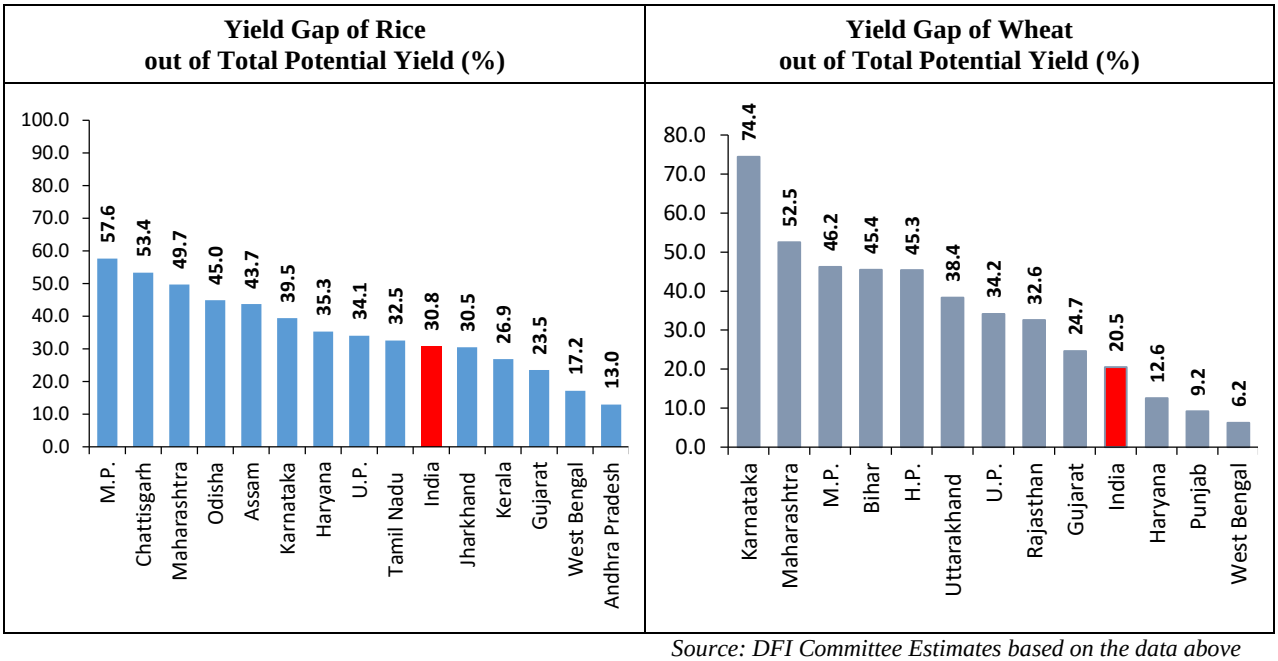
accounted lesser yield gap than the national level which was 7.88 qtl/ha (Table 3.1). Minimum yield gap of 1.83 qtl/ha was recorded in case of West Bengal. However, the average state yield and average experimental yield was much less compared to the major producing states of Punjab and Haryana. Punjab and West Bengal are the only two states which have realized more than 90 per cent of yield potential of wheat expressed by experimental yields, while Haryana has realized about 87.44 per cent of yield potential expressed by experimental yields conducted in the respective states.

Table 3.1 State-wise Actual, Experimental and Yield Gaps in Rice and Wheat in India during 2009-10 to 2013-14

States	Rice (Q/ha)			States	Wheat (Q/ha)		
	State Yield	Experimental Yield	Yield Gap		State Yield	Experimental Yield	Yield Gap
Karnataka	26.6	43.9	17.3	Karnataka	9.3	36.2	26.9
Madhya Pradesh	12.8	30.1	17.3	Madhya Pradesh	22.2	41.2	19.0
Maharashtra	18.1	35.9	17.9	Maharashtra	16.0	33.6	17.6
Uttar Pradesh	23.0	34.9	11.9	Uttar Pradesh	30.5	46.3	15.8
West Bengal	26.8	32.4	5.6	West Bengal	27.6	29.4	1.8
Gujarat	20.4	26.6	6.3	Gujarat	30.3	40.2	9.9
Haryana	30.7	47.5	16.8	Haryana	46.1	52.7	6.6
Punjab	50.4	64.6	14.2	Punjab	47.3	52.1	4.8
Odisha	16.6	30.1	13.5	Himachal Pradesh	15.4	28.1	12.7
Andhra Pradesh	30.6	35.2	4.6	Rajasthan	30.7	45.5	14.8
Assam	18.9	33.5	14.7	Uttarakhand	23.3	37.7	14.4
Chhattisgarh	15.8	33.9	18.1	Bihar	22.0	40.4	18.4
Jharkhand	20.1	28.9	8.8	**India**	**30.6**	**38.4**	**7.8**
Kerala	25.7	35.2	9.5				
Tamil Nadu	31.9	47.3	15.4				
India	**23.27**	**33.63**	**10.36**				

Source: NFSM, Govt. of India (http://nfsm.gov.in/fld.aspx), Siddiq (1998)

Fig 3.1 State-wise Share of Average Yield Gaps in Rice and Wheat out of Total Potential Yield during 2009-10 to 2013-14



Source: DFI Committee Estimates based on the data above

If these yield gaps are addressed for rice and wheat crops, these can contribute significantly to the output of these crops and meeting the food security requirements of the country.

3.2. Yield Gap and Yield Improvement Strategies

Technology adoption helps in reducing yield gap at farm level. The estimates derived for 2011-12 and 2013-14 show considerable yield gap across states among different crops (Table 3.2). Yield gap in paddy varied around one-fourth to one third. The estimates with respect to the best performing farmers in major paddy growing states like West Bengal, Uttar Pradesh, Andhra Pradesh and Punjab are 33, 29, 29 and 28 per cent respectively. In wheat, the estimates are slightly less. For Punjab and Haryana, it stands at 19 and 23 per cent, whereas for Uttar Pradesh and Madhya Pradesh, the corresponding figures are 27 and 33 per cent. There exists considerable yield gap in coarse cereals and pulses.

The states like Maharashtra and Karnataka in Jowar and Rajasthan in Bajra have yield gap of more than 50 per cent. Among pulses, while yield gap stands at 32 per cent in Madhya Pradesh for gram, it stands at 45 per cent in Rajasthan and Maharashtra. In case of tur, the yield gap stands at 60 per cent in Maharashtra and Karnataka. The estimate for maize stands at 33 per cent in Andhra Pradesh, whereas it accelerates to 45 per cent and 58 per cent in Karnataka and Bihar respectively. In Rajasthan, the estimates stand highest to 63 per cent. Estimates for cotton stands at around 45 per cent in Gujarat and Maharashtra. In Andhra Pradesh, it is slightly less (38 per cent). The estimates of sugarcane, the other major cash crop are 25 per cent, 35 per cent and 41 per cent for Uttar Pradesh, Karnataka and Maharashtra respectively.

The issue can be addressed by expanding irrigation, use of improved seeds in sowing and better credit access. For example, the Paddy yield levels can be appreciably raised in West Bengal through irrigation, where just around half of the area is irrigated. The yield differential between irrigated and unirrigated farms is significant, and is more by 6 quintals/ha in irrigated farms. Coarse cereals like Jowar and Bajra are barely irrigated in practice. Still, use of improved and hybrid seeds can help in bridging yield gaps.

The yield that the hybrids and improved seeds provide are relatively higher, and thus could be thought as a potential way of addressing the yield gap. Pulses are mainly grown as a rainfed crop. Despite, yield responses are positive and significant for irrigation, and better seeds provide better yields. The Gram yield levels are higher by 2.0 and 4.6 quintals/ha in Madhya Pradesh and Rajasthan, and in case of Tur, it is more than 5 quintals/ha in Maharashtra and Madhya Pradesh. Moreover, higher yields also correspond with improved seeds use.

The strategy of irrigation expansion holds true for Maize as well. Area covered under irrigation in major states like Andhra Pradesh and Karnataka are 50 per cent and 36 per cent respectively. The other major state Bihar, also suffers with less use of improved seeds. Only two-third of the farmers use hybrids and improved seeds use, and irrigation coverage is just 65 per cent. Being an input responsive crop, yield levels can be raised by better seed delivery

and irrigation. Irrigated cotton farms produce higher yield than the rest. The yield margins in irrigated farms are 11 qtl/ha and 6 qtl/ha in Gujarat and Maharashtra respectively

Table 3.2 Yield Gap and Associated Parameters (2011-12 to 2013-14)

Crop	State	Actual yield (qtl/ha)	Benchmark yield (qtl/ha)	Yield gap (%)	Improved, hybrid seeds (%)	Area under Irrigation (%)
Paddy	West Bengal	41	61	33	98	48.2
	Uttar Pradesh	39	55	29	100	83.1
	Andhra Pradesh	55	78	29	95	96.8
	Punjab	59	82	28	100	99.6
Wheat	Uttar Pradesh	36	50	27	98	98.4
	Punjab	48	59	19	100	98.9
	Madhya Pradesh	33	50	33	100	90.8
	Haryana	46	60	23	96	99.5
Jowar	Maharashtra	14	30	53	59	9.5
	Karnataka	11	24	56	66	11.5
Bajra	Rajasthan	13	26	50	78	3.3
	Uttar Pradesh	22	33	35	83	8.9
Maize	Andhra Pradesh	55	82	33	99	49.5
	Karnataka	39	70	45	98	36.0
	Bihar	26	61	58	67	65.2
Gram	Madhya Pradesh	11	16	32	100	57.9
	Rajasthan	11	20	46	50	49.2
	Maharashtra	12	23	45	84	24.2
Tur	Maharashtra	20	51	61	70	1.5
	Madhya Pradesh	10	15	36	52	1.6
	Karnataka	11	26	59	23	5.1
Cotton	Gujarat	19	35	47	-	58.7
	Maharashtra	18	33	45	-	2.7
	Andhra Pradesh	16	26	38	-	13.9
Sugarcane	Uttar Pradesh	515	688	25	-	95.1
	Maharashtra	989	1667	41	-	100.0
	Karnataka	778	1200	35	-	100.0

Source: DFI Committee Estimates. Yield gaps and seeds use are estimated based on MoAFW data (various years); irrigation coverage is based on Agricultural Statistics at a glance, 2015.

Note: Estimates of yield gap and seed use are obtained for 2011-12 to 2013-14. Yield at 90th percentile is used as bench mark in computing the estimates. Irrigation figures correspond to the year 2012-13.

Cash crops like maize and cotton as well provide high yield gap estimates across states. Expanding irrigation and delivering improved seeds together could help in addressing yield gap in gram and tur successfully. Sugarcane and wheat require special attention. Almost entire area is irrigated, and all the area under wheat are sown with improved and hybrid seeds. Still, there exist yield differences across and within the states.

3.3. Contribution of Total Factor Productivity (TFP)

A significant contributor to output growth would be the total factor productivity (TFP). A number of studies have been conducted on TFP, which dealt with disaggregated regions and crops, the summary is provided in Table 3.3. A recent exhaustive study completed at ICAR-

NIAP established that annual TFP growth in agriculture was around 1.55 per cent during 1980-81 to 2011-12 and it improved to 5.49 per cent during 2004-05 to 2011-12 (Jain and Chand, 2015). According to another study, estimated TFP growth was 2.33 per cent per year for crop sector, 2.66 per cent per year for livestock sector and 2.41 per cent per year for crops and livestock combined during 1981 to 2001 (Avila and Evenson, 2004). Study by the Reserve Bank of India establishes the TFP trend growth rate during 2000-08 at 0.7 per cent based on value added function framework (Goldar *et al.,* 2014). Chand et al (2012) estimated crop-wise and state-wise TFP and the given growth ranged from as low as -0.69 in red gram to as high as 1.92 in Wheat during 1975 to 2005.

Table 3.3 Growth in Total Factor Productivity

Author(s)	Commodity	Period	TFP Growth (%)	Author(s)	Commodity	Period	TFP Growth (%)
Evenson et al. (1999)	Crops	1956-65	1.1	**Jain and Chand (2015)**	Agriculture	1980-81 to 2011-12	1.55
		1966-76	1.39			2004-05 to 2011-12	5.49
		1977-87	1.05	**Chand et al. (2011)**	Rice	1975-85	0.9
Birthal et al. (1999)	Livestock	1951-70	-0.04			1986-95	0.74
		1970-80	0.93			1996-05	0.4
		1980-95	1.79			1975-2005	0.67
Fan et al. (1999)	Crops and Livestock	1970-79	1.55		Wheat	1975-85	1.6
		1980-89	2.52			1986-95	2.51
		1990-94	2.29			1996-05	1.61
		1970-94	1.75			1975-2005	1.92
Coelli and Rao(2003)	Crops and Livestock	1980-00	0.9		Gram	1975-85	0.06
Avila and Evenson (2004)	Crops	1961-80	1.54			1986-95	0.09
		1981-01	2.33			1996-05	0.34
	Livestock	1961-80	2.63			1975-2005	0.16
		1981-01	2.66		Groundnut	1975-85	0.49
	Crop and Livestock	1961-80	1.92			1986-95	0.55
		1981-01	2.41			1996-05	1.3
Joshi et al. (2003)	Rice (IGP)	1980-90	3.5			1975-2005	0.77
		1990-99	2.08		Cotton	1975-85	2.84
	Wheat (IGP)	1980-90	2.44			1986-95	0.92
		1990-99	2.14			1996-05	0.8
Kumar et al. (2008)	Wheat	1971-86	1.28			1975-2005	1.41
		1986-00	0.68	**Rada (2016)**	Grains	1980-2008	-1.83
	Pulses	1971-86	0.52		Pulses		-4.03
		1986-00	-0.39		Horticulture		2.45
	Oilseeds	1971-86	0.14		Oilseeds		-0.12
		1986-00	0.33		Specialty crops		-0.41
	Sugarcane	1971-86	0.79		Animal product		1.18
		1986-00	-0.1				

A study on change and efficiency of rice production in India by Suresh A. revealed that the mean TFP change for rice has been to the tune of 0.2 per cent per year during the overall period 1980-2009; the decomposition analysis indicated that the change in TFP was associated with the technical progress of 0.3 per cent and the deterioration of technical efficiency to the tune of -0.1 per cent indicating that technical efficiency could not catch up with the technical progress and was pulling down the TFP growth. Kumar et al (2008) indicated that the productivity gains occurred for sugarcane during the early years of green revolution have exhausted their potential.

About 90 per cent area under sugarcane during 1990s was facing stagnated TFP status, thus, the technological stagnation or decline is apparent in case of sugarcane it is the priority for the present and future agricultural research.

Murali (2012) revealed that a comparison of the productivity in the pre-introduction of the variety Co86032 period with after introduction of variety Co86032 shown that more technological progress and hence more improvement in productivity was recorded after introduction of variety Co86032 than pre introduction of variety Co86032 period. Co86032 variety is an early season variety which performs well in all soil types and extremely well in garden land condition, yielding good quality cane with higher yield having multi ratooning capacity and can be grown throughout the year.

The annual TFP growth over the whole period is 7.6 per cent. The improvement was more due to technological progress rather than improvement in efficiency. The study indicates greater TFP changes after introduction of variety Co86032 than pre introduction of variety Co86032.

3.4. Determinants of TFP

Understanding TFP and its various components help in increasing productivity and output. The major determinants from few previous standards on TFP growth and its determinants in Indian context are extracted here, for reference.

Tale 3.4 lists the major determinants from studies conducted like like Evenson, R. E., C. E. Pray, and M. W. Rosegrant (1998); Chand et al. (2012), Suresh K. and Chandrakanth M.G. (2015) ; Kannan E. (2011) ; Desai? Bhupat M. et al., (1997); and Rosegrant W. M. and Evenson R. (1995)]

These studies raise the issues of nature of TFP, its measurement, and its contribution. The studies highlight that TFP change is most influenced by government expenditure on research and development and agricultural extension, development of infrastructure like rural roads and regulated markets, along with balanced used of fertilizers and assured irrigation.

Table 3.4 Determinants of TFP Growth

Study	Study reference period	Sector/ crop	Region	TFP trends	Significant determinants and respective contribution
Evenson, R., Pray, C. and Rosegrant, M. (1999) Agricultural research and productivity growth in India. Research Report Number 109,	1956-87	For the major crops	All-India Level	For the period of 1956–65 was 1.27, 1.49 for the period of 1966–76 and for the period of 1977–87 the TFP was 1.1.4. Overall for the period of 1956–87 the TFP was 1.31.	Public sector research and extension and private sector research (invention) and adoption of modern varieties
Kumar P. and Sant Kumar (2012). Total Factor Productivity and Returns to Public Investment on Agricultural Research in India, Ramesh Chand,	1975-2005	For the major crops	All-India Level	Annual rate of TFP growth was 1.9 per cent for wheat, 1.4 per cent each for maize and barley, 1 per cent for pearl millet, 0.7 per cent for rice and 0.6 per cent for sorghum. The TFP growth in the edible oilseeds varied in the range of 0.7 - 0.8 per cent annually. Among pulses, TFP growth for green gram (0.5%), chickpea (0.2%). 1.4 per cent for cotton and 1.3 per cent for jute during 1975-2005.	Public investment in research; Public investment in the transfer of technology (extension) ; Natural resources management and infrastructure ; Assured irrigation water along with balanced use of fertilizers, Road density and electricity supply
Suresh K. and M.G. Chandrakanth (2015). Total factor productivity and returns to investment in Ragi (finger millet) crop research in Karnataka state, India	1990-2009	Ragi (finger millet)	Karnataka state, India	TFP for ragi increased from 1.27 in 1991 to 2.88 in 2009. The average TFP index for 20 years was 1.87.	Public research, road density and rural literacy significantly contributed to TFP growth in ragi.
Kannan E. (2011): Total Factor Productivity Growth and Its Determinants in Karnataka Agriculture.	1980-81 to 2007-08	Paddy, jowar, maize, ragi, arhar, groundnut, sunflower, safflower, cotton and sugarcane	Karnataka	Most crops have registered a decline in productivity growth during the nineties. During 2000-01 to 2007-08, all crops have showed positive growth in TFP.	Government expenditure on research, education and extension, canal irrigation, rainfall, and balanced use of fertilisers are the important drivers of crop productivity in Karnataka.

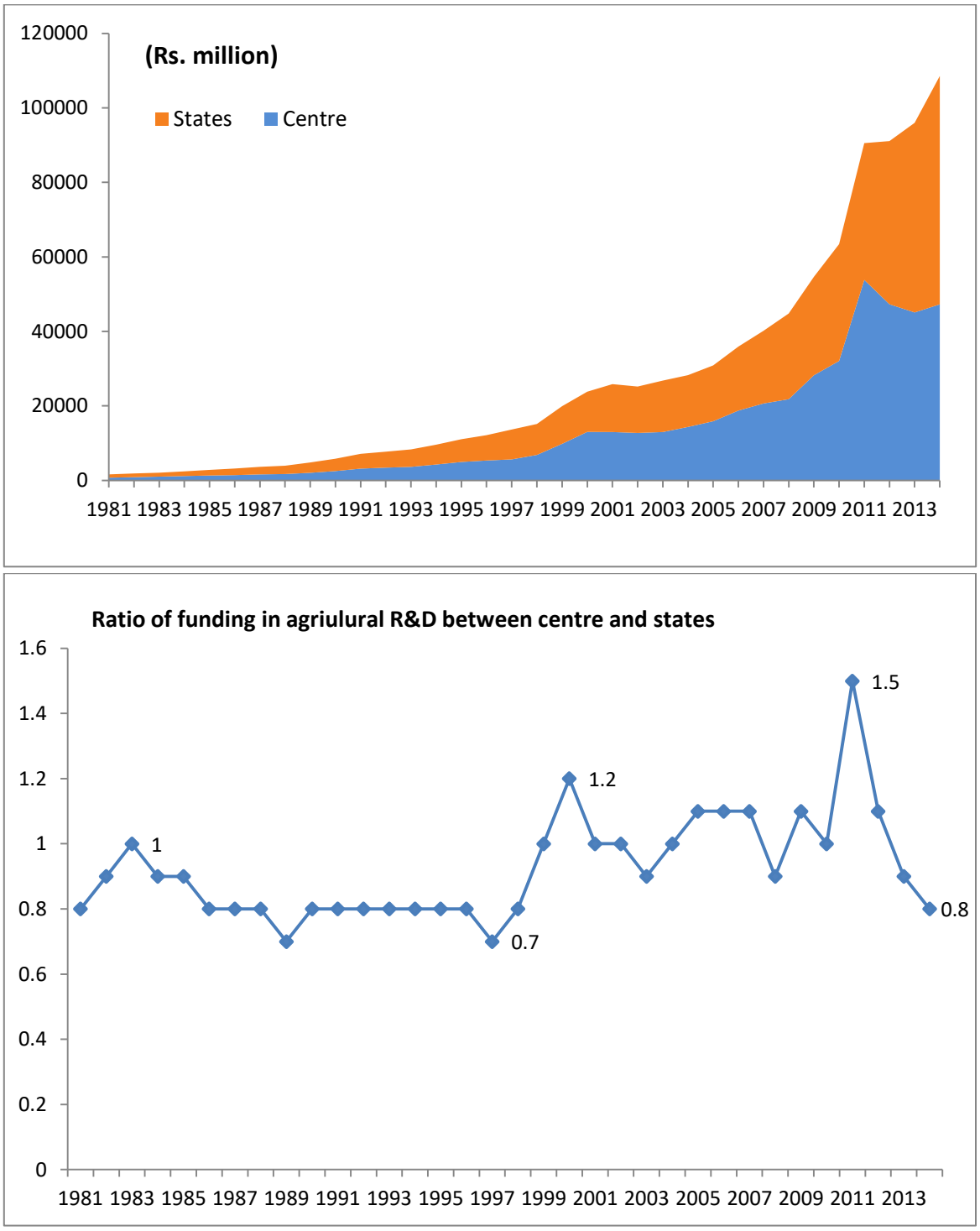
Study	Study reference period	Sector/ crop	Region	TFP trends	Significant determinants and respective contribution
Bhupat M Desai and N V Namboodiri (1997), Determinants of Total Factor Productivity in Indian Agriculture	1966-67 to 1989-90	For the major crops	All-India Level	The average annual Compound Growth Rate TFP index for the said period is 1.699.	Government expenditure on agricultural research and education and crop production programme, Gini ratio of operational land distribution, (OPLE), Per cent of rural literacy, Gini ratio of owned land distribution (ONLE) and Density of rural roads.
Mark W. Rosegrant and Robert E. Evenson, 1995,Total Factor Productivity And Sources Of Long-Term Growth In Indian Agriculture	1956-1987	Rice, wheat, sorghum, pearl millet, and maize along with fourteen minor crops	For 271 districts covering 13 states in India, 1956-87.	Total factor productivity for 1957-67 is 1.10, for 1967-76 it is 1.39 and for 1976-86 is 1.05 overall for the period 1957-86 the TFP value is 1.13.	Agricultural Extension, Public research, Foreign Private (Research and development) and Domestic Private (Research and Development).

Note: The detailed sources have been cited in References

These studies provide sufficient evidence to conclude that investment in agricultural research has resulted in good returns. Thus policies for supporting and further strengthening of research and extension system of the nation should be continued. Also, it is clear that India has achieved significant total factor productivity which enabled the nation to increase food production despite high population density and limited scope for cropland increase as a source of output growth. Besides these, infrastructure in terms of rural roads, electricity, markets, literacy etc play important role in enhancing the total factor productivity.

Most of the studies (Table 3.4) suggested that investment in public sector research is an important determinant for total factor productivity. Thus, most of these studies suggested and opined that India is benefiting from its investments on research and development. This calls for increasing research and extension programs but such a development should be supported by careful review of existing projects and programs. Fig. 3.2 depicts the trend of funding for agricultural research and education in India over various years. Growth is evident especially since the late 1990s and there has been continuous increase in funding both from the Union and State governments. Investment for agricultural research and education for the year 2014 stood at stood at Rs. 108.5 billion, of this, the Union Government contributed around 43.5 per cent and the rest 56.5 per cent was contributed by the State Governments (Pal, 2017).

Fig 3.2 Trends in public funding for agricultural research and education in India



Source: Pal (2017)

Table 3.5 provides the comparison of agricultural research funding for the year 2011-12 for India with other developing countries. China spends nearly 9,366 million 2011 PPP dollars on agricultural research and the intensity of funding (funding as percentage of AgGDP) has reached 0.62 per cent of AgGDP (Pal, 2017). Further, against 10,242 FTE scientists in India China has got around 43 thousand FTE scientists.

Table 3.5 International comparison of agricultural research funding, 2011-12

SN	Country	Number of scientists, Full-time equivalent	Funding in million 2011 PPP dollars	Research intensity (%)
1	Brazil	5,869.4	2,704.0	1.8
2	Bangladesh	2,121.0	250.6	0.4
3	China	43,000.0	9,366.0	0.6
4	Malaysia	1,609.4	592.3	1.0
5	Pakistan	3,678.3	333.0	0.2
6	Sri Lanka	618.8	61.8	0.3
7	South Africa	746.3	294.5	2.0
8	India	10,242.0	3,533.0	0.4

Source: Pal (2017)

The recent study by Pal (2017) reported that research and development for the Indian agriculture has so far responded well to the national challenges; now the basic thrust must be for developing local capacity to carry forward the findings at the top level so that the people at the grass root level will harness the maximum benefit from these researches. The system is to be developed in such a way that it not only complies with international commitments and scientific principles but also seeks participation of stakeholders and incorporates social voice in decision making along with the consideration of development challenges at different levels like efficient and inclusive development, sustainability of natural resources, nutritive and value products, environmental safety, etc., which are sometimes cumulative and conflicting needing more research resources and their targeting (Suresh Pal, 2017).

3.5. Irrigation Management in India

It has been reported that irrigation management can bring substantial growth in output through increase in productivity and saving of resources. As far as irrigation scenario is concerned, the irrigated area in the country increased by 11 per cent between TE 2006-07 and TE 2013-14 (Table 3.6). Irrigation intensity, expressed as the ratio of gross irrigated area (GIA) to gross cropped area (GCA), increased by 8 per cent. States like Madhya Pradesh, Chhattisgarh, Karnataka, Bihar, Gujarat and Rajasthan have shown appreciable increase in GIA and thereby increase in irrigation intensity. The growth performance (growth in GSDP) of these states has also been much ahead among other states.

