Indian Journal of Agricultural Economics 76: 1 (2021):12 -77
DOI:10.63040/25827510.2021.01.002

Indian Agriculture at a Crucial Stage: Change and Transformation 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. First of all, I would like to most heartily welcome all the members of the Society as well as all other participants and dignitaries attending the Conference. 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 which has been held before me by so many truly outstanding contributors 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 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 talk today is change, particularly the changes confronting Indian agriculture and the changes needed. In our world today, whether we like it or not, change has become the new constant. 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 scenario. Instead of the expected

*Presidential Address delivered at the 80th Annual Conference of the Indian Society of Agricultural Economics held during February 10-12, 2021 under the auspices of Centre for Agricultural and Rural Development Studies (CARDS), Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu).

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growing economy, there has been a major decline. And the major farmer protests at the turn of this year 2020-2021.

Apart from these more immediate deviations, big long term challenges are confronting Indian agriculture, the Indian economy and the world economy. These include significant changes in the nature of demand/ consumption and consumers, the production and producers, in various services, and the linkages between 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 of Indian agriculture, which are necessary to serve both the rural and urban population and India's economic development well. Without the change/transformation, there may be serious conflicts between the past and the future: the directions of the past and the new directions needed for a brighter future.

I would like to first dwell upon several of the major drivers or changes happening, which are visible or just nascent, and the challenges they are posing for Indian agriculture and the economy. Following this I will try to dwell upon what kind of changes are required in agriculture, the supply chains and the related services, 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 entirely due to production failure but actually due to 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 care in the country. As a result, it was the quantity of food demanded which began to substantially exceeding production. Thus substantially, the cause was demand for food – mainly the quantity. At that time the scientists, governments, farmers and industry responded magnificently to deliver the green revolution and prove the gloomy forecasts of Malthus wrong. The production was miraculously boosted to meet the food demand and consumption quantity. Today once again in the context of agriculture, the major problem is actually consumption. It is not the quantity but the "quality" demanded, that is the changing composition of food demand - the kinds of food demanded, as well as quality and convenience demanded by the consumers in the wake of rapid economic growth with rising per capita incomes especially since the 2000s. The major challenge for agriculture and 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, resulting in low farm incomes, food price inflation and a stalling of economic growth.

Food grain production and consumption growth in India up-to late 1980's were examined by many, including Sarma and Gandhi (1990), as well as Gandhi and Mani

(1995) who examined food demand growth with a focus on livestock product demand. 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 is rapidly changing and most studies from earlier periods cannot capture the recent dynamics and new emerging reality.

Gandhi and Zhou (2014) have more recently examined the food scenario in emerging economies of India and China and found that it is undergoing rapid change, creating major challenges for these countries as well as the world. The principal reason behind this is that both countries have witnessed rapid development with economic growth rates frequently of 6 to 9 per cent especially since 2000. With large populations and rising incomes, the food demand has not only increased in quantity but the composition of food demanded has changed rapidly. Even though the demand for cereals seemed somewhat manageable, there is a structural shift away from them and the demand for foods such as vegetables, fruits, animal products, edible oils and processed food products have grown more rapidly and often posed new problems. With continuing government food security emphasis only on basic staples, the issues of production, supply chains and policy support for these other foods were frequently ignored or poorly stressed, exacerbating the difficulties. The consequence was seen in terms of high inflation rates coming substantially from price inflation in these other foods, 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 for rural consumers are examined in Table 1 and for urban consumers in Table 2. (Unfortunately no parallel 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 20011/12. 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

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

										Percentage		
Item	1970/ 71	1977/ 78	1983	1987/ 88	1993/ 94	1999/ 2000	2004/ 05	2009/ 10	2011/ 12	1970/ 71	2009/ 10	2011/ 12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(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

										Per cent		
Item	1970/ 71	1977/ 78	1983	1987/ 88	1993/ 94	1999/ 00	2004/ 05	2009/ 10	2011/ 12	1970/ 71	2009/ 10	2011/12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(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.

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.

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. Thus, overall the demand for food is vibrant and showing a huge increase but the composition of the demand is changing.

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

Item	1999-2000 Quantity (kg)	2009-2010 Quantity (kg)	2011-12 Quantity (kg)	1999-2000 Value (US$)	2009-2010 Value (US$)	2011-12 Value (US$)
(1)	(2)	(3)	(4)	(5)	(6)	(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	1999-2000 Quantity (kg)	2009-2010 Quantity (kg)	2011-12 Quantity (kg)	1999-2000 Value (US$)	2009-2010 Value (US$)	2011-12 Value (US$)
(1)	(2)	(3)	(4)	(5)	(6)	(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.

More dynamically, the shift in theper capita consumption of different food groups forrural and urban consumers over the years from various NSS surveys are shown 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 this crosses cereals 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 2011-2012. 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 since 2000 – and trend may be expected to continue.

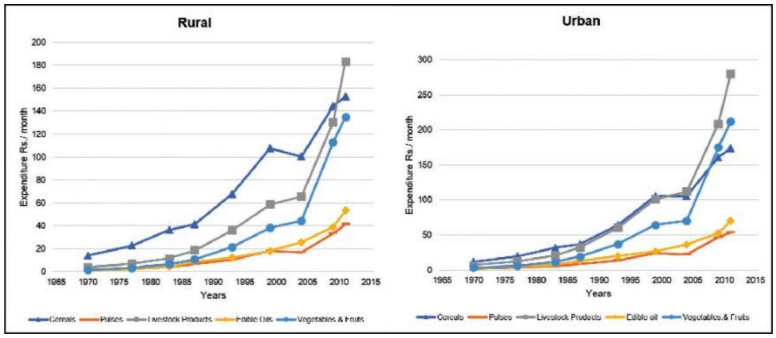


Figure 1. India: Per Capita Food Consumption over the Years, in Rs./month.

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. The 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 in share, 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.

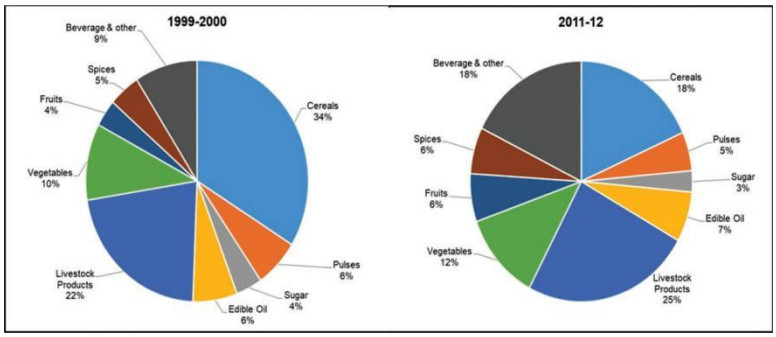


Figure 2. India: Change in Share of Different Food Items in Demand for 1999-2000 and 2011-2012.

Are there changes within the food groups? The Figure 3 shows that the major cereals consumed remain rice and wheat, but whereas the demand for rice remains at 53 per cent, the share of wheat has increased from 38 per cent to 41 per cent, indicating growth in its demand. 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 in 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 substantial changes in the composition of pulse demand within a reduced share of 5 per cent in food demand.

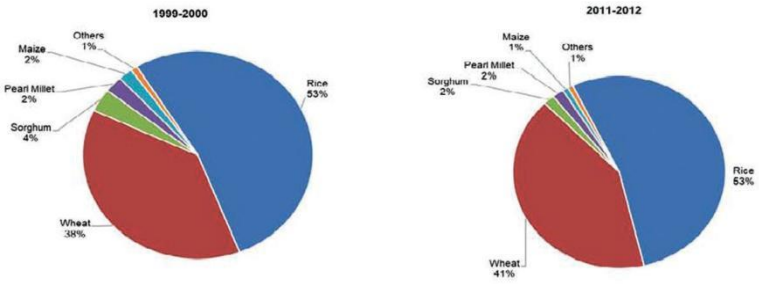


Figure 3. India: Share of Demand for Major Cereals, 1999-2000 and 2011-2012.

