

## **PRESIDENTIAL ADDRESS**

# **Indian Agriculture at a Critical Crossroad: Change and Transformation Needed for a Brighter Future\***

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### **I**

#### **INTRODUCTION**

I am deeply humbled and honored today to deliver to you the Presidential Address of 80th Annual Conference of the Indian Society of Agricultural Economics hosted by the Tamil Nadu Agricultural University (TNAU), Coimbatore. The Conference is being conducted in an online/ virtual mode for the first time, given the constraints imposed by the unprecedented Covid-19 pandemic in the country and the world. On the occasion of the Conference I would first like to most heartily welcome all the members of the Society as well as all other participants and dignitaries and participants present/attending the Conference. Particularly, I would like to sincerely thank the esteemed office-bearers and the members of the Society for bestowing on me this honor and unique opportunity. I feel truly humbled to be in this position today, which has been held before me by so many outstanding and eminent luminaries of the profession, several of whom I have been very lucky to have as my teachers and mentors in different ways, including Dr. V.S. Vyas, Dr. Raj Krishna, Shri J.S. Sarma, Dr. D.K. Desai, Dr. B.M. Desai, Dr. Katar Singh, Dr. Dayanatha Jha and Dr. A. Vaidyanathan. I have been blessed to have their presence in my career and life - my deepest remembrance and thanks to them, as well as to a few others, particularly Dr. G.M. Desai. My immense thanks also to Dr. Abhijit Sen, Dr. Dinesh Marothia and Dr. C. Ramasamy for their wonderful guidance and support. My sincere thanks also to the Conference Session Chairs/ Rapporteurs, the Keynote Paper writers, other paper-writers, and particularly to Dr. C.L.Dadhich, Secretary, ISAE and the Organising Secretary of the Conference Dr K.R. Ashok and his team at TNAU for their outstanding efforts in this difficult situation to make this conference a success.

The theme of my address today is change. This includes, in particular, the changes confronting Indian agriculture and the changes needed. In our world today, change has become the new constant ! - whether we like it or not. If we look back in recent times, no decade has been like the previous decade - every decade has thrown up new major challenges and problems, as well as new opportunities and solutions. In more recent times such as the last decade, no year has been like the previous year. Who would have expected 2020 to be so different from 2019! - the pandemic completely changing the

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scenario. Instead of the expected growing economy, there has been a major decline and then the surprise of the large farmer protests at the turn of 2020-2021.

Apart from these more immediate deviations, there are big long-term challenges confronting Indian agriculture, the Indian economy and the world economy. These include very significant changes in, for instance, the consumption/demand and the consumers, in production and the producers, in various services available, and the linkages between all of them. My proposition and the theme of my address today is that unless Indian agriculture changes and transforms in response to these, it will fail to deliver, it will fail to serve economic development, and may even become a constant burden on the economy rather than a contributor to growth and development of the country. It will not even serve well its main stakeholders, namely the farmers. Besides, if this transformation does not take place, the lagging past structures and policies will come into direct conflict with the policies/ changes that are required for a bright future for Indian agriculture, necessary to serve both the rural and urban population and Indian economic development. There may be serious conflicts between the past structures and the future needs, the directions of the past and the new directions needed for a brighter future.

I would like to first dwell upon the major drivers or changes taking place, some of which are visible and some nascent, and the challenges they are posing for Indian agriculture and the economy. Following this, I will try to discuss what kind of changes are required in agriculture, the supply chains and the related services, businesses, institutions and policies.

## II

### CHANGING DEMAND FOR FOOD

Many years ago, in the 1960s before the green revolution, there was a major food crisis in India and the crisis was not really about production failure alone, but substantially about the rapidly rising food demand in the country. The population was rapidly increasing due to declining death rates in the wake of improved disease control and health services in the country. As a result, the quantity of food demanded began to substantially exceed production. Thus substantially, a major cause was demand for food – mainly the quantity of food needed. At that time, amazingly, the scientists, governments, farmers and industry responded magnificently to deliver the green revolution and prove the gloomy forecasts of Malthus incorrect. The production was miraculously boosted to meet the food demand and consumption quantity and India emerged very well out of the crisis. Today, however, in the context of agriculture, a major problem is once again consumption. It is not the quantity but the “quality” demanded, that is the changing composition of food demand - including the kinds of food demanded, as well as quality and convenience demanded by the consumers in the wake of rapid economic growth and rising per capita incomes particularly since the 2000s. The major challenge today for agriculture, the related services and food supply chains is to transform to respond to this change. In the absence of this, there will be major mismatches, high costs and

inefficiencies, stagnating/low farm incomes, food price inflation and a stalling of economic growth.

Growth in food grain production and consumption in India up-to early 1990's has been examined by many researchers, including Sarma and Gandhi (1990), and Gandhi and Mani (1995) (with a focus on livestock product demand), and Meenakshi and Ray, 1999. Dastagiri (2004) examined the different aspects of food demand in India with data of 1993. Other studies include Gandhi and Zhou (2010), and Pingali (2007) who looked at the westernisation of diets in Asia. However, the situation has been changing rapidly and most of the studies from earlier years cannot capture the new dynamics and recent emerging reality.

More recently, Gandhi and Zhou (2014) have examined the emerging food scenario in the transforming economies of India and China, and find that the scenario is undergoing rapid change, creating new challenges for these countries and the world. The principal reason behind this is that both countries have witnessed rapid economic growth and development frequently at rates of 6 to 9 per cent per year particularly since 2000. With large populations and rising incomes, the food demand has not only increased in quantity but is changing rapidly in composition. Even when the demand for cereals seemed somewhat manageable, there is a structural shift away from them and towards the demand for foods such as vegetables, fruits, animal products, edible oils and processed food products, which has grown very rapidly and often posing new problems. However, with the continuing government food security emphasis only on basic staples, the issues of these other foods such as of production, processing, supply chains and policy support are frequently ignored or poorly stressed, which has exacerbated the difficulties. The consequences have been seen in terms of supply-demand mismatches and high inflation rates coming substantially from these other foods, often causing disruptions, public discontent and macroeconomic problems.

The changes for India can be tracked through the National Sample Survey (NSS) data. The figures over a long time-period from 1970-71 to 2009/10 are examined in Table 1 for rural consumers, and in Table 2 for urban consumers. (Unfortunately no similar NSS data are available beyond 2011/12). The rural data show that food continues to dominate in expenditure share but the share has dropped from 73.6 per cent to 52.9 per cent from 1970-71 to 2011/12. Further, the share of cereals in food has dropped steeply from 54.4 per cent in 1970-71 to only 20.2 per cent in 2011/12. Animal products have grown in share from 15.5 per cent to 24.2 per cent to emerge as greater in importance. Pulses and edible oils are considerably behind but vegetable and fruits have almost tripled in importance from 6.5 per cent to 17.9 per cent. The results for urban consumers in Table 2 indicate that share of food has also dropped substantially from 64.4 per cent in 1970/71 to 42.6 per cent in 2011/12 (though still remaining substantial). Whereas the share of cereals has fallen substantially to only 15.5 per cent, the share of livestock products has risen to 25.0 per cent, and of vegetables and fruits to 18.9 per cent by 2011/12. Thus, whereas the demand for cereals has dropped substantially in share, the demand for vegetables and fruits, and of animal products has risen sharply. There is an urgent need for agriculture, the supply-chains, and policy to transform to address this.

TABLE 1. ALL INDIA - RURAL: CONSUMPTION EXPENDITURE - AVERAGE PER CAPITA

Item (1)	1970/ 71 (2)	1977/ 78 (3)	1983 (4)	1987/ 88 (5)	1993/ 94 (6)	1999/ 2000 (7)	2004/ 05 (8)	2009/ 10 (9)	2011/ 12 (10)	Percentage		
										1970/ 71 (11)	2009/ 10 (12)	2011/ 12 (13)
	In Rs. per month											
Cereals	14.14	22.82	36.52	41.54	68.13	107.75	100.65	144.44	152.91	54.40	24.10	20.21
Pulses	1.56	2.92	4.25	6.65	10.72	18.5	17.18	33.6	41.58	6.00	5.60	5.50
Livestock products	4.03	7.13	11.85	18.74	36.09	58.7	65.91	130.44	183.36	15.50	21.70	24.24
Edible oils	1.26	2.46	4.53	8.88	12.43	18.16	25.72	38.92	53.44	4.80	6.50	7.06
Vegetables and fruits	1.7	3.37	6.86	10.8	21.9	38.34	44.49	112.9	135.14	6.50	18.80	17.86
Other food items	3.27	5.63	9.71	15.21	28.5	47.35	53.65	138.06	190.06	12.60	23.00	25.12
Food total	25.98	44.33	73.73	100.82	177.77	288.8	307.6	600.36	756.49	100.00	100.00	100.00
Food total	25.98	44.33	73.73	100.82	177.77	288.8	307.6	600.36	756.49	73.60	57.00	52.90
Non-Food total	9.33	24.56	38.71	57.28	103.63	197.36	251.18	453.29	673	26.40	43.00	47.06
Total cons. exp.	35.31	68.89	112.5	158.1	281.4	486.16	558.78	1053.64	1429.96	100.00	100.00	100.00

Source: India, National Sample Survey Organization (Various Rounds).

TABLE 2. ALL INDIA – URBAN: CONSUMER EXPENDITURE - PER CAPITA AVERAGE

Item (1)	1970/ 71 (2)	1977/ 78 (3)	1983 (4)	1987/ 88 (5)	1993/ 94 (6)	1999/ 00 (7)	2004/ 05 (8)	2009/ 10 (9)	2011/ 12 (10)	Per cent		
										1970/ 71 (11)	2009/ 10 (12)	2011/12 (13)
	(Rs. per month)											
Cereals	12.12	19.76	31.98	37.14	64.27	105.57	105.82	161.17	173.82	35.60	18.30	15.51
Pulses	1.76	3.67	5.6	8.85	13.92	24.25	22.51	47.06	53.66	5.20	5.30	4.79
Livestock products	6.91	12.49	21.07	32.68	60.39	100.95	111.77	208.99	280.3	20.30	23.70	25.01
Edible oil	2.41	4.46	7.94	13.23	20.09	26.81	36.37	52.85	70.03	7.10	6.00	6.25
Vegetables and fruits	3.35	6.11	11.63	19.39	37.17	64.58	70.49	175.2	211.82	9.80	19.90	18.90
Other food items	7.49	11.18	18.75	28.46	54.48	88.68	100.45	232.56	331.25	22.00	26.40	29.55
Food total	34.04	57.67	96.97	139.75	250.32	410.84	447.41	880.83	1120.88	100.00	100.00	100.00
Food total	34.04	57.67	96.97	139.75	250.32	410.84	447.41	880.83	1120.88	64.40	44.40	42.62
Non-Food total	18.81	38.48	67.06	110.18	207.72	444.08	604.95	1103.63	1508.79	35.60	55.60	57.38
Total cons. exp.	52.85	96.15	164	249.93	458.04	854.92	1052.36	1984.46	2629.65	100.00	100.00	100.00

Source: India, National Sample Survey Organization, Various Rounds.

In further evidence of rapid changes since 2000, Table 3 gives a comparison between 1999-2000 and 2011-12 in quantities and values of food consumption by food groups. The values are converted to US\$ for better comparison. The Tables 3 for rural and 4 for urban show that cereal consumption shows an absolute fall in quantity for both rural and urban consumers between 1999-2000 and 2011-12, but a rise in value indicating shift to more expensive/ higher quality cereals. Pulses also similarly show a fall in quantity but a rise in value. Animal products show a rise in quantity as well as value with very sharp rise in value for urban. Vegetables similarly show rise in quantities and sharp rises in value for both rural and urban. Fruit consumption shows rise in quantity and value, the

quantity being significantly higher for urban consumers, and this showing near quadrupling in value, indicating a shift to better quality/more expensive fruits. Sugar shows fall in quantity perhaps reflecting health awareness but rise in value. Beverages and other foods also show a substantial rise, increasing nearly five times in value for urban. The findings thus show substantial changes in quantities, values and composition of food demand. The US\$ values also show that there is actually a huge increase in the overall expenditure on food from 1999-2000 to 2011-2012: 2.4 times for urban consumers and nearly 2.3 times for rural consumers. This shows that the overall demand for food remains vibrant and displays a substantial increase over the years, along with a significant change in the composition of the demand.

TABLE 3. INDIA. PER CAPITA ANNUAL CONSUMPTION QUANTITY AND VALUE: RURAL

Item (1)	1999-2000 Quantity (kg) (2)	2009-2010 Quantity (kg) (3)	2011-12 Quantity (kg) (4)	1999-2000 Value (US\$) (5)	2009-2010 Value (US\$) (6)	2011-12 Value (US\$) (7)
Cereals	152.64	136.19	134.59	29.33	36.85	36.66
Pulses	10.08	7.81	9.42	5.21	8.94	9.97
Animal products	52.22	56.67	82.37	15.98	33.28	43.96
Edible oils	6.00	7.63	8.10	4.94	9.93	12.81
Vegetables	64.58	84.38	81.90	8.16	22.28	22.67
Fruits	9.44	14.61	42.10	2.28	6.52	9.71
Sugar	10.08	8.46	9.32	3.15	5.77	5.68
Spices	2.95	4.56	5.17	3.63	9.02	12.01
Beverages and other	-	-	-	5.55	20.40	32.25
Total Food	-	-	-	78.63	153.15	181.36
Total Non-food	-	-	-	53.71	115.64	161.34
Total	-	-	-	132.33	268.79	342.81

Source: India, National Sample Survey Organisation 2001, 2012. Conversion to US\$ is at official central bank exchange rates from fxtop.com. Number and volume units reported for some food items have been converted to weights using average weights.

TABLE 4. INDIA: PER CAPITA ANNUAL CONSUMPTION QUANTITY AND VALUE: URBAN

Item (1)	1999-2000 Quantity (kg) (2)	2009-2010 Quantity (kg) (3)	2011-12 Quantity (kg) (4)	1999-2000 Value (US\$) (5)	2009-2010 Value (US\$) (6)	2011-12 Value (US\$) (7)
Cereals	125.04	112.49	111.36	28.74	41.12	41.66
Pulses	12.00	9.46	10.82	6.86	12.53	12.87
Animal products	72.13	74.00	112.46	27.48	53.31	67.20
Edible oils	8.64	9.82	10.25	7.30	13.48	16.79
Vegetables	70.99	85.63	83.49	11.95	28.68	29.17
Fruits	17.94	25.70	43.54	5.63	16.01	21.60
Sugar	12.00	9.85	10.37	3.81	6.93	6.55
Spices	3.36	5.27	5.99	4.83	11.19	15.28
Beverages and other	-	-	-	14.78	41.25	71.01
Total food	-	-	-	111.86	224.70	268.71
Total non-food	-	-	-	120.91	281.54	361.71
Total	-	-	-	232.76	506.24	630.41

Source: India, National Sample Survey Organization 2001, 2012. Conversion to US\$ is at official central bank exchange rates from fxtop.com. Number and volume units reported for some food items have been converted to weights using average weights.

The shift in the per capita consumption of different food groups for rural and urban consumers over the years across various NSS surveys is shown more dynamically in Figure 1. The Figure shows that the demand for cereals consumption continues to be high

for rural consumers in share, but there is a sharp increase in the importance of livestock (animal) products, and the livestock product consumption becomes more than that of cereals in share between 2009-10 and 2011-12. There is also a sharp increase in importance of vegetables and fruits in demand, closing the gap substantially. In urban areas too, cereals are no longer dominant in consumption by 2011-12. The demand for livestock products surpassed that of cereals in share between 1999-2000 and 2004-05, and further, the demand for fruits and vegetables also surpassed cereals in share between 2004-05 and 2009-10. Thus, substantial transformation in food demand composition has taken place with rapid growth since 2000 – and trend is likely to continue.

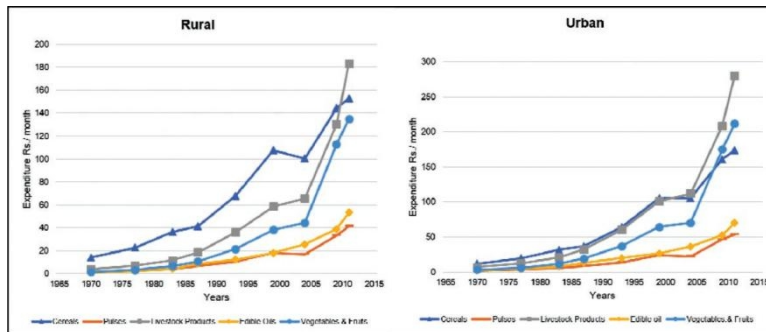


Figure 1. India: Per Capita Food Consumption over the Years, in Rs./month.

Figure 2 combines rural and urban (with population weights) to show the changes at India level between 1999-2000 and 2011-2012, a decade (12-years) of rapid economic growth. Figure 2 shows that the demand for cereals has reduced sharply from 34 per cent to only 18 per cent in share. The demand for pulses too reduces from 6 to 5 per cent, and that of sugar from 4 to 3 per cent. The demand for edible oils increases from 6 to 7 per cent, and that of already substantial livestock products from 22 to 25 per cent. The demand share of vegetables increases from 10 to 12 per cent, and that of fruits from 4 to 7 per cent. The share of beverages and other foods increases sharply from 9 per cent to 18 per cent. Thus, a substantial shift in food demand is evident, sharply away from cereals, and towards livestock products, vegetables, fruits, beverages and other foods.

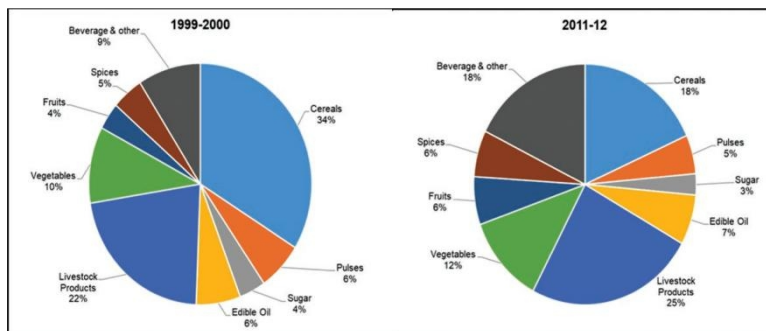


Figure 2. India: Change in Share of Different Food Items in Demand for 1999-2000 and 2011-2012.

What are there changes within the different food groups? The Figure 3 shows that the major cereals consumed remain rice and wheat, and whereas rice remains the major one at 53 per cent, the share of wheat increases from 38 per cent to 41 per cent. However, the demand for coarse cereals such as sorghum and maize reduces substantially from 4 to 2 per cent, and 2 to 1 per cent respectively in share. Even within pulses demand, there is a change in composition (Figure 4). The demand for the major Indian pulse pigeon pea (arhar) reduced from 31 per cent to 29 per cent in share, and the demand for red lentil (masur) (considered inferior/cheaper) reduces from 16 per cent to 13 per cent. Even for mung beans, the demand reduces from 13 to 12 per cent in share. However, the demand for chickpea (chana) and peas increases considerably, from 14 to 16 and 4 to 5 per cent in share respectively. This indicates significant changes in composition even within pulses, which shows a reduced share of 5 per cent within food demand.

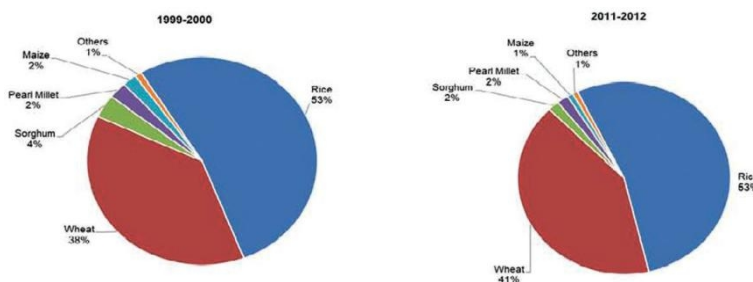


Figure 3. India: Share of Demand for Major Cereals, 1999-2000 and 2011-2012.

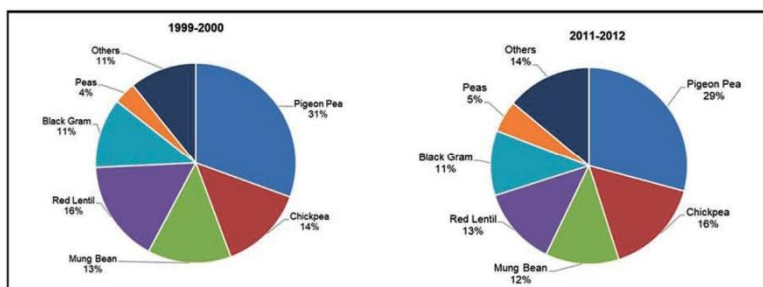


Figure 4. India: Share of Major Pulses in Demand for 1999-2000 and 2011-2012.

Figure 5 shows that even within edible oils there is a huge change in demand composition. The demand for groundnut oil shows a sharp fall from 26 per cent to 7 per cent in share, and the demand for the major edible oil mustard (canola) shows a substantial decline from 44 per cent to 39 per cent. Vanaspati/margarine reduce from 8 to 3 per cent. However, other edible oils show a huge growth in demand from 20 per cent to 49 per cent. This would include more “international”/ “healthier” edible oils such as sunflower and soybean oil, as well as cheaper edible oils such as palm oil, but the break-up is not available in the NSS data. Figure 6 covers vegetables, the demand for which has grown from 10 to 12 per cent within food demand between 1999-2000 and 2011-2012. Figure 6 shows that there are shifts in the composition of vegetable demand. The demand

for potatoes, onions, gourds, cabbage and brinjal has either reduced or remained constant in share, whereas the demand for cauliflower, lady's finger, tomato, leafy vegetables, and other vegetables has increased. The Figure 7 shows that larger changes are seen in the demand for fruits, the share of which has increased from 4 to 7 per cent in food demand. Within fruits, the demand share for apples has increased sharply from 7 per cent to 16 per cent, and that for oranges also substantially from 2 per cent to 4 per cent. Grapes also show a large jump from 3 per cent to 5 per cent. On the other hand, the share of some traditional fruits such as mango declines from 15 to 11 per cent, of banana from 27 to 18 per cent, and of coconut substantially from 24 per cent to 9 per cent. These reveal large changes in the structure of food demand, posing new opportunities and challenges for agriculture.