The country has brought more land under irrigation consistently. Between TE 2006-07 and TE 2013-14, area brought under irrigation in Madhya Pradesh alone has been 2.8 million hectares, followed by Rajasthan (1.8 million ha), Gujarat (1.3 million ha) and Uttar Pradesh (1.1 million ha). Note that around half of the total cropped area in the country lies in Uttar Pradesh, Rajasthan, Madhya Pradesh & Maharashtra. Average area irrigated in these states respectively during the TE 2013-14 are 78 per cent, 38 per cent, 39 per cent and 19 per cent, respectively. This shows notable scope to bring more area under irrigation, especially in Maharashtra.

Table 3.6 State wise Irrigated Area

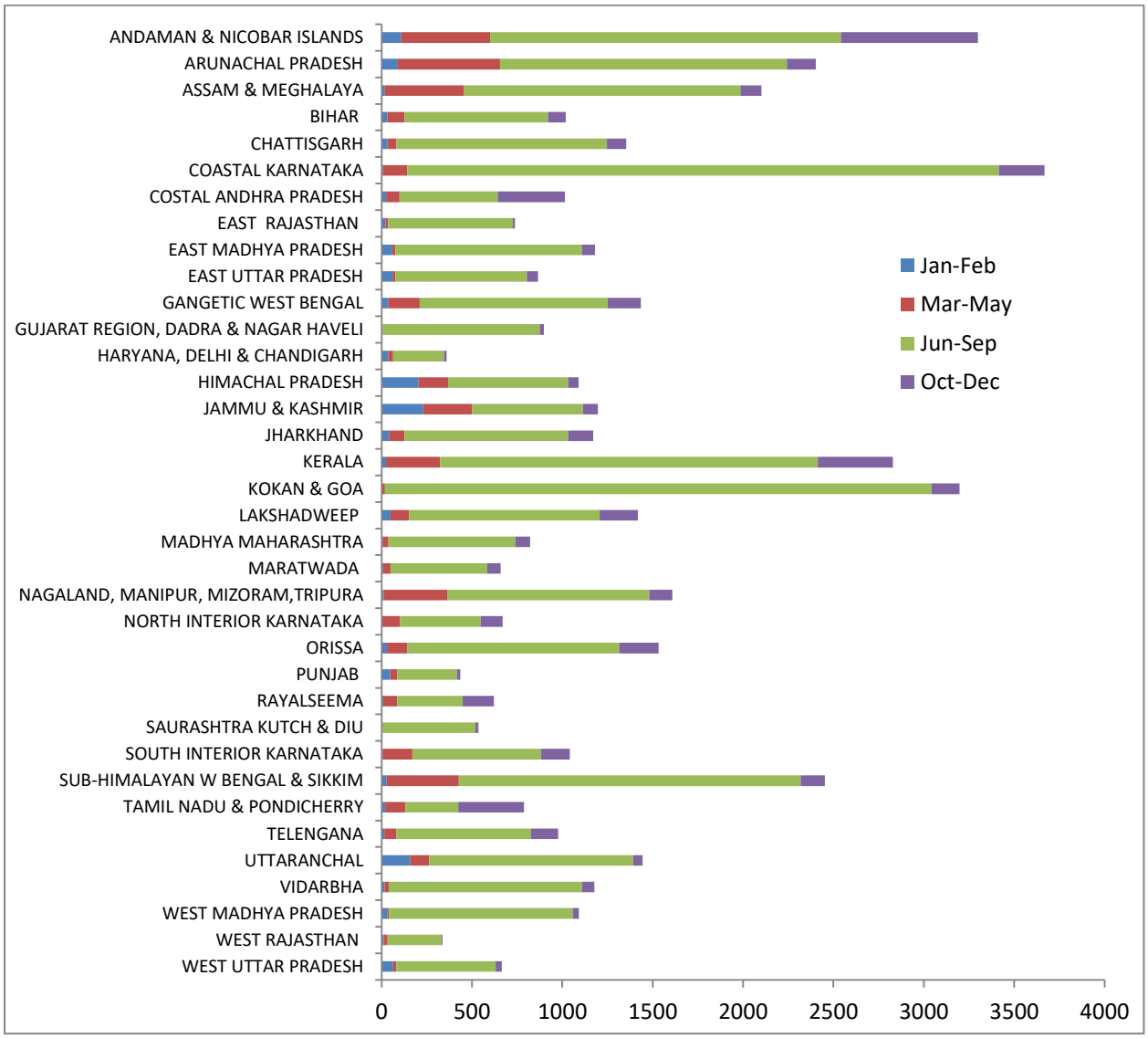
	Gross Cropped Area (Th ha)			Net Irrigated Area (Th ha)			Gross Irrigated Area (Th ha)			Irrigation Intensity		
States	***TE 06/07***	***TE 13/14***	***% Change***	***TE 06-07***	***TE 13/14***	***% Change***	***TE 06-07***	***TE 13/14***	***% Change***	***TE 06-07***	***TE 13/14***	***% Change***
Nagaland	391	487	25	66	86	31	106	95	-10	27	19	-28
Sikkim	123	143	16	12	13	16	16	13	-17	13	9	-28
Tripura	279	374	34	66	62	-7	103	102	-1	37	27	-26
Manipur	230	350	53	52	62	19	52	62	19	23	18	-23
Mizoram	95	109	15	15	14	-3	16	15	-10	17	13	-21
Odisha	8869	5067	-43	1976	1251	-37	2964	1479	-50	33	29	-13
Punjab	7886	7874	0	4040	4115	2	7683	7749	1	97	98	1
Jammu & Kashmir	1110	1160	4	311	323	4	457	488	7	41	42	2
West Bengal	9563	9477	-1	3151	3086	-2	5541	5577	1	57	59	3
Arunachal Pradesh	264	287	9	50	57	13	50	57	13	19	20	4
Haryana	6441	6445	0	2960	3035	3	5447	5686	4	85	88	4
Maharashtra	22498	22450	0	3269	3248	-1	4090	4260	4	18	19	4
Uttar Pradesh	25415	25885	2	13169	13921	6	19042	20165	6	75	78	4
Tamil Nadu	5922	5642	-5	2815	2762	-2	3264	3274	0	55	58	5
Goa	171	161	-5	24	39	63	39	39	0	23	24	6
Rajasthan	21432	24859	16	6223	7423	19	7623	9408	23	36	38	6
Himachal Pradesh	947	945	0	104	113	8	185	201	8	20	21	9
Uttarakhand	1219	1118	-8	345	335	-3	551	551	0	45	49	9
Andhra Pradesh	12897	11846	-8	4242	4226	0	5684	5716	1	44	49	10
Gujarat	11520	12724	10	3891	4233	9	4774	6055	27	41	48	15
Bihar	7505	7668	2	3219	3013	-6	4389	5210	19	58	68	16
Kerala	2967	2623	-12	396	401	1	468	490	5	16	19	18
Meghalaya	256	341	33	60	66	10	70	111	58	27	32	19
Karnataka	12757	12025	-6	2912	3472	19	3521	4085	16	28	34	23
Chhattisgarh	5731	5684	-1	1246	1442	16	1391	1708	23	24	30	24
Madhya Pradesh	19974	23231	16	6029	8631	43	6205	9037	46	31	39	25
Jharkhand	1611	1586	-2	106	193	83	150	211	41	9	13	42
Assam	3870	4116	6	140	262	87	152	305	101	4	7	90
ALL INDIA	**192074**	**196898**	**3**	**60937**	**66688**	**9**	**84037**	**93265**	**11**	**44**	**47**	**8**

Source: DFI Committee Estimates based on data compiled from DACNET

The states has been sorted according to the change in irrigation intensity during TE 06-07 and TE 13-14

Despite of higher irrigation share, while Madhya Pradesh and Uttar Pradesh has registered an 8 per cent and 3 per cent increase in irrigated area, Maharashtra has shown very little improvement. Between TE 2006-07 and TE 2013-14, irrigation intensity stagnates around 18%. Rather, higher expansion has been realized in Bihar (10%), Karnataka (6.4%), Gujarat (6.1%) and Chhattisgarh (5.8%). Further, having less land under irrigation, these states also provide further opportunity to expand irrigation, with appropriate planning.

Fig 3.3 Intensity and Distribution of Rainfall across States and Zones (TE 2012-13)



Source: Computed based on https://data.gov.in/resources/area-weighted-monthly-seasonal-and-annual-rainfall-mm-36-meteorological-subdivisions/download

It is also important to examine whether states with low irrigation intensity are able to meet some of the irrigation requirement from rainfall. Examining the distribution of rainfall pattern across states (Fig 3.3), it is observed that in case of north eastern states, Kerala and Karnataka the rainfall intensity was high, however, one can observe that these states were among the least irrigated states. Haryana and Punjab on the other hand succeeded in irrigated area with comparatively higher irrigation potential, but have low rainfall intensity.

3.6. Utilization of Irrigation Potential in India

Various steps have been taken by the Central and State Governments for development of irrigation potential and its utilisation in the country. The irrigation potential created and utilised till 2009-10 is given in Table 3.7. The irrigation potential (expressed as the share of ultimate irrigation potential) across states indicates that the states have created the potential ranging from as low as 36 per cent in Assam upto 112.7 per cent in Rajasthan. An examination of irrigation potential exhibits that the states like Himachal Pradesh, Maharashtra, Gujarat, Karnataka and Rajasthan have created significant irrigation potential during 1985-2010. States like Gujarat, Tamil Nadu, Karnataka and Rajasthan created more than 100 per cent irrigation potential by 2010, however, out of these only Karnataka utilised more than 100 per cent irrigation potential. Rajasthan and Gujarat could utilise only 50-60 per cent of the potential created. Thus, the gap between the irrigation potential created and utilised needs to be bridged to increase the production efficiency.

Table 3.7 Irrigation Potential Created and Utilized across States

State	Ultimate Irrigation Potential (Th ha)	Irrigation Potential Created (IPC) as per cent of UIP							Total IPC as % of UIP
		Before 1985	1985-90	1990-92	1992-97	1997-2002	2002-07	2007-10	
Assam	970	10.1	4.7	3.3	2.1	4.9	6.1	4.8	36.0
Madhya Pradesh	4853	32.8	4.6	3.0	7.3	-19.2	11.2	5.4	45.3
Himachal Pradesh	50	12.0	4.0	0.0	5.2	5.6	4.2	15.0	46.0
Bihar	5224	48.9	3.6	0.4	0.7	-2.3	3.8	0.3	55.4
Orissa	3600	34.3	3.3	1.5	4.1	7.5	4.1	2.0	56.8
Kerala	1000	37.5	2.7	1.4	9.7	9.6	6.0	2.3	69.3
Haryana	3000	64.1	3.3	0.5	1.5	0.7	3.1	0.4	73.5
Uttar Pradesh	12154	51.2	3.7	1.1	2.1	7.0	7.2	7.2	73.6
West Bengal	2300	51.5	2.6	4.7	4.0	10.4	3.1	7.2	76.7
Andhra Pradesh	5000	58.0	1.8	0.2	0.9	5.2	5.9	7.2	79.3
Jammu & Kashmir	250	61.2	2.0	0.0	6.3	2.4	3.0	5.2	80.1
Punjab	3000	75.1	3.1	0.8	4.9	1.0	1.1	2,5	88.2
Maharashtra	4100	42.0	6.4	1.1	6.9	22.6	6.2	7.0	92.2
Gujarat	3000	35.2	4.8	1.6	3.5	2.7	26.7	28.9	103.2
Tamil Nadu	1500	99.9	2.7	0.4	0.0	0.3	0.9	7.2	105.0
Rajasthan	2750	62.3	7.3	3.1	10.0	7.6	13.8	8.7	112.7
Karnataka	2500	46.6	5.7	2.8	11.6	18.2	20.7	6.9	112.4
Chhattisgarh	1147	0.0	0.0	0.0	0.0	80.4	18.7	5.4	104.6

Source: Central Water Commission (P&P Dte.) and Planning Commission.
The states have been sorted according to the last column

Owning to the fact that irrigation can increase production efficiency and thus output the Government of India has been implementing Centrally Sponsored Scheme on Micro Irrigation with the objective to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like drip & sprinkler irrigation technologies and encourage the farmers to use water saving and conservation technologies (Government of India, 2014).

It has been established that micro-irrigation can bring substantial increase in productivity and also result in water saving (Government of India, 2009). According to the report, increase in productivity ranged from 3 per cent in cow pea and cabbage to 27 per cent in gram. At the

same time, micro-irrigation resulted in water saving from 16 per cent in lucerne to 56 per cent in bajra and barley each.

Among different sources of irrigation, minor irrigation has certain advantages as it is less capital intensive and requires less time to construct, thus, in recent years, emphasis is being laid on the creation of minor irrigation schemes to cover both surface and ground water.

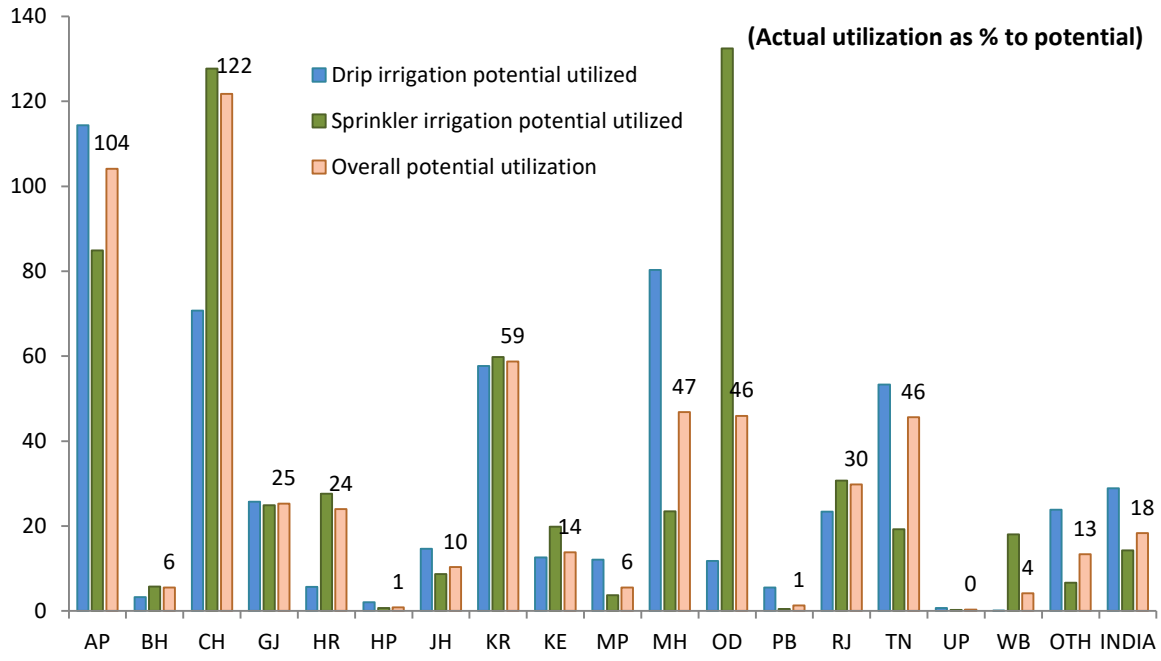
The recent statistics reveals that only 18 per cent of the potential area of 42.24 million hectares in the country is under minor irrigation (Table 3.8). Andhra Pradesh has utilized more than 100 per cent of the potential under minor-irrigation. It is reported that micro-irrigation systems like drips and sprinklers would significantly increase water-use efficiency and productivity.

Table 3.8 Status of potential and actual area under micro irrigation in India as on 31st March 2015 (million hectares)

State	Drip Irrigation		Sprinkler irrigation		Total	
	Potential	Actual	Potential	Actual	Potential	Actual
Andhra Pradesh	0.73	0.83	0.39	0.33	1.12	1.16
Bihar	0.14	0.00	1.71	0.10	1.85	0.10
Chhattisgarh	0.02	0.02	0.19	0.24	0.21	0.26
Gujarat	1.60	0.41	1.68	0.42	3.28	0.83
Haryana	0.40	0.02	1.99	0.55	2.39	0.57
HP	0.01	0.00	0.10	0.00	0.12	0.00
Jharkhand	0.04	0.01	0.11	0.01	0.16	0.02
Karnataka	0.75	0.43	0.70	0.42	1.44	0.85
Kerala	0.18	0.02	0.04	0.01	0.21	0.03
Madhya Pradesh	1.38	0.17	5.02	0.19	6.39	0.35
Maharashtra	1.12	0.90	1.60	0.37	2.71	1.27
Odisha	0.16	0.02	0.06	0.08	0.22	0.10
Punjab	0.56	0.03	2.82	0.01	3.38	0.04
Rajasthan	0.73	0.17	4.93	1.51	5.66	1.68
Tamil Nadu	0.54	0.29	0.16	0.03	0.70	0.32
UP	2.21	0.02	8.58	0.02	10.79	0.04
West Bengal	0.95	0.00	0.28	0.05	1.23	0.05
Others	0.15	0.04	0.23	0.02	0.38	0.05
Grand Total	11.66	3.37	30.58	4.36	42.24	7.73

Source: http://midh.gov.in/AtGlance/MI-AT-A-Glance.pdf and Palanisami (2011)

Fig 3.4 Micro-Irrigation Potential Utilized across States



Source: http://midh.gov.in/AtGlance/MI-AT-A-Glance.pdf

An impact evaluation study of National Mission on Micro-Irrigation was carried out and it reported that the irrigated area has increased in all the surveyed states after the introduction of NMMI Scheme. Maharashtra has topped the list with 22.28% growth in irrigated area followed by Chhattisgarh. The scheme has performed well in reducing the input cost and cost saving. The irrigation cost is reduced by 20%-50% with average of 32.3%. Saving of fertilizers with averages reduction of about 28% in total fertilizer consumption in the surveyed states (Table 3.9).

Micro irrigation has generated benefits to the farmers in terms of enhancement of the productivity. The average productivity of fruits and vegetables has increased about 42.3% and 52.8%, respectively mainly because of crop spacing, judicious use of water and other inputs etc, The detail have been elaborated in Table 3.9. The overall benefits accrued from the micro irrigation system are reflected in the income enhancement of the farmers.

Table 3.9 Impact of micro-irrigation across states

State	Increase in productivity (%)		Decrease in cost of irrigation (%)	Electricity saving (%)	Fertilizer saving (%)
	Fruits	Vegetables			
Andhra Pradesh	19.37	34.09	20.50	22.33	28.85
Bihar	15.18	31.62	28.60	40.00	7.59
Chhattisgarh	62.00	98.85	36.50	37.78	40.36
Gujarat	73.48	68.59	49.30	39.92	42.73
Haryana	38.25	22.13	49.00	49.39	37.52
Karnataka	28.20	29.00	24.70	26.75	28.21
Maharashtra	49.18	28.76	31.00	33.48	22.96
Odisha	34.97	28.19	26.50	22.46	20.90

State	Increase in productivity (%)		Decrease in cost of irrigation (%)	Electricity saving (%)	Fertilizer saving (%)
	Fruits	Vegetables			
Rajasthan	70.56	39.42	45.40	42.08	43.83
Sikkim	6.82	66.62	27.90	35.11	40.86
Tamil Nadu	17.36	26.40	24.80	15.10	27.08
Uttar Pradesh	34.14	30.71	27.60	18.43	22.77
Uttarakhand	32.42	49.65	23.30	29.89	17.96
Total	**42.34**	**52.76**		**30.65**	**28.48**

Source: Impact evaluation report by Global Agri-System

Table 3.10 Impact of micro irrigation on yield

Crops	Water Saving (%)	Yield Increase (%)
Bajra	56	19
Barley	56	16
Bhindi (Okra)	28	23
Cabbage	40	3
Cauliflower	35	12
Chillies	33	24
Cotton	36	50
Cowpea	19	3
Fenugreek	29	35
Garlic	28	6
Gram	69	57
Groundnut	20	40
Jowar	55	34
Lucerne	16	27
Maize	41	36
Onion	33	23
Sunflower	33	20
Wheat	35	24

Source: Micro Irrigation Division of Ministry of Agriculture, GOI

3.7. Gains from Irrigation: Impact on Crop Yield and Income

Table 3.11 provides evidences on impact of irrigation on crop yield and revenue gains based on the cost of cultivation plot level data. The evaluation for gains in yield and revenue was done for major crops and results are discussed subsequently.

Paddy: Irrigated paddy growing states have definite yield advantages. Among major paddy producing states, Punjab and Andhra Pradesh grow almost entire crop under irrigated conditions (paddy area under irrigation in these states are 99.6 per cent and 96.8 per cent during 2012-13, respectively). Irrigated area is relatively less in Uttar Pradesh (83.1 per cent during 2013-14). There exists huge potential to expand irrigation in West Bengal. Just half of the area is irrigated, and yield differentials are significant. Irrigated fields, on an average, record 8 quintals/ha higher yield than the unirrigated. Among others, Odisha offers scope to improve yield levels to a sizeable extent under irrigated environment.

Wheat: All major wheat producing states grow almost entire crop under irrigation, hence, offer limited scope to expand irrigation. While Madhya Pradesh has 91 per cent area under

irrigation, Uttar Pradesh, Punjab, Haryana and Rajasthan have more than 98 per cent area under irrigation. But yield differentials are high, enabling scope to achieve high production. Average yield levels are around 50 qtl/ha in Punjab and Haryana. In Uttar Pradesh and Rajasthan, it stands around 30 qtl/ha and in Madhya Pradesh it is 24 qtl/ha during 2013-14. Hence, efforts to achieve high wheat production depend on factors other than irrigation.

Gram & Tur: Madhya Pradesh, Maharashtra and Rajasthan produce around 70 per cent of total gram production. While the former two states have sizeable irrigation, just one-fourth of the gram area is irrigated in Maharashtra. In terms of yield gains due to irrigation, while Madhya Pradesh offers limited scope, Rajasthan and Maharashtra provide better output. The average yield gains in irrigated farms in Rajasthan and Maharashtra are 5.3 qtl/ha and 2.4 qtl/ha respectively. In terms of Tur, share of irrigation is almost negligible. Still, Maharashtra and Gujarat provide significant positive responses to irrigation.

Groundnut: Groundnut provides higher scope for irrigation. Extent of irrigation is relatively less among major producers and yield margins are positive almost in all major states. Margins due to irrigation are around 8 qtl/ha in Andhra Pradesh and around 5 qtl/ha in Tamil Nadu and Gujarat. These states offer high scope of expanding irrigation and output.

Maize: Yield response to irrigation is high in maize. All major maize producing offer high scope to expand irrigation, as much produce arises from unirrigated farms. Irrigated area in largest maize producing states viz. Andhra Pradesh, Maharashtra and Karnataka are 49 per cent, 36 per cent and 13 per cent respectively. Despite low contribution, Tamil Nadu has highest yield with an irrigated area of 39 per cent. In converse, while Bihar produces maize with 65 per cent of irrigated area, yield levels are relatively less. Tamil Nadu, Bihar and Andhra Pradesh offer high scope to expand irrigation. Marginal yields the irrigated farms produce in these states are 32 qtl/ha, 22 qtl/ha and 18 qtl/ha respectively.

Cotton: Major share of cotton comes from Gujarat, Maharashtra and Andhra Pradesh. While around 60 per cent of area under cotton is irrigated in Gujarat, it is just 3 per cent in Maharashtra. While positive yield differentials on irrigated plots are smaller, expanding irrigation in Maharashtra at larger scale could help in achieving higher production. Andhra Pradesh has no major yield differences, but differences are relatively high in Gujarat. Irrigated cotton fields produce around 8 quintals of more cotton per hectare. Expanding irrigation could be a better choice for Gujarat, and the strategy could be combined with other yield improving factors for Maharashtra.

West Bengal and Odisha provide scope to expand output oriented irrigation expansion in Paddy. In terms of wheat, factors other than irrigation could be thought of in attaining yield convergence. Millets, Pulses and Groundnut exhibit huge potential for irrigation expansion. Among commercial crops, while maize provides higher scope followed by cotton, sugarcane has limited potential as almost entire area is irrigated.

