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## **Contribution of Indian Agriculture to Nutritional Security: Trend and Patterns**

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### **Abstract**

This paper has examined the consumption and production patterns of proteins and calories in India over the past 25 years (1991-92 to 2014-15). The study has revealed that consumption and production trends have been diversified away from cereals towards fruits and vegetables as also towards foods of animal origin. Diversification in consumption and production of proteins and calories has relatively been more pronounced in the recent period. A higher proportion of protein and calorie supply was coming from non-traditional food commodities, especially of animal origin. Soybean's contribution to protein supply has increased significantly over the years even surpassing that of pulses. Protein and calorie production from livestock products has grown faster vis-à-vis food crops. While the pulse production per capita per day has declined drastically during the past decades to 40 grams during TE 2014-15 that has protein content of 8.02 grams, the protein produced from various foods increased to 93 grams. The instability index as measured in terms of de-trended CV has been found lower for food products of animal origin compared to food crops. Instability index has been found lower than the growth rates for livestock based foods. It is observed that growth rates are higher and instability lower during the recent periods. Overall, production patterns seems to match the consumption patterns.

**Key words:** Food production, gross calorie content, gross protein content, diversification, nutritional security

**JEL Classification:** O47, Q10, Q18 and Q19

### **Introduction**

Indian agriculture with impressive food-production performance has undisputedly ensured food security in the country. The food grain production has increased manifold since Independence to peak at 266 million tonnes in 2013-14. India is the largest producer, consumer and importer of pulses in the world. It holds 4th position in the world in production of coarse cereals. With an annual production of 33 billion eggs, India is the fifth largest egg-producing country. The country

ranks first in milk production, accounting for 18.5 per cent of world milk-production. In contrast, India ranks 80<sup>th</sup> among 117 countries in terms of *Global Hunger Index, 2015* (Von Grebmer *et al.*, 2015). Its hunger status, with an index value of 29, is classified as 'serious', notwithstanding the reduction in index value compared to the year 2000. The Hunger Index has three dimensions: inadequate food supply measured through undernourishment; child under-nutrition measured through wasting and stunting of under-five children; and child mortality measured through under-five children mortality. The data showed that 15 per cent of the population is undernourished and under-five

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mortality is 5.3 per cent in India. While the prevalence of wasting is 15 per cent for under-five children, stunting is as high as 38.8 per cent. Thus, nutrition security, especially for under-five children, the future citizens of the country, assumes importance and much effort is needed to ensure it.

Calorie and protein are the two important dimensions of nutrition. Increase in food supply ensures availability of calories, but the quality of such supply gets enhanced only when they come from diversified foods that can provide various nutrients. The quality of calorie basket would improve if more vegetables and fruits are added to the diet. The availability of protein — the building block of human body, on the other hand, can improve only when certain foods such as pulses, leguminous vegetables or foods of animal origin are consumed. Of late, protein supply, especially to the poor households, is in jeopardy, due to high and rising prices of pulses. Since production of pulses did not grow commensurate with population growth in India on account of stagnant productivity over time, the per capita pulse availability declined from 60 grams per day in 1950-51 to 41 grams/day in 2011-12 (NCAER, 2014 a). Pulses, being the traditional sources of protein, are an important constituent of Indian diet. But, in view of the recent episodes of soaring prices and supply shortage, should we not look out for alternative sources of protein is the question. Soybean and foods from animal sources is some such alternatives though the latter are expensive and are not consumed by certain sections of the society due to religious or cultural reasons.

The dietary pattern of people has evolved over time due to influence of factors such as income, prices, individual preferences and beliefs, cultural traditions, as well as geographical, environmental, social and economic factors including globalization. At the same time, Indian agriculture has been commercialized and diversified (Satyasai and Viswanathan, 1995). As a result, there is a possibility that the sources of protein and calories have also been diversified.

In this context, the present paper discusses the changing food consumption pattern in the country and examines if there are corresponding changes in the pattern of protein and calorie production from agricultural commodities and the trends thereof.

## Data and Methodology

The data used in the paper were collected from various secondary sources such as CMIE (Centre for Monitoring Indian Economy) data base, Indian Horticulture Database of various years and publications of Directorate of Economics and Statistics. The protein and calorie intake values of the food commodities were collected from NSSO report of *Nutrition Intake of India*.

The diversification of sources of protein or calorie production from agricultural commodities is measured using *Diversification Index (DI)*, in terms of deviation of Herfindahl Index values from unity. The Herfindahl Index is computed using the expression,  $\sum p_i^2$ , where  $p_i$  is the proportion of each activity in the production basket. It is bounded by 1 (total diversification) and 0 (total specialization) (Shiyani and Pandya, 1998).

In this paper we have aggregated 51 diverse agricultural commodities including livestock products, using respective calorific values, i.e. kilo calories (kcal) generated per 100 grams of the food commodity to obtain the Gross Calorie Content (GCC) of food production following the methodology given in Satyasai and Viswanathan (1996). The GCC gives a comprehensive estimate of the energy value of the food production covering commodities such as food grains, oilseeds, fruits, vegetables, milk, eggs and meat. Similarly, the Gross Protein Content (GPC) of food produced was obtained using the respective protein content per 100 grams of the food item. The paper focusses only on the production side. The distribution aspects and foreign trade in food, though important, were not covered. The analysis was done at all-India level.

