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Doubling Farmers' Income in India by 2022-23: Sources of Growth and Approaches§

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Abstract

The target of doubling farmers' income in a short period requires identification of sources of income growth and enabling conditions for harnessing their growth potential. Agriculture is the main source of farmers' income in India, and in this paper, we examine the sources of agricultural growth, and suggest technological, institutional policy options for making agriculture a remunerative enterprise. Technology is identified as one the most important sources of growth, and there are sufficient evidences to show that investment in agricultural research yields good dividends. There exist huge gaps between realized and potential yields of most crops that can be bridged to a large extent by enhancing farmers' access to key inputs, irrigation, markets, credit and extension services. Diversification of production portfolio towards high-value crops has considerable potential to accelerate growth in agriculture and farmers' income. However, extreme volatility in prices acts as disincentive to adopt productivity-enhancing technologies and diversification. Post-harvest management and small-scale processing would help farmers capture benefits of value addition. Effective coordination between centre and states is important in mainstreaming and channelizing policies and investment to achieve the target of doubling farmers' income.

Key words: Farmers' Income, Total Factor Productivity, Yield Gap, Irrigation, Diversification, Prices

JEL Classification: Q12, Q13, Q18, I31

Introduction

Owing to several biotic and abiotic stresses, the problem of agrarian distress in India has accentuated in recent years. To alleviate agrarian distress the government of India in its annual budget of 2016-17 set a target of doubling farmers' income by 2022-23, and initiated a number of steps, such as improving irrigation efficiency, providing crop insurance, improving market infrastructure and its efficiency, promoting organic farming, restoring soil health and so on. To ensure that the mission of doubling farmers' income moves in the right direction and is accomplished within the stipulated period, it is important that accurate information on key indicators of agricultural performance is generated and made available to policymakers and other stakeholders for their effective monitoring and corrective actions.

The pathway for doubling of farmers' income encompasses several dimensions, from production to post-harvest management. These include: bridging yield gap, crop diversification, improvements in total factor productivity and proper management of irrigation (GoI, 2007; Evenson and Rosegrant, 1999; Chand *et. al.*, 2011; Birthal *et al*., 2007) along with the provision of market and institutional support for efficient post-harvest management (Saxena and Chand, 2017; Government of India, 2015). Through the analysis of sources of growth and their enabling

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§ This paper is drawn from ICAR-NIAP Policy Paper 31 on Strategy for Doubling Income of Farmers in India.

conditions, in this paper we examine the pathways and approaches for doubling farmers' income by 2022-23. The paper is organized into 4 sections. The next section discusses data and methods. Section 3 discusses sources of growth and their enabling conditions. Conclusions and remarks are made in the last section.

Data and Methodology

The study is based on data compiled from official sources and publications. The data on gross domestic product (GDP) and its components were compiled from the National Accounts Statistics. To estimate yield differences between irrigated and unirrigated crops, plot-level data for the year 2013-14 were extracted from the Cost of Cultivation Scheme of the Ministry of Agriculture and Farmers' Welfare, Government of India. This data-set cannot be utilized directly to examine status of irrigation of a crop, hence it is assumed that if a crop receives at least one irrigation then the crop is considered as irrigated, else it is treated as unirrigated or rainfed. Extent of yield gaps in different crops across states is estimated using the same data-set. Yield gap is estimated as:

$$Y_g = \left\{1 - \frac{Y_a}{Y_r}\right\} * 100$$

where, Y_g, Y_a and Y_r represent yield gap, actual mean yield and reference yield, respectively. Actual mean yield is the average of the plot level yields, and 90th percentile of yield distribution is taken as reference yield.

To quantify gains from diversification, we use household-level data from the Situation Assessment Survey of Agricultural Households (NSSO, 2014). The data-set also provides information on crop sales and prices realized. Gross returns from individual crops have been aggregated into two broad groups, cereals and horticulture, and these were compared to examine gains from diversification.

To estimate price volatility, we use data on monthly wholesale price index (WPI) at 2004-05 base for major crops (WPI database of the Office of the Economic Advisor, Government of India). The instability in prices is measured in relative terms using Cuddy Della Vella index for two periods i.e. 2005-2010 and 2011-2016 as:

$$\text{Cuddy Della Vella Instability Index (CV*)} = \text{Coefficient of Variation} \times (1 - R^2)^{0.5}$$

Coefficient of variation is multiplied by square root of the difference between unity and coefficient of multiple determinations (R^2). The index value between 0 and 15 indicates low instability and more than 30 indicates high instability.