Table 3.11 Evidences on impact of irrigation on crop yield and revenue (2013-14)

Crop	State	Yield Difference in quintal/ha (irrigate-unirrigated)	P value	Revenue Difference in Rs./ha (irrigate-unirrigated)	P value	n(0)	n(1)
Rice	WB	6.08	0.00	7414	0.00	5,805	1,477
	UP	3.72	0.00	1699	0.06	559	2,281
	AP	-4.19	0.00	-4802	0.00	1,305	1,457
	PJ	5.32	0.02	-1147	0.43	34	1,565
	OD	-3.96	0.00	-6858	0.00	5,190	78
	BH	-1.90	0.00	1499	0.00	1,676	1,683
	CTG	3.34	0.00	3209	0.00	997	187
	TN	-0.76	0.07	2780	0.00	751	1,530
Wheat	UP	7.64	0.00	9699	0.00	479	3,646
	PJ	2.91	0.00	3560	0.00	276	1,626
	MP	-5.45	0.00	-5822	0.00	213	1,380
	HR	1.05	0.03	1633	0.02	113	1,111
	RJ	-2.18	0.00	-3057	0.00	329	1,330
Maize	AP	19.78	0.00	24909	0.00	199	345
	KR	7.27	0.00	9795	0.00	356	203
	MH	-	-	-	-		
	BH	23.72	0.00	23347	0.00	156	248
	MP	-	-	-	-		
	TN	21.03	0.00	27632	0.00	85	237
	RJ	3.70	0.03	5866	0.00	353	52
	UP	-0.28	0.39	2257	0.06	118	84
Gram	MP	2.00	0.00	12647	0.00	259	631
	RJ	4.59	0.00	16660	0.00	127	200
	MH	3.93	0.00	11998	0.00	249	581
	KR	-0.22	0.42	-513	0.44	114	26
	AP	0.73	0.25	3274	0.19	164	5
	UP	0.91	0.05	1794	0.17	186	128
Tur	MH	5.48	0.00	20649	0.00	832	142
	MP	5.51	0.00	14752	0.00	65	12
	KR	-2.13	0.05	-9550	0.02	186	16
	GJ	6.58	0.00	25183	0.00	127	111
	JRK	-	-	-	-		
	AP	10.39	0.00	36047	0.00	89	9
	UP	-0.80	0.04	-3864	0.02	241	71
Groundnut	GJ	5.04	0.00	21437	0.00	130	510
	TN	5.32	0.00	24047	0.00	108	232
	AP	8.67	0.00	37434	0.00	173	174
	KR	-0.37	0.35	4765	0.16	106	66
	RJ	-	-	-	-		
Rapeseed & Mustard	RJ	3.68	0.00	12478	0.00	180	1,016
	MP	-1.39	0.01	-4785	0.01	34	72
	HR	3.56	0.00	11431	0.00	42	371
	UP	2.80	0.00	9275	0.00	248	983
	WB	2.05	0.00	6494	0.00	87	742
	GJ	9.24	0.00	28300	0.00	14	255

Crop	State	Yield Difference in quintal/ha (irrigate-unirrigated)	P value	Revenue Difference in Rs./ha (irrigate-unirrigated)	P value	n(0)	n(1)
Soybean	MP	-	-	-	-		
	MH	4.47	0.00	13025	0.00	1,530	113
	RJ	5.36	0.01	22208	0.00	443	10
Cotton	GJ	10.74	0.00	49012	0.00	258	1624
	MH	6.15	0.00	23310	0.00	606	630
	AP	2.79	0.00	10850	0.00	414	100
	HR	-1.93	0.03	-7848	0.04	41	333
	KR	3.02	0.00	15668	0.00	259	81
	PJ	1.13	0.02	3777	0.07	137	232
Sugarcane*	UP	-94.37	0.00	-25890	0.00	76	1214
	MH	-42.58	0.15	-35244	0.00	66	1474
	KR	-68.07	0.25	-8171	0.36	5	233
	TN	68.02	0.16	22461	0.05	16	857

*Source: DFI Committee Estimates *The yield difference for sugarcane has been expressed in terms of Tons/Ha.*

3.8. Water Availability and Requirement

India with 2.4 per cent of the world's total area and 16 per cent of the world's population has only 4 per cent of the total available fresh water. Fortunately, at a macro level India is not short of water. While the total water resource availability in the country remains constant, the per capita availability of water has been steadily declining since 1951 due to population growth (Kapadia, 2016). Per capita availability of less than 1700 cubic metres (m^3) is termed as water stressed condition while if it falls below 1000 cubic meters, it is termed as water scarcity condition.

India's per capita water availability is continuously declining and as per Kapadia (2016), India will be a water stressed country on the basis of per capita water availability in 2050 with only 686 cubic meter per year.

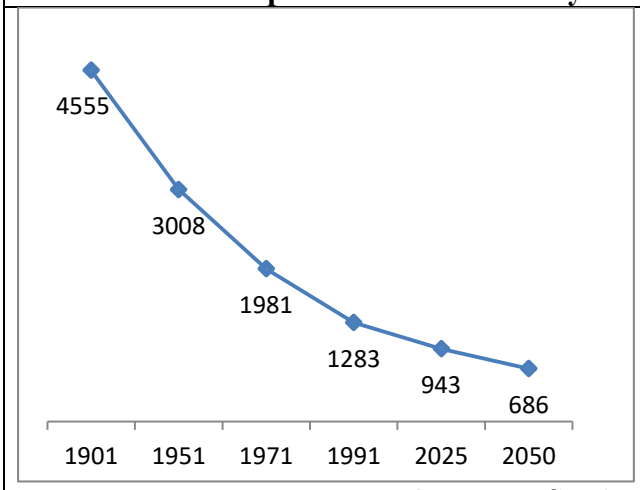
The water resource potential of the country has been assessed from time to time by different agencies. The different estimates are shown in Box 3.1. It may be seen that since 1954, the estimates have stabilized and are within the proximity of the currently accepted estimate of 1869 billion cubic meter (BCM) which includes replenishable groundwater which gets charged on annual basis.

National Commission on Integrated Water Resources Development (NCIWRD) estimated the requirement of water for various sectors in the year 2000. Agriculture sector mainly requires water for irrigation purposes. This requirement was estimated by NCWRD based on the assumption that the irrigation efficiency will increase to 60 per cent from the present level of 35 to 40 per cent.

Water required for irrigation purpose shows highest demand around 75-85 per cent share in total demand by the estimation of Standing Sub-Committee of MoWR but NCIWRD estimates based on the assumption that the irrigation efficiency will increase thus demand will be around 70 to 80 per cent (Table 3.12).

Box 3.1 Water Resource Situation in India

India's Per Capita Water Availability



Source: Kapadia, 2016

Estimates of Water Resources of India

Agency	Estimate in BCM
First Irrigation Commission (1902-03)	1443
Dr. A.N. Khosla (1949)	1673
Central Water & Power Commission (1954-66)	1881
National Commission on Agriculture	1850
Central Water Commission (1988)	1880
Central Water Commission (1993)	1869

Table 3.12 Water Requirement for Various Sectors

Sector	Water Demand in km3 (or BCM)					
	Standing Sub-Committee of MoWR			NCIWRD		
Year	**2010**	**2025**	**2050**	**2010**	**2025**	**2050**
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	**813**	**1093**	**1447**	**710**	**843**	**1180**

Source: Standing Sub-Committee of MoWR

These estimates not only provide an idea about the projected requirement of water for irrigation in the changing climate and circumstances, such estimates might not stand realistic. However, a clear indication may be drawn that irrigation requirement would increase continuously due to its contribution in enhancing crop yields and revenue. Objective estimates related to water requirement and availability based on the current situation would help plan the strategies for doubling farmer's income more efficiently.

3.9. Seed Use Pattern in India

The type of seeds used determines the yield, so as the income. Still, the reach of improved and hybrid seeds seem to be limited to specific crops. Major food crops like paddy and wheat are grown using improved seeds in general, still, reach of hybrids looks far beyond. Just 2% of paddy and wheat growers use hybrids. In turn, improved and hybrid seeds adoption is relatively higher in millets, especially Bajra. Just 10 per cent of the growers use local varieties and improved and hybrid seed use is equally shared between the rest. Around 50 per

cent of the Jowar growers use improved varieties, whereas around 40 per cent use seeds of local varieties, not the hybrids (Table 3.13). Hence, spread of hybrid seed use in millet growing areas would potentially benefit farmers in gaining higher yield and income. Among pulses, Tur offer scope to adopt hybrid and improved seeds, and among oilseeds, groundnut provides some chance.

Table 3.13 Seed use among farmers in the Country (2011-12 to 2013-14)

Crop	Hybrid	Improved	Local	Total	n
Paddy	2	85	13	100	12164
Wheat	2	89	9	100	6222
Jowar	16	47	37	100	409
Bajra	42	47	11	100	959
Maize	33	44	24	100	1361
Gram	1	78	20	100	961
Tur	4	55	41	100	694
Groundnut	4	75	22	100	625
Rapeseed & Mustard	15	73	12	100	1494
Soybean	2	92	6	100	1361
Sunflower	19	67	14	100	42
Jute	0	97	3	100	351

Note: Figures reported are in % terms to total users and 'n' refers the sample size.

Source: Estimated based on cost on cultivation plot level data.

The pattern holds true across states of major growers. Leaving Chhattisgarh and Andhra Pradesh, none of the states uses hybrids in paddy cultivation, and improved seeds of varieties dominate everywhere. Odisha has higher use of local seeds to an extent of 10 per cent. Since hybrid varieties are much less for wheat crop, all the states use improved seeds in entire cultivation. An exception is Rajasthan, where 16 per cent of wheat growers use hybrid seeds and 26 per cent growers use local seeds, providing scope to intervene to shift from local seeds use.

Around 30 per cent of Jowar and Bajra growers in Maharashtra and Rajasthan use improved seeds. While around 50 per cent of Jowar cultivation involves use of local seeds, around half of the Bajra cultivation involves hybrid seeds use. Hence, Maharashtra and Rajasthan offer potential shift towards hybrid seeds use in Jowar and Bajra respectively.

Except Andhra Pradesh, Tamil Nadu and Madhya Pradesh, hybrid seeds use is meagre in major maize producing states. In Andhra Pradesh and Tamil Nadu, 80 per cent of the maize cultivation involves hybrid seeds use. The figure stands at 60 per cent for Madhya Pradesh. Rest of the states depend other seed types rather. Karnataka and Bihar depend by more than 95 per cent and 63 per cent respectively on improved seeds for growing maize. Hence a focus towards hybrid seeds use in Karnataka and Bihar would help in achieving higher yield and income.

Gram offers better scope to shift from traditional seeds to improved seed type. Leaving Madhya Pradesh, which produces almost entire Gram using improved seeds, use of local seeds are relatively high in rest of the states, particularly in Rajasthan. Highest among all, around 10 per cent of the farmers in Andhra Pradesh use hybrid Gram seeds. Similar pattern

exists for Tur (Table 3.14). Rest of the crops as well involve high use of improved seeds, and to some extent the local seeds; not the hybrids.

Table 3.14 Seed use across States

Crop	State	Hybrid	Improved	Local	Total	N
Paddy	West Bengal	0	98	2	100	2394
	Uttar Pradesh	0	100	0	100	913
	Andhra Pradesh	9	83	8	100	926
	Punjab	0	100	0	100	434
	Odisha	1	89	10	100	1732
	Bihar	0	97	3	100	1027
	Chhattisgarh	10	90	0	100	423
	Tamil Nadu	2	98	0	100	739
Wheat	Uttar Pradesh	0	99	1	100	1366
	Punjab	0	100	0	100	639
	Madhya Pradesh	2	98	0	100	564
	Haryana	1	97	3	100	396
	Rajasthan	16	58	26	100	546
Maize	Andhra Pradesh	81	19	0	100	197
	Karnataka	2	96	2	100	182
	Bihar	0	63	37	100	124
	Madhya Pradesh	61	39	0	100	59
	Tamil Nadu	81	19	0	100	101
	Rajasthan	30	10	60	100	126
	Uttar Pradesh	2	98	0	100	51
Gram	Madhya Pradesh	0	100	0	100	273
	Rajasthan	4	43	53	100	143
	Maharashtra	0	82	18	100	285
	Karnataka	0	68	33	100	40
	Andhra Pradesh	11	46	43	100	54
	Uttar Pradesh	0	84	16	100	87
Tur	Maharashtra	0	72	27	100	318
	Madhya Pradesh	0	63	37	100	27
	Karnataka	0	17	83	100	75
	Gujarat	18	33	49	100	79
	Andhra Pradesh	54	43	4	100	28
	Uttar Pradesh	0	76	24	100	93
Groundnut	Gujarat	2	79	19	100	243
	Tamil Nadu	0	97	3	100	93
	Andhra Pradesh	16	69	15	100	105
	Karnataka	2	65	33	100	60
Rapeseed & Mustard	Rajasthan	39	50	11	100	408
	Madhya Pradesh	36	64	0	100	36
	Haryana	10	89	1	100	146
	Uttar Pradesh	0	98	2	100	389
	West Bengal	0	97	3	100	259
	Gujarat	26	50	24	100	115
Soybean	Madhya Pradesh	0	100	0	100	577
	Maharashtra	3	97	0	100	625
	Rajasthan	5	42	53	100	148

Note: Figures reported are in % terms to total users and 'n' refers the sample size.

Source: Derived based on Cost of Cultivation: Plot level data

In general, while paddy offers potential scope to shifting to hybrid seeds, millets offer for expanding both improved and hybrid seed use, shifting from seeds of local varieties.

Directing policies towards shift of local seeds use to improved and hybrid seeds could potentially increase national production and farmers' income.

3.10. Fertiliser Use Pattern

The total fertilizer use in India has increased from 2.65 million tonnes in 1971–72 to 28.12 million tonnes in 2010–11. This corresponds to an annual compound growth of over 6 per cent. The actual and normative levels of fertilizer use were computed for various for the triennium 2009–10 to 2011–12 are presented in Table 3.17. The actual use of nitrogenous fertilizer is higher than the normative level in the states of Andhra Pradesh, Assam, Punjab, Bihar, Haryana and Jharkhand and it is near optimal in Odisha. In all other states, the actual nitrogen use remains below the recommended norms (Chand and Pavithra, 2015).

The study indicated that the normative level of nitrogen for India as a whole is about 17 MT, not significantly different than the actual use of N; in case of phosphorus, the normative use is about 9.46 MT whereas the actual use is about 7.65 MT. Their estimates indicated that use of P in case of Madhya Pradesh, Uttar Pradesh and West Bengal is far lower than what is recommended for the prevailing cropping pattern in these states (Table 3.15). They suggested that this imbalance in use can partly be handled by creating awareness on use of fertilizers with respect to the recommended levels. The Government has issued soil health cards, which provides current nutrient availabilities in the soil, and recommended level of input use for a given field. This would greatly benefit in addressing fertilizer use imbalance as the normative levels are derived at field level than at the state level.

Table 3.15 Normative and Actual Use of N, P and K, Triennium Ending 2011–12

States	Normative Use: Thousand Tonne				Actual Use: Thousand Tonne			
	N	P	K	Total	N	P	K	Total
Andhra Pradesh	1,138	679	474	2,291	1,884	984	433	3,300
Assam	124	90	70	284	140	52	72	265
Bihar	688	368	245	1,301	921	265	136	1,322
Chhattisgarh	498	298	208	1,005	323	167	61	552
Gujarat	1,247	450	456	2,153	1,198	483	174	1,855
Haryana	807	339	202	1,348	996	350	51	1,397
Himachal Pradesh	82	43	33	158	33	11	11	54
Jharkhand	84	51	42	177	97	45	14	156
J&K	95	57	29	181	73	32	12	117
Karnataka	1,043	655	651	2,349	1,028	668	395	2,091
Kerala	227	164	349	740	116	60	91	267
Madhya Pradesh	1,080	1,181	449	2,710	967	667	109	1,742
Maharashtra	1,745	1,176	654	3,575	1,606	1,067	560	3,233
Odisha	313	177	176	666	316	156	83	555
Punjab	951	375	235	1,561	1,377	421	65	1,863
Rajasthan	1,335	742	130	2,206	832	371	33	1,235

States	Normative Use: Thousand Tonne				Actual Use: Thousand Tonne			
	N	P	K	Total	N	P	K	Total
Tamil Nadu	673	270	298	1,241	643	283	298	1,224
Uttarakhand	162	75	51	288	117	30	11	158
Uttar Pradesh	3,210	1,436	1,085	5,731	2,997	1,044	269	4,310
West Bengal	1,412	762	764	2,938	753	491	381	1,624
Others	114	82	73	270	30	13	7	50
All India	17,030	9,469	6,675	33,174	16,466	76,578	3,264	27,387

Source: Chand and Pavithra 2015.

Chand and Pavithra (2015) estimated normative ratio of fertilizer use for the states based on the state-specific and crop-specific fertilizer recommendations and the current cropping pattern, the results related to normative ratio and ratio based on actual use of N, P and K across the states are presented in Table 3.16. The study indicated that the optimum ratio or norm for balanced use of N, P and K for India should be 2.6:1.4:1 based on the current cropping pattern.

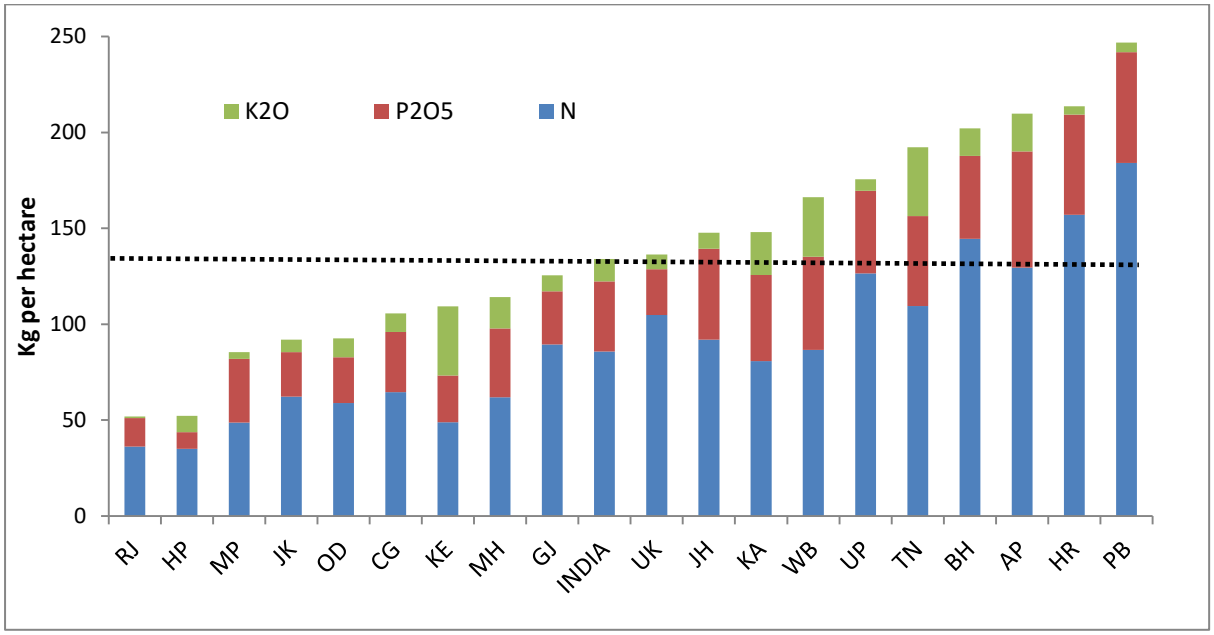
Table 3.16 State-wise Actual and Normative Ratio of NPK Use (2009–11)

States	Actual Ratio			Normative Ratio		
	N	P	K	N	P	K
Andhra Pradesh	4.41	2.28	1	2.40	1.43	1
Assam	1.94	0.73	1	1.77	1.28	1
Bihar	6.79	1.95	1	2.81	1.50	1
Chhattisgarh	5.27	2.72	1	2.39	1.43	1
Gujarat	6.89	2.78	1	2.73	0.99	1
Haryana	19.55	6.87	1	3.99	1.67	1
Himachal Pradesh	3.00	1.02	1	2.48	1.29	1
Jharkhand	7.20	3.31	1	1.99	1.20	1
J&K	6.16	2.72	1	3.26	1.96	1
Karnataka	2.6	1.69	1	1.60	1.01	1
Kerala	1.28	0.66	1	0.65	0.47	1
Madhya Pradesh	8.90	6.14	1	2.41	2.63	1
Maharashtra	2.87	1.91	1	2.67	1.80	1
Odisha	3.79	1.88	1	1.78	1.01	1
Punjab	21.2	6.48	1	4.05	1.60	1
Rajasthan	25.08	11.18	1	10.3	5.72	1
Tamil Nadu	2.16	0.95	1	2.26	0.91	1
Uttarakhand	10.24	2.63	1	3.18	1.47	1
Uttar Pradesh	11.14	3.88	1	2.96	1.32	1
West Bengal	1.98	1.29	1	1.85	1.00	1
Others	4.01	1.70	1	1.55	1.12	1
All India	5.04	2.35	1	2.55	1.42	1

Source: Chand and Pavithra 2015.

State-level norm for NPK estimated in their study show that the existing norm of 4:2:1 was close to estimated norm only in traditional Green Revolution belt of north-west India. Further, the optimum mix of NPK in other states except Rajasthan implies a lower share of N and higher share of P and K than what is implied by the ratio of 4:2:1. The study indicated the worst deviation or imbalance in case of Rajasthan followed by Punjab and Haryana, though it was severe even in other states like Uttar Pradesh, Bihar, Jharkhand and Madhya Pradesh. The study concluded that the state-level norms for the optimum mix of NPK are far away from the all-India average, hence, the fertilizer promotion and policy should be state-specific and there is need to attain state specific optimum mix and use of NPK. Fig 3.5 shows fertilizer consumption per hectare of the gross cropped area in the major states.

Fig 3.5 State-wise consumption of plant Nutrients per ha of Gross Cropped Area 2011-12 and 2012-13



Source: DFI Committee Estimates

The consumption of fertilizers varies significantly from states. All-India per-hectare consumption of total nutrients was 133.95 kg in BE 2012-13. Punjab consumes maximum fertilizer at the rate of 246.8 kg per ha, while Rajasthan consumes the least (51.9 kg) which is significantly lower in comparison to all-India average and also other states. Even the consumption of N P and K varies across states. Kerala, West Bengal and Tamil Nadu consume higher levels of K as compared to other states. While the North and South zones have a consumption of more than 135 kg/ha, the consumption is lower than 130 kg/ha in the East and West zones.

3.10.1. Yield Response to Nutrients

As per the study conducted by Satyanarayana and Tewatia (2009) the major factor contributing to declining yield response is continuous nutrient mining due to imbalanced nutrient use, leading to depletion of some of the major secondary and micro nutrients like P, K, S, Zn, Mn, Fe and B from the soil. Study exposes that during 1991-2000 Nutrient

Response Ratio (kg grain/kg applied nutrient) were 6 kg grain/kg applied nutrient which had been decline from 17.9 kg grain/kg applied nutrient during 1960-1970 (Table 3.17).

Table 3.17 Nutrient Response Ratio

Period	Increase in Nutrient Consumption (mt)	Increase in Food Production (mt)	Nutrient Response Ratio (kg grain/kg applied nutrient)
1960-1970	1.47	26.40	17.9
1971-1980	2.44	31.09	12.7
1981-1990	5.28	46.80	8.90
1991-2000	3.18	19.53	6.00

Source: Satyanarayana and. Tewatia (2009)

Chaturvedi (2006) revealed that the wheat yield responded significantly to increasing levels of nitrogen, compared to control. The study reveals that the highest yield of grain on the basis of two years combined average was 4667 kg/ha from the crop receiving dose of 125 kg N/ha and was statistically similar to 100 kg N/ ha (4577 kg/ha). Straw yield was also significantly affected with increasing levels of nitrogen. The highest straw yield (5884 Kg/ha) was observed in response to application of 125 kg N/ha, followed by (100 kg N/ha) giving 5791 Kg/ha straw yield.

Chatterjee and Srivastava (2010) reported that the yield will increase up to a limit with increasing dose of fertilizer and beyond which the yield will increase but at decreasing rate and after a limit it will be decrease following the 'Law of Diminishing Return. Fertilizer application based on targeted yield approach was found to be superior to general recommended dose.

The study reported that organic manure alone gave B:C ratio unity, indicating equal amount of cost of organics and net benefit. Highest benefit cost and response ratio was found with farmyard manure 10 tonnes/ha + yield target 2 000 kg/ha.

Soil Health Card: The Soil Health Card Scheme has been implemented in all States/UTs to assist the state Governments to evaluate fertility in farms across the country and issue the soil health cards to farmers, which provide information to farmers on nutrient status of their soil. The soil health cards also provide the recommendations on appropriate dosage of nutrients required for improving soil health. The details of soil health cards issued till 14th July 2017 are given in Table 3.18.

The southern region exhibits good performance in terms of number of sample targeted and number of sample tested, Andhra Pradesh achieved a target of 103.56 per cent. Gujarat, Maharashtra and Goa were good performers in western zone. Odisha and Bihar were identified as good performer in eastern zone.

Table 3.18 Progress report for State-wise Sample registration and Test Results (on 14-07-2017)

SN	State / UT	No. of Samples Entered	No. of Farmers Covered	Samples Tested	SHC Printed
I. Southern Zone					
1	Andhra Pradesh	1438801	4289693	1335261	2120561
2	Karnataka	1657054	8986387	1442110	7662360
3	Kerala	225470	805392	173047	595770
4	Tamil Nadu	1377086	5375278	1211082	4401408
5	Telangana	1060529	3021679	989924	2268492
II. West Zone					
6	Gujarat	2522833	4658012	1979085	2061466
7	Madhya Pradesh	693590	1522486	371027	620093
8	Maharashtra	2292753	5953026	1952379	3363664
9	Rajasthan	874665	945649	785436	47
10	Chhattisgarh	804461	4995109	708064	4316969
11	Goa	29845	30246	25003	24187
III. Northern Zone					
12	Haryana	861372	2648974	680835	1538945
13	Punjab	24540	25144	9782	5635
14	Uttarakhand	136822	527241	119915	420793
15	Uttar Pradesh	2513852	7623526	1738070	5177224
16	Himachal Pradesh	126745	673941	102853	507818
17	J & K	175195	739163	137906	534602
IV.	Eastern Zone				
18	Bihar	4471	4477	3759	0
19	Jharkhand	127507	524142	39442	136795
20	Odisha	422138	1518994	301160	1056519
21	West Bengal	88362	234633	6908	11184
V. North Eastern Zone					
22	Arunachal Pradesh	13636	13654	13348	12947
23	Assam	19472	67021	5479	16743
24	Manipur	403	403	356	0
25	Meghalaya	34740	184047	30050	150608
26	Mizoram	10008	10096	8019	4503
27	Nagaland	13411	13422	13326	13328
28	Sikkim	12144	50546	11134	45063
29	Tripura	29434	97708	26372	92329
VI. Union Territories					
30	Andaman & Nicobar	8226	8227	6570	3563
31	Dadar Nagar & Haveli	58	58	58	0
32	Puducherry	4934	5281	4004	3883
Total		**17604557**	**55553655**	**14231764**	**37167499**

Source: http://soilhealth.dac.gov.in

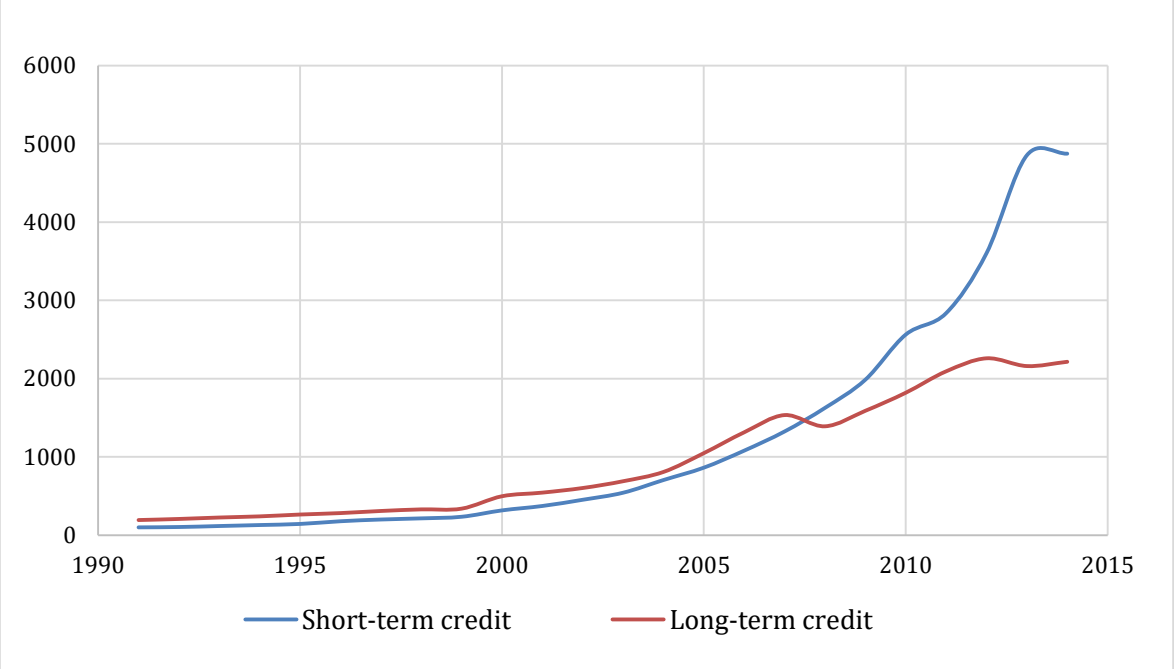
3.11. Agricultural Credit in India

The positive role of credit in raising agricultural productivity is well known. While short-term loans generally help in reaping better output through timely use of farm inputs, medium and

long-term credit help in farm assets creation such as construction of farm houses, deepening of wells and bore wells, and purchasing of machineries like tractors. In short, access to credit influences investment decisions of the farmers in agriculture. Institutional credit has consistently increased over years.

