सत्यमेव जयते

Ministry of Agriculture &
Farmers' Welfare

Report of the Committee on Doubling Farmers' Income

Volume I

"March of Agriculture since Independence and Growth Trends"

Historical Analysis and Examination of India's 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,
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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 owning 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, recognising 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 organisations, farmers' organisations, 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 organised 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
- Recognising 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 incentivising 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, organisation 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 realising 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 the 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 analysis that accessed various measures to infer the growth and included empirical assessments. The recent assessments by NITI Aayog and those from ICAR have also 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 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

The overall performance of agriculture and allied activities and dynamics of the agricultural sector since India's independence is discussed. An overview of the structure and changes in the land holding pattern is also provided. 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 economy. Though in absolute terms agricultural GDP is growing, as a ratio of the total GDP of the economy it has been declining. Simultaneously notwithstanding that percentage of population dependent on agriculture declined to 48 per cent in 2011, from a high of 85 per cent in 1951, seen in terms of absolute numbers, a sizable population is still dependent on agriculture for its livelihood. Since this sector influences the lives of the entire population, several efforts have been made since independence to evolve appropriate agricultural policies affecting both the producers and the consumers. Given the food deficiency that prevailed and the continued growth of population since independence, the growth strategy for agriculture has been production-centric. The sector received incentives, that have helped the nation to achieve high levels of production for its food security.

Various Commission and Committee Reports have influenced the agricultural policies of the country beginning with pre-Independence period.

The first ever Commission was the Royal Commission on Agriculture constituted in 1926 under the chairmanship of Victor Alexander John, which was mandated primarily to examine and report on the condition of agricultural and rural economy in British India and to make recommendations for agricultural improvement. The Commission submitted its Report in 1928. The first ever Committee, Food Grains Policy Committee (1943) was constituted under the chairmanship of T. Gregory, which mainly focused on food availability, supplies, distribution and control prices, which were the main challenges due to the Second World War. The country also faced severe food shortage due to lower yield levels and the problem of refugees immediately after attaining Independence, when the Government appointed a committee under P. Thakurdas in 1947. Also known as the Foodgrain Policy Committee (1947), it studied the aspects related to food distribution, and the main features of its recommendation were gradual withdrawal of control and removal of restrictions on movements of foodgrains. Various other Committees followed thereafter. These include Maitra Committee (1950), Mehta Committee (1957), Venkatappaiah Committee (1966). These were mandated to enquire into food and distribution problems and solve the issues. The recommendations of these Committees played important role in the formulation of subsequent agricultural policies.

The policies that came to make a major and long standing impact in the agriculture sector were adopted in mid-1960s. These measures adopted included production subsidies, minimum support prices, public procurement, storage and distribution of foodgrains, as also trade protection. During the 1960s and 1970s, widespread adoption of high yielding rice and wheat

varieties was promoted in response to glaring food deficit situation in the country. The country also expanded its irrigated area, promoted increased use of chemical fertilizers and pesticides, and improved access to institutional credit. Such a comprehensive policy package led to considerable rise in agricultural production making India self-sufficient in foodgrains at the national level.

The first comprehensive agricultural policy was brought out by the National Commission on Agriculture constituted under the chairmanship of N. R. Mirdha, which submitted its Report in 1976. It mainly emphasised on production, land and water development by addressing the conservation and issues of water management. Land reclamation and harvesting of ground water, development at animal husbandry & fishery sector, besides forestry were recommended. Development of subsidiary activities like poultry, piggery, sheep and goat rearing were also emphasised. Further, it gave thrust on research, education and training for promotion of agriculture and its application to field conditions. Along with the sectoral development, promotion of employment potential in the agricultural sector was also a concern. A Committee chaired by 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, which paved the way for introduction of the first ever comprehensive National Agricultural Policy in 2000.

Then came the National Commission on Farmers (NCF) constituted in 2004, which comprehensively studied the food situation, mostly addressing concerns regarding supplies for the public distribution system and those related to production and productivity. Several recommendations were made by the Commission for reforms in the Indian agriculture. Many of these related to land reforms, irrigation, 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 Commission also laid stress on timely and adequate supply of credit to farmers, and improving food security for the consumers by addressing of micronutrient deficiency and adoption of an integrated food-cum-fortification approach. The Commission also made an important suggestion to recognize farmer as an important stakeholder.

The Inter-Ministerial Committee on Doubling Farmers Income constituted by the Government in April 2016 is a clear departure from all earlier intentions and mandates. The Committee took shape following the vision shared by the Prime Minister in February 2016 to double the income of the farmers by 2022, when the nation celebrates 75th years of independence. The Committee has been assigned very clear & definitive terms of reference in this context. This Committee is required to take a more holistic, contextual and outcome based approach to agriculture. The Committee needed to redefine agriculture, and approach it not merely from a production-centric perspective, but as an enterprise with an income-centric view point, before formulating the strategies and major reforms required for fulfilling the mission of doubling of income. The DFI Committee also considered agriculture sector as an Agri-value System and recommended major market reforms and to bring increased focus on animal husbandry,

poultry, fisheries and other allied enterprises. The DFI Committee held consultations with different stakeholders, including the farmers, scientists, professionals trade & and industry bodies and public at large to benefit from international bodies associated with agriculture.

1.2. Trends in Agricultural Growth

Agriculture, not only makes the country secure in terms of food, fodder and other raw-materials as feedstock for industries, it also serves as the source of livelihood for the majority of the Indian population. India's economy is classified into three sectors - Agriculture & allied; Industry; and Services. Agriculture sector includes Agriculture (Agriculture proper & Livestock), Forestry & Logging, Fishing and related activities. The agriculture sector contributed about 14.5 per cent to the gross domestic product (GDP) of the country in 2016-17. To evaluate trends and growth, the data used on GDP, gross value added (GVA) along with value of production (VoP) of various sub-sectors, the price series in 2004-05 are used.

The agricultural sector grew at around 3.4 per cent per year during 2004-05 to 2016-17 and this was quite impressive as compared to 2.3 per cent per annum during the previous decade (1995-96 to 2004-05). During the recent decade of 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, suggesting its relative dominance. The same is also confirmed from the year-on-year fluctuations in different sub-sectors.

Table 1.1 Movement of Indian Economy: trends in GDP/GVA across sectors

Period	**1960-61/ 1968-69**	**1968-69/ 1975-76**	**1975-76/ 1988-89**	**1988-89/ 1995-96**	**1995-96/ 2004-05**	**2004-05/ 2016-17**
Average GDP @2004-05 prices (Rs Billion)						
Agriculture	**1636**	**1955**	**2547**	**3473**	**4358**	**5771***
Agriculture & Allied Activities	2004	2401	3047	4116	5174	7126
Industry	725	1000	1676	2958	4773	10021
Services	1859	2517	4078	7286	13083	32454
Share (%)						
Agriculture	**35.66**	**33.03**	**28.94**	**24.19**	**18.92**	**12.72***
Agriculture & Allied Activities	43.68	40.57	34.62	28.66	22.47	11.63
Industry	15.80	16.90	19.04	20.60	20.73	20.30
Services	40.52	42.53	46.34	50.74	56.81	68.07
GDP growth rate (% p.a.)						
Agriculture	**0.7**	**2.19**	**2.74**	**2.69**	**2.23**	**3.88***
Agriculture & Allied Activities	1.04	2.24	2.47	2.76	2.28	3.43
Industry	5.05	3.92	5.53	5.9	4.87	7.51
Services	5.03	3.37	5.4	6.15	7.86	8.69

Source: DFI Committee Estimates; Estimates for the period 2004-05 to 2016-17 are based on GVA
**upto 2015-16 only.*

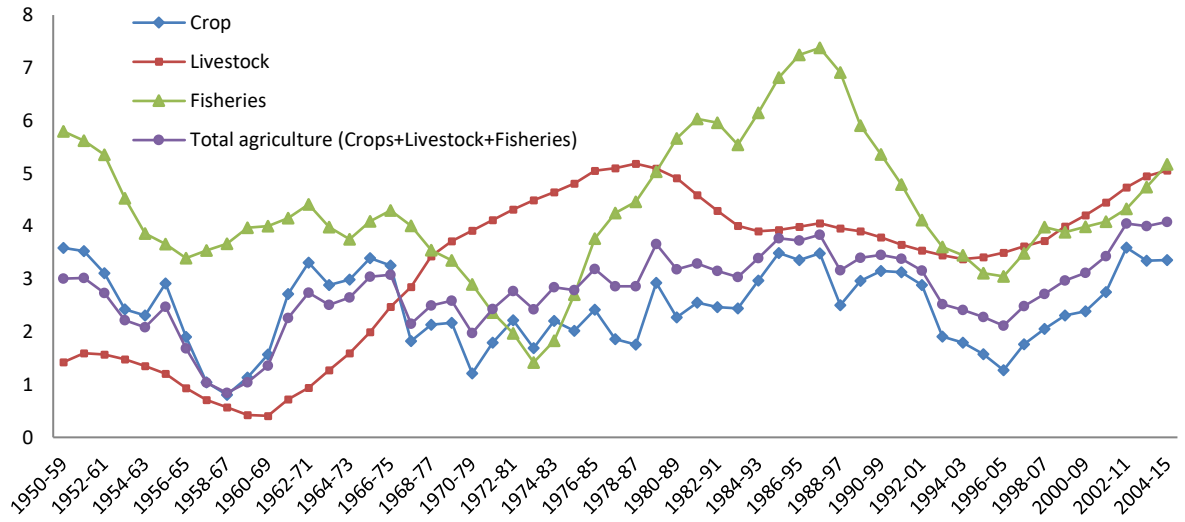
Such a robust growth of agriculture sector unleashes multiplier effect on the overall economy of the nation, and therefore needs to be persisted with (Table 1.1).

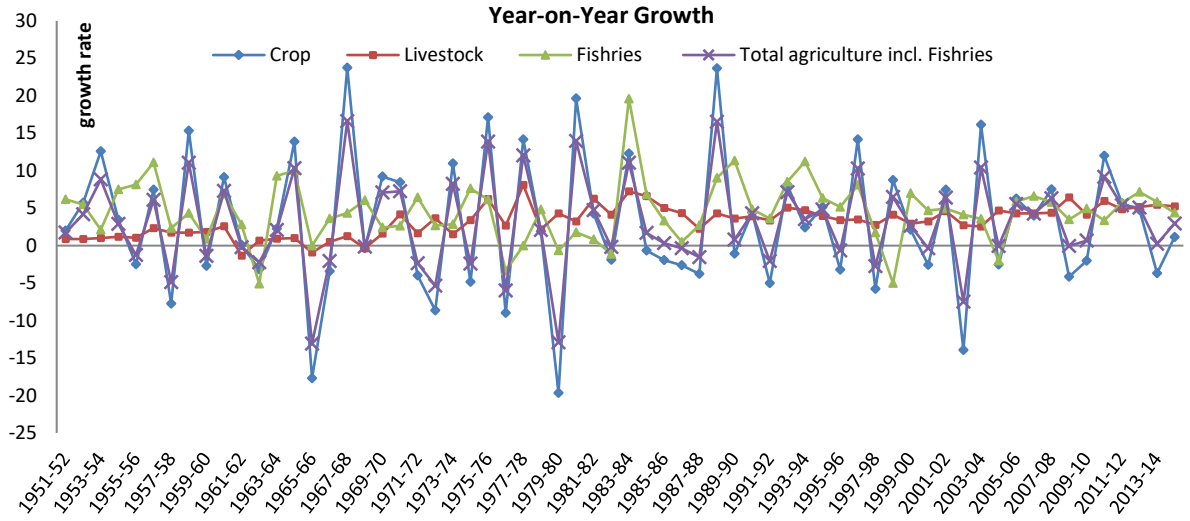
Chand and Shinoj (2012) estimated the moving decennial growth rates by fitting a semi-log trend to the smoothened data. The moving decennial growth rates were also computed in this study to examine the performance of various sub-sectors. The decennial growth rates indicate remarkable growth from 2004-05 onwards for all the sub-sectors, i.e. crop, livestock and fisheries. 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., higher MSP, increase in foodgrain procurement, increase in global agricultural prices and strong domestic demand for food.

It is interesting to note, that Livestock sub-sector is growing at an appreciable and sustainable rate and is ahead among all sub-sectors. It is remarkable that the livestock sub-sector never registered a negative growth in any of the years during the span of 34 years; which included several drought years; the lowest growth rate being one per cent in the year 2003-04.

The livestock sub-sector demonstrated that it can be relied upon for risk mitigation and minimizing the losses for the farmers even in case of worst outcomes from others sub-sectors and is likely to emerge as engine of growth of agricultural sector. Previous studies have unanimously reported that livestock is the best insurance against agrarian distress as the sector is the source of sustained income. The frequency of income from livestock sector is more perennial relative to season-bound crop sectors.

Figure 1.1 Growth rates in GDP across sub-sectors at 2004-05 prices
Moving Decadal Growth





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 for the farmers, given in case of worst outcomes from others sub-sectors.

Table 1.2 provides the existing growth rates for different crop categories based on Value of Production (VoP) at 2004-05 prices.

Table 1.2 Historical growth rates of crop categories, livestock and fisheries based on VoP at 2004-05 Prices

(% p.a.)

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
Condiment & spice	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 incentivised higher production. Improved marketing arrangements and innovations would help enhance the farmers' share in consumer's rupees.

As far as the trajectory of growth across various phases 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. During the post-reform period of 1995-96 to 2004-05, except for floriculture, fruits & vegetables, condiments & spices and sugar, performance of all other crop categories was found to be decelerating.

1.3. Area and Value Shares of Various Crops

Table 1.3 provides insight into the area share of different crop categories vis-à-vis the gross cropped area (GCA) over time. The period has been categorised 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). The recovery period was further extended up to 2014-15.

The area under almost all the major crops has increased over time, with exception of nutri-cereals and pulses, (the category of coarse cereals is covered under the term nutri-cereals now onwards. Recognised as an emerging and important category for assured health benefits, nutri-cereals cover finger millets, pearl-millets, sorghum and other small millets). The percentage area under these two crop categories has marginally declined in recovery period as compared to pre-green revolution period (Table 1.3).

Table 1.3 Area shares 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 the last about four decades. The area share of fruits and

vegetables has expanded overtime, signalling the orientation of demand and production for high value crops.

A continuous and significant increase in share of area to GCA under fruits and vegetables indicates the growing importance of these commodities, at both producer and consumer levels. Short duration nature of horticulture crops and their growing market demand are the incentives for increasing coverage. Short crop cycles enable the farmer to realise income yields at shorter intervals.

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 consumption shift from foodgrains towards fruits and vegetables, livestock products and fisheries. This is manifest in increasing area coverage and production in respect of these sectors, and reflects in the increasing value share of these items over time. The increasing demand for high value commodities like fruits and vegetables, livestock products and fisheries can be tapped better, by a shift in policy to focus on what would constitute the growth drivers in the coming years. This potential can be better harvested by reorienting the policy, to enhance investments in these allied sectors for improving productivity, quality and efficiency.

Table 1.4 Value shares of crop categories, livestock & fisheries to total VoP (2004-05 prices)

Crops	Pre-green revolution period (1960-61/ 1968-69)	Early green revolution period (1968-69/ 1975-76)	Wider technology disseminatio n (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

Since the time the country achieved food self-sufficiency in early 1970s, Indian agri-export performance compares more favourably than other sectors of the economy. Though the exports of agricultural commodities picked up after 1970-71, greater impetus is seen after 1994-95 with the launch of global trade reforms and trade integration with establishment of World Trade Organization.

Over the last 25 years since India's liberalisation, the foreign trade has expanded multi-fold and seen significant structural shifts in product mix as well as geographic spread. Liberalisation in trade policies related to easing of several trade restrictions, and reduction in tariff levels across different products have assisted the growth of foreign trade especially in the first two decades post liberalization phase. However, there exists much greater scope for agri-exports from India, and it needs to be tapped in the interest of farmer-producers.

India's exports increased from Rs. 0.32 lakh crores in 1990-91 to Rs. 17.16 lakh crores in 2015-16. Imports also shot up 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).

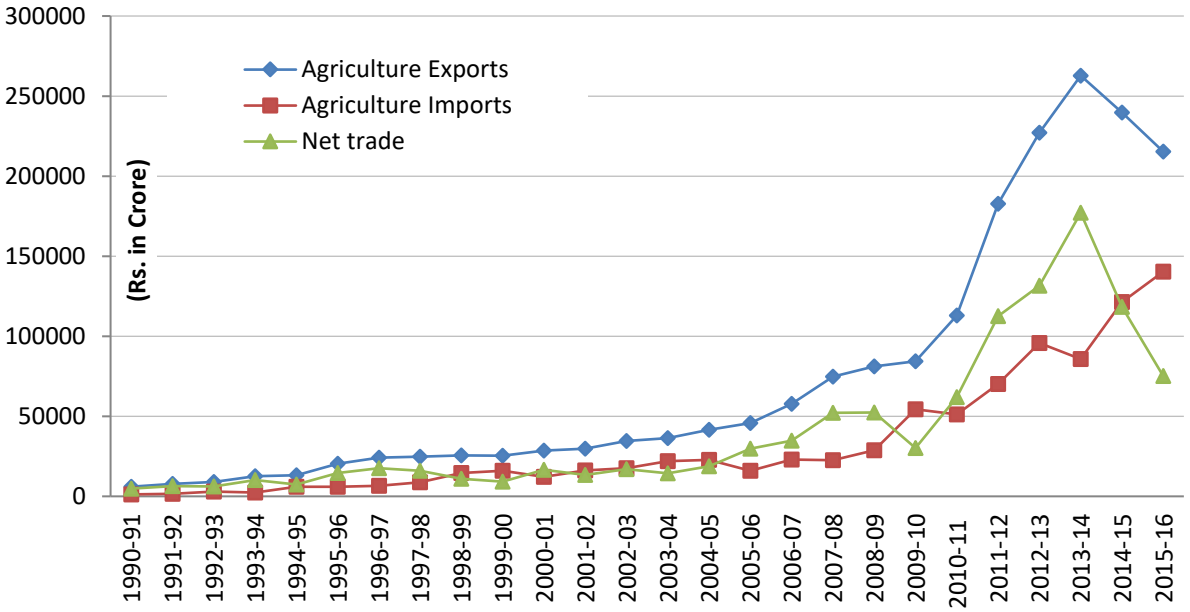
Table 1.5 Patterns and contribution of Agricultural Trade from India

Years	Agriculture Exports (Rs. crore)	Total Exports (Rs. crore)	Agriculture Exports to total Exports **(%)**	Agriculture Imports (Rs.crore)	Total Imports (Rs.crore)	Agriculture Imports to total Imports **(%)**	**Net 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)

The composition of exports has undergone substantial changes post liberalisation. 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.

Figure 1.2 Trends in agricultural Exports and Imports of India (Rs. Billion)

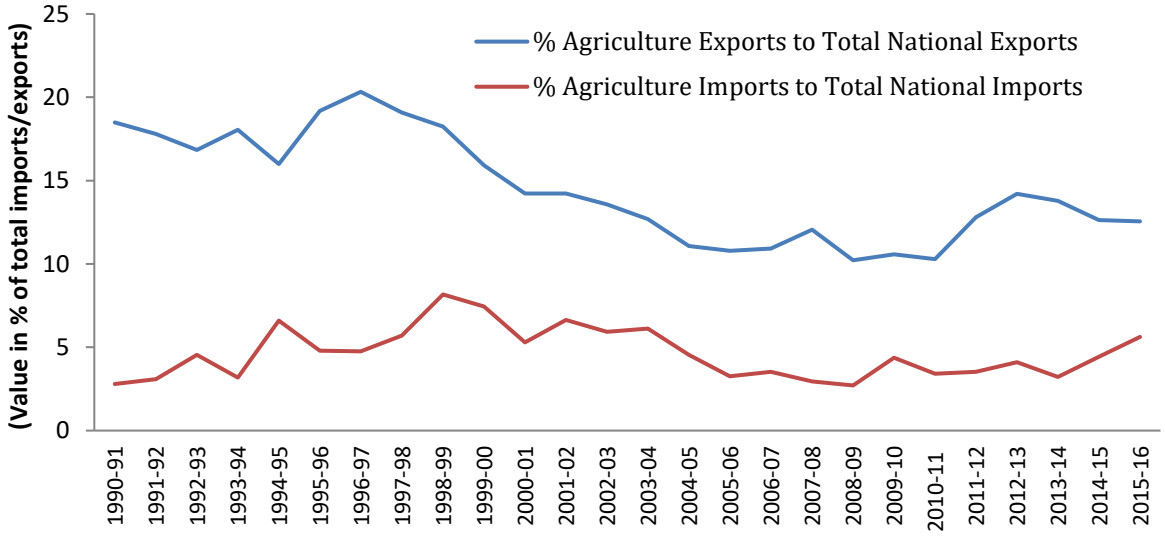


Source: Agricultural Statistics at a Glance (various issues)

Agricultural exports and imports have also increased considerably during the last 25 years. Since the year 2005-06, 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. Though the absolute agricultural trade has expanded, the share of both the agricultural imports and exports has declined considerably in the overall trade during the last 25 years, on account of increased share of manufactured and other value added products (Fig 1.3).

Figure 1.3 Contribution of Agricultural Trade to total National Trade



Source: DFI Committee

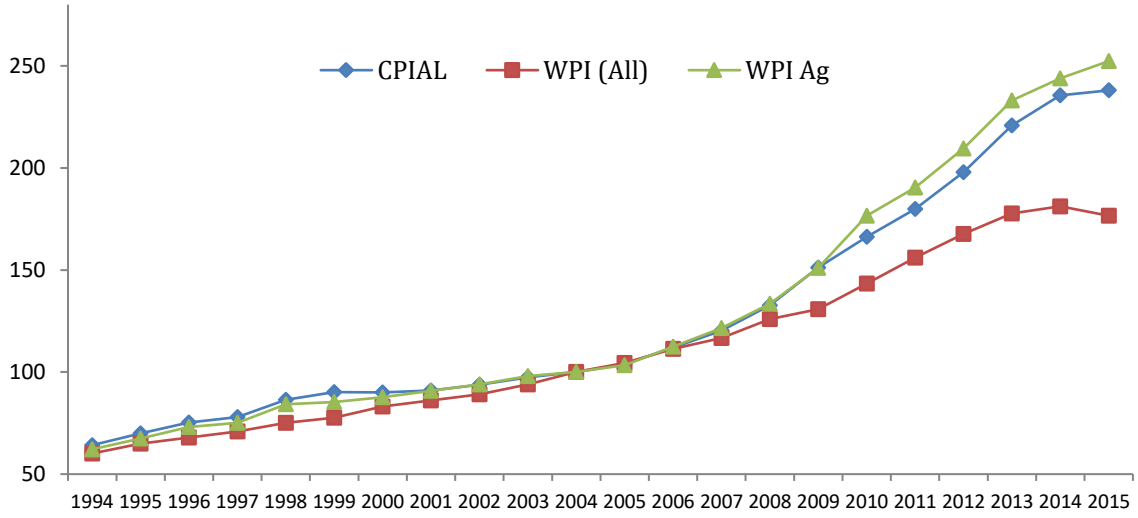
1.5. Prices Paid and Prices Received by Farmers

Prices determine the farmers' farm income and hence his welfare and influence the welfare cycle. The Wholesale Price Indices (WPI) for agricultural commodities may be considered as a representative index for the prices received by the farmers. An 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. A higher increase in WPI relative to CPI is more advantageous to the farmers, and yields positive impact on their welfare.