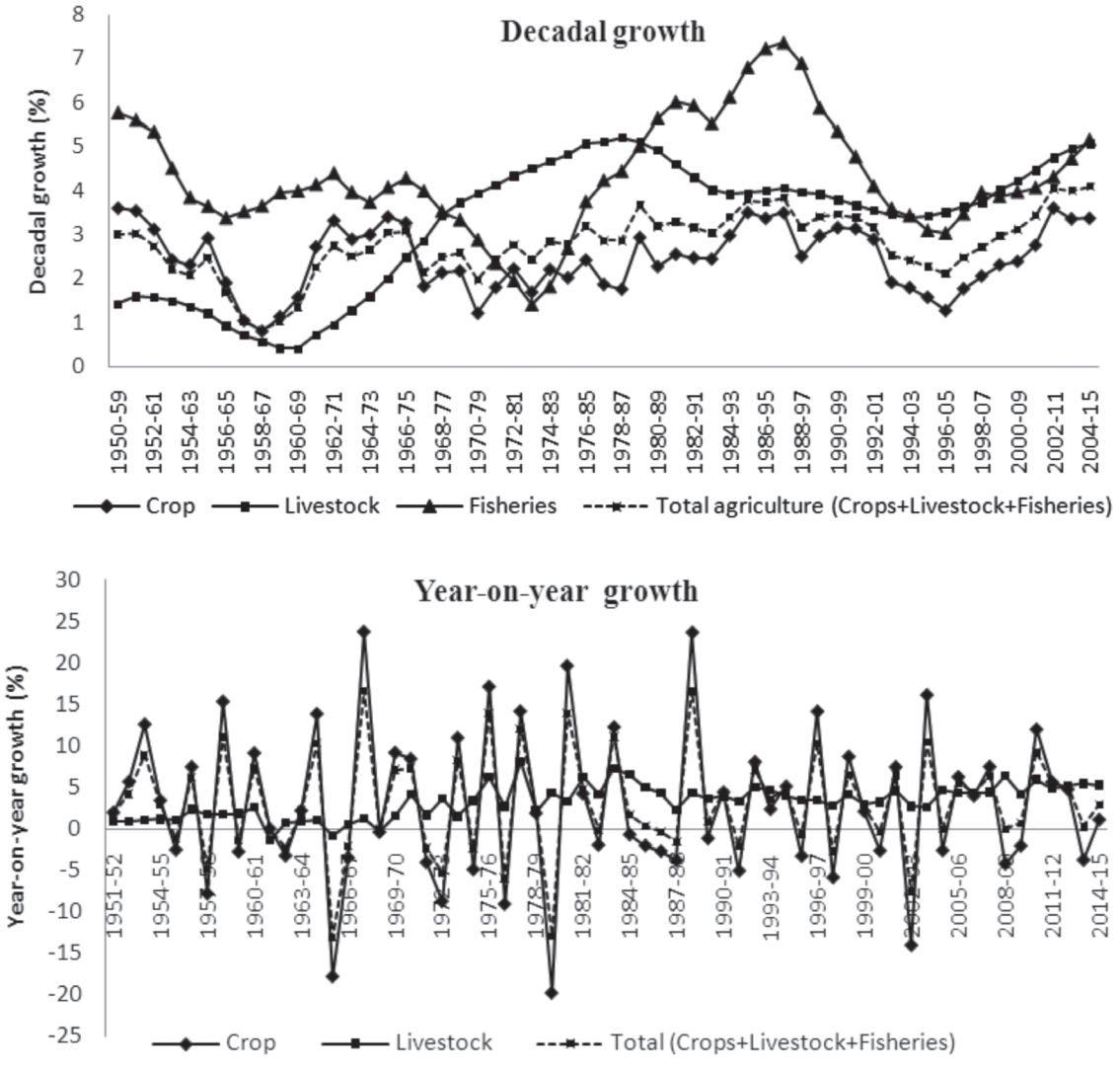
Sources of Agricultural Growth and their Enabling Conditions

An analysis of the existing growth scenario of agriculture is important for understanding future sources of growth. Following Chand and Parappurathu (2012), we estimated moving decennial growth rates by fitting a semi-log trend to the smoothened data to assess the performance of various sub-sectors of agriculture. Figure 1 shows the trends. There was a remarkable growth 2004-05 afterwards. During 2004-05 to 2014-15, crops, livestock and fisheries registered a growth rate of 2.93 per cent, 6.11 per cent and 5.13 per cent per annum, respectively.

These patterns in growth suggest that overall growth in agriculture moves in tandem with growth in crop sector. The same is also confirmed by year-on-year fluctuations. Livestock sector is growing at an appreciable and sustainable rate. It is worth mentioning that livestock sector never attained a negative growth at any point of time during the last three and half decades; the lowest growth rate was 1 per cent in 2003-04. Thus, livestock are important for risk mitigation.