The credit outstanding in agriculture and allied sector in the post-reforms period shows that both short-term and long-term credit has increased tremendously, especially since 2000s (Figure 3.6). However, the period 1990s have witnessed stagnation. Further, while long-term credit outstanding increased linearly after 2000, short-run credit, which helps in meeting direct inputs in agriculture, has increased exponentially. This increase in credit outstanding, especially since mid-2000s in short-run credit, and a consistent increase in long-run credit could have helped in part to the recovery of agriculture sector registered following growth deceleration.

Fig 3.6 Direct institutional Credit in Agriculture (Amount outstanding in Rs. billion)

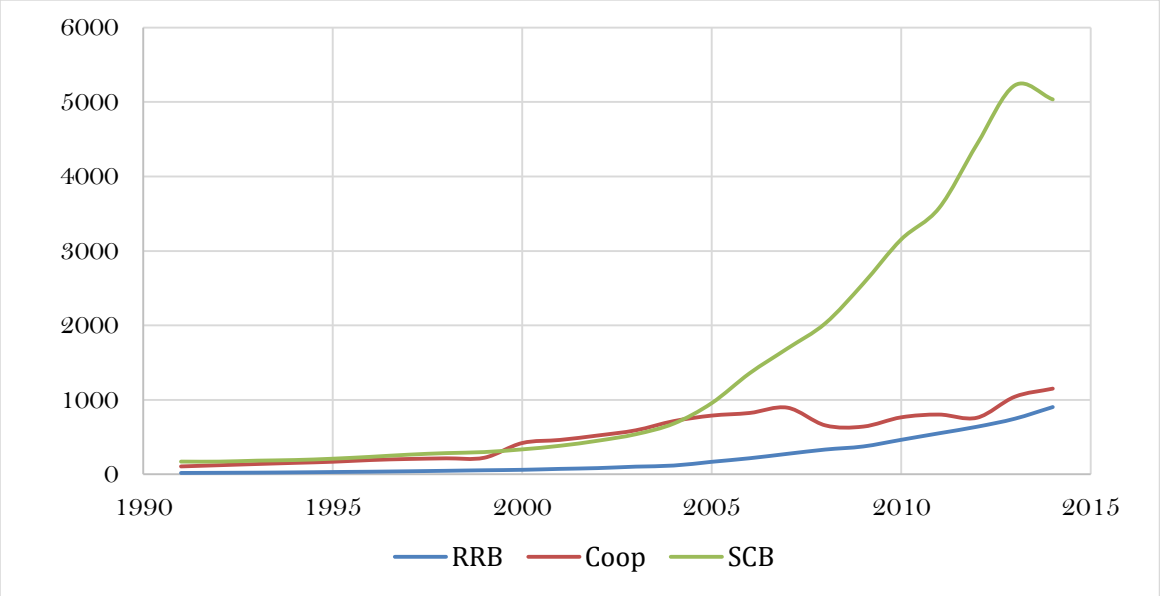


Source: DFI Committee Estimates

A glance at Fig 3.7 will provide a brief trend in credit outstanding of different agencies in agriculture. The co-operative banks, regional rural banks and the scheduled commercial banks have all been equally competitive in delivering both short-term and long-term credit to agriculture (Fig 3.8 & 3.9), but the quantum delivered had been very less by all agencies during 1990s. The scenario improved in the following decade, especially in delivering long-term credit by the co-operative and scheduled commercial banks. However, the RRBs lagged behind. The trend had not been permanent. Since mid-2000s, both the co-operative banks and RRBs had been overtaken by the commercial banks in providing both short and long-term credits. As mentioned, both the kind of credits have witnessed an exponential increase since mid-2000s, indicating extension of credit to the farmers in creating both variable and fixed farm capital equally. The recent period has witnessed a remarkable increase in short-term

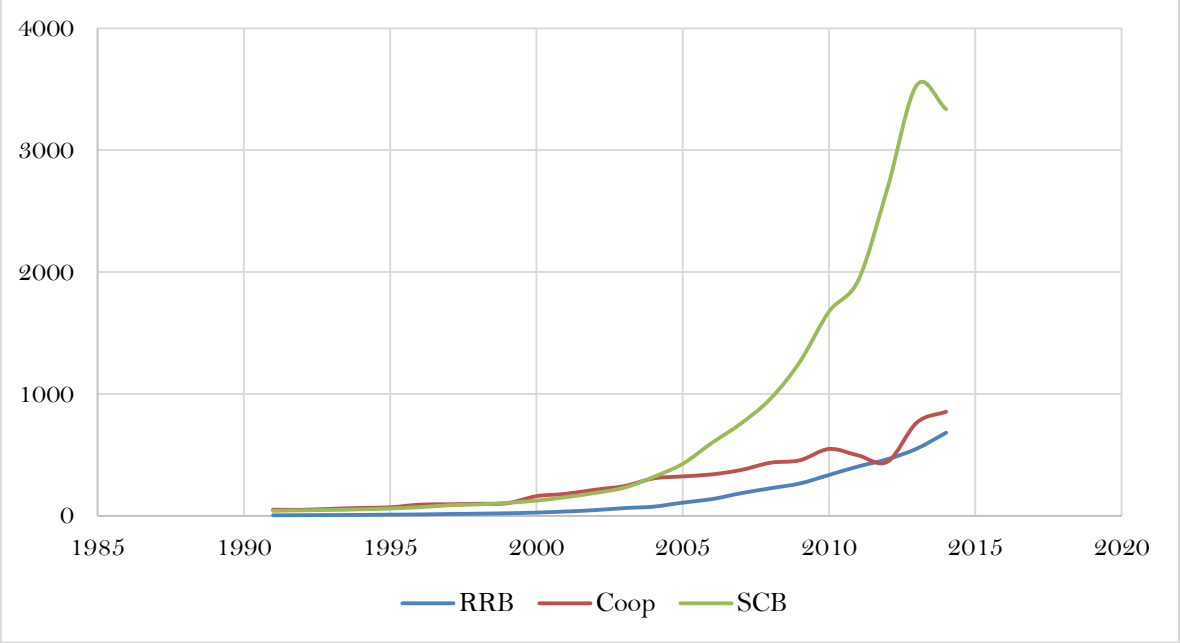
credit over its counterpart. Though the predominance of commercial banks over the cooperatives and regional rural banks is encouraging, the inclusiveness in access needs to be examined. Extent of access by marginal and small farmers needs special attention as they generally lack capital assets. Further, production efficiencies in different class of farmers in presence and absence of credit need to be examined so that credit policies can be effectively reoriented in increasing income of different class of farmers.

Fig 3.7 Contribution of different agencies in agricultural credit delivery
(Amount outstanding in billion)



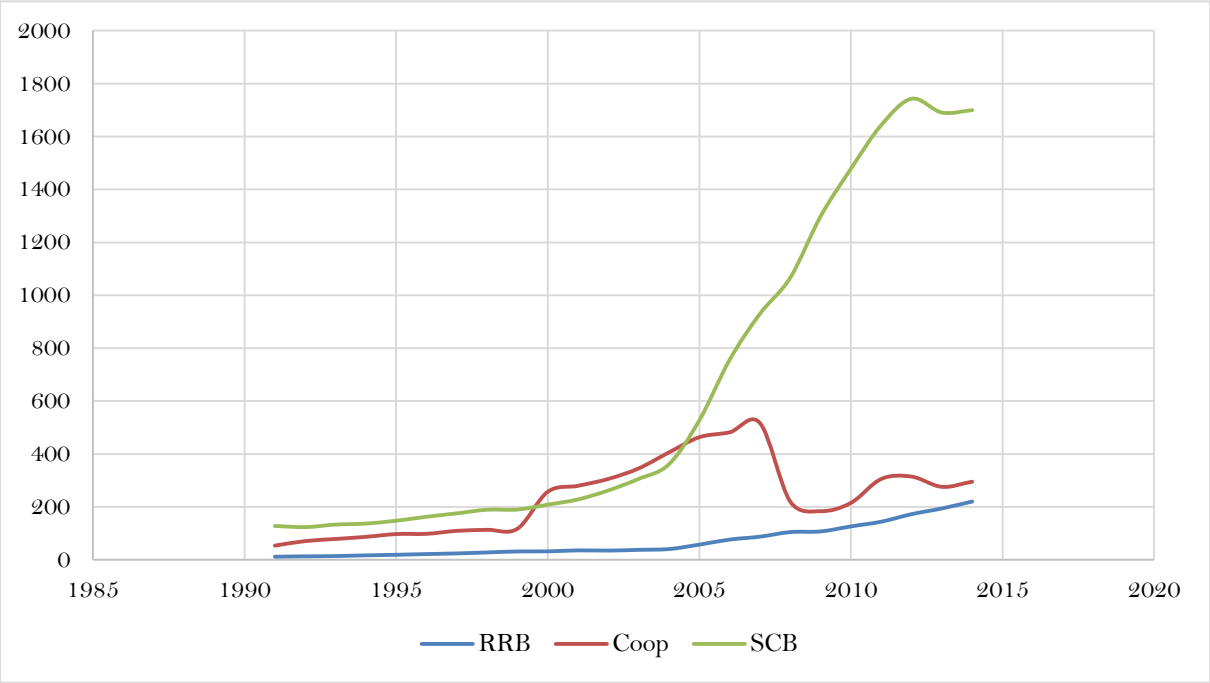
Source: DFI Committee Estimates

Fig 3.8 Contribution of different agencies in delivering agricultural credit (Short-term credit outstanding, Rs. in Billion)



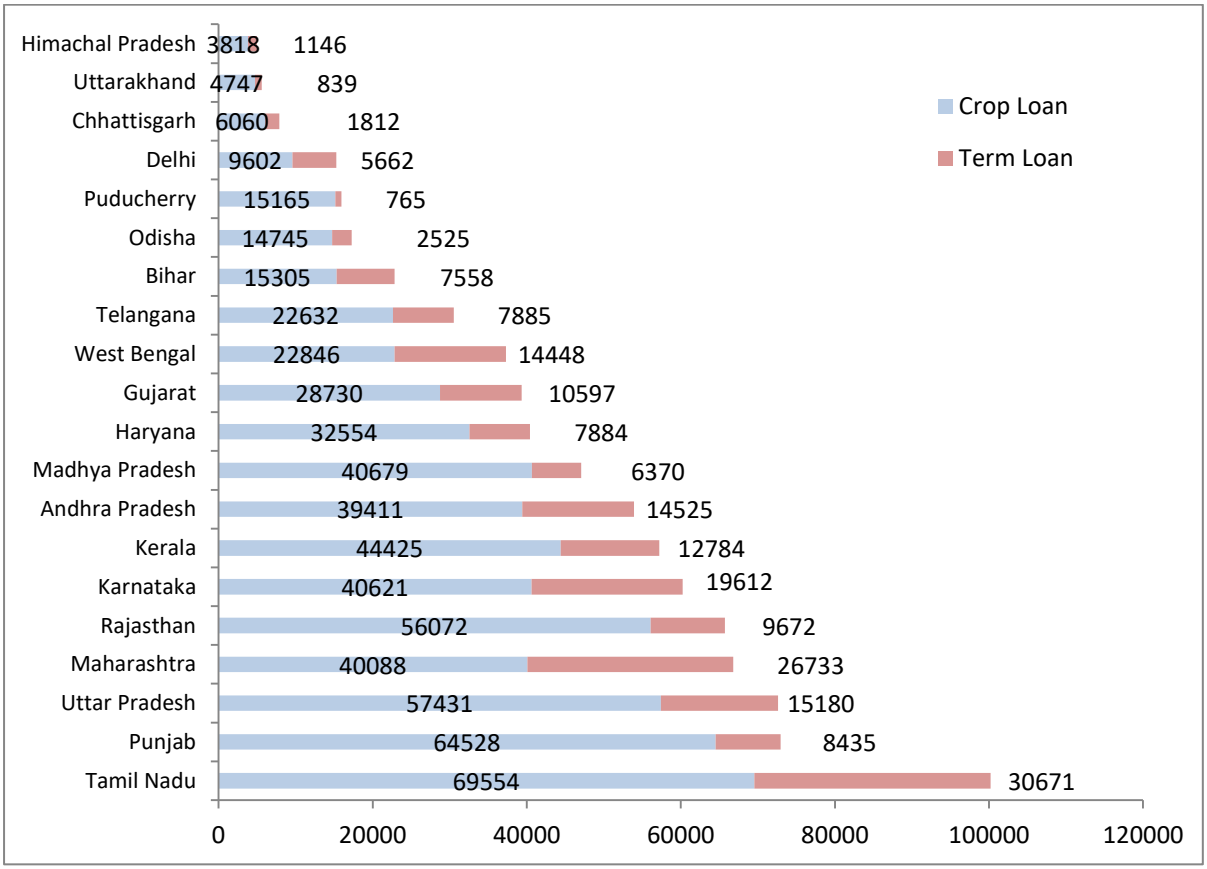
Source: DFI Committee Estimates

Fig 3.9 Contribution of different agencies in delivering agricultural credit (Long-run credit outstanding, Rs. in Billion)



Source: DFI Committee Estimates

Fig 3.10 Distribution of Crop and Term Loans across States



Source: Fertilizer Statistics

Government of India has initiated several policy measures to improve the accessibility of farmers to the institutional sources of credit; the emphasis has been on institutionalization for providing timely and adequate credit support to all farmers along with particular focus on small and marginal farmers and weaker sections of society. This would enable them to adopt modern technology and improved farm practices for increasing agricultural productivity.

In order to ensure that the farmers are provided with timely credit for their agricultural operations, the Government of India introduced the Kisan Credit Card Scheme, which enables the farmers them to purchase agricultural inputs such as seeds, fertilizers, pesticides, etc., and draw cash to satisfy their consumption needs. The cumulative number of KCCs as on 31 October, 2015 and the outstanding loan amount is given in Table 3.19 below:

Table 3.19 Operative KCC Accounts and Outstanding Amount as on 31.10.2015 Agency total operative KCC Accounts Amount outstanding (Rs. Crore)

Agency	Total operative KCC Accounts	Amount outstanding (Rs. Crore)	Out of these ATC Enabled RuPay KCC-cum-Debt Cards
Commercial Banks (as on 31.03.2015)	2,25,24,560	3,30,384.51	76,14,956
Cooperative Banks	3,88,40,776	1,13,324.37	2,50,086
Regional Rural Banks	1,25,26,342	84,235.03	31,01,504
Total	7,38,91,678	5,27,943.91	1,09,66,546

Source: RBI and NABARD.

3.11.1. Credit access and extent of indebtedness

Credit forms a basic need for farm operation in modern agriculture. The access to credit by the agricultural households has improved with time. The rate and extent of access, rather, had not uniform across states (Table 3.20).

Agricultural households in southern states have high access to credit, by more than 75% (Table 3.22). The share of indebted households, which in turn portrays shares of households accessed credit, for the states Andhra Pradesh, Telangana, Tamil Nadu, Kerala and Karnataka for the year 2012-13 were 93%, 89%, 82%, 78% and 77% respectively. Average credit outstanding per agricultural household is also high in these states. The corresponding figures for the above states respectively are Rs.1,23,400/-, Rs. 93, 500/-, Rs.1,15,900/-, Rs.2,13,600/- and Rs. 97,200/-.

To the other end, households of Assam, Jharkhand, Chhattisgarh and Bihar have poor access to credit. The shares of indebted households with credit access in these states are 17%, 29%, 37% and 42% against the all-India average of 52%. Average outstanding amounts in these states are also less i.e. Rs.3,400/-, Rs.5,700/-, Rs.10,200/- and Rs.16,300 respectively.

Table 3.20 Indebtedness and Credit Outstanding (2012-13)

Share of indebted households (%)	Average outstanding (Rs/agri. Household)		
	Low	**Medium**	**High**
Low	Assam, Bihar, Chhattisgarh, Jharkhand	Haryana	-
Medium	West Bengal	Gujarat, Uttar Pradesh, Madhya Pradesh, Maharashtra, Odisha, Rajasthan	Punjab
High	-	Telangana	Karnataka, Kerala, Tamil Nadu, Andhra Pradesh

Note: The categorization of states is based on 25th and 75th percentile values of loan outstanding and number of indebted households of states.

Source: Based on Key Indicators – SAS, 2012-13.

To note, share of credit to total household income is also high among the southern states. The share stands at 21 per cent for Andhra Pradesh, the highest among the southern states, followed by Kerala (18%), Tamil Nadu (17%), Telangana (15%) and Karnataka (11%). But the figures in rest of the states are low (Table 3.21).

Other than Rajasthan (10%), rest of states have a share of not more than the all-India average of 7 per cent. Expanding credit, especially the fast growing states like Bihar, Madhya Pradesh and Maharashtra that are converging faster with the high productivity states can immensely help in realizing better income to the agricultural households.

Table 3.21 Indebtedness and Credit Outstanding

State	Indebted agri. households (%)	Outstanding (Rs. '00/agri. household)	Share of credit outstanding in Total income (%)
Andhra Pradesh	92.9	1234	21
Assam	17.5	34	1
Bihar	42.5	163	5
Chhattisgarh	37.2	102	2
Gujarat	42.6	381	5
Haryana	42.3	790	5
Jharkhand	28.9	57	1
Karnataka	77.3	972	11
Kerala	77.7	2136	18
Madhya Pradesh	45.7	321	5
Maharashtra	57.3	547	7
Odisha	57.5	282	6
Punjab	53.2	1195	7
Rajasthan	61.8	705	10
Tamil Nadu	82.5	1159	17
Telangana	89.1	935	15
Uttar Pradesh	43.8	273	6
West Bengal	51.5	178	4
All-India	51.9	470	7

Source: Key Indicators, SAS 2012-13.

3.11.2. Loan Waiver: Boon or Bane for Agriculture

A working paper by the Indian Council for Research on International Economic Relations (ICRIER) reported that despite the successive efforts taken by the government, the latest All India Debt and Investment Survey (AIDIS) by the NSSO shows that non-institutional agencies still accounted for as much as 44 per cent of outstanding dues in 2012-13, an increase from the 36 per cent level in 1990-91.

The report also stated that in addition to subvention on short-term credit introduced in 2006-07, there has been an intensification in the use of the instrument of debt waivers, which results not only in a waste of financial resources but also has adverse consequences for the banking system and seriously impairs its ability to deliver agricultural credit on a regular basis.

It has been reported that generalised debt relief or loan waivers hamper the repayment system. As per the RBI report of Trends & Progress of Banking in India the massive write-off of loans has taken its toll on the banking system and the non-performing assets of commercial banks have risen three-fold in nominal terms between 2009-10 and 2012-13.

Very recently, four States Uttar Pradesh, Maharashtra, Punjab and Karnataka, announced farm loan waivers in June 2017. As per the report, the Maharashtra government waived off loans of Rs. 30,000 crore billion owed by farmers with up to five acres of land by October. Uttar Pradesh government decided that it would waive off the loans of Rs 36,359 crore taken by about 94 lakh small and marginal farmers in the state. Punjab government allocated Rs. 1,500 crore for farm loan waivers to provide the benefit 10.25 lakh farmers. Karnataka government announced the crop loan waiver of Rs 8,165 crore, for the benefit of more than 22 lakh farmers (compiled from recent news clippings).

Chand and Srivastava (2017) identified several drawbacks with respect to the loan waivers They concluded that first, it covers only a tiny fraction of farmers; second, it provides only a partial relief to the indebted farmers as about half of the institutional borrowing of a cultivator is for non-farm purposes; third, in many cases, one household has multiple loans either from different sources or in the name of different family members, which entitles it to multiple loan waiving; fourth, loan waiving excludes agricultural labourers who are even weaker than cultivators in bearing the consequences of economic distress; fifth, it severely erodes the credit culture, with dire long-run consequences to the banking business; and sixth, the scheme is prone to serious exclusion and inclusion errors, as evidenced by the Comptroller and Auditor General's (CAG) findings in the Agricultural Debt Waiver and Debt Relief Scheme, 2008. They suggested that a more inclusive alternative approach is to identify the vulnerable farmers' based on certain criteria and give an equal amount as financial relief to the vulnerable and distressed families.

3.12. Role of Technology[4]

ICAR Institutes developed a number of cost-effective technologies, techniques and products, not only to enhance the productivity of various crops and commodities, but also the quality of produce for remunerative agriculture and enhancing farmers' incomes. Details of important technologies extracted from various ICAR publications are given below:

Varietal Development

Role of ICAR is extremely crucial in developing and spreading the use of better yielding varieties suitable for different typologies which can contribute to farmers' incomes. Besides, the development of improved varieties/hybrids of food crops and their cultivation are central to increased farm production and consequently national food and nutritional security. During 2015-16, high-yielding varieties of cereals (21), oilseeds (16), pulses (8), forage crops (6) and commercial crop (3) were released from ICAR institutions for cultivation in different production ecologies of the country. Bio-fortified rice variety CR Dhan 310 was commercialized successfully in the Indo-Gangetic Plains belt and Swarna Shreya, a new rice variety for drought–prone conditions was released. To ensure a faster spread to farmers' fields, 978, 17562, 12847, 14000, and 3418 tonnes of breeder, foundation, certified, truthfully labelled seed and planting material, respectively, were produced.

Pusa Basmati 1121: Pusa basmati 1121 was released in the year 2003 and recommended for Punjab, Haryana, western Uttar Pradesh, and Uttarakhand along with other Basmati growing areas. The crop has the productivity of 4.0-4.5 t/ha and matures in 140-145 days, a fortnight earlier than Taraori basmati. The grain is longer (8 mm) with cooked grain length of approximately 20 mm and it is better in cooking compared to that of Taraori basmati. It requires low input and provides high yield with better quality rice for export.

Integrated Farming Solutions

Integrated farming is one of the solutions for enhancing the income and gains to farmers. An integrated farming system (1 ha) model comprising cropping systems (0.52 ha) + horticulture (0.32 ha) + dairy including bio-gas and vermi-compost unit (0.08 ha) + fish cum poultry (0.1 ha) + mushroom developed in western Himalayas, provided round the year improved production (21.52 tonnes REY (rice equivalent yield)/ year), profit (3.06 lakh/year) and employment (731 man days/year).

By rice-wheat-mungbean or rice-potato-mungbean cropping system, an increase of 12-15% in total productivity and a net profit of Rs 15000 to 22000/ha can be obtained as compared to rice-wheat cropping system. Cotton-wheat, pigeonpea-wheat, maize-vegetable pea / potato-sunflower, soybean-vegetable pea / potato sunflower and groundnut-wheat-mungbean cropping systems are economically acceptable and environmentally sustainable option for rice-wheat system. African mustard/Indian mustard based intercropping systems with potato (1:3 replacement series), wheat (1:4 or 1:6), linseed (1:6), and chickpea (1:4 or 2:8) are more

[4] This section has been extracted from ICAR Annual Reports and Annual Reports of ICAR Institutes.

productive and profitable than their sole stand. African mustard at 90 cm + 2 rows of peas, coriander, fenugreek or radish are more productive and remunerative compared to their sole stand. Horticulture will also assure substantial gains to the farmers. Nutrient management schedule for organic production of Grand Naine and Nendran banana; the technology for production of iron-fortified oyster mushrooms (Hypsizygus ulmarius); fertilizer adjustment equation for targeted yield (690–1140 kg/ha) of Appangala 1 and Green Gold varieties of cardamom and integrated nutrient management schedule with improved corn yield of turmeric variety Sudarsana, were developed. An integrated cropping system having coconut + cocoa + banana + pineapple with net income of 3.77 lakh/ha was developed and successfully demonstrated at Aliyarnagar, Tamil Nadu.

Protected Cultivation

Protected cultivation is a cropping technique for growing horticultural crops under protective structures to shield them from pests and weather for assured, climate-resilient and enhanced production of quality products.