The growth rates in this paper have been computed using exponential form of the type (1):

$$Y_t = A.e^{rt} \quad \dots(1)$$

where,  $Y_t$  is the production in year  $t$ ,  $A$  is the intercept,  $r$  is the growth rate and  $e$  is the base of natural logarithm. The instability in production has been measured in terms of de-trended coefficient of variation (CV) using Expression (2):

$$\text{De-trended CV} = CV(1-R^2)^{1/2} \quad \dots(2)$$

where, CV, the coefficient of variation, is the ratio of standard deviation to mean of the series and is given by the expression:

CV= (Standard deviation/mean)\*100.

This paper has used production data for the period 1991-92 to 2014-15 for analysis. Further, to observe growth rates during different sub-periods, we have followed the method suggested by Ray (as in Rao *et al.*, 1988) and have estimated growth and instability measures for the 10-year moving periods to minimize the impact of arbitrary selection of cut-off year on the conclusions.

## Results and Discussion

### Changing Food Consumption Pattern

The impressive inclusive economic growth over time and consequent income increase, have led to diversification of Indian diet, where consumers have moved away from inferior cereals such as *jowar* and *bajra* to superior grains such as wheat and rice and more recently, from cereals to high-value food commodities such as milk, egg, meat, and fruits and vegetables (NCAER, 2014 b; Viswanathan and Satyasai, 1996). Other factors contributing to the change in food consumption pattern are the increasing urbanization and globalization. Further, there has been a significant shift in consumption pattern away from rice, wheat and coarse cereals over the past two decades

in both rural and urban segments of the country (Table 1). The decline in consumption of coarse cereals, however, has been steeper, in the rural areas. The consumption of pulses increased up to the year 1999-2000 and later decreased in both rural and urban India. There was a steady increase in the consumption of edible oils and food products of animal origin (milk, eggs, fish and chicken) over the years from 1987 to 2010.

### Consumption Trends in Calorie and Protein Intake

The nutrition intake data from various rounds of NSSO surveys (NSSO, 2007; 2012; 2014) revealed that calorie intake in both urban and rural areas increased from 2073 kcal to 2206 kcal and from 2153 kcal to 2233 kcal, respectively between 1993-94 and 2011-12. The per capita protein intake also increased from 57.7 to 60.3 grams in urban areas and from 60.3 to 60.7 grams in rural areas between 1993-94 and 2011-12. Overall, the calorie and protein intake saw a marginal increase over the years among urban and rural households, but there was a negligible increase in protein intake for rural households (NCAER, 2014 b).

Table 2 presents the trends in protein and calorie intake through foods of animal and crop origin. The overall protein and calorie intake marginally increased

**Table 1. Trends in per capita consumption of major food commodities in India**

Food commodity	Rural areas				Urban areas			
	1987-88	1999-00	2009-10	Pattern over last 5 NSSO rounds*	1987-88	1999-00	2009-10	Pattern over last 5 NSSO rounds*
Rice	83.0	80.0	73.0	■ ■ ■ ■ _	64.0	62.0	53.0	■ ■ ■ ■ _
Wheat	55.0	54.0	52.0	■ ■ ■ ■ _	53.0	54.0	50.0	■ ■ ■ ■ _
Coarse cereals	38.0	20.0	13.0	■ ■ ■ ■ _	19.0	13.0	9.0	■ ■ ■ ■ _
Pulses	7.9	10.2	7.9	_ ■ ■ ■ _	9.4	12.2	9.6	_ ■ ■ ■ _
Edible oils	4.0	6.1	7.7	_ ■ ■ ■ ■	6.6	8.7	9.9	_ ■ ■ ■ ■
Milk	38.9	46.1	50.1	_ ■ ■ ■ ■	51.8	62.1	65.2	_ ■ ■ ■ ■
Chicken	0.2	0.5	1.5	_ ■ ■ ■ ■	0.2	0.7	2.2	_ ■ ■ ■ ■
Eggs	6.3	13.2	21.1	_ ■ ■ ■ ■	17.4	25.1	32.5	_ ■ ■ ■ ■
Fish	1.9	2.6	3.3	_ ■ ■ ■ ■	2.1	2.7	2.9	_ ■ ■ ■ ■

\*The pattern is constructed for last 5 NSSO rounds, viz., 1987-88, 1993-94, 1999-00, 2004-05 and 2009-10 though data given here are for only 3 rounds.

Source: NCAER (2014b)

**Table 2. Per capita protein intake and calorie intake from foods of animal and crop origin**

Period	Protein intake (grams/day)			Calorie Intake (kcal/day)		
	Animal	Crop	Total	Animal	Crop	Total
1987-1993	8.6 (15.6)	46.6 (84.4)	55.2 (100)	156 (7.0)	2090 (93.1)	2246 (100)
1994-1999	9.5 (17.2)	45.9 (82.9)	55.4 (100)	175 (7.7)	2108 (92.3)	2283 (100)
2000-2004	9.6 (17.6)	45.1 (82.5)	54.7 (100)	181 (8.0)	2076 (92.0)	2257 (100)
2005-10	10.7 (19.0)	45.5 (81.0)	56.2 (100)	201 (8.7)	2110 (91.3)	2311 (100)

Source: NCAER (2014 b)

Note: The figures within the brackets show percentage.

during 1987-1993 to 2005-2010. Importantly, the share of food of animal origin in protein as well as calorie intake of households has improved over time, though marginally. The relative share of foods of animal origin in protein intake has increased from 15.6 per cent in 1987-1993 to 19.0 per cent in 2005-2010. The relative share of foods of animal origin in calorie intake has increased from 7.0 per cent during 1987-1993 to 8.7 per cent during 2005-2010.