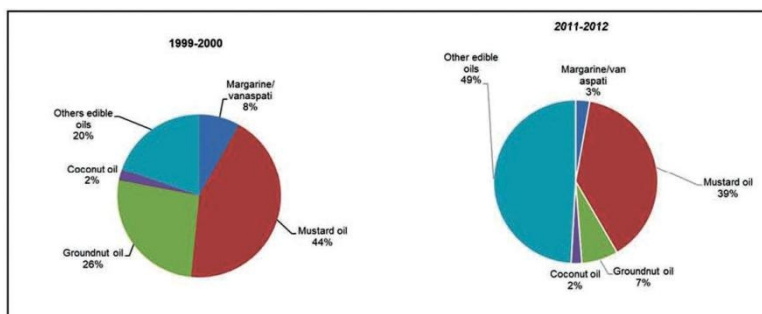


Figure 5. India: Share of Major Edible Oils in the Demand, for 1999-2000 and 2011-2012.

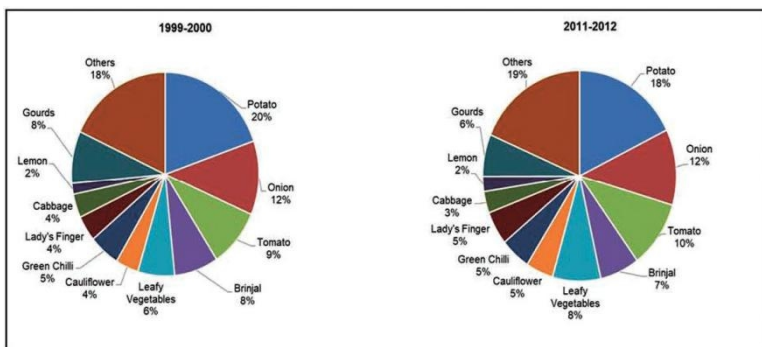


Figure 6. India: Share of Various Vegetables Demand for 1999-2000 and 2011-2012



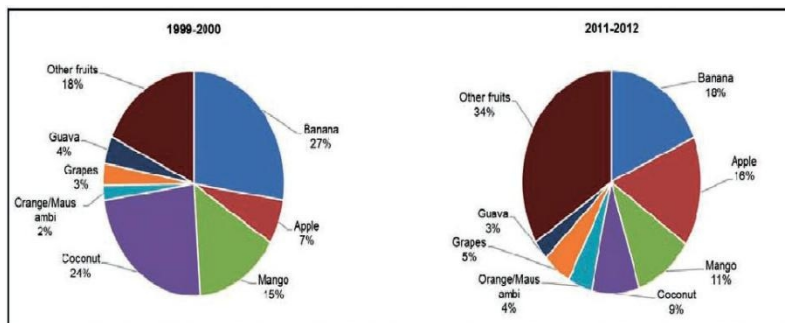


Figure 7. India: Share of Various Fresh Fruits in Demand for 1999-2000 and 2011-2012

The animal/ livestock product demand showed an increase in share from 22 per cent to 25 per cent in food demand from 1999-2000 and 2011-12. Figure 8 shows that there is substantial change in the composition of livestock product demand. Milk and milk products show a decline in demand share from 73 per cent to 64 per cent, but remains the largest. Many other animal products show expansion: the share of meat increases from 12 per cent to 18 per cent, fish/prawn from 10 per cent to 11 per cent, and eggs from 3 to 4 per cent. Thus, even though milk and milk products continue to dominate, there is a substantial movement towards meat, fish and eggs. Further examination in the Figure 9 shows the shifts even within milk and milk products. Liquid milk though remains dominant with a share increase of 90 per cent, but ghee and butter show reduction from 9 to 7 per cent in share which may reflect the effect of education and health consciousness. Other milk products show a growth from less than a per cent to 2 per cent. The Figure 10 indicates huge changes in meat demand. The demand for chicken shows a huge increase from 27 per cent to 52 per cent in share to become the dominant meat. On the other hand, goat meat/mutton demand declines substantially from a dominant share of 58 per cent to 34 per cent – falling below chicken. Beef declines from 15 to 11 per cent but Pork demand rise from less than a per cent to 2 per cent in share. Thus, there is a huge change in the composition of meat demand composition – substantially towards chicken and sharply away from goat meat and beef.

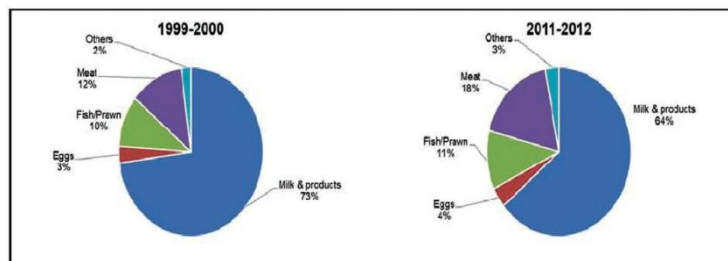


Figure 8. India: Share of Major Animal Products in Demand for 1999-2000 and 2011-2012.

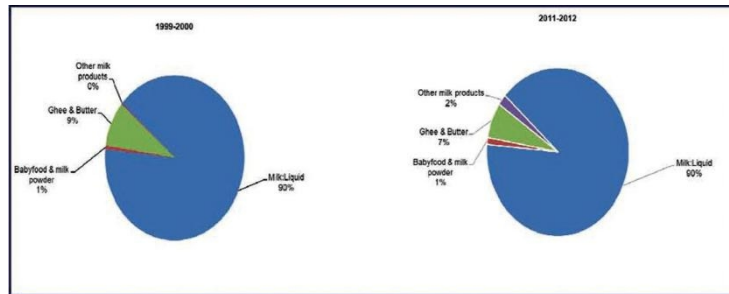


Figure 9. India: Share of Major Dairy Products in the Demand 1999-2000 and 2011-2012.

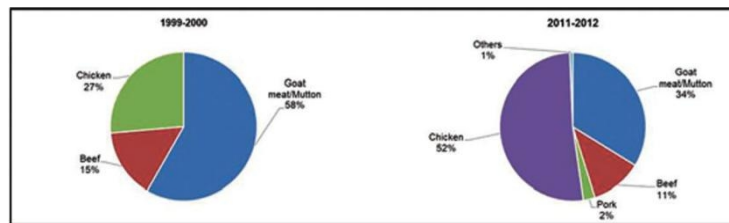


Figure 10. India: Share of Different Kinds of Meat Consumed in the Demand for 1999-2000 and 2011-2012.

### *Drivers of Demand Change and the Future*

What are the major drivers of change in food demand? Figure 11 below shows how food demand changes over consumer income (expenditure) classes based on cross-section NSS data for rural and urban consumers. The Figure shows that at low income, the demand for cereals dominates in both rural and urban areas. However, with higher incomes, the demand for livestock products rises rapidly over the income groups, to cross the demand for cereals for both rural and urban consumers. The Figure 11 also shows that the demand for vegetables and fruits rises substantially with increase in the incomes. Thus, income growth would be a major driver behind changes in the structure of food demand.

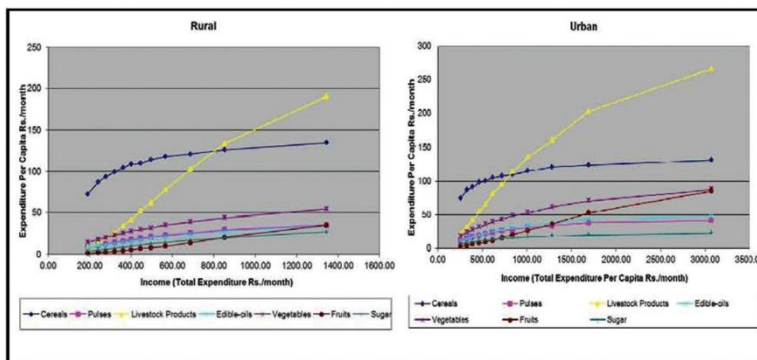


Figure 11. India: Relationship of Per Capita Consumption of Food with Income.

How much is the impact of income growth on food demand? This depends on the income elasticity of demand and the rate of growth of income. Income elasticities of demand for various foods are given in Table 5. The results for rural consumers indicate that for cereals: rice, wheat, and all-cereals, the elasticities are very low together (0.022, 0.188, 0.091 respectively), and for urban consumers the elasticities are even lower: negative for rice, other cereals and all-cereals. Thus, the demand for cereal would rise very little and even fall with increase in income. The elasticities for pulses are somewhat higher (rural: 0.50, urban 0.39). But the elasticities for liquid milk are very high (rural: 1.371, urban 0.777) and even higher for milk products (rural: 2.034, urban 1.319). This indicates that milk and milk product demand will grow rapidly in incomes. The elasticities are also very high for meat (rural: 1.265, urban 0.626) indicating a buoyant demand for meat with economic growth. The elasticities are also high for fruits and vegetables. Beverages, confectionaries and sweets show very high elasticities (rural: 1.079, 0.933, 1.738 respectively). The elasticities for purchased cooked meals (eating-out) are found to be very high for both rural and urban (2.692, 2.458 respectively (value elasticity). This indicates that there would be a steep rise in eating-out with increase in incomes. It is very important to note that the overall food demand elasticity is very high (rural: 0.805, urban: 0.706) indicating a strong overall food demand growth with income increase. However, large differences in elasticities of different foods will lead to substantial change in the composition of food demand – requiring significant changes in agriculture if it is to stay in line with demand.

TABLE 5. INDIA: REGRESSION RESULTS OF INCOME ELASTICITIES OF DEMAND FOR DIFFERENT FOODS IN RURAL AND URBAN AREAS, 2009-2010

Food Items (1)	Rural		Urban	
	Quantity Elasticity (2)	Value Elasticity (3)	Quantity Elasticity (4)	Value Elasticity (5)
Rice	0.022	0.307	-0.039	0.360
Rice products	0.495	0.580	0.339	0.405
Wheat	0.188	0.357	0.006	0.243
Wheat products	1.300	1.405	0.858	0.997
Other cereals	0.079	0.208	-0.436	-0.193
Cereals	0.091	0.320	-0.032	0.294
Pulses	0.504	0.676	0.391	0.495
Foodgrains	0.114	0.389	0.001	0.339
Liquid milk	1.371	1.472	0.777	0.878
Milk products	2.034	2.111	1.319	1.476
Milk and milk products		1.502		0.941
Sugar	0.792	0.842	0.334	0.389
Edible oils	0.616	0.605	0.391	0.485
Eggs	0.861	0.872	0.606	0.615
Fish	0.983	1.018	0.561	0.824
Meat	1.265	1.466	0.626	0.813
Potato	0.016	0.158	0.038	0.155
Onion	0.536	0.601	0.356	0.420
Green vegetables	0.455	0.702	0.372	0.589
Vegetables		0.582		0.507
Fruits		1.769		1.365
Beverages and juices		1.079		0.956
Confectionaries		0.933		0.874
Prepared sweets		1.738		1.444
Cooked meals purchased	2.369	2.692	2.103	2.458
Food		0.805		0.706

Source: Gandhi and Zhou (2014).

Apart from incomes, a number of other factors are also found to bring change in food demand (Gandhi and Zhou, 2014). Large local and regional differences in food consumption have existed, but these are converging. For example, people in the north and west were mainly wheat eaters whereas in the south and east mainly rice eater (Gandhi and Koshy, 2006). Milk consumption was 146.2 litres per capita per year in Haryana (north) and 2.5 litres in Manipur (east). Chicken consumption was 3.21 kg in Andaman and Nicobar (east) and 0.014 kg Rajasthan (west). Fish consumption was 44.2 kg in Lakshadweep (south) and only 0.03 kg per capita in Punjab (Gandhi and Zhou, 2010, NSS). However, with media impact, travel, availability and marketing taking place, there is change towards convergence of food consumption patterns across regions. People in the south and east are developing a taste and beginning to consume more wheat (chapatti, Punjabi cuisine) and those in the north and west consuming more rice (idli, dosa, south Indian cuisine). International exposure, travel and food availability are also having a large influence with change towards international foods such as pizzas, burgers and Chinese cuisine.

Another major force shaping food consumption is urbanisation. As shown above, rural and urban food consumption patterns differ substantially. In 1971, 20 per cent of the people lived in urban areas but by 1991 25.7 per cent population was urban. By 2011 31.2 per cent of the population lived in urban areas. Urbanisation affects not only the quantity of foods but also the composition of the diets (Huang and Rozelle, 1998). With urbanisation, the consumption of food grains tends to decrease, and that of other foods including animal products tends to increase. Gandhi *et al.* (2004) find that cereal consumption falls considerably with urbanisation, but whereas coarse cereal consumption falls sharply and rice consumption also falls, wheat consumption shows increase. Urbanisation also results in shift towards value-added processed foods, convenience foods and use of food services/ eating-out.

Eating-out or food away from home is a major trend. NSS data indicate that the average number of meals away from home rose to 4.2 meals per year in the rural areas and 16.8 meals per year in the urban areas by 2009-10. Annual expenditure on meals away from home was much higher for urban consumers and almost tripled from US\$ 0.74 to 1.91 for rural, and US\$ 3.02 to 9.10 for urban between 1999-2000 and 2009-10 (Gandhi and Zhou, 2014). Eating-out increases the food expenditure and changes the composition away from staples to more animal foods, vegetables, and edible oils.

Besides, in food consumption, food safety is becoming increasingly important - the assurance that food will not cause harm or disease to the consumer. The concerns include food borne diseases, chemical pollution as well as adulteration of food. A Food Safety and Standards Act was passed in 2006, and under this the Food Safety and Standards Authority of India (FSSAI) was established laying down science based standards for articles of food, and regulating manufacturing, processing, distribution, sale and import of food so as to ensure safe and wholesome food for human consumption. This affects both agriculture and the food supply chain (Gandhi and Zhou, 2014). Besides, a well-functioning market and supply chain network has assumed great importance for efficient flow of food from areas of surplus to areas of deficit in local, national and global markets. The network can also transmit price signals efficiently, helping changes in demand to be

met by supply. Stakeholders of this kind of a 'Farm to Fork' chain range from farm input suppliers, farmers, market intermediaries, processors, transporters, retailers, food service providers, besides investors and government. Food supply chains in India face many challenges including poor raw material quality, rural market imperfections, transportation inefficiencies, investment constraints, and product marketing challenges (Gandhi and Jain, 2011). Quantity, quality, reach and viability problems indicate major needs for improving the linkage between small farmers and the consumers in the food sector.

The development and modernisation of food processing is also of great importance. Food processing can not only save food by reducing wastage, but also contribute to distribution efficiency, value-addition, quality and safety. Rais *et al.* (2013) indicate that the food processing industry in India is under-developed, fragmented and dominated by the unorganised sector. There is great need to transform this industry, improve the science and technology capability in the industry, and increase its size. Pingali (2006) indicates that the growing diet diversity cannot be met by the traditional food supply chains and will require modernisation of the food processing and retail sector, and vertical integration of the food supply chains, linking the consumers' plate to the farmers' plough. It will also require changes in agricultural research and at the farm level, including commercialisation and diversification of small farm agriculture.

A great challenge will be the ongoing and expected steep rise in the demand for animal products, including dairy, meat, eggs and fish. Large quantities of plant food are required to produce a unit quantity of animal food. For example, the production of 1 kg poultry meat requires 2-4 kg grain, 1 kg pork requires 3.4-6 kg grain, and 1 kg beef requires 7-10 kg grain, depending on the production system and country (Sjauw-Koen-Fa, 2010). Economic growth and shift to animal protein diets may lead to a 70 per cent increase in food demand by 2050 – an exponential growth.. Countries lacking in natural resources (such as suitable additional land and water) may face great difficulty in expanding their food production to meet this demand. This will need new agricultural technology as well as substantially better management of natural resources - which are discussed below.

### III

#### NATURAL RESOURCES FOR PRODUCTION: SCARCITY AND INEFFICIENCY

Natural resources are fundamental to the agricultural sector, and typically determine the basic capacity to produce. They form the foundation on which the production and productivity of agriculture fundamentally depend. Increasing demand due to rising population and incomes, coupled with the scarcity of basic natural resources such as land and water (Gandhi, 2019), have been the major drivers of the development and modernisation of agriculture in India in the recent decades.

#### *Land*

Land is the most basic input in agriculture and the Table 6 below examines the trends in land from 1980-81 to 2015-16. The Table 6 shows that the geographic area of the country is 328 million hectares of which only about 55 per cent is cultivable, i.e., about 182 million hectares. The Table 6 shows that there is a declining trend of -0.06 per cent

over the years in cultivable area. The cultivated land is about 85 per cent of the cultivable land, i.e., 155 million hectares, and in this there is a small negative trend of -0.01 per cent. However, the decline is at a much faster rate of -0.10 per cent since 2010-11. The net cropped area in 2012-13 is about 90 per cent of the cultivated land, i.e., 140 million hectares and this shows a declining at -0.02 per cent overall, a 0.16 per cent rise between 2000-01 and 2010-11, and a sharper decline at -0.25 per cent from 2010-11. The decline shows increasing diversion of land from agriculture to non-agriculture, and with the land constraint becoming more severe, the contribution of land to agricultural growth is becoming negative. This indicates higher yields are needed and that production increases must be obtained from yield increases.

The gross cropped area is considerably more than the net sown area, i.e., 194 million hectares, given multiple season cropping on the same land, see Figure 12. The gross cropped area shows an increasing trend at 0.38 per cent from 1980-81 to 2015-16, however a very slow increase at 0.02 per cent after 2010-11, a matter of concern. The area sown more than once shows an increasing trend of 1.60 per cent since 1980-81 but a slower increase at 1.07 per cent after 2010-11. The growth in the gross cropped area, and in area sown more than once is expected to be closely related to irrigation development. Table 6 below shows that the gross irrigated area has grown quite well at 1.92 per cent reaching 97 million hectares, that is 49 per cent of gross cropped area by 2015-16. However, the gross cropped area is growing at only 0.38 per cent overall, at 0.77 per cent during 2000-01 to 2010-11, and slowing down to 0.02 per cent since 2010-11. Irrigated area growth has also slowed down to 1.76 per cent after 2010-11 but this is translating to only 0.02 per cent growth in gross cropped area. This is a matter of concern and indicates poor impact of irrigation in increasing gross cropped area which is important for production growth.

TABLE 6. TRENDS IN LAND AREA IN INDIA'S AGRICULTURE

<i>(area in '000 ha)</i>							
Year	Geographical area	Cultivable land	Cultivated land	Net cropped area	Gross cropped area	Area sown more than once	Gross irrigated area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980/81	328726	185156	155114	140288	172630	32342	49775
1985/86	328726	185127	155795	140901	178464	37563	54282
1990/91	328726	185187	156710	142870	185742	42872	63204
1995/96	328726	183623	156028	142197	187471	45274	71352
2000/01	328726	183455	156113	141336	185340	44005	76187
2005/06	328726	182686	155375	141162	192737	51575	84279
2010/11	328726	182012	155839	141563	197563	56000	88940
2013/14	328726	181849	155583	141426	200951	59525	95759
2014/15	328726	181829	155219	140128	198378	58250	96754
2015/16	328726	181603	154916	139506	197054	57548	96622
Annual Growth Rate							
1980/81-2015-2016	-	-0.06	-0.01	-0.02	0.38	1.60	1.92
1980/81-1990/1991	-	0.00	0.05	-0.02	0.50	2.52	2.33
1990/91-2000/2001	-	-0.09	-0.04	-0.07	0.28	1.22	2.26
2000/2001-2010-2011	-	-0.09	0.01	0.16	0.77	2.19	1.84
2010/2011-2015-2016	-	-0.04	-0.10	-0.25	0.02	1.07	1.76

Source: Ministry of Agriculture, Government of India.

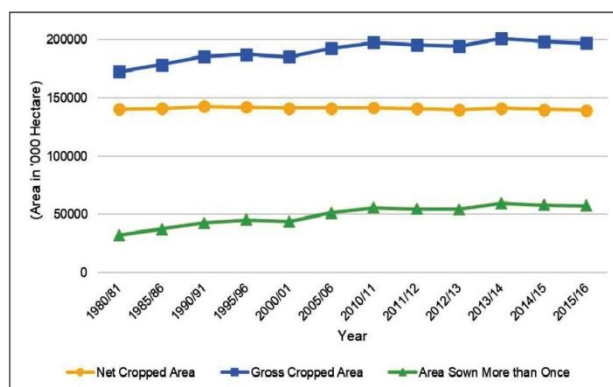


Figure 12. Growth in Cropped Area.

