Published Online on 22 December 2016

Proc Indian Natn Sci Acad **82** No. 5 December 2016 pp. 1579-1586
© *Printed in India.*
DOI: 10.16943/ptinsa /2016/48889

Review Article

Demand vs Supply of Food in India - Futuristic Projection

PRADUMAN KUMAR[1,*], P K JOSHI[2] and SURABHI MITTAL[3]
[1]*Indian Agricultural Research Institute, New Delhi, India*
[2]*Director South Asia, IFPRI, New Delhi, India*
[3]*Senior Economist & Coordinator, Center of Excellence, TARINA, TCI, Cornell University, New Delhi, India*

(Received on 20 May 2016; Accepted on 06 June 2016)

Achieving food self-sufficiency has always been the primary objective of agricultural policy in India. Driven by rising population, growing economy, increasing urbanization and changing tastes and preferences, the demand for food is continuously growing in the country. This study has attempted to answer questions like will India be able to produce enough to meet its growing food demand or will it open for imports of food commodities over the next two decades (2010-2030)? What would be the likely trends for future demand of various food commodities? Will the supply of key food commodities continue to keep pace with their demand? These are the questions, which need to be answered to evolve appropriate strategy and meet the future demand of food commodities in India. This study is an attempt to project demand for and supply of key food commodities by 2020 and 2030, and assesses their demand-supply gap. Such information will be useful to evolve appropriate medium- and long-term strategies in the food sector.

Keywords: Food Security; Nutritional Security; Consumption Pattern; Demand and Supply Projection; India

Introduction

India had a population of 1.03 billion in 2001 which increased to 1.21 billion in 2011 (Census of India, 2011). The population had been growing at the rate of 2.12 per cent per annum in the decade of 1991 to 2001 which declined to 1.76 percent per annum in the decade of 2001 to 2011. In the last few decades country has also witnessed decline in the magnitude of population below the poverty line. The percentage of population below the poverty line declined from 35.97% in 1993/94 to 27.5 percent in 2004/05 and to 23.52 percent in 2010/11 (GoI, 2014). The percentage of population under the poverty line might have declined but overall food security and nutrition has remained the focus of country's agriculture and food policy. Food security has been a very sensitive issue in India as it has the largest concentration of poor in the world. After nearly achieving self-sufficiency in staple food, the Government of India has launched a number of programs under production (supply), distribution and consumption (demand) across the country. Currently, around half of India's population is covered by one or the other scheme in which subsidized staple food is made available to the people.

India has made substantial progress in food grains production by following a new agricultural strategy. As a result, the food grain production has increased from 115.6 Mt in 1960-61 to 241.4 Mt in 2010-11. Horticulture has emerged as an indispensable part of agriculture, offering a wide range of choices to the farmers for crop diversification and much needed nutrition to the people.

The crop diversification is driven by rising population, economic growth, increasing urbanization and changing tastes and preferences. Thus the demand for non-cereal crops is continuously growing in the country. The changing consumption pattern is not only a result of demand side factors but also from the nutrition point of view it is important to diversify the food consumption basket in order to improve the level of nutrition. With this background, the present paper attempts to answer questions like will India be able to produce enough to meet its growing food

*Author for Correspondence: E-mail: pkumariari@gmail.com

demand or will it be open for imports of food commodities over the next two decades (2010-2030)? What would be the likely trends for future demand of various food commodities? Will the supply of key food commodities continue to keep pace with their demand? These are the questions, which need to be responded, to evolve appropriate strategy and meet the future demand of food commodities in India. This paper also briefly discusses the nutritional aspect of crop diversification. The paper presents projected demand for and supply of key food commodities by 2015, 2020, 2025 and 2030, and assesses their demand-supply gap. Such information will be useful to evolve appropriate medium- and long-term strategies in the food sector.