Table 3 gives composition data on total calorie intake by type of food computed from NSSO survey data for different rounds. The last column in the Table 3 depicts a pictorial representation of trend over four

time points. The relative share of cereals in total calorie intake declined from 65.0 per cent in 1987-1993 to 58.5 per cent in 2005-2010. The share of pulses also declined between these periods, though marginally. The shares of all other commodities, notably oils, fruits and vegetables, in the total calorie intake of households increased to some extent. This shows that the calorie intake pattern is diversified over time, especially towards the quality foods. The Diversification Index which grew from 0.557 in 1987-1993 to 0.630 in 2005-2010 reflects this.

The composition of protein intake (Table 4) also showed increasing diversification with time. While

**Table 3. Per capita calorie intake from different food commodities: 1987-2010**

Food commodities	1987-1993	1994-1999	2000-2004	2005-2010	(in per cent)
					Pattern over 4 time periods
Cereals	65.0	61.7	60.6	58.5	
Pulses	5.3	5.0	4.7	4.8	
Sugar	8.2	8.7	9.2	8.7	
Vegetable oils	6.5	7.8	8.2	8.8	
Milk	4.4	4.6	4.3	4.5	
Meat/Egg/Fish	1.2	1.3	1.4	1.5	
Fruits & vegetables	4.9	5.4	5.8	6.8	
Others	4.5	5.4	5.9	6.4	
Total calories	2245	2282	2256	2311	
Diversification Index	0.557	0.595	0.607	0.630	

Source: NCAER (2014 b)

**Table 4. Per capita protein intake from different food commodities: 1997-2010**

Food commodity	1987-1993	1994-1999	2000-2004	2005-2010	(in per cent)			
					Pattern over 4 time periods			
Cereals	62.6	60.1	59.5	57.0	■	■	■	—
Pulses	12.9	12.3	11.5	11.8	■	■	—	—
Sugar	0.4	0.4	0.2	0.2	■	■	—	—
Fruits & vegetables	4.4	4.7	5.1	5.5	—	■	■	■
Milk	9.8	10.8	11.1	11.9	—	■	■	■
Meat/Egg/Fish	5.6	6.1	6.4	7.0	—	■	■	■
Other	4.4	5.6	6.2	6.6	—	■	■	■
Total protein intake, grams	55.1	55.4	54.8	56.1	—	■	—	■
Diversification index	0.574	0.602	0.610	0.634	—	■	■	■

Source: NCAER (2014 b)

overall intake did not change much, the shares of cereals and pulses declined. During 2005-2010, the share of cereals was 57.0 per cent, down by 5.6 percentage points from 62.6 per cent in 1987-1993. The decline in share of pulses in protein intake was only of 1.1 percentage point to reach 11.8 per cent in 2005-2010. Milk, meat, fish, eggs, fruits and vegetables compensated the loss in share of cereals and pulses to a large extent with a gain in their combined share of 4.6 percentage points. The data once again indicated a shift in dietary consumption pattern away from food of crop origin to that of animal origin.

### Production of Food Commodities in Agricultural Sector

Table 5 represents the production data of different food commodities in India during the period TE 1993-94 to TE 2014-15. Food production of both crop and animal origin registered significant increase over the three triennia. Food grains production increased by 1.45 times from about 177.37 million ton in TE 1993-94 to about 258 million ton in TE 2014-15. Production of oilseeds increased by 1.5 times, and fruits & vegetables almost by 3 times. Compared to this, milk production increased by 2.4 times between the same time points. Also, fish production doubled and chicken production rose by more than 7 times.

The long-term compound growth in foods of animal origin was in the range of 1.59 to 6.00 per cent

per annum and of 4.18 to 10.30 per cent in foods of crop origin. Importantly, food production from animal sources was more stable, as indicated by the lower de-trended CV value range.

### Gross Protein Content in Food Production

Food production from different crop and animal sources was aggregated using their respective protein content to estimate the gross protein content (GPC) of food produced. Figure 1 depicts the trend in GPC and protein supply from some major food commodities. Indian agriculture produced food containing 42.90 million tonnes (Mt) of protein in 2014-15 which is nearly double the level of 22.99 million tonnes produced in 1991-92. While the protein supply from food commodities of animal origin had seen a steady growth over the years, there was near stagnancy in protein supply from pulses. The non-pulse food crops which represent all crops other than pulses, registered a growth from 17.8 Mt to 28.4 Mt between 1991-92 and 2014-15.

The shares of different food commodities in Gross Protein Content (GPC) of food production and per capita protein during three different time periods are given in Table 6. While the share of food crops in GPC decreased from 85.43 to 77.63 per cent between TE 1993-94 and TE 2014-15, the share of food from animal sources increased from 14.5 to 22.37 per cent during the same period. The per capita protein production

**Table 5. Production of major food commodities in India**

(million tonnes)

Crop/Crop group	TE 1993-94	TE 2003-04	TE 2014-15	Based on Long term series from 1991-92 to 2014-15	
				CAGR (%)	De-trended CV (%)
<b>Crop sources</b>					
Foodgrains	177.37	200.28	257.94	1.69	5.70
Cereals	164.66	187.14	239.44	1.69	5.52
Fine cereals	133.53	154.79	198.19	1.71	5.44
Coarse cereals	31.13	32.35	41.25	1.63	9.88
Pulses	12.71	13.14	18.50	1.59	10.75
Oilseeds	20.07	20.23	31.18	2.13	13.11
Vegetables	39.99	59.31	117.99	5.31	5.75
Fruits	22.13	35.50	67.96	6.00	7.60
<b>Animal origin</b>					
Diary groups					
Milk	58.07	86.23	138.80	4.18	1.31
Milk dry	0.08	0.22	0.49	9.72	8.15
Butter	1.12	2.50	5.04	7.83	5.94
Non-dairy group					
Eggs	1.15	1.98	3.45	5.63	4.06
Chicken	0.53	1.52	3.69	10.30	9.51
Beef & veal	1.12	1.98	4.00	6.92	10.72
Fish	4.35	6.13	9.49	3.62	3.11