Technology

Total Factor Productivity (TFP) is an indicator of technological change and efficiency gains. Several studies have analyzed trends in TFP in Indian agriculture. Jain and Chand (2015) have estimated annual TFP growth in agriculture at 1.55 per cent during 1980-81 to 2011-12, but the growth was faster (5.49 per cent) after 2004-05. Avila and Evenson (2004) estimated annual growth in TFP at 2.33 per cent for crops, 2.66 per cent per for livestock and 2.41 per cent for crops and livestock together for the period 1981 to 2001. Goldar *et al.* (2014) have estimated TFP growth at 0.7 per cent during 2000-2008. Table 1 provides details of TFP growth reported in other studies.



Source: National Accounts Statistics, various years

Figure 1. Growth rates in GDP across sub-sectors at 2004-05 prices

These evidences establish that technology has contributed significantly towards increase in food production in India despite limitations on the cropland as a source of output growth. The studies also provide sufficient evidences to conclude that investment in agricultural research yields good dividends. Thus, the policies for supporting and strengthening of the research and extension system should get priority.

Irrigation

Irrigated area in the country increased by 11 per cent between TE 2006-07 and TE 2013-14 and the irrigation intensity, expressed as the ratio of gross irrigated area (GIA) to gross cropped area (GCA), by 8 per cent. The states of Madhya Pradesh, Chhattisgarh, Karnataka, Bihar, Gujarat and Rajasthan have experienced appreciable increase in both the GIA and irrigation intensity. Based on plot level data on cost of cultivation for 2013-14, the difference in yield and income levels were examined under irrigated and unirrigated conditions and the results are provided in Table 2.

Rice — There is a huge potential to expand irrigation in West Bengal, as just half of the rice area is irrigated, and the yield difference is significant between irrigated and unirrigated plots. The irrigated plots, on an average,

Table 1. Growth in total factor productivity (TFP)

Author(s)	Commodity groups	Period	TFP growth (%)	Author(s)	Commodity groups	Period	TFP growth (%)
Evenson *et al.* (1999)	Crops	1956-1965	1.10	Jain and Chand (2015)	Agriculture	1980-1981 to 2011-2012	1.55
		1966-1976	1.39			2004-2005 to 2011-2012	5.49
		1977-1987	1.05				
Birthal *et al.* (1999)	Livestock	1951-1970	-0.04	Chand *et al.* (2011)	Rice	1975-1985	0.90
		1970-1980	0.93			1986-1995	0.74
		1980-1995	1.79			1996-2005	0.40
Fan *et al.* (1999)	Crops and livestock	1970-1979	1.55			1975-2005	0.67
		1980-1989	2.52		Wheat	1975-1985	1.60
		1990-1994	2.29			1986-1995	2.51
		1970-1994	1.75			1996-2005	1.61
Avila and Evenson (2004)	Crops	1961-1980	1.54			1975-2005	1.92
		1981-2001	2.33		Gram	1975-1985	0.06
	Livestock	1961-1980	2.63			1986-1995	0.09
		1981-2001	2.66			1996-2005	0.34
	Crops and livestock	1961-1980	1.92			1975-2005	0.16
		1981-2001	2.41		Groundnut	1975-1985	0.49
Joshi *et al.* (2003)	Rice	1980-1990	3.50			1986-1995	0.55
		1990-1999	2.08			1996-2005	1.30
	Wheat	1980-1990	2.44			1975-2005	0.77
		1990-1999	2.14		Cotton	1975-1985	2.84
Kumar *et al.* (2008)	Wheat	1971-1986	1.28			1986-1995	0.92
		1986-2000	0.68			1996-2005	0.80
	Pulses	1971-1986	0.52			1975-2005	1.41
		1986-2000	-0.39	Rada (2016)	Grains	1980-2008	-1.83
	Oilseeds	1971-1986	0.14		Pulses		-4.03
		1986-2000	0.33		Horticulture		2.45
	Sugarcane	1971-1986	0.79		Oilseeds		-0.12
		1986-2000	-0.10		Specialty crops		-0.41
					Animal products		1.18

produce 8 quintals/ha, higher than the yield on unirrigated plots. The state of Odisha too has considerable scope for improving rice yield through irrigation.

Wheat — Wheat is mostly grown under irrigated conditions. Yet, yield differences across states are high. The average yield is 50 quintals/ha in Punjab and Haryana, 30 quintals/ha in Uttar Pradesh and Rajasthan and 24 quintals/ha in Madhya Pradesh. Hence, an effort to achieve higher wheat production depends on the factors other than irrigation.

Maize — Yield response of maize to irrigation is high. All major maize producing states have enormous scope to expand irrigated area.