Food Basket in India: Changing Trends - *Nutrition and food trends*

In India, overtime the food basket has become more diversified in both rural and urban areas with a significantly higher share of milk, fruits, vegetables, meat and fish. As seen in Table 1 the consumption pattern is changing towards high value commodities. With this change, the nutritional intake has also changed (Table 2) but still the deficiency seems to be substantially high as seen in Table 3.

There is an increasing demand for livestock products (milk, meat and eggs) and this will push up the feed demand in the country. Dietary shift towards high-value food commodities would have a profound impact on agricultural production, marketing, processing and retailing sector. However, despite increasing demand for high-value commodities, the importance of cereals and pulses will continue for attaining nutritional security in the country because food grains account for more than three-fourth share in the total calorie and protein intake (Table 3).

Table 1: Changing in consumption pattern (kg/capita/year): India

Food groups	1983	2011	Percent Change
Cereals	168.0	133.4	-20.6
Pulses	11.8	10.0	-15.6
Sugar	11.4	10.0	-12.2
Edible oil	4.5	8.7	+78.5
Vegetables	47.9	56.2	+17.3
Fruits	3.3	11.9	+260
Milk	45.0	64.9	+44.3
Meat, fish and eggs	5.4	7.5	+39.7

Source: Calculated from various rounds of NSS consumer expenditure survey

Table 2: Change in intake of dietary nutrients: India

Food groups	1983	2011	Percent Change
Calories (kcal/capita/day)	2153	2104	-2.3
Protein (g/capita/day)	60.8	56.5	-7.1
Fat (g/capita/day)	29.3	44.5	51.8
Calcium (mg/capita/day)	489	579	18.3
Iron (mg/capita/day)	40.6	35.9	-11.7
Zinc (mg/capita/day)	8.4	9.9	16.9
Beta-carotene (µg/capita/day)	1358	1676	23.5

Source: Calculated from various rounds of NSS consumer expenditure survey
Note: g is grams; kcal is kilocalories; mg is milligram; µg is microgram

Table 3: Sources of nutrients in India (2011)

Nutrients	Sources (% of total intake)
Calories	Cereals (60%), edible oils (10%), beverages (7%)
Protein	Cereals (59%), milk (12%), pulses (12%), meat, fish and eggs (7%)
Calcium	Milk (51%), cereals (15%), vegetables and fruits (11%), beverages (10%), pulses (7%)
Iron	Cereals (63%), vegetables and fruits (9%), meat, fish and eggs (9%), beverages (9%)
Zinc	Cereals (45%), beverage (26%), vegetables and fruits (18%), pulses (7%)
β-carotene	Vegetables (52%), milk (27%), beverages (6%)

Source: Computed from NSS consumer expenditure data NSSO 2011

With the change in consumption pattern there is also a change in the nutrients intake. While the intake of calories declined marginally, there is substantial improvement in calcium, zinc and beta carotene in the consumption pattern of the population between 1983 and 2011.

Even with the shift in consumption pattern the nutritional diversification has not been adequate. This is so because the decline in cereal consumption over time has not been compensated adequately by the increased consumption of horticultural and livestock products. Table 4 shows that the majority of the population still faces the issue of nutrition deficiency.

Table 4: Status of percentage population undernourished in India, 2011, Unit: Percent of population

Nutrient Deficiency	BPL	APL
Calories	87	55
Proteins	53	20
Calcium	97	48
Iron	15	2
Zinc	76	52
Beta-carotene	100	98

Note: BPL - Population below poverty line; APL: population above the poverty line.
Source: computed from NSS consumer expenditure data NSSO 2011

This is true for population below the poverty line and also for the population above the poverty line. Both the groups have deficiency in different nutrients, which suggests an alarming situation (Table 4).