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; and has therefore 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.

Figure 1.4 Movements in Consumer Price Index and Wholesale Price Index (at 2004-05 base)



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

Prominent increase in case of prices of agricultural commodities, often leads to the inflationary situation in food commodities and affects overall well-being. The monthly and weekly WPI data for selected agricultural commodities exhibit severe volatility and affect the farmers' welfare.

1.6. Dependence on Agriculture

The livelihood dependence on agriculture can be ascertained from the number of workers employed in agriculture, in the form of cultivators and agricultural labourers. The data on agricultural workers is made available through population census, on a decadal basis. In addition, the National Sample Survey Organisation (NSSO) conducts surveys on employment and unemployment on quinquennial basis. The data from the two are dissimilar but a common underlying trend can be observed.

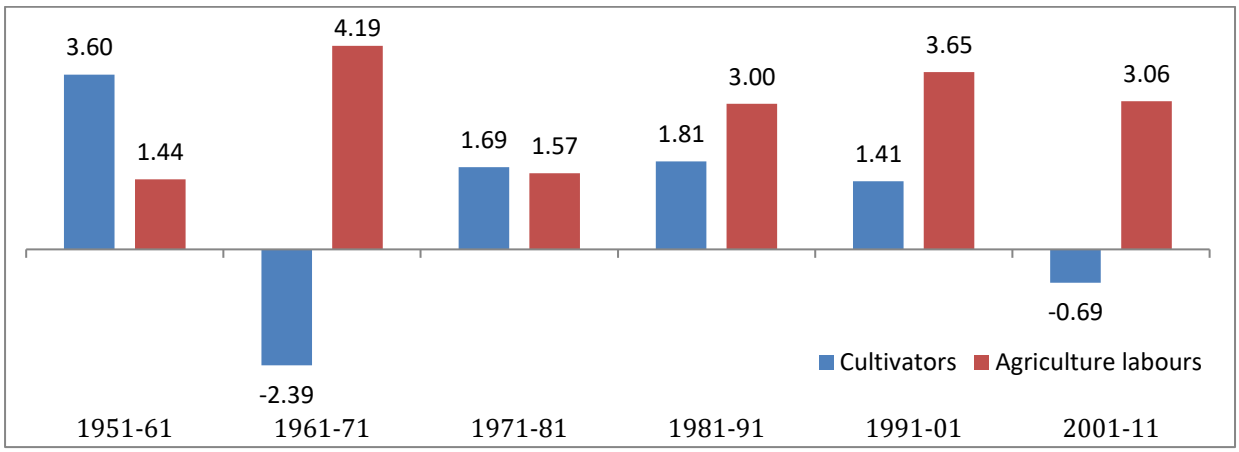
Table 1.6 Total number of workers and share of Cultivators and Agriculture Labourers based on Agricultural Census

Year	Total Workers	Agricultural Workers			Share in total workers (%)		
		Cultivators	Agricultural Labourers	Total	Cultivators in total workers	Agricultural labour in total workers	Agricultural workers in total workers
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	148.0	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

The decadal census is universal in nature and provides a truthful picture of ground level trends in regards agricultural workers and cultivators in the economy. Table 1.6 represents that except between 1961 and 1971, a continuous increase is observed in the number of total workers engaged in agriculture. However, at the disaggregated level, the number of cultivators showed a decline during 2001 and 2011, as well between 1961 and 1971. On the contrary, as regards agricultural labourers, their absolute numbers have grown, and in the decade between 2001 and 2011, they increased from 107 million to 144 million. However, the ratio of agricultural workers to total workers in the economy has been decreasing. The pattern indicated is, that generally some number of the population is shifting out from agriculture into other sectors.

Figure 1.5 Compound Annual Growth Rate of cultivators and agriculture labours (%)



Source: DFI Committee Estimates from NSSO data

Data from population census as well as NSSO indicate that, overall the interest of workers in agricultural activity is declining and there is a higher growth rate of workers in other sectors. Discussed in Volume II of the Report, one of the sources of income growth is a shift in working force from farming into other economic activities. The degree of such a shift is dependent upon of the robustness of the growth of manufacturing and service sectors - it would help if their growth rates are higher and they are able to absorb a larger section of the transiting agricultural population. It is also important that the jobs provided in these secondary and tertiary sector of economy, are more stable and income secure, as it would make transition less painful. A policy would be required to hand-hold such transitions and this will include training, professional skilling and social adjustment skill sets.

Considering the data from NSSO surveys on employment and unemployment, it shows that the number of agricultural labourers declined from 92.7 million to 78.2 million from 2004-05 to 2011-12 (different from census data). As per NSSO data, every year around 22 lakh agricultural labourers left the sector. At the same time, it indicates that the number of cultivators declined at the rate of 1.80 per cent per year during 2004-05 to 2011-12. While the NSSO numbers may be contrary to the census data, the indication is similar, that the trend is towards a general reduction in cultivators and agricultural workers to total workers in the country.

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 efficient utilisation of farm resources and technology adoption by the farmers, and as a result challenge economic productivity. Moreover, this also hinders the diversification process, which is considered a key in adding to 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. Farm Land Holdings across States

The state wise patterns of change in land holding do not exhibit significant change within a given category, except for the large farm category in a few states like West Bengal, North-Eastern States and Kerala. In most of the states, number of holdings 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, Andhra Pradesh, Maharashtra, Rajasthan and Karnataka have also noted an increase in the number of holdings, but the increase is not sizable.

In case of north eastern states and union territories, it was Tripura that represented the 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 holdings in the period.

It is clearly evident that small and marginal farmers, with around 85 per cent share, still dominate the number of holdings at national level. The scenario is the same across states, except for Nagaland where the majority of the farmers fall in medium and semi-medium categories As far as number of holdings within state is concerned, Kerala topped the list with the highest number of small and marginal farmers.

1.7.2. Average Size of Holdings across States and Size Classes

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

Table 1.8 Average size of Land Holding across 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**
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

State/UT	Marginal (<1 ha)		Small (1-2 ha)		Semi-Medium (2-4 ha)		Medium (4-10 ha)		Large (>10 ha)		All Holdings	
	2000-01	2010-11	2000-01	2010-11	2000-01	2010-11	2000-01	2010-11	2000-01	2010-11	2000-01	2010-11
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 states												
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
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
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)

An in-depth analysis brings out an interesting fact that average land holding size under the 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. This was 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 ha in Darjeeling and Jalpaiguri districts in the year 2010-11.

Likewise, the landholding size under large farm size category was high in Wayanad, Kollam, Idukki districts of Kerala, and in Hailakandi, Odalguri, Kokrajhar & Golapara districts of Assam. Interestingly, land holding size under the same category exhibited notable changes during the period 2000-01 and 2010-11 in these states, mainly because of change in size of institutional holdings over the period.

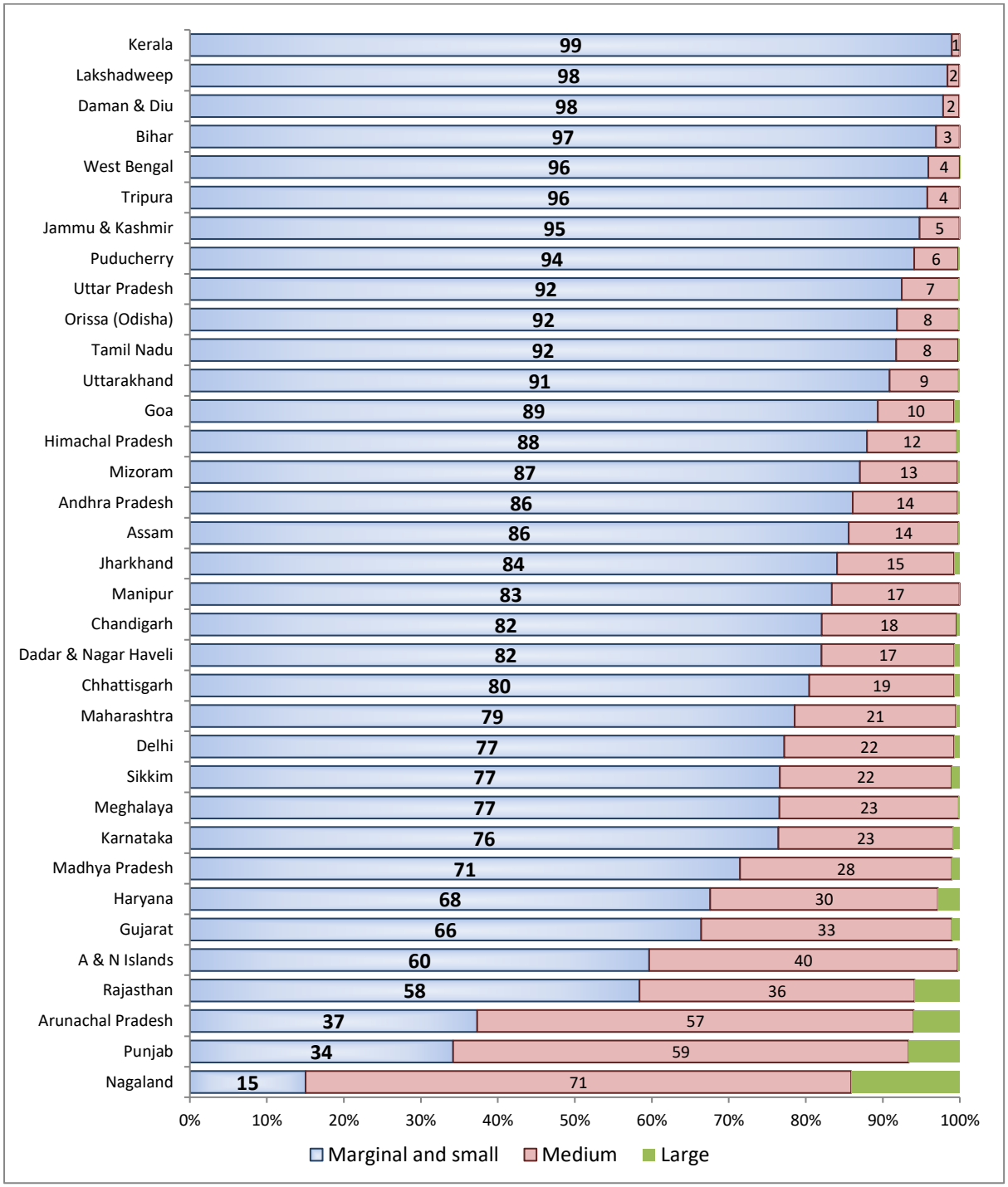
The number and share of holdings for various size groups and states are given in Table 1.9 and Fig 1.6, respectively.

Table 1.9 Number of holdings across states by size group in 2010-11 (no. in '000)

	Marginal	Small	Semi-Medium	Medium	Large	All Holding
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 States						
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
Tripura	499	55	22	3	0	578
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

Figure 1.6 Shares of Farm Size Classes to total number of holdings across States (2010-11)



Source: 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, Jammu & Kashmir, Uttar Pradesh, Odisha, Tamil Nadu and 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. However, the results indicated that land productivity was inversely related to farm size class.

This 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. Shift in Consumption Pattern

Among consumers, an increasing trend towards non-food expenditure is clearly visible and one would expect the trend to continue in near future. Around 15 per cent of household 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, refer chapter 9, Vol. XIII (for clearer appreciation). More than 9 per cent increase in expenditure on other goods and services also indicates increasing preference towards non-food items than the food items. 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 was roughly equal in rural India, it was more than 20 per cent in urban India. Amongst 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 respectively between 1993-94 and 2011-12.

Table 1.10 Trends and patterns in consumption

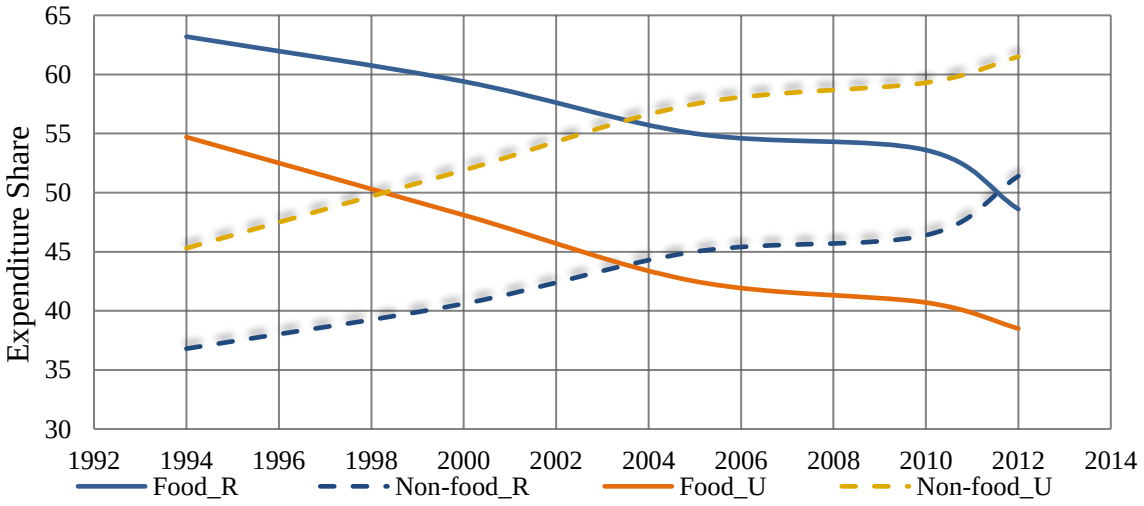
Item group	Share in total consumption expenditure (per cent)									
	Rural					Urban				
	1993-94	1999-00	2004-05	2009-10	2011-12	1993-94	1999-00	2004-05	2009-10	2011-12
Consumption pattern of major items (Per person per month)										
Cereals (Kg)	13.4	12.72	12.12	11.35	11.22	10.6	10.42	9.94	9.37	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

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
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 for shift towards more nutritious consumption expenditure and nutrition-led marketing. Over the past two decades, share of food in total expenditure (as explained by the monthly per capita expenditure, MPCE) 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 trend holds true for pulses as well. Rather, rapid improvements in consumption of allied agricultural products is observed, especially in urban India. Thus, a shift from consuming staple crops and pulses towards allied agricultural products is evident, in both physical as well as in value terms.

Figure 1.7 Shift in consumption expenditure (1993-94 to 2011-12)



Trends in components of non-food items remain more or less similar in rural (R) and urban (U) domains. However, while in rural areas share of food and non-food expenditure equalled recently, in urban India this happened in late 1990s, and the ratio of food expenses has continuously decreased to 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

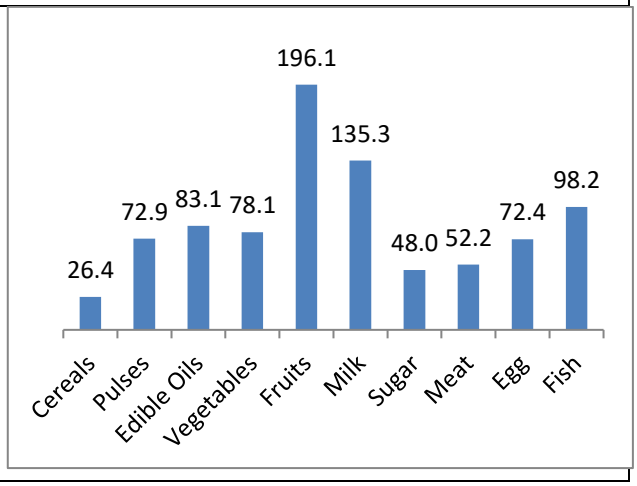
Owing to the increasing population over the years, demand for food is naturally expected to increase in coming years. Various studies have projected the demand of foodgrains under alternative assumptions of income growth, distribution of income and future dynamics of rural and urban populations. Box 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 are visible from the projections.

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.

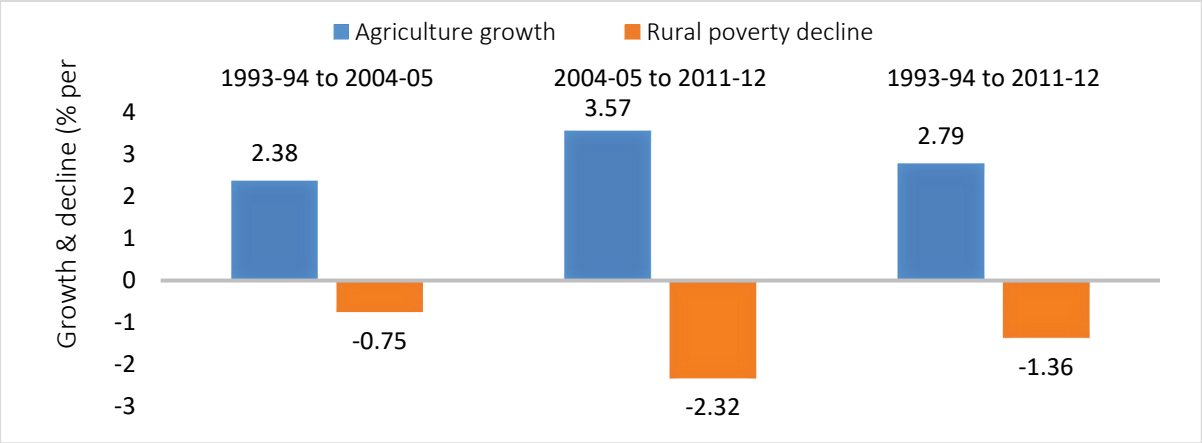
1.9. Agriculture-Poverty Linkages

Having direct and indirect linkages with rest of the economy, agriculture 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 that what the rest of the economy does. Following a growth deceleration in post-reforms period in India, the

sector recovered its momentum since mid-2000s. Output growth in agriculture[1] shows notable improvement since 2004-05 compared to the earlier period, from 2.4 per cent growth rate during the pre-reforms period to 3.4 per cent growth between 2004-05 and 2011-12 (Fig 1.8).

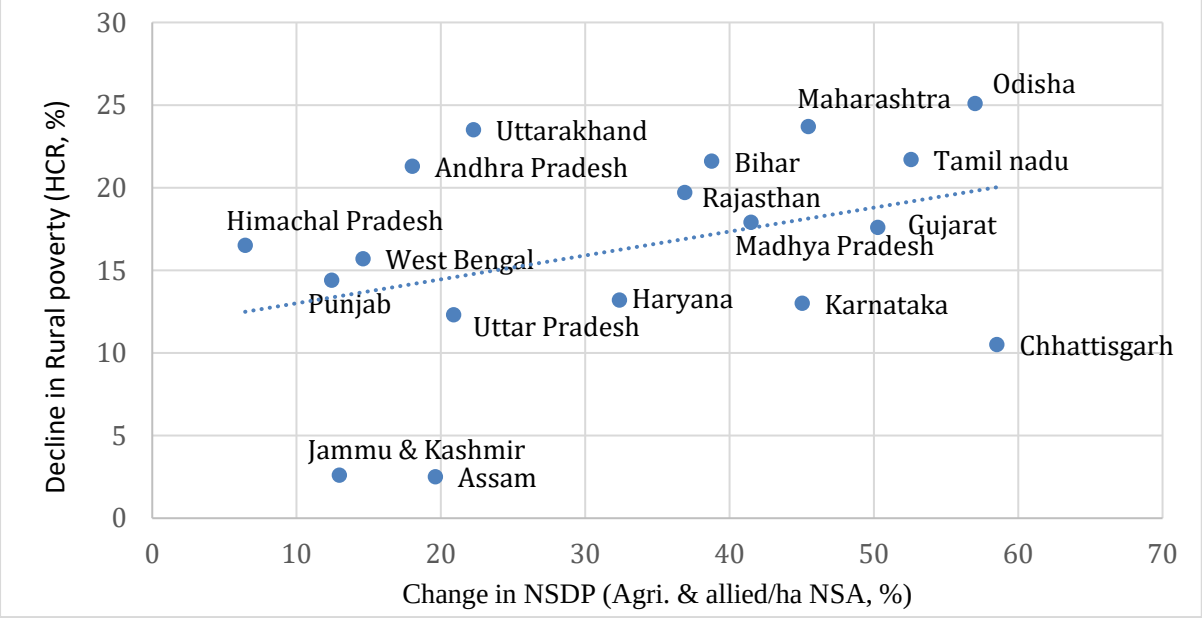
Rural poverty estimates of pre- and post-reforms period help one to understand the role of agriculture growth in rural poverty incidences. During the pre-reforms period, when growth in agriculture was relatively slow, rate of rural poverty reduction was less than 1 per cent a year. When growth in agriculture rejuvenated, poverty decline became faster and recorded a 2.32 per cent annual decline (Fig 1.9). This positive influence is not felt at national level alone.

Figure 1.8 Agriculture growth and poverty decline in rural India



Source: DFI Committee

Figure 1.9 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.

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

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

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 of what an agricultural 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 economic 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 an agricultural labourer (Table 1.11).

In recent years, farmers' suicides have been quoted as an indicator of farmers' distress. The issues related to farmers' suicides have gained lot of political attention. Madhya Pradesh, a state which was being seen as role model for robust and consistent growth in agriculture experienced unrest among farmers, largely linked to low prices on their produce.

To help the farmers harvest complete benefits from enhanced output, overall supply chain management is crucial, besides optimising the internal value chain of farmers. This will include relevant aspects that will enable integrating the farmer as a value chain actor in the supply chain of the associated industrial units, as well the ability to directly market their produce to markets of choice.

Table 1.11 Disparities in Agriculture and Non-agriculture Income

Year	Farm income (F) per cultivator (Rs)	Wage earning per agricultural labourer (L) (Rs)	Income per non-agriculture worker (N) (Rs)	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)

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

[3] This section has been drawn from 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).

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 a 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 WPI. This may also be a reason for lowered agricultural income growth. The difference between CPIAL and WPI growth rates is an obvious indicator of the low growth rate in net income from farms. 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, there have been no appreciable policies, that were 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 vision & mission of "Doubling of Farmers' Income" (DFI) in India have enthused and fuelled lot of energy and motivation among the stakeholders and triggering an environment for channelizing disparate efforts in a unified direction. The 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, etc. All of these will contribute towards maximising the gains from farming. These programmes and schemes, implemented in true spirit, will lead to many improvements 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 the DFI mission moves 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.

This DFI Report organised into 14 volumes outlines the strategies and provides a systematic approach. And, Volume-I elaborates the historical changes in Indian agriculture on major dimensions.

Key Extracts

- Overall growth in agriculture has moved correspondent to the crop sector. Livestock sector is growing at an appreciable and sustainable rate and is ahead among all the sub-sectors.
- During the period 2004-05 to 2011-12, data confirms that there was shift of both cultivators and landless agricultural labour from agriculture to non-agriculture sector. Such a shift is good provided they are productively and gainfully employed in alternate sectors/industries.
- The smallholders (including marginal farmers also) dominate the Indian agriculture. The situation is found to be sharper in the states like Kerala, Bihar, West Bengal, Jammu & Kashmir, 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 states need more inclusive approach and package of intervention considering the situation of smallholders.
- Considerable poverty decline was experienced in all the states where output growth was high. Barring few states viz. Jammu & Kashmir, Assam and Chhattisgarh, one could observe a positive relation between output growth in agriculture and poverty reduction in almost all the states, indicating positive correlation agriculture growth and rural poverty linkages.
- Trends in components of non-food items remain more or less equal in rural and urban domains. Rather, while food and non-food expenditures are converging in rural sphere, urban India shows a clear divergence, with a sharp fall in food expenses and a corresponding increase in non-food expenses.