Naturally ventilated polyhouse technology: This is a special structure made of G.I. pipes, insect proof nets and transparent plastic sheets, which protect the crops from adverse climatic conditions, insect-pests and different viruses. In this type of polyhouse, all four sides of the greenhouse are covered with an insect-proof, 40 mesh nylon net. Rollable plastic curtains from the ground are used to cover sides. During summer, this plastic curtain is rolled up and down in winter for proper cross ventilation with the help of a pipe. The roof is covered with 200 micron thick, transparent polythene film. An insect-proof nylon net is also used in place of roof ventilators for natural air flow and insect free ventilation. This kind of polyhouse does not require electricity (Box 3.2). For irrigation, low pressure drip irrigation system is used. This type of structure is suitable for peri-urban areas where high value vegetables like tomato, capsicum, parthenocarpic cucumber etc. and flowers like rose, chrysanthemum and gerbera can be grown easily.

Box 3.2 Economics of vegetable cultivation

Main components	Tomato	Capsicum	Parthenocarpic Cucumber
Expected yield	15 tonnes	6-7 tonnes	12 tonnes
Total cost of crop production	90,000/-	2,00,000/-	1,20,000/-
Expected gross income (15 x 15,000 kg)	2,25,000/-	3,50,000/-	2,40,000/-
Expected net return	1,35,000/-	1,50,000/-	1,20,000/-
Cost-benefit ratio	1:2.50	1:2.56	1:2.0

Source: ICAR Annual Report, 2015

Integrated Pest Management (IPM): The major contributions relate to validation and dissemination of IPM in the targeted crops (rice, cotton, pulses, oilseeds, vegetables and fruits). During 2008 to 14, area covered under IPM programmes in different target crops increased from 658-1587 ha. The e-Pest Surveillance and Advisory System covering 14 States with emphasis on Maharashtra and Odisha were established; this resulted in reduction in the use of insecticides for pest management without compromising the productivity of

crops. The IPM module developed by the Centre for pest management in basmati rice was found to be very effective in Uttarakhand, Haryana and Uttar Pradesh. IPM practices helped in increasing cotton productivity by 20-25%. The IPM modules developed for cotton also gave significant reduction in mealybug infestation in Punjab. IPM also showed good promise in pulse production. A major impact of IPM was observed in improving productivity of pigeonpea in Karnataka. A GIS-based automated crop pest mapping system has been developed for major pests and diseases of soybean, cotton, chickpea and pigeonpea.

Resource Conservation Technologies

Resource use efficiency may also contribute significantly to the savings on cost front and thus enhancing the revenues to farmers. Land resource inventory on 1:10,000 scale was prepared taking Landscape Ecological Unit (LEU) consisting of landforms, land use and slope as the base map while bio-climatic map of India was revised. Electronic atlas of water resources, developed for Odisha and Himachal Pradesh, is a useful tool for catch assessment and developing GIS based Decision Support System. The information will help planners to concentrate efforts, allocate resources and deploy manpower according to the distribution of fishery resources.

Zero–Tillage Technology: In zero tillage (ZT) technology, soil is not ploughed, but sowing of crop is done by using a specially designed zero-till seed-cum fertilizer drill/planter, which disturbs soil to the least possible extent. At the time of seeding, fertilizers are simultaneously placed beneath the seeds. Several modern seeding machines, such as happy seeder, turbo seeder, multi-crop planter, rotodouble disc planter are necessary for sowing in residue-laden conditions. Zero tillage proves better for direct-seeded rice, maize, soybean, cotton, pigeonpea, mungbean, cluster bean, pearlmillet during kharif season and wheat, barley, chickpea, mustard and lentil during rabi season. Wheat sowing after rice can be advanced by 10-12 days by adopting this technique compared to conventionally tilled wheat, and wheat yield reduction caused by late sowing can be avoided. ZT provides opportunity to escape wheat crop from terminal heat stress. Zero tillage reduces cost of cultivation by nearly 2500-3000/ha through reduction in cost of land preparation, and reduces diesel consumption by 50-60 litres per hectare. Zero tillage reduces water requirement of crop and the loss of organic carbon by oxidation. Zero tillage reduces Phalaris minor problem in wheat. The carbon status of soil is significantly enhanced in surface soil (0-5 cm), particularly under crop residue retention with zero tillage.

Bed planting technology for enhancing crop productivity: Bed planting is a promising technique of crop establishment during kharif season. It increases the productivity of crops like cotton, maize, pigeonpea, green gram, soybean, cowpea, vegetables, etc., which are grown in kharif and prone to water logging. Raised bed planting increases grain yield and economic returns, improves resource use efficiency and reduces weed problem. Bed planting system helps in efficient use of water under rainfed as well as irrigated conditions because of optimum water storage and safe disposal of excess water. Furrow irrigated raised-bed system (FIRBS) of wheat usually saves seed by around 25%, water by 25-30% and nutrients by 25%

without affecting wheat grain yield. It reduces weed populations on the top of beds, and lodging of wheat crop. The productivity of cotton-wheat, pigeonpea-wheat and maize wheat systems is higher under ZT bed planting with crop residue than in CT flat sown crops. In cotton-wheat cropping system, zero till-broad bed + residue is more remunerative, giving higher system productivity, net returns, and system water productivity than those in conventional till-flat planting. Cotton-wheat cropping system under ZT broad bed with residues of both crops gave higher system productivity and net returns than that in the transplanted rice-conventional till wheat cropping system. Therefore, it can be an alternative option for rice-wheat system under irrigated conditions.

Direct-Seeded Rice: Direct-seeded rice (DSR) avoids water required for puddling and reduces overall water demand compared to conventional puddled transplanted rice (TPR). DSR is a labour-, fuel-, time-, and water-saving technology, which gives comparable yield as that of TPR. Soil health is maintained or improved, and fertilizer and water-use efficiencies are higher in DSR (saving of 30-40% irrigation water). Therefore, DSR is a technically and economically feasible alternative to TPR. In North Indian conditions, summer mungbean can be adopted before DSR. It gives grain yield of 0.8-1.0 t/ha and usually adds 40-60 kg N/ha in soil, reducing N requirement for the subsequent crop.

Livestock Technologies

Livestock sector is supposed to contribute maximum among all sub-sectors to the farmers' incomes. India has been holding the position of leading milk producing nation in the world for the last several years with sustainable increase in the annual milk production wherein the research developments played a crucial role. Studies showed that average first lactation 305 days milk yield of cows was 3,703.6±31.3 kg and average age at first calving was 1,036.6±10.2 days. Under Conservation and Genetic Improvement of Indigenous Cattle Breeds, the milk yield showed an increasing trend among the progenies of different sets, and average 305 days milk yield increased from 1,958 kg in first set to 2,604 kg in 10th set.

Certain pockets in the country are dominated by the existence of small ruminants, proper management of which may contribute significantly to the incomes. The implementation of goat husbandry technologies in famers' flock provided average employment ranging between 80 and 140 man days in a year; and income improved from 67 to 257 % of investment in Assam hill goat.

Peste des Petits Ruminants (PPR) and Foot and Mouth Disease (FMD) Vaccine: PPR or goat plague is the most important disease of sheep and goats causing an economic loss to the tune of Rs. 1800 million/annum. The mass scale use of PPR vaccine developed by IVRI resulted in reduction of >75% disease incidence (< 300 outbreaks as against 1200 outbreaks/ annum) thus saving an annual loss of about Rs. 1200 million. The application of this vaccine has a very high impact on livelihood security of poor people, who depend on sheep and goat rearing. The technology has been transferred to four industries. FMD is the most important infectious disease of cattle and buffaloes causing an economic loss of Rs. 20000 crores

/annum. FMD vaccine production technology in India was first implemented at IVRI, Bangalore campus in late 1970s. About 52 million doses of trivalent vaccine has been produced and supplied till date for FMD prophylaxis throughout the country. The reduced incidence of the disease has ultimately impacted on livelihood security of poor people, who depend on these animals for milk and draught purposes.

Mineral Mixture Supplementation: The mineral deficiency is manifested in the form of loss of hairs, skin disorders, anemia, loss of appetite, bone abnormalities and suboptimum production and reproductive problems. Thus, supplementation of minerals is inevitable to achieve optimum health and production. The technology is available for the formulation of mineral mixtures as per the recommendations of Bureau of Indian Standards for different species i.e. cattle, buffalo and goat to supplement major and trace minerals like Ca, P, Mg, Fe, Zn, Mn, I and Co etc. There are two types of formulations of mineral mixture, one is with salt and the other is without salt. It should be mixed in the concentrate mixture @ 2kg per 100 kg (without salt) and @ 3 kg/100 kg (with salt). Supplementation increases the feed intake, feed conversion efficiency and productive performance of animals in terms of growth, reproduction and milk production. Mineral supplementation was found to enhance productive and reproductive performances of ruminant species, particularly to those who are deficient in particular types of minerals.

Fisheries Sector: ICAR has extended support for multiple breeding of Indian major carps for year round seed production. The technologies related to intensive carp culture and production levels of 10-15 tonnes/ha/yr along with improved rohu (Jayanti) with 17% higher growth realization per generation after eight generations through selective breeding have been developed. Besides these, the breeding, seed production and culture technology for important brackishwater and marine finfishes such as milkfish (Chanos chanos), pearlspot (Etroplus suratensis), Asian seabass (Lates calcarifer), cobia (Rachycentron canadum) and Silver pompano (Trachinotus blochii), etc. have also been developed.

Source: Annual Reports of ICAR and ICAR Institutes

3.13. Role of Infrastructure

To realize the DFI mission, a paradigm shift in resource allocation priorities and the approach to improving rural connectivity, electricity supply and availability of markets to sell the agricultural produce is the need of the hour and would enable the farmers to realize the remunerative gains to their produce.

The condition of rural infrastructure (roads, irrigation, electricity and markets) in a number of states is a matter of serious concern. The studies have reported that basic infrastructure can improve the total factor productivity, thus, it becomes the utmost requirement that basic concerns related to infrastructure are addressed.

Studies have shown that in terms of impact on farm income, rural connectivity holds tremendous importance. Besides delivering a host of other benefits, roads have the potential to lower input cost, reduce post-harvest losses, and addressing the issues related to gap

between farm-gate price and consumer price. Approximately 15 percent of crop produce is lost between the farm gate and the customer because of poor roads and improper storage facilities thus badly influencing the income of farmers (World Bank, 1997). Availability of proper road network provides the basics to facilitate trade, transportation, social integration and economic development.

Table 3.22 provides the details about national highways, state highways, rural roads and urban roads. Length of National Highways rose from 19,811 kilometres in 1951 to 70,93476,817 kilometres in 2012. Some of the states despite having the potential to become leading agricultural producing states in India are low in terms of road infrastructure like Jharkhand, Rajasthan, Haryana, Madhya Pradesh, Gujarat, Andhra Pradesh and Uttar Pradesh.

Table 3.22 Status of Road Length (As on 31st March 2013)

State/U.T.	Area (km^2)	National Highways		State Highways		Rural Roads		Urban Roads	
		Total (Km)	Per 100 sq. km of area	Total (Km)	Per 100 sq. km of area	Total (Km)	Per 100 sq. km of area	Total (Km)	Per 100 sq. km of area
Andhra Pradesh	275045	5022	1.8	10700	3.9	168516	61.3	13628	5.0
Bihar	94163	4168	4.4	4483	4.8	167579	178.0	8760	9.3
Chhattisgarh	135191	2289	1.7	5240	3.9	30295	22.4	8109	6.0
Goa	3702	269	7.3	279	7.5	5851	158.0	518	14.0
Gujarat	196024	3828	2.0	18506	9.4	53288	27.2	22199	11.3
Haryana	44212	1633	3.7	2416	5.5	4622	10.5	10211	23.1
Himachal Pradesh	55673	1506	2.7	1504	2.7	15145	27.2	1852	3.3
Jammu & Kashmir	222236	1695	0.8	-	-	13451	6.1	1185	0.5
Jharkhand	79714	2374	3.0	1960	2.5	17097	21.4	620	0.8
Karnataka	191791	4642	2.4	20749	10.8	163957	85.5	42909	22.4
Kerala	38863	1457	3.7	4341	11.2	124864	321.3	18923	48.7
Madhya Pradesh	308245	5116	1.7	10934	3.5	117722	38.2	14729	4.8
Maharashtra	307713	4498	1.5	38765	12.6	262371	85.3	20455	6.6
Orissa	155707	4416	2.8	3607	2.3	213446	137.1	18922	12.2
Punjab	50362	1557	3.1	1477	2.9	62900	124.9	15517	30.8
Rajasthan	342239	7180	2.1	10465	3.1	103441	30.2	12636	3.7
Tamil Nadu	130058	4943	3.8	10764	8.3	144583	111.2	22509	17.3
Uttar Pradesh	240928	7818	3.2	7703	3.2	113531	47.1	76549	31.8
Uttarakhand	53483	2042	3.8	3788	7.1	6933	13.0	4159	7.8
West Bengal	88752	2681	3.0	3952	4.5	184088	207.4	93774	105.7

State/U.T.	Area (km^2)	National Highways		State Highways		Rural Roads		Urban Roads	
		Total (Km)	Per 100 sq. km of area	Total (Km)	Per 100 sq. km of area	Total (Km)	Per 100 sq. km of area	Total (Km)	Per 100 sq. km of area
N.E States									
Assam	78438	2940	3.7	3134	4.0	222087	283.1	4518	5.8
Arunachal Pradesh	83743	2027	2.4	-	-	5262	6.3	18	0.0
Manipur	22327	1317	5.9	715	3.2	7635	34.2	166	0.7
Meghalaya	22429	1171	5.2	858	3.8	1793	8.0	30	0.1
Mizoram	21081	1027	4.9	310	1.5	2561	12.1	388	1.8
Nagaland	16579	494	3.0	1204	7.3	23783	143.5	98	0.6
Sikkim	7096	149	2.1	179	2.5	3343	47.1	133	1.9
Tripura	10486	400	3.8	689	6.6	18165	173.2	280	2.7
Union Territories									
A. & N. Islands	8249	300	3.6	264	3.2	-	-	139	1.7
Chandigarh	114	24	21.1	158	138.6	-	-	1802	1580.7
D. & N. Haveli	491	-	-	42	8.6	-	-	-	-
Daman and Diu	112	-	-	-	0.0	111	99.1	39	34.8
Delhi	1490	80	5.4	-	-	-	-	29510	1980.5
Lakshadweep	32	-	-	-	-	-	-	5	15.6
Pudducherry	492	53	10.8	41	8.3	1219	247.8	948	192.7

Source: Ministry of Road and Statistics

India is home to around 35% of the global population without access to electricity and only 44% of all rural Indian households are electrified (Samanta, 2015). According to the 2011 Census, 16.6 crore households use electricity as the primary source of lighting out of a total of 24.6 crore households in the country. Table 3.23 gives an overview of the status of village electrification across the 27 states of India. Out of total of 27 states, only 4 states have achieved 100 % village electrification as on the 30th April 2017.

Table 3.23 Rural Electrification in India (as on 30.4.2017)

State	Total Inhabited Villages	Un-Electrified Villages	Proportion of Electrified Villages	Total Rural Households (Millions)	Households Electrified (Millions)	Balance Rural Households to be Electrified (Millions)	Proportion of Un Electrified Households
Andhra Pradesh	26286	0	100	111.8	111.8	0	0.0
Bihar	39073	424	99	122.56	55.16	67.4	55.0
Chhattisgarh	19567	321	98	45.17	38.66	6.51	14.4
Gujarat	17843	0	100	66.94	66.94	0	0.0
Haryana	6642	0	100	34.18	27.12	7.06	20.7

State	Total Inhabited Villages	Un-Electrified Villages	Proportion of Electrified Villages	Total Rural Households (Millions)	Households Electrified (Millions)	Balance Rural Households to be Electrified (Millions)	Proportion of Un Electrified Households
Himachal Pradesh	17882	0	100	14.56	14.42	0.14	1.0
Jammu & Kashmir	6337	102	98	12.88	10.18	2.7	21.0
Jharkhand	29492	579	98	56.82	22.58	34.24	60.3
Karnataka	27397	25	100	96.08	83.95	12.13	12.6
Kerala	1017	0	100	70.97	70.73	0.24	0.3
Madhya Pradesh	51929	52	100	113.61	67.74	45.87	40.4
Maharashtra	40956	0	100	140.16	118.02	22.14	15.8
Odisha	47677	555	99	84.05	45.62	38.43	45.7
Punjab	12168	0	100	36.89	36.89	0	0.0
Rajasthan	43264	1	100	91.09	68.79	22.3	24.5
Tamil Nadu	15049	0	100	102.85	102.85	0	0.0
Uttar Pradesh	97813	6	100	304.87	147.78	157.09	51.5
Uttarakhand	15745	53	100	17.02	14.83	2.19	12.9
West Bengal	37463	5	100	138.13	136.85	1.28	0.9
N.E States							
Assam	25372	558	98	51.85	27.49	24.36	47.0
Arunachal Pradesh	5258	1229	77	2.32	1.51	0.81	34.9
Manipur	2379	77	97	3.88	2.81	1.07	27.6
Meghalaya	6459	230	96	4.63	3.24	1.39	30.0
Mizoram	704	18	97	1.08	0.97	0.11	10.2
Nagaland	1400	4	100	1.6	0.72	0.88	55.0
Sikkim	425	0	100	0.37	0.32	0.05	13.5
Tripura	863	0	100	7.96	5.73	2.23	28.0

Source: Deendayal Upadhyaya Gram Jyoti Yojana (Scheme of Govt. of India for Rural Areas)

Well-organized marketing is essential for the development of the agricultural sector as it provides outlets and incentives for increased production, the marketing system contribute greatly to the commercialization of subsistence farmers. The National Commission on Farmers (2004) has recommended that the facility of regulated markets should be available to the farmer within the radius of 5 km. The total number of regulated markets in India as on 31.3.2014 is 7114, and the number of rural periodical markets was 22759; the area covered by each regulated market was as low as 118 per sq. km in Punjab to 1031 per sq. km in Himachal Pradesh considering major states (AGMARKNET).

Table 3.24 gives the detail about the wholesale, rural primary and regulated market in India. These consist of more than 2479 principal markets and 4267 sub yards. The number of regulated markets is relatively more in geographically large states viz. Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, West Bengal and Rajasthan. These six states account for more than half of the regulated markets in the country. The states of Punjab and Haryana though geographically small, have a large number of regulated markets. Increasing of

farmers' incomes requires that adequate infrastructure is provided nearer to farmers' fields, connecting smallholders to the markets and strengthening value chain linkages.

Table 3.24 Details of wholesale, Rural Primary and Regulated Markets in Different States/UTs (As on 31.03.2015) and number of markets per lakh gross cropped area

	Number of Markets				Regulated Market			
States/UTs	Whole Sale	Rural Primary	Total	Number of total markets per lakh gross cropped area	Principal	Sub Market Yards	Total	Number of Regulated Market per lakh gross cropped area
Andhra Pradesh	190	157	347	4.3	190	157	347	4.3
Bihar	325	1469	1794	23.7	-	-	-	-
Chhattisgarh	2	1132	1134	19.9	69	118	187	3.3
Goa	4	24	28	17.7	1	7	8	5.1
Gujarat	205	129	334	2.7	213	187	400	3.2
Haryana	281	195	476	7.4	107	174	281	4.3
Himachal Pradesh	42	35	77	8.2	10	44	54	5.7
Jammu & Kashmir	0	8	8	0.7	11	0	11	1.0
Jharkhand	201	602	803	48.0	28	173	201	12.0
Karnataka	315	730	1243	10.1	157	356	513	4.2
Kerala	348	1014	1362	52.1	-	-	-	-
Madhya Pradesh	0	0	0	0.0	254	284	538	2.2
Maharashtra	881	3500	4381	18.8	305	603	908	3.9
Odisha	398	1150	1548	30.0	54	382	436	8.4
Punjab	424	1390	1814	23.1	150	274	424	5.4
Rajasthan	446	312	758	2.9	134	312	446	1.7
Tamil Nadu	0	0	0	0.0	277	6	283	4.8
Telangana	150	110	260	4.1	150	110	260	4.1
Uttar Pradesh	584	3464	4048	15.6	250	365	615	2.4
Uttarakhand	36	30	66	6.0	26	32	58	5.3
West Bengal	279	3250	3529	36.7	20	464	484	5.0
N.E States								
Assam	405	735	1140	27.8	20	206	226	5.5
Arunachal Pradesh	5	66	71	24.0	0	0	0	0.0
Manipur	24	95	119	31.6	-	-	-	-
Meghalaya	35	85	120	35.0	2	0	2	0.6
Mizoram	7	218	225	197.6	-	-	-	-
Nagaland	19	174	193	38.7	18	0	18	3.6
Sikkim	7	12	19	12.9	-	-	-	-
Tripura	84	470	554	-	21	0	21	-
Union Territories								
A & N Islands	0	28	28	115.3	NIL	NIL	NIL	-
Chandigarh	1	0	1	51.2	1	0	1	51.2
D & N Haveli	0	0	0	0.0	-	-	-	-
Daman & Diu	0	0	0	0.0	-	-	-	-
Delhi	30	0	30	84.9	7	8	15	42.5
Lakshadweep	0	0	0	0.0	-	-	-	-
Puducherry	4	5	9	35.6	4	5	9	35.6

Source: Directorate of Marketing and Inspection

Table 3.25 gives the information about the number of registered factories in food processing sector for the year 2013-14 across various states in India. States with having large number of registered factories in food processing sector are Andhra Pradesh, Tamil Nadu, Telangana and Maharashtra. Punjab and Uttar Pradesh despite the largest producer of food crops and milk are at fifth and sixth position respectively. Thus there is scope for promotion of food processing industries in these states primarily because of their strategic geographical location and proximity to National Capital Region, one of the major markets for processed foods.

Table 3.25 State wise distribution of registered factories in food processing sector (2013-14)

Name of the State/UTs	Number of registered units
Andhra Pradesh	5,739
Bihar	794
Chhattisgarh	1,049
Goa	86
Gujarat	1,904
Haryana	631
Himachal Pradesh	172
Jammu & Kashmir	144
Jharkhand	198
Karnataka	2,033
Kerala	1,460
Madhya Pradesh	672
Maharashtra	3,040
Orissa	932
Punjab	2,786
Rajasthan	862
Tamil Nadu	5,204
Telangana	3,850
Uttar Pradesh	2,037
Uttarakhand	380
West Bengal	1,739
N.E States	
Assam	1,294
Arunachal Pradesh	5739
Manipur	21
Meghalaya	18
Nagaland	15
Sikkim	21
Tripura	71
Union Territories	
A. & N. Islands	5
Chandigarh	19
D. & N. Haveli	3
Daman and Diu	31
Delhi	166
Puducherry	69

Source: Ministry of Food Processing Industries, Annual Report 2016-17

The Committee reviewed the study undertaken by National Centre for Cold-chain Development (NCCD) and NABCONs (NABARD Consultancy Services) in 2015, and took note of the infrastructure status in cold-chain. According to the study, the country had already created 31.82 million tons of cold storage space as on 31.3.2014, almost 90% of the overall capacity required with a current gap of 3.28 million tons in cold storage space (Bulk & Hub). However, there exist other critical gaps for integrating the cold-chain, as a medium that connect farms with markets. The current status and gaps in cold-chain are at Table 3.26.

Table 3.26 Gap Analysis of Cold-Chain Infrastructure in India

Type of Infrastructure	Infrastructure Requirement	Infrastructure Created	All India Gap	Shortfall (%)
Integrated Pack-house	70,080 nos.	249 nos.	69,831 nos.	99.6
Reefer Transport	61,826 nos.	<10,000 nos.	52,826 nos.	85
Cold Storage (Bulk)	341,64,411 MT	318,23,700 MT	32,76,962 MT	10
Cold Storage (Hub)	9,36,251 MT			
Ripening Units	9,131 nos.	812 nos.	8,319 nos.	91

Infrastructure in number, refers predefined unit size; in MT denotes metric tonnes *Source: NCCD 2015 Study*

Since 2014, additional cold-chain capacity has been created in the country, though mostly as cold stores. Table 3.27 gives the glimpse about the number of Cold storages created across various states in India. However, cold storages are only one segment of the cold-chain, which facilitates the smooth transfer of harvested value from farms to distant locations.

Only creation of cold storage facilities would not probably serve the purpose, it needs to be coupled with other logistic support like pack-houses, reefer vans, ripening chambers etc. with continuous power supply to connect farmer and consumers more effectively. NCCD reports that inadequate cold-chain facility is the major constraint in the case of horticultural commodities because of high product perishability of the products and less retention capacity of the farmers. Lack of cold-chain denies the farmers the ability to reach out and connect with a large number of consumers. This has resulted in huge post-harvest losses of perishable agricultural produce.

Table 3.27 Number of Cold Storages and Capacity (in '000 metric tonnes) in India

States/UTs	2014		2015		2016	
	Number	Capacity	Number	Capacity	Number	Capacity
Andhra Pradesh	404	1578	413	1622	426	1729
Bihar	303	1406	304	1411	305	1416
Chhattisgarh	89	428	97	471	98	485
Goa	29	8	29	8	29	8
Gujarat	560	2031	625	2323	692	2571
Haryana	295	589	307	639	318	696
Himachal Pradesh	32	39	34	53	53	106

States/UTs	2014		2015		2016	
	Number	Capacity	Number	Capacity	Number	Capacity
Jammu & Kashmir	28	65	29	70	33	101
Jharkhand	55	217	56	222	57	227
Karnataka	189	527	192	536	193	548
Kerala	197	78	197	78	196	78
Madhya Pradesh	260	1097	275	1168	294	1254
Maharashtra	540	706	555	763	575	882
Orissa	111	327	120	367	167	523
Punjab	606	2005	617	2051	655	2152
Rajasthan	154	480	157	491	159	521
Tamil Nadu	163	296	165	305	168	317
Uttar Pradesh	2176	13633	2209	13808	2250	13979
Uttarakhand	28	85	30	90	44	149
West Bengal	502	5902	506	5912	511	5941
N.E States						
Assam	34	120	35	126	35	153
Arunachal Pradesh	2	5	2	5	1	5
Manipur	1	2	1	2	1	3
Meghalaya	4	8	4	8	4	8
Mizoram	3	4	3	4	3	4
Nagaland	2	6	2	6	2	6
Sikkim	2	2	3	2	2	2
Tripura	13	39	14	45	14	45
Union Territories						
A. & N. Islands	2	0	2	0	2	0
Chandigarh	6	12	7	12	7	12
Delhi	97	130	97	130	97	130
Lakshadweep	1	0	1	0	1	0
Puducherry	3	0	3	0	3	0
All India	**6891**	**31824**	**7091**	**32729**	**7395**	**34050**

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India.