Food Projections - Data, Methodology and Elasticities

Food Demand Elasticity

The study used the household level data on dietary pattern and consumer expenditures provided through its regular surveys by the National Sample Survey Organization (NSSO), Government of India. The household data collected under major rounds of the National Sample Survey (NSS) covering the years 1983 and 2004-05 pertaining to 38th and 61st rounds, respectively were used for assessing the changes in dietary pattern and food expenditure. The household data were used to compute the average per capita consumption of all food and non-food commodities. The per capita expenditure was considered as a proxy for per capita income, and therefore, these were used interchangeably in the study. The population data is collected from census of India reports (GoI, 1996)

The demand elasticities[1] at regional level, rural/urban households and income groups are computed using Food Characteristic Demand System (FCDS) for rice, wheat, coarse grains and major commodity groups, viz. pulses, edible oils, vegetables, fruits, milk, meat, fish and eggs and other food and non-food commodities. National level estimates of income and own price elasticity[2]have been computed as the weighted averages of the disaggregated elasticity.

It is observed that demand elasticities vary widely across regions, rural/urban households and income groups due to changes in production environment and tastes and food preferences. The demand elasticities for staple food (rice, wheat, coarse cereals) have been found highly inelastic, close to zero and even negative for coarse cereals. The magnitude of elasticity has declined with rise in income across all income groups and is higher for rural than urban households. The expenditure elasticities have been found much higher for high-value food commodities, viz. livestock and horticultural products. With economic growth, the demand for high-value food commodities will increase faster than for the cereals.

The total demand for an individual commodity comprises direct as well as indirect demand. The direct demand consists of food consumption at home and outside home. The indirect demand includes its use as seed and feed, industrial uses and wastages. In this study, an attempt has been made to provide credible estimates of future demand for food grains and other food commodities by estimating their demand at the disaggregated level, in terms of income levels, rural and urban households and states/UTs of India, and these are added-up to derive the national estimates.

Supply Response Elasticities

To project supply of food commodities, one needs reliable empirical knowledge about the degree of responsiveness of input demand and crop output supply to input-output prices and technological changes (Lau and Yotopolous, 1972; Sidhu, 1974; Binswanger, 1974; Yotopolous *et al*., 1976). In the present study, the crop-related data are culled from the "Comprehensive Scheme for the Study of Cost of Cultivation of Principal Crops" of the Directorate of Economics and Statistics (DES), Government of India. It provides time series cum cross section data on yield, use of inputs and their prices. This data set has been used to estimate the Translog Cost Function to derive factor demand and output supply elasticities for cereals, pulses, edible oilseeds, sugarcane, onion, potato, cotton and jute.

[1]Demand elasticity of income is a measure of how much consumption (demand) will change with respect to change in income
[2]Own price elasticity is a measure of change in consumption (demand) of a commodity with change in its price

This data set is useful to estimate the profit function or cost function to derive factor demand and output supply elasticities. The factor demand and output supply elasticities for cereals, pulses, edible oilseeds, sugarcane, onion, potato, cotton and jute have been used to project domestic supply of these commodities. For livestock (milk, meat), poultry (chicken meat, eggs), horticultural commodities (vegetables and fruits), input-output data were not available, therefore, supply projections for these commodities are made based on past growth trend in their production. The survey of literature of recent studies on food supply estimates, estimation of food supply elasticities and food supply projections from 2010 to 2030 has been presented in the following section.

The output supply elasticities have shown the response of output prices and input prices on the supply of major crops of India. Among crops, highest supply elasticity with respect to its price was for coarse grains (0.53), followed by edible oils (0.51), cotton (0.33), jute (0.25), rice (0.24), wheat (0.22), groundnut (0.22), rapeseed & mustard (0.22), pulses (0.17), sugarcane (0.12), onion and potato (0.05). The input response elasticities were highly inelastic, nearly zero. The crop price had a dominating response on the supply of commodities and therefore, a positive price policy will enhance domestic supply of food commodities.