Chapter 2
Performance of Agriculture and Allied Sectors

This chapter provides indicators of the 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, growing at a 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 2014-15 (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 the output in any of the states.

Agricultural output as a highest share of the state output is in case of Madhya Pradesh with a ratio of 28 per cent. In Punjab, Uttar Pradesh and Andhra Pradesh, the shares range between 20 per cent and 25 per cent. The pattern is not just confined to the said year, but has been so from earlier itself. Between TE 2006-07 and TE 2014-15, output share 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 was 9 per cent in Uttarakhand, and 7 per cent in Jammu & Kashmir, Kerala, Haryana and West Bengal. Notwithstanding its higher share than agriculture, in many of the states, share of manufacturing also declined during this period. For example, share of manufacturing 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.

The service sector has captured the momentum and compensated the decline in share in output from agriculture and manufacturing. During TE 2014-15, Kerala produced 70 per cent of its output through service sector, followed by West Bengal (65 per cent), Tamil Nadu and Maharashtra (64 per cent both). As a pattern, none of the states recorded a negative change in this sector's output share. During the period TE 2006-07 to TE 2014-15, output share grew 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 on non-farm sector for growth.

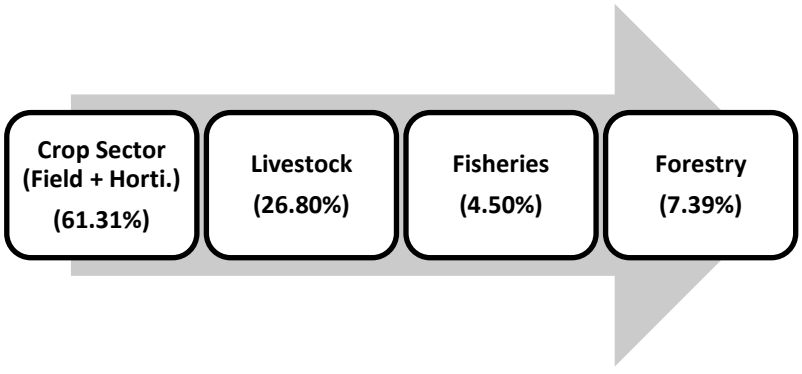
Output composition within agriculture sector shows mixed trends. Output shares in forestry sector in most of the states have not seen major changes. Fisheries sector has gradually picked up, albeit very marginally. Andhra Pradesh and Kerala have reduced their output share from crop and livestock sector. 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 between

TE 2006-07 and 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 (2010-11 to 2014-15) where agriculture sector reported an increase in growth in GSDP. Apart from this, in few states like Andhra Pradesh, Himachal Pradesh, Arunachal Pradesh 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 the 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 sectors play 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 TE 2014-15 (with base year 2011-12) has been presented in subsequent charts. Agriculture & allied sectors consist of four sub-sectors namely, **Crop sector, Livestock, Forestry and Fisheries**. The share of crop sector in the total Value of Production (VoP) from agriculture and allied activities at 61.31 per cent is the highest. Livestock comes next with a share of 26.80 per cent and is followed by forestry (7.39 per cent) and fisheries (4.50 per cent) sectors.



The economic activities included in these sectors are further divided. Crop sector includes field crops, plantation crops, horticultural crops, drugs and narcotics crops amongst others. Similarly in case of livestock it includes production of milk, meat, eggs, wool, dung, etc.

The milk group contributes highest (66.6 per cent) share in the VoP within the 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. The share of this sector in the total VoP from livestock is 20 per cent, and is followed by dung (6.31 per cent), eggs (3.43 per cent) and others (3.05 per cent).

Table 2.1 Performance of Agriculture, Manufacturing and Service Sectors across States (Rs. billion @ 2004-05 prices)

States	Agricultural and Allied 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
Odisha	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 as below:

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 Value of Production (VoP) in forestry.

The fishing sector comprises the following:

a) Inland fishing which retains highest share (59 per cent) in VoP of fisheries sector and

b) 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. These include a range of field crops, namely, cereals (27.24), pulses (4.46), oilseeds (8.30), sugar (6.24) and fibres (6.21) each of them contributing to the total VoP from sector as shown in respective parentheses (Fig 2.1).

Among the cereals, paddy and wheat alone contribute around 86 per cent share to the VoP and dominate. Similarly in case of pulses, gram, arhar and urd are the highest contributor to the VoP are gram, arhar and urad, while in oilseeds, soybean, rapeseed & mustard, groundnut and coconut are the major contributors. Cotton (kapas) is the lone highest contributor with 94.45 per cent share in the total VoP from fibres.

The other shares in the VoP from crop sub-sector are those from plantation & horticultural crops including medicinal & narcotics (3.75%); and condiments & spices (4.04%). Of these, it is the horticultural crops including fruits & vegetables that contribute the highest accounting for 25.17 per cent (Fig 2.2). This contribution is next only to that from cereals. Other contributors VoP shares from crop sub-sector include various crops like rubber, guar seed, fodder, grass, mulberry etc (8.19 per cent); by-products (5.56 per cent); and kitchen garden (0.45 per cent).

The share to VoP from livestock sector and the composition thereof are detailed in Fig. 2.3.
India is the land of diverse agro-ecologies and produces a number major and minor agri-based commodities. In terms of diversity of agro-ecologies and the potential for producing a cafeteria of agri-products, India is uniquely placed in the world and is incomparable.

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. These commodities vary in terms of their importance for food, feed & fodder, clothing as also 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							

Figure 2.1 Composition of Output (VoP) from field crops

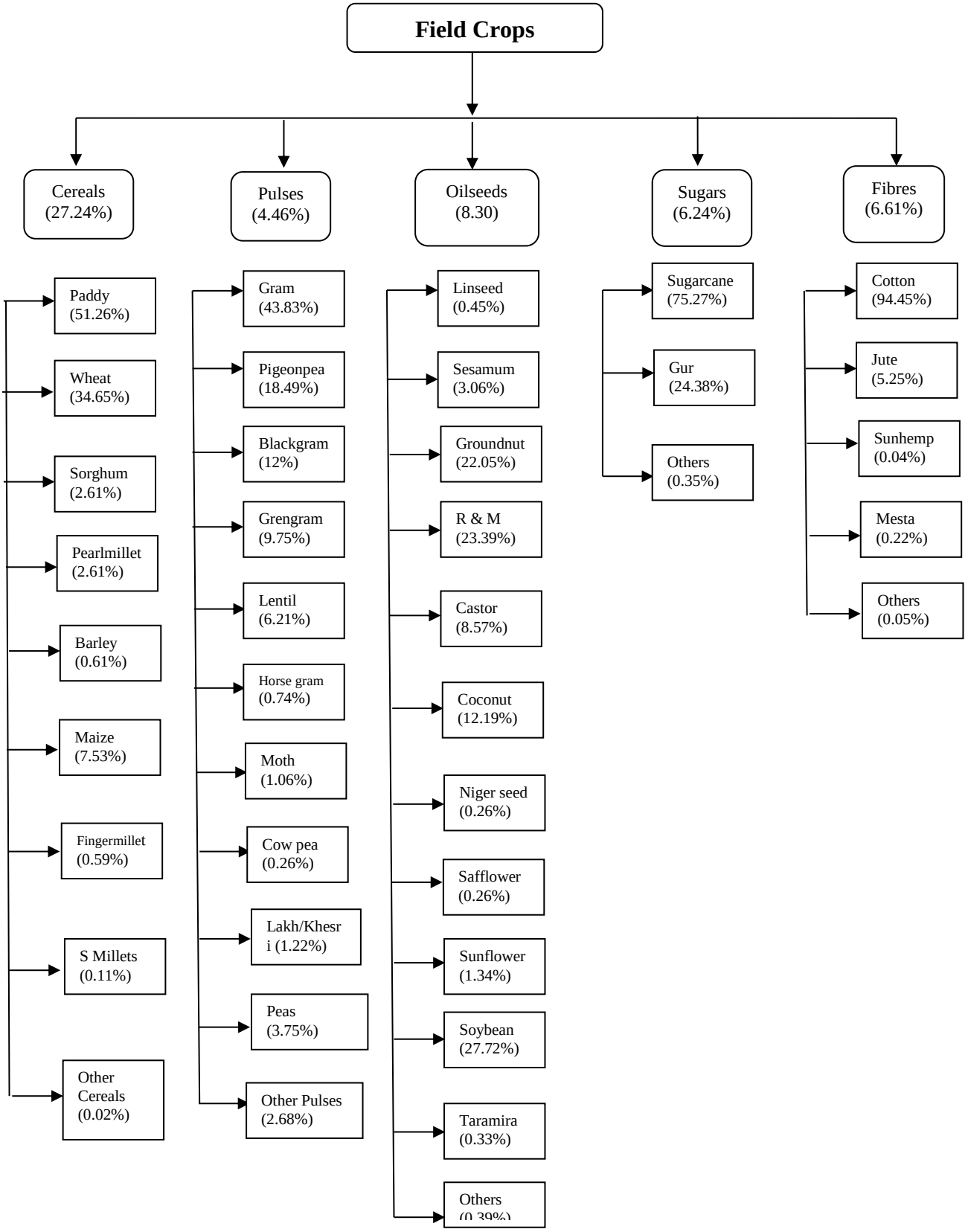
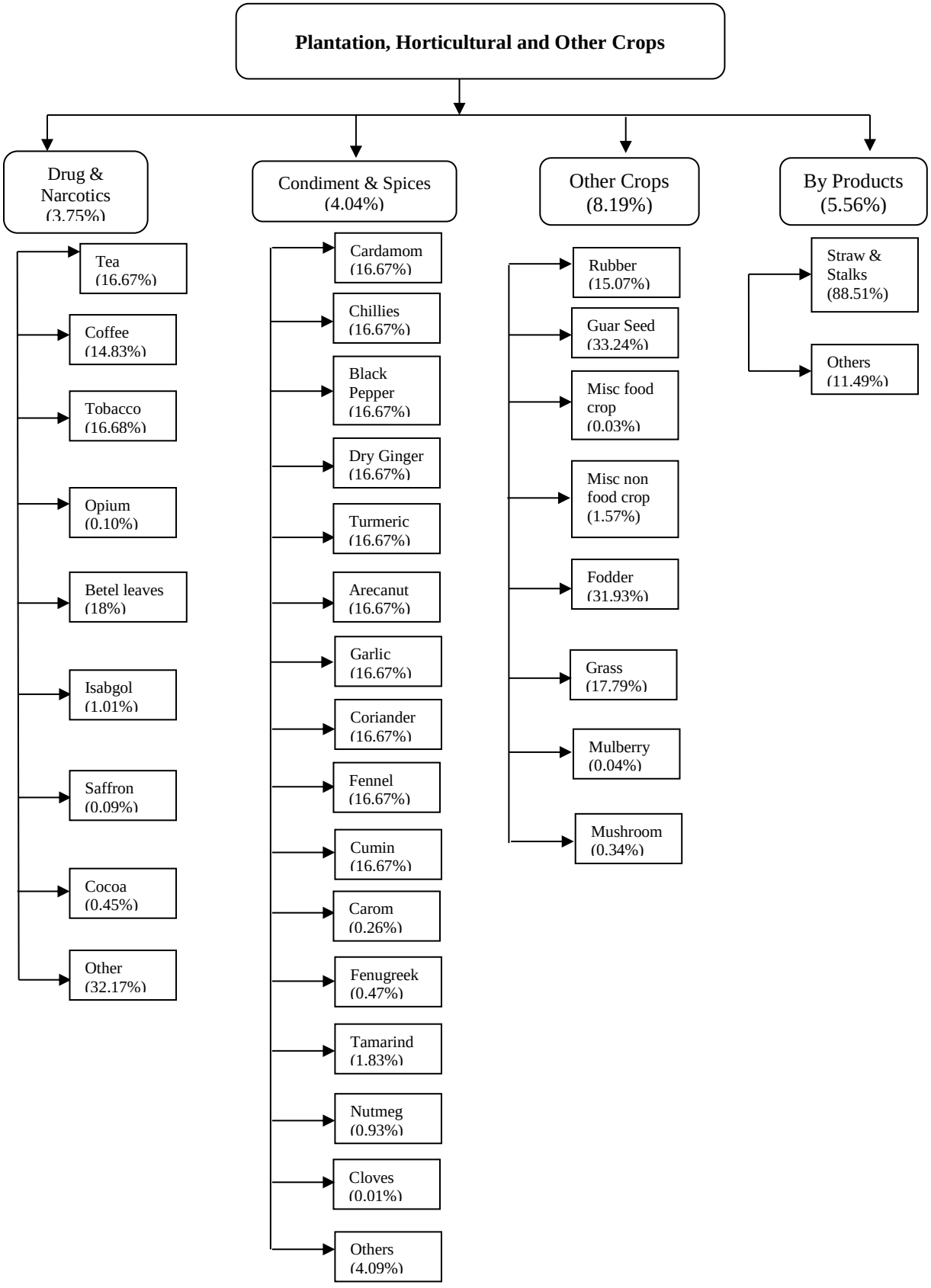


Figure 2.2 Composition of Output (VoP) from horticulture and other crops



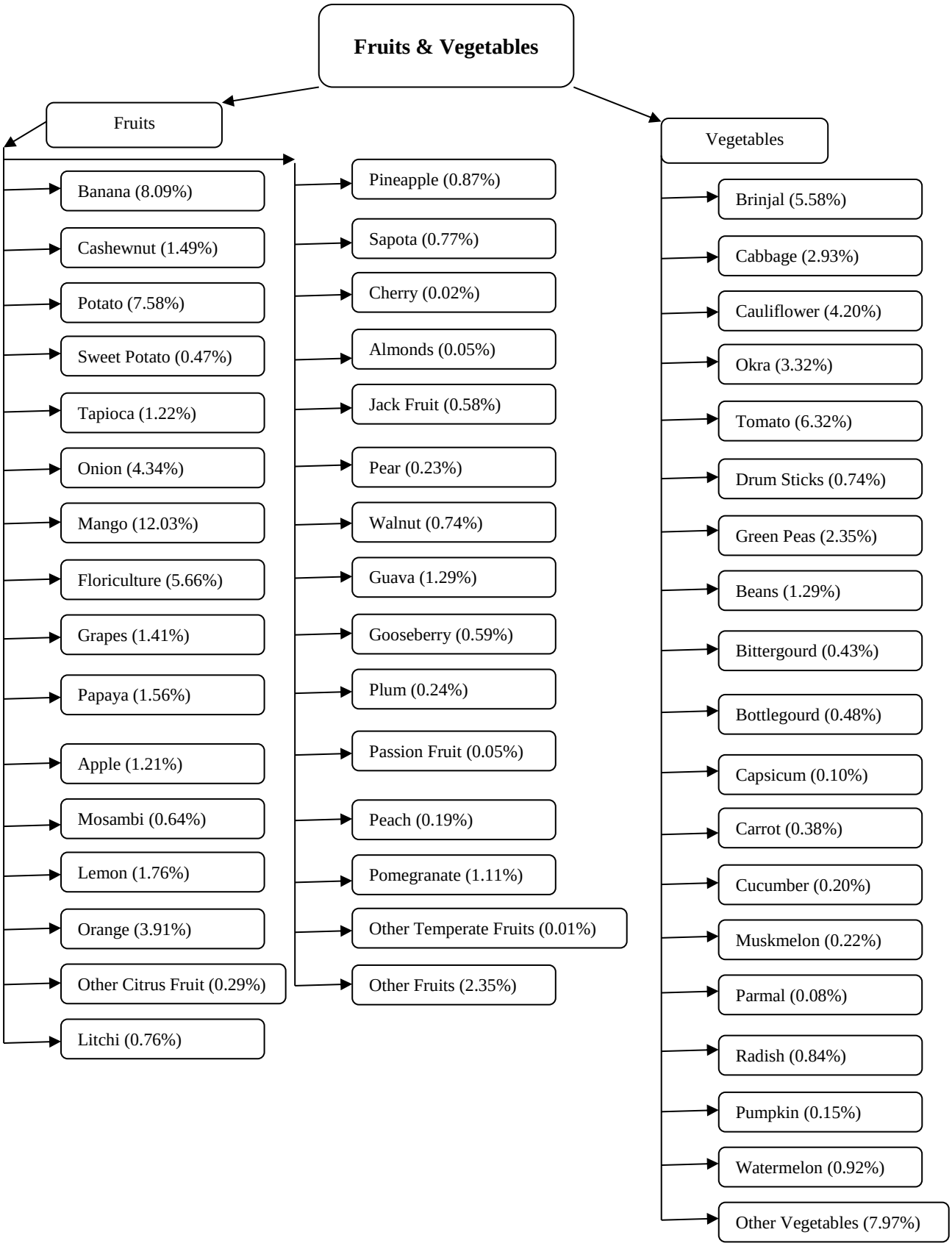
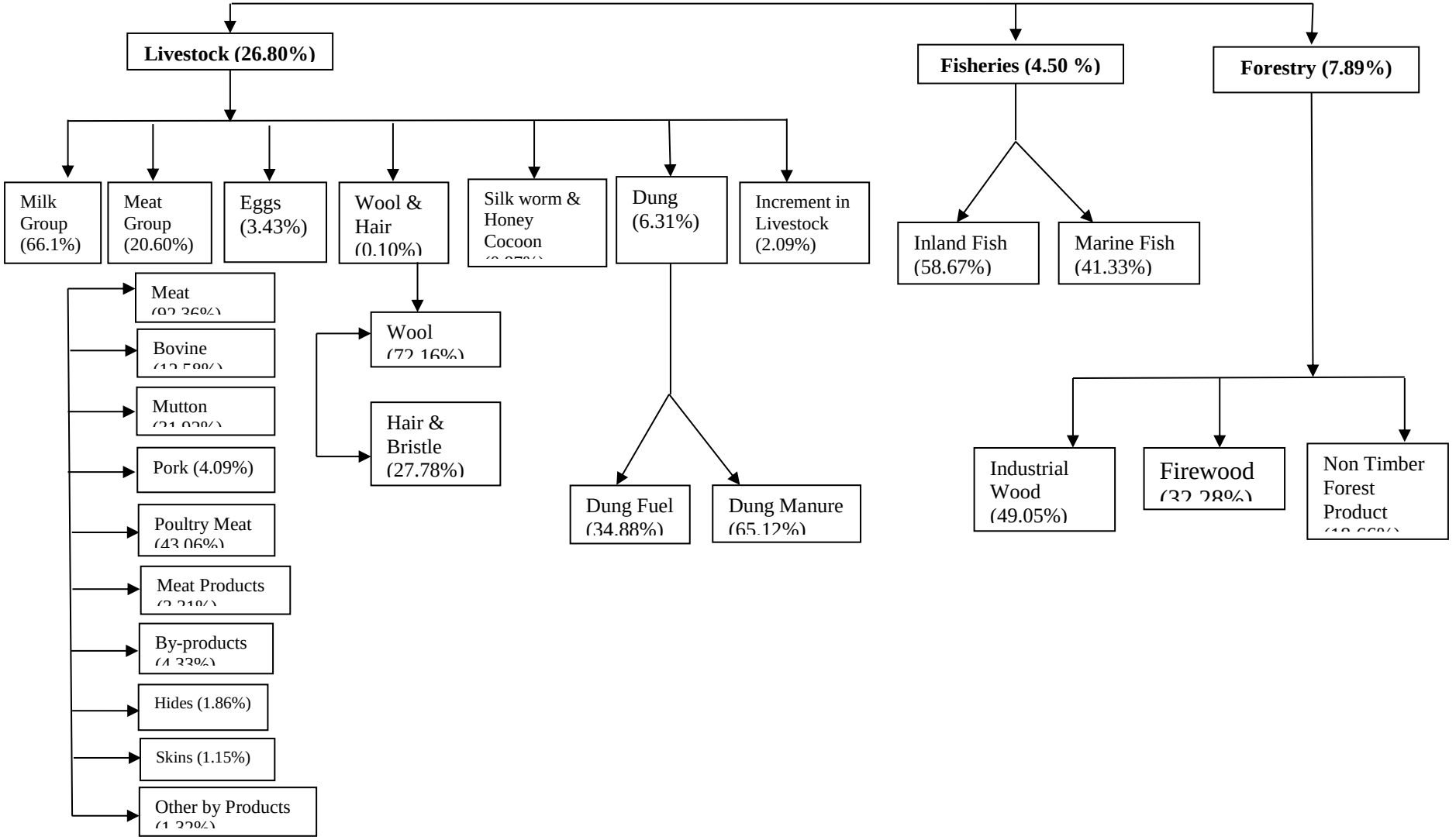

Fruits & Vegetables
Fruits
Vegetables
Banana (8.09%)
Cashewnut (1.49%)
Potato (7.58%)
Sweet Potato (0.47%)
Tapioca (1.22%)
Onion (4.34%)
Mango (12.03%)
Floriculture (5.66%)
Grapes (1.41%)
Papaya (1.56%)
Apple (1.21%)
Mosambi (0.64%)
Lemon (1.76%)
Orange (3.91%)
Other Citrus Fruit (0.29%)
Litchi (0.76%)
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%)

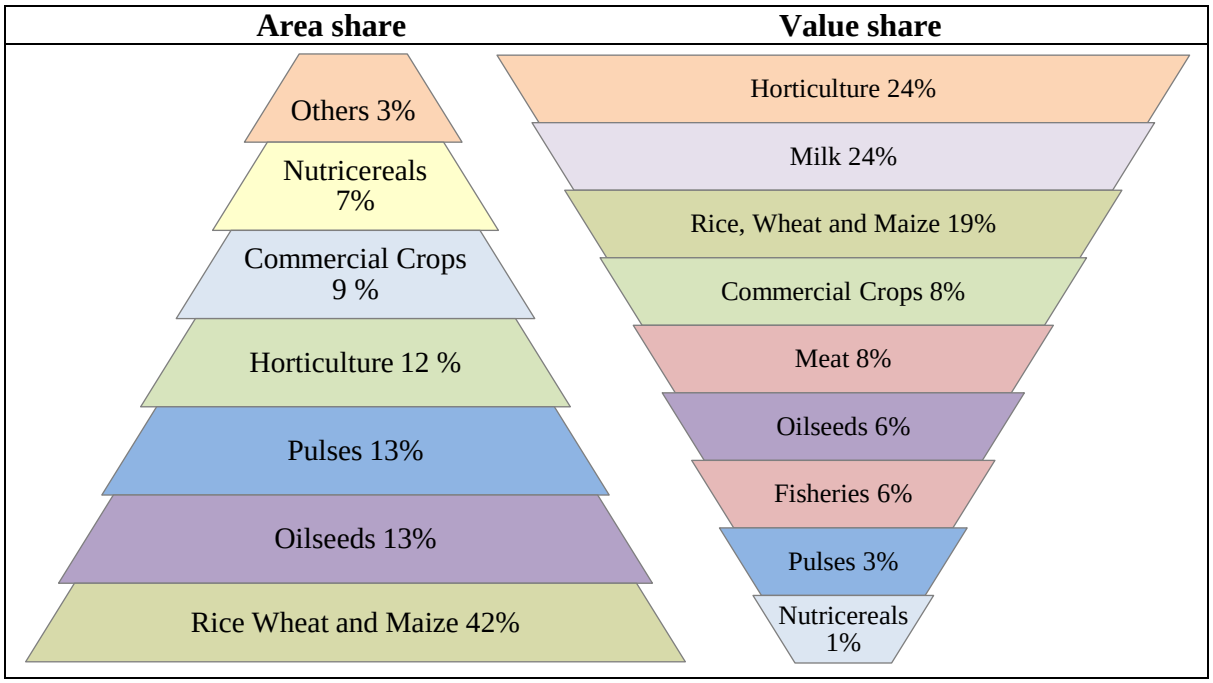
Figure 2.3 Composition of Output (VoP) from livestock, forestry and fisheries



Value of any agricultural produce is a manifestation of its demand, and the value realised from it depends on a number of factors. In some cases, demand is linked to administered and allocated prices, and in some cases the terms of trade many not be favourable, despite untapped demand, such as in the case of nutri-cereals (nutri-cereals were erstwhile called coarse grains). It would be worthwhile to evaluate the relationship between acreage and value and use this to plan future actions, to make the most of agricultural assets, outputs and markets.

