

Raising Agricultural Productivity and Making Farming Remunerative for Farmers*

An Occasional Paper

NITI Aayog, Government of India

16 December 2015

**This paper is based on the work of the Task Force on Agricultural Development constituted by the National Institution for Transforming India (NITI) Aayog, Government of India in March 2015. The paper does not represent the views of either the Government of India or the NITI Aayog. It concentrates on a subset of important issues confronting Indian agriculture and does not try to be exhaustive.*

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Abstract

As a source of livelihood, agriculture (including forestry and fishing) remains the largest sector of Indian Economy. While its output share fell from 28.3% in 1993-94 to 14.4% in 2011-12, employment share declined from 64.8% to 48.9% over the same period. Therefore, almost half of the workforce in India still remains dependent on agriculture. Given the low share of this workforce in the GDP, on average, it earns much lower income poorer than its counterpart in industry and services.

Therefore, progress in agriculture has a bearing on the fate of the largest proportion of the low income population in India. The paper identifies five important aspects of agriculture that need immediate attention to bring economic advantages to millions of farm families. First, output per hectare, which is a common measure of agricultural productivity, remains low for many crops when compared to many other countries. There are also large regional variations within the country. Reasons include low and faulty input uses, poor access to modern technology and no real technological breakthrough in recent times. Second, on average, farmers do not realize remunerative prices due to limited reach of the minimum support prices (MSP) and an agricultural marketing system that delivers only a small fraction of the final price to the actual farmer. Third, the farm size of the majority of the household has declined to unviable levels inducing farmers to leave land and look for better job opportunities elsewhere. Because land-leasing laws make it risky to lease land, increasingly, productive land is being left uncultivated. Changes in the land leasing laws may bring consolidation of land holding at operational level and attract better investment along with access to credit and relief to tenants. Fourth, relief measures in the event of natural disasters are inadequate and suffer from procedural inefficiencies and delays. The risk adaptation measures are poorly executed and have not worked effectively. This situation needs to be rectified with at least minimum quick relief to farmers for crop loss in case of natural calamities. Finally the potential of the eastern region needs to be harnessed with suitable interventions. This region is unique for its suitability to the production of certain commodities. However, taking advantage of this potential would require institutional support and investment in technological innovations. The paper offers ideas on how these problems can be addressed so as to accelerate agricultural growth and bring remunerative prices to farmers.

1 The Current Status of Indian Agriculture

Since 1970-71, trend growth in Indian agriculture has been approximately 3%, above that in population but well below that in the entire economy consisting of agriculture, industry and services. By implication, while per-capita agricultural output has seen a steady rise, the share of agriculture in the Gross Domestic Product (GDP) has fallen. The rise in per-capita agricultural production has gone a long way toward easing pressure on meeting food and nutrition security of the country. Unfortunately, however, growth in agricultural output is characterised by fluctuations; each high growth period is followed by a phase of low growth. This cyclical pattern has reflected itself in annual growth rates of approximately 3% in the 10th Plan, 4% in the 11th Plan and just 1.7% during the first three years of the 12th Plan. Specific sub sectors, most notably crop segment, are subject to occasional severe negative shocks leading to serious distress.

Crop production in the country is dominated by cultivation of paddy in Kharif and wheat in Rabi seasons. These two crops cover about 38 per cent of gross cropped area in the country. Cereals including coarse cereals occupy more than half of the total land under cultivation.

Table 1: Distribution of gross cropped area across major crops

Year	TE 2001-02	TE 2013-14
Rice	24.0	22.4
Wheat	14.2	15.6
Coarse Cereals	15.9	13.1
Total Cereals	54.0	50.9
Total Pulses	11.3	12.5
Total Food Grains	65.3	63.6
Sugarcane	2.3	2.6
Condiment and Spices	1.3	1.6
Total Fruits	2.1	3.6
Total Vegetables	3.3	4.7
Total Oilseeds	12.4	13.9
Total Fibres	5.2	6.6
Tobacco	0.2	0.2
Other Crops	7.8	4.2
GCA	100	100

Table 1 provides the distribution of gross cropped area over important crops and crop groups and changes in crop pattern at the turn of the new Century and currently. The table shows that there has been some shift in area away from cereals during last 12 years. Between triennium ending (TE) 2001-2 and TE 2013-14, area under cereal declined from 54% to 51 per

cent while that under pulses rose slightly from 11.3 to 12.5%. Area share of fruits and vegetables witnessed significant increase but it still remains below 10%.

Table 2 provides the area, production, yield and per cent area irrigated in food grains in different states of India. Uttar Pradesh accounts for the largest share by area as well as production by a wide margin. It accounts for almost one-fifth of the country's food grain production. While Punjab and Haryana have been traditionally seen as the major contributors to food grain production, Madhya Pradesh, Andhra Pradesh, Rajasthan and West Bengal have emerged as significant producers in recent years.

Table 2: Area, production and yield in food grain in 2013-14 and the proportion of area under food grains irrigated in 2011-12

State	Area (m. Hectares)	Per cent of India	Production (million tonne)	Per cent of India	Yield (kg per hectare)	% Area irrigated (2011-12)
Uttar Pradesh	20.23	16.05	50.05	18.9	2474	76.1
Punjab	6.56	5.2	28.9	10.92	4409	98.7
Madhya Pradesh	14.94	11.85	24.24	9.15	1622	50.5
Andhra Pradesh	7.61	6.04	20.1	7.59	2641	62.5
Rajasthan	13.42	10.64	18.3	6.91	1364	27.7
West Bengal	6.24	4.95	17.05	6.44	2732	49.3
Haryana	4.4	3.49	16.97	6.41	3854	88.9
Maharashtra	11.62	9.22	13.92	5.26	1198	16.4
Bihar	6.67	5.29	13.15	4.97	1971	67.4
Karnataka	7.51	5.95	12.17	4.6	1622	28.2
Tamil Nadu	3.55	2.81	8.49	3.21	2396	63.5
Odisha	5.15	4.09	8.33	3.15	1617	29.0
Gujarat	4.29	3.4	8.21	3.1	1917	46.0
Chhattisgarh	4.95	3.93	7.58	2.86	1532	29.7
Assam	2.53	2.01	4.94	1.87	1952	4.6
Jharkhand	2.24	1.77	4.19	1.58	1874	7.0
Uttarakhand	0.89	0.71	1.78	0.67	2001	44.0
Others	3.26	2.59	6.38	2.41		-
All India	126.04	100	264.77	100	2101	49.8

Yields and the proportion of area irrigated vary widely across states. Predictably, there is a strong correlation between these two variables. Punjab ranks the first and Haryana the second in terms of both variables. Among larger producers, Madhya Pradesh, Rajasthan and Maharashtra show relatively low yields. Rajasthan and Maharashtra also exhibit low proportions of area under irrigation. In Bihar, the proportion of area irrigated is above the national average

but not the yield. This is very likely due to high frequency of floods that occasionally destroy standing crops.

The international comparison of yields and share in world's output in rice, wheat and horticultural crops are presented in Tables 3, 4 and 5, respectively. The countries are ranked according to declining share in the output in each table. In terms of the total output, India ranks second in rice, wheat and potato with China ranking the first. In banana India ranks first followed by China.

India exhibits low yields in rice when compared to other countries but not in wheat. Rice yield in India is just 55% of rice yield in China. Average yield of rice in India is much lower than other major rice producing countries like Bangladesh, Indonesia and Vietnam.

Table 3: Country comparison of yields and shares in the world output in rice in 2012

Country	Yield (kg per hectare)	Production (% of world)	Country	Yield (kg per hectare)	Production (% of world)
World	4548	100	Pakistan	4068	1.27
China	6775	27.9	Cambodia	3089	1.26
India	3721	21.38	USA	8349	1.23
Indonesia	5136	9.35	Korea, Republic	6988	0.8
Bangladesh	4421	6.84	Egypt	9530	0.8
Viet Nam	5631	5.91	Nepal	3312	0.69
Thailand	3051	5.08	Nigeria	1800	0.65
Myanmar	3445	3.8	Madagascar	2938	0.62
Philippines	3845	2.44	Sri Lanka	3885	0.52
Brazil	4786	1.56	Iran	5000	0.33
Japan	6739	1.44	Russian Federation	490	0.14

It may seem surprising but India edges out the United States in yield per hectare in wheat. China is the major producer of wheat that has far higher productivity than India. France, Germany and the United Kingdom exhibit super-high productivity in wheat but their contributions to the world output are significantly smaller than those of India and China.

Table 4: Country comparison of yields and shares in the world output in wheat in 2012

Country	Yield (kg/ha)	Production (% of world)	Country	Yield (kg/ha)	Production (% of world)
World	3090	100	Iran	1971	2.06
China	4987	18.02	UK	6657	1.97
India	3177	14.13	Kazakhstan	683	1.47
USA	3115	9.19	Egypt	6582	1.31
France	7599	6	Poland	4144	1.28
Russian Fed.	1773	5.62	Argentina	2715	1.22
Australia	2215	4.45	Italy	4132	1.16
Canada	2865	4.05	Romania	2659	0.79
Pakistan	2709	3.5	Spain	2644	0.69
Germany	7328	3.34	Syrian Rep.	2252	0.54
Ukraine	2800	2.35	Bangladesh	2779	0.15

Table 5: Country comparison of yields and shares in the world output in horticultural crops in 2012

Potato			Banana		
Country	Yield (kg/ha)	Production (% of world)	Country	Yield (kg/ha)	Production (% of world)
World	18900	100	World	21200	100.00
China	16100	23.88	India	37000	27.82
India	21100	11.37	China	26400	9.87
Russia	13400	8.08	Philippines	20300	8.63
Ukraine	16100	6.36	Ecuador	33300	6.56
USA	45800	5.74	Brazil	14300	6.46
Germany	44800	2.92	Indonesia	58900	5.79
Poland	24400	2.49	Angola	25800	2.80
Bangladesh	19100	2.25	Guatemala	40900	2.53
Belarus	20800	1.89	UR of Tanzania	5700	2.36
Netherlands	45200	1.85	Mexico	30300	2.06

India is fairly placed in terms of contribution to global production of potato and banana but there also the level of productivity is less as compared to many countries. In potato the productivity of India is less than half of the productivity of USA, Germany and Netherlands while yield of banana in Indonesia is 1.5 times higher than that of India.

2 Issues Confronting Indian Agriculture

Indian Agriculture is confronted with several issues. After careful deliberations, the Task Force on Agricultural Development chose to concentrate on five major issues: agricultural productivity, remunerative prices for farmers, land policy, agrarian distress and eastern states that have lagged behind the rest of the country in farming. These issues are summarised immediately below with a more detailed dissection and associated policy recommendations provided in subsequent sections.

First, a series of essential steps are required to raise agricultural productivity. At a broad level, this issue has two aspects: low average productivity at the national level and high variation in it regionally. As explained earlier, the average productivity in rice is low relative to most of the major rice producing countries. India does better in wheat but the scope for improvement exists in this crop as well. The same goes for other crops including oilseeds, fruits and vegetables as well as activities such as animal husbandry, fisheries and poultry. The second broad productivity concern relates to regional variation. It is also evident that while Punjab and Haryana exhibit high productivity nationally, states such as Madhya Pradesh, Rajasthan, Maharashtra, Chhattisgarh, Odisha, and Karnataka suffer from quite low yields per hectare. The scope for improved productivity in these latter regions is substantial.

To increase productivity, progress is required along three dimensions: (i) Quality and judicious use of inputs such as water, seeds, fertilizer and pesticides; (ii) judicious and safe exploitation of modern technology including genetically modified (GM) seeds; and (iii) shift into high value commodities such as fruits, vegetables, flowers, fisheries, animal husbandry and poultry. In the longer run, productivity enhancement requires research toward discovery of robust seed varieties and other inputs, appropriate crops and input usage for a given soil type and effective extension practices.

Agricultural research and development (R&D) in India has made impressive contribution in the past. But the system is under significant stress today with lack of clarity on focus and inefficient use of financial resources. Links among sister institutions have weakened and accountability declined over time. There is need for a rethink of the R&D system.

Second, farmers need to be ensured to receive remunerative prices. This issue has two aspects, one relating to the Minimum Support Price (MSP) and the other relating to the farmer's share in the price paid by the final consumer. Taking the MSP first, it effectively applies to a specified set of commodities, predominantly rice, wheat and cotton, and is available only in a subset of producer states. In the states in which no procurement is done by the public agencies at the MSP, farmers lack the guarantee offered by the MSP (Chand 2003, Planning Commission 2007). Moreover, subsidized sales of cereals under the public distribution system (PDS) divert part of the demand thereby artificially lowering the price at which they must sell their produce. Likewise, for commodities such as fruits and vegetables, which are not subject to any procurement by official agencies, sometimes the market price can be excessively low due to perishability and localized nature of markets for them. The inadequate cold storage facility

makes matters worse by discouraging farmers from opting for these crops in the first place. Agricultural marketing has not seen any significant reforms and modernisation for decades. The supply chain remains fragmented, scale of operations is low and there is excessive presence of intermediaries. The poor state of competitiveness is more pronounced during above normal or below normal production. A small increase in production above normal level often results in price crash for farmers and a below normal production is followed by skyrocketing prices in the post-harvest period with hardly any benefit for the farmers.