The current capacity in dry warehouses and godowns is estimated to be between 150 million tons and 180 million tons as the capacity created under private sector is not been fully evaluated. Similar to the evaluation of cold-chain, a need appraisal is also recommended for the other infrastructure elements that empower farmers to integrate into the supply chain, and be better linked directly with markets.

A comprehensive and holistic assessment of infrastructure items such as dry warehousing, silos, rail and road transport, etc., mapped against market demand and with production is also required.

Key Extracts

- Despite many technological breakthroughs especially in rice and wheat crops the yield realized at farmers field remain considerably lower than demonstrated yield. The yield gaps are associated with many parameters such as quality of seeds and irrigated area under crop. Yield gaps can be addressed by expanding irrigation, use of improved seeds in sowing and better credit access.
- The state-level norms for the optimum mix of NPK are far away from the all-India average. Fertilizer promotion and policy should be state-specific and it should strive to attain state specific optimum mix and use of NPK.
- West Bengal and Odisha provide scope to expand output oriented irrigation expansion in Paddy. In terms of wheat, factors other than irrigation could be thought of in attaining yield convergence. Millets, Pulses and Groundnut exhibit huge potential for irrigation expansion. Among commercial crops, while maize provides higher scope followed by cotton, sugarcane has limited potential as almost entire area is irrigated.
- Just 2% of paddy and wheat growers use hybrids. The spread of hybrid seed use in cereals and millet growing areas would potentially benefit farmers in gaining higher yield and income. Among pulses, Tur offer scope to adopt hybrid and improved seeds, and among oilseeds, groundnut provides some chance.
- Extent of access by marginal and small farmers needs special attention as they generally lack capital assets. Further, production efficiencies in different class of farmers in presence and absence of credit need to be examined so that credit policies can be effectively reoriented in increasing income of different class of farmers.
- The condition of rural infrastructure (roads, irrigation, electricity and markets) in a number of states is a matter of serious concern. To realize the DFI mission, a paradigm shift in resource allocation priorities and the approach to improving rural connectivity, electricity supply and availability of markets to sell the agricultural produce is the need of the hour and would enable the farmers to realize the remunerative gains to their produce.
- Marketing infrastructure includes items that enable physical connectivity of farmers with markets, such as transport linkages integrated with assembly, aggregation and storage to maintain a state of steady supply to markets.

Chapter 4
Marketing, Prices & Trade

The Chapter highlights marketing, price and trade dimensions which have ponderous role in accentuating income of farmers. The chapter provides the realistic picture of marketed surplus and price realization in various crops across states and farm size classes. Awareness and participation in minimum support price (MSP) scheme across the region and farm size classes has also been discussed in detail. Subsequently, a brief overview of price volatility of different crops has been presented. At last, role of agricultural trade in enhancing gains of farmers along with a brief illustration of trade policy have been discussed.

4.1. Marketed surplus and price spread for various crops across states

Indian agriculture has witnessed remarkable growth during last few decades. Agricultural production in India has undergone a phenomenal change since the dawn of green revolution. Many technological breakthroughs have changed the face of Indian agriculture. Witnessing the contributions of various revolutions, the country not only became a self-sufficient nation but also became export oriented in many agricultural commodities.

Other revolutions and policies led to remarkable increase in the output of oilseeds, horticultural and livestock & fish products. Besides the growth per se the quality of growth has also seen considerable improvement and there has been progress relating to inclusiveness, regional equity and nutritional security (Chand, 2014). In the course of development, the agriculture sector has gone through different phases of growth, embracing a wide variety of institutional interventions, and technology and policy regimes (Chand and Parappurathu, 2012).

Some of the important crops like maize, gram, urad, cotton, onion and potato witnessed positive and comparatively high production growth rate during 2004-05 to 2013-14. These noticeable achievements on the production front led to increasing commercialization of Indian agriculture from a subsistence level.

The marketed surplus ratio (MSR), expressed as the ratio of output marketed to output produced, is also expressed in Table 4.1. The marketed surplus ratio depends upon the requirement of crop to be used for home consumption, seed, feed and wastages in handling. The marketed surplus ratio for most of the crops has increased appreciably during last 13 years from 1999-00 to 2013-14. The increase was much more noticeable during 1999-00 to 2004-05. As far as food grains are concerned, maize is the highest marketed crop in India.

The marketed surplus ratio is highest for cotton and some of the oilseeds due to obvious reasons. Thus, the growing MSR clearly indicates the increasing commercialization of Indian agriculture. Increasing commercialization requires that the required marketing infrastructure and marketing network are in place to ensure remunerative returns to the farmers.

Table 4.1 Marketed Surplus Ratio (MSR) and Production Growth of Important Agricultural Commodities in India

	Production growth (2004-05 to 2013-14)	Marketed Surplus Ratio		
		1999-00	2004-05	2013-14
I. Foodgrains: Cereals				
Rice	2.0	60.32	71.37	82.00
Wheat	4.3	54.48	63.33	73.11
Maize	6.4	62.79	76.22	86.98
Jowar	-3.8	46.83	53.44	65.25
Bajra	1.6	65.22	69.39	71.11
Ragi	-2.8	41.15	57.74	44.11
II. Pulses				
Arhar	1.1	62.93	79.52	86.99
Gram	6.5	65.63	93.76	89.58
Urad	4.4	80.91	85.76	80.71
Moong	4.6	70.13	76.79	92.22
Lentil	1.7	59.87	85.86	90.23
III. Oilseeds				
Groundnut	0.5	63.34	88.75	95.20
Rapeseed & Mustard	-1.1	71.57	89.66	94.49
Soybean	8	94.95	94.99	95.23
Sunflower	-12.3	99.3	98.32	65.42
Sesamum	1.3	84.45	87.38	92.91
Safflower	-26.5	86.8	91.34	-
IV. Other Commercial Crops				
Sugarcane	3.7	82.5	98.23	21.62
Cotton	10.3	94.58	94.94	97.32
Jute	1	97.5	90.72	100.00
V. Vegetables				
Onion	12.9	-	82.91	99.29
Potato	10.6	45.9	85	61.35

Source: DACNET & Agricultural Statistics at a Glance

Currently, the marketed surplus data is available at the aggregate level which does not factor in the importance from the point of view of product movement from one region to the other or from one market to the other markets. It would be appropriate for balancing supply and demand situation if the market level surplus is assessed. This will also help reduce the situation of price volatility and price triggers from certain locations/markets.

4.2. Agricultural Marketing Scenario and Challenges

The achievement on the production front in terms of a significant increase in production would translate into higher farm incomes, consumer welfare and poverty reduction only when it is supported by an efficient and competitive marketing system. Agricultural marketing system plays a pivotal role in fostering and sustaining the tempo of rural development and it

also triggers the process of agricultural development. An efficient and competitive agricultural marketing system is crucial not only to ensure an effective transfer of agricultural commodities from farmer to the consumers but also in achieving its broader objectives of providing market signals and production incentive to farmers, balancing the demand and supply of agricultural commodities and in ensuring efficient utilization of production resources (Acharya, 2003; Chand, 2012).

An excellent example for the role of good marketing system in facilitating the spread of technology on the production front and enabling its gains to reach the farmers in terms of higher profitability is provided by the case of Bt Cotton in India, wherein, the increased production resulting from the introduction of Bt technology, led to increased gains from trade and farmers profitability (Gulati, 2009).

In India, poor marketing linkages and infrastructure constraints have led to high and fluctuating consumer prices resulting in only a small share of consumer rupee reaching the farmer. In addition to this, the issues of poor produce handling, wastage of producing, lack of scientific grading and storage facilities have also affected the efficiency of agricultural marketing in India.

The agricultural marketing policy of India has aimed to address the issues related to market inefficiencies through regulatory mechanisms (Agricultural Produce Market Regulation Act-APMC Act), ensuring legal provisions like the Essential Commodities Act; and creation of market infrastructure and institutions. However, the inefficiencies in the agricultural marketing system have continued to persist.

There have been large gap in the development of the storage infrastructure, transportation, mechanization, grading standards, export promotion, processing industry support and market intelligence in India which requires upgradation. Market Intelligence or the dissemination of market information is an important area which could play a significant role in farmers' decision making regarding the production and marketing decisions of agricultural commodities by the farmers. Availability of accurate, timely and adequate market related information enables farmers in informed decision making as to when and where to sell their produce (Acharya, 2003).

Agricultural marketing in India is facilitated through a network of regulated markets established under the APMC Act. The objective of such intervention was to ensure regulation of marketing practices and protect the farmers from the exploitation of intermediaries. However, there is an argument that over a period, market regulation has taken the form of restrictive and monopolistic trade and the balance of power in transactions has moved in the favour of middle men and traders **(**Chand, 2012). As a result, the prices realized by the farmers still remain low. In fact, Acharya (2006) attributes the failure of agricultural marketing system in India to excessive state intervention.

4.3. Price realisations across states, crops and farm size classes

Despite the structural transformation in terms of its linkage with the international economy as well as the increasing role of private players, the farmer's share in consumer's rupee is quite low. Long supply chains with a number of intermediaries have resulted in high marketing costs, while the share of producer in consumer rupee is found to be 66 per cent it is as low as 20 per cent in the case of fruits and vegetables. This reflects the extent of inefficiencies existing in the agricultural marketing system of India (Gulati, 2009). It has been established that prices will be one of the major sources of growth even if the status quo in the production is maintained. It does not imply here that prices need to be increased essentially; it implies that we need to improve farmers' share in consumer price and need to minimize during the chain costs, margins and inefficiencies.

Table 4.2 and Table 4.3 provide the details of price realisation by the farmers for selected crops based on the Situation Assessment Survey of agricultural households. We also examined whether the price realisation varies across farm size for major agencies to which the produce is sold.

Table 4.2 Price realisation for major crops and farm categories (July-December 2012)

Agency	Farm category	Paddy	Jowar	Bajra	Maize	Arhar	Urad	Moong	Sugar cane	Cotton
Local Private	Marginal	12	13	11	12	36	29	37	2	37
	Small	11	4	10	11	38	28	38	3	39
	Semi-medium	14	9	11	12	31	28	41	2	39
	Medium	14	9	11	12	36	27	34	3	40
	Large	11	11		12	35		40	3	37
Mandi	Marginal	13	6	10	12	37	28	38	3	37
	Small	13	13	11	12	36	29	35	2	40
	Semi-medium	16	12	11	12	37	30	32	3	39
	Medium	14	14	10	12	34	28	38	4	40
	Large	15	12	13	12	38	27	44	3	37
Input dealers	Marginal	11	13	10	12	34	29	46	2	37
	Small	12	12	11	13	33	29	47	2	41
	Semi-medium	13	14	11	12	33	30	40	2	37
	Medium	12	13	12	12	32	28	53	2	40
	Large	14		10	11		26		2	38
Cooperat-ives & Govt. Agency	Marginal	13	20	15			25		2	37
	Small	14	24	13	13	40	12	50	3	36
	Semi-medium	13	12	11	12		32	27	2	38
	Medium	13	14	13	13	36		31	5	37
	Large	14	15		13					42
Processors	Marginal	12			13				3	37
	Small	13			14				2	39
	Semi-medium	13			11				3	38
	Medium	14							3	34
	Large	15							3	38

Table 4.3 Price realisation for major crops and farm categories (January-June 2013)

Agency	Farm category	Paddy	Jowar	Wheat	Barley	Gram	Lentil	Rapeseed/ Mustard
Local Private	Marginal	13	20	13	10	28	44	29
	Small	12	14	13	12	30	41	30
	Semi-medium	14	20	13	12	31	41	31
	Medium	15	15	13	10	33	43	30
	Large	14	12	13	11	35	39	29
Mandi	Marginal	14	14	14	13	28	33	31
	Small	12	14	14	10	30	35	31
	Semi-medium	13	15	14	12	30	37	31
	Medium	14	17	14	11	31	33	31
	Large	13	14	14		28	33	31
Input dealers	Marginal	12	25	12		30	46	29
	Small	13	14	12	13	30	35	30
	Semi-medium	12	14	13	13	29	34	31
	Medium	12	16	14	11	31	35	31
	Large	13		14		38		29
Cooperat-ives & Govt. Agency	Marginal	14		14		30		
	Small	13		14		28		30
	Semi-medium	14		14				
	Medium	14		14		32		32
	Large	18		14				
Processors	Marginal	15		16			30	20
	Small	10		13				28
	Semi-medium	11		11				20
	Medium	9		14				28
	Large							

Source: Computed from NSSS Unit Record Data on Situation Assessment Survey (2014)

In general, small and marginal farmers receive lower price as compared to relatively larger farm size categories. In case of maize and sugarcane there is not much variation in prices across different agencies, however in case of paddy jowar, bajra, pulses and cotton prices offered by different agencies shows variation.

At the state level, it was observed that there is high variation in prices of almost all the commodities and this variation is not only among the states but also among the agencies in both the season (Table 4.4 and 4.5).

Table 4.4 Price realization from local private traders and government & cooperative agency in different crops across states (June to Dec 2012)

States	Paddy		Bajra		Maize		Arhar		Urad		Sugarcane		Cotton	
	LPT	G&C	LPT	G&C	LPT	G&C	LPT	G&C	LPT	G&C	LPT	G&C	LPT	G&C
Andhra Pradesh	13	11	6		9		32	28	34		3	7	38	34
Bihar	11	11			10						2	2		
Chhattisgarh	11	13			10		53		38		2	2		
Gujarat	12	15	11	15	11		33	30	34		2	2	42	41
Haryana	17	19	11	13							3	3	42	39
Himachal Pradesh	12				12				50					
Jammu & Kashmir	19		10		13				60					
Jharkhand	10	11	9		10		41		24					
Karnataka	16	16	13	16	12	13	37	38	40		4	2	40	43
Kerala	12	17					33		47	12	22			
Madhya Pradesh	14	13	11		13	13	37		27		2	3	40	
Maharashtra	18	13	12	18	11	12	37	35	22		3	3	39	40
Odisha	11	12			12		31		54				34	
Punjab	31	14			11	12	17				3	3	41	39
Rajasthan	12		10		12	12	16		33	30			40	40
Tamil Nadu	14	14			14	14					2	2	41	42
Telangana	12	13			11	12	33	40		25		2	36	35
Uttar Pradesh	11	13	11	11	11		44		30		3	3	4	
Uttarakhand	15	12				15			60		3	3		
West Bengal	10	12			26								17	
North Eastern States														
Assam	10	9			12				40		17	18		
Arunachal Pradesh	19				8				50		20			
Manipur	11				12									
Meghalaya	19				4									
Mizoram	17	5			8						11			
Nagaland	22				23									
Sikkim	39				31				80					
Tripura	10													
Union Territory														
Delhi	21													

Source: Computed from NSSS Unit Record Data on Situation Assessment Survey (2014)

Table 4.5 Price realization from local private traders and government & cooperative agency in different crops across states (Jan to July 2013)

States	Wheat		Gram		Masoor		Rapeseed/ Mustard	
	LPT	G&C	LPT	G&C	LPT	G&C	LPT	G&C
A.P			31					
Bihar	12	13	37		42			28
Chhattisgarh	12		31		38		31	
Gujarat	14	15	25				30	31
Haryana	13	14	30				32	31
Himachal Pradesh	13	13						
J&K	14						21	
Jharkhand	15		28		35		40	
Karnataka	13	14	38					
Kerala			365					
M.P	14	15	32	32	31		28	
Maharashtra	15	13	30	32	42			
Odisha	13		37		55		37	
Punjab	13	14					28	
Rajasthan	14	16	30	28	45		30	31
T.N			40					
Telangana			31	32				
Uttar Pradesh	12	13	32		39			29
Uttarakhand	14	15	50		47		12	
W. Bengal	12		32		35		27	
North Eastern States								
Arunachal Pradesh	50						24	
Assam					32		33	
Manipur	10						20	
Meghalaya							47	
Union Territory								
Delhi	13	15					28	

Source: Computed from NSSS Unit Record Data on Situation Assessment Survey (2014)

The price offered by local private agency is comparatively higher than the government/ cooperative price. In some states the difference between both the prices is much higher, as seen in case of paddy in Punjab and Maharashtra and urad in Kerala. However, situation is reversed in case of jowar and moong where government agency has offered better price to the farmers.

4.4. Price Realization: Meta-analysis of Available Studies

As has been established, output growth only will not drive sufficient growth for farmers; rather it will be through efficient marketing arrangements that the income of farmers would be enhanced. Many innovative marketing arrangements have shown that farmers' share can be magnified and the marketing costs and margins of the chain can be handled efficiently. For gathering the temporal and spatial evidence of how the price realization across various commodities and regions, the meta-analysis of the studies conducted at regional level and published in various journals was done. The summary results presented on this basis are presented in Box 4.1. The price realization to farmers, expressed as share in consumer rupee, indicates that it is lowest for fruits and vegetables after pulses. Of course, it varies according to the marketing channel selected even within a given geography for the selected commodity.

Box 4.1 Farmers' share for various commodities, channels, states and years

Source: Compiled from various studies in Agricultural Marketing

It is surprising to note that the farmers' share in onion remains around 43-44 per cent despite being the highest and quality producer of the onion in the country. Banana trading seems to be efficient as only 15-18 per cent of the consumer rupee is wiped away during marketing.

The e-NAM is latest initiative which will provide national unified agricultural markets to farmers and bring better price realization through connectivity, transparency and enhanced integration. However, an ex-ante analysis may be conducted in those *mandies* which have already been connected through the e-NAM. Ensuring private sector participation can bring competition and will provide added gains to the farmers. Effective post-harvest management will yield not only in terms of increased availability rather it may help farmers fetch remunerative prices for their produce. The scenario is indicative of the situation of price realization across commodities, states and time period. However, a detailed analysis needs to be conducted at regional/ local level to present more realistic situation and decide suitable strategies accordingly.

Price realization by the farmer can be best computed from the price data on either the farm harvest price (FHP) available at state and district level or the wholesale price data during the peak season in the APMC's. FHP data is available only at the state or district level with a certain time lag. Appropriate mechanisms for collection of recent FHP at more disaggregated level like blocks/villages would be desirable.

4.5. The Minimum Support Price Scheme (MSPS) of Government of India: Awareness and Participation across Farm Size Classes

The volatile behaviour of market prices for agricultural commodities in India creates the situation of crop and resource allocation uncertainty for farmers. Thus, remunerative and stable price environment is essential for farmers; the price policy of Government of India (Minimum Support Price) in providing support is one of the initiatives in this direction. It is important to examine the efficacy of any such support programme which may be analysed in terms of its awareness and participation of farmers. As paddy is one the major crops in the country in terms of production as well as consumption, the details have been examined for paddy crop based on the household data of Situation Assessment Survey.

Table 4.6 reveals MSP awareness and participation situation for paddy across size classes in important states of the country. The awareness scenario for paddy presents an alarming indication as only 16 percent of the total paddy growers in the nation are aware about its price policy. Delhi, Punjab and Chhattisgarh are among the most aware states, whereas mainly hill states like Assam, Himachal Pradesh, J&K and Uttarakhand are among the least aware state. It is surprising to note that Maharashtra, being one of the highly agricultural dependant state, has overall awareness of only 8 per cent. It seems that farm size has direct relation with the MSP awareness. Large farmers were found to be most aware, whereas marginal farmers are least aware. MSPS intended to provide the price support to boost mainly the marginal and small farmers so that they remain protected from price fluctuations in the market. However, the situation of Haryana and Telangana is bit different in the above context, where the

marginal and small farmers are comparatively better off than the large farmers in MSP awareness situation.

This gives an indication that these farmers are better informed or have access to the market related activities, which can be a step towards progression in the new reform regime. Farmers' participation in MSPS revealed that only 24 per cent of aware farmers are selling their produce through the scheme. Across the farm size, medium farmers are participating maximum in MSPS whereas the proportion of marginal farmers selling the produce at MSP is lowest. Further, amongst states, Uttarakhand having the least aware paddy farmers are among the highest to participate in its sale at MSP.

More than 73 per cent farmers from Uttarakhand sold their produce at MSP, as against 100 per cent by large farmers, 93 per cent semi-medium, 81 per cent small and 67 and 43 per cent marginal and medium farmers, respectively. Uttarakhand was followed by Haryana, Telangana, Chhattisgarh and Punjab. Among these states, only in Haryana and Punjab, large farmers are participating maximum, whereas in Telangana, marginal farmers are participating maximum (71 per cent).

Table 4.6 Awareness and Participation (as per cent of aware) of Farmers in MSP

States	Farm Size										Overall	
	Marginal		Small		Semi-Medium		Medium		Large			
	A	P	A	P	A	P	A	P	A	P	A	P
Andhra Pradesh	5	6	10	4	15	20	8	5	23	2	9	10
Bihar	18	4	25	7	31	13	40	19	39	0	20	5
Chhattisgarh	44	52	44	69	46	60	43	67	50	0	44	59
Gujarat	7	9	9	20	8	30	22	3	17	22	9	13
Haryana	31	62	33	66	29	50	21	79	22	91	29	62
Himachal Pradesh	3	0	9	13	15	24	19	35	60	0	4	8
Jammu and Kashmir	5	7	13	8	20	11	22	35	-	-	6	8
Jharkhand	5	2	12	0	4	11	12	2	100	0	6	2
Karnataka	8	16	11	41	17	40	12	9	30	14	11	28
Kerala	15	3	22	13	24	34	20	15	73	6	17	7
Madhya Pradesh	16	21	22	19	25	28	35	50	50	57	22	27
Maharashtra	5	43	7	47	9	27	12	29	44	8	8	35
Odisha	18	13	26	28	37	45	46	71	49	89	21	21
Punjab	38	36	47	58	55	56	55	57	48	62	48	52
Rajasthan	9	10	17	5	12	14	21	15	38	2	14	10
Tamil Nadu	9	27	8	38	16	31	18	31	19	10	10	30
Telangana	26	71	31	57	20	45	22	66	8	0	26	61
Uttar Pradesh	15	19	26	26	30	30	25	30	36	61	18	23
Uttarakhand	5	67	39	81	26	93	52	43	50	100	8	73
West Bengal	21	7	35	2	29	6	35	5	33	0	22	7
Assam	2	4	2	4	4	3	5	54	100	0	2	5
Total	**14**	**18**	**19**	**28**	**20**	**33**	**23**	**38**	**37**	**28**	**16**	**24**

Source: *Computed from NSSS Unit Record Data on Situation Assessment Survey (2014)*

Note: 'A' indicates percentage of aware farmers and 'P' indicates percentage of participating farmers (out of the aware farmers)

4.5.1. Price Realization for Paddy

Table 4.7 provides the average price of paddy received by the farmers across states. There are certain states where the price realized by the farmer remains less than the minimum support price. The open market price remains higher than the MSP in states like Assam, Andhra Pradesh, Uttarakhand, Maharashtra, Madhya Pradesh, Tamil Nadu and Punjab. In other major states, the MSP is higher than the open market rates. However, except Chhattisgarh, very less quantity is flowing through the cooperative and government agencies. Therefore, it is must to ensure the effectiveness of MSPS to make sure that farmers get remunerative returns for the crop.

Table 4.7 Price Received for Paddy (Rs per kg)

States	Agency					
	Local Private	Mandi	Input dealers	Cooperative & Government Agency	Processors	Others
With Negligible Procurement						
Himachal Pradesh	12	13	13		12	
Jammu & Kashmir	19	9	26		11	10
Rajasthan	12	20				
Open Market Price > MSP						
Assam	10	9	9	9		9
Andhra Pradesh	13	18	13	11	13	13
Uttarakhand	15	10	12	12	10	
Maharashtra	18	21	16	13	18	25
Madhya Pradesh	14	15	15	13		17
Tamil Nadu	14	14	15	14	19	12
Punjab	31	14	13	14	19	13
MSP > Open Market						
Bihar	11	11	10	11	10	9
West Bengal	10	10	10	12	11	10
Odisha	11	12	11	12	11	10
Telangana	12	13	12	13	11	13
Chhattisgarh	11	12	11	13	13	
Uttar Pradesh	11	16	11	13	9	9
Gujarat	12	11	11	15		
Jharkhand	10	10	10	11	10	
Karnataka	16	18	17	16	18	14
Kerala	12	20		17		
Haryana	17	17	25	19	17	

Source: Computed from NSSS Unit Record Data on Situation Assessment Survey (2014)

Price policy in the current regime needs to be restructured to meet the current challenges faced by the agricultural community. Over the last four and a half decade, the price policy implementation has boosted mainly wheat and rice crop among food grains and sugarcane and cotton among other crops (Chand, 2003). This situation creates an imbalance in demand and supply situation in other important agricultural commodities like pulses, oilseeds and coarse cereals as most of the resources gets shift to traditional crops. Their prices often go below MSP due to lack of any effective price support mechanism. Moreover, trade policy also works independently of MSP policy.

In this context, the Shanta Kumar Committee Report on restructuring of FCI, recommended that pulses and oilseeds deserve priority and GoI must provide better price support operations for them, and dovetail their MSP policy with trade policy so that their landed costs are not below their MSP. Shanta Kumar Committee report states that in 2012-13, only 6 percent of total farmers in the country have gained from selling wheat and paddy directly to any procurement agency.

The second major criticism of the price policy is that a large number of crops and states are not covered by effective implementation of the MSP (Chand 2003). The prices received by farmers are often below the MSP in a large number of crops and in a large number of markets where it is not supported by effective procurement (Planning Commission 2007b: 67-68).

Reorienting the current price policy in an effective and sustainable manner can bring out change in the agricultural price scenario. Prof Ramesh Chand (Niti Aayog), had put forward the concept of Minimum Insured Price (MIP) and Deficiency Price Payment (DPP) in this regard for commodities other than rice and wheat. This can be considered as an additional option along with the development of infrastructural facilities for agriculture.