Source: Author's computation from CMIE, NHB, Directorate of Economics and Statistics

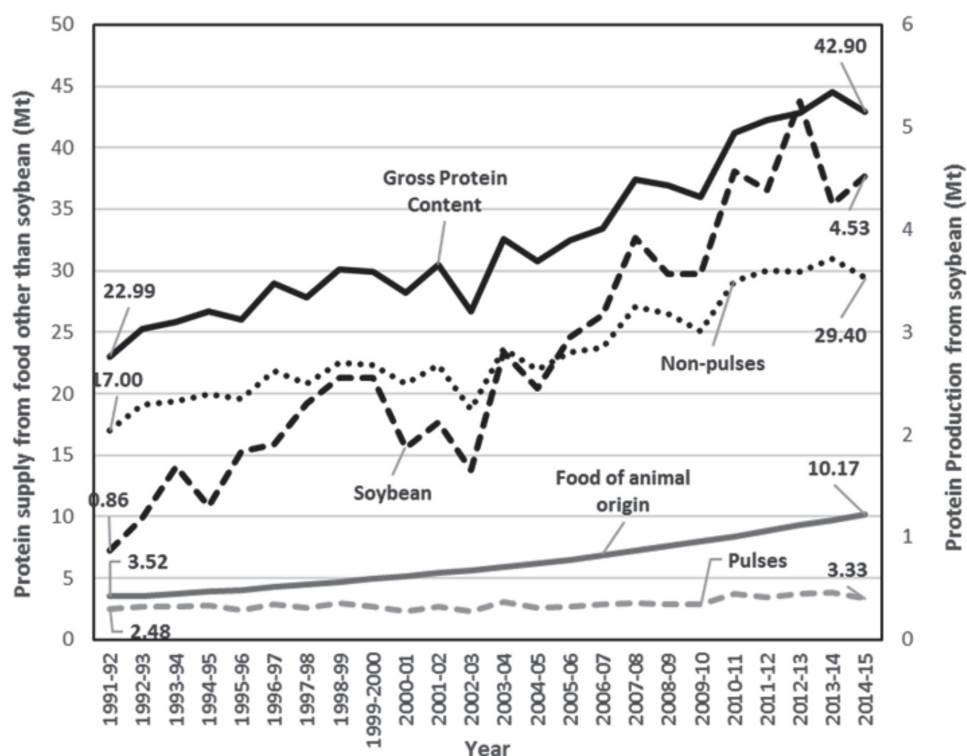


Figure 1. Trend in protein supply from major food commodities in India

**Table 6. The shares of different food commodities in gross protein content (GPC)**

Crop/Crop group	TE 1993-94		TE 2003-04		TE 2014-15		Long-term series :	
	Share in GPC (%)	PP/capita (kg/year)	Share in GPC (%)	PP/capita (kg/year)	Share in GPC (%)	PP/capita (kg/year)	CAGR (%)	De-trended CV (%)
Crop origin	85.43	24.15	81.06	22.96	77.63	27.29	2.16	6.95
Foodgrains	67.06	18.96	62.87	17.81	56.46	19.85	1.75	6.08
Cereals	56.50	15.97	53.91	15.27	48.13	16.92	1.81	5.62
Fine cereals	43.28	12.24	42.86	12.14	38.77	13.63	1.94	5.63
Coarse cereals	13.22	3.74	11.05	3.13	9.36	3.29	1.35	10.00
Pulses	10.56	2.98	8.96	2.54	8.33	2.93	1.44	10.60
Oilseeds	15.02	4.25	13.97	3.96	15.57	5.47	2.92	14.12
Vegetables	2.51	0.71	3.10	0.88	4.09	1.44	5.17	5.76
Fruits	0.83	0.24	1.12	0.32	1.50	0.53	6.14	7.57
Animal origin	14.57	4.12	18.94	5.36	22.37	7.86	4.88	1.29
Dairy group	8.33	2.36	10.47	2.97	11.84	4.16	4.44	1.14
Non-dairy group	6.24	1.76	8.46	2.40	10.53	3.70	5.44	2.74
Gross protein content	100.00	28.27	100.00	28.32	100.00	35.16	2.65	5.78
Absolute values	24.69 Mt	77 g/day	29.91 Mt	77 g/day	43.43 Mt	93 g/day		
Diversification Index	0.636		0.663		0.710			

Source: Estimated by authors based on data compiled from CMIE, NHB, Directorate of Economics and Statistics

Note: PP = Protein production

remained stagnant at 77 grams between TE 1993-94 and TE 2004-05, after which increased by 21 per cent to reach 93 grams/day in TE 2014-15. The per capita protein production from animal sources increased by 91 per cent between TE 1993-94 to TE 2014-15 against mere 13 per cent rise in protein production from crop sources. The diversification index measured in terms of protein production, rose from 0.636 to 0.710 between TE 1993-94 and TE 2014-15, indicating diversification over time.

The GPC grew at a compound annual rate of 2.65 per cent over about two and a half decades. The GPC of food of animal origin grew faster at 4.88 per cent compared to that from crop segment that grew at 2.16 per cent. The protein production from animal sources was relatively stable as the instability was 1.29 per cent compared to 6.95 per cent for foods from crop sources.