The second aspect of the price received by the farmer concerns the small fraction of the price paid by the final consumer that the farmer receives in the marketplace. The continued presence of regulations flowing from the Agricultural Produce Marketing Committees (APMC) Acts in most commodities in most states has meant that the farmer is compelled to sell her produce in the government-controlled marketing yards. These controls restrict transactions to the handful of local players and easy manipulations. The APMC market yards are subject to vast technical as well as marketing inefficiencies that undermine the prices that farmers receive (Chand 2012). Only a genuine implementation of the model APMC Act of 2003, which introduces all-around marketing reform, can ensure that the farmer gets her fair share of the price paid by the final consumer (Gulati and Ganguly 2010). Additionally, some of the restrictive features of the Essential Commodity Act, which create an environment of uncertainty and discourage the entry of larger players into agricultural-marketing infrastructure, requires review and possibly revision.

Third, for understandable historical reasons, land leasing laws in India have taken forms that discourage formal leasing contracts between the owner and the tenant. Field studies have shown that most of tenancy in the country is concealed and, thus, unofficial. This fact has the implication that tenants are often not identified as actual cultivators in the records. The lack of identification of tenants as actual farmers has very serious implications for the conduct of public policy. Benefits intended for the tenant farmer such as disaster relief or direct benefit transfers risk being disbursed to the owner of the land who appears as the cultivator in the official records. In the absence of official records, tenants also lack access to formal credit and other benefits available to cultivators. In many states, leasing laws can effectively result in the loss of land to the tenant leading owners to eschew leasing land altogether. Over the generations, as families have grown, land holdings have come to be divided and fragmented into small economically unviable parcels and plots.¹ Onerous leasing laws have prevented consolidation of these holdings. On the one hand, these smallholdings force owners to seek alternative means of livelihood and on the other their plots remain uncultivated with no prospect of being joined to other plots to produce more viable holdings.

Closely related, ownership rights in India are also poorly defined. All ownership is presumptive and subject to challenge in the courts. This feature has undermined the

¹ According to a recent study income earned from farming by 53 per cent farmers, who operate on land holdings below 0.63 hectare, is not enough even to keep them above poverty line (Chand et. al. 2015).

development of a vibrant land sales market with the owner unable to get the true value of his piece of land. In turn, this discourages land sales as well when the farmer finds his piece of land too small to be a viable source of livelihood. Equally important, in the absence of ownership titles and the prospects of land disputes, banks hesitate to accept land as collateral.

Fourth, farmers are frequently affected by natural disasters such as droughts, floods, cyclones, storms, landslides, hails and earthquakes. Because most farmers lead subsistence existence, such disasters can lead to extreme distress and hardship. Though some crop insurance schemes have been tried in the past, they have not worked effectively (Chand 2015, Raju and Chand 2007). One critical problem is that these programs predominantly cover only farmers with outstanding bank loans. Because the poorest farmers are unable to access the banking system in the first place, they are rarely covered by the insurance. There is acute need to rectify this situation by providing for at least minimum quick relief to marginal and small farmers in case of natural calamities that destroy a large proportion of the crop.

Fifth, we need to pay special attention to the problems of farmers in eastern states. Given fertile land and abundant water resources, these states have a high potential in agriculture. Yet, their productivity in various crops lags behind the national average. Despite favourable climatic conditions and water availability crop intensity in the region is low. Therefore, concerted effort is required to bring the Green Revolution to these states (Gulati, Gujaral and Nandakumar 2010).

Sections 3-7 discuss these five issues in detail. The final section, Section 8, offers concluding remarks and a summary of major recommendations.

3 Raising productivity to Accelerate Growth

As noted earlier, there exists considerable scope for raising productivity in agriculture in India. The level of productivity remains low in all the segments of agriculture, be it crops, livestock or fishery, notwithstanding the fact that there is large realizable potential in each case. The following sub-sections discuss various dimensions related to productivity along which nation needs to move to achieve full potential of agriculture.

3.1 Per Drop More Crop: The Challenges of Irrigation

Water is a critical input into agriculture in nearly all its aspects. How much, at what time and how plants are watered has determining effect on the eventual yield. Good seeds and fertilizer fail to achieve their full potential if plants are not optimally watered. Adequate availability of water is important for animal husbandry as well. Fisheries are, of course, directly dependent on water resources.

Increasing incomes, growing urbanization and rising prosperity are rapidly changing the composition of food basket away from cereals towards high value agricultural commodities such as fruits, vegetables, milk, poultry, fish and meat. Although per capita consumption of food grains has declined over the years, its total demand has been projected to increase due to increase

in population and indirect demand from feed. Most of the fruits, vegetables and livestock products are more water intensive as compared to cereals other than rice. Further preference to have fresh fruits and vegetables in all the seasons is resulting in increase in their cultivation in off season requiring much higher use of water. The amount of water required to produce a unit of animal origin products (chicken, mutton and eggs) is much higher than plant origin products (cereals, pulses and oilseeds). These developments point to growing demand for and therefore rising pressure on India's limited water resources. Moreover, close to 55 per cent of the current area under cultivation is not covered by irrigation. This results in low productivity and high risk to production due to erratic rainfall. Ways and means need to be devised to expand irrigation and enable dryland agriculture to have access to water to address at least critical water shortages.

India accounts for about 17 per cent of the world's population but only 4 per cent of the world fresh water resources. Distribution of these water resources across the vast expanse of the country is also uneven. Therefore, as incomes rise and the need for water rises for reasons explained in the previous paragraph, the pressure for efficient use of highly scarce water resources will rise manifold. As per the international norms, a country is classified as *Water Stressed* and *Water Scarce* if per capita water availability goes below 1700 m³ and 1000 m³, respectively. With 1544 m³ per capita water availability, India is already a water-stressed country and moving towards turning water scarce.

While the stress on limited water resources in the country is rising the scarcity is not reflected in use of water. India uses 2-4 times water to produce one unit of major food crops as compared to other major agricultural countries like China, Brazil, USA (Hoekstra and Chapagain 2008). These variations imply that if India attains water use efficiency of those countries it can save at least half of water presently used for irrigation purposes.

At present, irrigation consumes about 84 per cent of total available water. Industrial and domestic sectors consume about 12 and 4 per cent of total available water, respectively. With irrigation predicted to remain the dominant user of water, "per drop more crop" is an imperative. The efficiency of water use must improve to expand area under irrigation while also conserving water.

Irrigation infrastructure in India has seen substantial expansion over the years. The total irrigation potential created (IPC) from major, medium and minor irrigation schemes has increased from 22.6 million hectares during pre-plan period to 113 million hectares at the end of the 11th Plan. Because this irrigation potential represents 81% of India's ultimate irrigation potential estimated at 140 million hectares, the scope for further expansion of irrigation infrastructure on a large scale is limited. Therefore, priority must be given to improving the utilization of irrigation potential (IPU) of the existing irrigation potential. Currently, IPU is approximately 77 % (87 million hectares) of the IPC (113 million hectares). The underutilization of IPC is due to the slow pace of the Command Area Development Programme (initiated in 1973-74 to bridge the gap between IPC and IPU), depletion of professional staff in state irrigation agencies and paucity of non-plan funds available for irrigation departments. This necessitates review and restructuring of the underlying institutional setup in the irrigation sector.

Over the years, there has been significant shift in the sources of irrigation. The share of canal in net irrigated area has declined from 39.8 % in 1950-51 to 23.6 % in 2012-13. Alongside, the share of groundwater sources has increased from 28.7 % to a whopping 62.4 % during the same period. This expansion reflects the reliability and higher irrigation efficiency of 70–80% in groundwater irrigation compared with 25–45% in canal irrigation. While proving to be a valuable source of irrigation expansion, injudicious utilization of groundwater through the explosion of tube wells has raised several sustainability issues.

Although overall development of groundwater (groundwater draft as a proportion of the total availability) is 62 per cent, there exists wide regional variability. Over-dependence on groundwater beyond sustainable level use has resulted into significant decline in the groundwater table, especially in northwest India. The Central Groundwater Board has categorised 16.2 per cent of the total assessment units—Blocks, Mandals or Talukas—numbering 6607 as ‘Over-exploited’. It has categorized an additional 14 per cent as either at ‘critical’ or ‘semi-critical’ stage. Most of the over-exploited blocks are in northwest region of the country. The unsustainable groundwater use necessitates demand management and supply augmentation measures for improved water use efficiency in agriculture sector. On the other hand, eastern region, where groundwater utilization is on a limited scale, offer greater scope for harnessing the benefits of groundwater usage to improve crop yields.

Several regions in the country face acute water stress chronically. These include districts of South and North Interior Karnataka; Rayalseema in Andhra Pradesh; Vidarbha and Marathwada in Maharashtra; western Rajasthan and Bundelkhand region of U.P. and M.P. Low and erratic rainfall for consecutive years in these districts have rendered water-harvesting structures devoid of water and the conservation measures almost unviable. The water storage in reservoirs has depleted leading to scarcity of drinking water. The moisture index in majority of these districts in the range of -85 to -50%, denoting that natural precipitation is highly inadequate to support the arable cropping.² Neither normal agricultural practices nor the contingency measures may help the farmers. Specific attention is needed for linking these districts with some perennial source of water (linking of rivers or water grids). Furthermore, agriculture has to move from traditional crop centric farming to agri-pastoral-farm forestry systems (fruit trees, shrubs, perennial grasses and small ruminants). There is a strong case of the promotion of sources of livelihood support other than agriculture in these districts.

Cross-country comparison of water use efficiency shows that India uses 2-3 times the water used to produce one tonne of grain in countries like China, Brazil and USA. This implies that with water use efficiency of those countries India can at least double irrigation coverage or save 50 per cent water currently used in irrigation. Achieving these gains would require the application of multiplicity of instruments. These may include:

² Moisture index = [(actual rainfall (P₀)-potential evapotranspiration (PET))/ PET]*100. PET is the water requirement to meet the evaporation and transpiration needs of a large area completely and uniformly covered with growing vegetation having access to an unlimited supply of soil water and without advection or heating effects.

- Pradhan Mantri Krishi Sinchai Yojana (PMKSY) provides a sound framework for the expansion of as well as effective use of water in irrigation. The impact of the scheme can be greatly enhanced, however, by restoring the original flexibility of the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) in asset creation. This can be done without legislative action and through a simple notification modifying Rule 20 in Schedule I of the Act. The modifications can be made by a simple notification and do not require legislative action. They entail the enforcement of the 40% limit on the use of material and skilled labour at the level of the district instead of panchayat and permitting the use of contractors for this component. The twin modifications would allow the flexibility necessary to undertake lasting and efficient minor irrigation projects such as irrigation tanks.
- The method of irrigation followed in the country is flood irrigation, which results in a lot of water loss. Greater efficiency in irrigation can be achieved through proper designing of irrigation system for reducing water conveyance loss. Adoption of water saving technologies such as sprinkler and drip irrigation system have proven extremely effective in not just water conservation but also leading to higher yields by delivering water in a controlled manner in parts of the plant where it is most efficiently absorbed. New agronomic practices like raised bed planting, ridge-furrow method of sowing, sub-surface irrigation, precision farming offers vast scope for economising water use.
- Promotion of alternative methods of planting such as System of Rice Intensification and Direct Seeded Rice can lead to water saving and productivity increases.
- Water productivity can be improved by adopting the concept of multiple use of water, which is beyond the conventional sectoral barriers of the productive sectors. There is scope for increasing the income through crop diversification and integration of fish, poultry and other enterprises in the farming system. Multiple use of water approach generates more income benefits, decreases vulnerability by allowing more diversified livelihood strategies and increases sustainability of ecosystem.
- Emphasis should be given on water resources conservations through watershed development in suitable areas and development of micro-water structures for rainwater harvesting. The promotion of water conservation efforts has direct implications for water resources availability, groundwater recharge and socio-economic conditions of the population.
- Specialised solution is required in chronically water stressed areas where the normal measures may not be effective. Connecting highly water stressed areas with perennial source of water through linking of rivers or water grids is one such option. The value added agri-horti-pastoral agro-forestry systems and alternative source of livelihood are required in these districts. These districts could be ideal candidates for prioritised intervention of watershed plus activities (water conservation along with livelihood support activities) under recently launched Pradhan Mantri Krishi Sinchai Yojana (PMKSY) and convergence with MGNREGA.

- The effective water management is critically linked with the performance of local level water institutions. Therefore, institutional restructuring in favour of participatory irrigation management and water users associations (WUAs) needs to be strengthened. National Water Policy is emphasizing the concept of Participatory Irrigation Management and WUA through active involvement of people in execution of irrigation project. According to the latest data available, 56,539 WUA manage 13.16 million hectare of irrigated land. It will be useful to evaluate the effectiveness of this participatory approach.
- As previously noted, priority must be given to the completion of on-going irrigation projects over initiation of new ones through strengthening of programs such as Command Area Development Programme (CADP) and Accelerated Irrigation Benefits Programme (AIBP).