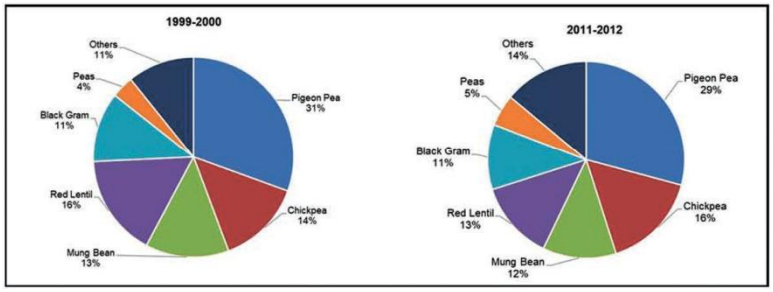


Figure 4. India: Share of Major Pulses in Demand for 1999-2000 and 2011-2012.

Figure 5 shows that in edible oils there are huge changes 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. The Figure 6 covers vegetables, the demand for which has grown from 10 to 12 per cent in the food demand share between 1999-2000 and 2011-2012. The 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 greater changes are seen in the demand for fruits, which showed an overall increase in share from 4 to 7 per cent. The demand for apples has increases sharply from 7 per cent to 16 per cent in share, 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.

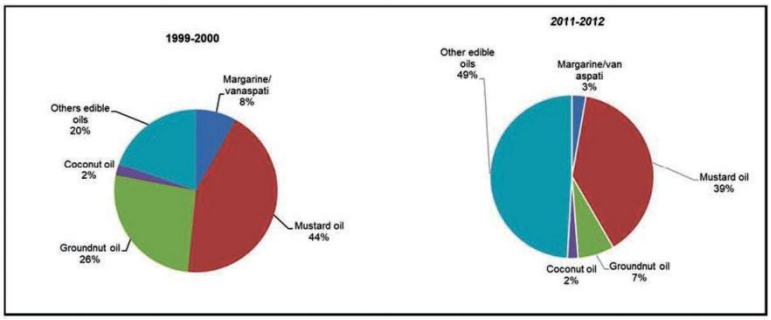


Figure 5. India: Share of Major Edible Oils in the Demand, for 1999-2000 and 2011-2012.

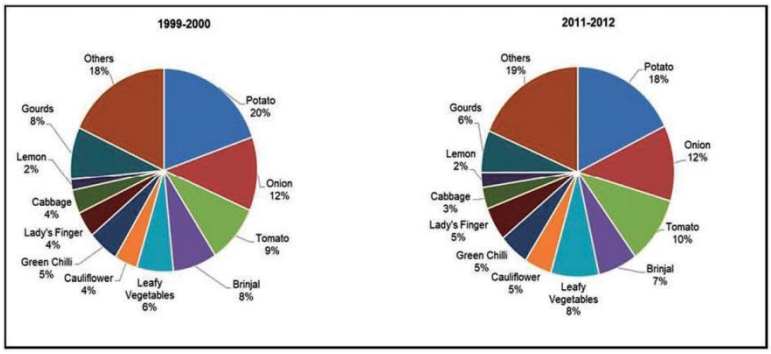


Figure 6. India: Share of Various Vegetables Demand for 1999-2000 and 2011-2012

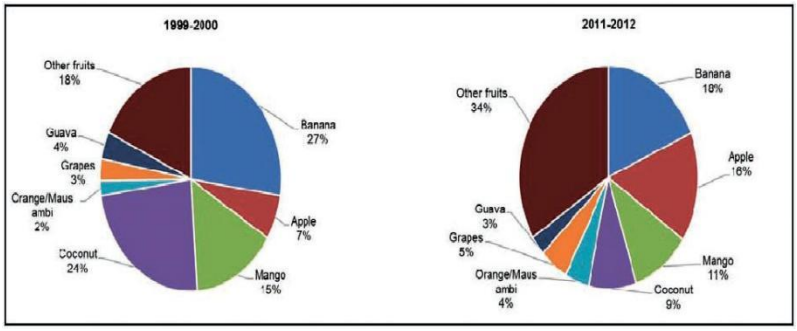


Figure 7. India: Share of Various Fresh Fruits in Demand for 1999-2000 and 2011-2012

The animal/ livestock product demand showed an increase in share from 22 per cent to 25 per cent 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.

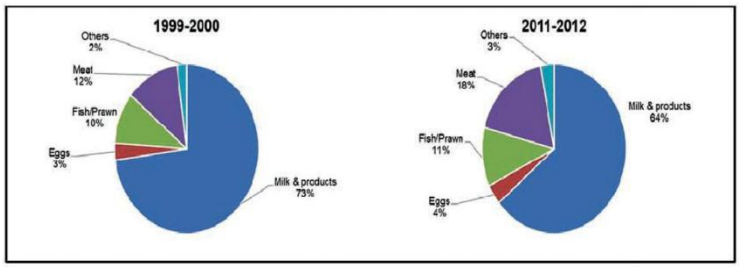


Figure 8. India: Share of Major Animal Products in Demand for 1999-2000 and 2011-2012.

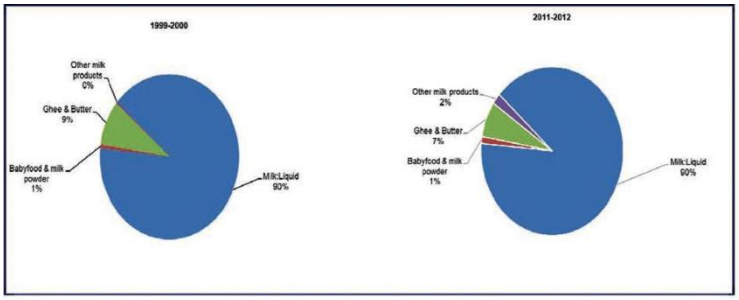


Figure 9. India: Share of Major Dairy Products in the Demand 1999-2000 and 2011-2012.

Drivers of Demand Change and the Future

Figure 11 below shows how food demand changes across income (expenditure) classes based on cross-section NSS data for rural and urban consumers. The Figure 11 shows that at low income levels the demand for cereals dominates in both rural and urban areas. However, with higher income levels the demand for livestock products rises rapidly across 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, rapid income growth would be a major driver behind changes seen in the structure of food demand.

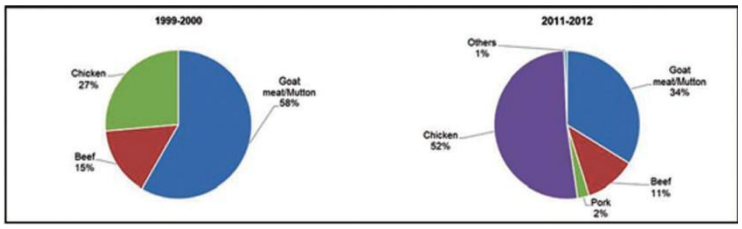


Figure 10. India: Share of Different Kinds of Meat Consumed in the Demand for 1999-2000 and 2011-2012.

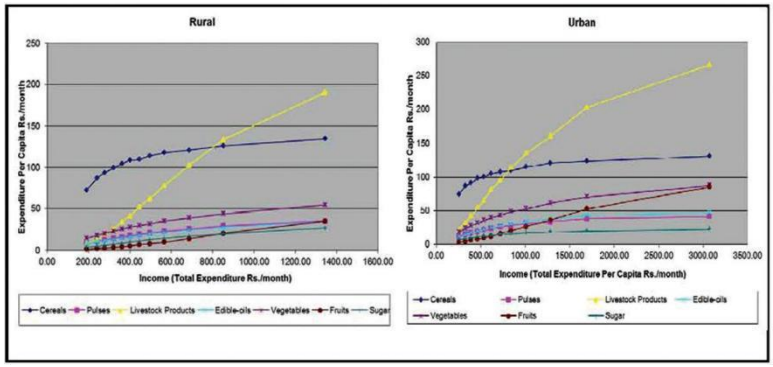


Figure 11. India: Relationship of Per Capita Consumption of Food with Income.