Gram — Madhya Pradesh, Maharashtra and Rajasthan together produce 70 per cent of total gram in the country. Madhya Pradesh and Maharashtra have

Table 2. Gains from irrigation, 2013-14

Crop	State	Yield (quintals/ha)		Probability*	Income (₹/ha)		Probability*
		without irrigation	with irrigation		without irrigation	with irrigation	
Rice	West Bengal	40.18	48.11	0.00	51091	61369	0.00
	Uttar Pradesh	35.76	40.33	0.00	58659	59808	0.31
	Andhra Pradesh	55.55	52.96	0.00	78635	72053	0.00
	Punjab	48.51	58.55	0.01	96215	95995	0.50
	Odisha	28.38	52.85	0.00	33064	63423	0.00
	Bihar	39.20	23.02	0.00	42032	25879	0.00
	Chhattisgarh	30.69	37.25	0.00	38927	45595	0.00
	Tamil Nadu	51.15	50.67	0.25	72018	72821	0.22
Wheat	Uttar Pradesh	27.96	36.99	0.00	38327	50575	0.00
	Punjab	46.45	49.49	0.00	65031	69288	0.00
	Madhya Pradesh	32.95	31.68	0.13	47073	47118	0.49
	Haryana	45.60	45.90	0.60	63845	64252	0.40
	Rajasthan	44.15	39.51	0.00	68125	60598	0.00
Maize	Andhra Pradesh	49.16	66.62	0.00	59653	79664	0.00
	Karnataka	38.06	44.45	0.00	43414	51935	0.00
	Bihar	10.09	31.74	0.00	12450	37259	0.00
	Tamil Nadu	23.81	55.85	0.00	28125	71832	0.00
	Rajasthan	19.51	23.17	0.12	23694	30067	0.03
	Uttar Pradesh	19.25	21.71	0.08	21701	28261	0.00
Gram	Madhya Pradesh	9.08	9.07	0.51	24021	29949	0.00
	Rajasthan	7.27	12.55	0.00	20369	38853	0.00
	Maharashtra	10.47	12.88	0.00	30075	37155	0.00
	Karnataka	9.42	10.59	0.28	28238	32250	0.27
	Uttar Pradesh	7.29	5.48	0.03	25549	18473	0.03
Pigeonpea	Maharashtra	23.76	26.79	0.15	90280	102608	0.13
	Karnataka	11.78	7.04	0.00	48824	27425	0.00
	Gujarat	6.17	15.03	0.00	23608	57681	0.00
	Uttar Pradesh	8.37	7.39	0.18	32715	27628	0.09
Cotton	Gujarat	0.38	22.54	0.00	71094	109089	0.00
	Maharashtra	17.81	20.03	0.01	81735	91764	0.02
	Andhra Pradesh	16.91	17.42	0.38	69778	72545	0.35
	Haryana	19.11	15.97	0.09	98088	80628	0.07
	Karnataka	14.78	16.63	0.19	70639	81113	0.15
	Punjab	17.20	17.40	0.40	89168	89148	0.50

Source: Computed by authors based on cost of cultivation data for 2013-14.
*Probability values have been obtained from two-group mean comparison using t-statistic and indicate the level of significance at given level of probability.

sizeable gram area under irrigation; it is just one-fourth in Rajasthan. In terms of yield advantage due to irrigation, Madhya Pradesh has limited scope, but Rajasthan and Maharashtra do have a considerable scope.

Pigeonpea — In pigeonpea, though the irrigation is extremely limited, yet in states of Maharashtra and Gujarat the crop shows a significant positive response to irrigation.

Cotton — Major share of cotton comes from Gujarat, Maharashtra and Andhra Pradesh. While around 60 per cent of area under cotton is irrigated in Gujarat, it is just 3 per cent in Maharashtra. Though the yield differences between irrigated and unirrigated plots are small, expanding irrigation in Maharashtra can help increase cotton yield. In Andhra Pradesh there is no significant yield difference between irrigated and non-irrigated plots, but it is quite large in Gujarat. The expansion of irrigation in cotton could be a better choice in Gujarat.

Considering the potential of micro-irrigation in saving water and nutrients, and improving crop yields, the emphasis needs to be on expanding micro-irrigation (GoI, 2009; 2014). According to the report of the Task Force on Irrigation, adoption of micro-irrigation enhances crop yields in the range of 3 per cent to 27 per cent. At the same time, micro-irrigation saves water in the range of 16 per cent to 56 per cent. According to Palanisami and Raman (2012), only 9.2 per cent of potential 42.23 million hectares is currently covered under micro-irrigation. This area has been further expanded totaling to 8.63 million hectares at the end of 2016 (Government of India, 2016). Therefore, the strategies for improving micro-irrigation can make significant contributions towards enhancing agricultural productivity and farmers' income.