The Table 7 below examines the use of the land area for major crop groups. Of the total area of 197 million hectares under crops, 142 million hectares (72 per cent) is under food crops and 55 million hectares (28 per cent) is under non-food crops in 2015-16. The bulk of the area under food crops is under food grains, i.e., 123 million hectares, see Figure 13. After 1980-81, the area under food grains is showing decline at the rate of -0.11 per cent and that under food crops is showing a slow increase at the rate of 0.09 per cent. However, the area under non-food crops is growing at the rate of 1.23 per cent per year. After 2010-11 the non-food crop growth rate is slower at 1.04 per cent, when the

TABLE 7. LAND AREA UNDER DIFFERENT CROPS

(‘000 hectare)									
Year	Rice	Wheat	Total cereals	Total pulses	Total foodgrains	Total oilseeds	Total foodcrops	Total non-foodcrops	Gross cropped area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1980/81	40237	22225	104900	22708	127608	15698	137675	34955	172630
1985/86	41220	23179	104319	24437	128756	19435	139943	38521	178464
1990/91	42744	24046	103065	24883	127948	25152	141031	44711	185742
1995/96	43016	25105	99826	23637	123463	27943	138276	49195	187471
2000/01	44761	25797	101354	21326	122680	24625	138493	46847	185340
2005/06	43920	26687	99939	23672	123610	30504	141168	51569	192737
2010/11	42863	29069	100270	26402	126672	28916	145121	52562	197683
2011/12	44006	29865	100293	24462	124755	28075	142319	53477	195796
2012/13	42754	29995	97514	23257	120771	29011	138931	55288	194219
2013/14	44136	30473	99829	25211	125040	30107	143994	56957	200951
2014/15	44111	31466	100746	23553	124299	28424	142822	55556	198378
2015/16	43499	30418	98306	24911	123217	28300	142145	54909	197054
Per cent	22.07	15.44	49.89	12.64	62.53	14.36	72.14	27.86	100.00
Annual Growth Rate									
1980/81-2015/16	0.24	0.89	-0.17	0.13	-0.11	1.49	0.09	1.23	0.36
1980/81-1990/91	0.51	0.54	-0.26	0.18	-0.18	4.43	0.03	2.17	0.50
1990/91-2000/01	0.68	1.35	0.05	-0.67	-0.08	-0.07	0.13	0.57	0.24
2000/2001-2010/11	-0.08	1.29	0.08	1.33	0.32	1.96	0.41	1.51	0.69
2010/11-2015/16	0.32	1.15	-0.18	-0.92	-0.33	-0.10	-0.16	1.04	0.16

Source: Ministry of Agriculture.

food crop area is showing a decline at -0.16 per cent. Thus, there is a shift from food crops to non-food crops. In the years after 2010-11, the rice area shows growth at 0.32 per cent and the wheat area at 1.15 per cent. But overall, cereals show decline at -0.11 per cent and pulses a sharper decline at -0.92 per cent after 2010-11, indicating a shift towards rice and wheat given the price support environment. The area under oilseeds also shows a decline at -0.11 per cent. Thus overall even though the gross cropped area is growing at 0.16 per cent after 2010-11, the composition of crop areas is undergoing a transition, away from food crops and towards non-food crops, but also towards rice and wheat, and away from pulses and oilseeds. This is against the trend of demand growth and is a matter of concern.

Thus, land, the most basic input in agriculture shows some disturbing trends. The net cropped area shows decline and a sharper decline after 2010-11. The gross cropped area shows a slow rise but this has slowed after 2010-11. Though the gross irrigated area is growing but this is not translating to growth in gross cropped area. Land resource is making a negative contribution to agricultural production growth in the net and little in gross. There is a shift in area from food crops to non-food crops, but rice and wheat are showing growth after 2010-11, however pulses and oilseeds are showing declines, and this is against the demand trends.

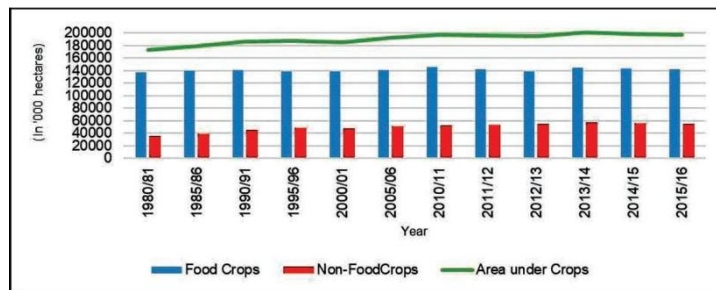


Figure 13. Area under food and non-food crops

#### *Land Productivity: Yield*

Increase in yield per hectare of land is of great importance especially in the light of cropped area declines and the Table below examines the trends in the yields for food grains. The Table shows that overall during 1980/81-2018/19, the yield of food grains has risen at only 2.10 per cent per year. The growth rate for rice and wheat is at 1.70 and 1.64 per cent respectively but that of cereals as a whole is 2.14 indicating that the yields of other cereals have been growing faster, with perhaps an important contribution of maize. For pulses, the yield growth rate is very low at only 1.21 per cent, see Figure 14. In the recent decade 2010/11-2018/19 compared to the previous decade 2000/01-2010/11 the yield growth rate for rice decelerates from 1.61 to 1.50 per cent, of wheat accelerates from 0.94 to 1.45 per cent, of total cereals decelerate from 1.91 to 1.87 per cent, of pulses decelerate from 1.78 to 1.35 per cent, and of food grains as a whole, slows down from 1.71 to 1.44 per cent. Thus, against increases required, most yield growth rates show declines.



TABLE 8. YIELD OF FOODGRAINS

Year (1)	Rice (2)	Wheat (3)	Total cereals (4)	Total pulses (5)	Total foodgrains (6)
	(kg/ha)				
1980-81	1,336	1,630	1,142	473	1,023
1985-86	1,553	2,046	1,324	547	1,176
1990-91	1,740	2,281	1,571	547	1,300
1995-96	1,797	2,483	1,703	513	1,403
2000-01	1,901	2,708	1,844	544	1,626
2005-06	2,103	2,619	1,968	598	1,715
2010-11	2,239	2,989	2,256	691	1,930
2015-16	2,400	3,034	2,393	655	2,041
2016-17	2,494	3,200	2,525	786	2,129
2017-18	2,576	3,368	2,657	853	2,235
2018-19	2,638	3,533	2,752	757	2,286
Annual Growth Rate					
1980/81-2018/19	1.70	1.64	2.14	1.21	2.10
1980/81- 1990/91	3.21	3.15	3.25	0.74	2.24
1990/91-2000/01	1.11	1.75	1.91	1.42	2.77
2000/01-2010/11	1.61	0.94	1.91	1.78	1.71
2010/11-2018/19	1.50	1.45	1.87	1.35	1.44

Source. Ministry of Agriculture, Government of India.

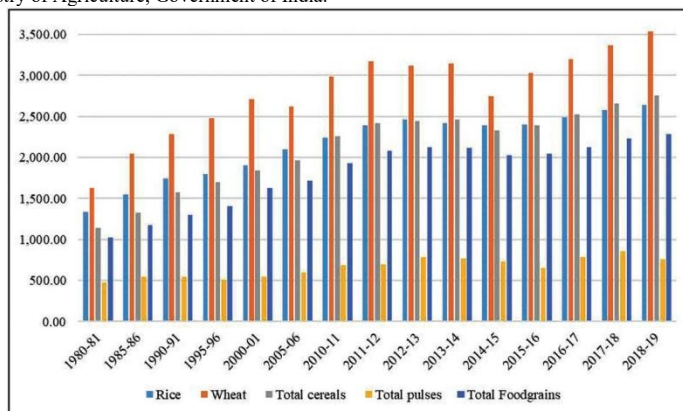


Figure 14. Yield of Foodgrains.

Table 9 below shows the yields and their growth rates for other crops including oilseeds, cotton, sugarcane, fruits and vegetables. Oilseeds show an overall growth rate of 1.94 per cent during 1980/81-2018/19, cotton 3.23 per cent and sugarcane 0.61 per cent, see Figure 15. During 2000/01-2010/11, cotton shows a tremendous acceleration to 10.81 per cent and oilseeds to 2.98 per cent. However, subsequently, in 2010/11-2018/19, the yield growth rate for cotton drops substantially becoming negative at -2.51 per cent and for oilseeds drops to 0.82 per cent, but for sugarcane rises to 1.50 per cent. Fruits show a substantial acceleration to 3.79 per cent, but vegetables show deceleration to 0.42 per cent after 2010-11 (Figure 16). Thus, there is substantial deceleration in yield growth of most crops in the recent years. The only exceptions are fruits and sugarcane. The trend in fruits is consistent with demand growth but this is not the case for sugarcane, is also of concern given its high water use and the increasing scarcity of water resource.

TABLE 9. YIELD OF NINE OILSEEDS, COTTON, SUGARCANE, FRUITS AND VEGETABLES

Year (1)	Major oilseeds (2)	Cotton (3)	Sugarcane (4)	Fruits (5)	Vegetables (6)
					(kg/ha)
1980-81	533	152	57844	-	-
1985-86	570	197	59893	-	-
1990-91	771	225	65395	-	-
1995-96	851	242	67777	12360	13420
2000-01	810	190	68578	11150	15020
2005-06	1004	362	66919	10400	15440
2010-11	1193	499	70091	11730	17250
2015-16	968	415	70720	14310	16730
2016-17	1195	512	69001	14580	17400
2017-18	1284	443	80198	14360	17690
2018-19	1271	378	80105	14830	18400
Annual Growth Rate					
1980/81-2018/19	1.94	3.23	0.61	-	-
1980/81- 1990/91	3.06	4.16	1.36	-	-
1990/91-2000/01	1.41	-1.29	0.82	-	-
2000/01-2010/11	2.98	10.81	0.61	0.54	1.83
2010/11-2018/19	0.82	-2.51	1.50	3.79	0.42

Source: Ministry of Agriculture, Govt. of India.

Note: (-) Not Available.

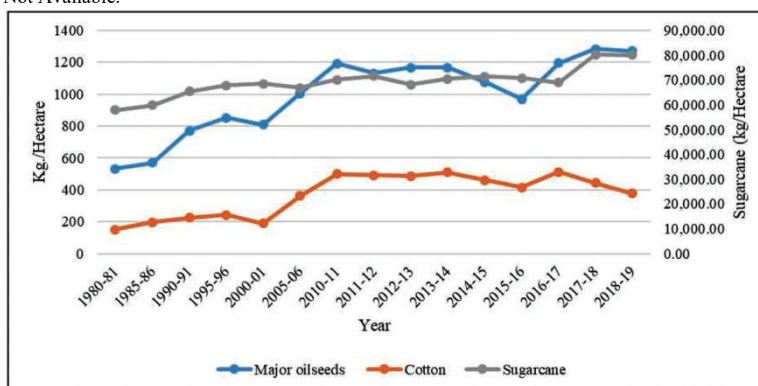


Figure 15. Trend in Yields of Nine Oilseeds, Cotton and Sugarcane.

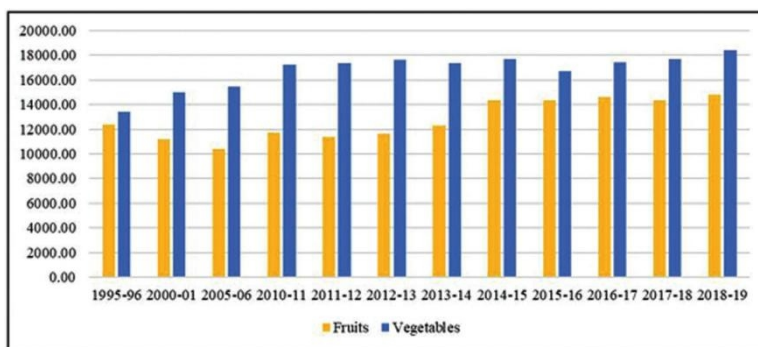


Figure 16. Trend in Yields in Fruits and Vegetables.

### Water: Irrigation

Water is a very major input for agriculture and Table 10 shows the trends in water use in agriculture in terms of irrigated area. The net irrigated area has increased substantially from 38 million hectares in 1980-81 to 67 million hectares in 2015-16. The growth in net irrigated area has been fairly steady over the years at 1.62 but has decelerated to 1.22 per cent after 2010-11. The gross irrigated area has increased from 49 million hectares to 96 million hectares from 1980-81 to 2015-16, see Figure 17. During the 1980s and 1990s, the growth has been quite rapid in the first two decades at about 2.3 per cent but this has decelerated to about 1.76 per cent after 2010-11. The per cent gross area irrigated has increased substantially from 28.8 per cent to 49 per cent from 1980-81 to 2015-16. However, the period from 2000-01 to 2010-11 shows a deceleration in the growth of per cent area irrigated to 1.13 per cent but after 2010-11 there is some acceleration to 1.59 per cent. Better growth is required and this can come from efforts to improve the conservation of water resources and enhance the efficiency of water use. This needs to include promotion of participatory irrigation management (PIM), watershed development, and the use of water conservation technologies such as drip and sprinkler irrigation.

TABLE 10. WATER: PROGRESS IN AREA IRRIGATED

Year	Net area sown	Gross total area	Cropping intensity (percentage)	Net irrigated area	Gross irrigated area	Irrigation intensity (per cent)	Percentage area irrigated ('000 ha)	
							Net	Gross
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1980-81	140288	172630	123.1	38720	49775	128.6	27.6	28.8
1985-86	140901	178464	126.7	41865	54282	129.7	29.7	30.4
1990-91	142870	185742	130.0	48023	63204	131.6	33.6	34.0
1995-96	142197	187471	131.8	53402	71352	133.6	37.6	38.1
2000-01	141336	185340	131.1	55205	76187	138.0	39.1	41.1
2005-06	141162	192737	136.5	60837	84279	138.5	43.1	43.7
2010-11	141563	197683	139.6	63665	88940	139.7	45.0	45.0
2011-12	140980	195796	138.9	65707	91786	139.7	46.6	46.9
2012-13	139934	194219	138.8	66287	92244	139.2	47.4	47.5
2013-14	141426	200951	142.1	68117	95759	140.6	48.2	47.7
2014-15	140128	198378	141.6	68384	96754	141.5	48.8	48.8
2015-16	139506	197054	141.3	67300	96622	143.6	48.2	49.0
Annual Growth Rate								
1980/81-2015-2016	-0.02	0.36	0.38	1.62	1.92	0.30	1.64	1.55
1980/81-1990/1991	-0.02	0.50	0.52	1.91	2.33	0.41	1.93	1.82
1990/91-2000/2001	-0.07	0.24	0.31	1.70	2.26	0.55	1.77	2.01
2000/2001-2010/2011	0.16	0.69	0.53	1.66	1.84	0.17	1.49	1.13
2010/2011-2015/2016	-0.23	0.16	0.41	1.22	1.76	0.53	1.45	1.59

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

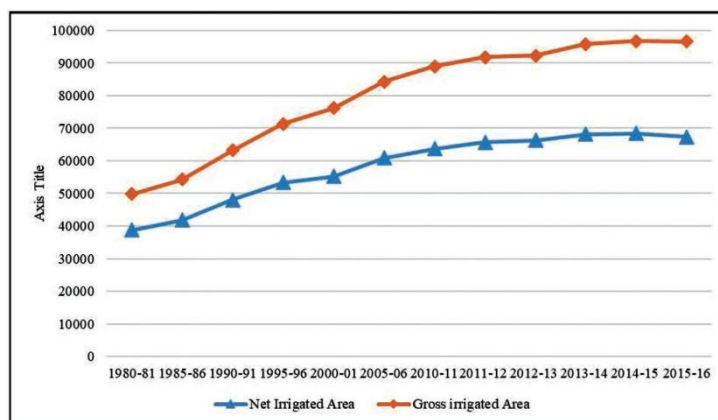


Figure 17. Trends in Net and Gross Irrigated Area.

Table 11 below shows the different sources of irrigation and the trends in them over the years. The Table shows that currently only about 22 per cent of the irrigated area is irrigated through canals whereas about 64 per cent is irrigated through wells. The canal

TABLE 11. IRRIGATED AREA BY SOURCES OF IRRIGATION

Year (1)	('000 ha)								
	Canals Government (2)	Canal Private (3)	Total Canals (4)	Tanks (5)	Tube wells (6)	Other wells (7)	Total wells (8)	Other sources (9)	Total net irrigated area (10)
1980-81	14,450	842	15,292	3,182	9,531	8,164	17,695	2,551	38,720
1985-86	15,715	465	16,180	2,765	11,903	8,515	20,418	2,502	41,865
1990-91	16,973	480	17,453	2,944	14,257	10,437	24,694	2,932	48,023
1995-96	16,561	559	17,120	3,118	17,910	11,787	29,697	3,467	53,402
2000-01	15,809	203	16,012	2,467	22,566	11,252	33,818	2,909	55,205
2005-06	16,490	228	16,718	2,083	26,025	10,044	36,070	5,966	60,837
2010-11	15,475	171	15,646	1,979	28,543	10,629	39,172	6,869	63,665
2011-12	15,837	172	16,008	1,917	29,943	10,594	40,537	7,245	65,707
2012-13	15,512	165	15,677	1,752	30,543	10,762	41,306	7,553	66,287
2013-14	16,116	167	16,283	1,842	31,130	11,310	42,439	7,553	68,117
2014-15	16,017	167	16,184	1,723	31,610	11,350	42,960	7,517	68,384
2015-16	15,023	155	15,178	1,736	32,162	10,956	43,117	7,269	67,300
Share in total irrigated (2015-2016)	22.32	0.23	22.55	2.58	47.79	16.28	64.07	10.80	100.00
Annual Growth Rate									
1980/81-2015/16	-0.07	-4.09	-0.15	-2.00	3.66	0.65	2.61	3.86	1.62
1980/81-1990/91	1.06	-2.71	0.91	-1.51	4.09	1.99	3.18	2.20	1.91
1990/91-2000/01	-0.18	-10.91	-0.39	-2.22	4.82	1.48	3.53	-0.32	1.70
2000/01-2010/11	0.76	-1.18	0.74	-1.71	2.27	-0.34	1.48	7.73	1.66
2010/11-2015/16	-0.22	-1.59	-0.23	-2.60	2.25	1.17	1.96	1.13	1.22

Source: Ministry of Agriculture, Central Water Commission, Water Resource Information System, MOSPI, Govt. of India.

irrigated area shows a negative trend of -0.15 per cent, a reversal between 2000-01 and 2010-11 to 0.74 per cent, but followed by a decline to -0.23 per cent. On the other hand, the area irrigated through wells (groundwater) has expanded rapidly at the rate of more than 3 per cent in the 1980s and 1990s but there is a sharp deceleration to 1.5 per cent between 2000-01 and 2010-11 followed by an acceleration to 1.96 per cent after 2010-11. The major engine of growth has been tube well irrigation which has expanded rapidly at more than 4 per cent in the 1980s and 1990s but shows deceleration to 2.27 per cent between 2000-01 and 2010-11, and further deceleration to 2.25 per cent after 2010-11. The findings indicate that there is a sharp increase in the dependence on ground water irrigation in the recent decades, see Figure 18. However, deceleration is evident between 2000-01 and 2010-11 and after 2010-11 indicating emerging constraints in ground water. This indicates excessive exploitation of ground water, and apart from efforts to control this, special efforts are needed in increasing groundwater recharge through conservation structures such as check-dams, watershed development activities in other areas, and the use of efficient irrigation methods such as drip and sprinkler irrigation.

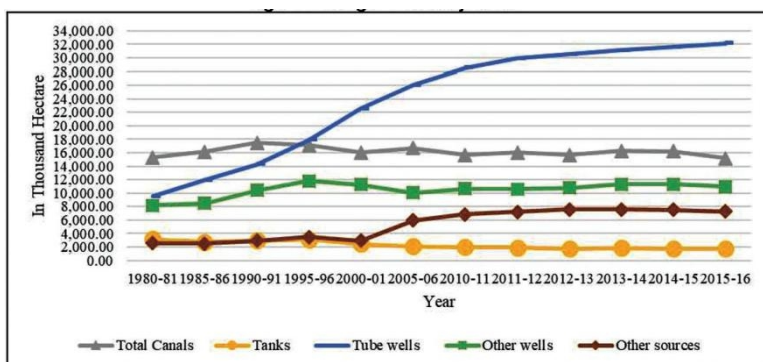


Figure 18. Irrigated Area by Source.

#### IV

#### AGRICULTURAL INPUTS

Since the Green Revolution, agricultural inputs have formed the backbone of productivity and production increases of India's agriculture. The kinds and level of inputs substantially determine the output and productivity of the country's agriculture. Especially after the green revolution, modern technology and inputs have played a huge role. The rise in population and incomes coupled with the scarcity of natural resources such as land and water has resulted in a huge dependence on raising yields for increasing agricultural production to meet the demand. This has led to a strong focus on application of science and technology for increasing yields/productivity and has resulted in various developments and discoveries (Gandhi, 2014) including:

- Better genetics/ high yielding variety seeds
- Better plant nutrition through fertilisers

- Better water provision through water sourcing technology and management
- Better pest control through pesticides
- Farm power and machinery for better physical and time efficiency.

The efforts have been not only through government and international systems/institutions but also private efforts and businesses. The need and demand for modern inputs has stimulated the growth of various input industries/agribusinesses including the seed industry, fertiliser industry, irrigation equipment industry, agro-chemical industry, and farm machinery industry. These are also making large contributions to agriculture. As farmers see advantage in using new technologies, there is a growing demand for modern inputs.

Table 12 below provides a quick picture of the growth in some of the major modern inputs in the recent decades – from early 1980s to 2018-19. It shows that the certified seed use has grown by 6.7 times from 45.0 to 320.4 lakh quintals. The fertiliser use has grown 3.8 times from 60.6 lakh tonnes to 273.75 lakh tonnes. Groundwater irrigation (with its equipment/ pump use) has increased by 2.5 times 19.34 to 43.12 million hectares. The tractor business representing farm machinery has increased the most - by over 7 times from 63.1 to 880.4 thousand tractors. Only the pesticide business has grown less – it grew from 50.0 to 72.1 thousand tonnes from early 80s to early 1990s but declined to 45.6 thousand tonnes by 2012-13, and grew again to 58.2 thousand tonnes by 2017-18. Apart from these, the basic input of agricultural labour shows considerable change as discussed below.