How will the food demand change further with growth in income? As far and the income effect is concerned, this will depend on the income elasticity of demand and the rate of growth of income. Income elasticities of demand for various foods were calculated 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 rise 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). These indicate 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 will

lead to substantial change in the composition of food demand – requiring significant changes in agriculture.

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

	Rural		Urban	
Food Items	Quantity Elasticity	Value Elasticity	Quantity Elasticity	Value Elasticity
(1)	(2)	(3)	(4)	(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 bringing change in food demand (Gandhi and Zhou, 2014). Large local and regional differences in food consumption 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 food consumption pattern is different from urban food consumption. In India 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.

Additionally, 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 a number of 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 is the ongoing and expected steep rise in the demand for animal products, including dairy, meat, eggs and fish. A large quantity of plant food is required to produce 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 in food demand. Countries lacking in natural resources (additional suitable land and water) will face great difficulty in expanding their food production. This will call for new agricultural technology, and substantially better management of natural resources.

III

NATURAL RESOURCES FOR PRODUCTION: SCARCITY AND INEFFICIENCY

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

Land

Land is the most basic input in agriculture and the Table 6 below examines the trends in land from 1980-81 to 2012-13. 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. 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, improvement to 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

(*Area in '000 ha*)

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, Govt. of India.

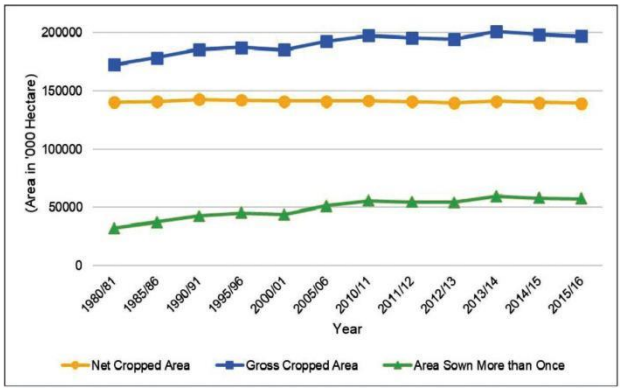


Figure 12. Growth in Cropped Area.

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 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 is 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.

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.

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 from food crops to non-food crops, but rice and wheat are showing growth after 2010-11, but pulses and oilseeds are showing a declining trend.

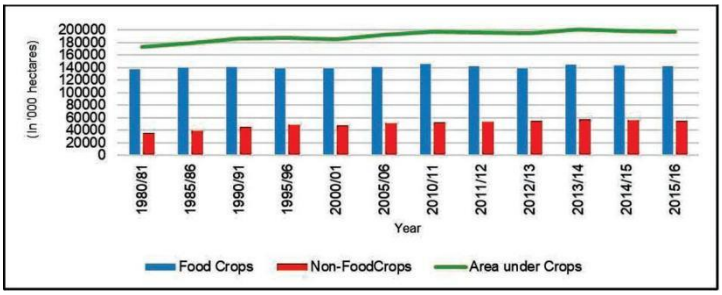


Figure 13. Area under food and non-food crops

Land Productivity: Yield

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. Table 8 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 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 decelerates from 1.91 to 1.87 per cent, of pulses decelerates 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. The fall of the food grains growth rate continues over the last two decades.

TABLE 8. YIELD OF FOODGRAINS

(*kg/ha*)

Year	Rice	Wheat	Total cereals	Total pulses	Total foodgrains
(1)	(2)	(3)	(4)	(5)	(6)
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.

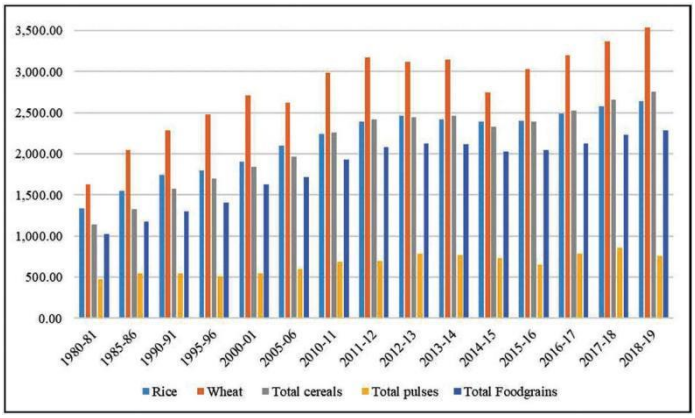


Figure 14. Yield of Foodgrains.

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 in sugarcane, it goes against it and is also not good for the scarce water resource.

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

(*kg/ha*)

Year	Major oilseeds	Cotton	Sugarcane	Fruits	Vegetables
(1)	(2)	(3)	(4)	(5)	(6)
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.

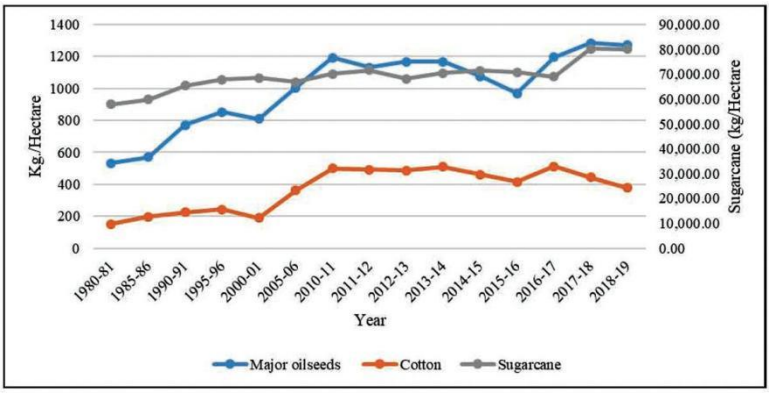


Figure 15. Trend in Yields of Nine Oilseeds, Cotton and Sugarcane.

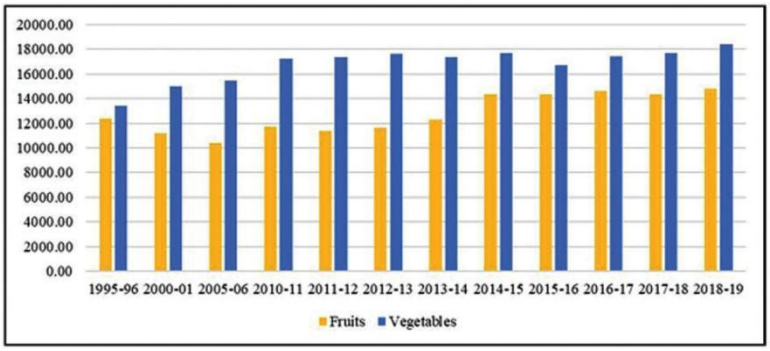


Figure 16. Trend in Yields in Fruits and Vegetables.

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. This shows a recent revival of the growth in irrigation which is a positive sign. The reasons for better growth could be the considerable effort to improve the conservation of water resources and improve the efficiency of water use. This includes 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

(*'000 ha*)

Year	Net area sown	Gross total area	Cropping intensity (percentage)	Net irrigated area	Gross irrigated area	Irrigation intensity (per cent)	Percentage area irrigated	
							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.