3.2 Seeds, Fertilizer and Pesticides

Seeds, fertilizers and pesticides constitute the three pillars of modern agriculture and have been central to pushing agricultural-productivity frontier out. The Green Revolution in India was begun by the introduction of the high Yielding Varieties (HYV) of seeds complemented by effective use of fertilizers and expansion of irrigation. Farmers often see a direct connect between seeds and fertilizer on the one hand and crop yield on the other.

3.2.1 Seeds

Seed is the true carrier of technology. In India, three sets of institutions produce seeds: research institutions and agricultural universities; public sector seed producing corporations; and private sector firms including multinationals. The last decade has seen two main developments in seed market. One, production of quality seed has risen at a rapid rate after 2005-06. And two, public sector has begun to effectively compete with the private sector.

Beginning with 2001-02, there has been a distinct change in the role of public sector in the development of hybrid in all crops. Till 2001-02, public sector had developed only 15 hybrids compared with 150 by private sector. Similarly, in maize the number of hybrids developed by private and public sector were 67 and 3, respectively. In the next seven years, share of public sector increased from 8 to 19% in cotton, 4 to 40% in maize and 25 to 58% in rice. Similar changes are observed in the case of other crops. Cotton and maize have been the most favourite crops for development of hybrids both by public and the private sectors. Private sector also evinced strong interest in pearl millet, sunflower and sorghum. Considering all crops together, private sector accounted for three-fourth of the total hybrids developed in the country till year 2009-10, which is significantly lower than that in 2001-02.

While these changes have led to better availability of quality seed, seed replacement rate (percentage of area sown using certified quality seeds other than the farm saved seeds from the previous crop) remains low in the country. On average, it is below 20 per cent in pulses and

below 30 per cent in paddy and wheat. Even now many farmers do not distinguish between common grain and seed and use common grain as seed.³ Recent data on breeder seed production indicated a drastic reduction of about 40% compared 2010-11. This is likely to impact the certified seed availability in coming years. Another serious factor responsible for low use of quality seed is sale of spurious seed in the market. In order to raise productivity there is a need to supply and promote use of quality seed and also assure quality.

Some important initiatives have been taken under the recently amended New Policy on Seed Development. The policy permits 100 per cent foreign direct investment under the automatic route and simplifies the procedure for inclusion of new varieties in the Organisation for Economic Cooperation and Development Seeds Scheme. The thrust is also on creating a seed bank. Since 2013-14, a Seed Rolling Plan has been in place for all the States for identification of good seed varieties and agencies responsible for production of seeds.

Several steps need to be taken to improve the quality of seeds used by farmers:

- Sometimes prices of good quality seeds, especially hybrids, are high and farmers are unable to afford them. Creating community Seed Banks in producing areas can reduce dependence on market for seeds. The seed banks not only protect the existing crop varieties but also ensure supply of seeds to the farmer to meet contingency.
- Proper storage of seeds is essential to get satisfactory germination. This factor assumes particular significance in the eastern region due to humid climatic conditions. Adequate-quality storage infrastructure according to agro-climate conditions and specific seeds to be stored, needs to be created to save the seeds from damage.
- Huge demand supply gap exists in forage seed. The seed companies are not coming forward for production of forage seeds. This is a major cause of concern for development of dairy sector in the country. The seed companies and State Agricultural Universities have to take-up forage seed production on a priority basis. In parallel, the dairy cooperatives should be encouraged to grow forage seeds.
- Regulatory measures for quality seed production have to be tightened so as to discourage the sales of spurious seeds to farmers. The seed companies should be made responsible for poor performance of seed supplied by them. The details of seed traits should be displayed on seed packages and agency website. The seed

³ It is important to note, however, that the optimal seed replacement rate (SRR) varies according to crop. In often self-pollinated crops (OSC) the SRR beyond 33% is not desirable. Since the chances of segregation of population into heterogeneous plants are low in OSC, if prudently managed, the same seeds can be used for three years without marked loss in yield. In the case of hybrids, the optimal SRR is 100% due to heterogeneity and expression of dominant and recessive traits in the subsequent generation. In crops where hybrids are available such as rice, maize, jowar, bajra, rice, Bt cotton and most of the vegetables, 100% SRR is recommended and farmers in India have generally adopted it.

companies should provide adequate compensation package for farmers in case of general failure of their seeds. Our research institutions must develop rapid testing kits for seed hybridity to allow quick seed testing, thus, enabling the detection of spurious seeds at the time of sale.

3.2.2 Fertilizer

Fertilizer use has seen rapid expansion and intensification in India and in other parts of the world with the spread of the Green Revolution technology. With the scope for raising production through the expansion of cultivable land exhausted, fertilizer will continue to play a key role in meeting the future requirement of food, feed and fibre. Therefore it is important that fertilizer is used judiciously and optimally.

Fertilizers supply three critical macro elements: nitrogen (N), phosphorous (P) and potash (K). A common belief is that the ideal balance among N, P and K in India is 4: 2: 1. But these proportions represent average across different soil types, crop and water availability. Moreover, independently of the proportions, the optimal *level* of fertilizer use also varies according to soil type, level of yield, crop and water availability. Soil type matters because the naturally available content of the nutrients varies across soil types. Similarly, there being complementarity between water and nutrient absorption capacity, optimal levels of fertilizer use are higher in irrigated than rain-fed regions. Finally, cereals such as rice, wheat, maize and jowar, cotton and sugarcane require larger doses of nitrogen per ton of output than pulses and fruits and vegetables.

Beginning with the launch of the Green Revolution, fertilizer use in India has steadily grown but it has been disproportionately tilted in favour of urea, the source of nitrogen. Already in the early 1970s, the average proportions across N, P and K were 6:1.9:1, they shifted in favour of nitrogen over time reaching 10:2.9:1 in 1996. There was minor shift in the reverse direction subsequently but in 2012-13, the proportions still stood at 8.2:3.2:1. Setting aside the sub-optimal mix of different nutrients, the *quantity* of fertilizer use per hectare in India remains significantly low than in most countries in the world. The average consumption of fertilizers in India rose from 105.5 kg per ha in 2005-06 to 128.34 kg per ha in 2012-13. But the level remains well below what is observed in the neighbouring Pakistan (205 kg per ha) and China (396 kg per ha).

There is common belief that Indian farmers use too much urea. But the observations above suggest that this is too simplistic a view. More nuanced analysis is required taking into account soil and crop type and irrigated versus rain-fed regions. In this context, it is noteworthy that a recent National Institute of Agricultural Economics and Policy (NIAP) study reports that one third of the major states apply excess N and two thirds apply it at below optimum level. While six states, namely, Andhra Pradesh, Assam, Punjab, Bihar, Haryana, and Jharkhand, use proportionately more N than would be warranted by the optimal mix, 12 states use it in sub-optimal proportion. The study finds similar regional imbalances in the use of P and K. There is clearly a need for nuanced approach to calibrating the use of fertilizers in different soils and

crops and under different irrigation facilities. Farmers must be provided soil analyses through soil cards and possibly modern technology and informed of what the right mix for their crops is.

Due to low use of organic fertilisers and increase in productivity and crop intensity micro nutrient deficiency in the soils is on increase. Thus, beside N, P and K use of micro nutrients also needs to be increased.

Fertiliser sector is not getting fresh investments and the industry is pressing for decontrol of urea. This needs to be looked into in the long term interest of fertilizer and agriculture sector. As the domestic industry is not able to meet the rising fertilizer demand even for urea the dependence on import is rising. In an attempt to reduce dependence on imports, the Government has gone on to revive some inefficient urea plants. If imports are available at prices below the cost of these domestic plants, the wisdom of such revival is not clear. The fundamental principle of international trade is that we must specialize in what we can produce cheaply, let other nations specialize in what they produce cheaply, and then trade. Even then if it is an objective not to rely on imports that are viewed as uncertain, a superior alternative to reviving costly domestic plants is to set up joint venture for urea production in countries where cheap gas is available. This may be quite viable as the pooled gas prices for urea plants in India is \$10.5/MMBTU [million metric British thermal units] compared to \$3/MMBTU recently in the Gulf countries (Gulati and Banerjee, 2015). We have already had a successful experience along these lines in the form of such a joint venture in Oman.

Finally, a major problem with the current regime arises from canalization of urea imports. Three designated public sector agents are currently permitted to import urea upon being given an import license. Because imports are seen as the source of filling the gap between demand and domestic supply, often there are bureaucratic delays in the issuance of licenses and imports being reaching farmers resulting in shortages some time.

Allowing decanalization of urea imports and giving the subsidy to farmers and producers via direct benefit transfer (DBT) would solve this problem while also enforcing greater efficiency in both production and distribution of fertilizer.

Under this system, fertilizer purchases and sales will take place at the import price with domestic fertilizer producers having to compete to meet that price. The farmer would pay the import price at the time of the actual transaction but would be reimbursed the difference between this price and the fixed subsidized price per-unit of purchase via a DBT deposit to her Aadhar linked bank account.

Turning to fertilizer producers, domestic plants unable to cover their costs at the import price will have to be given an output subsidy equal to the transaction price and per-unit cost. In the case of the plants with per-unit cost below transaction price, it will be desirable not to tax away the profits. This will encourage the more efficient plants to strive for greater efficiency so as to generate larger profits and market share for themselves.

This system has at least three advantages over the current one. First and most importantly, by freeing up imports, it will alleviate shortages of fertilizer that farmers face when domestic supply falls short of the demand. Bureaucratic delays at various levels in affecting

imports through public sector agents will give way to competing private and public sector retailers who would not be hamstrung by import licenses and act swiftly to take advantage of profit opportunities. Second, the system will help curb black market since fertilizer will be available to the farmer on demand. Eventually, once land records and tenancy reforms are in place, it will even be possible to assess the fertilizer need of each farmer and limit subsidized sale to that need. Finally, the system will promote transparency by making explicit the extent to which producers instead of farmers reap the subsidy. This too may motivate producers to strive for greater efficiency.

3.2.3 Pesticides

Crop yield losses in India due to pests, which include all biotic stresses such as weeds, insect-pests, diseases, nematodes and rodents, range from 15 to 25% depending on the source of estimates. In monetary terms, the figure ranges from 0.9 to 1.4 lakh crore rupees annually. Losses due to damages caused by pests in terms of quantity are sufficiently large that if they could be avoided, India would meet its needs for the year 2020 domestically without any other change. The flip side is that indiscriminate use of chemical pesticides has an adverse effect on the environment as well as humans who end up consuming produce containing high pesticide residue.

Although in per hectare terms pesticide use in India is much lower than in other countries, especially developed ones, pesticide residues in produce in India have been found to be high. There are at least five reasons for this phenomenon. First, while pesticides are overwhelmingly used to control weeds in the developed countries, they are used to control insects that attack grains, fruits and vegetables in India. Second, chemicals used in India are more dangerous than those used in developed countries. In India, organochloride formulations, which are more dangerous, continue to be used whereas the developed countries have shifted to safer organophosphates and pyrethroids. Third, after being applied, pesticides remain in soil, water or plant for some time before they break down. Farmers often lack knowledge of waiting period of various pesticides. Fourth, The Central Insecticide Board and Registration Committee (CIBRC) regulate pesticide use in India. Farmers often remain unaware of pesticides recommendations of CIBRC. Farmers are also unaware of the bio-pesticides that currently constitute 4.2% of the total pesticide market in India. So far, only 12 bio-pesticides are registered in India under the Insecticides Act, 1968. Finally, high pesticide residues in Indian food products also result from inadequate access to latest technologies. Technologies such as low drift nozzle and spray shields need to be adopted in India to enhance the application efficiency. It is estimated that currently only 0.1% of the applied pesticide in Indian farms hits the target with the remainder contaminating soil and water.

To improve outcomes with respect to pesticide residues, we must improve the advisory services. Farmers mostly depend upon the advice of dealers, who often advise to promote their own interests that may be in conflict with the consumer interest. It is essential to provide information to and create awareness amongst farmers to discourage them from using pesticides

indiscriminately. Often fruits and vegetables are subject to pesticide application after the harvest by aggregator or retailers, which needs to be curbed as well.

3.3 New Technologies

In recent decades, growth in agriculture has been driven by price incentives and input subsidies. In this process, there has been injudicious exploitation of soil, water and other natural resources. Excessive use of fertilizers has led to heavy salinization of soil in Punjab and Haryana. Ministry of Water Resources estimates that 80% blocks in Punjab have been subject to overexploitation of ground water. Haryana and Rajasthan are very close to similar situation with their water tables having declined to excessively low levels. To maintain productivity growth in a sustainable manner, there is a need to move from input intensive to technology intensive and skill intensive agriculture.