TABLE 12. RECENT GROWTH IN SELECTED AGRICULTURAL INPUTS

Year (1)	Certified quality seeds sales (lakh quintals) (2)	Fertilisers consumption in nutrients (lakh tonnes) (3)	Pesticides consumption (thousand tonnes) (4)	Groundwater irrigation (wells and tubewells) net irrig. area (000 ha) (5)	Tractors sales number thousands (6)
1982-83	42.06	63.88	50.00	19347	63.07
1983-84	44.97	77.10	55.00	19392	74.32
1991-92	57.5	127.28	72.13	26037	151.12
2001-02	91.8	173.59	47.02	35197	217.46
2010-11	277.34	281.22	55.54	39172	545.11
2011-12	294.85	277.9	52.98	40537	607.66
2012-13	313.44	255.36	45.62	41306	590.67
2014-15	303.12	255.76	56.12	42960	626.84
2015-16	304.04	267.53	50.41	43117	571.25
2017-18	352.01	265.91	58.16	NA	796.87
2018-19	320.41	273.75	53.45	NA	880.47
Increase (multiple)	×6.73	×3.78	×0.78	×2.52	×7.02

Sources: Gandhi (2014), Directorate of Economics and Statistics, Min. of Ag., Government of India, 2014, and Fertiliser Association of India, 2013. (Note: na=not available)

### *Agricultural Labour*

Labour is a primary input in agriculture and the Table 13 below provides a profile of the changes in agricultural labour. India's total population reached 1210 million in 2011 and of this, 834 million was rural constituting 69 per cent of the total. Of this, 263 million were agricultural workers, including 119 million cultivators and 144 million agricultural

labourers. The growth rate of the total population has slowed down over the decades, from 2.16 per cent to 1.64 per cent. Between 2001 and 2011, whereas the total population has grown at 1.64 per cent the rural population has grown at a far slower rate of 1.16 per cent. This is due to substantial migration from rural to urban areas. The number of agricultural workers is growing at 1.17 per cent per year. However, the number of cultivators is showing a decline at -0.70 per cent whereas the number of agricultural labourers is increasing at 3.06 per cent. The data therefore indicates a slowing growth in rural population but a growing population of agricultural labourers in the country, see Figure 19 (Gandhi, 2019). A reason for the trend is the fragmentation of land holdings leading to increasing number of less viable farms causing farm sales and increasing number of agricultural labour.

TABLE 13. POPULATION AND AGRICULTURAL WORKERS IN INDIA

Year	Total population	Rural population	Agricultural workers-cultivators	Agricultural workers-agricultural labourers	Total agricultural workers
(1)	(2)	(3)	(4)	(5)	(6)
1981	683.3	526	93	56	148
1991	846.4	631	111	75	185
2001	1028.7	743	127	107	234
2011	1210.6	834	119	144	263
Annual Growth Rate					
1981-2011	1.92	1.55	0.83	3.24	1.93
1981-1991	2.16	1.84	1.81	3.00	2.27
1991-2001	1.97	1.65	1.41	3.65	2.37
2001-2011	1.64	1.16	-0.70	3.06	1.17

Source: *Agricultural Statistics at Glance 2014*, Ministry of Agriculture, Govt. of India, Gandhi 2019.

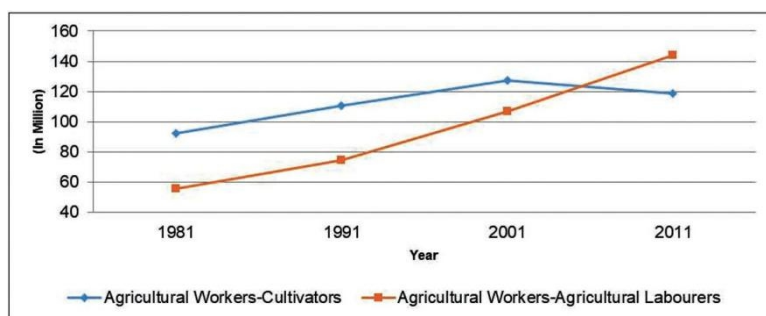


Figure 19. Trends in Agricultural Workers.

Examining the workforce statistics, Table 14 below provides a break-up of the total workforce into agricultural and non-agricultural workforce. The Table 14 indicates that whereas the total workforce stands at 467 million in the year 2011-12, the agricultural workforce stands at 228 million, constituting 48.8 per cent of the workforce. The Table indicates that the share of the agriculture workforce has been declining from 59.9 per cent in 1999-2000 to 48.8 per cent in 2011-12. The rate of growth was positive 0.26 per cent between 1999-2000 and 2009-10, but becomes negative at -2.9 per cent between 2009-10 and 2011-12. The share of agricultural workforce is showing a decline and the rate of decline is showing an increase from -1.06 per cent between 1999-2000 and 2009-10 to -2.90 per cent between 2009-10 and 2011-12. Thus, even though the total workforce has been growing in the country, the share of the agricultural workforce is showing a decline

which is accelerating. This shows a movement of the workforce away from agriculture to non-agriculture. The absolute number for agricultural workforce is also showing a decline from 2004-05 to 2011-12, see Figure 20. This shows decreasing workforce availability in agriculture. The reason for this trend may be growing and better employment opportunities, formal and informal, in the non-agriculture sector.

TABLE 14. AGRICULTURAL AND NON- AGRICULTURAL WORKFORCE

Years (1)	Total workforce (2)	Agri workforce (3)	Non agri workforce (4)	Share agri labour force (5)
1999-2000	397	238	159	59.9
2004-2005	457	259	198	56.7
2009-2010	460	245	215	53.3
2011-2012	467	228	239	48.8
Annual Growth Rate				
1999/00-2011/12	1.26	-0.33	3.18	-1.56
1999/00-2009/10	1.35	0.26	2.78	-1.06
2009/10-2011/12	0.50	-2.37	3.59	-2.90

Source: Ministry of Agriculture, Government of India.

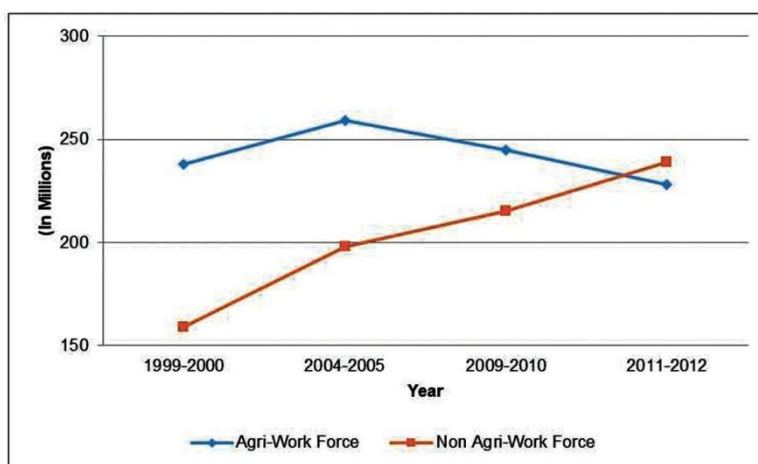


Figure 20. Agricultural and Non-Agricultural Workforce.

Summarising, whereas the number of cultivators has declined at -0.70 per cent, the number of agricultural labourers has increased at 3.06 per cent, indicating a growing proportion of agricultural labourers. This may increase unemployment and poverty unless new employment opportunities are created. Also, there is a movement of workforce away from agriculture to non-agriculture, and even the number in agricultural workforce is declining between 2009-10 and 2011-12. This indicates that the labour work force available to agriculture is reducing significantly and is an important concern. This will require technology and inputs which enhance the productivity per labour if the production of agriculture is to be maintained and increased.

### Fertilisers

Fertilisers are very important modern inputs for agriculture addressing the key need for soil fertility, critical for good yields. High yielding varieties depend substantially on them for good productivity. Table 15 below shows that the fertiliser use has grown quite



rapidly from 55 million tonnes to 274 million tonnes from 1980-81 to 2018-19 at the annual rate of about 4.1 per cent. However, after a rapid 8 per cent growth in the 1980s, 4 per cent in the 1990s and 6 per cent in the 2000s, there is substantial slow down and even negative growth after 2010-11 and even a declines in fertiliser consumption. The nitrogenous fertiliser growth slows down to just 0.62 per cent, and the phosphatic and potassic fertiliser show negative growth at -1.1 and -1.7 per cent respectively, see Figure 21. The changes may relate to adverse fertiliser subsidy and pricing policies. A shift to nutrient based subsidy (NPS policy) has led to a considerable reduction in subsidy on phosphatic (P) and potassic (K) fertilisers, and their prices were decontrolled. This led to a sharp rise in the prices of P and K fertilisers and reduced P and K fertiliser use. The growth rates indicate that whereas the NPK balance had improved in the 2000s, it has worsened after 2010-11 which is likely to have a negative impact. Overall this may worsen soil fertility and negatively impact agricultural production. There is great need to review and reform the fertiliser policy regime.

TABLE 15. FERTILISERS CONSUMPTION

(lakh tonnes)				
Year (1)	Nitrogenous fertilisers (N) (2)	Phosphatic fertilisers (P) (3)	Potassic fertilisers (K) (4)	Total fertilisers (5)
1980-1981	36.78	12.13	6.23	55.15
1985-1986	56.61	20.05	8.08	84.74
1990-1991	79.97	32.21	13.28	125.46
1995-1996	98.23	28.98	11.56	138.77
2000-2001	109.20	42.15	15.67	167.02
2005-2006	127.23	52.04	24.13	203.40
2010-2011	165.58	80.50	35.14	281.22
2015-2016	173.72	69.79	26.75	267.53
2016-2017	167.35	67.05	25.08	259.49
2017-2018	169.58	68.54	27.79	265.91
2018-2019	176.28	69.68	27.79	273.75
Annual Growth Rate				
1980/81-2018/2019	3.97	4.48	4.20	4.12
1980/81-1990/1991	7.66	10.17	6.96	8.18
1990/91-2000/2001	4.10	4.37	3.36	4.08
2000/01-2010/11	4.79	7.03	9.98	5.95
2010/11-2018/2019	0.62	-1.06	-1.67	-0.16

Source: The Fertilisers Association of India, Delhi

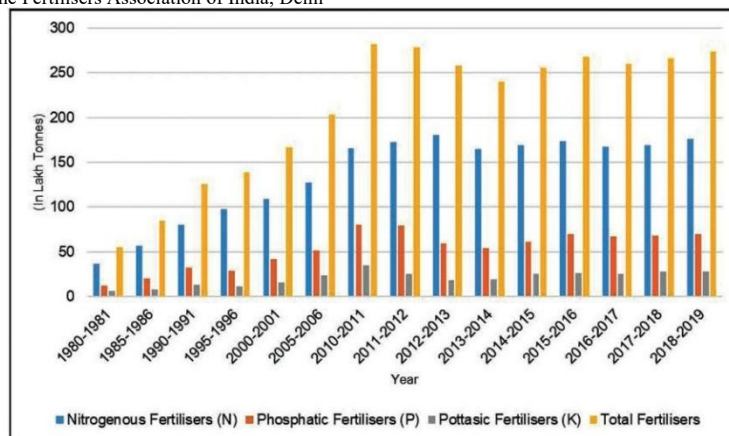


Figure 21. Fertiliser Consumption

Changes in fertiliser use per hectare basis are given in Table 16. The Table 16 shows that the fertiliser consumption per hectare has grown substantially from 32 kgs per hectare in 1980-81 to 137 kg per hectare in 2018-19. However, the growth rates were much higher during the 1980s, 1990s and 2000s, and dropped after 2010-11, the growth rates drop to 0.25 per cent for N, -1.46 per cent for  $P_2O_5$  and -0.66 per cent for  $K_2O$ , see Figure 22. Thus, after a peak of 142 kg per hectare in 2010/11, there is a substantial drop in the fertiliser use to 131 per hectare in 2016/17 with some recovery to 137 kg per hectare by 2018-19. This is much lower than other countries such as China (503 kg/ha). This may have adverse consequences for soil fertility and agricultural production over time.

TABLE 16. CONSUMPTION OF FERTILISERS PER HECTARE

Year (1)	Gross cropped area (in '000 hectares) (2)	Consumption in Kg. per Hectare			
		N (3)	$P_2O_5$ (4)	$K_2O$ (5)	Total (6)
1980-1981	172630	21.31	7.03	3.61	31.95
1985-1986	178464	31.72	11.24	4.53	47.48
1990-1991	185742	43.06	17.34	7.15	67.55
1995-1996	187471	52.40	15.46	6.17	74.02
2000-2001	185340	58.92	22.74	8.46	90.12
2005-2006	192737	66.01	27.00	12.52	105.53
2010-2011	197683	83.76	40.72	17.78	142.26
2011-2012	195796	88.36	40.42	13.15	141.93
2012-2013	194246	86.60	34.25	10.61	131.46
2013-2014	200950	83.35	28.03	10.44	121.83
2014-2015	198360	85.45	30.75	12.77	128.96
2015-2016	198164	87.67	35.22	12.12	135.00
2016-2017	NA	84.45	33.84	12.66	130.95
2017-2018	NA	85.58	34.59	14.03	134.20
2018-2019	NA	89.01	34.87	13.53	137.40
Annual Growth Rate					
1980/81-2018/2019	0.87*	3.59	4.15	3.84	3.76
1980/81-1990/1991	0.50	7.11	9.63	6.42	7.63
1990/91-2000/2001	0.24	3.86	4.12	3.11	3.83
2000/01-2010/11	2.82	4.07	6.29	9.21	5.22
2010/11-2018/19	0.24*	0.25	-1.46	-0.66	-0.35

Source: The Fertiliser Association of India and Ministry of Agriculture and Farmers Welfare.

\* Growth Rate till 2015-2016.

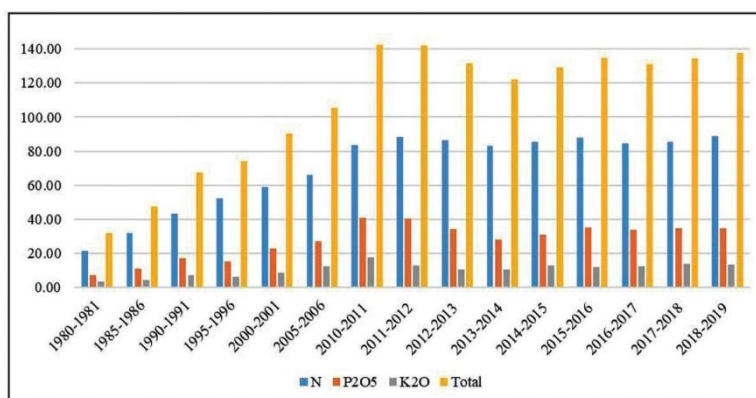


Figure 22. Fertilisers Consumption in Nutrients per hectare

### Seeds

The input of quality certified seeds is of immense importance for increasing agricultural production. Table 17 below shows the trend in the use of quality seeds in India. Overall, between 1990-91 and 2018-19, the seed use has grown at a rapid pace of 7.85 per cent per year. There is particularly rapid growth between 2000-01 and 2010-11 at 13 per cent overall, and in pulses at 17 per cent and in oilseeds at 16 per cent, see Figure 23. But after 2010-11 the overall growth rate falls to only 1.86 per cent (from 13.13 per cent). Pulses show a steep fall in growth rate, and oil seeds, fibre, potato and other seeds all show negative growth (other seeds at -20.3 per cent). This major slowdown after rapid growth would have an adverse impact. The use of quality certified seeds is of significant importance for increasing agricultural production. There is great need to revive the growth of good seed use, which are fundamental to a productive agriculture.

TABLE 17. CROP-WISE DISTRIBUTION OF CERTIFIED QUALITY SEEDS USED IN INDIA

(lakh quintal)							
Year (1)	Cereals (2)	Pulses (3)	Oilseeds (4)	Fibers (5)	Potato (6)	Others (7)	Total (8)
1990-1991	34.70	3.41	8.59	2.16	7.97	0.27	57.10
1995-1996	44.03	3.58	12.64	2.58	6.85	0.24	69.92
2000-2001	59.47	3.85	12.54	2.91	7.23	0.27	86.27
2005-2006	86.73	7.37	24.35	2.89	5.08	0.33	126.75
2010-2011	182.62	20.83	50.61	2.64	20.08	0.55	277.34
2015-2016	194.95	22.71	47.44	2.49	33.88	2.57	304.04
2016-2017	229.11	29.47	49.97	2.17	0.38	0.33	311.43
2017-2018	238.00	23.54	57.23	2.46	30.57	0.20	352.01
2018-2019	206.87	31.80	48.26	2.46	30.83	0.19	320.41
Annual Growth Rate							
1990/91-2018/19	8.09	10.02	7.96	0.55	3.76	4.98	7.85
1990/91-2000/01	6.49	1.91	3.81	4.90	-0.35	-6.91	5.00
2000/01-2010/11	12.64	17.42	16.69	-0.93	9.59	8.66	13.13
2010/11-2018/19	2.48	3.43	-1.60	-2.83	-6.79	-20.30	1.86

Source: Indian Council of Agricultural Research, Ministry of Agriculture, Govt. of India.

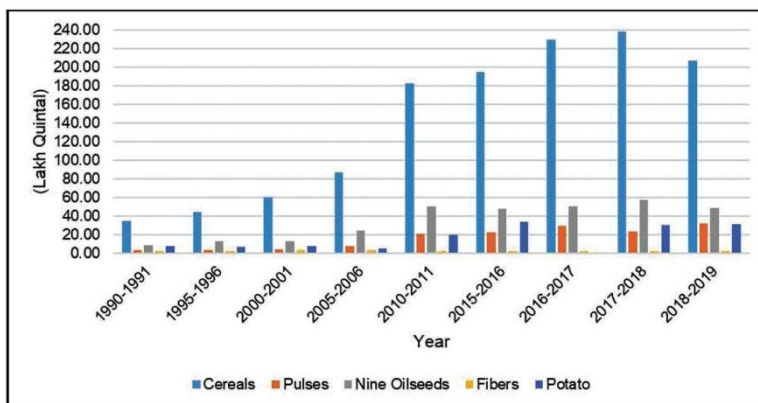


Figure 23. Use of Certified Quality Seeds

### Pesticides

The damage by pests can substantially reduce productivity and is a serious problem for farmers. Pesticides often assume considerable importance to protect and save the crops. It can be seen from Table 18 that the consumption of pesticides has increased from 45 thousand tonnes in 1980-81 to 75 thousand tonnes in 1990-91 but fell to 43 thousand tonnes by 2000-01. Since then it has fluctuated and was 53 thousand tonnes in 2018-19, see Figure 24. Overall the growth rate is negative at -0.48 per cent and has remained low since 2000-01, being only 0.40 per cent during 2010-11 to 2018-19. Thus, the recent growth rate of this input too is very low. The reasons may include various restrictions on their use, pest resistant varieties such as Bt cotton, less bulky new pesticides, and non-availability of latest pesticides in India due to intellectual property regime and policy issues. This requires study in the context of crop productivities.

TABLE 18. CONSUMPTION OF PESTICIDES

Year (1)	Consumption (2)
1980-81	45.00
1985-86	52.00
1990-91	75.00
1995-96	61.26
2000-01	43.58
2005-06	39.77
2010-11	55.54
2011-12	52.98
2012-13	45.62
2013-14	60.28
2014-15	56.12
2015-16	50.41
2016-17	52.75
2017-18	58.16
2018-19	53.45
Annual Growth Rate	
1980/81-2018/19	-0.48
1980/81-1990/91	5.41
1990/91-2000/01	-5.37
2000/01-2010/11	0.55
2010/11-2018/19	0.40

Source: All India Report on Input Survey, Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare.

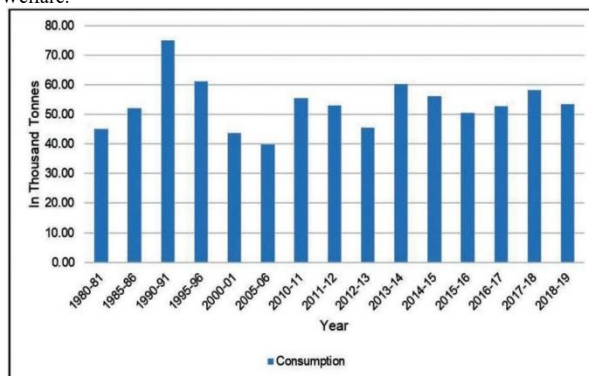


Figure 24. Pesticide Consumption.

There is variation within pesticides and Table 19 below shows recent trends in different kinds of pesticides. It shows that whereas insecticides are showing a significant negative growth rate of -3.39 per cent, fungicides are showing a strong positive growth rate of 12.40 per cent and herbicides/weedicides are also showing an uptrend between 2006-07 and 2013-14, see Figure 25. This shows a changing profile of pest problems and solutions in Indian agriculture in years. Better/new solutions are required in many cases.

TABLE 19. CONSUMPTION OF PESTICIDES BY TYPE IN INDIA (2006-2007 TO 2013-2014)

Year (1)	Insecticide (2)	Fungicide (3)	Weedicide (4)
	<i>(in '000 MT)</i>		
2006-07	38.23	23.12	11.14
2007-08	39.19	26.99	12.91
2008-09	38.2	35.32	12.43
2009-10	34.65	31.55	8.66
2010-11	45.75	26.74	10.01
2011-12	39.36	44.38	7.92
2012-13	32.78	45.72	6.59
2013-14	29.02	58.88	12.05
Annual Growth Rate 2006/07-2013/14	-3.39	12.40	0.99

Source: Ministry of Chemicals and Fertilisers.

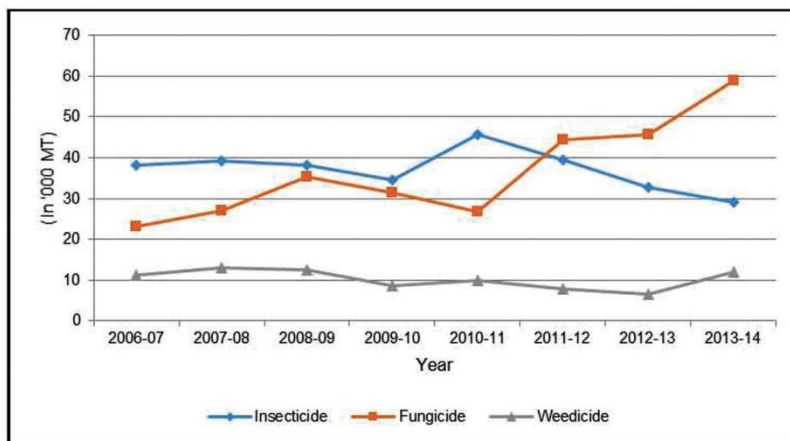


Figure 25. Product-Wise Consumption of Pesticides

### *Farm Machinery and Equipment*

Farm machinery and equipment are becoming increasingly important for India's agriculture due to multiple cropping time pressures and labour shortages. Table 20 below shows that the number of tractors sold per year has increased 12 times from about 70 thousand in 1980-81 to almost 880 thousand in 2018-19. The 1980/81-2018/19 growth rate is 6.92 per cent. There was an acceleration in growth to 9.94 per cent in the 2000s but after 2010-11 there is a deceleration in growth to 5.12 per cent, see Figure 26. Thus, almost all the inputs are showing a slowdown in the growth during the recent decade after 2010-11, which indicates emerging problems in Indian agriculture which need to be addressed, since modern agricultural inputs play a critical role.