Specifically in case of India, agriculture produces surplus foodgrains, which contributes vastly to food security; however, grains alone cannot assure nutritional security, as also the desired gains in farmers' income. The DFI Committee analysed the area used and value generated and no direct correlation is observed. As depicted in Box 2.2, the area & value pyramids show that in case of field crops, 42 per cent of the area under major cereal crops (rice, wheat and maize) contributes only 19 per cent in value; and in contrast horticulture with just 12 per cent of area contributes is 24 per cent to the value created.

Box 2.2 Area, Volume and Value Pyramids



Source: DFI Committee

2.3. Marketing Interventions

Price policy is an important instrument for providing incentives to farmers for motivating them to go in for production oriented investment and technology, and thereby plays a pioneering role in the economic development of a country. 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 before the sowing/planting time in respect of select crops raised in kharif and rabi seasons. The support

price is notified in the form of minimum support price (MSP). It is recommended to the Government by the Commission on Agricultural Costs and Prices (CACP) and the Government notifies it after due consideration. The MSP is based on cost of production with a certain margin of profit added to it, and serves as a price signal to the market. The intention of such a price signal was to assure the farmer that, in the event of markets failing to discover appropriate prices, and if there is a fall below the MSP, then the government shall enter the market to procure from the farmers. While this is in practice since 1971, prior to that and beginning 1965, government used to notify two separate prices, namely support price and procurement price. While support price served as a price signal to the farmer, procurement price was the one at which the government itself undertook procurement.

The government had historically stepped in to procure stocks regularly, mainly of paddy and wheat, for which there is robust procurement mechanism. Paddy and wheat have been integrated into the food public distribution system in which Government issues these commodities to state governments at a concessional rate. The state governments are free to add further concessions on this issue price. In case of pulses and others the procurement intervention has mainly been driven by market demand, under the price support scheme of the Ministry of Agriculture, and is therefore not as robust. While, under the National Food Security Act (NFSA) 2006, there exists the provision for the inclusion of other commodities like pulses, millets etc., as of now this is not in practice. Procurement of paddy and wheat and integration into PDS has created a sustainable cycle for the two.

On account of the subsidised issue price, not only does the central government bear substantive fiscal obligations, but market forces also stand to get distorted. The areas sown for the majority of crops, are influenced by the actual prices farmers realise for the previous crop and their price expectations from the crop in the coming season's market. The support prices should generally effect farmers' decisions, regarding land allocation to crops, however, the notified price is realised by farmers only where regular government procurement is made possible (mainly paddy and wheat), and this in turn became an influencing market force.

The three-pronged market intervention sketched above, combined with new cropping technologies for wheat and paddy, resulted in a total shift towards rice-wheat cropping and consumption since the launch of green revolution in the country. Between 1960s and 2010, wheat consumption of urban Indians almost doubled from 27 kg to 52 kg per capita per annum. However, this happened at the cost of consumption of traditional cereals like sorghum and other millets, reducing the average annual per capita consumption from 32.9 kg to 4.2 kg in the corresponding period. In result of this approach, the area under millets has shrunk by 23 per cent for pearl millets, 49 per cent for finger millets, 65 per cent for sorghum and 85 per cent for small (or minor millets).

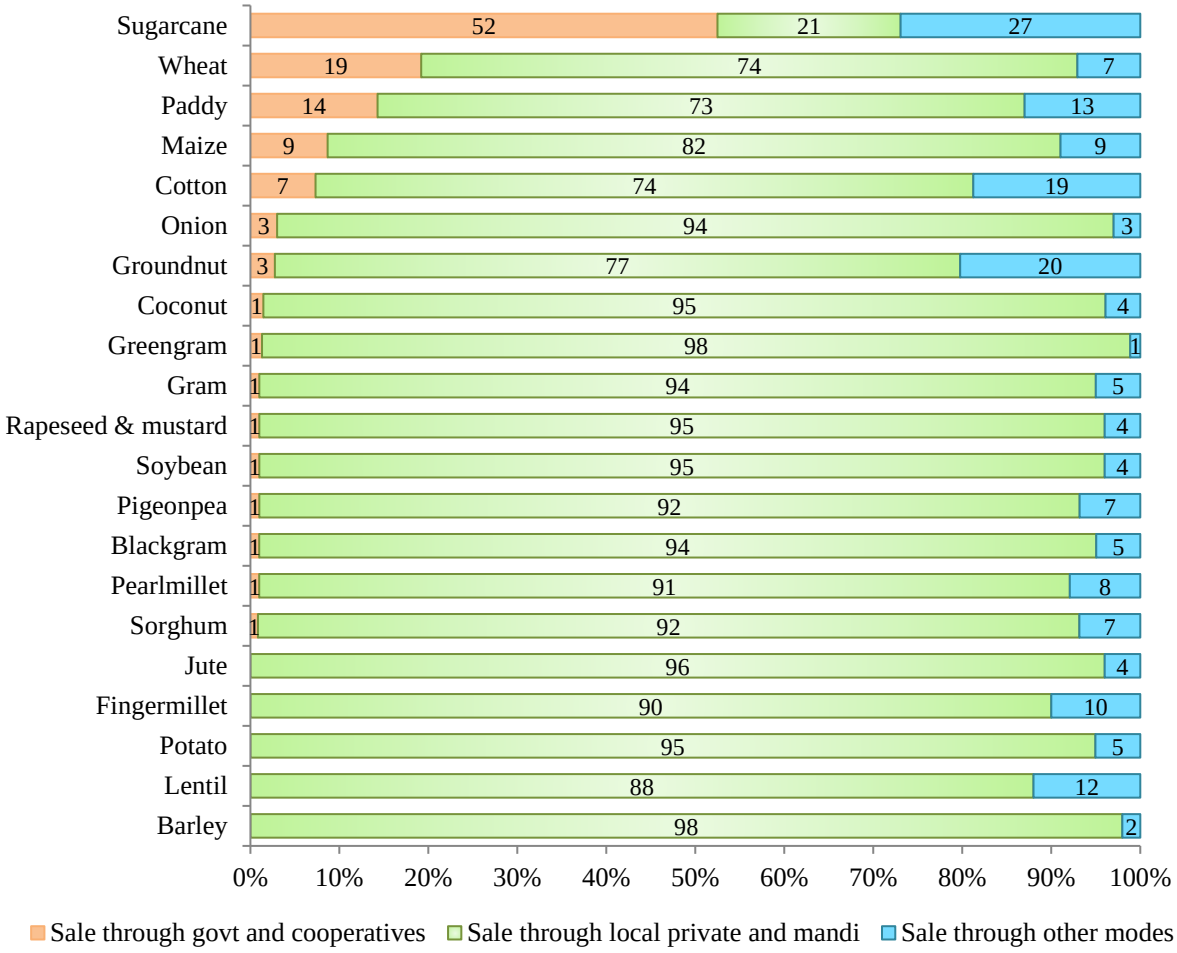
While it is generally believed that this dietary shift has been demand led, (since wheat and rice are perceived as superior to millets), studies indicate that the shift is significantly supply driven. The supply push has come from a higher MSP assured procurement, concessional rate of issue price and a systematic channelisation through PDS. The unseen consequence of this calorie-

dominant food security approach has been nutritional deficiency in the consumer. This is borne out by the latest findings of national family health survey conducted by NSS in 2015-16.

India fares badly in terms of Infant Mortality Rate (IMR), Maternal Mortality Rate (MMR), and anaemia among women in reproductive age. Nutrition related diseases like Kwashiorkar are high. To exemplify through a specific case, the NSS study shows that anaemia in women of reproductive age has increased in Telangana (part of erstwhile Andhra Pradesh) from 49.8 per cent in its first survey (1999-2000) to 55 per cent in its latest survey of 2015-16. There is clearly the need to revisit the strategy for demand and supply including PDS system (as well through ICDS, Mid-Day Meal scheme, etc.) for balancing the nutritional requirements and nutritional security of the country.

Marketing plays a crucial role in affecting the agricultural situation of a country. The major problem faced by farmers is where to sell the produce. In this context, the role of a selling agent is important and choosing between agencies is governed by several factors; price offered, being the primary. Crops sold through various agencies by farmers is shown in Fig 2.4.

Figure 2.4 Sale of different commodities through various agencies (%)



Source: DFI Committee Estimates based on NSSO (2014)

As observed, in almost all of the crops the majority of sale is through local private and mandis and only a few are sold through government and cooperative agencies. Only in case of

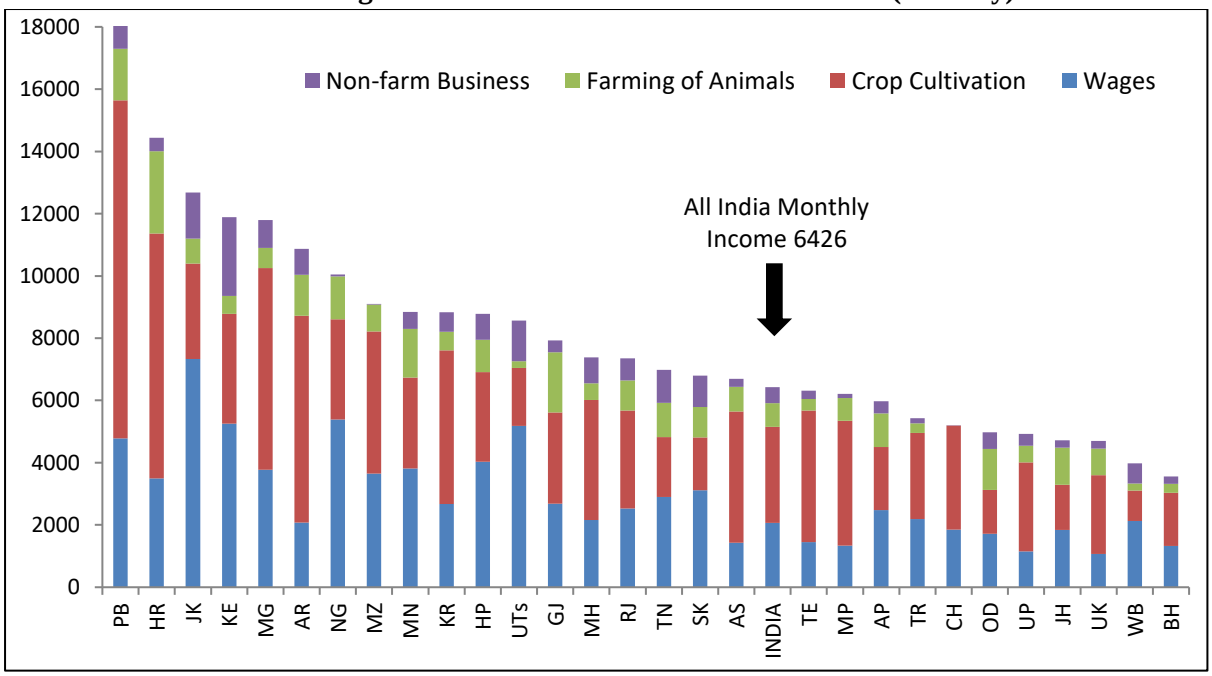
sugarcane, the majority of sale is done through government and cooperative agencies. The major crops like paddy and wheat whose procurement is governed and monitored through Food Corporation of India (FCI) also shows lower volume of sales through a government or cooperative agency in the country. This raises a question on the effectiveness of procurement.

Procurement of foodgrains at MSP is carried out by FCI. However, FCI operates in only certain states and selected districts, that initially had a surplus of foodgrains. The quantity to be procured is determined by the government's stocking needs and under the public distribution system. The role of FCI has evolved over time, from being an agency to procure food grains and distribute to states for the public distribution system (PDS), to one that is expected to be a device to maintain MSP rates by procuring whatever is offered. Over the years, FCI has encouraged decentralised procurement through the states, in preference to direct purchase. With this, the procurement zone has expanded to cover states like Madhya Pradesh, Odisha etc.

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

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

Farmers rely on multiple sources to secure their livelihood. As far as non-farm business and wages & salary 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 dominated by specialised horticultural and/or fishery products. These states need to develop a differentiated strategic framework. It is also noted that Chhattisgarh farmers derive their total income only from crops and wages; hence, the state would need to take this into consideration for preparing an appropriate strategic plan.

In Punjab, the state with highest farmer income in the country, the share in income among crop cultivation, farming of animals, wages and non-farm income stands at 60, 9, 26 and 4 respectively. In Bihar, the state with the lowest farmer income, the respective share of aforesaid income sources are 48, 8, 37 and 7. While these ratios will vary from state to state depending on local situation, on the whole, the desirable strategy should be to increase the share of income from farming sources (crops and animals). This is critical if farming is to be rendered more viable.

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).

Table 2.3 Real and Current Farm Income and Wage earnings of agricultural worker

Year	Per cultivator	Per hectare of net sown area	Per holding	Wage earning per worker
Real income (Rs.)				
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 (Rs.)				
2011–12	78,264	80,817	81,753	32,311
Growth in farm income (Rs.)				
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.

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 to 2004/05. A higher growth in farm income on per cultivator basis in 2004-05 to 2011-12 could be due to decline in number of cultivators, as estimated by NSSO from 16.7 crores in 2004–05 to 14.6 crores in 2011–12.

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 only agriculture, but the manufacturing sector also reflects a declining share in contribution to GDP. Despite a 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 from cultivation of crops is relatively higher in Punjab, Haryana, Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Uttarakhand while income from farming of animals occupies the larger share in Haryana, Gujarat, Odisha, Jharkhand and Andhra Pradesh. Surprisingly, Chhattisgarh is found to derive total income from crops and wages; thus the state needs to take this into 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 to take special attention and separate strategic framework for doubling income of farmers.
- As moving away from agriculture has been reported as an important factor for growth in farm income, the diversification in the sources of income like employment in non-farm sectors and earnings from wages and salaries, should also be the policy focus of the connected ministries of the government.

Chapter 3
Technology and Cultivation Practices

Various technology and cultivation practices are followed across states. There exist exigent challenges in terms of yield gaps and there is need to consider the contribution of total factor productivity (TFP) to bridge these gaps. This chapter also provides a 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.

3.1. Managing Yield Gaps

There exist large yield gaps in the 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 and the average farmer practices. 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.

An examination of the production portfolio of the country reveals that rice and wheat are the staple crops of India, and are viewed as important in terms of food security for majority of the population 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 this requires 28-29 per cent yield enhancement to achieve an average yield of 2.65 tonnes per hectare 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 via the higher productivity route. Despite many technological breakthrough, especially in rice and wheat crops, the crop yield realised at farmers' field remain considerably lower than the experimental yields demonstrated. 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 the states.

The yield gap in rice (percentage difference between state average yield and average potential yield of rice) was found to be highest 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%). The yield gap in these states was also found to be higher than the national average (30.8%). Thus, it means that these states possess a higher potential yield as compared to the existing average yield. If these yield gaps are addressed, it would significantly contribute to higher production.

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

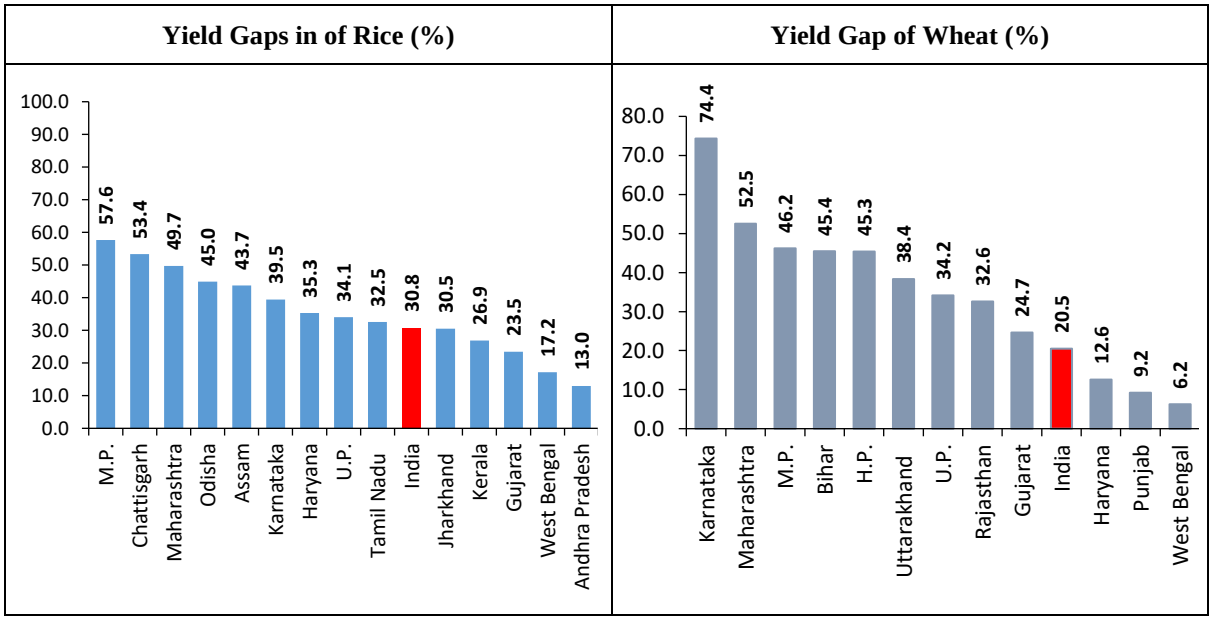
per cent of yield potential of wheat expressed by experimental yields, while Haryana has realized about 87.4 per cent of yield potential expressed by experimental yields conducted in the respective states.

Table 3.1 State-wise Yields- actual, experimental and gaps in rice & wheat (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)

Figure 3.1 State-wise Yield Gaps in rice and wheat 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 future production 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 for 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 exist considerable yield gap in nutri-cereals (coarse cereals earlier) 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 yield gap estimate for maize stands at 33 per cent in Andhra Pradesh, whereas it is higher at 45 per cent and 58 per cent in Karnataka and Bihar, respectively. In Rajasthan, the estimates stand highest at 63 per cent. Gap estimates for cotton stand 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 for 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.

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.

Nutri-cereals like jowar and bajra are barely irrigated in practice. Higher use of improved and hybrid seeds can help in bridging yield gaps. 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 yield that the hybrids and improved seeds provide are relatively higher, and thus could be thought of as a potential way of addressing the yield gap.

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 also show high yield gaps 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 the

period of 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).

A 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)**	Agriculture	1980-2008	1.90
	Pulses	1971-86	0.52				
		1986-00	-0.39				
	Oilseeds	1971-86	0.14				
		1986-00	0.33				
	Sugarcane	1971-86	0.79				
		1986-00	-0.1				

A study on change and efficiency of rice production in India by Suresh (2013) revealed that the mean TFP change for rice has been to the tune of 0.2 per cent per year during the overall period of 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. This is an area of priority for the present and future agricultural research.

Murali (2012) compared the productivity in the period of pre-introduction of the variety Co86032, with after introduction of variety Co86032. It showed that greater improvement in productivity was recorded after introduction of variety Co86032. The annual TFP growth over the whole period was 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 this variety.

This 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.

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. Table 3.4 lists the major determinants from studies conducted on TFP.

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 use of fertilizers and assured irrigation.

Most of the studies (Table 3.4) suggested that investment in public sector research is an important determinant for total factor productivity. They suggest 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.

Table 3.4 Studies on 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	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
Ramesh Chand, Praduman Kumar and Sant Kumar (2012). Total factor productivity and returns to public investment on agricultural research in India	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 (0.5per cent), chickpea (0.2 per cent). 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.

It is clear that India has achieved significant total factor productivity which enabled the nation to increase food production despite limited scope for increasing its cropland 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.

Table 3.5 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 by the governments at both central and state levels.

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 the contribution of the State Governments (Pal, 2017).

Table 3.5 Trends in Public Funding for Agricultural Research & Education (Rs. million)

Year	Centre	State	Total	Ratio of central funding to state funding
1981	730	893	1624	0.82
1982	873	1003	1876	0.87
1983	1019	1056	2075	0.96
1984	1175	1257	2433	0.93
1985	1319	1512	2831	0.87
1986	1425	1772	3197	0.80
1987	1622	2024	3646	0.80
1988	1719	2226	3945	0.77
1989	2046	2779	4826	0.74
1990	2513	3313	5826	0.76
1991	3172	3965	7137	0.80
1992	3429	4289	7718	0.80
1993	3644	4685	8329	0.78
1994	4270	5329	9600	0.80
1995	4956	6107	11063	0.81
1996	5349	6801	12150	0.79
1997	5651	8012	13663	0.71
1998	6846	8311	15157	0.82
1999	9820	10105	19925	0.97
2000	13029	10792	23821	1.21
2001	12989	12865	25854	1.01
2002	12743	12462	25204	1.02
2003	12990	13810	26800	0.94
2004	14356	13906	28262	1.03
2005	15883	14992	30875	1.06
2006	18751	17172	35923	1.09
2007	20658	19514	40172	1.06
2008	21806	23009	44815	0.95
2009	28227	26431	54658	1.07
2010	32073	31363	63436	1.02
2011	53831	36720	90551	1.47
2012	47293	43803	91096	1.08
2013	45097	50901	95998	0.89
2014	47263	61314	108576	0.77

Source: Pal (2017)

Table 3.6 provides the comparison of agricultural research funding for the year 2011-12 in 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 (Full-Time Equivalent) scientists in India, China has got around 43,000 FTE scientists.

Table 3.6 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 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; these include 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 (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 gross irrigated area in the country increased by 13 per cent between TE 2006-07 and TE 2014-15 (Table 3.7). Irrigation intensity, expressed as the ratio of gross irrigated area (GIA) to gross cropped area (GCA), increased by 9 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 of other states.