To know if the growth performance was the same throughout the time period of the analysis, we plotted moving growth rates and de-trended CV for successive

10-year periods for various food groups as given in Figure 2. Protein production from food crops crossed the 2 per cent growth barrier from the 10-year period ending 2008-09, after which the growth rates improved to touch 4 per cent and instability declined. Till the moving period ending 2008-09, the growth declined and instability increased. Protein production from animal sources appears to be stable in terms of growth as well as instability compared to the food crop during the successive 10-year moving period while that from pulses showed higher growth rates in recent periods. The instability in protein production from pulses remained above 8 per cent for most periods.

Soybean showed a cyclical pattern in growth rate while instability declined since 2007-08. Non-dairy foods as a supplier of protein remained steady and stable at around 5 per cent growth. Protein from dairy sources grew at different rates during the successive periods but was within a band of 4 to 5 per cent. Interestingly, foods of animal origin remained the stable sources of protein with instability being lower than the



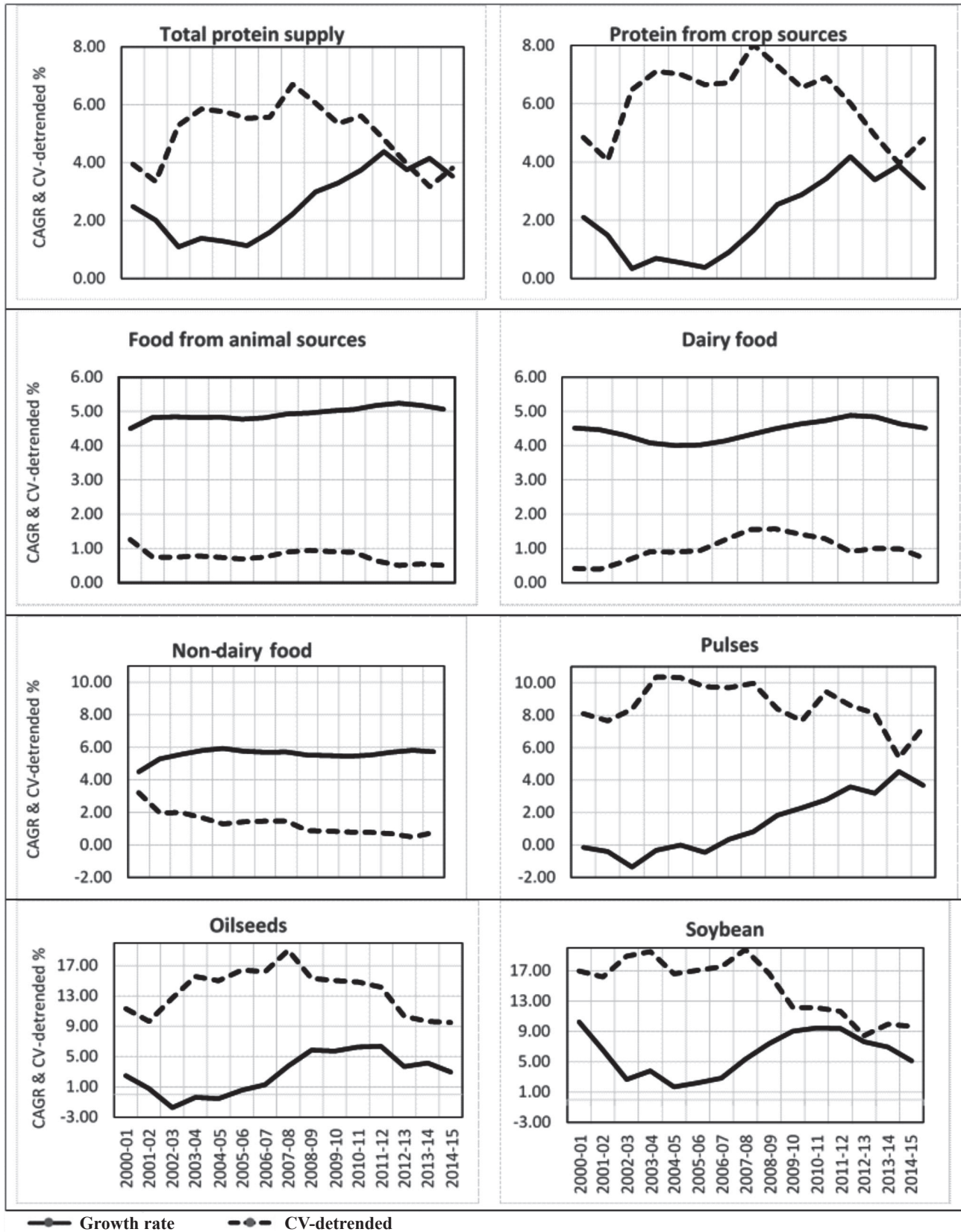


Figure 2. Trends in moving growth rate and de-trended CV in protein supply from food production

**Table 7. Diversification in protein sources: TE 1993-94 to TE 2014-15**

Crop/Crop group	(million tonnes)		
	TE 1993-94	TE 2003-04	TE 2014-15
Chickpea	0.86	0.98	1.64
Arhar (Pigeon pea)	0.52	0.50	0.65
Blackgram	0.37	0.37	0.44
Greengram	0.31	0.29	0.34
Other pulses	0.55	0.54	0.55
Total pulses	2.61	2.68	3.62
Soybean	1.25	2.20	4.68
Protein from food of animal origin	3.60	5.66	9.71

Source: CMIE, Directorate of Oilseeds Research

growth rate throughout the study period. The trend in GPC remained more or less similar to that from crop sources, except for the relatively stable production which was due to the contribution of food from animal sources.