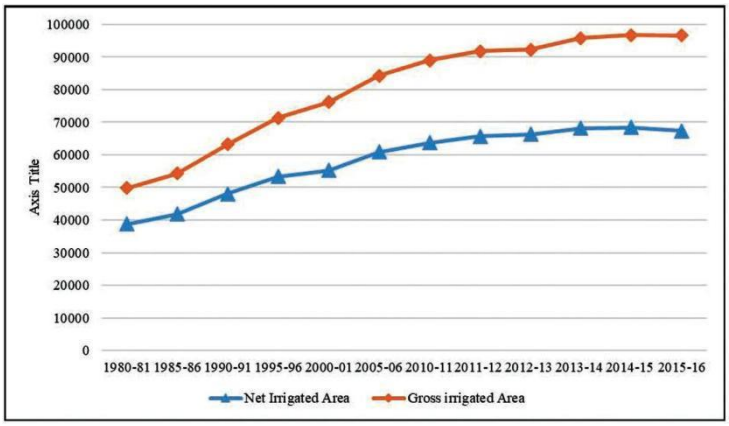


Figure 17. Trends in Net and Gross Irrigated Area.

Table 11 indicates the sources of irrigation and the trends 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 irrigated area shows a negative trend of -0.07 per cent but a reversal between 2000-01 and 2010-11 to 0.76 per cent, but followed by a decline to -0.22 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. 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 after deceleration to 2.27 per cent between 2000-01 and 2010-11, and further deceleration to 2.25 per cent after 2010-11, see Figure 18. The findings indicate that there is a sharp increase in the dependence on ground water irrigation in the recent decades. Some deceleration was evident between 2000-01 and 2010-11 indicating emerging constraints, but the growth of ground water irrigation has again accelerated after 2010-11. This may be negative as well as positive. It indicates increasing exploitation of ground water, but also the effect of special efforts made towards groundwater recharge through check-dams in some areas, watershed development activities in other areas, and the use of efficient irrigation methods such as drip and sprinkler irrigation.

TABLE 11. IRRIGATED AREA BY SOURCES OF IRRIGATION

('000 ha)

Year	Canals Government	Canal Private	Total Canals	Tanks	Tube wells	Other wells	Total wells	Other sources	Total net irrigated area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(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.

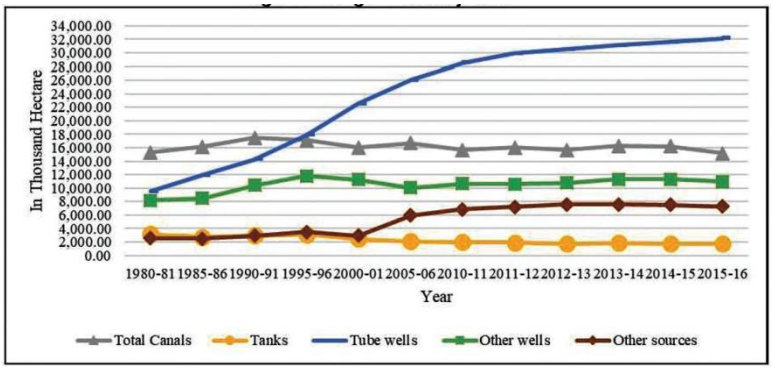


Figure 18. Irrigated Area by Source.

IV

AGRICULTURAL INPUTS

Agricultural inputs form the backbone of Indian agriculture in recent times, and the production and productivity of India's agriculture depend substantially on agricultural inputs. The level and kinds of inputs substantially determine the production and productivity of agriculture. Modern technology and inputs have played a major role in the growth of agricultural production in India especially after the green revolution. The rise in population and incomes coupled with the scarcity of various natural resources such as land and water has led to substantial dependence on yield increase for raising agricultural production and an intense focus on science and technology to increase productivity/ yields (Gandhi, 2019). This has resulted in various discoveries and developments 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 included not only government and international systems and institutions but also private sector industries and businesses. The need and demand for these 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 now making large contributions to agriculture. As farmers see advantage in using new technologies for raising production and profits, there is a growing demand for modern inputs.

Table 12 below provides a quick picture of the growth in some of the major agricultural 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.

TABLE 12. RECENT GROWTH IN SELECTED AGRICULTURAL INPUTS

Year	Certified quality seeds sales (lakh quintals)	Fertilisers consumption in nutrients (lakh tonnes)	Pesticides consumption (thousand tonnes)	Groundwater irrigation (wells and tubewells) net irrig. area (000 ha)	Tractors sales number thousands
(1)	(2)	(3)	(4)	(5)	(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, 833 million was rural constituting 69 per cent of the total. Of this population, 263 million were agricultural workers, including 118 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 far more slowly at

TABLE 13. POPULATION AND AGRICULTURAL WORKERS IN INDIA

(in million)

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.

1.16 per cent. This is substantially due to 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). The trend may be due to fragmentation of land holdings leading to increasing number of less viable farms causing farm sales and increasing number of agricultural labour.

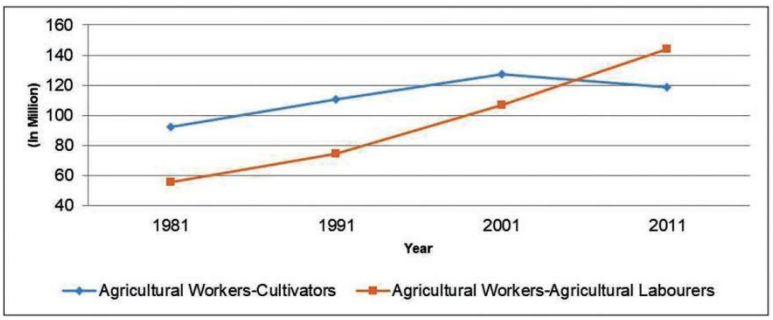


Figure 19. Trends in Agricultural Workers.

Other statistics available are that of the workforce and the 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 1999-00 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 some acceleration from -1.09 per cent between 1999-2000 and 2009-10 to about -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

TABLE 14. AGRICULTURAL AND NON- AGRICULTURAL WORKFORCE

(*in millions*)

Years	Total workforce	Agri workforce	Non agri workforce	Share agri labour force
(1)	(2)	(3)	(4)	(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.

a decreasing workforce availability in agriculture. The reason for this trend may be increasing and relatively better formal and informal employment opportunities in the non-agriculture sector.

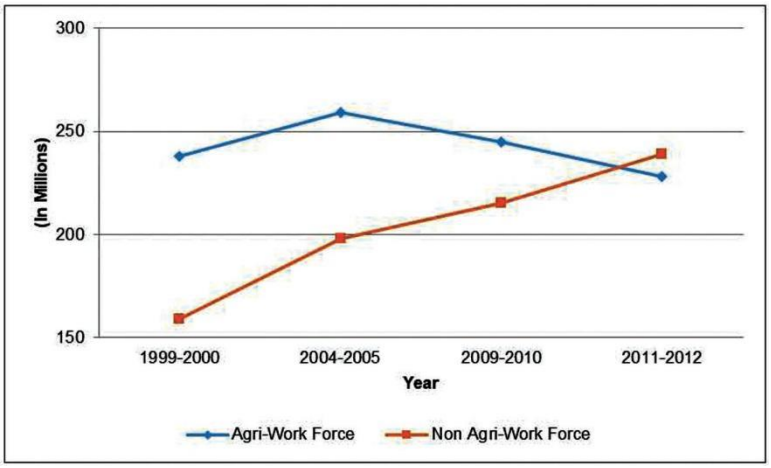


Figure 20. Agricultural and Non-Agricultural Workforce.