The country has steadily brought more land under irrigation. Between TE 2006-07 and TE 2014-15, area brought under irrigation in Madhya Pradesh alone was 3.5 million hectares, followed by Rajasthan (2.2 million ha), and Uttar Pradesh (1.5 million ha). Note, that around half of the total cropped area in the country lies in the states of Uttar Pradesh, Rajasthan, Madhya Pradesh & Maharashtra. Average areas irrigated in these states respectively during the TE 2014-15 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 3.7 State wise Irrigated Area

States	Gross Cropped Area (Th ha)			Net Irrigated Area (Th ha)			Gross Irrigated Area (Th ha)			Irrigation Intensity		
	TE 06/07	*TE 14/15*	*% Change*	*TE 06-07*	*TE 14/15*	*% Change*	*TE 06-07*	*TE 14/15*	*% Change*	*TE 06-07*	*TE 14/15*	*% Change*
Nagaland	391	496	27	66	91	38	106	99	-6	27	20	-26
Sikkim	123	142	16	12	13	6	16	13	-21	13	9	-31
Tripura	279	477	71	66	79	20	103	110	7	37	23	-38
Manipur	230	356	55	52	62	19	52	62	19	23	17	-24
Mizoram	95	125	31	15	15	2	16	17	8	17	14	-19
Odisha	8869	5136	-42	1976	1250	-37	2964	1495	-50	33	29	-12
Punjab	7886	7858	0	4040	4125	2	7683	7744	1	97	99	2
Jammu & Kashmir	1110	1165	5	311	326	5	457	496	9	41	43	4
West Bengal	9563	9589	0	3151	3094	-2	5541	5643	2	57	59	3
Arunachal Pradesh	264	293	11	50	57	13	50	57	13	19	19	2
Haryana	6441	6461	0	2960	3002	1	5447	5735	5	85	89	4
Maharashtra	22498	22915	2	3269	3245	-1	4090	4296	5	18	19	4
Uttar Pradesh	25415	25955	2	13169	14115	7	19042	20520	8	75	79	5
Tamil Nadu	5922	5677	-4	2815	2682	-5	3264	3232	-1	55	57	4
Goa	171	159	-7	24	38	58	39	38	-3	23	24	3
Rajasthan	21432	24769	16	6223	7677	23	7623	9830	29	36	40	10
Himachal Pradesh	947	941	-1	104	113	8	185	199	8	20	21	6
Uttarakhand	1219	1107	-9	345	332	-4	551	547	-1	45	49	10
Andhra Pradesh (with Telangana)	12897	13690	6	4242	4844	14	5684	6647	17	44	49	10
Gujarat	11520	12620	10	3891	4233	9	4774	5955	25	41	47	15
Bihar	7505	7677	2	3219	2991	-7	4389	5246	20	58	68	18
Kerala	2967	2611	-12	396	402	2	468	465	-1	16	18	11
Meghalaya	256	342	34	60	72	19	70	126	81	27	37	37
Karnataka	12757	12087	-5	2912	3522	21	3521	4102	16	28	34	21
Chhattisgarh	5731	5705	0	1246	1459	17	1391	1754	26	24	31	28
Madhya Pradesh	19974	23662	18	6029	9196	53	6205	9728	57	31	41	33
Jharkhand	1611	1628	1	106	211	99	150	231	54	9	14	58
Assam	3870	4086	6	140	307	119	152	375	147	4	9	130
ALL INDIA	**192074**	**197852**	**3**	**60937**	**67595**	**11**	**84037**	**94825**	**13**	**44**	**48**	**9**

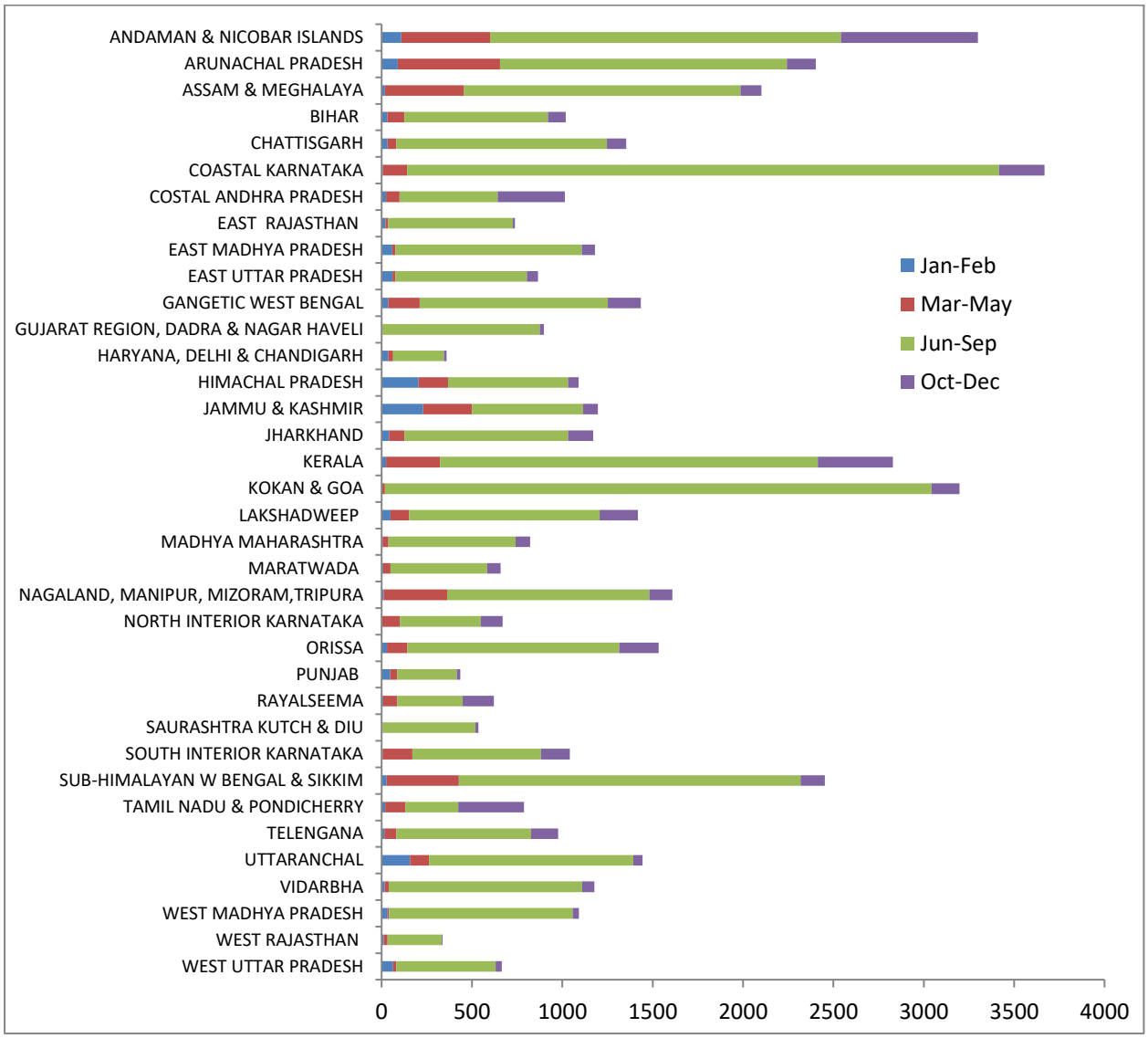
Source: DFI Committee Estimates based on data compiled from DACNET

The states has been sorted according to the change in irrigation intensity during TE 06-07 and TE 14-15

Between TE 2006-07 and TE 2014-15, irrigation intensity stagnates around 18%. Maharashtra has shown very little improvement despite a higher irrigation share, while Madhya Pradesh and Uttar Pradesh registered an 8 per cent and 3 per cent increase in irrigated area. Higher expansion has been realized in Bihar (10%), Karnataka (6.4%), Gujarat (6.1%) and Chhattisgarh (5.8%). Having less land under irrigation, these states also provide future opportunity to expand irrigation, with appropriate planning.

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 3.2), it is observed that in case of southern states of 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 creating comparatively higher irrigation potential, but have low rainfall intensity.

Figure 3.2 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

3.6. Utilisation 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 3.8. The irrigation potential across states (expressed as the share of ultimate irrigation potential) indicates that the states have created the potential ranging from as low as 36 per cent in Assam up to 112.7 per cent in Rajasthan. An examination of irrigation

potential exhibits that, 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, 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 realise higher production efficiency.

Table 3.8 Irrigation Potential Created and Utilised across States

State	Ultimate Irrigation Potential (Th ha)	Irrigation Potential Created (IPC) as per cent of Ultimate Irrigation Potential (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 the output, the Government of India has been implementing Centrally Sponsored Scheme on Micro Irrigation. The objective is to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like drip & sprinkler irrigation systems 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, and 27 per cent in gram. At the same time, micro-irrigation resulted in water saving of 16 per cent in Lucerne, and 56 per cent in bajra and barley.

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 reveal that only 18 per cent of the potential area of 42.24 million hectares in the country is under minor irrigation (Table 3.9).

Table 3.9 Status of Potential and Actual area under Micro-irrigation in India as on 31 Mar 2015 (million hectares)

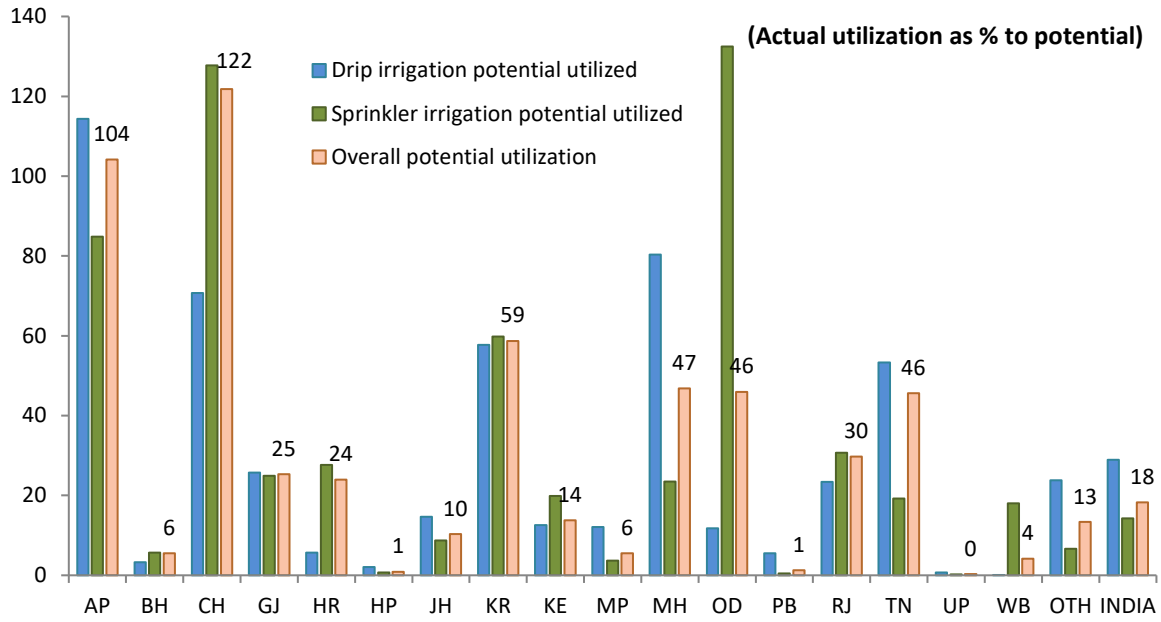
State	Drip Irrigation		Sprinkler irrigation		Total	
	Potential	Actual	Potential	Actual	Potential	Actual
Andhra Pradesh	0.73	0.83	0.39	0.33	1.12	1.16
Bihar	0.14	0.00	1.71	0.10	1.85	0.10
Chhattisgarh	0.02	0.02	0.19	0.24	0.21	0.26
Gujarat	1.60	0.41	1.68	0.42	3.28	0.83
Haryana	0.40	0.02	1.99	0.55	2.39	0.57
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)

Andhra Pradesh has utilized more than 100 per cent of the potential under minor-irrigation (Fig 3.3). As already highlighted in the preceding paragraph, micro-irrigation systems like drips and sprinklers would significantly increase water-use efficiency and productivity.

An impact evaluation study of National Mission on Micro-Irrigation (NMMI) reported that the irrigated area has increased in all the surveyed states after the introduction of NMMI Scheme. Maharashtra topped the list with 22.28 per cent growth in irrigated area, followed by Chhattisgarh. The scheme did well in reducing the input cost and resource saving. The irrigation cost reduced by 20-50 per cent with an average of 32.3 per cent. Saving of fertilizers with average reduction of about 28 per cent in total fertilizer consumption was reported in the surveyed states (Table 3.10).

Figure 3.3 Micro-irrigation Potential utilised across States



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

Micro irrigation has generated benefits to the farmers in terms of enhancement of the productivity. The average productivity of fruits and vegetables has increased by about 42.3 per cent and 52.8 per cent, respectively, mainly because of crop spacing, judicious use of water and other inputs etc. The detail have been elaborated in Table 3.10 and 3.11. The overall benefits accrued from the micro-irrigation system get reflected in the income enhancement of the farmers.

Table 3.10 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
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 3.11 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 3.12 provides evidence on the differences in yield and revenue in irrigated and unirrigated plots based on the plot level cost of cultivation data. The evaluation for gains in yield and revenue was done for major crops and results are discussed subsequently.

Paddy: States practising Irrigated paddy growing states have definite yield advantages. Among major paddy producing states, Punjab and Andhra Pradesh grow almost the 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 which has half of its area irrigated, with significant yield differentials. 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 the entire crop under irrigation, and hence, offer limited scope to expand irrigation based cultivation. While Madhya Pradesh has 91 per cent area under irrigation, Uttar Pradesh, Punjab, Haryana and Rajasthan have more than 98 per cent wheat area under irrigation. But yield differentials are high, with 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 seem to depend on factors other than irrigation.

Gram & Tur: Madhya Pradesh, Maharashtra and Rajasthan account for 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 respect of tur, its share of irrigation is almost negligible. Information from Maharashtra and Gujarat indicate 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 states offer high scope to expand irrigation, as substantive produce is from unirrigated farms. Irrigated area in largest maize producing states viz. Andhra Pradesh, Maharashtra and Karnataka stands at 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. The yields, that the irrigated farms produce, in these states produce 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. Although yield differential is not that large, expanding irrigation in Maharashtra could help in achieving higher production. While yield differential in Andhra Pradesh is not substantive, it is 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 3.12 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 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

Crop	State	Yield difference in quintal/ha (irrigate-unirrigated)	P-value	Revenue difference Rs./ha (irrigate-unirrigated)	P value	n(0)	n(1)
	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
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 geographical area and more than 17 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. Though the total water resource availability in the country may remain constant, the per capita availability of water is steadily declining due to population growth. Per capita per year 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.

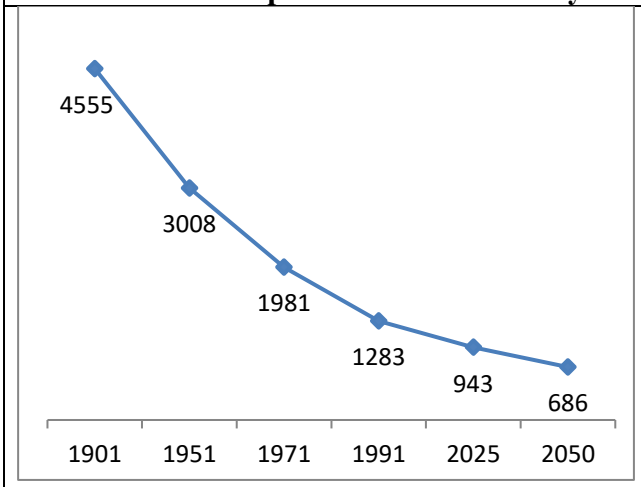
The water resource potential of the country has been assessed from time to time by different agencies. The different estimates are shown in Box 3.1. It may be seen that since 1954, the estimates have stabilized and are within the proximity of the currently accepted estimate of 1869 Billion Cubic Meter (BCM) which includes replenishable groundwater that 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 demands water for irrigation purposes. This requirement was estimated by NCIWRD 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 is estimated at around 75-85 per cent share in the total demand by the Standing Sub-Committee of MoWR. However, NCIWRD estimates are based on the assumption that the irrigation efficiency will increase, and thus demand share will be slightly lesser at around 70 to 80 per cent (Table 3.13).

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 3.13 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 only provide an idea about the projected requirement of water for irrigation in the changing climate and circumstances; and 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. 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. And the reach of hybrids is however much limited. Just 2 per cent of paddy and wheat growers use hybrids. In turn, adoption improved and hybrid seeds 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 them in the remaining 90 per cent space. Around 63 per cent of the jowar growers use improved varieties, whereas 37 per cent use seeds of local varieties (Table 3.14). A greater spread of hybrid seed use is possible in millet growing areas, to benefit farmers in gaining higher yield and potentially higher income. Among pulses, tur offers scope to adopt hybrid and improved seeds, and among oilseeds, groundnut provides some chance.

Table 3.14 Seed use (%) among Farmers in the country (2011-12 to 2013-14)

Crop	Hybrid &Improved	Local	Total	Sample Size
Paddy	87	13	100	12164
Wheat	91	9	100	6222
Jowar	63	37	100	409
Bajra	89	11	100	959
Maize	77	24	100	1361
Gram	79	20	100	961
Tur	59	41	100	694
Groundnut	78	22	100	625
Rapeseed & Mustard	88	12	100	1494
Soybean	94	6	100	1361
Sunflower	86	14	100	42
Jute	97	3	100	351

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, with use of seeds of improved

varieties dominating. Odisha has higher use of local seeds to the extent of 10 per cent. Since there are less hybrid varieties for wheat, almost all the states use improved seeds in its cultivation. An exception is Rajasthan, where 16 per cent of wheat growers use hybrid seeds and 26 per cent growers use local seeds.

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 use of hybrid seeds.

Except for Andhra Pradesh, Tamil Nadu and Madhya Pradesh, hybrid seeds use is marginal 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 on other seed types. Karnataka and Bihar depend on improved seeds for growing maize, about 95 and 63 per cent, respectively.

Gram offers better scope to shift from traditional seeds to improved seed type. Barring Madhya Pradesh, which produces almost entire gram using improved seeds, use of local seeds are relatively higher in rest of the states, particularly Rajasthan. Highest among all, around 10 per cent of the farmers in Andhra Pradesh use hybrid gram seeds. Similar pattern exists for tur (Table 3.15).

Table 3.15 Seed use across States (%)

Crop	State	Hybrid & Improved	Local	Sample Size
Paddy	West Bengal	98	2	2394
	Uttar Pradesh	100	0	913
	Andhra Pradesh	92	8	926
	Punjab	100	0	434
	Odisha	90	10	1732
	Bihar	97	3	1027
	Chhattisgarh	100	0	423
	Tamil Nadu	100	0	739
Wheat	Uttar Pradesh	99	1	1366
	Punjab	100	0	639
	Madhya Pradesh	100	0	564
	Haryana	97	3	396
	Rajasthan	74	26	546
Maize	Andhra Pradesh	100	0	197
	Karnataka	98	2	182
	Bihar	63	37	124
	Madhya Pradesh	100	0	59
	Tamil Nadu	100	0	101
	Rajasthan	40	60	126
	Uttar Pradesh	100	0	51
Gram	Madhya Pradesh	100	0	273
	Rajasthan	47	53	143
	Maharashtra	82	18	285
	Karnataka	68	33	40
	Andhra Pradesh	57	43	54
	Uttar Pradesh	84	16	87

Crop	State	Hybrid & Improved	Local	Sample Size
Tur	Maharashtra	72	27	318
	Madhya Pradesh	63	37	27
	Karnataka	17	83	75
	Gujarat	51	49	79
	Andhra Pradesh	96	4	28
	Uttar Pradesh	76	24	93
Groundnut	Gujarat	81	19	243
	Tamil Nadu	97	3	93
	Andhra Pradesh	85	15	105
	Karnataka	67	33	60
Rapeseed & Mustard	Rajasthan	89	11	408
	Madhya Pradesh	100	0	36
	Haryana	99	1	146
	Uttar Pradesh	98	2	389
	West Bengal	97	3	259
	Gujarat	76	24	115
Soybean	Madhya Pradesh	100	0	577
	Maharashtra	100	0	625
	Rajasthan	47	53	148

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 from 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 states for the triennium 2009–10 to 2011–12 are presented in Table 3.16. 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 from 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 3.16). 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 3.16 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
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 3.17. 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 3.17 State-wise Actual and Normative ratio of NPK use (2009–11)

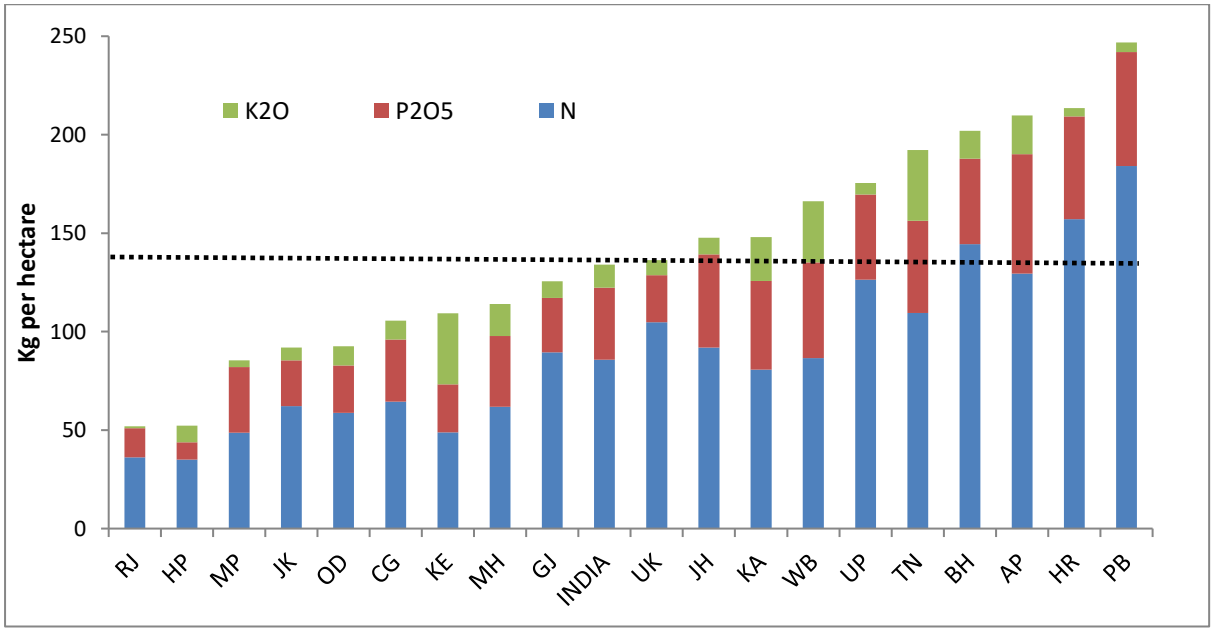
States	Actual Ratio			Normative Ratio		
	N	P	K	N	P	K
Andhra Pradesh	4.41	2.28	1	2.40	1.43	1
Assam	1.94	0.73	1	1.77	1.28	1
Bihar	6.79	1.95	1	2.81	1.50	1
Chhattisgarh	5.27	2.72	1	2.39	1.43	1
Gujarat	6.89	2.78	1	2.73	0.99	1
Haryana	19.55	6.87	1	3.99	1.67	1
Himachal Pradesh	3.00	1.02	1	2.48	1.29	1

States	Actual Ratio			Normative Ratio		
	N	P	K	N	P	K
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 for 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. Fig 3.4 shows fertilizer consumption per hectare of the gross cropped area in the major states.

Figure 3.4 State-wise consumption of Plant Nutrients per ha of Gross Cropped Area
(Biennium Ending 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. 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 specific to each state-region and there is need to attain state-specific optimum mix and use of NPK.