The trends discussed so far reveal that there has been diversification in sources of protein supply and that new sources of protein emerged over time. Soybean is one such source, animal sources being the other. Table 7 shows protein diversification towards soybean and food from animal sources. Protein supply from pulses, the traditional source, registered an increase from 2.61 Mt during TE 1993-94 to 3.62 Mt during TE 2014-15. Soybean, on the other hand, contributed 1.25 Mt and 4.63 Mt and animal foods produced 3.60 Mt and 9.71 Mt of protein, respectively, between the same time points.

The protein supply through pulses has remained higher than what soybean contributed till 2004-05, after which soybean supply more protein, peaking at 5.26 Mt in the year 2012-13, compared to pulses. Thus, there is an opportunity to fight against protein deficiency by promoting soybean as an alternative source of protein instead of being obsessive about pulses. We suggest that soybean may also be classified as pulse crop in view of its protein content. There were efforts to manufacture analogue to natural *dal* from soybean which did not take off well (GoI, 2009; Gulati and Verma, 2016).

### Gross Calorie Content (GCC) in Food Production

In this section, we have examined trend in total calorie intake. Table 8 shows the shares of calorie supply by both crop and animal origin food commodities along with their share and per capita calorie supply by the aggregate commodities. Calorie supply from both crop and animal origin increased over the past three triennia. The Gross Calorie Content (GCC) from food production increased more pronouncedly from 1059.73 trillion kcal in TE 2003-04 to 1473.56 trillion kcal in 2013-14, given the base level of 901.14 trillion kcal in TE 1993-94. Between TE 1993-94 and TE 2014-15, the share of foods of crop origin in total GCC decreased from 93.84 to 89.17 per cent and of food from animal sources increased from 6.16 per cent to 10.83 per cent.

The per capita calorie production from both crop and animal origin increased from 2827 kcal to 3268 kcal per day between TE 1993-94 and TE 2014-15. The per capita calorie intake is generally higher, though not to a greater extent, than the nutritional intake level discussed earlier in the paper. Considering refuse factors for various foods, the production levels may barely be on par with intake levels. Interestingly, the calorie intake basket also moderately diversified as the Diversification Index improved from 0.590 in TE 1993-94 to 0.604 in TE 2003-04 and further to 0.649 in TE 2014-15. The major improvement in diversification occurred between TE 2003-04 and TE 2014-15.

The food from animal sources has recorded a compound annual growth rate of 5.26 per cent compared to 2.00 per cent in the food from crop sources, during the period 1991-92 to 2014-15. The GCC from crop segment showed a lower growth but higher instability (5.84%), while GCC from animal sources grew relatively faster but with a lesser instability of 1.48 per cent. Overall, the GCC grew at 2.27 per cent per annum with an instability index of 5.40 per cent. The GCC basket was diversified over time as the index value increased from 0.590 to 0.649 in two decades.

Importantly, there has been a secular growth in calorie production from both the crop and animal sources over time (Figure 3). In linear terms, crop segment added 21 trillion kcal every year while animal segment added 5 trillion kcal.

**Table 8. Calorie production by aggregate food commodities: TE 1993-94 to TE 2014-15**

Crop/Crop group	TE 1993-94		TE 2003-04		TE 2014-15		Long term: 1991-92 to 2014-15	
	Share in TCP (%)	CP/capita ('000 kcal/year)	Share in TCP (%)	CP/capita ('000 kcal/year)	Share in TCP (%)	CP/capita ('000 kcal/year)	CAGR (%)	De-trended CV (%)
Crop origin	93.84	864	91.39	985	89.17	1345	2.00	5.84
Foodgrains	65.87	680	64.46	782	60.22	1016	1.81	5.74
Cereals	61.24	632	60.37	736	56.14	947	1.83	5.56
Fine cereals	51.75	534	50.95	618	46.87	791	1.71	5.45
Coarse cereals	9.49	98	9.42	114	9.27	156	2.51	10.48
Pulses	4.63	48	4.09	50	4.08	689	1.57	10.94
Oilseeds	14.04	145	11.62	141	12.47	210	1.82	12.94
Vegetables	2.18	22	2.74	33	3.73	63	5.08	6.50
Fruits	1.69	17	2.36	29	3.27	55	6.22	7.47
Others	10.06	104	10.21	119	9.47	136	1.64	9.79
Animal origin	6.16	64	8.61	105	10.83	183	5.26	1.48
Dairy group	4.86	50	6.73	82	8.32	140	5.11	1.62
Non-dairy group	1.31	14	1.89	23	2.51	42	5.79	3.31
Total GCC	100.00	1032	100.00	1004	100.00	1193	2.27	5.40
Absolute values	901.14	2827	1059.73	2750	1473.56	3268		
	trillion kcal	kcal/day	trillion kcal	kcal/day	trillion kcal	kcal/day		
Diversification Index	0.590		0.604		0.649			

Source: Estimated by authors based on data compiled from CMIE, NHB, Directorate of Economics and Statistics