TABLE 20. PRODUCTION AND SALE OF TRACTORS IN INDIA

Year (1)	Tractors number	
	Production (2)	Sale (3)
1980-81	71024	72012
1985-86	75550	76886
1990-91	139233	139828
1995-96	191311	191329
2000-01	235602	251939
2005-06	296080	291680
2010-11	548397	545109
2015-16	571565	571249
2016-17	777914	744536
2017-18	790673	796873
2018-19	758929	880472
Annual Growth Rate		
1980/81-2018/19	6.84	6.92
1980/81-1990/91	6.41	6.73
1990/91-2000/01	7.87	8.10
2000/01-2010/11	10.61	9.94
2010/11-2018/19	3.93	5.12

Source: Agricultural Research Data Book.

Note: Sale includes Exports.

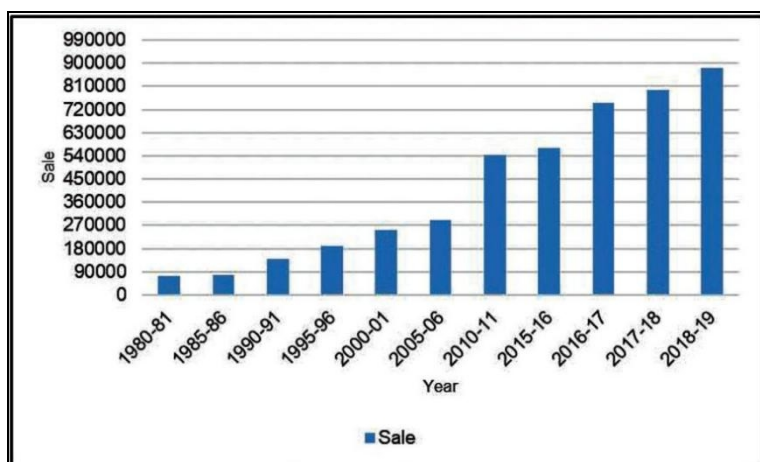


Figure 26. Sale of Tractors.

V

## NATIONAL ACCOUNTS STATISTICS: CHANGES IN OUTPUT, INPUTS, AND GDP

The performance and growth of agriculture is comprehensively measured and reported nationally through the National Accounts Statistics. Table 21 examines data on agriculture in the National Accounts Statistics at constant 2001/12 prices including the growth in inputs, output and the gross domestic product (GDP). The Table indicate that the total value of output-agriculture and allied activities grew at 2.82 per cent between 1980-81 and 2017-18 in constant prices. The growth rate has remained fairly similar across the different decades but during the recent decade 2010/11-2017/18, and shows an

TABLE 21. VALUE OF OUTPUT, INPUTS AND GROSS DOMESTIC PRODUCT OF AGRICULTURE AND ALLIED ACTIVITIES: (CONSTANT PRICES, 2011-12)

	(Rs. crore)									
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2010-11	2015-16	2016-17	2017-18
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Total Value of Output- Agriculture and allied activities	808907	917853	1070001	1187237	1377138	1552963	1808780	2112124	2240437	2342176
Agriculture sector	518476	579468	682657	739558	853742	961231	1120136	1206717	1275548	1321941
Livestock	134750	179101	214690	262461	310764	368178	462531	595242	640811	677960
Total Input	101578	111553	126342	140066	156303	178648	207771	226280	233400	240315
Seed	20626	22257	25641	26982	26658	27665	29544	28406	30073	29499
Organic manure	15666	16842	16750	16944	18531	20432	20896	22793	23578	24061
Chemical fertilisers	9587	15702	21978	27127	29350	34689	47024	43486	42215	43403
Current repairs, maintenance of fixed assets and other operational costs	1538	1850	2341	3356	3759	4205	7418	12222	13262	14311
Feed of livestock	26447	26242	26772	28054	31566	34132	29839	30197	30089	30048
Irrigation charges	1548	1891	2373	2574	3534	2742	4179	3967	3929	3929
Market charges	16310	18400	22335	21785	27071	30825	36309	38856	41073	42567
Electricity	916	1334	3006	6490	5622	5223	7744	11730	12564	13518
Pesticides and insecticides	776	1028	848	1094	907	1175	1642	2119	2003	2227
Diesel oil	3510	5417	8074	9881	12718	17562	23176	32504	34615	36753
Financial intermediation services indirectly measured	952	2010	5067	6958	7788	14548	27762	45644	59373	61269
Gross domestic product	359251	424668	509125	569470	665167	768035	884603	934793	982774	1020358
Annual Growth Rate										
	1980/81-2017/18		1980/81-1990/91		1990/91-2000/01		2000/01-2010/11		2010/11-2017/18	
Total value of output- agriculture and allied activities	2.82		2.59		2.94		2.59		3.29	
Agriculture Sector	2.57		2.46		2.86		2.65		1.80	
Livestock	4.10		4.76		3.77		3.99		5.60	
Total Input	2.38		2.06		2.46		2.73		2.13	
Seed	0.87		1.70		1.11		1.12		0.12	
Organic manure	1.10		0.62		0.86		1.47		1.94	
Chemical fertilisers	3.87		8.68		3.64		5.37		-0.38	
Current repairs, maintenance of fixed assets and other operational costs	5.85		4.11		5.50		7.07		9.88	
Feed of livestock	0.60		0.03		1.85		-1.02		-0.25	
Irrigation charges	2.46		4.42		2.48		0.27		-1.04	
Market charges	2.59		2.80		2.58		2.84		1.74	
Electricity	6.60		13.77		8.02		3.37		7.91	
Pesticides and insecticides	2.37		1.73		-0.69		3.91		3.49	
Diesel oil	6.19		8.13		4.60		6.42		6.95	
Financial intermediation services indirectly measured	10.86		17.34		3.53		14.91		12.13	
Gross domestic product	2.88		3.26		3.21		2.71		1.29	

Source: Central Statistical Organization, Government of India.

NA: not available for 2011-12 prices \*Growth Rate for 2011-12 to 2017-18.

acceleration to 3.29 per cent, see Figure 27. However, within this total value of output, the agriculture (crop) sector (which has a share of 56 per cent) shows a deceleration from 2.65 to 1.80 per cent. This is cause for concern. The output of the livestock sector (which has a share of 29 per cent in agriculture and allied) grew faster a 4.10 per cent over 1980-81 to 2017-18, 3.99 per cent during 2000/01-2010/11, and shows an acceleration to 5.60 per cent in the recent decade 2010/11-2017/18. This is a positive sign considering the growing demand for livestock products. However the crop sector which is twice as large shows a slow down as indicated above.

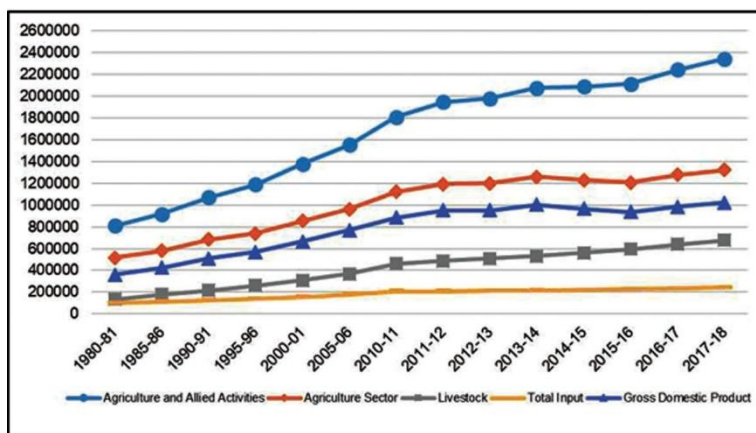


Figure 27. Value of Output, Inputs and GDP of Agriculture and Allied Activities.

The total input in agriculture grew at 2.73 per cent during 2000/01-2010/11 but decelerated to 2.13 per cent during 2010/11-2017/18. Among the different inputs, chemical fertilisers, irrigation charges and livestock feed show negative growth rates in 2010/11-2017/18, and seeds, pesticides, and market charges show fall in growth rates. However, high growth rates are shown in repairs maintenance and operational cost, financial intermediation, and electricity 9.88, 12.13 and 7.91 per cent respectively, and acceleration in diesel oil cost. However, all put together, GDP growth which is a measure of net income shows a deceleration to only 1.29 per cent, which is less than half the previous decade (2.71 per cent). This is a cause for concern.

Changes in the agriculture (crop) sector value of output across different major crop groups and their growth rates based on National Accounts Statistics, are examined in Table 22. The Table 22 shows that composition has been changing over the years. By 2017-18, fruits and vegetables have become larger in value than cereals as well as all other crop groups. The growth rate of value of cereals has been decreasing and has dropped substantially to 1.16 per cent during 2010/11-2017/18, whereas the growth rate for fruits and vegetables has been higher and accelerates to 4.33 per cent in 2010/11-2017/18. The growth rate for pulses has accelerated to 4.38 per cent in 2010/11-2017/18, but the growth rate for oilseeds decelerated and become negative at -0.97. The growth rate of other crops also become negative at -0.57 per cent. Overall the agriculture (crop) sector value of output growth rate falls to only 1.80 per cent in 2010/11-2017/18 below



the long term rate of 2.57 per cent. Thus, apart from a higher growth rate in the livestock sector, pulses, and fruits and vegetables, some disturbing trends are seen in the agriculture numbers in National Accounts Statistics in the recent decade 2010/11-2017/18 including considerable slowdown in crop sector output growth, adverse trends in several inputs, and slower growth of agriculture GDP.

TABLE 22. AGRICULTURE: VALUE OF OUTPUT (AT CONSTANT PRICES 2011-12)

							(Rs. crore)
Year	Cereals	Pulses	Oilseeds	Sugars	Fruits and vegetables	Other crops	Value of output from crop agriculture
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980-81	170794	32482	36423	27895	84830	50403	518476
1985-86	196615	38967	40947	29680	97482	44938	579468
1990-91	233073	43134	67533	41364	109662	51257	682657
1995-96	241865	37120	78607	46491	135994	49945	739558
2000-01	264594	35323	66645	71591	185287	63658	853742
2005-06	274199	41144	98367	63085	209591	80637	961231
2010-11	313742	53219	111138	72114	265526	83607	1120136
2015-16	325628	49060	92974	74159	335293	93580	1206717
2016-17	347238	70244	106085	68207	352163	85139	1275548
2017-18	356777	76873	106401	81734	362794	83600	1321941
Share per cent 2017-18	26.99	5.82	8.05	6.18	27.44	6.32	100.00
Annual Growth Rate							
1980/81-2017/18	1.87	1.40	2.68	2.99	4.18	2.25	2.57
1980/81-1990/91	3.08	1.93	5.63	2.83	2.33	-0.43	2.46
1990/91-2000/01	1.91	-0.02	0.86	5.63	5.94	1.90	2.86
2000/01-2010/11	1.84	2.60	4.57	0.39	3.77	1.42	2.65
2010/11-2017/18	1.16	4.38	-0.97	0.50	4.33	-0.57	1.80

Source: Ministry of Agriculture, Govt. of India.

## VI

### URBANISATION, COMMERCIALISATION, LIBERALISATION AND GLOBALISATION

The economic environment of the agriculture sector is substantially influenced by the mega forces of urbanisation, commercialisation, liberalisation and globalisation and these are showing major changes and impacts.

#### Urbanisation

A major force of change in India is rising urbanisation due to the migration of people from rural to urban areas. In 1971, 20 per cent of people lived in urban areas, but by 1991 this was 25.7 per cent. By 2011, 31.2 per cent of the population lived in urban areas, and by 2020 an estimated 35 per cent. The change has been even bigger in many Asian countries such as China where urbanisation level was less than 20 per cent in the late 70's but with rapid economic growth since the 1980s, it doubled to 40 per cent by 2003. By 2012 end, the percentage of urban population reached 52.6 per cent - more Chinese people live in urban areas than in rural – a huge transformation. This has reached 60.6 per cent by 2020.

The major impact of urbanisation on agriculture is that it leads to a growing off-farm food demand. People who were once producing and consuming themselves in the rural

areas are no longer in the rural areas producing, but are only consuming in the urban areas. The remaining people in the rural areas need to produce them and they must produce not for own consumption but for the markets. This is a big opportunity as well as a transformative force. Producing for the market leads to increasing commercialisation of farming activity and increasing marketed surplus. The farmers need to and begin responding to the market forces and demand signals and need to diversify their production according to market demand. They start producing for incomes rather than their own consumption, and start using modern inputs to boost production/ incomes thereby transforming the agriculture and moving it towards higher value agriculture. This also creates the need for many special services such as for better marketing, efficient supply chains, information and extension advise, finance and risk mitigation.

Thus, the growing urbanisation leads to expansion in off-farm food demand, resulting in farmers producing for the market, and commercialisation of agriculture, and the use of more externally purchased inputs. Agriculture is no longer practiced for subsistence but for the markets and for profits and incomes. A manifestation of this is the growing marketed surplus of the farmers, and Table 23 below shows the high and increasing marketed surplus levels of selected crops in recent years. It shows that even for major staple crops the marketed surplus has risen to very high levels such as 84 per cent for rice and 74 per cent for wheat. Even for coarse grains it has reached 66 per cent for sorghum, 68 per cent for pearl millet and 49 per cent for ragi.

TABLE 23. MARKETING SURPLUS RATIO OF IMPORTANT AGRICULTURAL COMMODITIES

Crops (1)	2012-13 (2)	2013-14 (3)	(per cent)
			2014-15 (4)
I. Foodgrains: Cereals			
1. Rice	81.51	82.00	84.35
2. Wheat	77.49	73.11	73.78
3. Maize	84.32	86.98	88.06
4. Jowar	64.14	70.62	66.64
5. Bajra	76.77	71.11	68.42
6. Barley	67.39	80.63	77.67
7. Ragi	29.53	44.11	48.92
II. Pulses			
8. Arhar	84.33	86.99	88.21
9. Gram	83.67	89.58	91.10
10. Urad	89.65	80.71	92.25
11. Moong	85.55	92.22	90.65
12. Lentil	88.75	90.23	94.38
III. Oilseeds			
13. Groundnut	93.54	95.20	91.63
14. Rapeseed/Mustard	90.41	94.49	90.94
15. Soybean	95.32	95.23	97.60
16. Sunflower	99.18	99.29	100.00
17. Sesamum	90.50	94.47	95.37
18. Safflower	-	-	100.00
IV. Other Crops			
20. Sugarcane	77.84	93.10	85.37
21. Cotton	99.41	97.32	98.79
22. Jute	100.00	100.00	98.59
V. Vegetables			
23. Onion	99.23	99.29	91.29
24. Potato	86.17	93.74	89.54

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation.

Commercialisation leads to diversification of production, as farmers respond to market signals of demand and prices, and seek profits. There is a shift to high value crops/ products such as fibers, spices, vegetables, fruits, flowers and livestock products. Table 24 below gives some statistics on the growth of high value agriculture in India. It shows that high value agriculture has increased in size by 4 times between 1971 and 2011, and some components such as milk and milk products have multiplied in size by nearly 6 times.

TABLE 24. INDIA: GROWING HIGH VALUE AGRICULTURE - GROSS VALUE OF PRODUCTION  
(IN MILL. US\$ AT CONSTANT 2004-06 PRICES)

(1)	1971 (2)	1981 (3)	1991 (4)	2001 (5)	2011 (6)	Increase (multiple) (7)
Milk and milk products	6417	9783	15320	23730	35910	×5.6
Meat, egg, fish	1315	1798	3120	4581	7890	×6.0
Vegetables	9893	12800	16773	23002	33417	×3.4
Fruits and nuts	6768	8460	10838	15273	24601	×3.6
Spices	647	719	955	1672	2435	×3.8
High value agriculture	25040	33560	47006	68258	104253	×4.2
Per cent of all agriculture	42.7	44.6	45.1	49.8	54.0	

Source: FAOstat.

### *Economic Liberalisation and Globalisation*

The other major forces shaping the economic environment for agriculture are liberalisation and globalisation. In the initial stages, the government may need to play a significant role of support, capital investment, and control in the processes of development. Even though this may be initially very important, the government interventions may later prove restrictive for faster economic growth and development in the economy. Thus, liberalisation becomes necessary, and in the Indian economy, substantial liberalisation took place from 1991 onwards in which numerous government controls and regulations were reduced or dismantled, thereby giving a free hand to market forces and the business sector. Liberalisation brought a huge transformation of the Indian economy, resulting soon in a quantum leap of national income growth rates from 3 per cent average to a high of 9 per cent. Simultaneously, population growth rates were falling, resulting in a big jump in per capita income growth rates – this doubled from 2 to 3 per cent to over 6 per cent per year (5 year moving average), see Figure 28. Large numbers were lifted out of poverty, and this also had an enormous impact on the quantity, quality and composition of the food demand (discussed above), also often creating food price inflation.

The process of liberalisation also includes reduction of government involvement in a number of activities. This creates spaces and opportunities for new businesses to develop to fill the gaps, such as in seeds, pesticide and agro-processing industry. A freer hand to market forces and private sector often led to better organisation of production and marketing activities and a quicker supply response, resulting in improvement in the availability and quality of a number of products. Besides liberalisation, another major force affecting agriculture has been globalisation, the opening out to international involvement and competition. This has led to increasing foreign investment and

participation of international firms in the Indian economy. Globalisation was further accelerated by the GATT agreement and the formation of the WTO. Trade barriers and

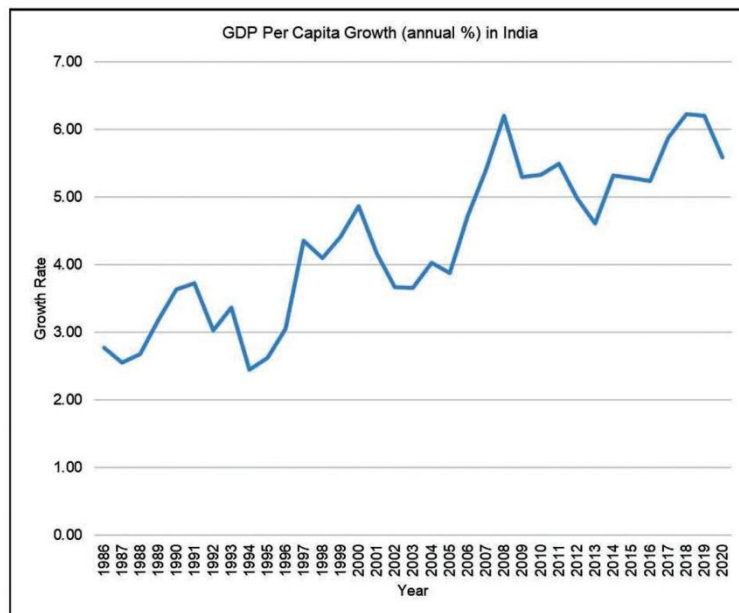


Figure 28. 5- Year Moving Average Per Capita Income (GDP) Growth Rate in India.

subsidies were reduced giving agricultural trade a boost. Table 25 provides a picture of the growth in agricultural exports based on FAO data, and Figure 29 gives the break-up of the exports based on national data. Globalisation provides substantial opportunities for Indian agriculture going beyond the Indian market and if utilised can have a major impact on the development and profitability of agriculture. Globalisation brings both threats and opportunities for Indian agriculture, and also has a growing influence on consumer preferences and demand for food. The outcomes of urbanisation, commercialisation, liberalisation and globalisation for agriculture depend substantially on the efficiency of the marketing systems.

TABLE 25. INDIA: EXPORT VALUE OF AGRICULTURE PRODUCTS

(million US\$)								
Years	Cereals	Pulses	Oilseeds	Fruit and vegetables	Dairy products and eggs	Meat and meat preparations	Fodder and feeding stuff	Agricultural products
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1981	447.3	0.5	54.7	335.5	6.1	74.7	191.2	2698.0
1991	372.2	16.0	46.0	464.5	8.3	94.9	379.7	2796.1
2001	1071.8	82.5	210.9	873.2	74.5	262.8	534.8	5233.9
2010	2939.8	193.2	910.8	2350.7	181.9	1818.9	2051.6	19974.6
2015	6970.0	219.9	763.0	3825.6	224.6	4344.8	1009.6	28656.6
2016	5647.5	230.3	629.1	3994.5	208.4	3973.4	739.7	26489.3
2017	7425.9	214.0	696.2	4261.2	235.2	4310.4	1355.2	30423.5
2018	7828.1	311.0	721.0	3858.9	379.8	3738.7	1570.7	30740.9
2019	7178.4	264.4	667.6	3913.9	344.9	3453.4	1369.6	29299.4
Annual Growth Rate								
1981-2019	12.08	15.40	11.38	8.18	17.11	14.13	7.20	8.90

Source: Faostat.