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 declined from 17.9 kg grain/kg applied nutrient during 1960-1970 (Table 3.18).

Table 3.18 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 is also significantly affected with increasing levels of nitrogen. The highest straw yield (5884 Kg/ha) observed was in response to application of 125 kg N/ha, followed by (100 kg N/ha).

Chatterjee *et. al.*, (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 2000 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. The soil health cards, provide information to farmers on nutrient status of their soil.

Table 3.19 Progress Report for Soil Health Cards: 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		**17,604,557**	**55,553,655**	**14,231,764**	**37,167,499**

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

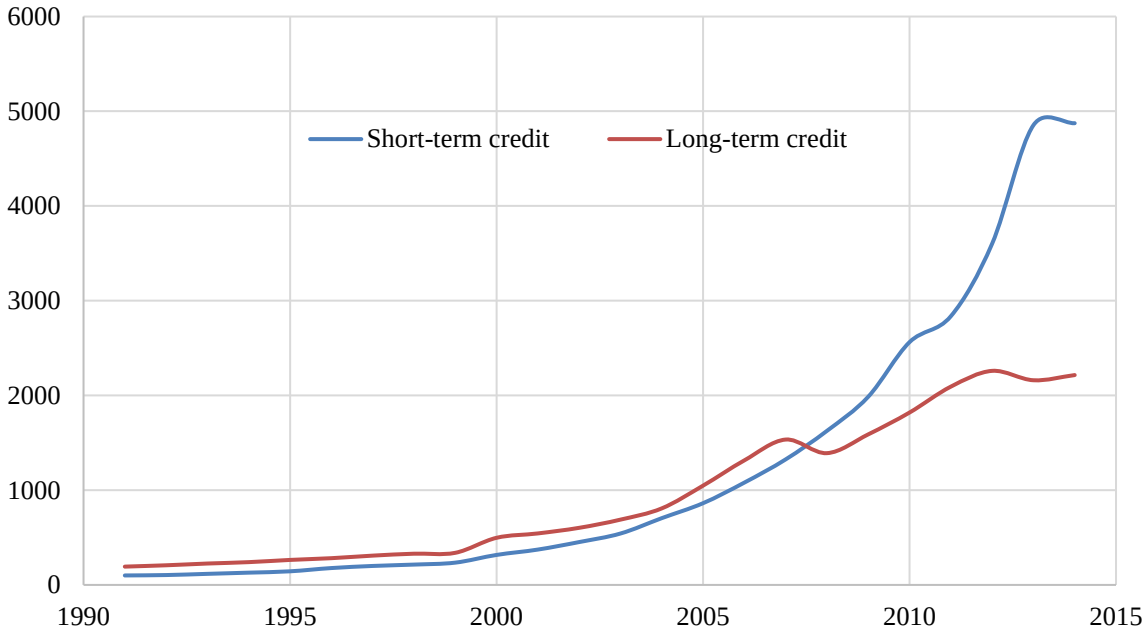
The southern region exhibits good performance in terms of number of sample targeted and number of sample tested, Andhra Pradesh achieved a target of 103.56 per cent. Gujarat, Maharashtra and Goa were good performers in western zone. Odisha and Bihar were identified as good performers in eastern zone.

3.11. Agricultural Credit in India

The positive role of credit in raising agricultural productivity is well known. While short-term loans are generally used for timely farm inputs to help reap better output, medium and long-term credit help in creation of farm assets such as deepening of wells and bore wells, purchasing of machineries like tractors, construction of post-production facilities and farm houses. In short, access to credit influences investment decisions of the farmers. Institutional credit has consistently increased over years.

The outstanding credit in agriculture and allied sector in the post-reforms period shows that both short-term and long-term credit has increased remarkably, especially since 2000s (Fig 3.5). Further, while long-term credit outstanding increased steadily 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.

Figure 3.5 Direct Institutional Credit in Agriculture (amount outstanding in Rs. billion)

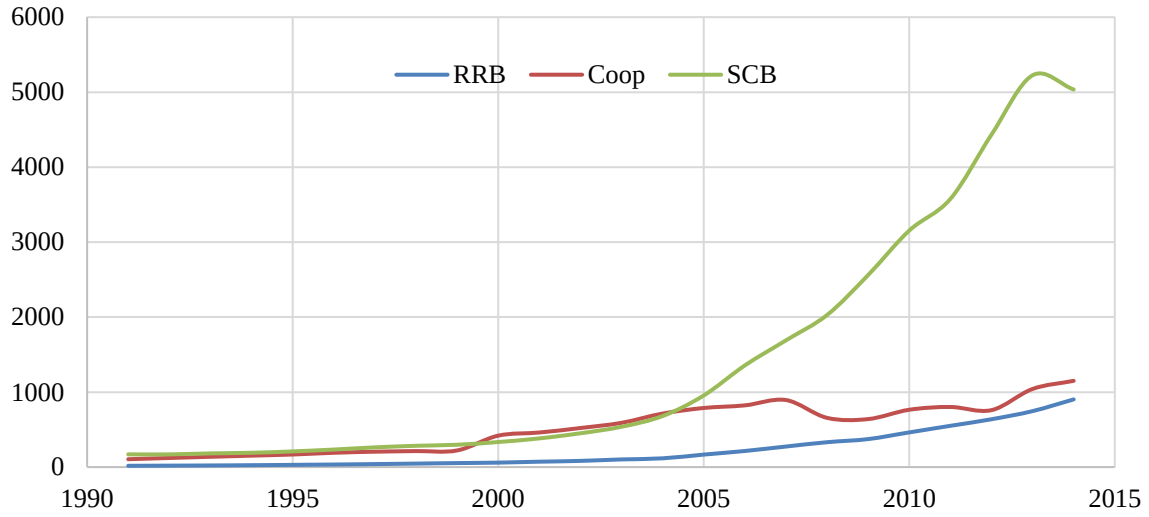


Source: DFI Committee Estimates

A glance at Fig 3.6 provides a brief trend in credit outstanding of different agencies in agriculture. The co-operative banks, regional rural banks and the scheduled commercial banks have been delivering both short-term and long-term credit to agriculture (Fig 3.7, 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

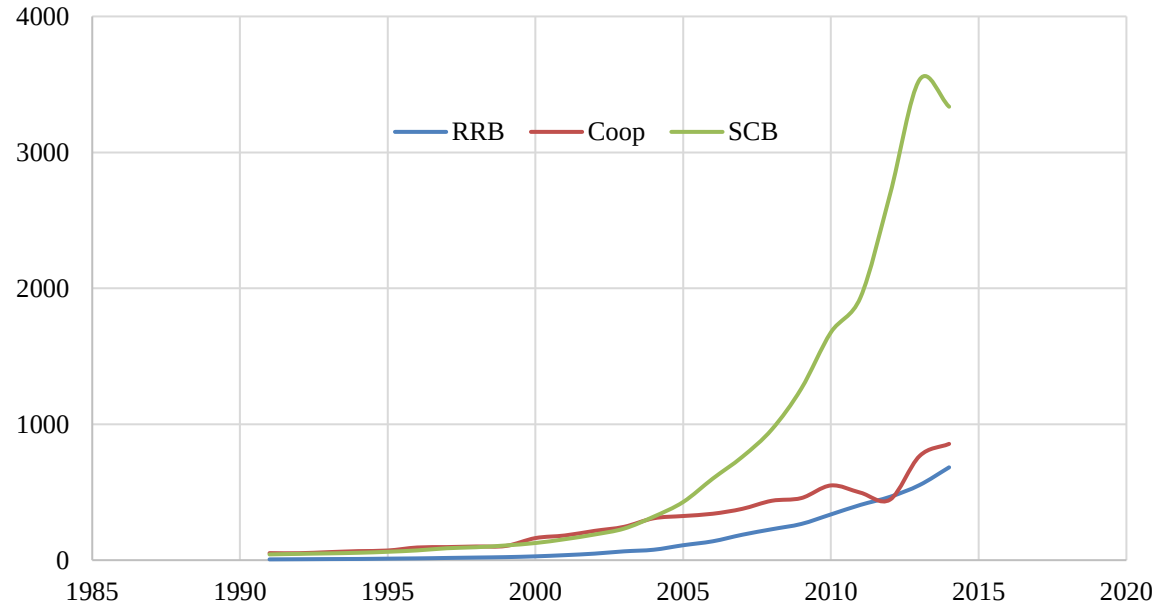
of credit to the farmers in creating both variable and fixed farm capital equally. The recent period has witnessed a remarkable increase in short-term credit over its counterpart. Though the predominance of commercial banks over the cooperatives and regional rural banks is encouraging, the inclusiveness 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.

Figure 3.6 Contribution of different agencies in Agricultural Credit Delivery (Amount Outstanding in Rs. billion)



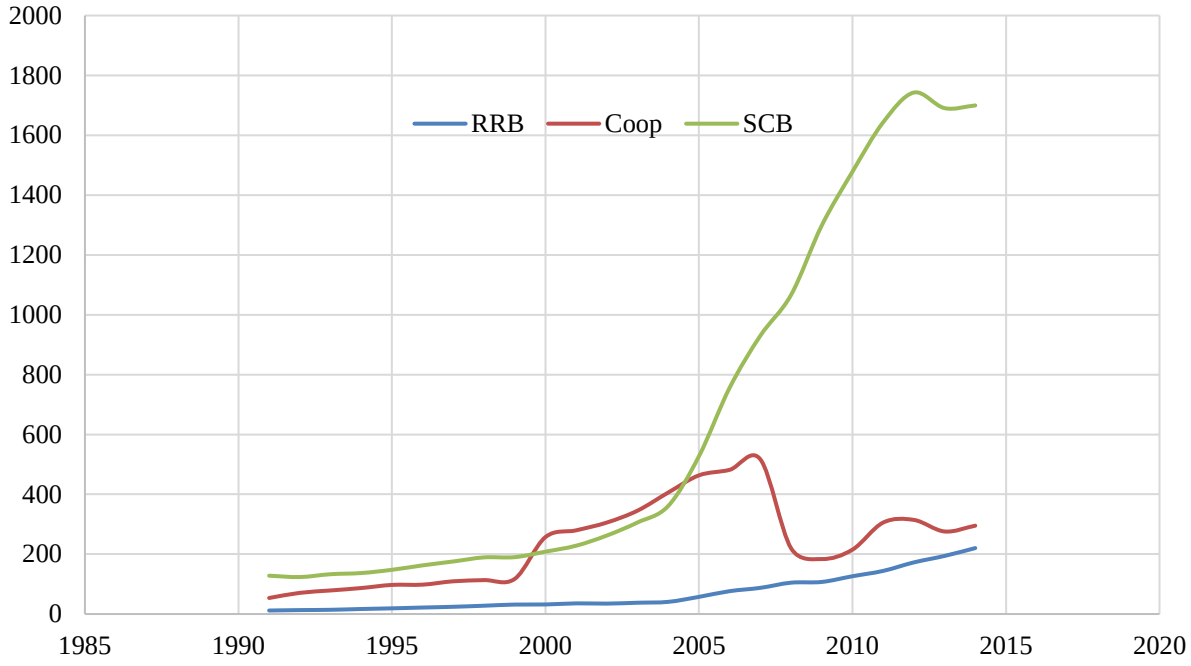
Source: DFI Committee Estimates

Figure 3.7 Contribution of different agencies in Delivering Agricultural Credit (Short-term Credit Outstanding, Rs. billion)



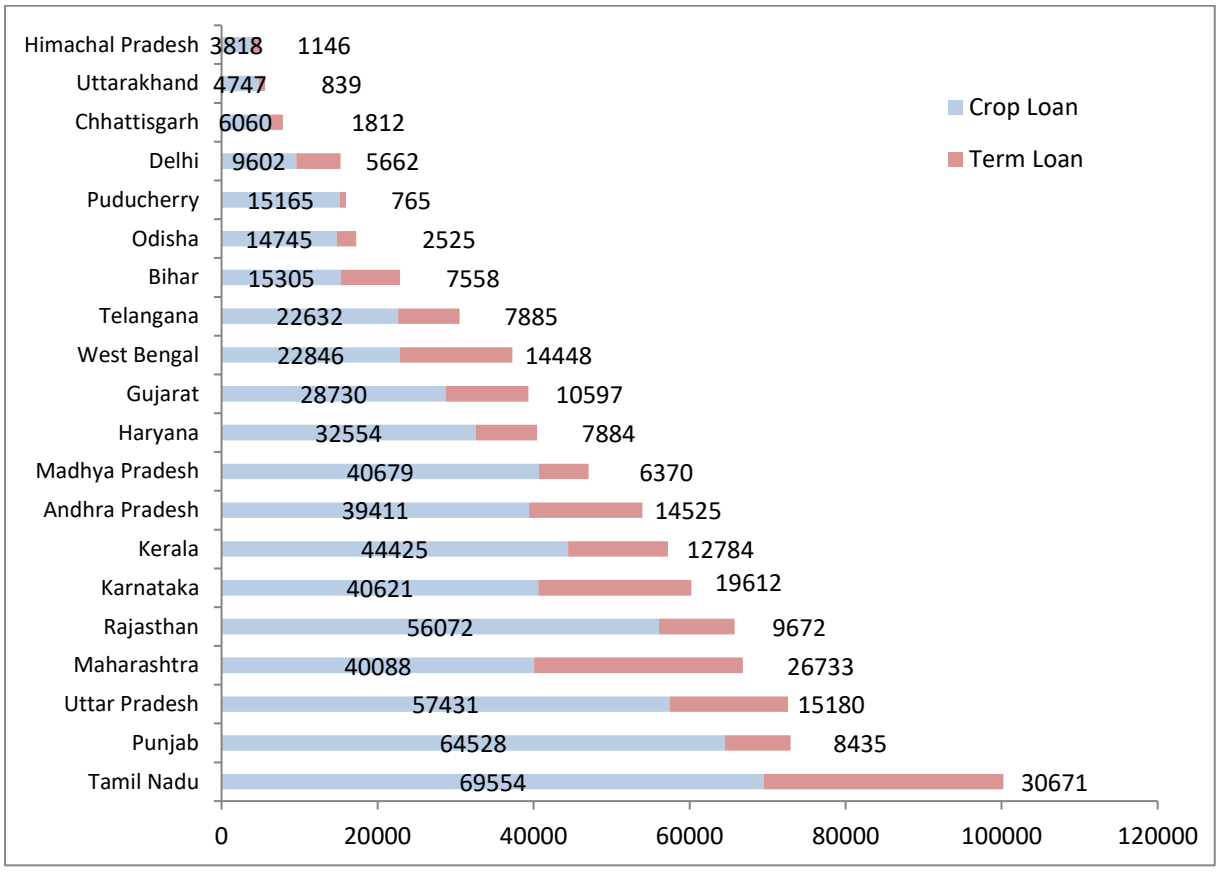
Source: DFI Committee Estimates

Figure 3.8 Contribution of different agencies in Delivering Agricultural Credit (Long-run Credit Outstanding, Rs. billion)



Source: DFI Committee Estimates

Figure 3.9 Distribution of Crop and Term Loans across States, 2014-15 (Rs. crore)



Source: Fertilizer Statistics

Government of India has initiated several policy measures to improve the accessibility of farmers to the institutional sources of credit; and 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 (KCC) Scheme during 1998, for hassle-free credit access for the farmers. The scheme enables the farmers to purchase agricultural inputs such as seeds, fertilizers, pesticides, etc., and draw cash to satisfy their consumption needs. The status of cumulative number of KCCs as on 31 October, 2015 and the outstanding loan amount is given in Table 3.20 below:

Table 3.20 Operative KCC accounts and Outstanding Amount as on 31.10.2015 (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 extent of farmers' access to credit can be assessed from the share of indebted agricultural households in a state. This is not uniform across states (Table 3.21).

Agricultural households in southern states appear to have high access to credit, with more than 75 per cent (Table 3.22) of the agri-households having taken credit. This share in the states of Andhra Pradesh, Telangana, Tamil Nadu, Kerala and Karnataka for the year 2012-13 was 93 per cent, 89 per cent, 82 per cent, 78 per cent and 77 per cent, respectively. The 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/-.

At the other end, households of Assam, Jharkhand, Chhattisgarh and Bihar appear to have poor access to credit. The share of indebted households in these states is 17 per cent, 29 per cent, 37 per cent and 42 per cent respectively, against the all-India average of 52 per cent. 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 3.21 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%). The figures in rest of the states are lower (Table 3.22). 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 3.22 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: Based on 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 made 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 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.

Recently, four states namely Uttar Pradesh, Maharashtra, Punjab and Karnataka, announced farm loan waivers in June 2017. As per the report, the Maharashtra government waived off loans amounting to Rs.30,000 crore owed by farmers owing upto five acres of land. 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 and concluded that,

i. it covers only a tiny fraction of farmers;
ii. 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;
iii. 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;
iv. loan waiving excludes agricultural labourers who are even weaker than cultivators in bearing the consequences of economic distress;
v. it severely erodes the credit culture, with dire long-run consequences to the banking business; and
vi. 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 have 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 per cent 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

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

2:8) are more 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 2014, 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 per cent. 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 per cent, water by 25-30 per cent

and nutrients by 25 per cent 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 per cent 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 10^{th} 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 per cent 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 > 75b per cent 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 @ 2 kg 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 extends 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 per cent 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

Infrastructure is important to trigger and sustain high growth of agriculture. This calls for higher Gross Capital Formation (GCF) in agriculture, besides in domain outside the sector, that include roads, electricity, markets etc. Hence resource prioritization is essential. An efficient market structure would enable the farmers to realise optimal remunerative returns on their produce and break the inverse relation between production and income. The condition of rural infrastructure (roads, irrigation, electricity and markets) in a number of states is a matter of serious concern. The studies suggest that basic infrastructure can improve the total factor productivity, and hence the need for suitable attention to GCF.

Studies show that in terms of impact on farm income, rural connectivity and logistics services hold tremendous importance. Besides delivering a host of other benefits, road connectivity has the potential to lower input cost, reduce post-harvest losses, and address issues related to gap between farm-gate price and consumer price. Approximately, 15 per cent of crop produce is

lost between the farm gate and the consumer, because of poor roads and improper storage facilities thus badly influencing the income of farmers (World Bank, 1997). Proper transport linkage is equally important. Availability of road network provides the basics to facilitate trade, transportation, social integration and economic development. Table 3.23 provides the status of national highways, state highways, rural roads and urban roads. Length of National Highways increased from 19,811 kilometres in 1951 to 70,93476,817 kilometres in 2012.

Table 3.23 Status of Road Length (as on 31.03.2013)

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
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
Puducherry	492	53	10.8	41	8.3	1219	247.8	948	192.7

Source: Ministry of Road and Statistics

Some of the states with immense potential to become leading agricultural producers in India are poor in terms of road infrastructure.

Table 3.24 Rural Electrification in India (as on 30.4.2017)

State	Total Inhabited Villages (Numbers)	Un-Electrified Villages (Numbers)	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
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)

India is home to around 35 per cent of the global population without access to electricity and only 44 per cent 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 3.24 gives an overview of the status of village electrification across the 27 states of India. Of these, 4 states have achieved 100 per cent village electrification as on the 30 April, 2017.

Well-organized marketing is essential for the development of the agricultural sector as the marketing system contributes greatly to monetisation of the farmers' agri-produce. An efficient

system of price discovery in a market can incentivise the farmers to make investments for higher productivity & production. The National Commission on Farmers (2007) had recommended that the facility of regulated markets should be available to the farmer within the radius of 5 km. This recommendation flows from the initial recommendation made by the Royal Commission on Agriculture (1928). Considering the critical importance of a robust agricultural market infrastructure and the vastly transformed transportation & communication infrastructure of the country, this subject finds contemporaneous examination and appropriate recommendation in Volume IV of this Report.

The total number of regulated markets in India as on 31.3.2014 was about 7000, 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 3.25 gives detail about the wholesale markets and rural primary markets in India; as also the status of their regulation. These are more than 2,400 principal markets and more than 4,200 sub market yards in the country. The number of regulated markets are 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 still 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 supply chain linkages. Farmers' income is closely linked to market infrastructure. Small and marginal farmers in particular require good market nearer their farming gates, with robust market linkages.

Table 3.25 Details of Wholesale, Rural Primary and Regulated Markets in different States/UTs (As on 31.03.2015)

	Number of Markets				Regulated Market			
States/UTs	Wholesale Markets	Rural Primary Markets	Total Markets	Total markets per lakh ha of GCA	Principal Markets	Sub Market Yards	Total Regulated Markets	Regulated Market per lakh ha of GCA
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

States/UTs	Number of Markets				Regulated Market			
	Wholesale Markets	Rural Primary Markets	Total Markets	Total markets per lakh ha of GCA	Principal Markets	Sub Market Yards	Total Regulated Markets	Regulated Market per lakh ha of GCA
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

This Committee reviewed the All India Cold-chain Infrastructure Capacity study undertaken by National Centre for Cold-chain Development (NCCD) in 2015. The study assessed the status and gaps in cold-chain, and informs that the country had already created 31.82 million tons of cold storage space as on 31.3.2014, almost 90 per cent of the overall capacity required with a current gap of 3.28 million tons in cold storage space (comprising Bulk storage & distribution Hubs). The Committee took note that there existed higher and critical gaps in other infrastructure needed for enabling the cold-chain to function as a medium that directly connects farms with markets. The status and gaps reported 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*

Since this study by NCCD, additional cold-chain capacity has been created in the country, though mostly as cold stores. However, cold storages are only one segment of the cold-chain, which should facilitate the smooth transfer of harvested value from farms to distant locations.

What needs to be borne in mind is, that mere creation of cold storage facilities would not probably serve this purpose; it needs to be coupled with other logistics support like pack-houses, reefer transport, ripening chambers, etc. to connect farmer and consumers more effectively. This subject is further discussed in detail in Volume-III of this Report. Lack of cold-chain denies the farmers the ability to reach out and connect with a large number of consumers. This lack of connectivity is the key cause that results in huge post-harvest losses of perishable agricultural produce.

In case of dry warehouses and godowns, the current capacity created 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 carried out for 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 required.

Table 3.27 informs about the number of registered factories in food processing sector for the year 2013-14 across various states in India. The states having large number of registered factories in food processing sector are Andhra Pradesh, Tamil Nadu, Telangana and Maharashtra. Punjab and Uttar Pradesh, which are the largest producers of food crops and milk are at fifth and sixth position, respectively.

Table 3.27 State wise distribution of Registered Factories in Food Processing (2013-14)

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

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

All states need to focus on upgrading food processing facilities, so as to maximise capturing all possible value from food production, bring greater market integration and organisation over time and enable farmers with access to assured demand for their produce. In addition, non-food processing industries will also require focus, so that agricultural diversification finds the needed forward linkages.