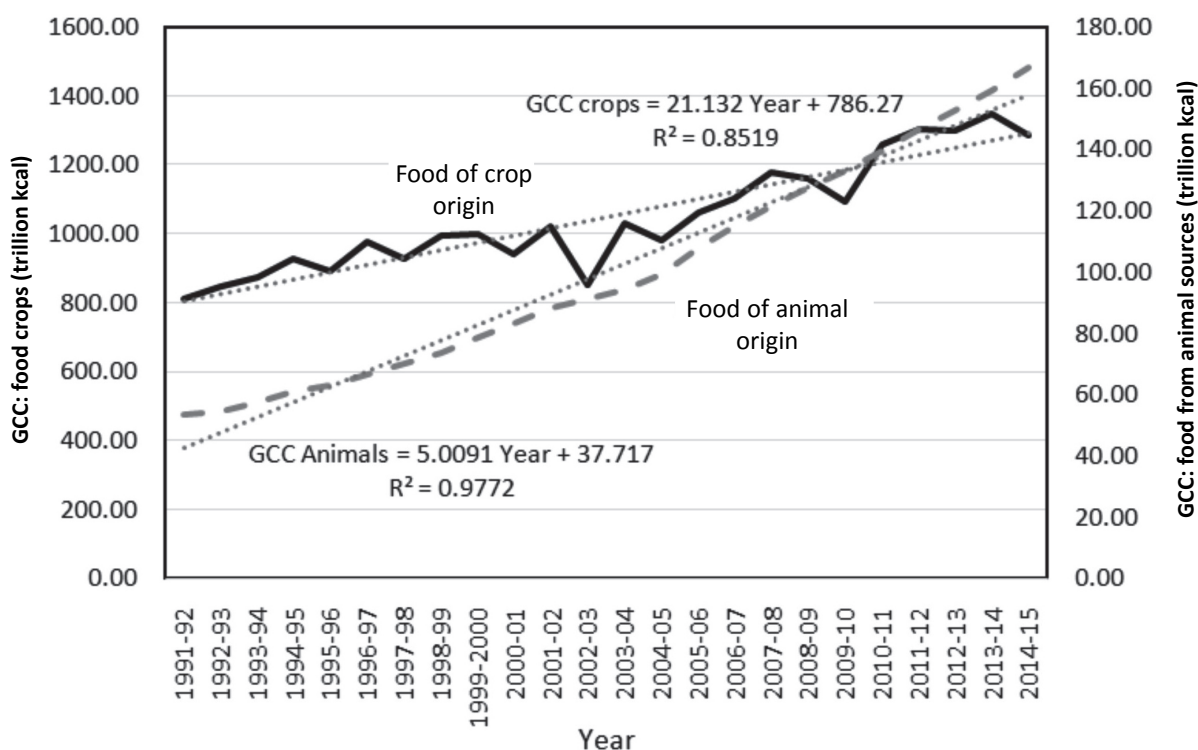


Figure 3. Calorie production content from food from crop and animal sources: 1991-92 to 2014-15

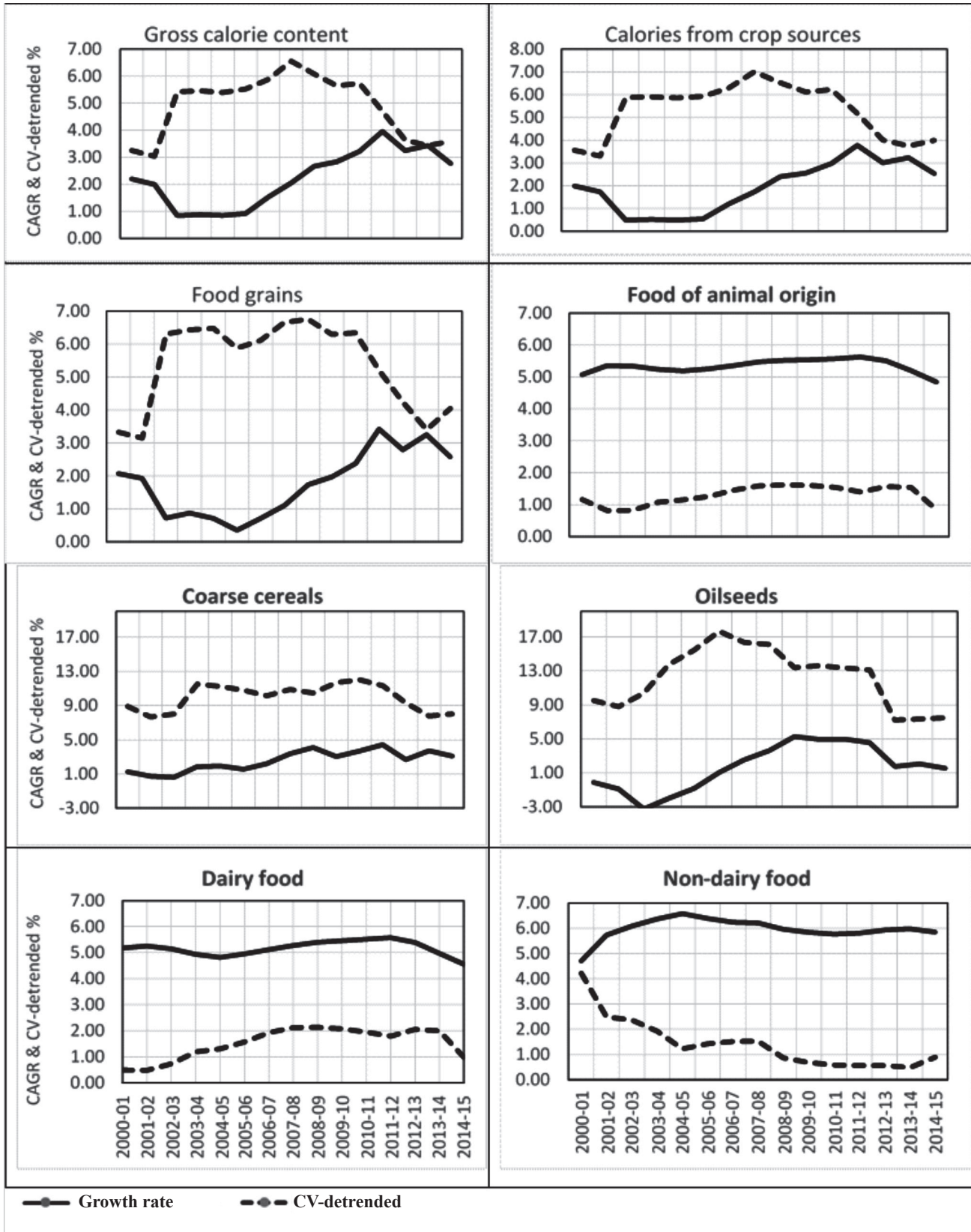


Figure 4. Moving growth rates and instability in calorie production from a few food groups

We computed the moving growth rates and instability indices for successive 10-year periods starting from 1991-92. The trend in growth rates and instability over the successive moving periods in case of GCC overall and from food crops as well as food from animal sources has been found similar to the one observed in case of protein production. Figure 4 presents the dashboard.