Projections and Demand Supply Gap

Demand Projections

The demand projections have been made under several alternative assumptions of rate of income growth and change in income distribution. The assumptions vary across rural and urban population and different income groups. The direct demand for food is driven by population growth, income growth and changes in income distribution. The total demand for food grains, except for export, was arrived by adding their direct demand (human food consumption at home and outside home) and indirect demand (seed, feed, industrial uses, and wastages). The demand for each food grain has been projected and presented in table 5.

In the year 2020, the demand is worked out to be about 112 Mt for rice, 98 Mt for wheat, 36 Mt for coarse grains, 22 Mt for pulses, 252 Mt for total cereals, and 274 Mt for total food grains. In the year 2030, the total food grains demand will grow to the level of 311 Mt comprising 122 Mt of rice, 115 Mt of wheat, 47 Mt of coarse grains and 27 Mt of pulses.

Demand projections for High-value Commodities includes the demand for edible oils, sugar and horticultural, livestock, poultry, and fishery products. The demand for edible oils will grow faster than the growth in population and food grains. The total domestic demand for edible oils is projected to be 17 Mt in 2020 and 21.3 Mt in 2030. The requirement of edible oils is and will continue to remain much higher than the domestic production in the country and shall depend on their import in large quantities. The sugar demand at the national level is estimated to be 33 Mt.

Table 5: Demand-Supply projections and gaps for major food grains, edible oils and sugar, India (Unit: Million tons)

Commodities	Year	Supply projection	Demand projection	Demand-supply gap
Rice	2010	95.7	98.7	-3.0
	2020	108.1	111.8	-3.7
	2030	122.1	122.4	-0.3
Wheat	2010	84.2	83.0	1.2
	2020	104.2	98.3	5.9
	2030	128.8	114.6	14.2
Coarse cereals	2010	39.6	36.4	3.2
	2020	50.4	42.5	7.9
	2030	64.2	47.2	17.0
Total cereals	2010	219.5	218.1	1.4
	2020	262.6	252.6	10.0
	2030	315.1	284.2	30.9
Pulses	2010	16.2	18.0	-1.8
	2020	20.7	21.9	-1.3
	2030	26.4	26.6	-0.2
Food grains	2010	234.0	236.2	-2.2
	2020	281.2	274.4	6.8
	2030	338.8	310.8	28.0
Edible oils	2010	8.2	13.6	-5.5
	2020	12.5	17.0	-4.5
	2030	19.1	21.3	-2.1
Sugar	2010	27.7	27.6	0.1
	2020	33.4	33.1	0.3
	2030	40.3	39.2	1.1

In the year 2020 and it will grow to 39 Mt by the year 2030. In the year 2020, the demand for vegetables is projected as 155 Mt. This demand will grow to the level of 192 Mt by the year 2030. The demand for fruits is projected to be 81 Mt in 2015, 103 Mt in 2030. The total milk demand in the country is projected to be 138 Mt by 2020and 170 Mt by 2030 (Table 6).

The total fish demand including indirect demand is assessed to be in the range of 8.2 Mt by 2020 and 11 Mt by 2030. The national demand for eggs is projected to be 4.4 Mt by 2020 and 5.8 Mt by 2030. The demand for eggs will grow much faster than the population growth and will increase pressure on the supply of coarse grains and oilcakes as feed.

Food Supply Projections and Gap

The supply for different commodities has been projected using Triennium Ending (TE) 2010 as the base year production. The supply projections for different food commodities under different scenarios have been presented at 10-year intervals from 2010-2030. To provide a glimpse, food supply and demand gaps for food grains, edible oils and sugar are presented in Table 5 and for high-value commodities, viz. vegetables, fruits, milk, meat, eggs and fish, are given in Table 6.

Rice

The domestic production of rice under the baseline scenario is estimated to be 108.1 Mt by the year 2020 and 122.1 Mt by the year 2030. A look at the past trend reveals that India has been marginally surplus in rice production and has been even exporting rice in small volumes (2-4 Mt). As per these projections India is not likely to remain rice surplus and may even become deficit in rice production to the extent of 3 to 5 Mt in the coming years.