Benefits of technology and skill intensive farming are beginning to be experienced albeit on a limited scale in recent years. Genetically modified (GM) seeds for cotton production, hybrids in maize and vegetables, system of rice intensification, precision farming and farm mechanization, hi-tech cultivation of fruits and vegetables and flowers, resource conservation technologies and many off-farm activities related to mechanization, primary and secondary processing introduced in earlier part of this century offer some areas of success. In the following, some of these technologies and their potential are selectively elaborated.

3.3.1 GM and Other Technologies

Genetically modified (GM) seeds have emerged as a powerful new technology promising high productivity and lower use of fertilizers, weedicides and pesticides in the last one to two decades and have gained increasing acceptance among farmers around the world. They are likely to play increasingly important role in addressing many of the current problems in agriculture. The most important and so far the only example of this technology in India has been Bt cotton.

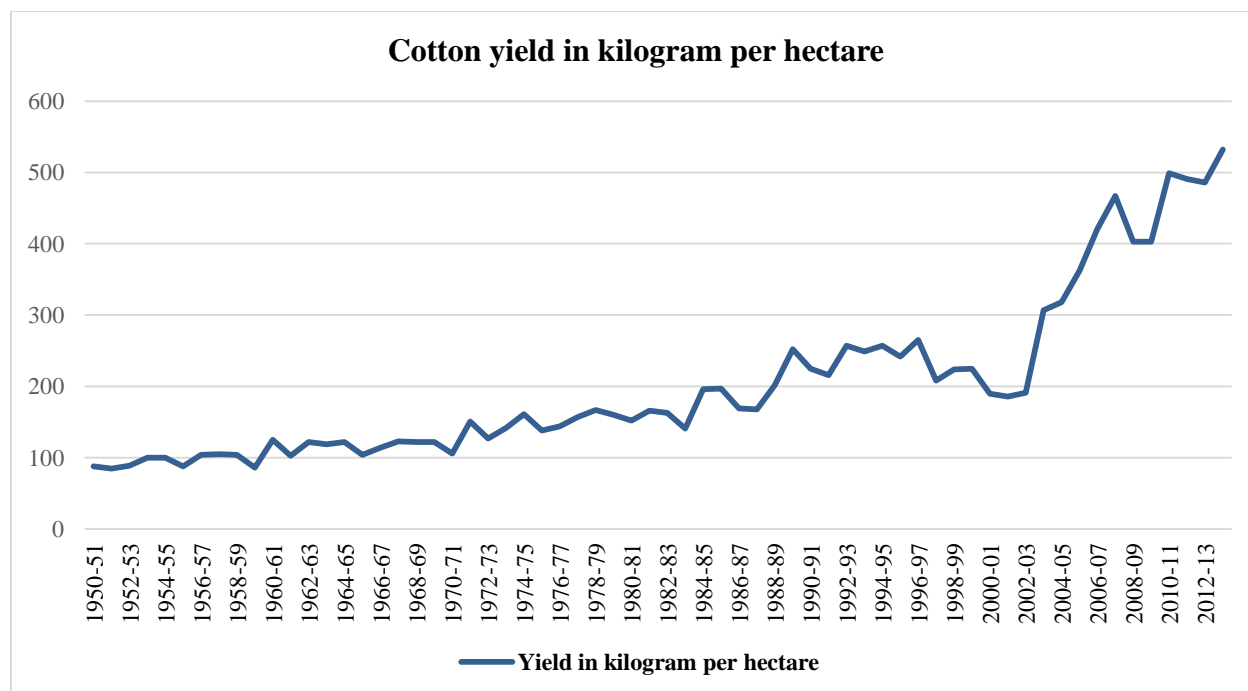


Figure 1: Cotton yield (kg/ha) in India, 1950-51 to 2013-14

Source: Agricultural Statistics at a Glance 2014, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

Figure 1 shows the average cotton yields in India from 1950-51 to 2011-12. Adoption of Bt cotton in India started in year 2002 and the area under it expanded rapidly reaching 11.6 million hectares or 95% of the total cotton acreage by 2014. The peak yield prior to the introduction of Bt cotton, reached in 1996-97, was 265 kg/ha. But the yields declined steadily thereafter, reaching 186 kg/ha in 2001-02. After Bt cottonseeds were introduced in 2002, yields rose continuously and touched a new peak of 532 kg/ha in 2013-14. Cotton farmers in the three largest cotton-growing states, Maharashtra, Andhra Pradesh and Gujarat in that order, experienced large gains. It is a fair assertion that the success in cotton has made an important contribution to the success of agriculture in general in Andhra Pradesh and Gujarat. Between 2001 and 2010, Bt cotton helped reduce the use of insecticides by more than fifty per cent.⁴

It has been argued that credit for the rise in the yields cannot be given to Bt cottonseeds since increases in yields predate their spread. Until 2005-06, Bt cotton had come to cover only a little more than one-tenth of the total cotton acreage. This is too small to account for the rise in yield from 186 kg/ha in 2001-02 to 362 kg/ha in 2005-06. While partially valid, this argument misses two points. First, when Bt cotton was introduced, cotton yields had been rapidly

⁴ See the press note "Area under Cultivation of Bt. Cotton to be around 94 Lakh Hectares in 2011-12," December 20, 2011 by the Ministry of Agriculture at <http://pib.nic.in/newsite/erelease.aspx?relid=79063> (accessed April 20, 2013).

declining. Even if it may not account for the bulk of the rise in yields to 362 kg/ha by 2005-06, Bt cotton played a critical role in reversing the trend and surely contributed to the rise in the yield on the margin. Second, Bt cotton spread rapidly from 2006-07 onwards. In 2006-07, nearly two-fifths of cotton acreage had come under Bt cotton and the share rose to 95% in 2014. This spread demonstrates that farmers saw a significant opportunity in Bt cotton even as the productivity of the existing varieties may have been simultaneously rising. More importantly, with the trend growth rate under the conventional varieties in the prior decades being much lower, it is inconceivable that yields under those varieties could have reached as high as 499 kg/ha.

The success of Bt cotton in India and many more GM seeds elsewhere in the world testifies to the potential of GM technology in giving a major boost to productivity in agriculture. Nevertheless, GM seeds and technologies have remained controversial in India and other countries. Thirteen years have passed since the introduction of Bt cotton and no scientific evidence of detrimental effects on either Bt cotton users or other crops located in the vicinity of Bt cotton farmers has been produced. But India has not introduced any new GM seeds. In 2010, after all of the relevant official bodies had cleared Bt brinjal, the environment ministry blocked its introduction. Many traditional varieties of brinjal require the application of pesticides every third or fourth day, which results in significant pesticide residue on it when it reaches the consumer. Bt Brinjal would have considerably alleviated this problem by mitigating the need for pesticide use.

A serious adverse effect of the publicity and actions against GM technology has been the loss of interest on the part of students and researchers to opt for biotechnology. The success of Bt cotton had given new impetus to the study of this field at postgraduate and doctoral levels in the State Agricultural Universities and ICAR institutions. But the Supreme Court decision to implement a moratorium on field trials for 10 years on all GM research has had a chilling effect on the study of biotechnology. This too needs to be rectified.

Objections to GM technologies are based on the twin fears that they may harm humans consuming the resulting produce and they may have adverse effects on biodiversity. But no compelling evidence supporting either of these fears has emerged more than two decades after the original introduction of GM foods in 1994. On the contrary, GM technology has proven useful in curtailing the use of pesticide and insecticide in combating pests and diseases. In the Indian context, it also offers the prospects of making crops tolerant to drought, salinity and other abiotic stresses. The fortification of grains and edible oils with vitamin A and modified fatty acid profile are some examples of upstream benefits to consumers. The United States has reaped these benefited for at least one and half decades. Recently, even India has been importing and consuming canola oil made from GM rapeseed with no adverse health effects reported to-date.

A consultation was held with scientists, farmers and a journalist. Scientists uniformly argued that with proper regulation GM technologies were safe and promised to significantly raise productivity in a variety of crops. Farmers uniformly protested being deprived of a technology that promised to give them higher yields and therefore better lives to their children. They

specifically noted the necessity of frequent doses of pesticides to preserve the conventional brinjal varieties from catching insects. The journalist offered arguments against the technologies but they did not persuade the scientists and farmers present during the consultation. A public letter by two scientists addressed to Vice Chairman, NITI Aayog also noted, “World’s leading scientific bodies like the US National Academy of Sciences, the UK’s Royal Society, the German Risk Assessment Agency, the European Academy of Science, the Canadian Royal Society, the New Zealand Royal Society, and India’s seven science academies have declared GM crops safe. Innumerable scientific associations and regulatory bodies have all concluded that GM crops are safe and economically beneficial, based on hundreds of independent economic assessment studies published in the best scientific publications that undergo rigorous peer review.”⁵

As a part of its strategy to bring a Second Green Revolution, India must return to permitting proven and well-tested GM technologies with adequate safeguards. Additionally, India urgently needs technological breakthrough in oilseeds and pulses. Our dependence on imports for meeting domestic demand for edible oils has risen to 70 per cent. Even if India doubles its current level of oilseed production, the import dependence will remain at 40 per cent level. The situation is worse in pulses. Per capita intake and availability of pulses in the country has declined to two third since early 1960s. During the 50 years between 1964-65 and 2014-15, per capita production of pulses declined from 25 kg to 13.6 kg. Even imports, which constitute about one fifth of domestic demand, have failed to arrest decline in the availability of pulses in the country. It will be worthwhile to explore the possibility of GM technology in raising oilseeds and pulses output as conventional technologies have not helped in raising output to keep pace with country’s requirements. It should not be forgotten that high yielding varieties of seeds had been the key to the first Green Revolution. Recognizing the general sensitivity to permitting multinationals to sell GM seeds, it may be prudent for the government to proceed with domestically sourced GM seeds only. Luckily, Indian scientists and institutions have been active and successful in this area. According to the evidence presented to the taskforce by the scientists it consulted, a large number of India sourced candidates for field trials and eventual commercialization already exist.

3.3.2 Precision Farming and other Modern Technologies

System of Rice Intensification (SRI), which improves the productivity of rice by 30 to 35% in the conventional varieties and over 50% in hybrids, is another potential source of technological revolution for small and marginal farms. It is a skill intensive technology that cuts the need for inputs such as seeds and fertilizers while raising yields per ha. The area under SRI has increased progressively since 2000-01. The leading states that are practicing this are Tamil Nadu, Bihar and Tripura. The government may consider expanding the scope of the technology through extension programs as a part of its strategy to bring the Green Revolution to eastern India.

⁵ See <http://swarajyamag.com/magazine/you-must-stand-firm-on-gm/>

Similarly, modern machinery such as laser land levellers, self-propelled sprayers, precision seeders and planters, transplanters for rice and vegetable seedlings, multi-crop threshers, harvesters for cereals and sugarcane today allow technically highly efficient farming and resource conservation. The single operation of laser levelling can reduce water application charges by 25 to 30% with greater water use efficiency. Coupled with precision farming, the resources conservation technologies like zero tillage and residue management can reduce the cost of cultivation by 25 to 30% over conventional farming practices.

It is predicted that in the next ten years, Nano-technology led application will play a critical in agriculture.⁶ These applications are related to release and efficient dosage of water and fertilizers and drugs (for livestock) and herbicide delivery. We may also see the emergence of Nano sensors for soil quality, plant health monitoring and pests detection. The Nano-particles for new pesticides, insecticides, and insect repellents may also come to play an important role.

Recently, Madhya Pradesh has introduced a programme on raised bed planting of soybean in the State. Planting of soybean on ridges has helped conserve water and raise productivity. Micro irrigation via sprinklers and drips has helped bring dramatic change in several pockets of the country especially in undulating topography and sand dunes areas where no other method of irrigation can work.

Hi-tech horticulture like poly house cultivation of vegetables, flowers, medicinal plants and fruits constitutes one of the most technology and skill intensive agricultural practices. Being remunerative and skill oriented it can also attract youth. However, being capital intensive, it requires access to credit and participation of business entrepreneurs.

While technology and knowledge intensive agriculture holds enormous promise, it must be remembered that they are also capital intensive and would displace labour. Therefore, while the government may create a facilitating policy framework for private entrepreneurs to engage in these practices, it should resist the temptation to indiscriminately subsidize them and prematurely push farmers towards them. The emphasis should be on informing farmers of the opportunities new technologies offer, improving access to credit and creating an enabling policy environment for their adoption without major direct financial commitments.

3.3.3 R&D in Agriculture

Breakthroughs in basic and other modern sciences offer voluminous opportunities for developing transformative technologies for agriculture. However, this has not been happening in the country for a variety of reasons. Public sector institutions comprising state agricultural universities and a large network of ICAR institutes known as National Agricultural Research System (NARS) dominate India's agricultural research system. NARS had played an important role in ushering in the Green Revolution and subsequent attainment of food security in the country. It has helped place Indian agriculture on a stronger footing. However, future challenges in agriculture are much more formidable. Addressing these challenges require a vibrant,

⁶ For further details on this please refer to Salamanca-Buentello, et.al (2005).

responsive, market oriented, globally competitive research systems equipped with state of the art knowledge and scientific manpower of high calibre equipped with adequate resources. An important concern in this respect is that the proliferation of institutions has not only thinly distributed the financial but also human capital. This has undermined the ability of the scientists to optimally exploit the synergies for transformational research. If we are to move from incremental to transformational research, the proliferation of agricultural institutions must be arrested in favour of greater focus.