Key Extracts

- Notwithstanding many technological breakthroughs, the yields realised at farmers field are considerably lower than demonstrated yield. Yield gaps can be addressed by expanding irrigation, use of improved/hybrid seeds and better credit access.
- Access by marginal and small farmers to financial institutions needs special attention. Further, production efficiencies in different class of farmers in the 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 state-level norms for the optimum mix of NPK are at variance from the all-India average. Fertilizer promotion and policy should be state-specific and strive to attain area specific optimum mix and use of NPK.
- Millets, pulses and groundnut exhibit potential for irrigation expansion. Maize provides higher scope for irrigation followed by cotton, but sugarcane has limited potential as almost entire area is irrigated.
- Only 2 per cent of paddy and wheat growers use hybrids. The spread of hybrid seed in cereals and millet growing areas has potential to benefit from gaining higher yield. Among pulses and oilseeds, some crops show higher potential in adoption of hybrids.
- The condition of rural infrastructure (roads, irrigation, electricity & markets) in a number of states is a matter of serious concern. Farm incomes are a function of high agricultural growth. Infrastructure is important to trigger and sustain high growth, which entails enhanced Gross Capital Formation (GCF). Both public & private sector investments need to be channelized to strengthen and upgrade support infrastructure like roads, electricity, markets etc.
- Marketing infrastructure includes facilities that enable physical connectivity of farmers with markets, such as transport linkages integrated with assembly, aggregation and storage to maintain a state to steady supply to markets.

Chapter 4
Marketing, Prices & Trade

Marketing, price and trade dimensions have a vital role in doubling the income of farmers. This 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. The role of agricultural trade in enhancing income of farmers, along with a brief illustration of trade policy is also 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 in the agricultural sector, the country today is not only self-sufficient in food sector, but is also a net exporter of several agricultural commodities.

Various other interventions and policies led to a remarkable increase in the output of oilseeds, horticultural and livestock & fish products. Besides production 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 commercialisation of Indian agriculture, moving beyond its erstwhile status of a subsistence scale economic activity.

Larger marketable surpluses across crops and regions are being generated, reflected in higher marketed surplus ratios. The marketed surplus quantity depends upon the farmers' individual requirement of a crop, to be used for home consumption, seed and feed, besides losses in handling. The Marketed Surplus Ratio (MSR), expressed as the ratio of output marketed to output produced, is expressed in Table 4.1. The marketed surplus ratio for most of the crops has increased appreciably during last 16 years from 1999-00 to 2014-15. The increase was much more noticeable during 1999-00 to 2004-05. Among the foodgrains, maize is the highest marketed crop in India. The MSR is highest for cotton and some of the oilseeds due to obvious reasons.

The growing MSR clearly indicates the increasing commercialisation of Indian agriculture. This increasing commercialisation requires that equal impetus is given to putting in place the required marketing infrastructure and market network to ensure optimal returns to farmers.

Table 4.1 Marketed Surplus Ratio (MSR) and production growth of major agricultural commodities

	Production growth (2004-05 to 2013-14)	Marketed Surplus Ratio (%)		
		1999-00	2004-05	2014-15
I. Foodgrains: Cereals				
Rice	2.0	60.32	71.37	84.35
Wheat	4.3	54.48	63.33	73.78
Maize	6.4	62.79	76.22	88.06
Jowar	-3.8	46.83	53.44	66.64
Bajra	1.6	65.22	69.39	68.42
Ragi	-2.8	41.15	57.74	48.92
II. Pulses				
Arhar	1.1	62.93	79.52	88.21
Gram	6.5	65.63	93.76	91.10
Urad	4.4	80.91	85.76	85.56
Moong	4.6	70.13	76.79	90.65
Lentil	1.7	59.87	85.86	94.38
III. Oilseeds				
Groundnut	0.5	63.34	88.75	91.63
Rapeseed & Mustard	-1.1	71.57	89.66	90.94
Soybean	8	94.95	94.99	97.60
Sunflower	-12.3	99.3	98.32	100.00
Sesamum	1.3	84.45	87.38	93.80
Safflower	-26.5	86.8	91.34	100.00
IV. Other Commercial Crops				
Sugarcane	3.7	82.5	98.23	85.37
Cotton	10.3	94.58	94.94	98.79
Jute	1	97.5	90.72	98.59
V. Vegetables				
Onion	12.9	-	82.91	91.29
Potato	10.6	45.9	85	89.28

Source: DACNET & Agricultural Statistics at a Glance

Currently, marketed surplus data is available only 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 situations, if the market level surplus is also assessed and acted upon. 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 cultivation side 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 incentive and production signals to farmers, balancing the demand and supply of agricultural commodities and in ensuring efficient utilisation of agricultural resources.

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 being transferred to the farmer. In addition to this, the issues of poor produce handling, loss of produce, lack of scientific grading and storage facilities have also affected the efficiency of agricultural marketing in India. There has been large gap in the development of the storage infrastructure, transportation, mechanisation, grading standards, export promotion, processing industry support and market intelligence in India which requires upgradation.

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), legal provisions like the Essential Commodities Act (with various Control Orders thereunder); and creation of market infrastructure and institutions. However, the inefficiencies in the agricultural marketing system have continued to persist. Thanks to impressive growth in agricultural production and market surpluses across several commodities, a new approach is now needed in the marketing domain. This indicates the need to have policies that can readily and easily evolved and remain more contextual and relevant to current day situations. The underlying principle has to be competition based on agricultural liberalisation. Market Intelligence or the dissemination of information on market demand and availability is an important area which could play a significant role in farmers' decision making in respect of both production and marketing of agricultural commodities. As more marketed surpluses are generated, farmers will need to know which market to transfer their produce, what price to expect, availability of marketing infrastructure and status of competing supply.

Agricultural marketing in India has been facilitated through a network of regulated markets established under the APMC Act. The objective of such a network 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 having a number of intermediaries has resulted in high marketing costs, while the share of producer in consumer rupee is found 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 (Gulati, 2009).

It has been established that a higher share in final value 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; but infers the need to improve farmers' share in consumer price and need to minimise the chain of 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.

Table 4.2 Price Realisation (Rs./kg) 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

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

Table 4.3 Price Realisation (Rs./kg) 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 NSSO Unit Record Data on Situation Assessment Survey (2014)

In general, it is observed that 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.

The information would potentially be different for other types of produce, such as milk, fruits and vegetables, as these involve a different type of market access, network, production and selling cycles.

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 Realisation (Rs./kg) from Local Private Traders and Government & Cooperative Agency in different crops across States (July 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 NSSO Unit Record Data on Situation Assessment Survey (2014)

Table 4.5 Price Realization (Rs./kg) 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 NSSO Unit Record Data on Situation Assessment Survey (2014)

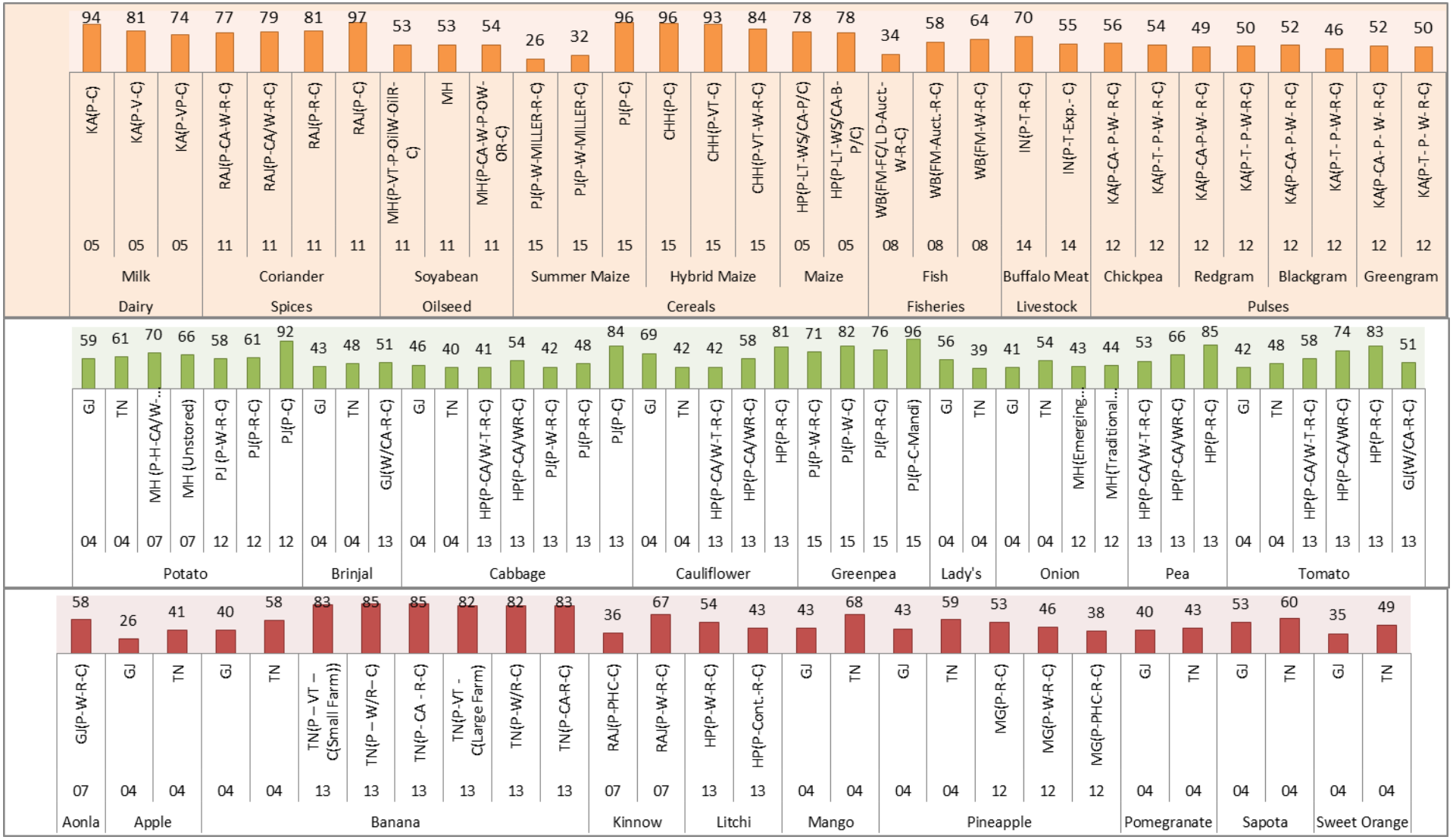
The price offered by local private agency is comparatively higher than the government/ cooperative price. In some states the difference between both the prices is much higher, as seen in case of paddy in Punjab and Maharashtra and *urad* in Kerala. However, situation is reverse in case of *jowar* and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

These statements may not however hold good uniformly across the country, indicating absence of market integration across the country.

4.4. Price Realisation: Meta-analysis of Available Studies

As deliberated, output growth alone will not drive sufficient growth for farmers; income growth will require efficient marketing arrangements so that production is submitted for optimal exchange. Many innovative marketing arrangements have shown that farmers' share can be magnified and marketing costs and margins of the chain can be managed efficiently. The meta-analysis of some studies conducted at regional level and published in various journals, evaluates the temporal and spatial evidence on price realisation across various commodities and regions. The summary results presented on this basis are presented in Box 4.1.

Box 4.1 Farmers' Share for Various Commodities, Channels, States and Years



Source: Compiled from various studies in Agricultural Marketing

The price realisation 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, within a given geography for the selected commodity. It is surprising to note that the farmers' share in onion remains lower, around 43-44 per cent. Banana trading seems to be more efficient as only 15-18 per cent of the consumer rupee is eroded in the marketing process.

The e-NAM (electronic National Agricultural Market) is the latest initiative rolled out by government to provide a platform to unify the country's agricultural markets. Such enhanced integration should benefit the farmers by bringing better price realisation through information connectivity and transparency. An ex-ante analysis may be conducted in those *mandis* which have already been connected through the e-NAM to evaluate the impact. Promoting private sector participation can bring in competition to greater benefit of farmers. Effective post-harvest management will yield not only in terms of increased availability, but also improve the physical connectivity of farmers produce with a choice of various market channels. The scenario is indicated by the situation of price realisation across commodities, states and over time. A detailed analysis needs to be conducted at national, regional and local level to present a realistic scenario status and decide on the most suitable strategies accordingly.

Price realisation by the farmer can be best computed from the price data on the Farm Harvest Price (FHP) available at state and district level and 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 most recent FHP at more disaggregated level like blocks/villages would be desirable.

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

The volatile behaviour of market prices for agricultural commodities creates the situation of uncertainty in crop and resource allocation for farmers. Frequent and rampant market volatility, as witnessed in India, is also due to the marketing system being ineffective in design and operations to manage even slight variations in supply and demand. Such ineffective systems add to inefficiencies, which are passed down to the weakest actor in the chain, the farmer.

A remunerative and stable price environment is essential for farmers; and the price policy of India, especially MSP 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 the participation of farmers. As paddy is one the major crops in the country in terms of production as well as consumption, the details regarding MSP awareness and price realised were examined based in the Situation Assessment Survey. It presents that only 32 per cent of the paddy growers in the nation were aware of MSP policy and only 27 per cent of total paddy sales were made at MSP.

Table 4.6 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 MSP. 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 in the state of Chhattisgarh, very little quantity is flowing through the cooperative and government agencies.

Table 4.6 Price received for paddy (Rs. per kg)

States	Agency					
	Local Private	Mandi	Input dealers	Cooperative & Government Agencies	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)

Over the last four and a half decade, the price policy implementation has boosted mainly wheat and rice crops among foodgrains and sugarcane and cotton among other crops (Chand, 2003). This did not leave resources for other crops, and created an imbalance in demand and supply of other important agricultural commodities like pulses, oilseeds and coarse cereals. In absence of an effective price support mechanism, in case of these crops, market prices often fall below MSP. Moreover, the trade policy works independently of MSP policy, to create disconnected supply variations, to the disadvantage of farmers. The current price and trade policy needs to be restructured to meet the existing challenges faced by the agricultural community.

In this context, the Shanta Kumar Committee Report on restructuring of Food Corporation of India (FCI), recommended that pulses and oilseeds deserve priority and Government of India (GoI) must provide better price support operations for them, and dovetail their MSP policy with trade policy, so that the landed costs of imports are not below the domestic MSP rate. Shanta Kumar Committee Report states that in 2012-13, only 6 per cent of total farmers in the country 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).

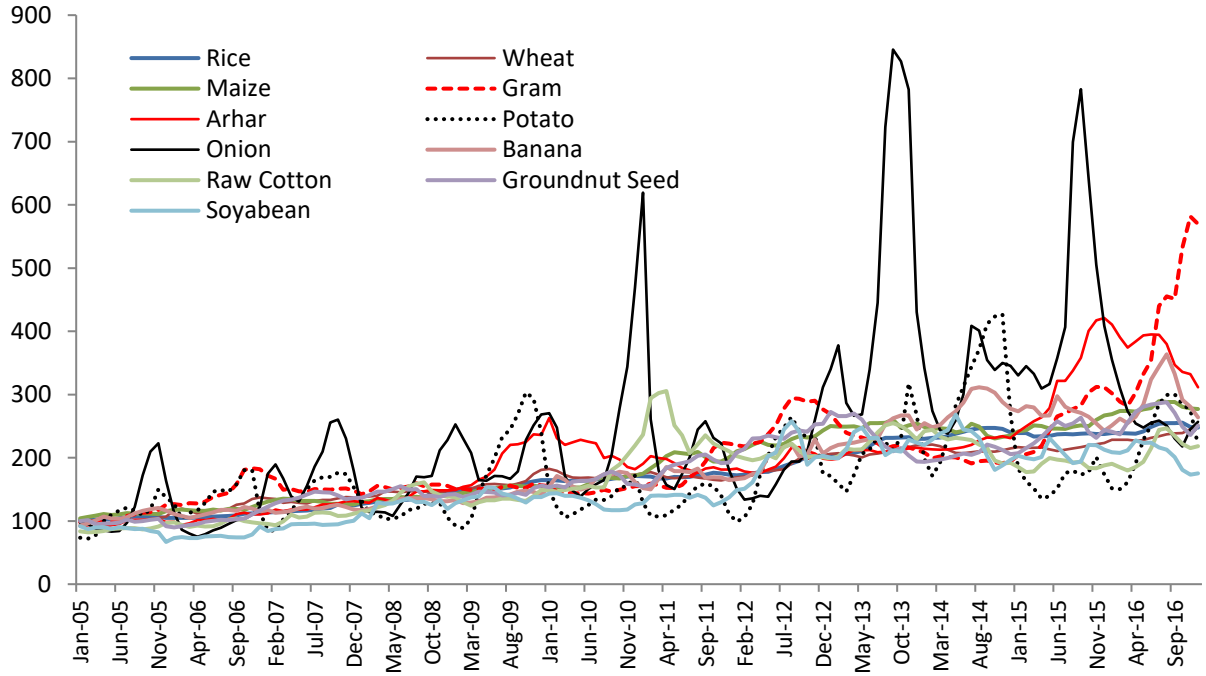
Reorienting the current price policy in an effective and sustainable manner can bring change in the agricultural price scenario. Various price support options need to be considered to buttress markets, assure market price to farmers, along with the development of infrastructural and market intelligence facilities for agriculture, to allow the farmer to transcend into a powerful market force in his own right.

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 persisted both 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. The prices of agricultural commodities have typically been more volatile than those of the non-farm commodities. Fig 4.1 reflects 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 Wholesale Price Index (WPI).

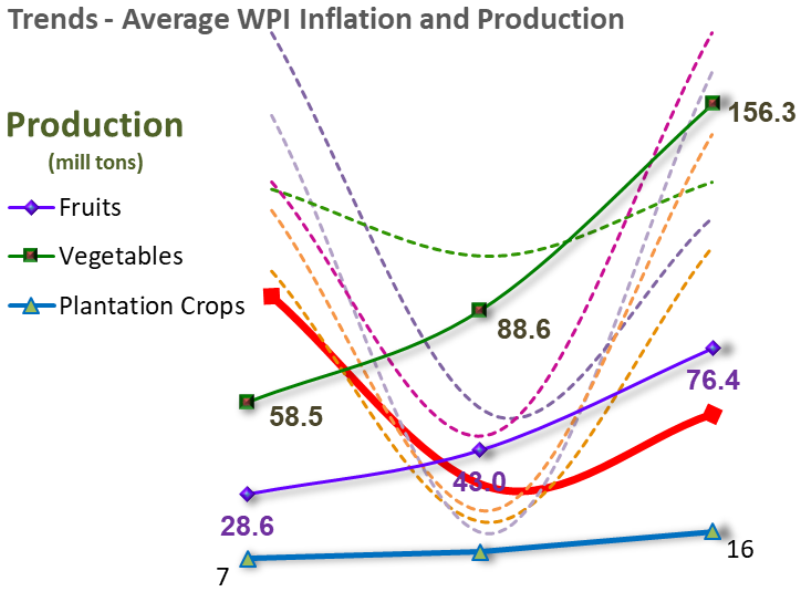
Figure 4.1 Trends in WPI of selected Agricultural Commodities



Fruits and vegetables exhibit the highest price volatility among various agricultural commodities. Some commodities in this category, like onion, have many a times created a crisis like situation due to 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 sharp falls, even within short time periods. Onion is viewed as a highly price sensitive commodity in the fruits and vegetables category, whose WPI touched the highest peaks of 619 in January, 2011 and 846 in September, 2013 and 782.8 in September, 2015.

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 shows the correlation in decadal trend of inflation rate (WPI and food items) with production of high value foods.

Figure 4.2 Inflation Trends and Supply Response



WPI	1982-83 to 1993-94	1995-96 to 2004-05	2005-06 to 2011-12
All Commodity	7.9	5.9	6.6
Cereals	8.2	5.6	8.5
Pulses	10.4	5.5	11.1
Vegetables	11.8	6.6	8.9
Fruit	9.3	8.4	9.4
Milk	9	5.7	10.1
Eggs, Meat, Fish	9.4	6.4	11.8

Source: NCCD analysis

Food is now the prime driver of WPI with perishable commodities contributing the highest. On the surface, the trend can indicate that demand for perishable produce continues to outstrip supply. Actually, the inflationary pressure is from a lack of efficient supply system – the existing logistics system, intended to function as a conduit to markets, is unable to cope rate of

growth in production. The inability to connect production with markets, feeds losses and results in a supply shortfall in the face of higher production growth, and in turn causes inflation in perishable food items. Continual demand for food distribution and agricultural logistics is foreseen over the coming decades.

The extent of volatility is also examined from Table 4.7, which also indicates that the major drivers of food inflation are the horticultural commodities mainly potato and onion which have shown a higher instability in prices in both the periods taken under consideration. Apart from horticultural commodities, gram in particular (among pulses) has shown an unstable behaviour in the prices in the later phase. Such volatile behaviour in agricultural commodities brings about frequent changes in price at consumer end and uncertainty of income at producers end.

Table 4.7 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, besides 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 is intended to safeguard the farmers from making a distress sale when prices fall to very low level in the event of a bumper crop. The scheme is implemented on the request of a concerned State government for a given commodity and the losses accrued from such an intervention 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 nations has remained an important economic activity and has played a significant role in the economic development of trading partners. Typically, geographical proximity is one of the major determinants of trade and also 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 one looks at the trade matrix of the country; cotton, cereals, edible fruits and vegetables and tea and coffee comprise the major share (Table 4.8). Growth in exports of most of agricultural commodities seems to be encouraging during the 2001-16 period. Meat and meat products witnessed the highest growth in this period.

Table 4.8 Trends and Composition of Agricultural Exports in India

Product	Exports (Billion Dollars)			Growth (2001-16)	Composition of Exports		
	TE 2003	TE 2010	TE 2016		TE 2003	TE 2010	TE 2016
Overall exports	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

More than 10 per cent growth in exports is also witnessed in products like cereals, rubber, plantation crops, fish, edible vegetables, dairy produce, wood and paper, cotton and sugar. However, the starting base is minimal and multi-fold opening of export markets has to be a top priority to empower the next phase of growth in Indian agriculture.

The major and regular agricultural imports in India comprise animal and vegetable fats and oil, edible vegetables and edible fruits and nuts (Table 4.9). 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 4.9 Trends and Composition of Agricultural Imports in India

Product	Imports (Million Dollars)			Growth (2001-16)	Composition of Imports		
	TE 2003	TE 2010	TE 2016		TE 2003	TE 2010	TE 2016
Overall imports	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

Source: *Computed from International Trade Statistics*

As international market may prove to be more lucrative for farmers, it was analyse how the unit value realised (UVR) from the trade vary in domestic and international markets. This is examined for one of the traditional commodities i.e. cotton and one for an emerging commodity i.e. bovine meat and the details are provided in Box 4.2. In case of bovine meat, the UVR realised from the domestic and international markets vary significantly. Thus, in case of carabeef (buffalo meat) international markets provide a lucrative situation to the farmers. Enhancing the exports of bovine meat may be gainful for 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 various products like raw cotton, cotton yarn, and other value added products. Cotton yarn (other than sewing thread, containing >= 85 per cent 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 corded nor combed is the other major product being exported under this category. The exports of cotton yarn do not seem to be particularly lucrative, 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 of 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

A 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 so as to concentrate efforts on the optimal products and 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 fulfil the commitments with foreign buyers. The gains from trade can further be enhanced by promoting networking among academic, research institutions and practicing organisations 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 have been

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 have long term impact on trade relations. 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 improves the fiscal budget of the country but also builds global competitiveness. A stable trade policy helps build 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 market linkages and infrastructure constraints have led to high and fluctuating consumer prices, and resulting in only a small share of consumer rupee reaching the farmers. In the case of fruits and vegetables this is as low as 20 per cent, reflecting 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 quite large, as seen in case of paddy in Punjab and Maharashtra and urad in Kerala. However, situation is reverse 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 crops among foodgrains and sugarcane and cotton in other crops. The prices of other crops often dip below MSP due to lack of effective market support mechanism for them. Moreover, trade policy also works independently of MSP policy, and many a time, imports of pulses happen at prices much below their MSP, disincentivising diversification.
- In the recent years, the issue of high price volatility in agricultural commodities in domestic as well as international markets 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 problem is absence of efficient supply systems which means supply failure in the face of large output, that in sequel feeds 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 Farmer Income and Climate 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 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 are done at district level in India. They used a 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.