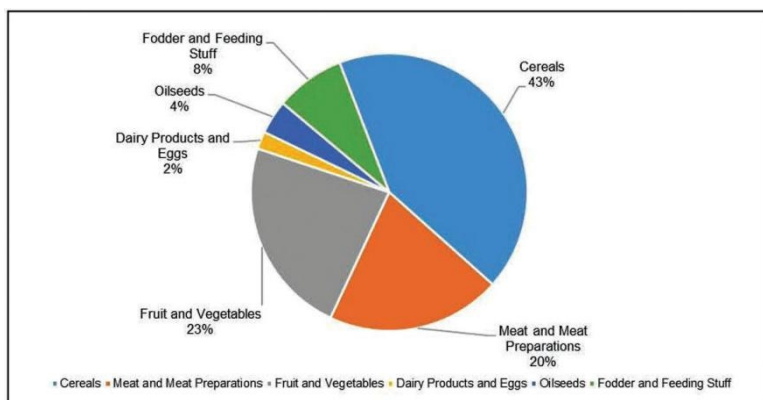


Figure 29. India: Export Value of selected Agriculture Products (2019) (1000 US\$)

## VII

### MARKET INEFFICIENCIES AND FAILURES

Efficiently functioning markets and marketing systems are extremely crucial for bringing better incomes and performance to agriculture in the context of urbanisation, liberalisation and globalisation discussed above, as well as the changing demand, resource and technology situation shown above. However, in this context there are serious problems. The efficiency of marketing of agricultural produce including fruits and vegetables has become of significant concern in India in the recent years (Gandhi and Namboodiri, 2002). Poor efficiency in the marketing channels and poor marketing infrastructure is a major cause not only of high and fluctuating consumer prices, but also of little of the consumer rupee reaching the farmer (Kaul 1997, Ashturker and Deole, 1985). Indian farmers typically depend heavily on middlemen for various commodities and particularly for fruits and vegetable marketing. The producers and the consumers typically get a poor deal and the middlemen control the market, and do not add much value. There is also massive wastage, deterioration in quality as well as frequent mismatch between demand and supply both spatially and over time (Subbanarasiah, 1991, Singh M.*et al.*, 1985).

Especially for fruits and vegetables, the marketing is quite complex and risky due to the perishable nature, seasonal production, and bulkiness. Whereas market infrastructure is better developed for foodgrains, fruits and vegetables markets are not well developed and markets are often congested and unhygienic (Sharan and Madhavan, 1998). Studies show that producers' share in consumers' rupee is often very low for perishable crops (Saikia, 1985, Singh M., 1985). This is reported to be due to a variety of factors such as perishability, number of intermediaries, cost of market functions rendered by intermediaries, and spread of locations between the producers and consumers.

Market legislations such as the Agricultural Produce Market Committee (APMC) Act have been made to regulate and improve marketing of agricultural commodities in India covers almost all the commodities. Since the regulation of markets is a state subject, the

regulatory measures adopted by states differ. In many areas, regulated markets are the first destinations, and growers take or send their produce to these markets for sale and traders and retailers buy them for the consumers. The basic objective of regulating the marketing of agricultural products was to bring both producer and buyer/trader closer together in a competitive environment and reduce imperfections. Regulated markets also provide a platform for both producers and buyers to represent their grievances and discuss matters of mutual concern. The regulated markets usually benefit farmers in proportion to the effectiveness with which market committees supervise the trading. Thus, effective implementation of regulatory measures, improved market infrastructure, and dissemination of market information are needed. But agricultural marketing is plagued by many imperfections such as inadequate infrastructure, lack of scientific grading system, and defective weighing.

Though the market regulation is successful in some areas, it has often not achieved its objectives. Besides, many wholesale markets are yet to be brought under market regulation. But regulating the markets is only a first step in improving marketing efficiency - studies have brought out various deficiencies in the functioning, infrastructure, and prices realisation by farmers in regulated markets. There is often congestion and crowding during business hours. Significant mechanical damage and contamination occurs in the course of loading, unloading and handling (Sharan and Madhavan, 1999). Grading and providing price information are frequently neglected and other problems identified are lack of standardised price quotations, and disparities in market fees rates. In some markets there were very few traders, and hence a healthy competition does not exist and price realisation by farmers is poor. It is often found that it is the traders and not the farmers who obtain the major benefit of the regulated markets. The evidence indicates that though there has been some improvement, but there is still a huge scope and need for improving the marketing of agricultural produce.

Studies for Ahmedabad indicate that before the establishment of regulated markets, wholesale trade in fruits and vegetables was largely controlled by a few traders (Gandhi and Namboodiri, 2002). Unfair and exploitative practices were common and the market efficiency was very low. With the establishment of the Agricultural Produce Marketing Committee (APMC), a governing body consisting of representatives of licensed commission agents, farmers, traders, co-operatives and the government took control of supervising the fruits and vegetables wholesale marketing. Ahmedabad APMC consists of 17 members: 8 agriculturists, 4 traders, 2 Government nominees, and 2 members of cooperative societies and one member from the elected city administration. The term of the market committee was 4 years and of the chairman was 2 years. There were also special sub-committees such as for licensing, budget, sanitary, canteen, seasonal agricultural produce, disputes and so on. The three market yards in Ahmedabad had 159, 115 and 120 licensed commission agents, and 3 licensed co-operative societies.

There were deficiencies in the system market transaction followed, which is a major factor determining fair price realisation for producers. Table 26 and Figure 30 indicate that the share of open auction is only 11 per cent (Gandhi and Namboodiri, 2002) and 40 per cent of the transactions are through secret bidding, 49 per cent are by simple

transactions. Thus, the efficiency gains possible in open auction system are not realised in these regulated markets since the share open auctions is very low.

TABLE 26. AHMEDABAD APMC: SYSTEM OF SALE REPORTED

Commodities (1)	Percentage distribution		
	Open auction (2)	Secret bidding (3)	Simple transaction (4)
CJP market yard:			
Onion	22.2	51.9	25.9
Potato	16.7	56.7	26.7
Above vegetables	19.3	54.4	26.3
SP market yard:			
Tomato	11.1	33.3	55.6
Cabbage	5.9	35.3	58.8
Cauli flower	5.9	29.4	64.7
Brinjal	0.0	27.3	72.7
Green pea	9.1	27.3	63.6
Lady's finger	9.1	27.3	63.6
Above vegetables	6.6	30.3	63.2
Naroda fruit market:			
Mango	16.7	33.3	50.0
Banana	0.0	0.0	100.0
Sapota	0.0	50.0	50.0
Pomegranate	0.0	50.0	50.0
All fruits and vegetables	11.3	40.3	48.4

Source: Gandhi and Namboodiri 2006.

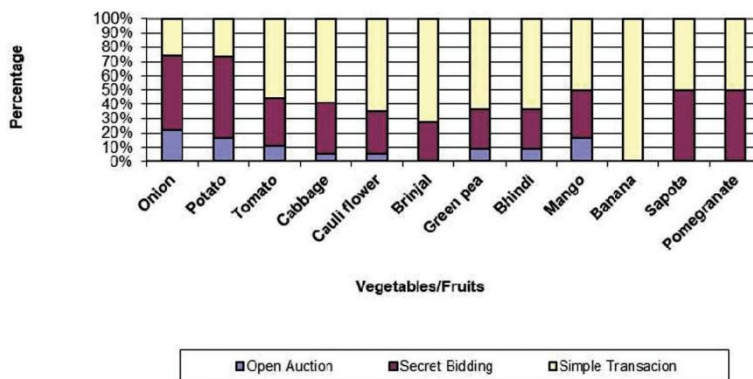


Figure 30. System of Sale Followed by Commission Agents in APMC Markets

The farmer to consumer price difference is examined in Table 27, covering the marketing cost, and the implicit profit margin for the Ahmedabad APMCs. The analysis shows that the costs frequently amounts only to about 10 to 20 per cent of the price difference. The profit margin, which remains is very high, frequently 80 to 90 per cent of the price difference. This is indicative of large trader profits and relatively poor marketing efficiency (including spoilage and wastage).

Similar results for fruits are given in Table 28. The results indicate that the costs amount frequently to only about 20 per cent of the price difference, with the exception of apple where it amounts to only 6-7 per cent. The profits margin seem to be very high and

amount frequently to 80 per cent of the price difference, and in the case of apple to 93 per cent. This is indicative of high profits and relatively poor market efficiency.

TABLE 27. VEGETABLES: FARMER-CONSUMER PRICE DIFFERENCE, MARKETING COST, AND PROFIT

Vegetables (1)	Farmer-consumer price difference Rs./ unit		Marketing cost Rs./ unit		Cost over price difference per cent		Profit margin over price difference per cent	
	Min (2)	Max (3)	Min (4)	Max (5)	Min (6)	Max (7)	Min (8)	Max (9)
Potato (G)	311.85	382.13	71.00	78.74	22.77	20.61	77.23	79.39
Onion (OG)	246.06	265.73	92.27	99.49	37.50	37.44	62.50	62.56
Tomato (OG)	873.20	1297.82	153.55	179.51	17.58	13.83	82.42	86.17
Cabbage (G)	411.71	563.77	83.33	100.40	20.24	17.81	79.76	82.19
Cabbage (OG)	432.24	624.25	106.21	122.17	24.57	19.57	75.43	80.43
Cauli flower (G)	1001.94	1211.40	113.94	129.89	11.37	10.72	88.63	89.28
Cauliflower (OG)	1052.82	1277.46	144.78	168.54	13.75	13.19	86.25	86.81
Brinjal (G)	486.58	712.42	91.14	102.38	18.73	14.37	81.27	85.63
Green pea (OG)	592.67	1050.17	219.20	272.33	36.99	25.93	63.01	74.07
Lady's finger(G)	746.65	885.40	126.22	160.34	16.90	18.11	83.10	81.89

Source: Gandhi and Namboodiri 2006.

Note: G=from Gujarat, OG=from outside Gujarat. Min=at minimum price, Max=at maximum price.

TABLE 28. FRUITS: FARMER-CONSUMER PRICE DIFFERENCE, MARKETING COST AND PROFIT

Fruits: (1)	Farmer-consumer price difference Rs./ unit		Marketing cost Rs./ unit		Cost over price difference per cent		Profit margin over price difference per cent	
	Min (2)	Max (3)	Min (4)	Max (5)	Min (6)	Max (7)	Min (8)	Max (9)
Mango(OG)	899.33	1048.14	228.65	269.72	25.42	25.73	74.58	74.27
Apple(OG)	4548.81	6480.74	331.66	398.81	7.29	6.15	92.71	93.85
Sapota(G)	407.30	1028.94	175.55	223.16	43.10	21.69	56.90	78.31
Banana(G)	455.63	769.52	157.76	164.18	34.62	21.34	65.38	78.66
Sweet orange(OG)	37.51	43.09	7.91	8.25	21.09	19.15	78.91	80.85
Pine-apple(OG)	90.20	83.00	19.06	18.43	21.13	22.20	78.87	77.80
Pomgranate(OG)	1371.47	1242.08	211.21	294.79	15.40	23.73	84.60	76.27

Source: Gandhi and Namboodiri 2006.

Note: G=from Gujarat, OG=from outside Gujarat. Min=at minimum price, Max=at maximum price.

The market intermediaries/commission agents collect a sizable commission at the APMCs, and it would be interesting to see what services they provide to the farmers in return. Some results on this are available in the context of wheat (Gandhi and Koshy, 2006) and Table 29 gives the findings on the marketing services provided. The findings indicate that the farmers do frequently avail of the service of the commission agents but do not receive service/help on most matters, including on critical matters of market information and price negotiation. The main services provided is limited to routine assistance with auction, collecting payments from buyers/ government, payment of market fees and other taxes, and cleaning. Other services including quality enhancing services such as grading, testing, treatment and storage are rarely provided. Agriculture related services are generally not provided. There is a limited role in terms of credit including consumption loans – but not very common. Spot cash payment or part-payment is the main service. The averages across services indicate that 70 per cent response is “never” and the average is “rarely” (2). These findings indicate that very little service is provided by the primary market intermediaries to the farmers in return for the sizable commission collected. It also appears that given the limited size and objectives of the



market intermediaries, it is unlikely that they would reinvest any profits in improving the marketing.

TABLE 29. FARMERS RESPONSE ON MARKETING SERVICES PROVIDED BY PRIMARY MARKET COMMISSION AGENTS AND TRADERS

	<i>(per cent)</i>					
(1)	Never (2)	Rarely (3)	Sometime (4)	Mostly (5)	Always (6)	Average (7)
1. Whether services availed of	0.0	0.0	20.2	79.8	0.0	3.8
2. Providing market information : Price / Arrival / Demand	71.1	0.0	14.0	7.9	7.0	1.8
3. Price negotiation	46.0	0.9	31.9	5.3	15.9	2.4
4. Open Auction	0.9	0.0	0.0	6.3	92.9	4.9
5. Secret Bidding	100.0	0.0	0.0	0.0	0.0	1.0
6. Simple transaction	82.1	0.0	17.0	0.0	0.9	1.4
7. Contract selling	100.0	0.0	0.0	0.0	0.0	1.0
8. Payment of market fees and other taxes	50.4	0.0	1.8	0.9	46.9	2.9
9. Collect payment from buyer/ government agency	26.5	0.0	4.4	0.9	68.1	3.8
10. Transportation	98.2	0.0	0.9	0.0	0.0	1.0
11. Loading / unloading	48.7	0.0	8.0	11.5	31.0	2.7
12. Cleaning	49.1	0.0	2.7	2.7	45.5	3.0
13. Grading	60.0	0.0	0.9	1.8	37.3	2.6
14. Testing	63.3	0.0	0.9	0.9	34.9	2.4
15. Storage	63.3	0.9	0.9	0.9	33.9	2.4
16. Treatment of grains	69.7	0.0	7.3	0.0	22.9	2.1
17. Supply inputs : Seeds/fertilisers/ pesticides	93.9	0.0	4.4	0.9	0.9	1.1
18. Arrange inputs : Seeds/fertilisers/pesticides	92.1	0.0	4.4	2.6	0.9	1.2
19. Advice about farming practices / recommendations	93.0	0.0	6.1	0.0	0.9	1.2
20. Advice about crop insurance	97.3	0.0	1.8	0.9	0.0	1.1
21. Crop loan / advances (for farming)	61.3	0.0	21.6	8.1	9.0	2.0
22. Consumption loan / advances	54.5	0.0	33.9	3.6	8.0	2.1
23. Charge interest	82.8	0.0	0.0	2.0	15.2	1.7
24. Assistance for loans through banks	69.7	0.0	25.7	2.8	1.8	1.7
25. Spot cash payment (Full payment)	1.8	0.0	8.8	17.7	71.7	4.6
26. Spot cash payment (Part payment)	57.1	0.0	20.0	2.9	20.0	2.3
27. Dated cheque (Full payment)	99.0	0.0	0.0	0.0	1.0	1.0
28. Dated cheque (Part payment)	100.0	0.0	0.0	0.0	0.0	1.0
29. Adjust against advances	79.0	0.0	14.3	1.0	5.7	1.5
30. Pay interest on balance amount	97.7	0.0	0.0	0.0	2.3	1.1
Average, Per cent	69.3	0.1	8.0	2.8	19.8	2.0

Source: Gandhi and Koshy 2006

Table 30 below summarises the responses on the satisfaction of the different stakeholders with respect to the current marketing system (Gandhi and Koshy 2006). The results indicate that most of the farmers are unhappy with the system - a majority of them rate it as medium to unsatisfactory, indicating substantial need for change. The traders, however, are happy - a majority of them rate the system as good to excellent. Thus,

TABLE 30. RATING OF THE MARKETING SYSTEM (PER CENT RESPONSE)

Response (1)	Farmers (2)	Primary market CAs and traders (3)	Urban market traders (4)
Excellent (5)	7.0	22.7	0.0
Good (4)	35.7	36.4	66.7
Medium (3)	47.8	36.4	33.3
Unsatisfactory (2)	9.6	2.3	0.0
Poor (1)	0.0	2.3	0.0

Source: Gandhi and Koshy, 2006.

whereas most farmers are not happy with the marketing system, most traders are happy and would want the system to continue.

In an overall context, given India's huge numbers of small farmers and small farm sizes, there is need to improve scale economies and organisation in relation to production and marketing. Increasing rural to urban migration, commercialisation, profit focus and shortage of manpower, also raises the need for improving scale economies and therefore reorganisation of many agriculture related operations and activities. This could be on the lines such as contract farming to achieve better scale economies and even corporate farming in plantation agriculture. Another way of development of linking new agribusinesses or collaborative networks/arrangements in production, procurement and marketing to bring advantages of scale and efficiency, and bring reach to new markets, domestic and interenational.

Research indicates that a large number of problems are faced by agribusinesses trying to overcome the market failures/ inefficiencies (Gandhi and Jain, 2012; Gandhi *et al.*, (1999). These include

#### Raw material supply constraints

- Poor quality, inappropriate varieties, residues
- Short period of availability - seasonality
- Small producers, scattered supplies, perishability
- Competing markets – large market for fresh

#### Constraints in processing

- Old technology – poor efficiency, quality
- Poor capacity utilisation due to seasonality
- Unsuitability for export or high value markets

#### Constraints in Marketing

- Limited market size/ nascent markets, changing customer preferences
- High product and brand development costs
- Long inefficient supply chains, small retail stores

#### Financial Constraints

- Needs more working capital, can't get, higher interest rates
- High investment requirement for latest technology

#### Government Policy

- Processed/ packaged foods considered luxuries taxed heavily - affects the economics
- Many special regulations faced – e.g., MPO, Safety
- Squeeze between governments input price support and output price control
- Ad hoc export and import controls

These call for new ways and models for overcoming market inefficiencies and failures, and of improving scale economies, which are discussed in a subsequent section below.

### VIII

#### INSTITUTIONAL INEFFICIENCIES AND FAILURE

Apart from market inefficiencies and market failures, a serious present problem is institutional inefficiencies and failures. This is seen in many spheres but particularly in

natural resources, especially water which is extremely critical for agriculture's performance. Researchers indicate that there is a crisis in the management of water in India (Saleth, 1996, Vaidyanathan, 1999; Brisco and Malik, 2006, Gandhi and Namboodiri, 2002, 2009, and Crase and Gandhi 2009a,b), and the crisis is not about having too little but about managing the water badly (World Water Vision, 2000). Research and experience indicates that the major difficulty is not physical or technical but in the poor development and design of water institutions (Saleth, 1996, Crase and Gandhi, 2009a,b). Natural resource management is complex and good institutional arrangements are urgently needed. Good institutions are a must in water because the management of the resource needs the combining of scientific approaches with community participation, knowledge and ownership. This is increasingly critical for agriculture, rural livelihoods and poverty alleviation.

There has been serious concerns about unsatisfactory management, delivery and utilisation of irrigation water (Brewer *et.al.*, 1999). The physical development of irrigation has made considerable progress, but the efficient management and distribution of the water for agriculture has poised many difficulties. The water use efficiency in India's agriculture is very low compared to global standards. Vaidyanathan and Sivasubramaniyan (2004) find that it is as low as 25-35 per cent, – which indicates that 65 to 75 per cent of the water is wasted. A major reason is not only poor management but also the widespread and inefficient use through conventional flood irrigation. In such surface water irrigation, tail reach is usually insufficient, water delivery is untimely, and maintenance is poor resulting in substantial losses and poor efficiency. In ground water there is inability to control tube well development and the excessive draft of water (Shah, 1993). Engineering solutions are unable to provide the answer by themselves since the problems are substantially rooted in poor institutional development and design (Saleth 1996, Gandhi 1998, Crase Dollery and Lockwood, 2002, Gandhi and Namboodiri, 2002). Markets are generally not suited for managing water and market failures are common - institutional presence and control are required. The consequences of weak institutions are poor efficiency in water use, low crop productivity, environmental cost, inequity, disputes and substantial under-utilisation of the potential.

Evidence for the above observations is shown in Figure 31 which indicates that there is growth in the irrigation potential created over the different five-year plan periods in India but, there is a large and growing gap between the potential created and potential utilised, and between potential utilised, and the actual irrigated area. The Figure shows that even though irrigation is being created through engineering and technology, its conversion to actual irrigated area is far below expectations. As indicated by many studies, this is substantially due to poor development and performance of institutions in water resource management (Saleth, 1996, Gandhi and Namboodiri, 2009).

Further the official estimates and projections given in Table 31 below shows that agriculture (irrigation) is by far the largest water user in the year 2000 and will continue to be so even in 2025. Table 32 shows that with growing population, the per capita water availability is continuously falling. This indicates the growing need for better management of water resources.

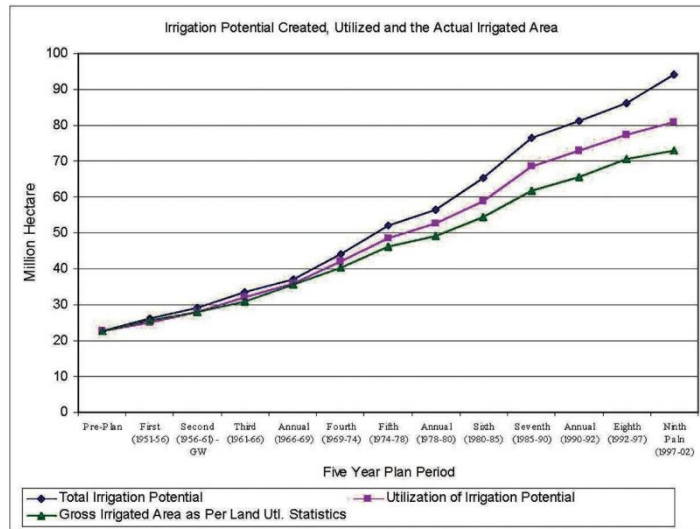


Figure 31. Irrigation Potential Created, Utilised and the Actual Irrigated Area.

Source: Based on India, Ministry of Water Resources

TABLE 31. WATER REQUIREMENT (BILLION CUBIC METER)

Use (1)	2000 (2)	2010 (3)	2025 (4)
Domestic	30	56	73
Irrigation	501	688	910
Industry	20	12*	23
Energy	20	5*	15*
Other	34	52	72
TOTAL	605	813	1093

Source: India, Ministry of Water Resources.

\* Partial estimates.

TABLE 32. ANNUAL PER CAPITA AVAILABILITY OF WATER

Year (1)	Cubic Meters (2)
1951	5177
2001	1869
2025	1341
2050	1140

Source: India, Ministry of Water Resources.