While public sector research institutes have important strengths, they also face serious challenges in meeting future needs of Indian agriculture. Resources have been thinly spread on proliferating agricultural universities around the country with the leading research institutes simultaneously facing severe resource crunch. Most of the scientific energy is spent on routine type of research on the same issues at multiple institutions in the name of location specificity. Lab to land connect has been weakening. Problem oriented research is not showing desired results. There is need to seriously rethink the allocation of financial resources spent on agricultural education and research to generate larger bang for the buck. The institute in turn also need to arrest the deterioration in work culture, lack of discipline, bureaucratic centralisation of decision making, demoralisation of scientists, improve collaboration with global research institutes and connect better with farmers. While public sector research shows symptom of decline there are serious apprehensions about the role of private sector, particularly relating to pricing and protection of technologies. Moreover, with the intellectual property rights regimes progressively tightening around the world, the scope for spill over benefits from lateral inflow of technology from developed countries is declining. There is greater and more urgent need than ever before to reform the system of agricultural education and research. Urgent action is needed to overhaul the public sector R&D institutions while creating favourable environment for private sector participation in agricultural research and technology development. An important step in this direction is to put in place performance indicators for institutions and individuals. We also need to modify the existing rules and regulations to facilitate public private partnerships in agriculture research.

Agricultural extension is the heart of the State Agricultural Department. Since independence, the program has gone through several phases. The Training and Visit Programme supported by the World Bank and launched in the 1970s provided a fillip to transfer of technology with the extension workers operating at the level of the panchayat. But over the years, agricultural extension system of the country weakened both in terms of human resources and technological advancement. A revival requires greater involvement of the States with adequate manpower deployed in the extension activity and focus on technology in the programme administration.

3.4 Shift into High Value Commodities

A shift from lower- to higher-value commodities offers an important avenue to enhancing productivity, wages and incomes. Many high-value agricultural activities such as fruits and

vegetable cultivation, dairying, poultry, piggery and small ruminant husbandry have short gestation periods, require low initial investment and generate output streams that translate into generous cash. Currently, India grows fruits and vegetables on less than 10 per cent of the area under all crops. CSO data on the value of output for year 2013-14 reveal that fruits and vegetable crops on average generate Rs. 3.30 lakh worth of output per hectare compared with Rs. 37.5 thousand in the case of cereals and Rs. 29 thousand and Rs. 48.7 thousand in the cases of pulses and oilseeds, respectively. These variations in value productivity suggest a very large scope for raising the value of agricultural output through a shift from cereals, pulses and oilseeds into fruits and vegetables. Given the high proportion of poor among those deriving their incomes from agriculture, such shift also carries the promise of cutting rural poverty. States of Andhra Pradesh and Gujarat have seen a rapid decline in their rural poverty while achieving this shift during the last decade.

An advantage of high value commodities is that even small farmers can benefit from shifting to them. Typically, they have a larger endowment of labour in relation to land and high value commodities provide an opportunity to utilize this labour more effectively. High value crops also offer the opportunity to overcome land shortages since they produce yields per hectare that are several times those of conventional crops. Adopting capital- and energy-intensive modern techniques like poly house can further increase the yields per unit of land manifold.

High value commodities also pose certain challenges, especially for small farmers. They require more capital, modern technologies, quality inputs, support services and timely information. Small farmers may lack access to these inputs. Most high-value commodities are perishable and therefore carry greater production and market risks. Local rural markets for many of these commodities are thin and absent well-developed supply chains, accessing even nearby urban markets may prove costly.

In the ultimate, it is demand side factors that would drive diversification towards high-value food and non-food commodities. Demand for these commodities rises rapidly with per capita income and urbanization. Consumption data in India shows that per capita cereals intake is either stagnant or falling whereas per capita intake of fruits, vegetables, milk, eggs, meat, fish is rising. Per capita intake of cereals in India fell by 16 per cent between 1993-94 and 2011-12. Over the same period, per capita consumption rose by 21 per cent in the case of fruits, 14 per cent in the case of vegetables, 11 per cent in the case of milk and 23 per cent in the case of meat, eggs and fish. With robust demand, food inflation in recent years has manifested itself disproportionately in the prices of high value commodities, both food and non-food.

While high value commodities have seen significant growth alongside rising incomes in recent years, there is considerable scope for their acceleration. Many of the steps necessary to achieve this acceleration are related to the reform of the Agricultural Produce Marketing Committees (APMC) Acts in the states. The farmer must be given the full right to sell her produce to whomsoever she wants. This would allow the farmer to minimize the number of intermediaries and receive a higher fraction of the price paid by the ultimate consumer. A well-functioning system of contract farming will go some distance towards providing a guaranteed

price as well as necessary technical support to the farmer. There is also a need for the development of cold storage facilities so that the farmer has the option to store the produce so that she may hold it back when the market is saturated and sell it when shortages occur. Above all, policies that facilitate the development of food processing industry will go a long way towards creating demand at lucrative prices for high value commodities. Turning food-processing industry into a major export industry can also create vast employment opportunities for workers since it is a labour-intensive industry. With the corporate sector keen on investing in agribusiness to harness the emerging opportunities in domestic and global markets, time is opportune for reforms that would provide healthy business environment for this sector. Small scale has been a major constraint on the growth of this industry and hence on the diversification by the vast majority of India farmers into high value agriculture. Investment in infrastructure comprising roads, electricity, and communication would reduce agribusiness costs and induce the private sector to invest in agro-processing, cold storage facilities, refrigerated transportation, and retail chains. Institutional arrangements such as contract farming, producers' organizations, and cooperatives that provide farmers easy access to markets, distribute price risks, and reduce marketing and transaction costs can go a long way in pushing high value agriculture.

3.5 Animal Husbandry and Livestock: A Closer Look

Though animal husbandry and fishing constitute high-value commodities and therefore may be subsumed in the discussion in the previous section, they are sufficiently important to require separate consideration. These subsectors of agriculture currently contribute one third of agricultural GDP and are likely to become even more important in the forthcoming years due to their significantly faster growth. Animal husbandry consists of dairying, poultry, piggery, goatary and wool while fisheries includes both inland and marine harvesting. The CSO data for 2012-13 indicated that livestock and fishery together contribute 33.9% of agricultural GDP at 2004-05 prices with livestock accounting for 29.2% and fisheries for 4.7%. The share has risen from 29.8% in 2004-05 with the increase originating entirely in livestock (the share of fisheries actually fell marginally by 0.1% percentage point during this period). Share of livestock in total output of agriculture sector is rising due to much faster growth of livestock output compared to crop output. Livestock sub-sector growth was always higher than crop sub-sector since 1970. This was even during the heydays of green revolution (seventies and eighties); when the policy emphasis was largely focused on the crop sub-sector. The acceleration continued in the eighties (4.9%) but it slackened in the nineties and after 2000s. Even then, this sub-sector was able to maintain a respectable growth rate close to 4 per cent per annum. Further, livestock imparts resilience to Indian agriculture, as its output does not show year-to-year fluctuations. The main challenge in livestock sector is low productivity of milch animals. Average milk yield in India is 4.90 kg per in-milk buffalo and 3.1 kg per in-milk cow. It is estimated that about 37 per cent growth in milk output has been due to increase in productivity of in-milk population and increase in number of livestock is the dominant source of growth (Birthal et. al. 2006). This type of growth associated with increase in population pressure of livestock is not sustainable. Breed

improvement, better feed and nutrition, animal health, and better herd composition are important measures for raising livestock productivity.

Animal husbandry, dairying and fisheries have also undergone transformation over the years from traditional to modern skill-intensive technology. The artificial insemination, disease and pest management, diversification of milk and meat products are all skill intensive. In dairying from normal milking to automated milking and feed management, health and disease control need skill improvement and capacity building.

Animal husbandry and fisheries offers unique opportunity for growth as the shifts in diet already under way and likely to continue as incomes increase. NSSO data on household consumption pattern indicate that the consumption behaviour of both rural and urban population is changing in favour of these sectors. Between 1993-94 and 2011-12, cereals consumption declined by 16.3% in rural and 12.4% in urban areas. During the same period, consumption of milk and milk products increased by 9.97% in rural and 10.87% in urban areas and of meat and fish increased by 23%.

The growth in different components of livestock (dairy, meat, poultry and wool) varied from 4 to 13.2% in 2013-14, significantly higher than the crop sector. To sustain this growth, we must introduce yield-enhancing and waste-minimizing technologies in the sector. While animal nutrition is crucial to maintain and enhance the livestock productivity, vaccination and health care infrastructure and services are equally critical. The health, quarantine and hygienic services assume even greater importance in view of the diseases outbreaks and in the context of rearing of high yielding exotic breeds. The infrastructure related to vaccination, veterinary services and others are highly inadequate in the vast majority of the states. However, the resources crunch in states as well as at national level is heavily affecting health and vaccination related animal welfare programmes. Consequent upon re-structuring and rationalization of funding in 2015-16, the major programme of foot and mouth disease (FMD) and vaccination might suffer. In the longer term, this may adversely impact animal productivity. It may be worth considering the expansion of primary health centres, super-specialities and effective diagnostics and vaccines using modern technologies. Genetic improvement of livestock and conservation of indigenous germplasm, adaptable to adverse climatic conditions may also give boost to Animal Husbandry. The extension services in livestock sector are very poor and require strengthening.

Close to 75 per cent of cattle population is concentrated in rainfed areas where the access to feed, fodder and drinking water is becoming increasingly scarce. The growing numbers of unproductive male cattle is posing a serious problem. The fodder base is not strong due to problems in pasture management and shrinking of common properties. Innovations in institutional aspects of pasture protection and management and usufruct sharing is required. During a drought the scarcity and resulting price rise in feed and fodder causes high inflation in prices of livestock products. A greater co-ordination between agencies responsible for livestock and those for crops that sustain livestock is required. The poultry sector achieved much acceleration despite new challenges such as periodic outbreaks of avian influenza. The major reason for this growth has been a large and vibrant commercial poultry sector with adequate

economies of scale and good backward and forward linkages. Consequently, meat was the fastest growing segment in livestock sector with a growth of 5.5 per cent per annum.

The Prime Minister has emphasised to reinvigorate the growth in fisheries sector to bring in Blue revolution in the country. The performance of the fisheries sub-sector has been decelerating since mid-1990s on account of stagnation of marine fishery, which is almost over exploited. The major potential lies in inland fisheries particularly of brackish water linked export oriented prawn cultivation. There is also strongly growing domestic demand for fresh water fish. Fish production can be enhanced 2 to 4 times in water bodies, whether irrigation reservoirs, natural wetlands or ponds and tanks created by watershed development or MGNREGS. Along with quality fish seed, feed and disease control, the marketing infrastructure, modern fish processing plants, re-engineering of the value chain will be the prime movers.

4 Remunerative Prices for Farmers

In order to facilitate productivity growth, it is important to ensure that farmers receive lucrative prices for their produce. Issues related to price fall under two categories. First, for some commodities and in some regions, the government has arrangement for procurement at a preannounced Minimum Support Price (MSP). By design, the MSP is available only in regions in which the government procures the commodities and only on commodities it chooses to procure. In other regions, even for commodities covered, not all farmers are able to sell their produce at the MSP. Second, the prevailing marketing arrangements under the conventional APMC Acts in the states have meant that the farmer receives a small fraction of the price paid by the final consumer. Marketing arrangements under these acts have undermined the interests of the farmers and benefited the intermediaries (Chand 2012; Gulati 2013).

4.1 The Minimum Support Prices

India introduced price interventions in food grain market beginning in the mid-1960s as a part of its efforts to make the Green Revolution a reality. Since then, agricultural price policy has aimed to offer remunerative prices to producers through a system of minimum support prices (MSP) backed by procurement of grain, minimize short-run and year to year price fluctuations through open market operations and distribute food grains at subsidized prices through public distribution system (PDS). The policy has been partially responsible for rapidly rising output of wheat and rice. Acute food grain shortages that had prompted the Prime Minister Lal Bahadur Shastri to call upon all Indians to fast one day each week in the mid 1960s are now a thing of the past. Instead, the country now routinely runs grain surplus, which is exported.