Agricultural diversification

Sustained economic growth and increasing urbanization are fuelling rapid growth in the demand for high-value food commodities like fruits, vegetables, milk, meat, eggs and fish and farmers are responding positively to these signals by altering their production portfolio (Rao *et al.*, 2006). Agricultural diversification towards high-value crops can potentially increase farm incomes, especially in smallholder agriculture (Birthal *et al.,* 2007). Birthal *et al*. (2014) reported that although technology is the most important source of agricultural growth, diversification is emerging as a sustainable source of growth. Further, it is found that growth in high-value agriculture has come largely from area reallocation from less profitable coarse cereals, mainly millets and sorghum. They also establish relationship between degree of diversification (share of area dedicated to HVC) and economic well-being of the farmers— households diversifying toward HVCs are less likely to be poor (Birthal *et al.,* 2015).

Table 3 shows ratios of the gross revenue from fruits and vegetables to the gross revenue from cereals. Jammu & Kashmir and Himachal Pradesh, due to their agro-climatic conditions, are highly suitable for cultivation of horticultural crops. For example, marginal and small farmers in Himachal Pradesh can harvest 23 times more returns from HVCs as compared to cereals. Considering income-generating potential of HVCs, there is a need for regional crop planning for different agro-climatic zones. However, the diversification process needs to be coupled with provision of markets, strong infrastructure and logistic support.

Yield gaps

There exist huge yield gaps in crops. A study by the Planning Commission estimated yield gaps between 6 to 300 per cent in cereals, 5 to 185 per cent in oilseeds and 16 to 167 per cent in sugarcane across different states (GoI, 2007). Such gaps exist at two levels: (i) between the best scientific practices and the best farm practices, and (ii) between the best farm practices and the average farmer practices. The estimates of yield gaps using the later approach are reported in Table 4. The crop yield at 90th percentile at farmers' plots is used as bench mark in computing the yield gap. There is huge yield gap in different crops across states. The yield gap in paddy is one-fourth to one-third of the benchmark yield. The estimates with respect to the best performing farmers in major paddy growing states like West Bengal, Uttar Pradesh, Andhra Pradesh and Punjab are 33 per cent, 29 per cent, 29 per cent and 28 per cent, respectively.

Yield gap in wheat is estimated as 19 per cent in Punjab and 23 per cent in Haryana, while the corresponding figures are 27 per cent and 33 per cent for Uttar Pradesh and Madhya Pradesh, respectively.

Table 3. Ratio of the gross returns of high value crops to the gross returns from cereals

State	Marginal farmers (< 1 ha)		Small farmers (1-2 ha)		All categories	
	Fruits	Vegetables	Fruits	Vegetables	Fruits	Vegetables
Andhra Pradesh	0.8	1.0	2.2	1.7	1.7	2.4
Assam	1.7	1.7	2.5	1.1	1.9	1.5
Bihar	1.1	1.9	19.1	2.4	4.8	1.9
Chhattisgarh	-	2.7	2.4	4.1	2.2	3.2
Gujarat	1.9	1.8	1.9	2.6	2.1	1.7
Haryana	0.9	2.0	-	1.0	0.7	1.6
Himachal Pradesh	22.2	3.5	23.6	4.5	22.0	3.6
Jammu & Kashmir	28.5	1.4	10.4	1.9	27.9	1.4
Jharkhand	12.0	2.9	18.4	3.1	13.1	2.9
Karnataka	2.8	6.6	3.2	3.7	3.1	4.5
Kerala	2.6	1.7	2.1	1.7	2.4	1.6
Madhya Pradesh	-	2.5	-	2.5	*	2.5
Maharashtra	2.5	2.3	4.7	3.8	4.7	2.7
Odisha	9.9	2.8	2.3	2.6	9.2	3.5
Punjab	-	0.6	-	2.5	1.9	1.4
Rajasthan	-	1.3	-	1.0	0.4	1.5
Tamil Nadu	5.1	2.9	6.0	2.3	5.6	2.9
Telangana	-	2.5	0.7	3.6	1.0	1.7
Uttar Pradesh	1.8	1.9	3.1	1.6	2.3	1.9
Uttarakhand	3.7	2.1	*	0.7	3.4	2.1
West Bengal	3.6	2.2	4.4	2.4	3.7	2.2
Rest of the states	0.9	0.5	0.9	1.3	0.9	0.6
All States	6.1	2.1	4.5	2.1	5.9	2.2

Source: Computed by authors based on unit record NSSO data (2014)
Note: *Unrealistic estimates

Table 4. Yield gaps, adoption of improved and hybrid seeds and area irrigated

Crop	State	Yield gap (%)	Adoption of improved & hybrid seeds (%)	Area under irrigation (% of cropped area)
Paddy	West Bengal	33	98	48.2
	Uttar Pradesh	29	100	83.1
	Andhra Pradesh	29	95	96.8
	Punjab	28	100	99.6
Wheat	Uttar Pradesh	27	98	98.4
	Punjab	19	100	98.9
	Madhya Pradesh	33	100	90.8
	Haryana	23	96	99.5
Jowar	Maharashtra	53	59	9.5
	Karnataka	56	66	11.5
Bajra	Rajasthan	50	78	3.3
	Uttar Pradesh	35	83	8.9

Contd...