In eastern India which needs focus, the central government has often taken a large role in managing the water resource, partly due to weak local state capacity (Gandhi and Johnson, 2019). However, the institutional arrangements are usually incomplete and over-focus on top-down accountability rather than on the desired results of water management. The World Bank (2007) finds significant weaknesses in the institutional setup and indicates that without institutional arrangements which can bring active participation and cooperation of the stakeholders, neither better management nor development can take

place. Thus, institutional arrangements which involve the user community are strongly required for effective water resource management.

## IX

### OVERCOMING INSTITUTIONAL FAILURE

As indicated, large number of writers believe that water resource management in India is heading for a crisis unless policies and institutions are radically transformed, (see Saleth, 1996, Vaidyanathan, 1999, and Gandhi and Namboodiri, 2002). This requires better design of water resource institutions including a water rights regime that can effectively limit and regulate the use of water. Worldwide experience indicates that managing water is very challenging because of its basic nature. Managing water resources is difficult because water is fugitive, lumpy and rife with externalities, (Livingston and DEC, 1993). Managing water involves large transaction costs and there are serious information deficiencies (see Crase, Dollery and Lockwood (2002), Herath (2002). Institutions need to be designed to deal with the peculiarities of water, and to create the right incentives, controls and efficiencies. Many disappointing investments in water have resulted from institutional failure. There is a need to understand how rules combine with the local physical, economic and cultural environment in appropriate institutions (Ostrom, 1992). Improving the performance of irrigation hinges substantially on appropriate institutional design.

In this critical context, the fundamentals of new institutional economics and management governance can be effectively applied to understand good institutional design and overcome institutional failure (Crase and Gandhi, 2009 a,b, Gandhi and Johnson, 2019). Under new institutional economics, institutions are defined as humanly devised constraints that structure human interaction (North, 1990). Beyond capital, labor and technology, institutions are known to matter substantially in determining performance and outcomes. Under new institutional economics, institutions include “macro” institutions – such as the formal “rules of the game”: constitutions, laws and property rights, and informal rules such as traditions and codes of conduct; they also include “micro” institutions, such as institutions of governance including market or other modes of managing transactions and seeing activities through. (Williamson, 2000, Olson, 2000, and Picciotto, 1995). The major reason for the need and existence of institutions are transaction costs and property rights (see North, 1997, Drobak and Nye, 1997). Transaction costs, particularly, are frequently ignored, and when they are large, they destroy performance. According to North (1997), the major challenge is to evolve institutions which: (1) Minimise transaction costs (2) Create incentives that favour co-operative solution, in which cumulative experiences and collective learning are best utilised. Based on these fundamentals and the empirical literature on water management institutions (including Ostrom, 1992, Crase *et al.*, 2002, Herath, 2002, Gandhi, 1998, Gandhi and Namboodiri, 2002), some important institutional characteristics that matter have been identified, Pagan (2009). These are:

1. **Clear Objectives:** Clear objectives and clarity of purpose. Clear objectives and their acceptance by stakeholders lead to congruence, less conflict, and lower transaction costs.
2. **Good Interaction:** Interaction including meetings helps bring the formal and the informal (rules) together, thereby reducing transaction costs and promoting cooperative solutions. This included both internal and external interaction.
3. **Adaptiveness:** As opposed to rigidity, adaptiveness reduces transaction costs and improves inclusiveness and sustainability in face of a changing external and internal environment.
4. **Appropriate Scale:** Appropriate scale in size and scope. Too large institutions may have high transaction costs, whereas too small institutions may not be able to reduce transaction costs much.
5. **Compliance:** Institutions are constraints or rules that structure human interaction. Without compliance to the rules, institutions would have little meaning and impact.

Relevant concepts have also been drawn from management studies of organisational governance and design (see for example Nystrom and Starbuck, 1981, Groth, 1999, Ackroyd, 2002). These concepts indicate that good governance of institutions or organisations requires the addressing of at least three important rationalities:

1. Technical Rationality: Efficient conversion of inputs to outputs: Technical rationality leading to high technical efficiency. Includes sound technology and other determinants of high productive efficiency.
2. Organisational Rationality: organisation and coordination. Includes sound division of labor/ responsibilities, and specialisation in functions, and effective coordination across them to best achieve overall goals.
3. Political Rationality: Sense of fairness and justice. Given human involvement/ interdependence in institutions, concerns of fairness and justice must be addressed for sustainable performance.

In-depth case studies of watershed management projects in Andhra Pradesh, Gandhi and Crase (2012), as well as water user associations (WUAs) under participatory irrigation management (PIM) in Assam and Bihar in the Eastern Indo-Gangetic Plains, Gandhi, Johnson, Neog and Jain (2020) showed that the framework needed expansion. It was necessary to add more rationalities to the framework to make it better applicable and the proposed expanded list of rationalities is given and described below:

- Technical Rationality
- Environmental Rationality
- Economic Rationality
- Social Rationality
- Political Rationality
- Organisational Rationality
- Financial Rationality
- Government Rationality

### *Technical Rationality*

Efficient conversion of inputs into outputs - the use of the right/ appropriate technology and operational methods for high productive efficiency. Involvement of technically skilled people or experts, in natural resource management: aspects such as sound location, planning, technology, structures, construction, repairs and maintenance.

### *Environmental Rationality*

Consideration of the environment and its conservation. Care and contribution to the conservation of water, soils and natural vegetation, drainage, avoiding over-exploitation, long term sustainable resource use.

### *Economic Rationality*

Consideration of costs, benefits, returns and incomes in the use of scarce resources. Activity selection considering markets, demand, prices, profitability and returns to investment. Infrastructure and marketing arrangements, improving incomes and livelihoods.

### *Social Rationality*

Taking into account the social or people setting, including castes, tribes, religions, professions, landholding-sizes, men, women, rich and poor. Achieving acceptance, cooperation, fair distribution of costs and benefits.

### *Political Rationality*

Leaders, individuals, power and interest groups and the perception of fairness and justice. Involvement and participation, balancing needs and concerns. Avoiding conflicts and non-acceptance.

### *Organisational Rationality*

Organisation and coordination. Specialisation, division of labour, coordination for good performance. Managerial, leadership skills, knowledge, activity groups, committees, meetings. Dealing with government/ external agencies, procedures

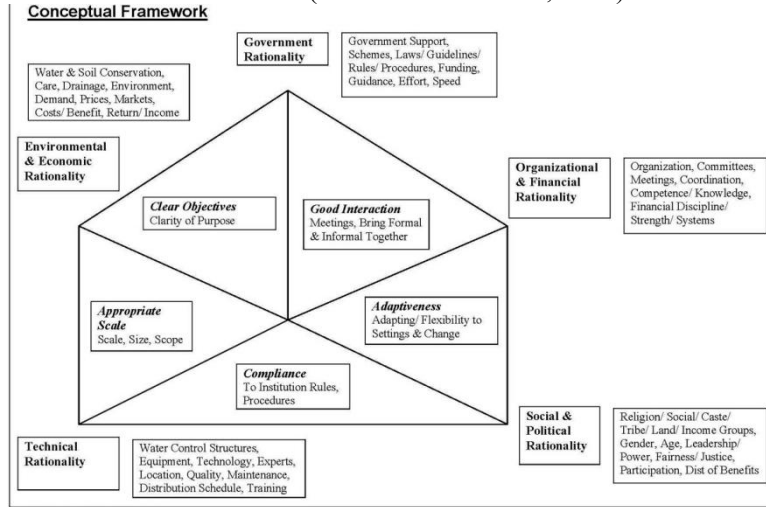
### *Financial Rationality*

Discipline and care in the handling financial resources. Effectively use for intended purpose, not misused or lost, accounting systems, procedures, (else conflicts, government sanctions).

### *Government Rationality*

Kind, quantum and speed of government support. Appropriate design of government schemes, guidelines, budgets, procedures. Commitment of government functionaries their knowledge, skills, help in mobilising, guiding, training.

The conceptual framework given in Figure 32 below depicts and summarises the institutional features and rationalities (Gandhi and Johnson, 2019).



Source: Gandhi and Johnson 2019.

Figure 32. Conceptual Framework.

The framework was empirically tested with data from a farmer-institutional survey of 510 households across 51 water user associations in Bihar and Assam. The relationships between the framework features and performance were examined using multivariate ordered probit regression analysis (Gandhi and Johnson, 2019). The results for overall performance given in given in the Table 33 below. They show that technical rationality is found to have a strong positive association with performance indicating the great importance of technical rationality for delivering performance. Economic rationality also shows a strong significant relationship indicating the importance of good economic decisions such as right crop choice, prices and marketing to deliver performance. Besides this, social, environmental, organisational and financial rationalities also show positive and statistically significant associations indicating their relevance in determining performance. Political rationality shows a weaker but positive relationship.

TABLE 33. ORDERED PROBIT REGRESSION RESULTS – RATIONALITIES AND OVERALL PERFORMANCE

Parameter (1)	DF (2)	Estimate (3)	Standard Error (4)	t Value (5)	Approx Pr >  t  (6)
Intercept	1	-3.481219	0.338816	-10.27	<.0001
TechR	1	0.462224	0.100692	4.59	<.0001
EnvR	1	0.211463	0.099028	2.14	0.0327
EcoR	1	0.380315	0.079068	4.81	<.0001
SocR	1	0.430323	0.108434	3.97	<.0001
PolR	1	0.214952	0.116745	1.84	0.0656
OrgR	1	0.245714	0.081435	3.02	0.0026
FinR	1	0.188955	0.079932	2.36	0.0181
GovR	1	-0.227159	0.082229	-2.76	0.0057
d1Bihar	1	-0.439755	0.128491	-3.42	0.0006

Source: Gandhi and Johnson, 2019.



With respect to the institutional features and performance the relationship was examined similarly through multivariate Ordered Probit. The results given in the Table 34 below indicate that all the institutional features have a positive relationship with performance and 4 out of 5 are statistically significant. Good interaction shows a strong positive association indicating the substantial importance of good interaction representation, and meetings. Scale/size is also strongly related indicating the importance scale/size in terms of coverage, authority and responsibility. Adaptiveness also has a significant relationship indicating the need for flexibility/ avoiding rigidity in rules in face of change and variation. Compliance too is found strongly related indicating the importance of bringing compliance to the institution rules for good performance.

TABLE 34. ORDERED PROBIT REGRESSION RESULTS – INSTITUTIONAL FEATURES AND OVERALL PERFORMANCE

Parameter (1)	DF (2)	Estimate (3)	Standard Error (4)	t Value (5)	Approx Pr >  t  (6)
Intercept	1	-3.142061	0.384192	-8.18	<.0001
Clrob	1	0.099127	0.072542	1.37	0.1718
GooInt	1	0.424164	0.08385	5.06	<.0001
Adap	1	0.270281	0.070108	3.86	0.0001
ScSz	1	0.675628	0.129632	5.21	<.0001
Compl	1	0.272105	0.09626	2.83	0.0047
d1Bihar	1	0.152624	0.122917	1.24	0.2144

Source: Gandhi and Johnson, 2019.

The results show that just creating water institutions is not enough. The institutions need to be designed/ structured, and given guidance and support so that they strongly address the different critical rationalities and institutional features. This can go a long way in avoiding institutional failure in water and making the irrigation management institutions stronger and more effective in delivering the required efficient water resource management. The framework may be found useful also for other institutions and activities in resources management and development.

Apart from establishing and improving the functioning of water institutions, another important approach in water management is the adoption and use of new water saving technologies to improve water use efficiency. A recent study (Gandhi, Johnson and Singh, 2020) shows that with the adoption of micro-irrigation (drip and sprinkler irrigation), there is substantial water-saving. The study finds that micro-irrigation brings a 33 per cent reduction in hours of water pumping overall, with crop-wise variation from 14 to 53 per cent (see Table 35A below) and 98 per cent of the sample farmers believe that micro-irrigation saves water. The total input cost increases by 74 per cent overall as farmers use more fertilisers, better seeds and more labour to benefit from the investment in assured/accurate irrigation. However, there is a 88 per cent increase in the yields – varying across crops from 35 to 216 per cent, as well as an increase in prices due to better quality. As a result, the revenue or gross income increases substantially by 166 per cent on an average, and the net profit/ income increases by 360 per cent.

TABLE 35 (A). PERFORMANCE INDICATOR CHANGES WITH THE ADOPTION OF MICRO-IRRIGATION

S. No	Parameter/ Indicator	Crop									Overall Average
		Sugarcane	Banana	Wheat	Cotton	Chilli	Soybean	Broccoli	Chickpea	Cauliflower	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1)	Change in hours of pumping water	-53	-14	-51	-52	-35	-33	NA	28	NA	-33
5)	Change in electricity cost	-11	4	7	-18	-12	-2	NA	-29	0	-6
8)	Change in total cost	-2	139	6	29	87	168	53	102	50	74
9)	Change in productivity/ yield	40	216	36	44	57	168	46	92	36	88
10)	Change in revenue/ gross income	56	387	43	79	86	232	56	145	55	165
11)	Change in net income/ profit	153	3095	105	230	86	333	63	182	67	360

Source: Gandhi, Johnson and Singh, 2020.

The study also indicates that the adoption of micro-irrigation brings changes in the cropping pattern in the right direction (Table 35B). The differences between adopters and non-adopters indicates that with micro-irrigation, farmers shift away from crops such as rice, maize, wheat, soybean, lentil and fodder, towards crops such as beans, pea, cauliflower, tomato, cabbage, banana, orange and cotton towards which demand is moving in many cases use less water and fetch higher prices and incomes.

X

#### OVERCOMING MARKET INEFFICIENCIES AND MARKET FAILURES

As described above in the context of marketing inefficiencies and failures, the market efficiency for agricultural products is often very low and many improvements are required. For this more markets need to be brought under proper market regulation and put under the supervision of well-represented market committees. Second it is important to enforce transparent practice such as open auction in the markets. Third, it is important to create conditions which bring larger numbers of buyers and sellers to the markets to encourage healthy competition and closer to perfect market conditions, resulting in sound price discovery and good price realisation by producer. Also needed are improvements in market infrastructure such as in auction floor space, loading/ weighing facilities, storage, and better road links, as well as improvement in cold-chain facilities especially for fruits and vegetables. There is need to improve the transparency in market transactions through effective supervision by the market committee. Further, it is very important to improve the market information access and display of latest and extensive market information including through internet, mobile phones and other means of communication. Establishing futures markets with high participation and good links with the mandis/spot markets, and creating mechanisms for farmer participation, would also help good price discovery and better marketing efficiency (Dey, Gandhi and Debnath, 2019).

TABLE 35(B). DIFFERENCES/ CHANGES IN THE CROPPING PATTERN WITH THE ADOPTION OF MICRO-IRRIGATION

Crop (1)	Micro-irrigation non-adopters (per cent growing) (2)	Micro-irrigation adopters (per cent growing) (3)	Change (Per cent) (4)
Rice	13.5		-13.5
Fodder	5.0		-5.0
Maize	5.0		-5.0
Soybean	8.0	3.6	-4.4
Wheat	13.8	9.4	-4.4
Urd	2.8		-2.8
Buckwheat	2.5		-2.5
Lentil	1.9		-1.9
Chickpea	8.3	7.4	-0.9
Cowpea		0.4	0.4
Groundnut		0.4	0.4
Red chilli		0.5	0.5
Capsicum		0.7	0.7
Ginger	3.0	4.1	1.0
Sugarcane	6.4	7.6	1.2
Bitter Gourd		1.5	1.5
Cotton	7.7	9.4	1.7
Chilli	3.3	5.2	1.9
Orange		2.2	2.2
Broccoli	3.9	7.0	3.2
Banana	1.9	5.1	3.2
Cabbage	2.5	5.7	3.2
Tomato	1.7	4.9	3.2
Cauliflower	3.6	8.3	4.7
Pea	1.9	6.9	5.0
Beans	3.3	9.8	6.5
Total	100.0	100.0	

Source: Gandhi, Johnson and Singh, 2020..

Given the challenges and complexities of market inefficiencies and failures, the quest to meet the changing demand, and address various objectives including profits, and performance, with contribution to rural and small farmer development - there is a great need for new innovative institutional models and approaches for the organisation/ re-organisation of the marketing, processing and supply-chains in agriculture and food. In the context, based on experience, a set of key success factors have been identified for the success of such innovative institutional models and approaches (see Gandhi and Jain, 2012, and Gandhi et al., 2001). These are:

- 1) Performance in organising production and procurement: Must reach out to a large number of small farmers and provide incentive to produce. Good procurement system - low transaction cost
- 2) Promote the adoption of best technology/practices by the farmers: including the latest technology, inputs, R & D, extension. Transform agriculture, generate quality and quantity raw material at reasonable cost

- 3) State-of-the-art processing technology to produce quality products. Invest in best processing technology, produce high quality output, obtain the necessary financial resources to invest – in fixed and working capital
- 4) Deliver strong marketing effort. Undertake strong marketing. Reach the large market and complex demand, invoke nascent product demand in processed agri-foods, address tastes and changing consumer behaviour
- 5) Create win-win across the supply chain, appropriate ownership/ management/ relationships/networks to create win-win across all the stakeholders, from farm to fork.

Given below are examples of some of the successful innovative business models which have overcome the market inefficiencies and failures in several commodity settings to create win-win from farmers, to processing/marketing, to consumers (Gandhi and Jain, 2012; Gandhi, 2014).

#### *The AMUL Model*

In this well known model, ownership rests with the farmers on a cooperative basis. It has a three-tier organisational structure, with primary cooperatives at the village level, a co-operative union at the district level, and a cooperative federation at the state level. The village co-operatives procure the milk from the farmers/village milk producers, the district union transports and processes it, and the federation markets the milk and milk products nationally. The organisations are governed at the top by farmer-elected rotating boards/ managing committees who confine themselves to strategic and policy decisions. The operational management is entrusted to professional managers/ staff who are largely independent and highly empowered. Apart from the milk business, the cooperative is substantially engaged in providing development inputs such as veterinary, breeding and feed services as well as extension. These enhance cohesion and commitment to the organisation and help long-term growth and development.

The base is the village co-operative society which consists of milk producer members-shareholders and an elected managing committee consisting of 9 to 12 voluntary representatives and an elected chairperson. The managing committee appoints a paid secretary and staff for day-to-day operations. The cooperative society collects milk from the milk producers, and makes payments at district union fixed prices based on objective measurement of the quantity and quality of milk. It also provides some services to the members such as veterinary first aid, artificial insemination (AI) breeding service, and sale of nutritious cattle-feed. The village societies are members of the district-level cooperative milk union, represented by their chairpersons. The union is governed by an elected board of directors consisting of 9 to 18 representatives from village society chairpersons and an elected board chairperson. The board appoint a professional managing director and staff. The union collects the milk from village societies, sometimes chills it, and transports it to its own modern dairy processing plant. Here it is pasteurized, stored, packaged or processed into milk products. The union also proactive in initiation, training and supervision of the village societies, and arranges for a number of important services including veterinary doctor services, AI breeding services, cattle

feed supply and vaccination. The district unions are members of the state-level cooperative milk federation represented by their chairpersons. The federation is governed by a board of directors elected from among the union chairpersons, and an elected federation chairperson. The board appoints a professional managing director and staff. Federation undertakes and coordinates the marketing of the milk and milk products of the milk unions.

### *The Nestlé Model*

Nestlé is one of the largest private food and beverages companies in the world. The company uses the milk district model for its agribusiness activity in India. Nestlé milk processing factory in the Moga district of Punjab produces milk powder, infant products and condensed milk. In 2008, it covered about 100,000 farmers and had a procurement of 1.25 million litres milk/day. A milk district setup involves negotiating agreements with farmers for twice-daily collection of milk, establishing collection centres and chilling centres at larger community collection points or adapting existing collection infrastructure, arranging transportation from collection centres to the district's factory, and implementing a programme to improve milk quality. Each of the six districts from which Nestlé sources raw milk are referred to as 'Moga Milk Districts'.

In the Nestlé or 'Moga model', the job of sourcing milk from farmers is carried out by a private commission agent appointed by the company. Nestlé operates a network of 1100 agents who receive a commission on the value of the milk supplied to the dairy. Dairy farmers supply milk under contract and the company maintains their records. The company has stringent quality specifications. Nestlé staff members regularly monitor milk quality and performance *vis-à-vis* contractual obligations, and the farmers obtain feedback on milk quality at the collection points. Company technologists determine quality in laboratories with samples being taken in the presence both of the farmers and the company representatives. Nestlé is not obliged to collect milk that does not meet the quality standards specified in the contract. The contract also allows the technologists to penalise the producer with a 30-day ban. If antibiotics are found, the price of milk is reduced by 15 per cent. Repetition of any discrepancy is considered a serious breach of contract. Farmers have the right to complain through registers located at each collection point if they believe there is a problem. The system works because it provides an assured market for the farmers at remunerative prices for the milk.

### *Comparing the Nestlé and AMUL models*

In terms of scale and reach, Nestlé's milk procurement pales in comparison with that of AMUL. During 2000-01, AMUL's unions procured an average of 4.58 million kg of milk per day from over 2 million farmer-members in Gujarat. Every third litre leaving a milch animal's udders in the state was collected by societies affiliated to AMUL, (Damodaran, 2001). Nestlé's operations are much smaller and confined to districts around Moga. Nestlé's average procurement of 0.65 million kg per day covers barely 3 per cent of Punjab's annual milk output. The average Nestlé farmer supplies about 7.25

kg of milk per day, whereas figure for AMUL is about 2 kg per day, indicating AMUL's reach extends substantially to small/marginal farmers and landless farm labourers who may own only 1–2 milch animals (Gandhi and Jain, 2012).

With respect to price, Nestlé in 2000-01 paid an average price of Rs 9.84 per kg, lower than the Rs 13–14 per kg that AMUL paid to its farmers. However, adjusting for the fat content, there is little difference between the farm gate prices paid by Nestlé and AMUL. In 2000-01, Nestlé's payments to Moga's farmers for milk as well as development inputs amounts to almost 47 per cent of the value of the company's sales of milk products. In comparison, this proportion for AMUL and its unions is over 80 per cent. Thus, a much larger share of the consumer rupee reaches the farmers in case of AMUL as compared to Nestlé. It must be noted that Nestlé is a company accountable to its shareholders and investors, while AMUL is an entity owned by and accountable to the farmers (Damodaran, 2001).