Nevertheless, the system of price intervention has come under serious criticism in recent years (Chand 2005, 2009). While instrumental in alleviating food grain shortages, the price policy of the past four and a half decades has also distorted the cropping pattern between wheat and rice supplies on the one hand and other crops on the other. While the government currently announces MSP for 23 crops, procurement is effective mainly for wheat, rice and cotton and

even for these crops, it is restricted to a subset of farmers in a few States. Sugarcane is another crop where millers are under legal obligation to pay statutory minimum price fixed by various states. The result has been excessive focus on the cultivation of wheat, rice and sugarcane in the procurement states at the expense of other crops such as pulses, oilseed and coarse grains. While rice and wheat have had to be either stored in excessive volumes for excessively long periods or exported at the taxpayer's expense, the country has faced shortages in pulses and edible oils. Despite significant volume of imports, prices of pulses have seen frequent spikes. Moreover, inclusive of imports, per capita availability of pulses, a major source of protein in Indian diet, suffered a decline from 25.2 kg in 1961 to 18.7 kg in 1971, and 15.3 Kg more recently. In the case of oilseeds India's dependence on import has risen to 60 per cent of domestic consumption. Policy induced changes in production pattern towards rice and wheat have also put strain on natural resources. Intensive cultivation of these two cereals has resulted in depletion of water resources, soil degradation and deterioration in water quality in some states, especially in the north-western region.

In parallel to these developments, the pricing policy has also discriminated against eastern states where procurement at the MSP is minimal or non-existent. With part of the demand in these states satisfied by subsidized PDS sales of the grain procured in other states, prices of wheat and rice in these states end up below what they would be in the absence of price interventions of the government. The price policy has thus also created a regional bias in crop pattern as well as incomes of farmers.

Therefore, there is pressing need for reorientation of price policy if it is to serve the basic goal of remunerative prices for farmers. This goal cannot be achieved through procurement backed MSP, however, because it is neither possible nor desirable for the government to buy each commodity in each market in all regions. Financial cost of such a policy would place fiscal consolidation at risk and administrative burden would put challenge the capacity of the bureaucracy.

One measure that can help check the prices received by farmers to some degree is the system of "Price Deficiency Payment". While MSP may still be used for need-based procurement, under the deficiency payments system, a subsidy would be provided on other targeted produce in case the price falls below a pre-specified assured threshold. This approach would help prevent unwanted stocks and spread price incentives to producers in all the regions and all the crops considered important for providing price support. Under the system, the government would announce a floor price for each crop. This floor may be the average of the market price in the preceding three or four years. Each farmer would register her crop and acreage sown with the nearest APMC mandi. If the market price then fell below the floor price, the farmer would be entitled to the difference up to a maximum of, say, 10% of the assured price that could be paid via direct benefit transfer into an Aadhar linked bank account. This system would keep the quantum of the subsidy in some check and also meet the restrictions on the subsidy imposed by the World Trade Organization (WTO). The system can initially be piloted in selected districts in a few states in a crop such as cotton in which price discovery is

institutionalised. Satisfactory implementation would require transparent land-leasing laws and land records so that the actual cultivator and her plot of land can be identified and given the payment due.

4.2 *Agricultural Marketing and Higher Price for the Farmers*

Demand pattern of agricultural commodities both at consumer and industry level has been shifting towards high quality and processed products.⁷ These changes favour integrated supply chain rather than conventional marketing channels, assured market rather than open market and specific produce rather than generic one. Such supply chains also offer considerable scope for cutting the margins of middlemen. An integrated supply chain is particularly beneficial to small holders who dominate the scene in India. A well-functioning supply chain can reduce the cost of marketing by linking farmers more closely to processing firm and consumers. It can also inform them about changing consumer preferences for quantity, quality, variety, and food safety. Modern supply chain also consists of quality standards and their enforcement (Gulati 2009).

It has been observed that farmers in all states and for almost all major agricultural commodities are seeking price guarantee like MSP on the lines given for rice and wheat in selected states. The major reasons for this are that agricultural markets in India are not keeping pace with the changes in production and demand and to ensure competitive prices to farmers (Chand 2012). Agricultural marketing suffers from fragmentation resulting from large number of intermediaries and poor infrastructure, lack of vertical integration and policy distortions. A consequence of this fragmentation is that the farmer often receives a small fraction of the final price paid by the consumer. Therefore, urgent reforms are needed in agricultural marketing so as to enable farmers to receive a larger proportion of the final price paid by the consumers.

One possible solution is to encourage contract farming under which the buyer can provide the farmer access to modern technology, quality inputs, other support and a guaranteed price.⁸ A few experiments of direct procurement backed with technical support have shown to benefit the farmers in some States.

Another model is direct sales by farmer to consumers either as individuals or as an organization. Such models have been developed in some states like *Apni Mandi* in Punjab and Haryana, *Raythu Bazaar* in Andhra Pradesh and *Uzavaar Sandhai* in Tamil Nadu. Under these arrangements, farmers are allowed to sell their produce as retail to consumers in the towns on selected days and time without intermediaries. However, the scale of operation of these marketing arrangements is quite low as only farmers located in the vicinity of big towns can benefit from this form of marketing.

⁷ Chand (2012) and Panagariya and Rao (2014); Patnaik (2011) offers a detailed analysis of the state agricultural marketing and necessary reforms in this area.

⁸ For instance, Maharashtra has introduced contract farming of pulses and other commodities.

One way to overcome this hurdle is to encourage integrators who would buy fruits and vegetables at village level just as milk collection centres collect milk currently and supply these directly to retailers including e-retailers in towns and cities. This backend to frontend linkage will connect farm to consumers and is a win-win step for both the producer and the consumer.

In order to promote reforms in agricultural marketing, in 2003, the central government had suggested a model Agricultural Produce Marketing Committee (APMC) Act. However, many States are yet to implement it in earnest. Certain desired provisions like out-of-mandi transactions and exemption of market fee on horticultural produce have not found place in the amended statutes in several States. All States need to implement the model Act without diluting it to serve the interests of particular groups. This will pave the way for direct marketing and vertical co-ordination through contract farming. It will also provide alternative options to producers and create competitive environment for services that are currently a monopoly of the market committee.

The Committee on Encouraging Investments in Supply Chains, including provision for cold storages for more efficient distribution of farm produce, set up by the erstwhile Planning Commission, had recommended exempting perishables from the purview of APMC, provide freedom to farmers to sell directly to aggregators and processors, introduce electronic auction platforms, and replace licensees of APMC markets with open registration backed by bank guarantees. The Committee had further recommended encouraging large scale private investments in the cold chain sector using PPP Model with Viability Gap Funding besides providing budgetary support and capitalizing on schemes such as Rural Infrastructure Development Fund (RIDF). The Working Group on Consumer Affairs under the chairmanship of the then Chief Minister of Gujarat (now the Prime Minister of India) had also given a number of suggestions including setting up Ministerial Level Coordination mechanism, liberalization of agricultural markets, promoting organized retail and cooperatives and development of agricultural market infrastructure including storage capacities in food deficit regions, cold chains and agro-processing. The implementation of these recommendations varies from State to State and needs to be expedited.

Organized retailing in India has seen steady growth during the last decade. FDI in organized retail promises to boost food retail and offer significant benefits to farmers. It would also help in developing the back end processing facilities and cut down wastages (Reardon and Gulati 2008). The idea of e-marketing of the agricultural and horticultural products has also been catching on lately. While “organized retail” may not be a panacea for addressing all the problems of the agricultural marketing, it could help in improving the supply chain and bring down wide margins between farm gate and consumer prices. Further, given the vastness and diversity of Indian agriculture, the country requires multiplicity of instruments including the model APMC act, scaling up of successful experiences like cooperative milk marketing and organised retail to impart efficiency, competitiveness and modernisation of agricultural marketing. There is also a need for the states to promote producers association, producers companies and co-operative marketing societies to improve bargaining power of producers.

The move towards common National Agricultural Markets announced in the Union Budget 2015-16 need to be pursued vigorously to ensure remunerative prices to farmers from the open market and to reduce the demand for price support mechanism. In addition to reforms in the APMC Acts, there is also a need to have a relook at some of the provisions of the Essential Commodities Act which discourage large scale private investments in agricultural markets, without diluting its basic premise of ensuring supplies of essential commodities to public and preventing exploitation by unscrupulous traders. One possible strategy would be to provide exemptions to certain categories of players such as exporters, food processors, multiple outlet retailers and large departmental retailers from applicability of stock limits. This would ensure that genuine players are not harassed while action is still taken against black-marketers.

The agricultural produce marketing systems suffer from major distortions and multiplicities of levies and mandi taxes (Patnaik 2011 and Subramanian 2014).⁹ These are neither transparent nor uniform across the States and are a major barrier to farmers realizing remunerative prices. There remain serious restrictions on the movement of agricultural commodities even within states. In this context, a model has been developed by Karnataka which has integrated a number of markets into a single licensing system with a joint venture of State government agency and NCDEX spot exchange, which offers automated auction and post auction facilities. This model can be replicated in other States. Besides, a National Agricultural Market has been envisaged through Agri-Tech Infrastructure Fund (ATIF) set up by the Department of Agriculture and Cooperation with an outlay of Rs.200 crore. The ATIF is aimed at implementation of agricultural marketing reforms by initiating appropriate e-market platforms in States (especially in 642 regulated markets) with a view to move towards a National Market. This e-marketing platform is expected to help farmers in better marketing of produce, get market related information and facilitate better price discovery through efficient, transparent and competitive marketing platform with access to large number of buyers from within and outside the State through transparent auction processes. It would also increase the farmers' access to markets through warehouse based sales and thus obviating the need to transport such produce to the mandi. Implementation of this platform need to be expedited backed by adequate resources from the Government.

In another important development, Government has set up a Price Stabilisation Fund for procurement and distribution of perishable agricultural and horticultural commodities. This is expected to smoothen out the price differential across seasons. While the initial focus was on potato, rice and tomato, the government has recently extended the program to pulses. This program must be carefully studied before being scaled up. Price stabilization is a tricky business and its success crucially depends on the ability of the stabilization authority to judge when the prices are high and when they are low and then quickly move to buy and sell the produce. Mistakes can easily result in destabilization of prices.

⁹ For further details on this and other government controls on agriculture see Gulati (2013).

5 Agricultural Land Policy: Leasing and Titling

The need for a law that formally recognizes tenancy has been felt widely. Such a law is not only a source of consolidation of land holding and other efficiency enhancing measures in land use but is also essential for the implementation of government programs and reforms that require the identification of the actual cultivator. For example, disaster relief is meant for the actual cultivator but absent formal recognition of tenancy, the benefit may accrue to the landowner who continues to be as the cultivator in the revenue records. Similarly, fertilizer subsidy can be given through the direct benefit transfer system to the actual cultivator if the latter can be identified.

Land leasing laws in agriculture in most of the states in India were enacted during decades immediately following the independence.¹⁰ At the time, the abolition of Zamindari and redistribution of land to the tiller were the highest policy priorities. Tenancy and sub-tenancy were viewed as integral to the feudal system that India had inherited from the British and sought to abolish. Therefore, tenancy reform laws that various states adopted in the post-independence era sought to not only transfer ownership rights to the tenant but also prohibited or heavily discouraged leasing and sub-leasing of land.

Unfortunately, however, politically influential landowners successfully subverted the land reforms in India. As P.S. Appu has documented in his 1996 book *Land Reforms in India*, till as late as 1992, ownership rights were transferred to the cultivator on just 4% of the operated land. Moreover, just seven states, Assam, Gujarat, Himachal Pradesh, Karnataka, Kerala, Maharashtra, and West Bengal, accounted for 97% of this transfer.

In trying to force the transfer of ownership to the cultivator, many states abolished tenancy altogether. The policy resulted in minimal land transfer and had the unintended effect of ending any protection to tenants and forced them underground. Some states allowed tenancy but imposed a tight ceiling on land rent requiring that it be no more than one-fifth to one-fourth of the produce. But since this ceiling fell well below the level acceptable to the landowner, contracts became oral in these states as well, with the rent settling closer to 50% of the produce.

Today, Telangana, Bihar, Karnataka, Madhya Pradesh and Uttar Pradesh ban land leasing with exceptions granted to landowners among widows, minors, disabled and defence personnel. Kerala has for long banned tenancy entirely, permitting only recently self-help groups to lease land. Some states including Punjab, Haryana, Gujarat, Maharashtra and Assam do not ban leasing but tenancy for a specified period makes the tenant eligible to buy the leased land. This provision too has the effect of making tenancy agreements oral, leaving the tenant vulnerable. Only the states of Andhra Pradesh, Tamil Nadu, Rajasthan and West Bengal have liberal tenancy laws with the last one limiting tenancy to sharecroppers. A large number of states with otherwise liberal tenancy laws do not recognize sharecroppers as tenants.

¹⁰ For a more detailed analysis of land leasing laws in India, see Haque (undated).

These restrictions have detrimental effects on not only the tenant whom they were originally designed to protect but also the landowner. The tenant lacks the security of tenure that she would have if laws permitted her and the landowner to freely write transparent contracts. In turn, this discourages her from making long-term investments in land and also leaves her feeling perpetually insecure about continuing to maintain cultivation rights. Furthermore, it deprives her of potential access to credit that may be available to cultivators including that under priority sector lending. Landowner also feels a sense of insecurity when leasing land encouraging many choosing to leave land fallow rather than lease it. The practice of leaving the land fallow is becoming increasingly prevalent with landowners and their children seeking non-farm employment.