Thus, 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 would 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 supply to agriculture is reducing in the recent years. Thus, inputs and technology which enhance the productivity per labour are needed if the production of agriculture is to be maintained or 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. 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 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 declines in the 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 will impact productivity. 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	Nitrogenous fertilisers (N)	Phosphatic fertilisers (P)	Potassic fertilisers (K)	Total fertilisers
(1)	(2)	(3)	(4)	(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

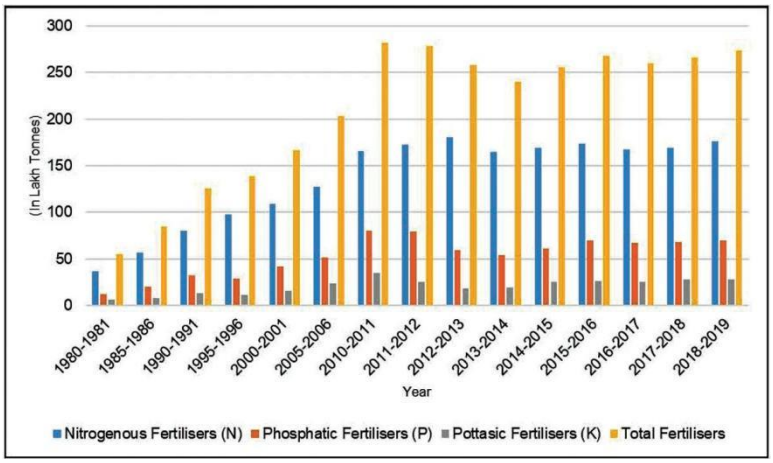


Figure 21. Fertiliser Consumption

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 consequences for soil fertility and agricultural production.

TABLE 16. CONSUMPTION OF FERTILISERS PER HECTARE

Year	Gross cropped area (in '000 hectares)	Consumption in Kg. per Hectare			
		N	P2O5	K2O	Total
(1)	(2)	(3)	(4)	(5)	(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.

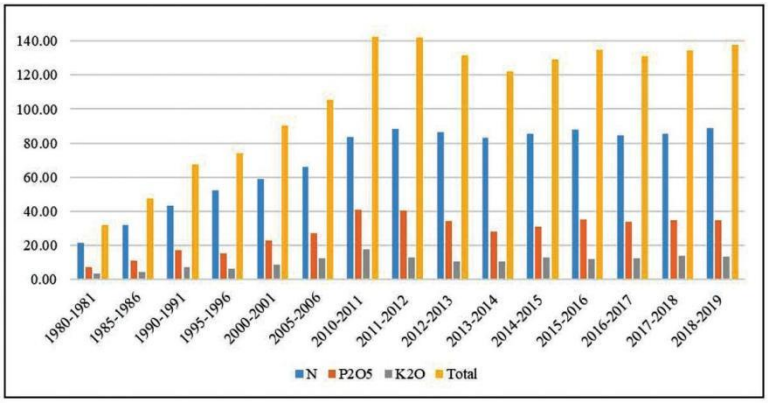


Figure 22. Fertilisers Consumption in Nutrients per hectare

Seeds

The input of quality certified seeds is of significant 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. There is a decline in case of fibres at -0.93 per cent, coinciding with Bt cotton introduction. 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 is indicative of an adverse market environment.

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

(*lakh quintal*)

Year	Cereals	Pulses	Nine Oilseeds	Fibers	Potato	Others	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(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.

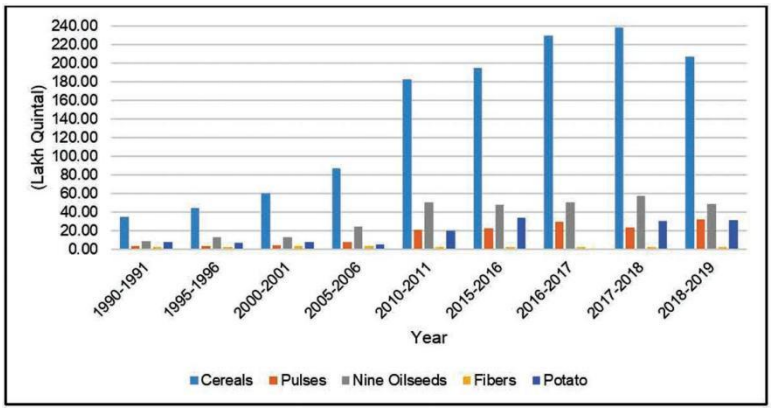


Figure 23. Use of Certified Quality Seeds

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.

Pesticides

The damage by pests is a serious problem for farmers and pesticides often become important 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, pest resistant varieties such as Bt cotton, new pesticides being less bulky, and non-availability of latest pesticides in India due to IPR and policy issues.

TABLE 18. CONSUMPTION OF PESTICIDES

(*thousand tonnes*)

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.

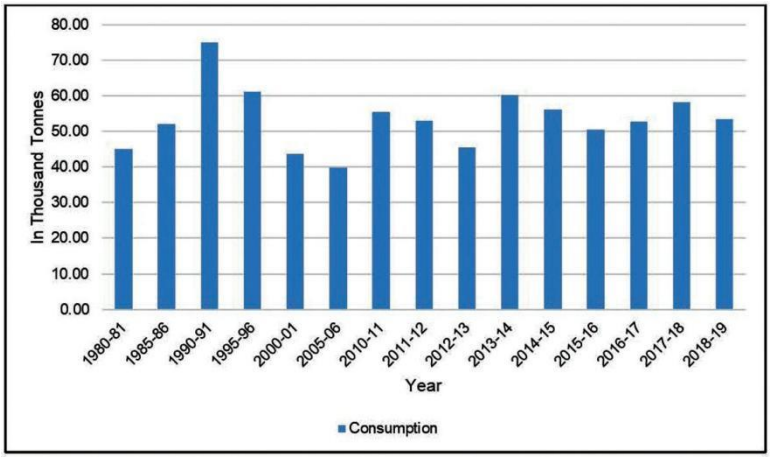


Figure 24. Pesticide Consumption.

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 indicates a changing profile of problems and solutions in the recent development of agriculture in India.

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

(*in '000 MT*)

Year	Insecticide	Fungicide	Weedicide
(1)	(2)	(3)	(4)
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.

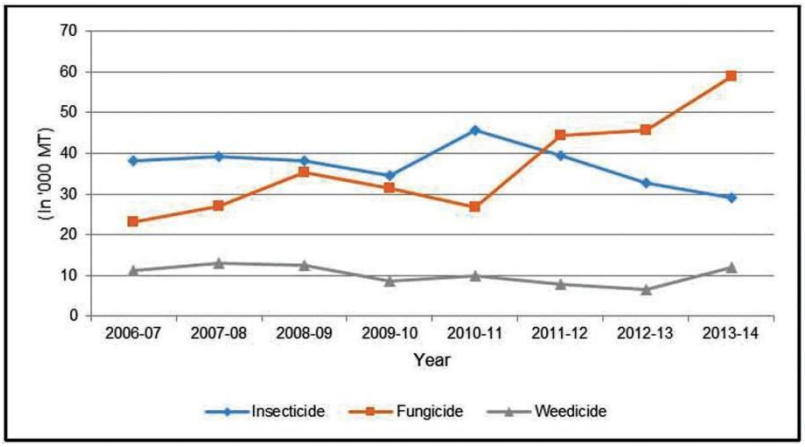


Figure 25. Product-Wise Consumption of Pesticides

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, there is a considerable slowdown in the growth of tractor sales during 2010-11 to 2018-19.

TABLE 20. PRODUCTION AND SALE OF TRACTORS IN INDIA

Year	Tractors number	
	Production	Sale
(1)	(2)	(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.