The following trends were noticed in calorie production:

- (1) Growth in calorie production from food from animal origin moved in a relatively higher band of 5 to 6 per cent, and instability was higher in recent periods, led by trends in dairy food.
- (2) There was a slight improvement in growth of calories from coarse cereals and reduction in instability in recent periods after remaining at a higher level for most of the earlier periods;
- (3) Calories from foodgrains showed pattern similar to that in food crops.

## Conclusions

India's faster economic growth after the 1990s has raised per capita income (expenditure) and has significantly affected its food consumption patterns by causing a change in the structure of food basket. There has been a steady increase in the per capita consumption of edible oils and food products of animal origin over the years. Thus, there has been an increase in diversification in calorie intake (from 0.557 to 0.630) and protein intake (from 0.574 to 0.634) during the period of 1991-92 to 2014-15. An analogous increase was observed in Gross Calorie Content (from 0.590 to 0.649) and Gross Protein Content (from 0.636 to 0.710) over the time series. This result indicates an alongside change in production patterns with respect to the consumption trends.

In terms of absolute production values, the animal origin food commodities, fruits and vegetables have registered the CAGR of 5 per cent and above. A similar trend has been observed in GPC and GCC over the time period of 1991-2015. The non-crop food commodities have managed a steady rise in the share of GPC (from 14.57 to 22.37%) and GCC (from 6.16 to 10.83%) during this period.

Among non-food grains, the share of protein production under oilseeds as well as fruits has increased over time. In the animal origin group, the protein production has increased in both dairy and non-dairy commodities. This indicates a change in the production patterns in protein intake. It has also been observed that diversification is less in the livestock sector with specialization towards milk production. The nature of diversification was such that the loss of area share of foodgrains (cereals and pulses) was compensated by the gain in area share of non-foodgrain crops having food value (oilseeds, fruits and vegetables). The per capita protein production of crops having food value increased from 2827 kcal to 3268 kcal between the years of 1991 to 2015. On the similar lines, the gross protein content per capita per day production of food items value has increased from 77 to 93 grams. That is, while per capita per day protein availability through pulses is 8.02 grams from 40 grams of pulses protein availability from all sources is 93 grams. In fact, protein supply improved quite significantly more than offsetting decline in the protein supply from pulses.

Thus, the study has indicated the diversified food consumption pattern and matching patterns in production of proteins and calories over time and enhanced availability of protein with substitution of alternative sources for pulses.

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## References

- GoI (Government of India) (2009) *Report of Expert Group on Pulses* (Chair: Y.K. Alagh). Department of Agriculture and Cooperation, Minister of Agriculture, New Delhi.
- Gulati, A. and Verma, S. (2016) From plate to plough- Pricy pulses, politics and policies, *The Financial Express*, 01 August.
- NCAER (National Council of Applied Economic Research) (2014 a) *India's Pulse Scenario — A research paper prepared under the project Agricultural Outlook and Situation Analysis Reports*. New Delhi.
- NCAER (National Council of Applied Economic Research) (2014 b) *An Analysis of Changing Food Consumption Pattern in India — A research paper prepared under*

- the project Agricultural Outlook and Situation Analysis Reports*. New Delhi.
- NSSO (National Sample Survey Office) (2007) *Nutrition Intake Report 2004-05*. 61<sup>st</sup> round. Ministry of Statistics and Program Implementation, Government of India, New Delhi.
- NSSO (National Sample Survey Office) (2012). *Nutrition Intake Report 2011-12*, 66<sup>th</sup> round. Ministry of Statistics and Program Implementation, Government of India, New Delhi.
- NSSO (National Sample Survey Office) (2014). *Nutrition Intake Report 2011-12*, 68<sup>th</sup> round. Ministry of Statistics and Program Implementation, Government of India, New Delhi.
- Rao, Ch.Hanumantha, Ray, S.K. and Subbarao, K. (1988) *Unstable Agriculture and Droughts*. Vikas Publishing House Ltd, New Delhi.
- Satyasai, K.J.S. and Vishwanathan, K.U. (1995) *Commercialization and Diversification of Indian Agriculture*, Occasional Paper 5, DEAR, NABARD, Mumbai.
- Satyasai, K.J.S., and Vishwanathan, K.U. (1996) Diversification of Indian agriculture and food security. *Indian Journal of Agricultural Economics*, **51**(4): 674-679.
- Shiyani, R.L. and Pandya, H.R. (1998) Diversification of agriculture in Gujarat: A spatio-temporal analysis. *Indian Journal of Agricultural Economics*, **53**(4): 627-639.
- Von Grebmer, K., Bernstein, J., De Waal, A., Prasai, N., Yin, S. and Yohannes, Y. (2015) *2015 Global Hunger Index: Armed Conflict and the Challenge of Hunger*. International Food Policy Research Institute, Washington, DC and Concern Worldwide, Dublin: Welthungerhilfe.