Over the generations, land holdings have become progressively small and fragmented. The absence of transparent land leasing laws has hampered the consolidation of these holdings. In the present-day context when many in farmer families seek non-far employment, greater potential for consolidation has opened up.

The absence of transparent leasing laws also poses challenges for public policy. For example, there are calls for expanded and more effective crop insurance. Recognizing that such insurance is likely to be highly subsidized, as has been the case with the past programmes, a natural question is how to ensure that the tenant who bears the bulk of the risk of cultivation receives this benefit. Absent formal records of tenancy, it is unlikely that the actual cultivator will be able to reap this benefit. The same problem arises in the face of a natural calamity; if tenancy is informal, we cannot ensure that the actual cultivator would benefit from the disaster relief programmes.

In a similar vein, fertilizer subsidy today is subject to vast leakages with fertilizer purchased at subsidized prices sold in the black market. In principle, these leakages could be sharply curtailed by the introduction of direct benefit transfer (DBT) using Aadhar seeded bank accounts along the lines of the cooking gas subsidy transfer. But in the face of the difficulty in identifying the real cultivator, DBT cannot be satisfactorily implemented.

The introduction of transparent land leasing law that allows the potential tenant or sharecropper to engage in written contracts with the landowner is a win-win reform. In the presence of such a law, the tenant will have an incentive to make investment in improvement of land and will also be able to access credit including under priority-sector lending. Under the law, the landowner will also be able to lease land without fear of losing it to the tenant. Among other things, this will also permit the consolidation of land holding so essential in the face of declining size of and fragmented land holdings. Finally, with the tenant formally recognized, the government will be able to implement its policies aimed at the cultivator as the beneficiary efficiently.

An argument against liberalisation of land lease market is that landowners may evict the existing tenants who had acquired rights to cultivate upon abolition of Zamindari. But giving these existing tenants the first right of refusal or even leaving them outside the purview of the new leasing law can alleviate this problem. Another fear is that opening of the lease market will

bring private investors into agriculture. While, in principle, private investment is desirable for enhancing productivity, it may potentially hurt small and marginal farmers by restricting their access to land. There are two answers to this argument. First, more productive farms would create well-paid jobs that potentially provide better living than that of a small or marginal farmer. And second, an overall ceiling may be imposed on the amount of land that private investors can cultivate in any region.

An important instrument for creating vibrant land lease market is land bank. Such a bank may be held by a public agency. Interested landowners may deposit their land parcels in the bank and potential cultivators may lease in land from it. The public agency would work essentially as a clearinghouse. It would transfer rent from actual cultivator to owner while charging a small fee to cover its costs. Land banks can give confidence to the owners that their land would remain safe while also earning them competitive rent. On the other hand, potential tenants would find it easier to find land parcels they wish to lease in.

A closely related but more difficult reform involves giving conclusive ownership titles to landowners. Documents relating to land transactions in India are registered under the Registration Act of 1908. But such registration only provides the evidence of the transaction having taken place without providing any guarantee whatsoever of ownership of the property to the buyer. Ambiguity arises from the possibility that a third person may at any time challenge the ownership of the seller in the first place. Therefore, the ownership of a person with the possession of a piece of land is secure only as long as no one else challenges it in a court of law. In effect, land ownership in India is entirely presumptive. Revenue records from the British era and purchase-sales documents registered under the Registration Act of 1908 are the only source of information on ownership. When these records and documents are incomplete or patchy as is that case in many instances, they lead to litigation.

The absence of conclusive titles has many adverse implications. Banks can sometimes refuse to provide credit to a farmer against her land if they are unsure about her ownership of the latter. A tenant may feel insecure if the ownership right of the lessor is in doubt. Land sales market also functions inefficiently when titles are ill defined. Absence of titles can also be in the way of reform of land leasing laws. For instance, if presumptive owners fear that reformed land leasing laws that formally recognize tenancy rights would pave the way for a future populist government to transfer ownership to the tenants, they would oppose such reform. In contrast if they held indefeasible ownership titles, they would assured of their ownership rights and support the reform.

The first step towards the introduction of land title is to digitize the revenue and registration records. The two databases have to be searchable so that presumptive ownership of a piece of land at any point in time can be readily ascertained. The two databases must also interface such that any new registration of a transaction automatically triggers a change of ownership in the revenue records. Finally, maps have to be updated using modern technology so that the scope for dispute between ownership of adjacent piece of land is minimized.

In 2011, the Ministry of Rural Development prepared the draft to amend the Registration Act of 1908. The Registration (Amendment) Bill, 2013, sent to Parliamentary Standing Committee on 8 May 2015, provides for a model law for all States and UTs to enact uniform law conferring conclusive property titles on owners. But as noted above, a precondition for the conclusive titles is digitization of revenue and registration records and updating of maps using modern technology.

Under the proposed model law, a register of land-holdings maintained by the government will establish the land titles. It will maximize transparency and eliminate uncertainty. At present no register, which reliably confirms title, exists anywhere in India. Small experiments in some states to build such register have not been successful. Existing registers suffer from problems arising from lack of up-to-date records, informal family partitions, unregistered power of attorney transactions and numerous boundary and ownership disputes.

The creation of a land-holdings register requires that land parcels be identified, with their boundaries, and ownership established. The former requires maps of individual land parcels and their location within an area's land grid, both correlated accurately with the prevailing ground conditions. The latter requires undisputed, litigation-free ownership rights. Both these records will then have to be publicly notified before the conclusive title is granted.

The National Land Records Modernization Programme, initiated by the Government of India in 2008, aims to build a transparent and integrated system of real-time land records based on land surveys, updating of survey and settlement records. The high-resolution satellite imagery and ground truth data collection by electronic total station and GPS are to be used. It also envisages computerization of land records and registration, modernizing of record rooms and setting up of record management Centres.

So far only four states—Gujarat, Haryana, Karnataka and Tripura—are in advanced stages of modernizing records. Another eight —Andhra Pradesh, Bihar, Delhi, Goa, Maharashtra, Odisha, Rajasthan and Uttar Pradesh—have made substantial progress. Nine other states including Chhattisgarh, Himachal Pradesh, Madhya Pradesh, Tamil Nadu and West Bengal have made some beginning towards modernizing land records, while Kerala, Arunachal Pradesh, Jammu & Kashmir, Jharkhand, Manipur, Meghalaya, Mizoram and Nagaland are very slow.

It is noteworthy that states like Chhattisgarh, Orissa and Tripura has implemented Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (popularly called as Forest Right Act 2006) under which the forest dwellers were provided 1-2 acre land for settled farming. By September 2013, titles for 2.18 million ha had been given to eligible forest dwellers.¹¹

It needs to be noted that under the Indian Constitution, land is a State subject. Therefore, the changes in this area would require action by states. Given its mandate to promote cooperative and competitive federalism, the NITI Aayog is the obvious institution to assist the states in catalysing these changes.

¹¹ See <http://tribal.nic.in/WriteReadData/archiveDoc/201402260217218437500MPRforthemonthofSeptember2013.pdf>.

6 Farmer Distress and Immediate Relief

Natural disasters such as droughts, floods, cyclones, storms, landslides and earthquakes can lead to extreme distress and hardship among farmers who predominantly lead subsistence existence. In these situations, they need at least a minimal amount of relief at rapid pace. In the past, crop insurance has been the vehicle for such relief but crop insurance typically covers only those farmers who have outstanding loans from banks. This leaves out marginal farmers who are unable to borrow from the banks. It also leaves out landless workers who depend on agricultural employment but are themselves not farmers.

Therefore, a mechanism is required to bring quick relief to all those impacted directly or indirectly by natural disaster. Given that much of the cost of insurance is borne by the government, it is effectively a transfer rather than genuine commercial program. Therefore, it may be best to conduct the relief transparently as an emergency social program. The government should create a database that identifies farmers and landless workers with their respective Aadhar seeded bank accounts. In case of a natural disaster, transparently identified by weather data and a set of weather related criteria, the government should then transfer a minimum specified sum of cash immediately into these accounts. The cash would provide instant relief to those damaged by the natural calamity. For richer farmers who may want insurance above this relief, a separate commercially viable crop insurance program may be operated.

If the government has a preference for an insurance program for this purpose, it should evolve a mechanism for the introduction of a diversified set of crop insurance products offered by different insurers who compete against one another. The objective should be to cover all farmers—small, marginal and others— with those having 2 ha or less land covered at substantial subsidy on the premium. Farmers with more than 2 ha land should be required to pay the premium in full to avail the benefits.

Appropriate avenues should also be explored to create jobs for those farmers interested in exiting farming. Farm-oriented processing and small-scale industries offer two such avenues.

7 Bringing the Green Revolution to Eastern States

Eastern States of Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, eastern Uttar Pradesh and West Bengal contribute about 30% of gross cropped area and 40% production of food grains. The region has fertile soil and ample water resources, the two prerequisite for high productivity. National Bureau of Soil Survey & Land Use Planning (NBSS&LUP) under ICAR has estimated a length of growing period (LGP) of 240 days or more for majority of the areas in these states.¹² This LGP is adequate to support double cropping. Annual rainfall ranging from 1000 mm to 2500 mm and abundant ground water provide the necessary water resources. The groundwater

¹² see Velayutham, et al (1999) for further details

draft is much less than ground water availability. Nevertheless, rice yields in the region are much lower than in Punjab, Haryana and Western Uttar Pradesh.

Data on rice production indicate that drought hits eastern region the hardest. This happens because farming in this region is predominantly rain dependent. Severe drought was experienced in the year 2002-03. In spite of low base that year, net sown area between 2002-03 and 2011-12 has shown declining trend. The loss was substantial in the States of Jharkhand, Orissa, West Bengal, Chhattisgarh and Bihar. The irrigation expansion has also been negative in Bihar, Jharkhand and Orissa, which have abundant supply of surface water and underutilized groundwater. At the same time, rising area of irrigated maize in Bihar, diversification towards pulses and oilseeds in Odisha and increase in procurement of rice/paddy in Chhattisgarh, Jharkhand and Odisha offer some hopeful signs.

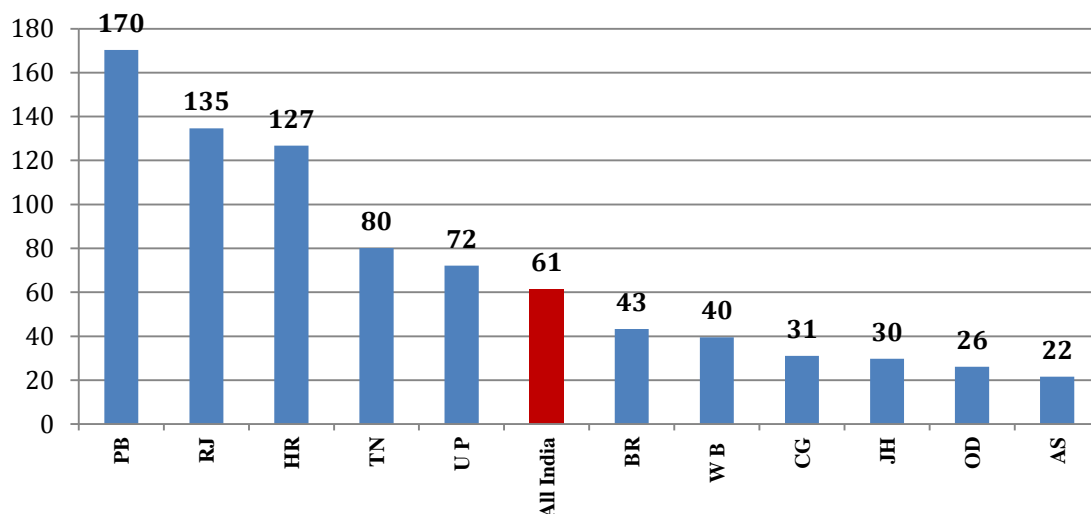


Figure 2 : Grounwater Development (%) in select states

Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, Uttar Pradesh and West Bengal account for 61per cent of 153.66 BCM of total available groundwater for future use. As shown in Figure 2, groundwater development in these states except Uttar Pradesh is quite low; less than 50 per cent. With the exception of Uttar Pradesh, the states in eastern region also have lower groundwater development than the national average. Therefore, there is considerable scope for groundwater development in the region though with the important qualification that high arsenic levels may disqualify certain areas for it. The abundance of surface and ground water and less intensive use of land resources mean that the region has considerable scope for increase in agricultural productivity and production. Therefore, Hon'ble Prime Minister is right to have called the region the ideal place for ushering in the Second Green Revolution.

Rice is the predominant crop in eastern agro-climatic condition. Therefore, any intervention for enhancing agricultural production must include rice as its major component. Rice-based cropping system in eastern regions of India faces several constraints. The main factor constraining the productivity of rice-based cropping system is abiotic stress such as drought, flood, submergence and salinity. Data show that about two-thirds of area under rice is prone to

droughts and floods. In these states, electricity consumption for agriculture purposes is less than half of that in Punjab and Haryana. In Odisha and Jharkhand electricity use in agriculture is minuscule.