Wheat

The domestic production of wheat under the baseline scenario is estimated to be 104.2 Mt by the year 2020 and 128.8 Mt by 2030. A perusal at the supply-demand

Table 6: Demand-Supply projections and gaps for high-value food commodities in India

Commodities	Supply, demand and gap	Projections (Million tons)			Post-harvest losses (%)
		2010	2020	2030	
Vegetables	Supply (S)	140.6	186.4	210.5	23.99
	Demand (D)	124.7	154.8	192.0	
	Availability (A)	106.9	141.7	160.0	
	Gap (A-D)	-17.8	-13.1	-32.0	
Fruits	Supply (S)	73.5	97.7	116.4	20.00
	Demand (D)	64.8	80.9	103.0	
	Availability (A)	58.8	78.2	93.1	
	Gap (A-D)	-6.0	-2.7	-9.9	
Milk	Supply (S)	116.5	156.6	188.7	5.03
	Demand (D)	111.9	138.3	170.4	
	Availability (A)	110.6	148.7	179.2	
	Gap (A-D)	-1.3	10.4	8.8	
Poultry & bovine meat	Supply (S)	4.4	6.6	8.4	4.98
	Demand (D)	5.2	6.8	9.2	
	Availability (A)	4.2	6.3	8.0	
	Gap (A-D)	-0.9	-0.5	-1.2	
Eggs	Supply (S)	3.1	4.7	6.2	5.02
	Demand (D)	3.4	4.4	5.8	
	Availability (A)	2.9	4.5	5.9	
	Gap (A-D)	-0.5	0.1	0.1	
Fish	Supply (S)	7.4	10.2	13.9	15.05
	Demand (D)	6.4	8.2	11.1	
	Availability (A)	6.3	8.7	11.9	
	Gap (A-D)	-0.1	0.5	0.8	

scenario reveals that wheat demand will continue to be met from the domestic production and there may even be marginal surplus of about 1.2 Mt by the year 2020, which is likely to grow to 14.2 Mt by 2030. It is observed that a shift in consumption from rice to wheat is taking place even in the traditionally rice-eating states of India. Therefore, the surplus wheat production is likely to substitute rice leading to lower availability of surplus wheat, as predicted in the study.

Coarse Cereals

The domestic production of coarse cereals is estimated to be about 50 Mt by the year 2020, which will grow to 64 Mt in 2030 under baseline growth scenarios. The surplus of coarse grains is projected to be of 8 Mt by the year 2020, which may grow to a higher level of 17 Mt by the year 2030. This projection of demand-supply balance of coarse grains has provided some valuable insights about the possible level of self-sufficiency in India in coarse grains production, particularly their availability for meeting the feed requirements of the fast-growing livestock sector products in the country in the years to come.

Total Cereals

In India, the domestic supply of total cereals, which is summation of rice, wheat, and coarse grains production, is projected to be 240 Mt by 2020, which will rise to 315 Mt by the year 2030. A look at the supply-demand balance for the cereals reveals that their demand in future will be met with the national production and there could even be a surplus of 10 Mt cereals by 2020 and of 31 Mt by 2030.To maintain cereals security, there is a need to strengthen efforts towards maintaining the present total factor productivity (TFP) growth by enhancing respective TFP growth for rice, wheat and coarse cereals.

Pulses

The domestic production of pulses is projected to be about 21 Mt in 2020 and 26 Mt in 2030.The supply of pulses will fall short of their supply by about 1.3 Mt in 2020 and India will have to continue their imports to meet the domestic needs.

Food grains

In India, the domestic supply of total food grains, which is the summation of rice, wheat, coarse cereals and pulses, is projected to be about 281 Mt in the year 2020 under the baseline scenario and will grow to 339 Mt by the year 2030. A look at the supply and demand balance of food grains in India reveals that their future domestic demand will be met with national production and there is likelihood of a marginal surplus of say about 6.8 Mt in 2020 and surplus of 28 Mt is predicted by the year 2030.