#### *Heritage Foods Model*

The Heritage model involves harnessing the current milk collection centres and rural retail points to penetrate the rural market. Two-way or reverse logistics are used to transfer and sell goods from the urban markets to rural markets, and through this retail presence also mobilize milk procurement. This enables economies of scale in supply chain costs, serves both the rural customer and producer, and improves penetration in the rural areas. This also provides opportunities for Heritage to launch its private labels in rural markets. The company's rural retail network has increased to 1515 stores with 13 distribution centres. A typical rural store is about 10 square metres in size and is based on a franchise model to cater to villages with a population of less than 5000. The objective is to deliver popular fast-moving consumer goods (FMCG) products and quality groceries at affordable prices to interior villages across South India, and leveraging for the milk procurement network.

Apart from milk, vegetables and seasonal fruits are also procured through contract farmers and reach pack houses via collection centres strategically located in identified villages. The collection centres undertake washing, sorting, grading and packing and dispatch to retail stores through distribution centres. Other features of the model include: promotion of an annual crop calendar of sourcing that seeks to ensure regular supply and higher income per unit area, technical guidance - agri-advisory services, training of farmers, input supply and credit linkage, package of improved farm practices for better productivity and quality, an assured market at the doorstep, assured timely payments, transparency in operations. The Heritage model provides an example of using the existing marketing points and chains for the purpose of agribusiness rather than building new/dedicated chains. This achieves faster roll-out and reach. It also provides an example of using two-way or reverse logistics for improving the efficiency and economics of the supply chain (Gandhi, 2014).

#### *Suguna Poultry Model*

In Suguna's business model, farmers who own land and have access to resources such as water, electricity and labour can become growers of Suguna's Ross breed of

chicks. Suguna takes the responsibility and provides all the other required inputs - day old chicks, feed, medicines as well as supervision to the farmers. Suguna also brings good management practices and technical know-how that lead to higher productivity. The method of growing the chicks is standardized and must conform to the exacting standards laid down by the company; quality control checks are carried out by company staff to ensure the norms are being met. The broilers are procured by Suguna as long as they comply with established quality norms, and the farmer is paid a 'growing' commission or charge. If a farmer does not comply with procedures as laid down, or sells chickens to another party, this is considered a breach of trust and the contract is unlikely to be renewed. Suguna also offers farmers a safety net: it bears production and market risks, taking responsibility for losses from a change in the market environment. A rise in the feed prices does not affect the farmers because they are supplied with feed directly by Suguna. Similarly, when the bird flu attack occurred, Suguna absorbed the financial loss suffered by the farmers. Thus, farmers receive assured returns. Regardless of the market prices, the farmers receive the assured growing charge/cost, and incentives.

The Suguna model offers fast scalability because the company does not have to buy or lease farms. It keeps costs low, and offers economies of scale including in buying raw materials, feed and medicines. Suguna has benefited large numbers of rural households, improving their lives with its innovative business model. Seeing the impact, other States such as Andhra Pradesh, West Bengal, Punjab and Jharkand invited the company to set up operations in their States. Suguna has proved that every state in India is fit for poultry operations with its presence in 11 states. The model has also attracted visitors from abroad who are keen to learn from Suguna's initiatives and success and adopt the model in their countries.

#### *PepsiCo Model*

The PepsiCo model involves backward integration by a private company with strong marketing capabilities and established products and brands. Under this model contracts for production and procurement of tomatoes were made with small farmers. The company has built relationships of trust with farmers. It brought in experts and promoted the use of appropriate varieties and farm technology, bringing to bear research and know-how available worldwide. Seedlings were provided to the farmers and planting was scheduled and programmed using computers. Tomatoes were procured by the company and it used the best technology in processing and its strong marketing capabilities and networks in selling quality end-products. More recently, a similar initiative has been launched for potato. The product quality parameters put in place through the chain are driven by the specific needs of processing, and of buyer requirements. Stringent quality control is required at all levels in the chain. The requirements are met by ensuring quality compliance at every stage: farming, storing, processing, and packaging (Punjabi, 2008). Seed potatoes of the specific varieties are provided by the company. The company ensures that farmers have availability of all the required inputs at the right time. The costs of inputs if provided are deducted during buy back of potatoes. Teams of agricultural graduates employed by the company work with the farmers to provide technical advice and monitor production. The agronomists regularly monitor the fields including at

planting, spraying, and harvesting. After harvest, the selected procured potatoes are taken to the hi-tech processing plant. There they are washed, peeled and inspected for physical damage and discolouration. Then they are run through rotating slicers, deep fried, mixed with spices and packed. The company has partnered with more than 10,000 farmers working over 10,000 acres of potato across the states of Punjab, Uttar Pradesh, Karnataka, Jharkhand West Bengal, Kashmir and Maharashtra.

This model is more than simple procurement or contract farming and entails substantial company involvement in developing a mutually beneficial partnership between the agribusiness and the farmers. The model can result in very good benefits to small farmers in a limited area, but it requires a long-term view and commitment from the company and a willingness to absorb substantial start-up costs and initial losses (Gandhi, Kumar and Marsh, 2001). It should treat farmers as partners and share the benefits and risks with them, thereby creating a long-term sustainable business relationship and a win-win situation for both the farmers and corporates.

#### *ITC e-Choupal Model*

The model was launched by ITC in the villages of Madhya Pradesh in the year 2000. ITC opened three soya processing and collection centres and then identified six nearby villages for establishing *e-choupals*. The company identified an educated farmer to head the *e-choupal* in each village. The person is called the *sanchalak* and is trained to operate and coordinate the activities of the *e-choupal*. To establish the *e-choupal*, a personal computer is installed at the house of the *sanchalak*, and the *sanchalak* is given training in using it. The computer is connected to the Internet via telephone as well as satellite and has back-up power. The *sanchalak* helps the farmers in using the system, guiding them to the specially created website of the company and to see the prevailing prices and other related information on it. To initiate a sale, the farmer brings a sample of the produce to the *e-choupal*. The *sanchalak* inspects the produce and performs quality tests (including foreign matter and moisture content) to assess the quality in the presence of the farmer and explains the if there are any deductions. He then obtains the benchmark price from the computer, makes the appropriate deductions, and conveys a conditional quote to the farmer. If the farmer chooses to sell to ITC, the *sanchalak* gives the farmer a note with his name, village name, particulars about the quality tests, approximate quantity and conditional price. The *sanchalaks* is paid 0.5 per cent of the value of soya procured.

The farmer takes the note from the *sanchalak* and proceeds with his produce to the nearest ITC procurement hub. At the ITC procurement hub, a sample of the farmer's produce is taken and set aside for laboratory tests. A chemist visually inspects the soybean and verifies the assessment of the *sanchalak*. Deductions for the presence of foreign matter such as stones or hay are made based on visual comparison with other produce such as of his neighbour's and the farmer may accept the deductions and the final price. Laboratory testing for oil content is performed after the sale and does not alter the price. The farmer's produce is then weighed on an electronic weighbridge and following which the farmer can collect his payment in full at the payment counter. The farmer is also reimbursed for transporting his crop to the procurement hub. The process is accompanied by appropriate documentation. The farmer is given a copy of inspection



reports, agreed rates, and receipts for his records. The system also has *samyojkas* (who were former commission agents) who are responsible for collecting the produce from villages that are located far away from the processing centres and bringing it to the ITC centres. The *samyojka* is paid a 1 per cent commission. At the end of the year, farmers can redeem accumulated bonus points through the *e-choupal* for farm inputs, or insurance premiums. Some procurement hubs also have Choupal Saagars which offer goods and services farmers may need including agri-equipment, agri-inputs, personal consumer products, insurance service, pharmacy and health centre, agri-extension clinic, fuel station and food court. Information and services provided by the *e-choupal* web site and e-commerce system include: weather information, information on scientific practices, guidance on how to improve crop quality and yield, access to input supply (fertilisers, pesticides) along with recommendations, and to soil testing service. The model has principally aimed at increasing the efficiency of procurement, resulting in value creation for both the company and the farmer. In addition, the model takes internet penetration to the villages, offering information and global commercial contact. The *e-choupal* allows the farmers daily access to information on prices of many *mandis* which helps them to make better decisions on when and where to sell the produce. Thus, *e-choupal* tries to provide farmers a better price. The incremental income from a more efficient marketing system is estimated to be about US\$6 per tonne on average, or an increase of about 2.5 per cent over the *mandi* system (Gandhi, 2014).

### *Comparison of the Different Models*

Table 36 below provides a broad comparison and evaluation of the models (for models not described here see Gandhi and Jain, 2012). As can be seen, the strengths vary substantially across the models. Whereas Amul and ITC e-choupal are strong in reach to small farmers, Suguna and Pepsi are strong in ensuring adoption of the right technology

TABLE 36. BROAD COMPARISON OF DIFFERENT MODELS ON PERFORMANCE PARAMETERS

Agribusiness model (1)	Reaching large numbers of small farmers and procuring quantity (2)	Ensuring adoption of good technology by farmers for quantity and quality (3)	Investment in modern processing technology and meeting the capital requirements (4)	Delivering strong marketing effort (5)	Organisation of ownership/management and control to bring benefits to all stakeholders (6)
AMUL	Strong	Reasonable	Strong	Strong	Strong
Nestlé	Limited	Reasonable	Strong	Strong	Limited
Heritage	Good	Limited	Good	Good	Limited
Suguna	Good	Strong	Strong	Good	Good
Pepsi	Reasonable	Strong	Strong	Strong	Reasonable
ITC e-Choupal	Strong	Limited	Strong	Strong	Limited
Other Models					
Nandini	Good	Limited	Limited	Reasonable	Good
Mother Dairy	Limited	Limited	Good	Good	Reasonable
Safal Market	Limited	Limited	Good	Limited	Limited
HPMC	Reasonable	Limited	Good	Poor	Poor
McCain	Reasonable	Strong	Strong	Strong	Limited
Desai fruits and vegetables	Reasonable	Good	Good	Strong	Reasonable

Source: Gandhi and Jain (2012).

for quality and quantity. Nestle, Pepsi and Amul are strong on investing in modern processing technology as well as at delivering a strong marketing effort to reach a huge food market. Amul is strong on commitment and benefits to all stakeholders, Suguna is good at it too, and Pepsi is reasonably good.

It is observed that no single model is appropriate/ best for all the products and regions. It is critical that alternative agribusiness models are experimented with and given a chance. Those models, which are organisationally and economically strong and contribute substantially to rural incomes/ development, as well as transform and modernise the supply chain, need particular encouragement.

### *New Models/ Start-ups*

Beyond those described above, a number of new models and start-ups have also emerged in the recent years. A few are being described here.

#### *NinjaCart*

The Ninjacart- a Bengaluru based start-up seeks to minimize the inefficiencies in the fruit and vegetable supply chain. Farmers face problems of low price, spoilage, and heavy dependence on middlemen. Retailers face problems of storage, mismatch of demand and supply, and high cost of operation. In the Nijcart system, farmers bring their produce to Collection Centres (CC) in their respective villages. There the items are graded, weighed, batched, and then dispatched to Fulfilment Centres (FC). Then the products go from the FC to the Distributing Centres (DC) across the city. There is random inspection of the quality of produce in each vehicle and once the produce reaches DC, it is picked and batched according to retailer requirements. It is then delivered to the retailers. With the help of IT the entire process is managed very efficiently so that vegetables and fruits reach from the farmers to retailers in less than 12 hours, which helps greatly reduce spoilage/wastage.

Farmers growing fruits and vegetables register themselves with the NinjaCart. The service can be accessed through a mobile based application or by calling on a toll free number. There are standards for the produce in terms of shape and weight which farmers have to adhere to. Farmers deliver the fruits and vegetables to Village Collection Center. Items are graded, weighed, batched, and dispatched to Fulfillment Centers. A statement of accounts is given to the farmer. All payments are made by electronic transfer. In the Fulfillment Centers, the items are randomly inspected once again and then sent to Distribution Centers across the city. When the produce reaches Distribution Centers, the items are picked and batched according to customers' requirements. Crates are fixed with radio-frequency identification (RFID) tags that help in seamless end-to-end operations. Retailers who pre-order the items, receive them within 12 hours. Use of IT and AI allows NinjaCart to reduce the inefficiencies in the agri supply chain. Farmers are also made aware of the demand and prices of the commodities a day before the harvest, which

enables them to decide and have some bargaining power. All the payments are made within 24 hours from the time of sale.

In 2019, NinjaCart served about 17000 retailers across 7 major cities — Bangalore, Chennai, Hyderabad, Ahmedabad, Pune, Mumbai, and Delhi. These items are delivered by over 3000 delivery executives known as “Ninjas”. NinjaCart now covers twelve major cities. The daily average volume is around 1000 tonnes of vegetables and fruits (Seksaria, 2019).

### *AgriBazaar*

AgriBazaar is a Delhi-NCR based agritech start-up which provides online market for farmers. As in a mandi, where physical transactions take place between buyers and sellers, here the trading happens online. An electronic e-mandi aggregator model is created where farmers, buyers and merchants come together for buying and selling of agri-produce. Farmers register themselves and when the produce is ready, they upload the information on the website. Buyers or merchants interested to buy the produce will contact the farmers, and if the deal is decided, AgriBazaar provides the logistics in which the produce is picked up from the farmer’s door step and delivered the produce to the buyer. The payment is credited to farmer’s bank account. The whole process of buying and selling happens online. An efficient agri-value chain using IT is established.

The process is that the farmers register themselves with a procurement center. A lot slip is created with the details of the crop/ produce. Samples of crop/ produce are sent for lab testing. The lot is listed for online auction. If the deal is made, the weighing of produce is done. The money is transferred online to farmers. The digitisation of the agriculture trading has enabled creation of an efficient supply chain where both the buyers and sellers can win. With reduction in inefficiencies in the supply chain, huge profits are possible for farmers and retailers.

By 2020, AgriBazaar had facilitated Rs 9000 crore (Gross Merchandise Value) worth of transactions since its inception, making it one of India’s largest online agri-trading marketplaces. Apart from e-mandi, the startup also helps farmers with warehouse solutions. In 2018-19, over 15 lakh MT of commodities were stored in 700+ warehouses by AgriBazaar, providing substantial storage for farmers. Other facilities include quality testing and agriculture advisory services. So far the company has delivered to over 160 locations in India.

Besides these models, there are also procurement systems related to major retailers such as Tata-Star Bazaar, D-Mart and Reliance-Mart. Besides, numerous farmer producer organisations are also emerging. Other innovative models operating in parts of the supply chain include AgroStar, Gramophone, BigBasket and Grofers.

## XI

### IMPERATIVES FOR THE FUTURE

1. *Need to address the changing food demand:* The composition of food demand is changing substantially with growth in incomes and development especially since 2000.

This has been brought out clearly by the various rounds of NSS surveys. For example, the share of cereals in consumption has dropped from 54 per cent in 1970/71 to 34 per cent in 1999/00 to 18 per cent in 2011/12. The share of vegetables and fruits has risen to 20 per cent and of livestock products to 25 per cent. No NSS consumption data is available since 2011/12 but by now these would have changed even further. It is very important that agriculture does not stay with old production patterns and should adjust as quickly as possible with the changing demand. This would help agriculture realize better prices and higher incomes. Else huge mismatches between supply and demand will develop and would result either in price collapse or low profitability, or the need for continuous government support resulting in huge expenditures and inventories. Agriculture would then become a drag on economy rather than a contributor and supporter of economic growth and development of the country. Thus, shifting to new demand patterns is very important.

2. *Using natural resources with care and efficiency*: Natural resources are becoming increasingly scarce and need to be used in the most efficient way in order to ensure sustainable growth. Net cropped area is showing a negative trend indicating that less and less land is available for agriculture due to diversion for industrial and other uses. Given the need to produce enough and increase production it is firstly important to convert the net cropped area to maximum gross cropped area through multiple cropping. The data indicates that much improvement is required here since even irrigation growth is not translating to equivalent gross cropped area growth. Secondly, higher yield growths are required to overcome the land constraint and here there is a slowdown rather than acceleration in the last decade. The best technology available globally needs to be deployed in India without much delay and hesitation, especially in non-staple crops where faster growth is required due to rising demand – be it through seeds, nutrients, plant protection or precision farming. The adoption and following of best practices at the farm level needs to be strongly promoted and facilitated. Further, not only quantity but quality is also required.

The other major natural resource critical for agriculture, namely water, is being very inefficiently used. The water use efficiency is very low in India at only 25 to 35 per cent indicating that 65-75 per cent of the water is being wasted. The per capita water availability is reducing very sharply on the other hand and agriculture is the largest user. Besides, though irrigation investment is taking place, there is a growing gap between irrigation potential created and the actual irrigated area – indicating poor management. Markets generally don't work in water and market failures are common. Institutions are required. But though there are success stories, water institutions are frequently ineffective and institutional failures are common. However, experience indicates that water is best managed by its users and participatory irrigation management (PIM) institutions need be formed in large numbers throughout the country to take care of the scarce water resources. However, just creating water institutions is not enough. They need to be guided, structured and designed through training and support to effectively address the five institutional features and eight management rationalities that have been identified for their success in studies of water institutions across many states. They can then sustainably improve the water use efficiency, providing a great foundation for agricultural prosperity.

Besides, there is great need to promote the adoption the new water saving technologies such as drip and sprinkler irrigation which can save over 50 per cent of the water and greatly boost yields and profits.

3. Growth and effective use of the best agricultural inputs: Agricultural inputs form the backbone of India's agriculture but in the recent years there is a decline in the growth of almost all modern agricultural inputs. The consequence of this is seen in terms of a decline in the yield growth of almost all the crops. There is great need to revive the growth in the use of the inputs. There is need to revamp the fertiliser policy to reduce controls, restore incentives in production and marketing, and wean the sector away from perpetual dependence on subsidies. This will lead to effective, balanced, need based and judicious use of fertilisers along with organics towards sustainable management of soil fertility as seen in east Asian countries, minimising impact on the environment. In the case of seeds and crop protection, the farmers must have access to the latest and the best in the world without excessive hesitation and delay given that in a globalizing economy the Indian farmers and agriculture need to be competitive with the rest of the world. There is a need for appropriate and greater mechanisation to maintain productivity and viability in face of rising wages and labour shortages. Here innovations are constantly required to provide appropriate and low cost technologies which are labor augmenting rather than labour substituting.

4. Need to use the opportunities thrown up by urbanisation, liberalisation and globalisation: Urbanisation, liberalisation and globalisation are mega forces reshaping the economy and the world. They are bringing rapid income growth in urban areas, creating substantial new opportunities. For example vegetables, fruits, livestock products and edible oils are growing rapidly in demand but some such as edible oils are being imported. Indian agriculture must respond and make the best of these opportunities - connecting and adjusting and meeting the demand in order to boost agricultural and rural incomes. Well-functioning markets and marketing systems are very important for this and getting a fair share to the farmers.

5. Improving the functioning and efficiency of markets: Market inefficiencies and market failures need to be overcome so that the maximum share of the consumer rupee reaches the farmers, and consumers too are served in the best possible way. There is great need to improve the performance of APMCs in providing a strong and efficient market connection. The present mandis and their systems are very traditional and provide very few services to the farmers. They are frequently dominated by traders and provide very poor marketing efficiency reflected in high farmer-consumer price differences and high trade profits. It is important to bring more markets under proper market regulation and put them under the supervision of well-represented market committees. Second it is important to enforce transparent practices of transaction particularly open auction in the markets. Third, it is important to bring large numbers of buyers and sellers to the markets to encourage healthy competition and closer to perfect market conditions, resulting in sound price discovery and good price realisation by producer. Also needed are improvements in market infrastructure such as in auction floor space, loading/ weighing facilities, storage, and better road links, as well as improvement in cold-chain facilities especially for fruits and vegetables. There is need to improve the transparency through

better supervision by the market committee. Further, improving the market information access and display of latest and extensive market information including through internet, mobile phones and other means of communication.

6. *Encouraging innovative and modern agribusiness models*: The national and world economy is becoming increasingly complex and advanced and farmers by themselves are incapable of make the best of it. Traditional marketing systems are also lacking. Linkages with expertise and capabilities of various kinds is required. Organised models including integrated agribusiness models are very important in facilitating a good connection, overcoming the market inefficiencies and failures, and bringing farmers a fair share. Innovative institutional business models can go a long way in efficiently connecting agriculture with the consumers and export markets leading to modernisation of the supply chains and higher returns to farmers, as well as efficient use of resources. Individuals by themselves would be generally ineffective in overcoming market imperfections and failures and organised approaches are required to best connect agriculture to the growing and transforming urban and international market. Good examples are models such as Amul, Nestle, Suguna, Heritage, Pepsi, ITC and McCain and these and more should be encouraged. Retailers such as Tata-StarBazaar and Reliance-Mart have also developed their linkages and systems and capable international players are also exist. Besides there are numerous innovative start-up models such as Ninjacart and AgriBazaar. It is important to learn from, support, and further develop these models, so that they can help the farmers and agriculture adjust with and benefit the most from the changing market environment and growing world economy. India's income elasticity of demand for food overall is still very high (0.7-0.8) (add population growth) indicating strong demand and growth prospects for agriculture.

From the policy point of view, the right incentives, linkages and investments are requires and it is a challenge how best to make all this work. The government can play a huge supporting role through enabling policies, planning, and infrastructure development. It is important to let the markets and a number of these models work – to connect and drive the transformation. They may not be able to cover and benefit all and here again the role of the government is important to encourage equity in operations and benefits, and provide a safety-net for those that cannot be immediately covered or benefited. The government also has big role in the development of the human resource – the farmer and the skilled workforce whose roles are critical for performance. The government should also invest heavily in research with a strong agenda for the innovations and development of new ideas and solutions for the problems currently faced. The overall vision should be to develop a high performance agriculture which is competitive, market savvy, and responsive to demand, supply and price signals; an organized agriculture which functions like a well-oiled efficient machine to deliver best benefits for the producers and consumers, and which thereby contributes very effectively to the economic growth and development of the country.

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