Table 4 *contd.*

Gram	Madhya Pradesh	32	100	57.9
	Rajasthan	46	50	49.2
	Maharashtra	45	84	24.2
Tur	Maharashtra	61	70	1.5
	Madhya Pradesh	36	52	1.6
	Karnataka	59	23	5.1
Maize	Andhra Pradesh	33	99	49.5
	Karnataka	45	98	36.0
	Bihar	58	67	65.2
Cotton	Gujarat	47	-	58.7
	Maharashtra	45	-	2.7
	Andhra Pradesh	38	-	13.9
Sugarcane	Uttar Pradesh	25	-	95.1
	Maharashtra	41	-	100.0
	Karnataka	35	-	100.0

Note: Estimates of yield gap and seed use are obtained for 2011-12 to 2013-14. Yield at 90th percentile is used as bench mark in computing the estimates. Irrigation figures correspond to the year 2012-13.
Source: Yield gaps and seeds use are authors' estimates based on Ministry of Agriculture data (various years); irrigation coverage is based on Agricultural Statistics at a Glance, 2015.

There exist considerable yield gap in coarse cereals and pulses also. The yield gaps can be bridged by providing farmers better irrigation facilities, access to technology, markets, extension and credit.

Prices

Prices play a crucial role in making agriculture remunerative. However, agricultural prices in the recent past have become extremely volatile (Table 5). The instability in prices of vegetables remains a matter of concern, as the wholesale price indices of these commodities have remained much higher than all other commodities. Especially, onion and potato have been highly price-sensitive commodities. This is due to their perishability and lack of price support from the governments. Such a volatile behaviour of prices makes it difficult for farmers to choose a remunerative crop plan.

Table 5. Wholesale price indices and volatility therein

Commodity	Mean Wholesale Price Index (WPI)			WPI Range		Instability Index (%)	
	2005-10	2011-16	2005-16	2005-10	2011-16	2005-10	2011-16
Rice	131.1	216.6	173.9	101-171	167-255	4.0	5.3
Wheat	138.6	204.4	171.5	96-182	164-252	4.0	4.5
Maize	134.7	241.2	187.9	104-172	175-297	3.0	5.5
Gram	143.4	254.7	199.0	98-183	152-582	11.2	28.5
Pigeonpea	144.9	250.9	197.9	89-263	176-421	14.0	16.4
Groundnut	131.4	227.4	179.4	90-178	154-288	7.3	11.2
Soybean	108.3	198.7	153.5	67-153	125-268	12.7	14.6
Cotton	121.5	216.3	168.9	82-220	177-306	10.6	11.2
Potato	139.4	206.7	173.0	72-304	99-427	31.5	34.4
Onion	165.6	325.9	245.8	75-469	134-846	33.7	49.3
Banana	128.9	242.1	185.5	93-178	150-364	6.1	10.0

Source: Computed by authors based on the wholesale price index from the Office of Economic Advisor, Ministry of Commerce and Industry, GoI.

The growth in onion production shows that it is the lagged production that determines the current period onion prices (Box 1). In year 2012-13, onion production declined by 17 per cent leading to 238 per cent increase in its price in the following year. In the next year, onion production increased by 26 per cent and price declined by 43 per cent. This led to a decline in gross revenue by 28 per cent. The cycle repeated in the next two years also. Such volatility in prices needs to be curbed through proper market information and intelligence. The role of procurement agencies like NAFED is also important to provide an assured market to farmers. The e-NAM, the latest initiative to connect markets across the country can help better price realization.

Post-harvest management and food processing

Effective post-harvest management will help farmers realize remunerative prices for their produce. It is more important for highly perishable commodities. Jha *et al*. (2015) estimated that output worth Rs. 92651 crores is lost due to poor post-harvest management. Table 6 shows post-harvest losses in different commodities. Management of such losses requires support in the form of infrastructure and logistics. Public-private partnership can provide boost to post-harvest management.

Another important avenue to enhance farmers' income is to augment small-scale processing through farmers' organizations so that the farmers can capture benefits of value addition directly. Food processing in India is undertaken by the corporates as well as households. Grain milling and processing accounts for the major chunk of processing. The extent of processing of horticulture and livestock products is quite low (Figure 2).