Edible Oils

Similar to pulses the deficit in edible oils supply is projected to be about 4.5 Mt by the year 2020, and it may reduce to about 2 Mt by the year 2030. Thus, India will continue to depend on imports of edible oils even in the coming decades. The domestic production of edible oils is projected to be about 12 Mt by 2020 and 19 Mt by 2030.

Sugar

The supply of sugar is projected to be about 33 Mt in the year 2020 and it is likely to increase to 40 Mt by 2030. The domestic supply of sugar will be able to meet the demand of sugar in India in the coming years and there could be a marginal surplus of about one million ton by the year 2030.

High-Value Commodities

The domestic supply projections to 2030 for high-value commodities, viz. vegetables, fruits, milk, eggs, meat and fish, are presented in Table 6. The table presents the production as supply, demand and also availability, i.e. net domestic supply, has been computed from production after adjusting for post–harvest losses. The gap is computed as difference of availability and demand.

Vegetables

The net domestic supply of total vegetables is projected to be 141 Mt in the year 2020 and 160 Mt by the year 2030. The supply-demand gap in total vegetables reveals that there will be substantial shortage of vegetables unless post-harvest losses are minimized, which is as high as 24 percent.

Fruits

The net domestic supply of fruits is projected to be 78.2 Mt in 2020 and 93.1 Mt by the year 2030.

Looking at the supply-demand gap, it appears that India will have short supply of fruits by 10 Mt by 2030.

Milk

The milk supply in the country is projected to be 149 Mt in 2020 and 179 Mt in 2030. Supply-demand gap in milk reveals that the country will be able to meet its national domestic demand with surplus of 8.8 Mt by the year 2030.

Meat

The total meat production from cattle, buffalo, sheep, goat, pig and poultry at all-India level increased from 1.85 Mt in 2000 to 4.2 Mt in 2010. The poultry meat has not only accounted for the highest contribution to total meat production but has also witnessed the highest acceleration since 2000. Looking at the past growth, the supply of total meat by 2020 is projected to be 6.3 Mt. The total meat supply will grow to 8.0 Mt by 2030. It appears that India will remain deficit in the total meat production in the years to come.

Eggs

The domestic egg production is projected to be 4.5 Mt in 2020 and 5.9 Mt in the year 2030. It seems that India will be able to meet the domestic demand for eggs with a marginal surplus.

Fish

India is the second largest producer of fish in the world with contribution of 5.54% to the global production. The total fish production during 2010 is estimated at 8.03 Mt with a contribution of 5.07 Mt from inland sector and 2.96 Mt from marine sector. The value of output from the fisheries sector at current price during 2010 was 4.9% of total output of agriculture & allied sector. India's exports of marine product have, for the first time, crossed US$ 2 billion. During 2010, the volume of fish and fish products exported was 0.753 Mt registering the highest growth rate of 10% in volume of fish exports in recent years. The projected domestic supply of fish is about 6.3 Mt in 2010, 8.7 Mt in 2020 and 11.9 Mt in 2030. The supply-demand gap of fish is projected to be 0.4 - 0.7 Mt. It appears that the country will continue to remain self-reliant in fish supply and will also be able to undertake international trade at the present level.

Conclusions

During the past two decades, the per capita consumption of cereals as food has declined while that of horticultural, livestock and fisheries products has increased. There is no doubt that household income and food prices strongly influence the food dietary pattern. There are a number of arguments which support the shifts in consumption structure as distinguished by the income and price effects. The consumption of food items increases with rise in income. In India, the food basket has become more diversified in both rural and urban areas with a significantly higher share of milk, fruits, vegetables, meat and fish. Therefore, there is an increasing demand for livestock products (milk, meat and eggs) and this will push up the feed demand. Dietary shift towards high-value food commodities would have a profound impact on agricultural production, marketing, processing and retailing sector. However, despite increasing demand for high-value commodities, the importance of cereals and pulses will continue for attaining nutritional security in the country because food grains account for more than three-fourth share in the total calorie and protein intake. Cereals continue to be the most important food for nutritional requirements and are the cheapest source of energy and protein.