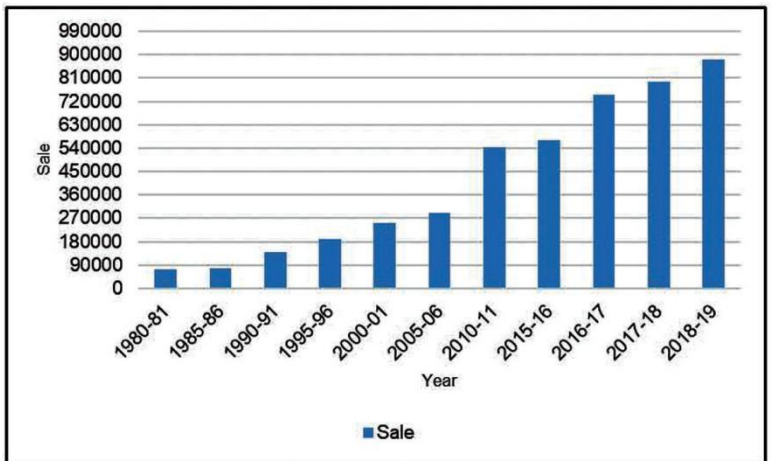


Figure 26. Sale of Tractors.

Thus, almost all the inputs are showing a slowdown in growth during the recent decade after 2010, indicating problems in agriculture.

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 below examines data on agriculture from the National Accounts Statistics at constant 20011/12 prices including the growth in inputs, output and the gross domestic product (GDP). The Table

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

(*Rs. crore*)

(1)	1980-81 (2)	1985-86 (3)	1990-91 (4)	1995-96 (5)	2000-01 (6)	2005-06 (7)	2010-11 (8)	2015-16 (9)	2016-17 (10)	2017-18 (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.

indicate that the total value of output of agriculture grew at 2.82 per cent between 1980-81 and 2017-18 in constant prices. The growth rate has remained fairly steady across the different decades but during the recent decade 2010/11-2017/18, and shows an acceleration to 3.29 per cent, see Figure 27. However, the agriculture (crop) sector shows a deceleration to only 1.80 per cent. This is cause for concern. The output of the livestock sector within agriculture 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 healthy sign considering the growing demand for livestock products. However the crop sector which is twice as large shows a slow down as indicated above.

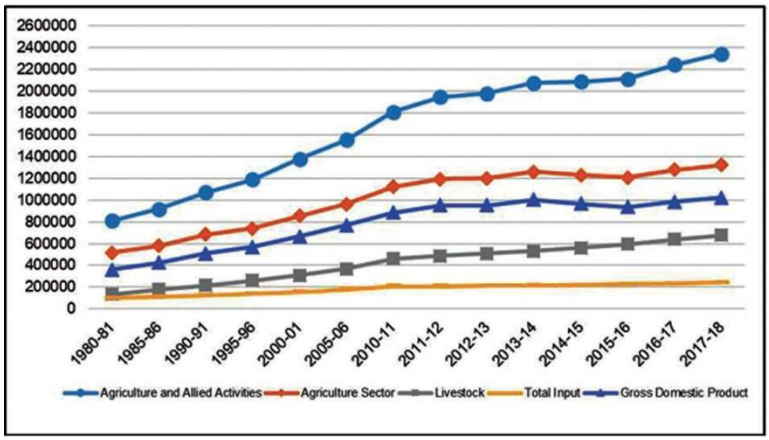


Figure 27. Value of Output, Inputs and GDP of Agriculture and Allied Activities.

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, 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. This is a cause for concern.

The breakup of the agriculture sector (crop) value of output across different major crop groups in the National Accounts Statistics, and their growth rates are given below 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. Thus, the overall agriculture (crop) sector value of output growth rate fall to only 1.80 per cent in 2010/11-2017/18.

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.

Thus, a number of disturbing trends are seen in the agriculture numbers in National Accounts Statistics in the decade following 2010-11 including considerable slowdown in crop sector output growth, in a number of inputs, and in agriculture GDP growth.

VI

URBANISATION, COMMERCIALISATION, LIBERALISATION AND GLOBALISATION

Urbanisation, commercialisation, liberalisation and globalisation are the mega forces affecting the economic environment for the agriculture sector and are having 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 for agriculture is that it leads to a growing off-farm demand for food. People once producing and consuming themselves in the rural areas are

no longer producing in the rural areas but are only consuming elsewhere in the urban areas. The remaining people in the rural areas have to produce for them. Thus, farmers begin to produce for the market. This can be a huge opportunity and a transformative force. Farmers producing for the market leads to increasing commercialisation of farming activity and increasing marketed surplus. The farmers then begin and need to respond to the market and demand signals and 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 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 gives the marketable 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. MARKETED SURPLUS RATIO OF IMPORTANT AGRICULTURAL COMMODITIES

Crops	2012-13	2013-14	2014-15
(1)	(2)	(3)	(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 also 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

Other major forces are liberalisation and globalisation. In the initial stages, the government often plays a major roles of support, capital investment, and control in the processes of development. Even though this is initially very important, the interventions may later prove restrictive for faster economic growth and development in the economy. Thus, liberalisation becomes necessary, and substantial liberalisation took place in the Indian economy from 1991 onwards in which numerous government controls and regulations were dismantled, giving a free hand to market forces and business sector. Liberalisation brought a huge transformation of the Indian economy, soon resulting in a quantum leap of national income growth rates from 3 per cent average to a high of 9 per cent. With the population growth rate falling, this resulted in a huge increase in per capita income growth rates – the 5-year moving average of this doubled from 2 to 3 per cent to over 6 per cent per year, see Figure 28. Through this, huge numbers were lifted out of poverty/low incomes, having also an enormous impact on the quantity and composition of the food demand (discussed above), including frequent food price inflation situations.

Liberalisation also includes reduction of government involvement in a number of activities. This creates space and opportunity 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 great improvement in the availability and quality of a large number of products. Further to liberalisation, there was globalisation, the opening out to international participation and competition, leading to a rise in foreign investment and participation of international firms in the Indian economy. The process of globalisation was further accelerated by the GATT agreement and the

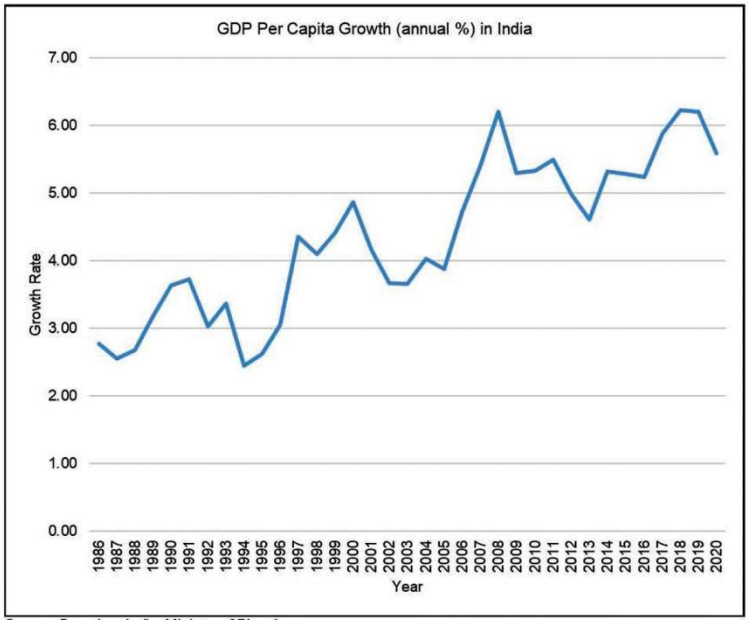


Figure 28. 5- Year Moving Average Per Capita Income (GDP) Growth Rate in India.

creation of the WTO, making globalisation a major force. Trade barriers and subsidies have been 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. There are major opportunities here 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. There is also growing influence of globalisation on consumer preferences and demand for food leading to changes and opportunities.

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.