Agriculture to agribusiness

The number of farmers (cultivators) declined from 16.6 crores in 2004-05 to 14.6 crores in 2011-12

Box 1. Losses to farmers from price volatility: Case of onion in Maharashtra

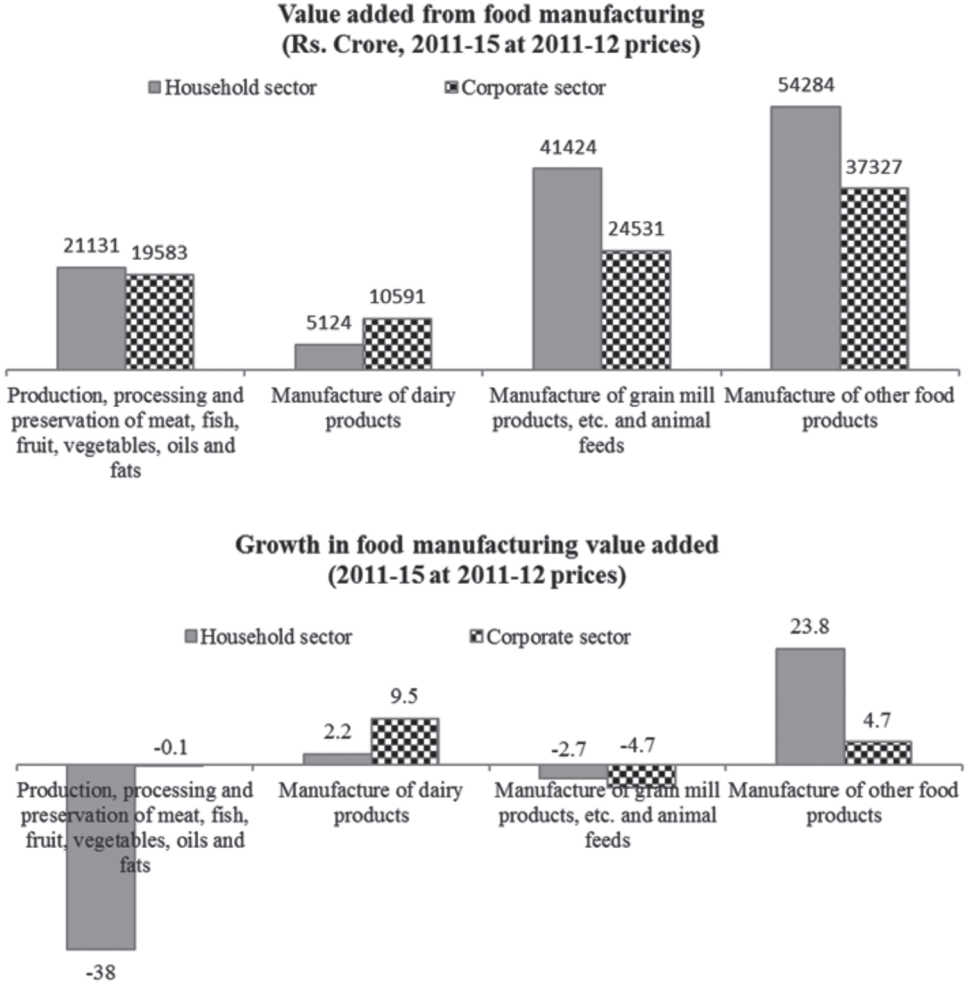
	Onion area (000ha)	Onion output (000mt)	Onion price (Rs./qtl)	Gross revenue from onion (Rs. million)
2012-13	260	4660	1807	84190
Δbetween 11/12 & 12/13	-31.9 %	-17.3 %	237.5 %	
2013-14	468	5864	1034	60627
Δbetween 12/13 & 13/14	80 %	25.8 %	-42.8 %	
2014-15	442	5362	1679	90045
Δbetween 13/14 & 14/15	-5.6 %	-8.6 %	62.4 %	
2015-16	522	6529	653	42636
Δbetween 14/15 & 15/16	18.2 %	21.8%	-61.1 %	