Eastern states receive adequate rainfall and soil and climate are very congenial for cropping after harvest. Yet farmers often leave their fields fallow after the harvest of rice for two reasons. First, they normally begin raising nursery after the onset of rains and grow long duration rice varieties that vacate field late, leaving little time for the sowing of a second crop. Second, they let cattle loose on the fields after the harvest of rice that discourages farmers from growing a second crop. The solutions could be raising community nursery of improved varieties of medium duration rice varieties at assured irrigation sites within the Panchayat to facilitate transplanting with the onset of rains. This could advance harvesting by about 21 to 30 days and help for timely sowing of second crop on residual moisture. Very early varieties may not hold promise as their harvesting may coincide with rains and lead to loss of harvested produce. The second problem is primarily social and may automatically be alleviated once large groups of farmers start cultivating the second crop. The estimates of International Crop Research Centre for Semi-Arid Tropics (ICRISAT) reveal that about 11.6 million ha¹³ area is left fallow after the harvest of rice in the country. Of this, about 82% lies in the eastern states. This offers a unique opportunity for productivity enhancement both at aggregate level and at farm level through crop intensification.

There are two prerequisite for bringing about this change: improvement of institutions and input delivery mechanism. The prevailing institutional services are settled down at a very low level and are not in tune with modern agricultural practices. Farmers often depend on semi-monopolistic public and private organizations. Small and marginal farmers lack capital necessary to adopt modern agricultural practices. Availability of inputs such as seeds, fertilizers and power is inadequate and must be rectified.

A closely related but long term solution would be to develop crop varieties that grow well within shorter time schedule allowing double cropping without yield penalty. The agro-techniques for harnessing the best of residual moisture would also be critical. The agricultural extension services in the states need revitalization through deployment of manpower along with technology. Greater linkages with R&D institutions and gross root extension functionaries would help enhance outreach on frontier technologies. The marketing infrastructure, farm energization for irrigation along with access to institutional credit would be prerequisite for penetrating the technologies. The solar photovoltaic pumps could be an attractive technology for energization of low lift pumps in shallow water table areas. The low cost farm implements will add quality in farming in tribal areas.

Establishment of cold chain and quality testing labs with good infrastructure, instruments and technicians would reinforce these measures. Hon'ble Prime Minister has also emphasized on several occasions for the need for the creation of adequate marketing infrastructure and support mechanism so as to sustain any such revolution for a longer time.

¹³ See Subba Rao et al (2001) for more details.

The tribal dominated area of Odisha, Jharkhand and Chhattisgarh where the chemical fertilizer use is very low and farming is organic by default offer good scope for expansion of organic farming. The organic farming in this region can be made sustainable with its orientation towards export market. However, to achieve this, very strong infrastructure on quality control and certification, processing and branding is required. The farm size in majority of the states is very small and generally uneconomical. The farmers in the region should align the farming with growing demand for fruits and vegetable through technology and skill intensive farming. Some of the initiatives in Jharkhand and Odisha on group formation and subsequent results are encouraging. These may be scaled up by other States to empower the small and marginal farmers.

8 Conclusion and Recommendations

This paper has concentrated on a select but important set of policy issues confronting Indian agriculture to come up with recommendations that would help bring about a second Green Revolution in India and sustain robust growth in agriculture. Five such issues have been chosen: measures necessary to raise productivity, policies ensuring remunerative prices for farmers, reforms necessary in the area of land leasing and titles, a mechanism to bring quick relief to farmers hit by natural disasters, and initiatives necessary to spread Green Revolution to eastern states.

While measures that have been outlined are essential for rejuvenation of agriculture as well as ensuring a decent life for farmers, we must not lose sight of the fact that relief to farmers will remain incomplete without the creation of job opportunities for them in non-agricultural sectors. With industry and services able to grow much faster than agriculture—the fastest that agriculture has grown over a continuous ten-year period in the post-independence era is 4.7% during the 1980s—the share of agriculture in the GDP will continue to decline. Already, this share is down to approximately 15% while it supports 49% of the workforce. In order that today's farmer families can share in the faster growth occurring in industry and services, it is essential that some of them be able to find good jobs in these sectors. As some of the farm families move out of agriculture, the opportunities for consolidating and enlarging land holdings will open up as well. In turn, this will allow greater use of modern machinery and farm techniques allowing productivity and wages to rise rapidly in agriculture as well. The following offers a summary of policy recommendations:

- Despite rising scarcity and stress on water resources, India uses irrigation water very inefficiently. Area under irrigation can be doubled in the country without requiring extra water if we attain water use efficiency level of countries like China, USA, and Brazil. We need to learn from and adopt irrigation technologies used in the other countries and adopt new agronomic practices for realising the goal of “*per drop more crop*” and *Har Khet Ko Pani*.

- Accelerate seed replacement rate with the objective of raising it to 33 per cent in high yielding varieties and 100% in hybrids. Additionally, revitalise the seed chain with focus on replacing varieties older than ten years by new ones. Incentivise public sector and facilitate private sector to raise quality seed production to generate adequate supply.
- To ensure that the farmer can buy subsidized urea when he needs it, de-canalize its imports, allow transactions to take place at the import price and pay fertiliser subsidy directly to farmers and domestic urea producers.
- Realign fertilizer use recommendations to emerging fertilizer products such as neem-coated urea and urea briquette. Provide information to farmers on the optimal use of different fertilizers according to soil type, crop and water usage. Farmers must be encouraged to better calibrate the balance as well as level across different fertilizers.
- In the post-reform era, India has relied more heavily on prices to expand agricultural production with technology and other non-price factors taking backseat. This has had the unhappy side effect of relatively high food inflation and cyclical growth pattern. In the process, the technological factors have been neglected. The imbalance must be corrected.
- In particular, the success of Bt cotton in India and many more GM seeds elsewhere in the world testifies to the potential of GM technology in giving a major boost to productivity in agriculture. India should explore selective use of transgenic seed varieties with the necessary safeguards in areas where conventional technology is not yielding much needed gains like pulses and oilseeds. Transgenic seed varieties can also help in addressing adverse effect of pesticide on human health and environment, food safety, abiotic stresses and vitamin and nutrient deficiencies in diets.
- In a similar vein, the rising concern for sustainability and efficiency necessitate harnessing of natural resource management technologies and improved practices. Modern machinery such as laser land levellers, self-propelled sprayers, precision seeders and planters, transplanters for rice and vegetable seedlings, multi-crop threshers, harvesters for cereals and sugarcane available today allow technically highly efficient farming and resource conservation. Public extension agencies and development departments need to change their orientation from varieties and inputs to other areas like resource-conserving technologies, farm mechanisation, post harvest and marketing. India must also keep an eye on the use of Nano technology applications in agricultural inputs to enhance input use efficiency.
- Due to several weaknesses that have crept into ICAR and State Agricultural Universities and low participation of private sector in R&D and technology generation, India is falling behind in agricultural technology. If public sector does not deliver and private sector is not welcome, both farmers and consumers will

suffer. Urgent steps are needed to overhaul, reform, restructure and revitalise National Agricultural Research System to make it effective. Public sector alone cannot meet future challenges and requirements of agriculture. There is a need to create favourable environment for private sector participation in agricultural research and technology development.

- Demand side factors are highly favourable for diversification towards high value horticultural and livestock products and attribute-based products. However, infrastructure, institutions and public policy are not very favourable towards them. There is a need for measures to improve health and hygiene of the livestock for improved quality of meat and meat products, expand cold storage facilities and provide market finance to farmers. We must pay special attention to veterinary services and vaccination to avoid the disease outbreaks and sustain the growth of the livestock. We must also exploit more fully the potential for inland fisheries reinforced by post-harvest management and export-oriented fish farming in brackish water. Above all, policies that facilitate the development of food processing industry will go a long way towards creating demand at lucrative prices for high value commodities. Turning food-processing industry into a major export industry can also create vast employment opportunities for workers since it is a labour-intensive industry.
- Liberalised land lease market offers solution to several problems of Indian agriculture like consolidation of operational holdings, fallow lands, access to institutional credit, and productive use of land belonging to farmers unwilling engage in farming. A transparent land leasing law that allows the potential lessee or tenant or sharecropper to engage in written contracts with the landowner is a win-win reform. Under the law, the landowner will also be able to lease land without fear of losing it to the lessor. The biggest advantage of liberalised and secure land lease market will be that it will ease the exit of those farmers who find farming unattractive or non-viable and economically strengthen those farmers who want to stay in the farming and raise the scale of operational holdings. Among other things, this will also permit the consolidation of operational land holding so essential in the face of declining size of and fragmented land holdings.
- NITI Aayog should prepare “model land leasing acts” that can be used by various states to reform their existing land lease provisions and acts keeping in view the differences in existing laws, land tenure systems and special circumstances of hilly states.
- Another instrument for creating vibrant land lease market is land bank held by a public agency. Interested landowners may deposit their land parcels in the bank and potential cultivators may lease in land from it. Under this system, the public agency acts as an intermediary and transfers rent from actual cultivator to owner while charging a small fee to cover its costs.

- A closely related but more difficult reform that is worthy of further study involves giving conclusive ownership titles to landowners as the absence of conclusive titles has many adverse implications. The first step towards the introduction of land title is to digitize the revenue and registration records. The two databases must also interface such that any new registration of a transaction automatically triggers a change of ownership in the revenue records. Finally, maps have to be updated using modern technology so that the scope for dispute between ownership of adjacent piece of land is minimized.
- Agricultural markets in India have witnessed at best limited reforms during the last three decades and the mandi system is characterised by inefficient physical operations, excessive crowding of intermediaries, long and fragmented market chains and low scale. This is depriving farmers of fair share of the price paid by the final consumer. Consequently farmers are seeking MSP for almost all crops and everywhere, which is not feasible. There is a need for paradigm shift from price centric direct intervention to non-price policy instruments. The aim should be to create enabling market environment for produce for higher price realization for farmers. Many of the steps necessary to achieve this are related to the reform of the Agricultural Produce Marketing Committees Acts in the states. The farmer must be given the full right to sell her produce to whomsoever she wants in virtually all products. This would allow the farmer to minimize the number of intermediaries and receive a higher fraction of the price paid by the ultimate consumer. A well-functioning system of contract farming will go some distance towards providing a guaranteed price as well as necessary technical support to the farmer. With the corporate sector keen on investing in agribusiness to harness the emerging opportunities in domestic and global markets, time is opportune for reforms that would provide healthy business environment for this sector. In states that have repealed APMC Act or do not have it, there is need for the integration of their agricultural markets with National Agricultural Market. There is also need to apply the Essential Commodity Act more judiciously so as to make private investments in the marketing and storage infrastructure more attractive.
- Institutional arrangements such as contract farming, producers' organizations, and cooperatives that provide farmers easy access to markets, distribute price risks, and reduce marketing and transaction costs can go a long way in pushing high value agriculture. The removal of restrictions to buy and sell agriculture produce can revolutionise fruits and vegetable production particularly at small farms. We need to encourage integrator and vegetable and fruit buyers to collect and purchase produce at village level, like milk collection centres, and supply these directly to retailers including e-retailers in towns and cities. This backend to frontend linkage will connect farm to consumers and is a win-win step for both the producer and the consumer.

- There is a need for reorientation of price policy if it is to serve the basic goal of remunerative prices for farmers. This goal cannot be achieved through procurement backed MSP since it is neither feasible nor desirable for the government to buy each commodity in each market in all regions. One possible way to keep a check on prices falling below threshold level is to adopt system of "Price Deficiency Payment". While MSP may still be used for need-based procurement, the remainder of the produce may be covered under " price deficiency payment". This approach would help prevent unwanted stocks and spread price incentives to producers in all the regions and all crops. To assess the viability of deficiency price payment system, cotton may be adopted as a test crop for pilot in selected districts of leading states.
- There is acute need to pay special attention to the needs of eastern states and other rain-fed regions. With procurement concentrated in regions with well-developed irrigation and PDS bringing subsidized grain to eastern states, farmers face depressed prices in the local markets. Replacing procurement based MSP by deficiency payments will go some distance toward alleviating this problem. Additionally, markets and infrastructure in the eastern states are highly underdeveloped requiring public intervention.
- Organic farming in eastern and north-eastern States could be rewarding. The appropriate support for quality input supply, quality testing and certification and processing would be pre-requisites. Value addition in the produce can be achieved with appropriate branding for export promotion.
- A mechanism is required to bring quick relief to all those impacted directly or indirectly by natural disaster. It may be best to conduct the relief transparently as an emergency social program. The government should create a database that identifies farmers and corresponding Aadhar seeded bank accounts. In case of a natural disaster, transparently identified by weather data and a set of weather related criteria, the government should then transfer a minimum specified sum of cash immediately into these accounts. The cash would provide instant relief to those damaged by the natural calamity.
- If there is preference for crop insurance to deal with distress situations, the government should evolve a mechanism for the provision of a diversified set of crop insurance products by a diverse set of insurer firms. Farmers with less than 2 ha of area inclusive of all crops may be provided a substantial subsidy on the premium while larger farmers are required to pay commercial rates for coverage.

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