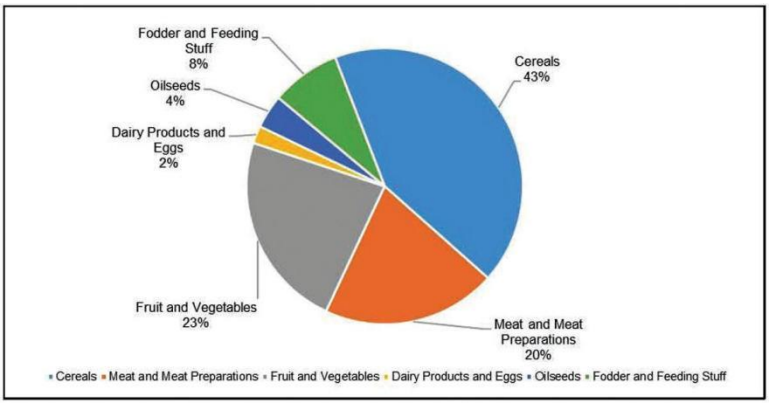


Figure 29. India: Export Value of selected Agriculture Products (2019) (1000 US$)

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, 2006). 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.*etal*., 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, 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 legislation in India covers almost all agricultural commodities. Since regulation of markets is a state subject, the regulatory measures adopted by various 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 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. 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.

Though the market regulation is successful in some area, it has often not achieved its objectives. Besides, many wholesale markets are yet to be brought under market legislation. Regulating the markets is only a first step in improving marketing efficiency, and studies have brought out various inadequacies in the functioning, infrastructure, and prices realized by farmers. Grading and providing price information have been neglected by most regulated markets. Few other problems identified are lack of standardised price quotations, and disparities in the rate of market fees. It is often found that it is the traders and not the farmers who obtain the main benefit of the regulated markets. But in some markets there were very few traders, and hence a healthy competition does not exist and price realisation by farmers is low. There is often congestion and crowding during business hours. Significant mechanical damage and contamination occurs in the course of loading, unloading and handling (Sharan, 1998). The evidence suggests that though there has been change, there is still a huge need and scope for improving the marketing of agricultural produce in the country.

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, 2006). 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.

A major factor determining fair prices for the producers is the system market transaction followed. Table 26 and Figure 30 indicate that the share of open auction is only 11 per cent (Gandhi and Namboodiri, 2006). Forty per cent of the transactions are through secret bidding, 49 per cent are by simple transactions. Thus, the share open auction system is very low, and the significant efficiency gains possible in open auction system are not realised in all these regulated markets.

TABLE 26. AHMEDABAD APMC: SYSTEM OF SALE REPORTED

Commodities	Percentage distribution		
	Open auction	Secret bidding	Simple transaction
(1)	(2)	(3)	(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.

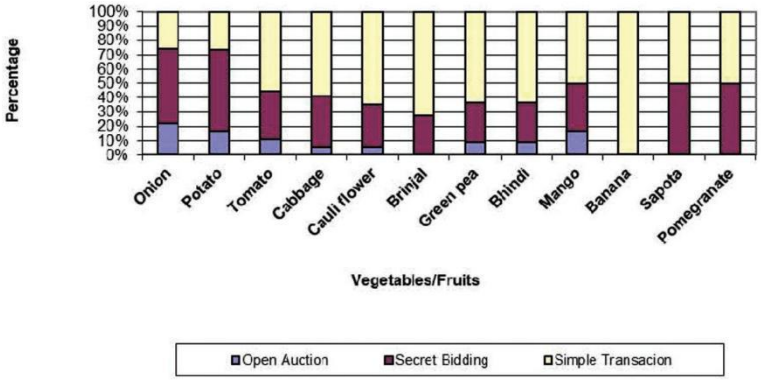


Figure 30. System of Sale Followed by Commission Agents in APMC Markets

An examination of the farmer to consumer price difference, the marketing cost, and the implicit profit margin – for vegetables are given in Table 27. The analysis shows that the cost frequently amounts only to about 10 to 20 per cent of the price difference. The profit margin, on the other hand, 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

	Farmer-consumer price difference Rs./ unit		Marketing cost Rs./ unit		Cost over price difference per cent		Profit margin over price difference per cent	
Vegetables	Min	Max	Min	Max	Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(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

	Farmer-consumer price difference Rs./ unit		Marketing cost Rs./ unit		Cost over price difference per cent		Profit margin over price difference per cent	
Fruits:	Min	Max	Min	Max	Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(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
Pomagranate(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.

At the APMCs, the market intermediaries/commission agents collect a sizable commission and for this it is important 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. It indicates that the farmers frequently avail of the service of the commission agent but usually do not receive much help on most matters - such as important matters of market information or 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 indicate that the 70 per cent response is never and the average is rarely (2). Findings indicate that not much service is provided by the primary market intermediaries to the farmers – in return for the sizable commission collected. It also appears that given their small size and inclination, it is very unlikely that they would reinvest their profits to make the necessary large improvements

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

(per cent)

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

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.

In an overall context, given India's very small farm sizes in agriculture, there is need for better scale economies and reorganisation in relation to production and marketing. Increasing rural to urban migration, shortage of manpower, as well as commercialisation and profits focus raises the need for larger or optimum scale and of reorganisation of many farm related operations, and activities. This could be on the lines such as contract farming to improve scale economies and even corporate farming in plantation agriculture. Another major possibility is the development of new kinds of agribusinesses and agribusiness collaborative networks and arrangements in production, procurement and marketing to obtain and bring the advantage of scale and efficiency, and reach to new markets and opportunities and trade.

However, 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*., (2001). 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

VIII

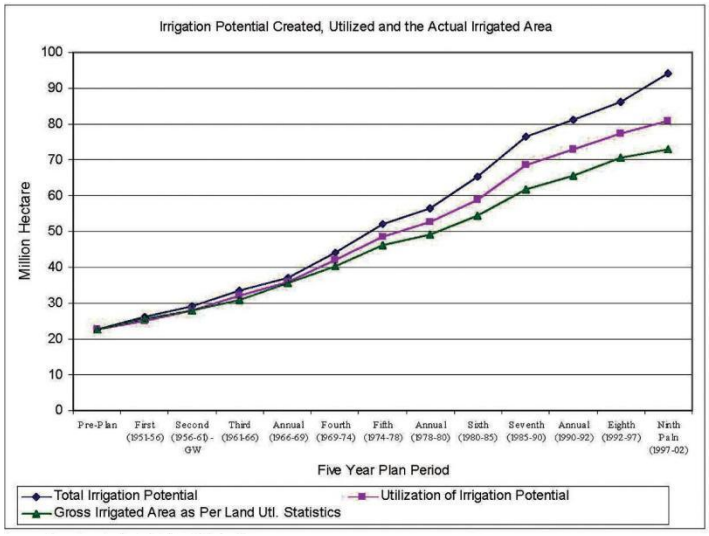
INSTITUTIONAL INEFFICIENCIES AND FAILURE

Apart from market inefficiencies and market failures, a serious current problem is the institutional inefficiencies and failures. Nowhere is this more evident than in natural resources, especially water which is 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 2009), 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 of poor institutional development and design (Saleth, 1996, Crase and Gandhi, 2009). This is required particularly because the management of the resource requires combining scientific approaches with community participation, knowledge and ownership. Natural resource management is complex and good institutional arrangements are urgently needed. Effective management of natural resources is increasingly critical for agriculture, rural livelihoods and poverty alleviation.

In this context, the physical development of irrigation has made considerable progress in India, but the proper management and distribution of the water for agriculture has poised many difficulties. There has been serious concerns about unsatisfactory management, delivery and utilisation of irrigation water (Brewer *et.al.*, 1999). The water use efficiency in India's agriculture is very low compared to global standards. Vaidyanathan and Sivasubramaniyan (2004) find that this as low as 25-35 per cent, – which indicates that 65 to 75 per cent of the water is wasted. A major reason is 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). Markets are generally not suited for managing water and market failures are common - institutional control is required. 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 and Gandhi, 2002, Gandhi and Namboodiri, 2002). 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 in Figure 31 below shows that there is considerable growth in the irrigation potential created over the different five-year plan periods in India. However, there is a



Source: Based on India, Ministry of Water Resources

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

large emerging gap between the potential created and potential utilised, and between potential utilised, and the actual irrigated area. The gaps are actually widening. Thus, even though, through engineering and technology, irrigation potential is being created, its conversion to actual irrigated area is far below expectations. It is widely believed and indicated by many studies that this is substantially due to poor performance of institutions in water resource management (Saleth, 1996, Gandhi and Namboodiri, 2009).