Source: Computed by authors

Table 6. Extent of post-harvest losses in India

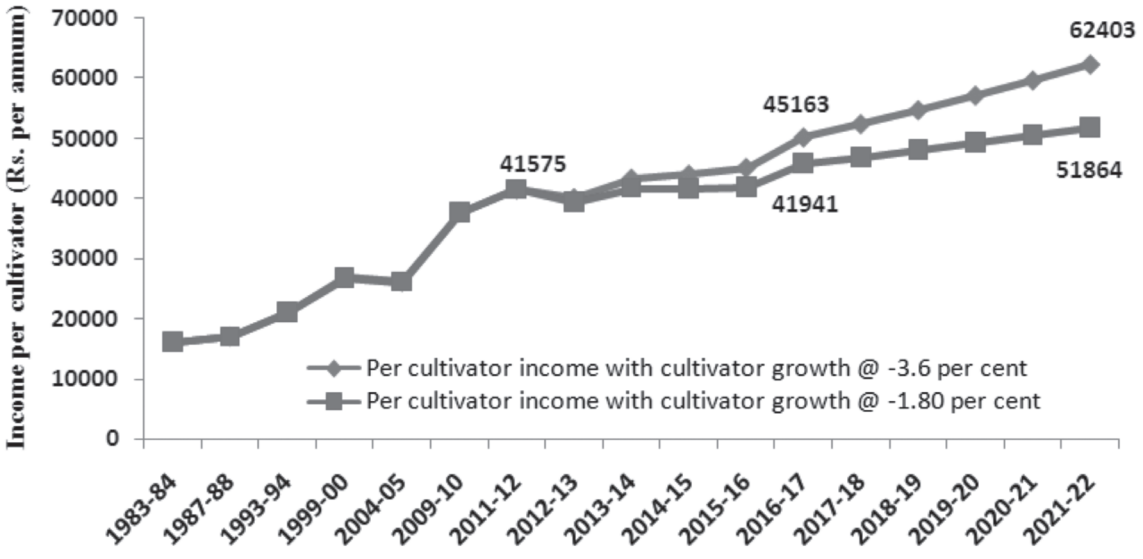
Commodity groups	Monetary losses (Production of 2012-13 and prices at 2014, in ₹ crore)	Major crops/segments in term of monetary losses for the given category
Cereals	20698	Paddy (50), wheat (38), other cereals (12)
Pulses	3877	Chickpea (63), pigeonpea (25), other pulses (12)
Oilseeds	8278	Soybean (65), mustard (18), other oilseeds (16)
Fruits	16644	Mango (43), banana (23), citrus (9), apple (8), other fruits (16)
Vegetables	14842	Potato (34), tomato (25),onion (16), cauliflower (8), other vegetables (18)
Plantation and cash crops	9325	Sugarcane (60), coconut (22), Others (18)
Livestock produce	18987	Milk (23), marine fish (23), poultry meat (21), inland fish (20), others (13)

Source: Jha *et al*. (2015), Figures in parentheses indicate percentage to the category total.



Source: Computed by authors

Figure 2. Level of processing and growth in various components of food manufacturing in household and corporate sectors



Source: Computed by authors

Figure 3. Impact of decline in number of cultivators on farmers' income (₹ per annum)

(NSSO, 2003) at an annual rate of 1.8 per cent. Assuming the same rate of decline in the next six years, it may lead to an increase of 24 per cent in cultivators' income by 2021-22. However, in the last few decades, the non-farm sector has grown at much faster rate indicating further scope for shifting labour force from agriculture. Moving on the premise that better agribusiness and non-farm sector would create more employment opportunities, the rate of decline in the number of cultivators would accelerate to 3.6 per cent, leading to an increase in per capita farm income from ₹ 45163 in 2015-16 to ₹ 62403 in 2021-22, that is 38 per cent (Figure 3). The increasing emphasis on agribusiness requires that agriculture units do not remain isolated from cultivating units rather are transformed into agri-enterprises. Encouraging processing and building value chains would help create nonfarm jobs in rural areas (Gulati and Saini, 2016).

Conclusions and Policy Implications

To realize the goal of doubling farmers' income by 2022-23, it is important that the sources of growth in income are identified. Increase in TFP would be a significant contributor to output growth. Irrigation management can bring a substantial growth in output. Micro-irrigation can also bring substantial gains in productivity and resource use efficiency. Likewise, diversification towards high-value crops can bring significant gains to farmers' income. This requires strong emphasis on regional crop planning and preparation of optimum crop plans for identification of competitive crops in different agro-climatic conditions. However, the diversification process needs to be coupled with strong infrastructure and logistics support along with provision of efficient marketing network. There are considerable yield gaps in crops. If these are bridged through proper technological and scientific interventions, a lot of agricultural output could be saved. The agricultural prices in the recent past have witnessed extreme volatility that needs to be addressed through proper market information and intelligence efforts. Besides, effective post-harvest management and small scale food processing at household-level would facilitate growth in farmers' income.

There is a need to prioritize areas for investment based on their potential to contribute to the targeted growth, and both the public and private sectors work in tandem to achieve the goal of doubling farmers' income. In this context, effective coordination between centre-states is essential to mainstream and channelize policies and investment.

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