4.6. Price Behaviour of Agricultural Commodities

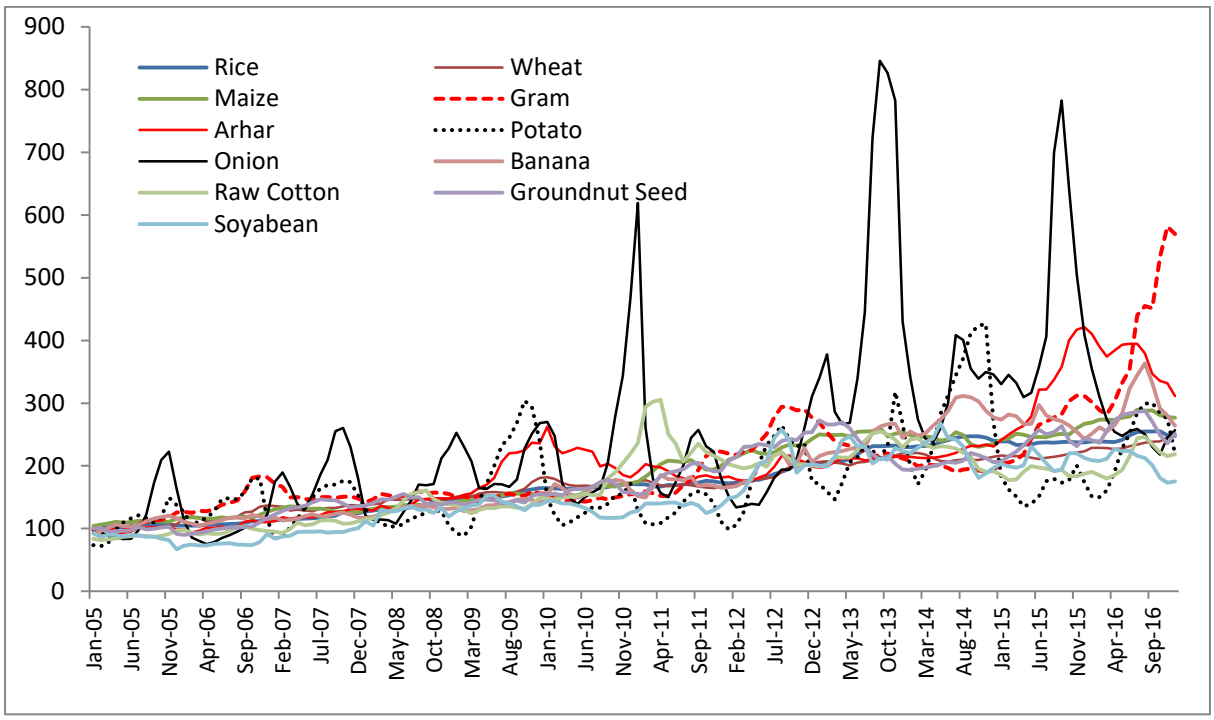
In the recent years, the issue of high price volatility in agricultural commodities in domestic as well as international market has assumed critical importance. Recently, the prices of many agricultural commodities have shown a high degree of volatility.

Food inflation has remained higher than non-food inflation for several years. This relationship remained in fact both ways when overall inflation was high and also when it turned low (in last two years). The food inflation remaining stubbornly high has remained a matter of concern for the policymakers. There is enough evidence to show that prices of agricultural commodities are more volatile than those of the non-farm commodities (Chand and Parappurathu, 2011).

Fig 4.1 depicts the trends in inflation for various food commodities. The changes have been depicted on the basis of both annual series as well as monthly series of WPI. Fruits and vegetables exhibit highest price volatility among all agricultural commodities. Some commodities in this category, like onion, have created crisis situation in the economy many a times due to the extreme volatility in their prices.

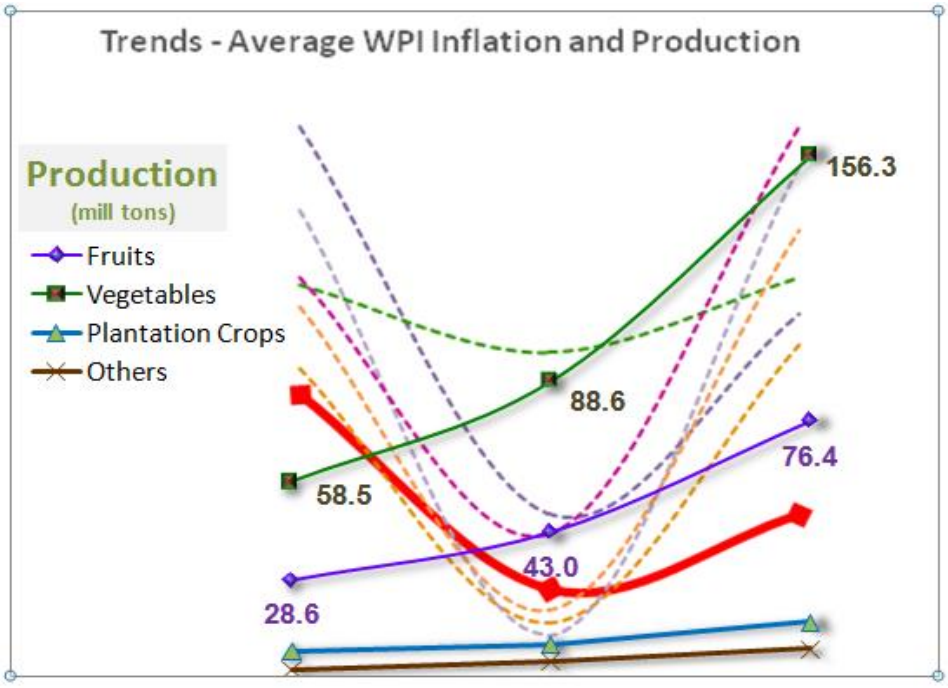
In the case of products like onion, potato, tomato and some other horticultural products; prices have shown violent rise and also sharp fall even during a short period. Onion is a highly sensitive commodity in fruits and vegetables category, whose WPI has touched the highest peaks of 619 in January, 2011 and 846 in September, 2013 and 782.8 in September, 2015.

Fig 4.1 Trends in WPI of selected Agricultural Commodities



Low price elasticity of demand and low income elasticity and inherently instable production are considered as important factors for high volatility in food prices. Despite farmers showing robust response by increasing supply, inflationary pressure resurfaced.

Fig 4.2 Inflation Trends and Supply Response



Source: *Horticulture division, MOA, RBI & MOSPI*

Food is now the prime driver of WPI with perishables commodities contributing highest. On surface, the situation indicates that demand for perishable produce continues to outstrip

supply. Actually, the major problem is a lack of efficient supply systems, in the face of higher output, which then feeds inflation in food items. Continual demand for food distribution and agricultural logistics is foreseen over coming decade. Fig 4.2 shows the correlation in decadal trend of inflation rate (WPI and food items) with production of high value foods.

The extent of volatility as examined from Table 4.8 also indicates that the major drivers of food inflation are the horticultural commodities mainly potato and onion which have shown a high instability in prices in both the periods taken under consideration. Apart from horticultural commodities, pulses especially gram has shown an unstable behaviour in the prices in the later phase. Such volatile behaviour in prices of agricultural commodities brings about frequent changes in the food inflation leading to higher price at consumer end and uncertainty at producers end.

Table 4.8 Extent of volatility across commodities

Commodity	Mean WPI			Range		Instability Index		
	2005-10	2011-16	2005-16	2005-10	2011-16	2005-10	2011-16	2005-16
Under MSP based Price Support								
Rice	131.1	216.6	173.9	101-171	167-255	4.0	5.3	9.4
Wheat	138.6	204.4	171.5	96-182	164-252	4.0	4.5	8.0
Maize	134.7	241.2	187.9	104-172	175-297	3.0	5.5	10.9
Gram	143.4	254.7	199.0	98-183	152-582	11.2	28.5	15.8
Pigeon Pea	144.9	250.9	197.9	89-263	176-421	14.0	16.4	16.0
Groundnut	131.4	227.4	179.4	90-178	154-288	7.3	11.2	13.7
Soybean	108.3	198.7	153.5	67-153	125-268	12.7	14.6	15.4
Raw Cotton	121.5	216.3	168.9	82-220	177-306	10.6	11.2	14.9
Under MIS based Price Support								
Potato	139.4	206.7	173.0	72-304	99-427	31.5	34.4	16.4
Onion	165.6	325.9	245.8	75-469	134-846	33.7	49.3	25.3
Banana	128.9	242.1	185.5	93-178	150-364	6.1	10.0	15.5
No Price Support								
Mutton	137.8	244.3	191.1	102-197	186-289	7.6	3.4	5.6

Source: DFI Committee based on the data available with Office of Economic Advisor

The price support from the government, beside MSP support and operations, is also available through Market Intervention Scheme (MIS). MIS includes horticultural commodities and other agricultural commodities which are perishable in nature and not covered under the MSP scheme. It prevents the farmers making distress sale when prices fall to very low level in the event of bumper crop. The scheme is implemented on the request of a State Government concerned for the given commodity and the losses are shared on 50:50 basis between Central and the State Government.

4.7. Role of Agricultural Trade in Enhancing Gains to Farmers

Trade among the nations has remained an important economic activity and has played a significant role in the economic development of trading partners. The literature on trade suggests that proximity is one of the major determinants of trade. Geographic proximity is also used as an important explanation for regional trade groupings or blocs. One would expect trade to take place based on inherent comparative and competitive advantages, but often, in case of sectors like agriculture, trade occurs to meet the objectives of food security and achieving price stability. If we look at the trader matrix of the country; cotton, cereals, edible fruits and vegetables and tea and coffee comprise the major share (Table 4.9). Growth in exports of most of agricultural commodities seems to be encouraging during 2001-16. Meat and meat products have witnessed highly appreciable growth during this period.

Table 4.9 Trends and Composition of Agricultural Exports in India

Product	Exports (Billion Dollars)			Growth (2001-16)	Composition of Exports		
	TE2003	TE2010	TE2016		TE2003	TE2010	TE2016
All products	51.1	193.0	281.0	14.7	100.0	100.0	100.0
Meat and edible meat offal	0.3	1.4	4.5	24.5	0.6	0.7	1.6
Fish and crustaceans	1.3	1.6	5.0	12.0	2.5	0.8	1.8
Dairy produce	0.1	0.3	0.4	12.1	0.1	0.1	0.1
Edible vegetables	0.3	0.8	1.1	12.1	0.5	0.4	0.4
Edible fruit and nuts; peel of citrus fruit or melons	0.6	1.1	1.6	8.5	1.1	0.6	0.6
Coffee, tea, mate and spices	0.7	1.8	2.9	12.3	1.4	0.9	1.0
Cereals	1.3	3.3	7.5	16.1	2.5	1.7	2.7
Preparations of meat and fish	0.0	0.2	0.2	15.5	0.1	0.1	0.1
Sugars	0.4	0.9	1.5	16.9	0.7	0.5	0.5
Miscellaneous edible preparations	0.1	0.3	0.6	13.2	0.3	0.1	0.2
Tobacco and products	0.2	0.8	1.0	13.9	0.4	0.4	0.3
Rubber and articles	0.5	1.5	2.5	14.0	1.0	0.8	0.9
Raw hides and skins	0.5	0.7	1.1	6.5	1.0	0.4	0.4
Articles of leather.	0.9	1.5	2.4	8.2	1.7	0.8	0.9
Wood and wood articles	0.0	0.2	0.4	18.1	0.1	0.1	0.1
Paper and paperboard articles	0.2	0.6	1.1	13.5	0.5	0.3	0.4
Cotton	2.1	4.9	7.5	11.6	4.2	2.5	2.7

Source: *Computed from International Trade Statistics*

The major regular agricultural imports in India comprise of the imports of animal and vegetable fats and oil, edible vegetables and edible fruits and nuts (Table 4.10). Palm oil, soybean oil and safflower oil are the major items being imported under the category of animal and vegetable fats. Chick pea comprises more than two-third share in the category of edible vegetables. Certain commodities are imported to meet the crises situations related to shortages in domestic supply.

Table 4.10 Trends and Composition of Agricultural Imports in India

Product	Imports (Million Dollars)			Growth (2001-16)	Composition of Exports		
	TE2003	TE2010	TE2016		TE2003	TE2010	TE2016
All products	60185	310714	402273	16.4	100.0	100.0	100.0
Animal or vegetable fats and oils	1883	4849	10539	16.2	3.1	1.6	2.6
Edible vegetables and certain roots and tubers	617	1802	3465	15.3	1.0	0.6	0.9
Edible fruit and nuts; peel of citrus fruit or melons	354	1197	2804	17.0	0.6	0.4	0.7
Cotton	426	526	807	5.2	0.7	0.2	0.2
Sugars and sugar confectionery	20	675	740	29.6	0.0	0.2	0.2
Coffee, tea, maté and spices	102	290	718	16.1	0.2	0.1	0.2
Raw hides and skins (other than furskins) and leather	213	455	668	8.8	0.4	0.1	0.2
Cereals	1	135	224	37.4	0.0	0.0	0.1
Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn	53	129	330	15.7	0.1	0.0	0.1
Wool, fine or coarse animal hair; horsehair yarn and woven fabric	183	295	368	5.7	0.3	0.1	0.1
Cocoa and cocoa preparations	12	80	234	27.2	0.0	0.0	0.1
Silk	197	380	209	0.1	0.3	0.1	0.1

As international market may prove to be lucrative and help in realisation of better prices. To analyse this, it was tried to analyse how the unit value realized from the trade vary in domestic and international markets. This is examined for one of the traditional commodities i.e. cotton and one for emerging commodity i.e. bovine meat and the details are provided in Box 4.3. In case of bovine meat, the UVR realized from the domestic and international markets vary significantly. Thus, international markets provide a lucrative situation to the farmers. Enhancing the exports of bovine meat may be gainful for the animal farmers. However, the meat exports require very sophisticated kind of logistics and are subject to many quality and policy restrictions. A detailed probe in this regard would be further useful.

Cotton category comprises of various products like raw cotton, cotton yarn, and other value added products. Cotton yarn (other than sewing thread, containing >= 85% cotton by weight) is the major product being exported from the country and comprises around 49 per cent share in value. Besides this, Cotton, neither carded nor combed is the other major product being exported under this category.

It was examined that how the UVRs in both these product compare with the UVR of cotton realised in the domestic market. The exports of cotton yarn do not seem to be competitive as the UVRs realized from international markets is quite close to the domestic market. However, the UVR realized from the export of cotton yarn is much higher than the UVR of cotton in the domestic market. Cotton yarn is a value added product and would also involve the cost of value addition.

Box 4.2 Evidences from gains in trade

	Unit	2011	2012	2013	2014
Bovine Meat					
Total Meat Exports	000 US $	2593017	2995860	4486552	4800183
Share of bovine exports	%	96.5	95.2	94.1	94.6
Unit Value Realized (UVR) Exports	Rs/kg	131	157	173	
UVR, Domestic market	Rs/kg	93	100	101	
Impact of change in Export Price to Domestic Price	Proportionate change		0.362	0.089	
Impact of change in Exports to Domestic Price	Proportionate change		0.768	0.018	
Cotton					
Cotton Exports (5201)	Ton	1871156	1918283	2367741	1528379
Cotton Exports (5205)	Ton	647838	917830	1361509	1245726
Share of 5201 and 5205 in cotton exports	%	78.82	79.38	82.23	77.86
UVR, Exports (5201)	Rs/kg	86.79	103.45	115.33	112.87
UVR, Exports (5205)	Rs/kg	203.84	187.05	212.10	201.00
UVR, Domestic market	Rs/kg	124	109	122	108
Impact of change in Export Price to Domestic Price (5205)	Proportionate change		1.48	0.88	2.15
Impact of change in Export Price to Domestic Price (5201)	Proportionate change		-0.64	1.03	5.29
Impact of change in Exports to Domestic Price (5201)	Proportionate change		-1.61	0.50	0.30
Impact of change in Exports to Domestic Price (5205)	Proportionate change		-0.84	0.23	0.79
Exchange rate	Rs. per US$	47.92	54.41	60.5	61.1

Source: Computed based on International Trade Statistics and National Accounts Statistics

Thus, the detailed analysis may be carried out for all potential commodities to examine the impact on domestic prices and supply, thereby, the impact on farmers' gains. This is extremely important that concerted efforts are continued to achieve the market related objectives. The commodities having significant trade potential need to be governed by sustained policies and regulates to protect the interest of exporter and fulfill the commitments with foreign buyers. The gains from trade can further be enhanced. For this, networking is required among academic, research institutions and practicing organizations for proper technical supervision and guidance.

Agriculture marketing in India is governed through various kinds of interventions by the central and state governments. The trade related interventions include subsidies, tariff or non-tariff barriers and other trade policy instruments. Exports of agricultural commodities have been restricted through export prohibitions, licenses, quotas, marketing controls, and minimum export prices (MEPs).

To protect the interests of domestic consumers, the controls on export were enforced through trading enterprises. There are few essential commodities like onion, which are exhibiting extreme price fluctuations. In such cases, MEP has been administered several times to control its price in the domestic market. Such short-term policy options may settle the current crises,

but may long term impacts. These ad-hoc measures need to be properly examined to prevent the potential threats on the country's image as a reliable trade partner.

Generating foreign revenues not only improved the fiscal budget of the country but also builds global competitiveness. A stable trade policy helps build a credibility as a reliable supplier-partner. DFI Committee feels that a more farmer centric" approach to trade policy is required, to allow farmers avail the advantage of domestic as well as global markets.

Key Extracts

- Poor marketing linkages and infrastructure constraints have led to high and fluctuating consumer prices resulting in only a small share of consumer rupee reaching the farmer, which comes out to be as low as 20 per cent in the case of fruits and vegetables. This reflects the extent of inefficiencies existing in the agricultural marketing system of India.
- There is high variation in prices of almost all the commodities and this variation is not only among the states but also among the agencies in both the season.
- The price offered by local private agency is comparatively higher than the government/cooperative price. In some states the difference between both the prices is much higher, as seen in case of paddy in Punjab and Maharashtra and urd in Kerala. However, situation is reversed in case of jowar and moong where government agency has offered better price to the farmers.
- Price policy needs to be restructured - over the last four and a half decades, the price policy implementation has boosted mainly wheat and rice crop among food grains and sugarcane and cotton in other crops. Their prices often go below MSP due to lack of any effective market support mechanism. Moreover, trade policy also works independently of MSP policy, and many a times, imports of pulses come at prices much below their MSP which hampers diversification. Reorienting the current price policy in an effective and sustainable manner can bring out change in the agricultural price scenario.
- In the recent years, the issue of high price volatility in agricultural commodities in domestic as well as international market is evidenced. Fruits and vegetables seem to exhibit highest price volatility among all agricultural produce. On surface, the situation indicates that demand for perishable produce continues to outstrip supply. Actually, the major problem is a lack of efficient supply systems which continues to feed inflation in food items.

Chapter 5
Identification of Vulnerable Zones

This chapter establishes the link between climate vulnerability with farmers' income at disaggregated level and the most vulnerable districts have been identified from climate and income perspective. Further, profiling of vulnerable states based on major attributes of farm and farmer's income has been carried out.

5.1. Vulnerable Districts from Climate and Income Perspective

Climate change and variability is one of the most important matters of concern in terms of livelihood and income of farmers. Impending threat of climate change on agriculture and thus income and livelihood of farmers has been widely recognized by scholars across the globe. Several studies have also been conducted in Indian context and significant inverse relation between climate change and farm income has been unanimously established. In one such attempt Rama Rao et al. (2013) assessed vulnerability of agriculture to climate change and variability at district level considering the fact that most of the development planning and programme implementation is done at district level in India. They used number of indicators that reflect the three components of vulnerability – Exposure, Sensitivity and Adaptive Capacity based on reviews from previous standard studies and discussion with experts.

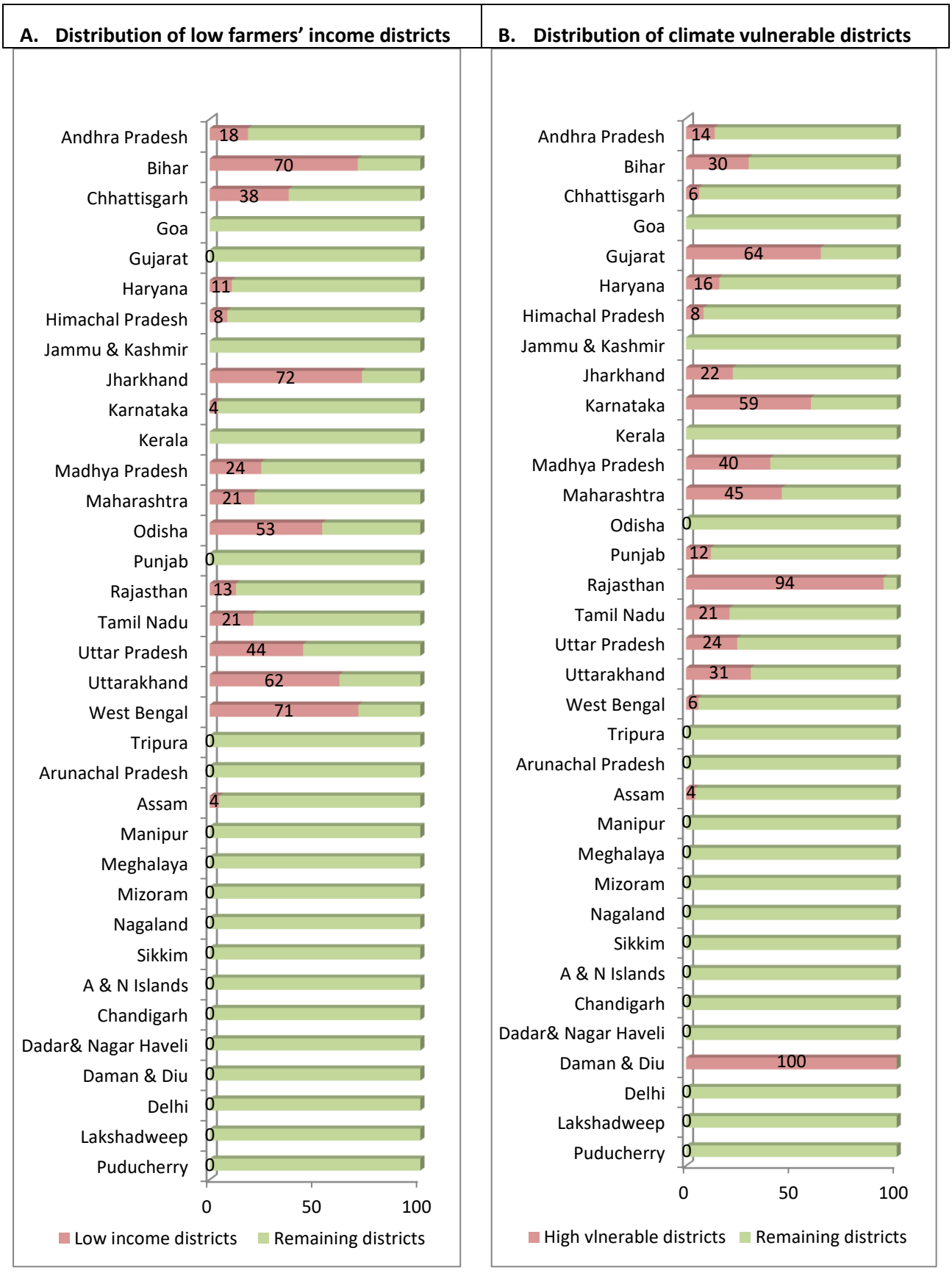
Here 150 districts which topped under very high vulnerability status category in their study with that to 150 districts having lowest income status from agriculture as per NSSO-SAS survey, 2013 are compared. Figure 5.1 represents proportion of districts within State/UTS which are very high vulnerable to climate change. It can be seen that most of the districts with very high vulnerability status are in the state of Rajasthan.

Interestingly, agriculturally developed states like Gujarat and Karnataka where proportion of districts falling under low agricultural income category is zero and 4 per cent respectively (Fig 5.1) are also having major proportion of districts (around 60 %) under high vulnerability category. Low farm income reduces adaptive capacity of the farmers to withstand climate shocks and thus increases their vulnerability.

With exception of Daman and Diu where entire area reported to be vulnerable, all north-eastern states and UTs have either negligible proportion or very low (for example Assam) proportions of districts under high vulnerability status as well as low agricultural income status.

The situation seems to be more grieved in 33 districts out of 150 districts, which on the one hand are highly vulnerable to climate change and on the other hand are agriculturally undeveloped and falling in bottom 150 districts list having lowest agricultural income (Table 5.1). Therefore, these districts need priority attention in terms of area specific policy formulation as well as implementation to enhance income of farmers thus raising their adaptive capacity and reducing vulnerability of agriculture to climate change in these areas.

Fig 5.1 Comparison of states/districts in vulnerability and income status



Source: DFI Committee Estimates

Table 5.1 Double Stressed Districts in terms of Climate Vulnerability and Low Income

SN	Districts	State	SN	Districts	State
1	Karbi-Anglong	Assam	17	Jaisalmer	Rajasthan
2	Kishanganj	Bihar	18	Dungarpur	Rajasthan
3	Madhubani	Bihar	19	Banswara	Rajasthan
4	Araria	Bihar	20	Udaipur	Rajasthan
5	Darbhanga	Bihar	21	Perambalur	Tamil Nadu
6	Supaul	Bihar	22	Dharmapuri	Tamil Nadu
7	Bhagalpur	Bihar	23	Ramanathapuram	Tamil Nadu
8	Saran	Bihar	24	Chitrakut	Uttar Pradesh
9	Saharsa	Bihar	25	Banda	Uttar Pradesh
10	Siwan	Bihar	26	Hamirpur	Uttar Pradesh
11	Godda	Jharkhand	27	Ballia	Uttar Pradesh
12	Sahibganj	Jharkhand	28	Deoria	Uttar Pradesh
13	Dindori	Madhya Pradesh	29	Shravasti	Uttar Pradesh
14	Ratlam	Madhya Pradesh	30	Bageshwar	Uttarakhand
15	Sidhi	Madhya Pradesh	31	TehriGarwal	Uttarakhand
16	Aurangabad	Maharashtra	32	Almora	Uttarakhand
			33	Malda	West Bengal

Source: DFI Committee

In other districts which ranked high on vulnerability status, however are more developed in terms of income from agriculture. Agro-climatic positioning of the districts will play a role for suitable policies for reducing climate vulnerability and augmenting income of the farmers.