Inequitable distribution of food among different segments of the population is one of the major factors responsible for under-nourishment in India. Low levels of income prevent households from substituting the nutritional value of cereals with increased consumption of fruits and vegetables, milk, meat, fish, etc. The price of cereals plays an important role in providing food and nutritional security in India. Higher cereal prices might build grain stocks with the Government, but result in their reduced consumption, which is detrimental to household food-security. Due importance should continue to be provided to the role played by cereals and pulses in achieving adequate nutritional and food security. The food consumption patterns have significant implications on future demand, research-priority setting and resource allocations to achieve food and nutritional security in the country.

Empirical studies on the dynamics of supply and demand of food crops are valuable for a country like India from the point of achieving of food security, and

often provide deep insights to policy planners regarding the existing state of affairs and future directions on food self-sufficiency. This study has estimated the factor demand and output supply elasticities for major food crops in India. The elasticities have provided insights on the responsiveness of output supply and factor demand to changes in product and factor prices. The estimates have been used to make supply projections of food crops to 2030. The projections have been made under different growth scenarios crop area, total factor productivity and input-output prices and have essentially presented the changes in supply of major food commodities. An assessment of crop demand-supply balance under different scenarios provides valuable insights on the possible levels of self-sufficiency and trade potential for each of the selected crops in the coming years.

The study has observed that the demand for rice and wheat will be met with their domestic production in the coming years, may be with a marginal surplus/deficit under the scenarios of with or without total factor productivity growth and acreage response. However, it is quite likely that pulses, edible oils and sugar would be short in supply of demand in the coming years and India will be open for imports of these commodities. The policies that can help in maintaining the TFP growth in the long-run will be able to keep a balance between domestic production and demand for cereals, pulses, edible oils and sugar. This emphasizes the need for strengthening the efforts at increasing production potential through public investments on irrigation, infrastructural development, agricultural research and efficient use of water and plant nutrients. To meet all the food and nutritional requirements of the growing population, the nation will have to increase its current levels of food production with higher emphasis on better natural resources management, achieving technological breakthroughs and addressing climatic and environmental concerns.

Acknowledgement

This paper is drawn from the study report of TAPSIM (Trade, Agricultural Policies and Structural Changes in India's Agrifood System; Implications for National and Global Markets) project, funded by IFPRI.

Reference

Binswanger Hans P (1974) A cost function approach to the measurement of factor demand elasticities of substitution *American Journal of Agricultural Economics* **56** 377-386

Census of India (2011) Provisional Population Totals, Paper 1 of 2011 India, Series-1, Office of the Registrar General & Census Commissioner, New Delhi

GoI Government of India (1996). *Census of India 1991, Population Projections for India and States 1996 - 2016,* Report of the Technical Group on Population Projections Constituted by the Planning Commission August 1996, Registrar General, India (1996), Government of India, New Delhi

NSSO (National Sample Survey Organization) (2011). Consumer Expenditure Survey. Government of India, New Delhi.

GoI (Government of India) (2014) *Level and Pattern of ConsumerExpenditure Various reports* National Sample Survey Organization, Ministry of Statistics and Programme Implementation, New Delhi.

Lau L J and Yotopolous P A (1972) Profit, supply and factor demand functions *American Journal of Agricultural Economics* **54** 11-18

Sidhu S S (1974) Relative efficiency in wheat production in Indian Punjab *American Economic Review* **64** 742-751

Yotopolous P A, Lau, Lawrence J and Lin Wau Long (1976) Micro-economics output supply and factor demand function in the agriculture of the province of Taiwan *American Journal of Agricultural Economics* **58** 333-340.