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.

TABLE 31. WATER REQUIREMENT (BILLION CUBIC METER)

Use	2000	2010	2025
(1)	(2)	(3)	(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	Cubic Meters
(1)	(2)
1951	5177
2001	1869
2025	1341
2050	1140

Source: India, Ministry of Water Resources.

In many states such as in eastern India, 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. 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. Institutional arrangements and links 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), 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, 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 – engineering solutions by themselves are unable to provide the answer in water management.

Concepts of new institutional economics and management governance can be applied to understand and overcome institutional failure (Crase and Gandhi, 2009, Gandhi and Johnson, 2019). In 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 and Kahkonen, 2000, Picciotto, 1995). The rationale for the existence of institutions include transaction costs and property rights (see North, 1997, Drobak and Nye, 1997). Transaction costs are frequently ignored, and when they are large, they destroy performance. According to North (1997), a 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. Transaction costs are hard to measure but based on 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 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). The studies 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.

Following in-depth case studies of watershed management projects in Andhra Pradesh, as well as water user associations (WUAs) under participatory irrigation management (PIM) in Assam and Bihar in the Eastern Indo-Gangetic Plains, it was found that the framework needed expansion. It was found necessary to add more rationalities to the framework to make it effective 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

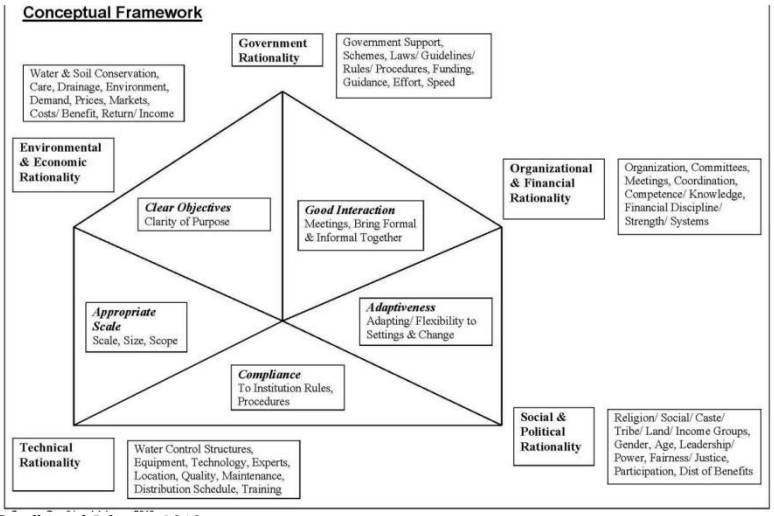
Financial Rationality

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.

Applying the framework through data from a farmer-institutional survey of 510 households across 51 water user associations in Bihar and Assam, the relationships between the rationalities and performance were examined using multivariate ordered probit regression analysis (Gandhi and Johnson, 2019). The results for overall performance given in the Table 33 below show that technical rationality has a strong positive association with performance indicating the importance of sound technical decisions in the institutions for delivering performance. Economic rationality also shows a strong significant relationship indicating the importance 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 slightly 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.

The relationship between the institutional features and performance was also similarly examined in a multivariate Ordered Probit framework. The results for overall performance are 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 has a strong association indicating the substantial importance of representation, interaction and meetings. Scale/size also has a strong relationship indicating the importance of the right choice in scale/size and the distribution of powers and responsibilities. Adaptiveness has a significant relationship indicating importance of keeping flexibility/ avoiding rigidity in rules in face of changes and variations. Good compliance too is found significantly associated indicating the need for WUAs to use powers and penalties to bring compliance to the rules and schedules for good performance.

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

Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
(1)	(2)	(3)	(4)	(5)	(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 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 also be found useful for institutions involves in other development activities.

Apart from establishing and improving the functioning of water institutions, the adoption of new water saving technologies can also go a long way in improving water use efficiency. A recent study (Gandhi, Johnson and Singh, 2021) 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 50 per cent reduction in hours of water pumping overall, with crop-wise variation from 14 to 53 per cent, see Table 35 below. 98per cent of the sample farmers believe that micro-irrigation saves water. The total input cost increases by 59 per cent overall as farmers use more fertilisers, better seeds and more labour to benefit from the investment in assured and accurate irrigation. However, there is a 73 per cent increase in the yields – varying across crops from 35 to 216per cent, as well as an increase in prices due to better quality of output. As a result, the revenue or gross income increases substantially by 141 per cent on an average, and the net profit/ income increases by 310 per cent.

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

S. No	Parameter/ Indicator	Crop									
		Sugarcane	Banana	Wheat	Cotton	Chilli	Soybean	Brocolli	Chickpea	Cauliflower	Overall Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Per cent Change									
1)	Change in hours of pumping water	-53	-14	-51	-52	-35	-33	-35	27	NA	-50
5)	Change in electricity cost	-11	4	7	-18	-12	-2	NA	-29	0	-11
8)	Change in total cost	-2	139	6	29	87	168	53	102	50	59
9)	Change in productivity/ yield	40	216	35	43	56	186	46	95	36	73
10)	Change in revenue/ gross income	56	387	43	79	86	232	56	145	55	141
11)	Change in net income/ profit	153	3095	105	230	86	33	63	182	67	310

Source: Gandhi, Johnson and Singh , 2021.

The study also indicates that the adoption of micro-irrigation brings changes in the cropping pattern in the right direction, Table 35A. 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 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, 2021).

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

Crop	Micro-irrigation non-adopters (per cent growing)	Micro-irrigation adopters (per cent growing)	Change (Per cent)
(1)	(2)	(3)	(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, 2021.

For the agriculture and food sector as a whole, the challenges and complexities arising from the various market inefficiencies and failures, and the quest to meet the changing demand, and address various objectives including profits, and performance, with contribution to rural and small farmer development, raises the need to encourage innovative institutional models and approaches for the organisation/ re-organisation of the marketing, processing and supply-chain activity and overcome market failure. A set of key success factors or objectives have been identified from experience for such innovative institutional models and approaches (see Gandhi and Jain, 2011, and Gandhi et al., 2001), and these include:

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) Bring adoption of best technology/practices by the farmers: Promote modern technology, input use by farmers. RandD, extension. Transform and modernise production, generate quality and quantity raw material at reasonable cost
3) Have the 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 – 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 behaviour
5) Build an organisation. Build appropriate ownership/ management/ links/ relationships to create win-win across the whole value chain of stakeholders. From farm to fork.

Given below are some of the successful innovative models which have overcome the market inefficiencies and failures in different commodity settings.

The AMUL Model

In this 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, (*Business Line,* 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.

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 (*Business Line,* December 9, 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.

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 advise 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 andperforms 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 by ITC.

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.

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, 2011). 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 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.

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/manage-ment 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).

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

A number of new models and start-ups have emerged in the recent years. A few are 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 them delivered to the retailers. With the help of IT the entire process is managed very efficiently so that such that vegetables and fruits reach from the farmers to retailers in less than 12 hours.

Famers growing fruits and vegetables registers 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 Distrubution 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, receives 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.

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.

In the process, the farmers register themselves in 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. 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.

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 hand 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 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 labor shortages. Here innovations are constantly required to provide appropriate and low cost technologies which are labor augmenting rather than labor 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 for the farrmers.

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 contributes strongly to the economic growth and development of the country.

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