5.2. Most Vulnerable Zones based on Farm Income and Climate Vulnerability

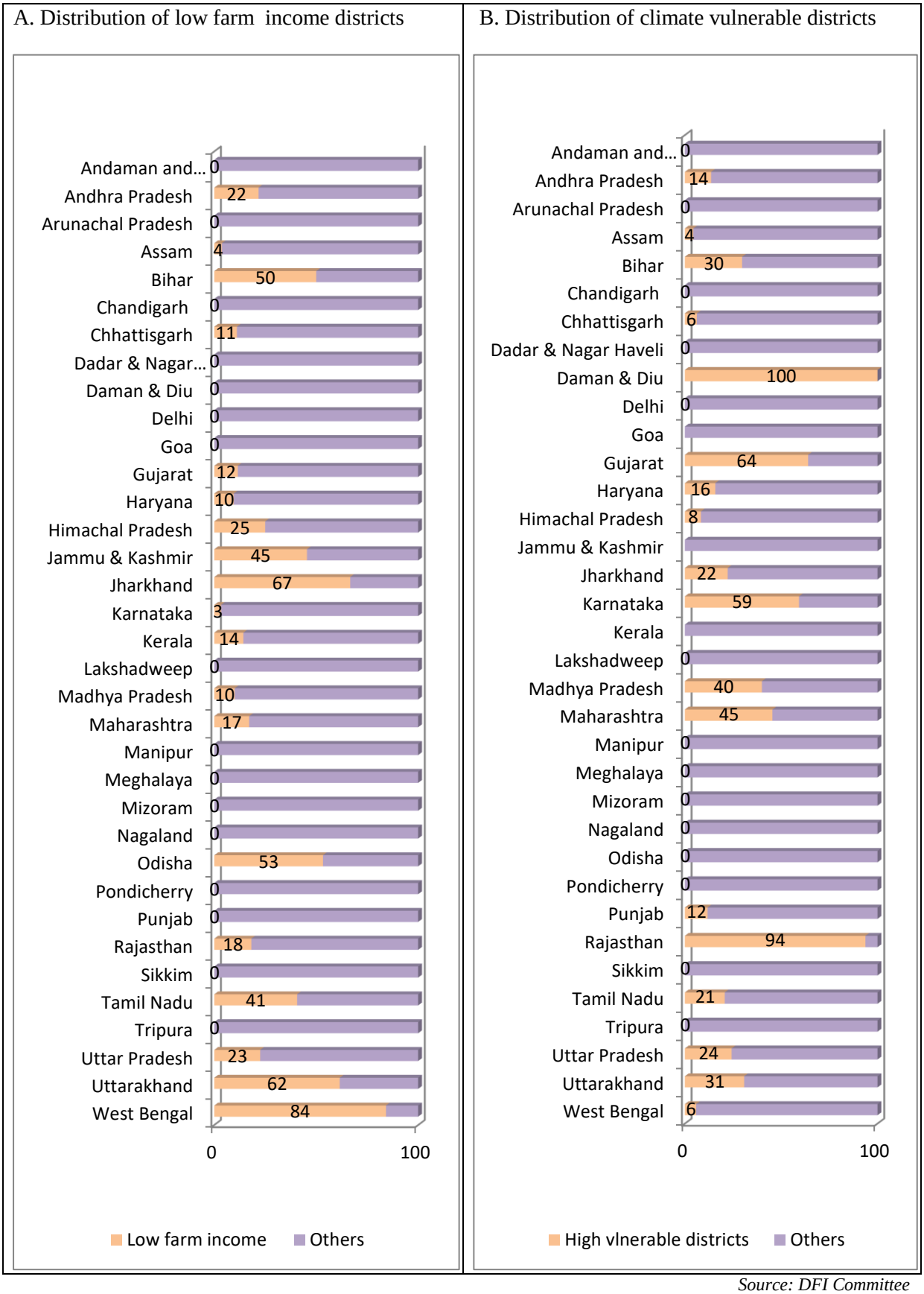
Considering the mandate of the DFI Committee and mandate of Department of Agriculture and Cooperation and Farmers' Welfare, an examination of the poorest districts based on farm income and climate vulnerability was done and is presented in Fig 5.2.

Poorest 150 districts in terms of lowest farm income derived from crop and farming of animals as per NSSO-SAS survey, 2013 have been compared with very high climate vulnerable districts (as explained in the earlier section). Interestingly out of 150, the number of double stressed districts reduced to 29 from the previous 33 (Table 5.2).

A clear inference can be drawn that income from farm sources are more prominent in poorer states than that of non-farm sources. One can easily notice that percentage of districts falling under low farm income in poor districts of Bihar, Uttar Pradesh and Madhya Pradesh has declined as compared to when the poor districts were identified based on farmer's income. It seems that income from crop and livestock are more reliable and prominent than that of income from non-farm sources like wages and salary.

Special attention needs to be given to these areas in terms of technology package, infrastructure and targeted policy support. On the contrary, income from non-farm sources hold major position in farmer's income in few southern states like Kerala, Andhra Pradesh and Tamil Nadu and hilly states like J&K and Himachal Pradesh, as indicated by increase in the percentage of districts falling under low farm income status in these states.

Fig 5.2 Comparison of states/districts in vulnerability and farm income status



Source: DFI Committee

Table 5.2 Double stressed districts in terms of climate vulnerability and low farm income

SN.	State	Districts
1.	Bihar	Madhubani
2.	Bihar	Araria
3.	Bihar	Bhagalpur
4.	Bihar	Gopalganj
5.	Bihar	Saran
6.	Bihar	Saharsa
7.	Bihar	Siwan
8.	Chhattisgarh	Bijapur
9.	Gujarat	Surendranagar
10.	Himachal Pradesh	Hamirpur
11.	Jharkhand	Godda
12.	Jharkhand	Sahibganj
13.	Madhya Pradesh	Ratlam
14.	Madhya Pradesh	Mandla
15.	Maharashtra	Jalna
16.	Maharashtra	Aurangabad
17.	Rajasthan	Nagaur
18.	Rajasthan	Jaisalmer
19.	Rajasthan	Pali
20.	Rajasthan	Udaipur
21.	Rajasthan	Dungarpur
22.	Rajasthan	Banswara
23.	Tamil Nadu	Ramanathapuram
24.	Uttar Pradesh	Banda
25.	Uttar Pradesh	Deoria
26.	Uttar Pradesh	Ballia
27.	Uttar Pradesh	Chamoli
28.	Uttarakhand	Bageshwar
29.	Uttarakhand	Almora

These districts are highly vulnerable and disadvantaged in terms of double stress created from low income as well as high climate vulnerability. Special programmes need to be designed to support these disadvantaged districts.

It would be appreciable if these districts are taken up as mentoring districts and work in coalition with state agencies and line departments to create favourable and facilitating environment to trigger the path of doubling of farmers' income.

5.3. Profiling of Vulnerable States

Various governments over the years have made efforts through different ways to increase income levels of growers through initiation of various schemes, incentives etc. But, still there exist a large number of districts in India which are backward in terms of agricultural income because of various reasons.

This section to look into various attributes associated with climate vulnerable and low income. Based on the number of climate vulnerable and low income districts falling in different states, the states have been identified as poor income or climate vulnerable states.

As far as poor income states are concerned, all these states except Jharkhand have percentage of small holder's share with average size of holding ranging from 0.4 hectare in Bihar to 1.2 hectare in Jharkhand (Table 5.3). The productivity of wheat in 2011-12 in these states ranges from a high of 3113 kg/ha in Uttar Pradesh to 1644 in Odisha.

In case of rice productivity ranges from 2688 kg/ha in West Bengal to 1450 kg/ha in Odisha. In terms of infrastructure West Bengal has got the highest intensity of rural road network with figures of 207 km per 100 sq. km of area and Jharkhand has the minimum with only 21.4 km per 100 sq. km of area.

A study by Rama Rao et al. (2013) tried to assess vulnerability of Indian agriculture to climate change at district level based on the IPCC framework of Exposure (of future climate), Sensitivity and Adaptable capacity. Based on that study top five states were selected having maximum number of climate vulnerable districts as shown in the Table 5.3.

Various attributes of these states were studied to identify important factors contributing to vulnerability for proper policy suggestions.

Among the these states which are most climates sensitive UP has got the highest number of small and marginal farmers 92.46 per cent whereas Rajasthan has got the lowest share 58.4 per cent. The land holding size is quite small from 3.07 in Rajasthan to 1.55 hectare in Karnataka. Also people depending on on-farm income are in minority in these states thus majority of people in all these states are dependent on agriculture. In the entire selected climate change sensitive states percentage of gross irrigated area to total cropped area is less than 50 per cent ranging from states with maximum number of districts thus making them more prone because of rainfall fluctuations.

It can also be seen that area under area under horticulture crop is also quite low in all these states ranging from 407.27 thousand hectares in 2014-15 in Karnataka to 39.27 thousand hectares in Rajasthan. All these states are also marked by high population and low literacy level in the rural areas. Length of rural road which is considered an important factor while considering the returns from the agriculture is also found lacking specially in states of Gujarat, Rajasthan and Madhya Pradesh.

Table 5.3 Major Attributes of Climate Vulnerable and Low Income States

Attributes	States with maximum coverage of climate vulnerable districts				Common state	States with maximum coverage of lowest farmers' income districts			
	Madhya Pradesh	Gujarat	Karnataka	Rajasthan	Uttar Pradesh	Jharkhand	Odisha	West Bengal	Bihar
Share of Small holders (%, including Marginal farmers, 2011)	71.5	66.4	76.4	58.4	92.5	84.1	91.9	95.9	96.9
Average size of holding (ha., 2011)	1.8	2.0	1.6	3.1	0.8	1.2	1.0	0.8	0.4
Monthly Agriculture household income (Rs., 2013)	6210	7926	8832	7350	4923	4721	4976	3980	3558
Dependence on non-farm income (%, 2013)	23.5	38.6	37.4	44.1	31.0	44.0	45.3	69.8	43.9
Area under rice and wheat 2011-12 (% to GCA)									
Wheat	5.5	13.1	2.3	16.1	58.8	11.5	0.0	6.0	40.8
Rice	10.8	8.1	14.3	0.7	35.9	106.2	89.1	103.8	1.3
Productivity (kg/ha.) 2011-12									
Rice	1340	2141	2793	1886	2358	2131	1450	2688	2155
Wheat	2360	3014	858	3175	3113	1908	1644	2765	2206
Area under horticulture 2014-15 (000 ha.)									
Fruits	1.4	3.6	4.1	0.2	2.8	6.8	7.3	4.4	5.8
Vegetables	4.4	5.6	4.7	0.9	6.9	22.9	14.9	26.5	16.0
Flowers	0.1	0.2	0.3	0.0	0.1	0.1	0.2	0.5	0.0
Irrigation intensity (2010-11, GIA as % to GCA)	33.7	45.9	32.8	32.0	76.3	12.0	28.3	58.2	61.8
Government intervention in procurement (000 Tones)									
Procurement of Wheat (% to production, 2011-12)	43.0	2.6	-	14.0	11.4	-	-	-	11.8
Procurement of Rice (% to production, 2011-12)	28.5				23.9		49.3	13.9	
Credit availability (Rs. per hectare)									
Crop Loan per hectare (Rs)	26377	27888	40935	30695	34710	12424	32803	43652	29140
Term Loan per hectare (Rs)	4131	10287	19764	5295	9175	5782	5617	27606	14390
Population (Million Number, 2011)	72.6	60.4	61.1	68.5	199.8	33.0	42.0	91.3	104.1
Literacy (%, 2011)	69.3	78.0	75.4	66.1	67.7	66.4	72.9	76.3	61.8
Rural literacy	65.3	73.0	68.9	62.3	67.6	62.4	70.8	73.0	61.8
Road network									
Area (000 km²)	308	196	192	342	241	80	156	89	94
Total rural road (000 km)	118	53	164	103	114	17	213	184	168
Rural road per 100 sq. km of area	38.2	27.2	85.5	30.2	47.1	21.4	137.1	207.4	178

Source: DFI Committee Estimates

Key Extracts

- Smallholders' share (58.4 per cent to 76.44 per cent) in climate vulnerable states is very less as compare to low income states (78.55 per cent to 96.92 per cent) because of adverse impact of climate will be more on small holding farmers.
- Income from farm sources is more prominent in poorer states than that of non-farm sources.
- Vulnerable states were growing more high yielding variety as compared to low income group states but productivity differences were not significant. Irrigation intensity was lower in both the cases and varied between 12 per cent in Jharkhand to 61.8 per cent in Bihar except Uttar Pradesh which has comparatively better status in terms of irrigation.
- There are 29 districts which are highly vulnerable and disadvantaged in terms of double stress created from low income as well as high climate vulnerability. Special programmes need to be designed to support these disadvantaged districts. It would be appreciable if some KVKs and extension agencies adopt these districts and work in coalition with state agencies and line departments to create favourable and facilitating environment to trigger the path of doubling of farmers' income.

Chapter 6
Observations and Recommendations

A number of interventions and initiatives have been taken for the promotion of agriculture sector in the country as discussed in the volume. However, following crucial observations are made from the volume and required suggestions are done to bring the desirable outcomes.

6.1. Major Observations

6.1.1. Overall and Agricultural Economy

- ✓ Agriculture & Allied economy consists of four sectors namely Crop sector, Livestock, Forestry and Fisheries. The share of crop sector in the total VOP from agriculture and allied activities is highest (61.31 per cent) among the other sectors as being the largest contributor. Livestock comes next with a share of 26.80 per cent in the total VOP, which is followed by forestry (7.39 per cent) and fisheries (4.50 per cent) sector.

- ✓ Overall growth in agriculture moves parallel with the crop sector, as established from comparing the year-on-year fluctuations among sectors. The growth has not been consistent across regions and crops. Livestock sector is growing at an appreciable and sustainable rate and is ahead among all other sectors. Livestock sector is likely to emerge as engine of growth of agricultural sector and can be relied upon for risk mitigation and minimizing the losses to the farmers in case of even worst outcomes from others sub-sectors.

- ✓ Livestock sector's performance was found to be the best during the recovery phase. Pulses achieved a growth of 2.63 per cent during the recovery phase. Within the crop category, fibres, condiments & spices, fruits & vegetables, floriculture performed quite well during 2004-05 to 2014-15. As reported, the important reason behind good performance of agricultural and allied sectors in recovery phase was remunerative price received by farmers which further encouraged further production. Efforts are required at all stakeholder levels to maintain the production incentive of farmers. At the same time, improved and innovative marketing arrangements and are required to enhance the economic returns to the farmers.

- ✓ A continuous and significant increase in share of area to GCA under fruits and vegetables indicates that importance of these farm commodities have significantly increased at both producer as well as consumer levels. Short duration nature and growing market for horticulture crops along with quicker cash inflow from these crops are important reasons to be mentioned that have led the farmers to grow more fruits and vegetables.

- ✓ Rice and wheat still occupy more than 1/3rd share in the cropping pattern. The share of nutri-cereals has gone down substantially during last more than five decades. The

signals in favour of orientation towards high value crops are clearly evident as area share of fruits and vegetables has expanded overtime.

- ✓ It is clearly evident that small and marginal farmers with around 85 per cent share still dominate in number of holdings at national level. The situation is found to be worst in states like Kerala, Bihar, West Bengal, J&K, Uttar Pradesh, Odisha, Tamil Nadu, Uttarakhand along with few NE states and UTs where the share of smallholders is found to be more than 90 per cent. Out of these, states like Bihar, West Bengal and Uttar Pradesh have higher shares of geographical pockets with lowest incomes in the country. These areas need more inclusive approach and package considering the situation of smallholders.

- ✓ It is surprising to note that Chhattisgarh derives total income only from crops and wages; thus, the state needs special consideration in terms of preparation of strategic plan of the state. As far as non-farm and wages & salary as alternate sources of income are concerned, states like Kerala, Jammu & Kashmir, Himachal Pradesh, Tamil Nadu and West Bengal earn maximum from these two sources. As these states are special states in terms of the typology i.e. the states fall into either hilly or coastal typology and thus being dominated by specialised horticultural and fishery products. Thus, farmers rely on alternate sources to ensure their livelihood. These states need special attention and separate strategic framework is required for doubling of income.

- ✓ A decent growth in farm income requires some cultivators moving away from agriculture along with high growth in output and favourable prices for farm produce as has also been opined by Chand et al. (2015). This again emphasized the need of employment in non-farm sectors and income from wages and salaries to reduce the income disparities and promotion of inclusive growth.

6.1.2. Technology and Management Practices

- ✓ Technology adoption helps in reducing yield gap at farm level. If yield gaps are addressed for major crops like rice and wheat, these can contribute significantly to the output of these crops and meeting the food security requirements of the country. Cash crops like maize and cotton as well provide high yield gap estimates across states. The estimates derived for 2011-12 and 2013-14 show considerable yield gap across states among different crops. The issue can be addressed by expanding irrigation, use of improved seeds in sowing and better credit access

- ✓ Micro irrigation has generated benefits to the farmers in terms of enhancement of the productivity. Irrigated paddy growing states have definite yield advantages. There exists huge potential to expand irrigation in West Bengal. Irrigated fields, on an average, record 8 quintals/ha higher yield than the unirrigated. Among others, Odisha offers scope to improve yield levels to a sizeable extent under irrigated environment.

- ✓ In case of wheat, all major wheat producing states grow almost entire crop under irrigation, hence, offer limited scope to expand irrigation. While Madhya Pradesh has 91 per cent area under irrigation, Uttar Pradesh, Punjab, Haryana and Rajasthan have more than 98 per cent area under irrigation. But yield differentials are high, enabling scope to achieve high production. West Bengal and Odisha provide scope to expand output oriented irrigation expansion in Paddy. In terms of wheat, factors other than irrigation could be thought of in attaining yield convergence.

- ✓ A clear indication may be drawn that irrigation requirement would increase continuously due to its contribution in enhancing crop yields and revenue. Objective estimates related to water requirement and availability based on the current situation would help plan the strategies for doubling farmer's income more efficiently.

- ✓ The type of seeds used determines the yield, so as the income. Still, the reach of improved and hybrid seeds seem to be limited to specific crops. Major food crops like paddy and wheat are grown using improved seeds in general, still, reach of hybrids looks far beyond. Just 2% of paddy and wheat growers use hybrids. Spread of hybrid seed use in millet growing areas would potentially benefit farmers in gaining higher yield and income. Among pulses, Tur offer scope to adopt hybrid and improved seeds, and among oilseeds, groundnut provides some chance. In general, while paddy offer potential scope to shifting to hybrid seeds, millets offer for expanding both improved and hybrid seed use, shifting from seeds of local varieties. Directing policies towards shift of local seeds use to improved and hybrid seeds could potentially increase national production and farmers' income.

- ✓ Developing and spreading the use of better yielding varieties suitable for different typologies can contribute to farmers' incomes. Besides, the development of improved varieties/hybrids of food crops and their cultivation are central to increased farm production and consequently national food and nutritional security. Integrated farming is one of the solutions for enhancing the income and gains to farmers.

- ✓ Investment in agricultural research has resulted in good returns, thus policies for supporting and further strengthening of research and extension system of the nation should be continued. Also, it is clear that India has achieved significant total factor productivity which enabled the nation to increase food production despite high population density and limited scope for cropland increase as a source of output growth. Besides these, infrastructure in terms of rural roads, electricity, markets, literacy etc play important role in enhancing the total factor productivity.

6.1.3. Marketing, Prices and Trade

- ✓ Current price policy needs to be restructured. Over the last four and a half decade, the price policy implementation has boosted mainly wheat and rice crop among food grains and sugarcane and cotton among other crops. This situation creates an

imbalance in demand and supply situation in other important agricultural commodities like pulses, oilseeds and coarse cereals as most of the resources gets shift to traditional crops. Their prices often go below MSP due to lack of any effective price support mechanism. Moreover, trade policy also works independently of MSP policy.

- ✓ Generating foreign revenues not only improves the fiscal budget of the country but also made the country stand in the global competitiveness, thus, the country needs to have sustained and stable trade policy to continue with the image of a credible supplier and reliable trade partner. The policy instruments need to be designed accordingly.

6.1.4. Vulnerable Districts

- ✓ Climate change and variability is one of the most important matters of concern in terms of livelihood and income of farmers. Vulnerable states were growing more high yielding variety as compared to low income group states but productivity differences were not significant. Irrigation intensity was lower in both the cases and varied between 12 per cent in Jharkhand to 61.8 per cent in Bihar except Uttar Pradesh which has comparatively better status in terms of irrigation.

- ✓ Smallholders' share (58.4 per cent to 76.44 per cent) in climate vulnerable states is very less as compare to low income states (78.55 per cent to 96.92 per cent) because of adverse impact of climate will be more on small holding farmers. Income from farm sources is more prominent in poorer states than that of non-farm sources.

6.2. Major Recommendations

6.2.1. Data related

- ✓ Price realization by the farmer can be best computed from the price data on either the farm harvest price (FHP) available at state and district level or the wholesale price data during the peak season in the APMC's. FHP data is available only at the state or district level with a certain time lag. Appropriate mechanisms for collection of recent FHP at more disaggregated level like blocks/villages would be desirable.

- ✓ Currently, the marketed surplus data is available at the aggregate level which does not hold much importance from the point of view of product movement from one region to the other or from one market to the other markets. It would be appropriate if the market level surplus is assessed, for managing and balancing supply and demand. This will also help reduce the price volatility arising at certain locations/markets.

- ✓ The detailed analysis may be carried out for all potential commodities to examine the impact on domestic prices and supply, thereby, the impact on farmers' gains.

6.2.2. Policy related

- ✓ The technological interventions will increase the profitability, but as has been experienced in the past that producers become the victims of increased supply and loose significantly and, thus, suitable, procurement, logistics and marketing interventions will help optimise the revenues to farmers. The time has come when things are to be dealt in totality not in isolation. Neither the productivity centric nor the marketing and price centric approach are going to work in isolation. Every commodity has to be dealt in a holistic value chain approach where suitable interventions are required at all the critical stages. Commodity outlooks would be extremely important for efficient planning and management of value chains.

- ✓ Reorienting the current price policy in an effective and sustainable manner can bring out change in the agricultural price scenario. Prof Ramesh Chand (NITI Aayog), had put forward the concept of Minimum Insured Price (MIP) and Deficiency Price Payment (DPP) in this regard for commodities other than rice and wheat. This can be considered as an additional option along with the development of infrastructural facilities for agriculture.

- ✓ This is extremely important that concerted efforts are continued to achieve the market related objectives. The commodities having significant trade potential need to be governed by sustained policies and regulates to protect the interest of exporter and fulfill the commitments with foreign buyers. The gains from trade can further be enhanced. For this, networking is required among academic, research institutions and practicing organizations for proper technical supervision and guidance.

- ✓ To realize the DFI mission, a paradigm shift in resource allocation priorities and the approach to improving rural connectivity, electricity supply and availability of markets to sell the agricultural produce is the need of the hour and would enable the farmers to realize the remunerative gains to their produce. The condition of rural infrastructure (roads, irrigation, electricity and markets) in a number of states is a matter of serious concern. The studies have reported that basic infrastructure can improve the total factor productivity, thus, it becomes the utmost requirement that basic concerns related to infrastructure are addressed.

- ✓ There are 29 districts which are highly vulnerable and disadvantaged in terms of double stress created from low income as well as high climate vulnerability. Special programmes need to be designed to support these disadvantaged districts. It would be appreciable if some KVKs and extension agencies adopt these districts and work in coalition with state agencies and line departments to create favourable and facilitating environment to trigger the path of doubling of farmers' income.

- ✓ Marketing infrastructure is a key player in enhancing the farmers' welfare and progress as it not only provides incentives for higher production but also promotes

commercialization of subsistence farmers. Adequate marketing infrastructure helps in maintaining the quality of agricultural produce as well as in reducing the losses in handling. There is still lack of conducive market infrastructure facilities for the sale of agricultural produce. Agricultural markets lack proper infrastructural facilities like trade, storage and support infrastructure which are the key parameters in development of market infrastructure.

- ✓ Role of agricultural credit is extremely important in meeting the crop cultivation, animal rearing and other sub-sectors' requirements in agriculture. The Government of India has initiated several policy reforms to ensure the timely and required availability of credit to the farmers with the purpose to have progressive institutionalization with an inclusive approach. National Bank for Agriculture and Rural Development is extensively promoting the micro-finance and the Farmer Producer Organizations. Some state governments and NABARD are also promoting FPOs; however, the number and network of FPOs is very small and it needs to be expanded to enable farmers to reduce transaction coasts, access technology, raise their negotiation power and integrate with value chains (Chand 2017). Credit expansion across regions and farm size classes would further help in enhancing efficiency and farmers' gains.

- ✓ In regards Trade policy, it seems that a more consumer-centric approach is being adopted to cater to the "price hike" situations. DFI Committee feels that a more farmer centric" approach is required to make the farmers avail the advantage of lucrative price scenario at domestic as well as global arena.

- ✓ As most of the farmers in the country lie in the marginal and small category with very small holding size which makes the diffusion of advanced technologies difficult. The holdings are tiny and scattered particularly in the hilly areas. Thus, land consolidation coupled with other suitable reforms need to be effectively implemented. Further, the climatic risks are resulting in decline in productivity and creating distorting impact on prices. Thus, risk management is an essential component to be studied in detail.

Doubling of farmers' income requires not only interventions to develop the agricultural sector but also requires strong linkages with manufacturing and service sector to transform the 'agricultural units to agricultural enterprises'. Thus, it is not an isolated game that would transform the face of Indian agriculture. Rather, it will need putting all forces together for the holistic development of this sector to provide it more modern and professional orientation.

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