This Committee compared the 150 districts which topped under very high vulnerability status category in their study, with the 150 districts having lowest income status of farmers as per NSSO-SAS survey, 2013. Fig 5.1 represents the proportion of districts within State/UTs which bear very high vulnerable to climate change and those that have low farmer income. Low income reduces the adaptive capacity of the farmers to withstand climate shocks and thus increases their vulnerability.

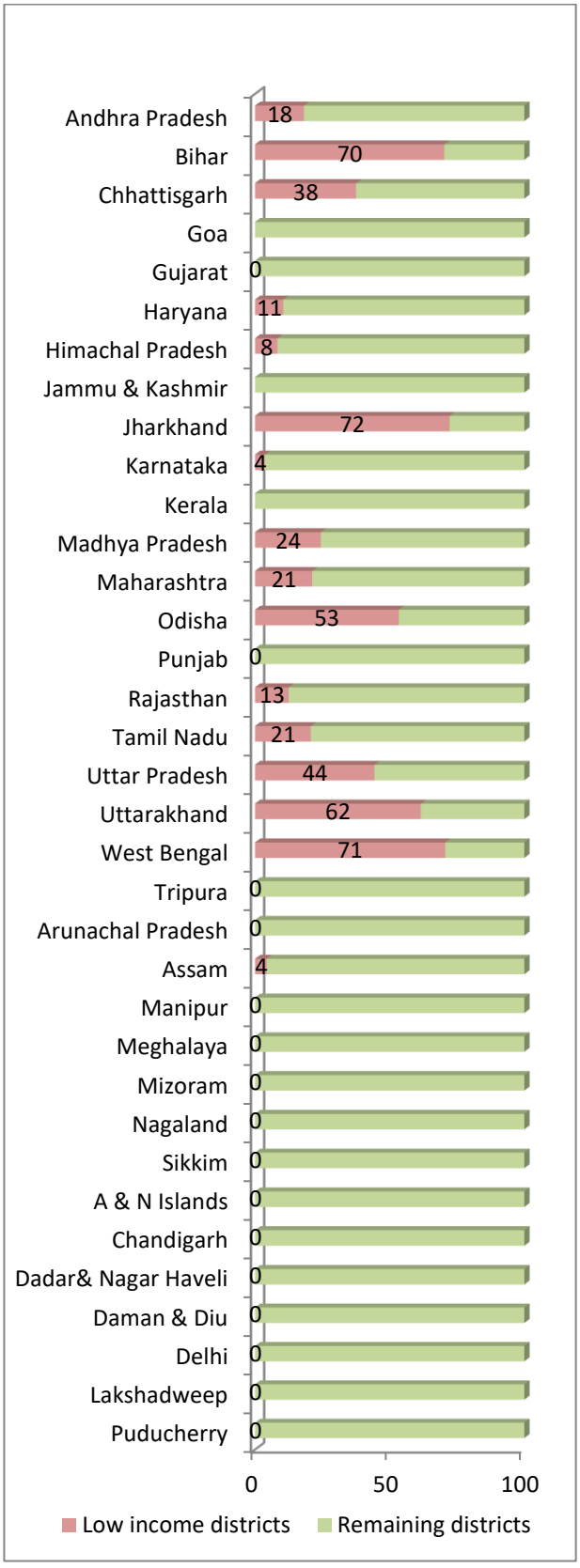
It can be seen that most of the districts with very high vulnerability status are in the state of Rajasthan. Interestingly, agriculturally developed states like Gujarat and Karnataka, where the proportion of districts falling under low farmer income category is zero and 4 per cent respectively (Fig 5.1) are also having major proportion of districts (around 60 per cent) under high vulnerability category.

With the exception of Daman and Diu where entire area is 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 climate vulnerability status, along with low farmers' income status. The situation seems to be more grievous in 33 out of 150 districts, which on the one hand are highly vulnerable to climate change, and on the other are agriculturally undeveloped, and fall in the bottom 150 having lowest agricultural income (Table 5.1).

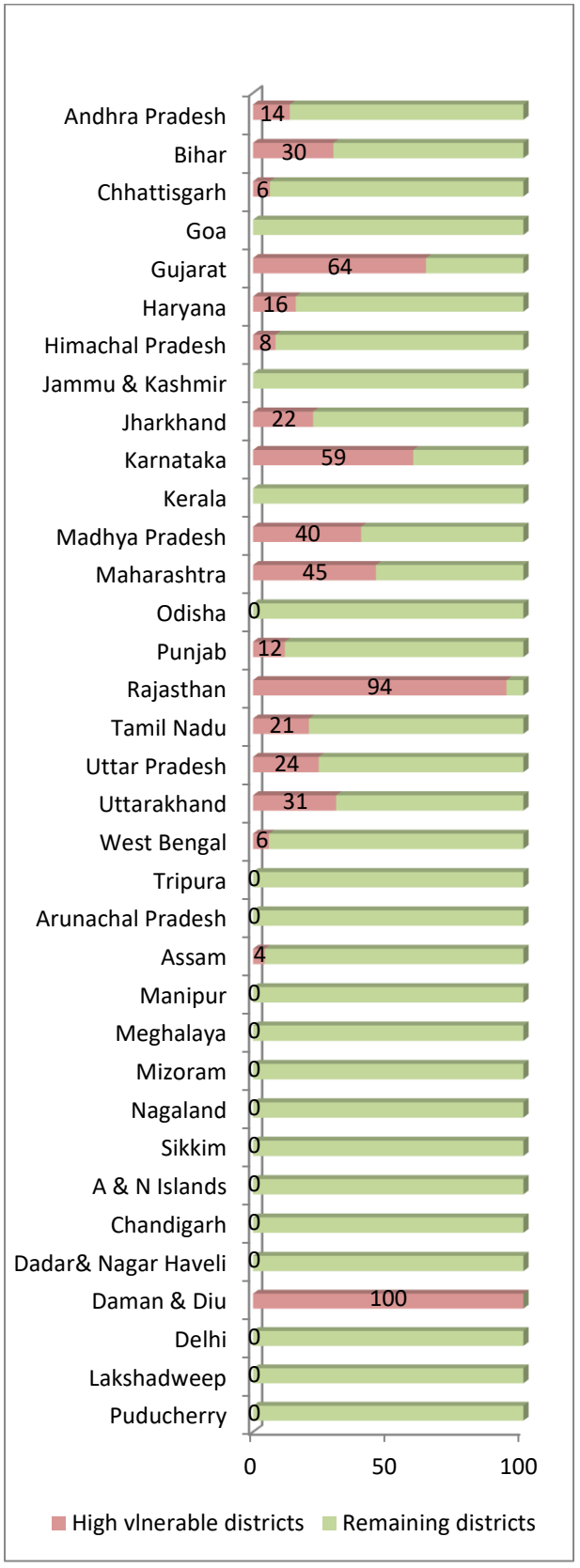
Therefore, these 33 districts need priority attention in terms of area specific policy formulation as well as implementation to enhance income of farmers, thereby thus raising their adaptive capacity and reducing vulnerability of agriculture to climate change in these areas.

Figure 5.1 Comparison of States/Districts in Vulnerability and Income Status

A. Distribution of Low Farmers' Income Districts



B. Distribution of Climate Vulnerable Districts



Source: DFI Committee Estimates

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

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

Source: DFI Committee

Some districts that ranked high on vulnerability status, were however more developed in terms of farmers' income. Agro-climatic positioning of the districts will play a role for suitable policies for reducing climate vulnerability and augmenting income of the farmers. It may be noted that farmer's income is a combination of farm income and non-farm income.

5.2. Vulnerable Districts from Farm Income and Climate Perspective

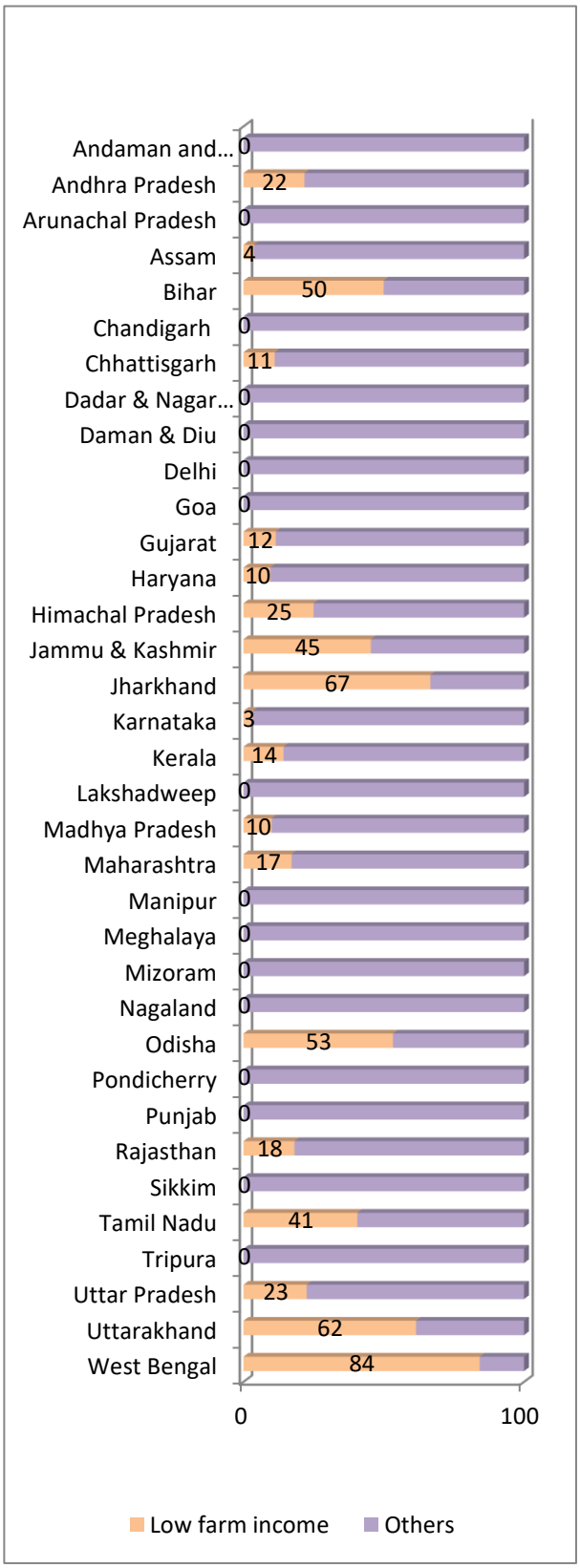
Considering the mandate of this DFI Committee and the mandate of the Department of Agriculture, Cooperation & Farmers' Welfare, an examination of the poorest districts based on farm income, which is typically a major component of farmers' income, and climate vulnerability was done. The poorest 150 districts in terms of lowest farm income (income from crops and animals derived from NSSO-SAS survey, 2013) were compared with very high climate vulnerable districts (see the previous section). Interestingly on this basis, out of 150, the number of double stressed districts identified is 29 (see Table 5.2).

One can easily notice that the percentage of districts falling under low farm income in states like Bihar, Uttar Pradesh and Madhya Pradesh has declined, as compared to when the poor districts were identified on the basis on farmer's total income. It appears that income from crop and livestock is a more reliable and prominent factor 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.

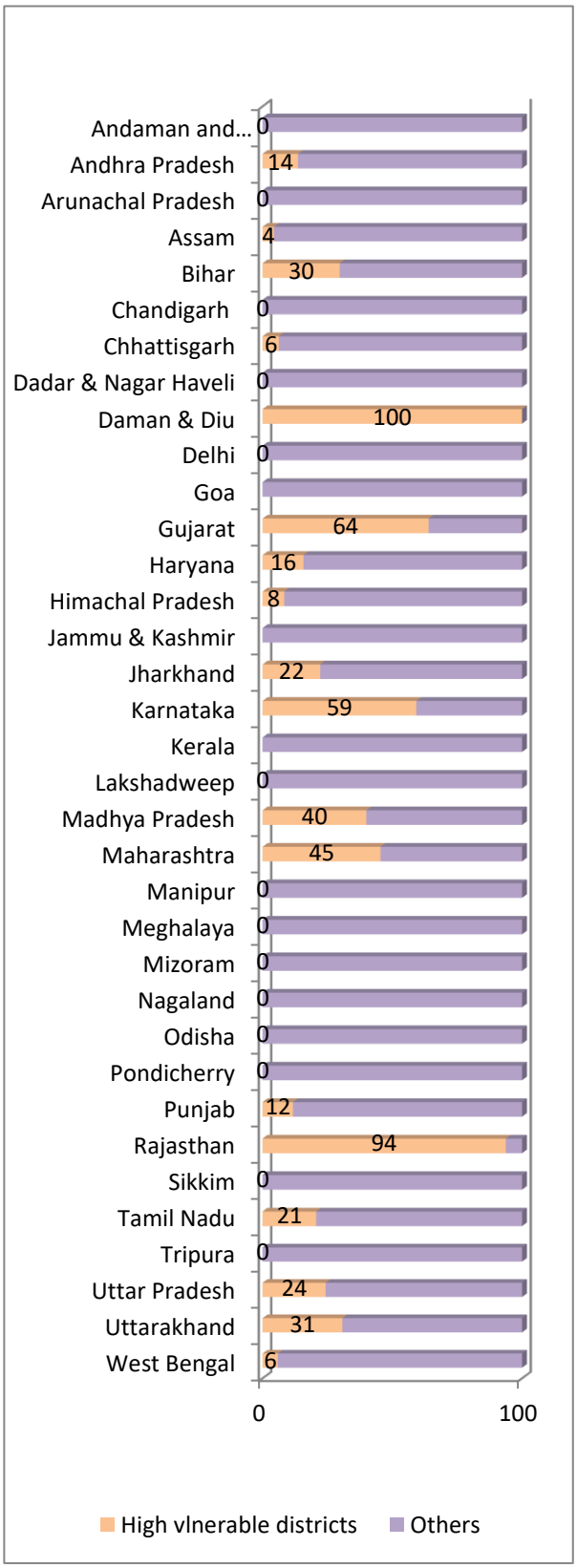
In a few southern states like Kerala, Andhra Pradesh and Tamil Nadu, and hilly states like Jammu and Kashmir and Himachal Pradesh, income from non-farm sources is seen to play a critical role in farmer's income, as indicated by the increase in the percentage of districts falling under low farm income status in these states.

Figure 5.2 Comparison of States/Districts in Vulnerability and Farm Income Status

A. Distribution of Low Farm Income Districts



B. Distribution of Climate Vulnerable Districts



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

These districts can be taken up for focussed mentoring and works progressed 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 in 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 looks 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 a larger percentage of small holders 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 ranged from a high of 3,113 kg/ha in Uttar Pradesh to a low of 1,644 kg/ha in Odisha. In case of rice productivity, it ranged from 2,688 kg/ha in West Bengal to 1,450 kg/ha in Odisha.

In terms of infrastructure, West Bengal possesses the highest intensity of rural road network with figures of 207 km per 100 sq. km of area and Jharkhand the minimum with only 21.4 km per 100 sq. km of area.

Based on Rao *et al*., (2013), the top five states having maximum number of climate vulnerable districts are 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 these states which are most climate 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 small, ranging from 3.07 hectare in Rajasthan to 1.55 hectare in Karnataka. Also, the number of people depending on non-farm income are in a minority in these states, thus the majority of people in all these states are dependent on agriculture.

In all the selected climate change sensitive states, the 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 to rainfall fluctuations.

It can also be seen that the area under horticultural crops 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 rural areas. The length of rural roads, which is considered an important factor while evaluating the returns from agriculture, is also found below par, especially 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 tonnes)									
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

- Livelihood and income of farmers are closely linked to the influence of climate change and variability. There exists an inverse correlation between the two.
- Impact of climate vulnerability is relatively higher on small & marginal farmers.
- Low income of farmers reduces the adaptive capacity of the farmers to withstand climate shocks and in consequence increases their vulnerability.
- Vulnerable states are seen to be growing more of high yielding varieties as compared to low income group states but productivity differences are 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.
- Special programmes need to be designed to support these disadvantaged districts. It would be appreciable if SAUs/KVKs and state extension agencies adopt these districts and work in coalition with state agencies and line departments to create favourable and facilitating environment to trigger special action plan.
- Comparison of 150 districts most vulnerable to climate change with 150 districts suffering from lowest agricultural incomes (crops + livestock) yields 33 double-stressed districts.
- A similar comparison as above taking into account only incomes from crop sector yields 29 districts.

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 this first volume of the DFI Report. Some of the major observations on the march and growth trends of agricultural economy and broad recommendations are introduced.

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 during the triennium 2012-13 to 2014-15). Livestock comes next with a share of 26.80 per cent followed by forestry (7.39 per cent) and fisheries (4.50 per cent) sector.

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

- Livestock sector's performance was found to be the best during the recovery phase (2004/05-2014/15). 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. While it is necessary to incentivise farmers to push up their production, simultaneously, improved and innovative marketing arrangements are required to enhance the economic returns to the farmers.

- 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. However, there are clear signals in favour of high value crops as evident from expanding area under fruits and vegetables over the years.

- A continuous and significant increase in share of area to GCA under fruits and vegetables indicates growing importance of these farm commodities both at 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 that have led the farmers to take to more fruits and vegetables, the latter in particular.

- The small and marginal farmers account for 85 per cent share in total number of holdings at national level. The share is still higher in states like Kerala, Bihar, West Bengal, Jammu & Kashmir, Uttar Pradesh, Odisha, Tamil Nadu, Uttarakhand and few NE states and UTs, where it is found to be more than 90 per cent. 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 dedicated developmental package considering the situation of smallholders.

- In Chhattisgarh where farmers derive major income from crops and wages; there is need for a strategic plan to broadbase agriculture. As far as non-farm activities and wages & salary as alternate sources of income are concerned, it is the states like Kerala, Jammu & Kashmir, Himachal Pradesh, Tamil Nadu and West Bengal that earn maximum from these two sources. 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 developmental framework for doubling of farmers' income.

- A decent growth in farm income of farmers requires some cultivators moving away from agriculture to non-agriculture sector, along with high growth in output and favourable prices for farm produce.

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 higher output and in meeting the food security of the country, while releasing land now under these crops for other high value crops and activities. The estimates derived for 2011-12 and 2013-14 show considerable yield gap across states among different crops.

- Access to institutional credit and robust extension in transfer of technology to the farmers will help in bridging yield gaps.

- Micro irrigation has generated benefits to the farmers in terms of enhancement of productivity and water use efficiency. 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, the scope for expansion of irrigation is limited. 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 in respect of wheat. But yield differentials are high, enabling scope to achieve still higher 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 demand for irrigation 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 optimally harvesting the utilisable water in the country.

- The type of seeds used determines the yield, so as the income. Still, the reach of improved and hybrid seeds seems to be limited to specific crops. Major food crops like paddy and wheat are grown using improved seeds in general, but use of hybrids is low. Spread of hybrid seed use in millet growing areas would potentially benefit farmers in gaining higher yield and income. Among pulses, tur offers scope to adopt improved seeds; and among oilseeds, groundnut provides good scope. In general, while paddy possesses scope to enhance use of hybrid seeds, millets offer potential to expand use of both improved and hybrid seeds by substituting local varieties dominating now. Hence, seed substitution should occupy an important place in achieving higher production and incomes.

- 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 risk management and income gains.

- Investment in agricultural research has resulted in good returns, and 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 efficiency in total factor productivity. Besides these, infrastructure in terms of rural roads, electricity, markets, literacy etc. play important role in enhancing the total factor productivity. Hence, investments in both R&D, and infrastructure need upgradation.

6.1.3. Marketing, Prices and Trade

- Current price policy needs to be restructured. Over the last four and a half decades, the price policy implementation has boosted mainly wheat and rice crops among food grains and sugarcane and cotton among other crops. This situation that has disfavoured other important agricultural commodities like pulses, oilseeds and millets need correction. The market prices often go below MSP due to lack of effective price support mechanism or them. Moreover, trade policy also works independently of MSP policy. Hence the need for a comprehensive price support and trade policy that supports various crops is necessary.

- In the mission for doubling farmers' income, priority attention needed is post-harvest segment, including marketing.

6.1.4. Vulnerable Districts

- Climate change and variability constitute one of the most important matters of concern in terms of livelihood and income of farmers. Vulnerable states are seem to be growing more of high yielding varieties as compared to low income states, but productivity differences are 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.

- Climate vulnerability impacts small and marginal farmers more adversely.

6.2. 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 levels or wholesale price data during the peak season in the APMCs. The data on FHP 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 another 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.

- A 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 productivity and profitability. But as has been experienced in the past producers become the victims of increased supply when demand cannot match with it, and therefore, loose on market returns. A pro-farmer policy framework consisting of robust procurement, logistics and marketing interventions will help optimise the revenues to farmers. The time has come when things are to be dealt in totality and not in isolation. Neither the productivity centric nor the marketing and price centric approach can work in isolation. Every commodity has to be dealt in a holistic manner to tackle issues along all the stages of its supply chain, which is addressed as a value based system. Commodity outlooks would be extremely important for efficient planning and management of the supply chain.

- It is extremely important that concerted efforts are made to achieve market related objectives. The commodities having significant trade potential need to be supported by stable and long term trade policies. The gains from trade can further be enhanced by networking

among academic & research institutions and practising organisations, for meticulous technical supervision and guidance.

- A paradigm shift in the resource allocation in favour of rural connectivity, electricity supply and availability of markets to sell agricultural produce is the need of the hour. The condition of rural infrastructure (roads, irrigation, electricity and markets) in a number of states is a matter of serious concern and this needs priority attention. The studies have reported that basic infrastructure can improve the total factor productivity and this should be kept in mind.

- 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 through higher growth. Technological support will be needed and therefore agricultural science centres like ICAR, SAUs, KVKs etc. may adopt and mentor these districts in association with state governments.

- Marketing infrastructure is key to in enhancing the farmers' welfare and progress, as it not only provides incentives for higher production but also promotes commercialization of subsistence farming. Agriculture markets need total reforms for liberalisation.

- Role of agricultural credit is extremely important in meeting capital needs of crop cultivation, animal rearing and other sub-sectors. The sector needs easy access to timely and adequate volumes of institutional credit. More importantly, in addition to agronomic and commercial crops (cotton and sugarcane), new growth engines, namely, animal husbandry & fishery sectors need to be offered such KCC-enabled facilities at interest subvention on par with crops.

- The agricultural land structure in the country is dense with high population dependence, leading to land division and fragmentation. Majority of landholdings are small and marginal at more than 85 per cent of the total land holdings, challenging viability of operations. In order to improve efficiency by effecting scales of operations, it is necessary to mobilise farmers and aggregate produce, by promoting farmer producer organisations (FPOs), contract farming etc.

What is needed is an income approach to agriculture, where under agriculture is practised as an enterprise. In addition to improving incomes from farming, growth of manufacturing and service sectors, and their ability to absorb manpower shifting from agriculture will also be important.

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