

Demand Projections for Foodgrains in India¹

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Abstract

Demand for foodgrains has been estimated for India for the years 2011-12, 2016-17 and 2021-22, by accounting for the factors like urbanization, regional variations in consumption pattern, shifts in dietary pattern and income distribution, limit on energy requirement and changes in tastes and preferences of consumers for food varieties. Indirect demand including 'home away demand' has also been considered in working out these food demand projections. Policy scenario has been presented and yield targets for the years 2011-12, 2016-17 and 2021-22 have been projected to meet the demand of foodgrains in these years.

Introduction

Sustained economic growth, increasing population and changing lifestyles are causing significant changes in Indian food basket, away from staple foodgrains towards high-value horticultural and animal products (Kumar *et al.*, 2007; Mittal, 2007). While per capita consumption of foodgrains has declined, their total consumption has increased due to increasing population. Also, changes in the dietary pattern towards animal products have led to an increased demand of foodgrains as feed. Nonetheless, foodgrains particularly rice and wheat, continue to be the main pillars of India's food security.

On the supply side, stimulated by the public investment in irrigation and rural infrastructure and rapid spread of high-yielding varieties of rice and wheat, together with improved crop production practices, India has achieved an impressive growth in foodgrain production. Per capita annual production of foodgrains increased from 183 kg during early-1970s to 207 kg by mid-1990s, even though country's population increased

more than 50 per cent during this period (Economics Survey, 2007). After mid-1990s, per capita foodgrain production started declining due to deceleration in the total factor productivity (TFP) growth (Kumar *et al.*, 2004; Kumar and Mittal, 2006). It is a matter of concern for Indian food-security. This changing scenario of consumption and production will have a significant influence on the demand and supply prospects of food. A number of studies have estimated future demand for foodgrains. These estimates, however, vary widely, depending on the assumptions and parameters (demand elasticities) used. Projections for foodgrains from a few selected studies are given in Annex Table 1.

This paper is an attempt to provide credible estimates of future demand for foodgrains (rice, wheat, coarse cereals and pulses) by estimating their demand at the disaggregated level, in terms of income, lifestyle and region, and the added-up estimates so obtained have been used to arrive at national level estimates.

Data and Methodology

We have used household level data from various rounds of consumption surveys conducted by the National Sample Survey Organization (NSSO). The latest available survey is for 2004-05 (61st round) for projecting future demand for foodgrains. Consumption patterns differ across income groups and lifestyles, and hence to capture their effects we have classified rural and urban households into 8 expenditure strata — 4

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Table 1. Expenditure elasticities of foodgrains

Item	Rice	Wheat	Coarse cereals	Pulses
Rural	0.064	-0.056	-0.151	0.309
Urban	0.016	-0.080	-0.165	0.214
Rural				
Very poor	0.183	-0.026	-0.173	0.611
Moderately poor	0.106	-0.055	-0.170	0.454
Non-poor lower income	0.035	-0.072	-0.153	0.310
Non-poor higher income	-0.018	-0.057	-0.097	0.121
All groups	0.064	-0.056	-0.151	0.309
Urban				
Very poor	0.148	0.005	-0.135	0.612
Moderately poor	0.078	-0.078	-0.213	0.442
Non-poor lower income	0.010	-0.125	-0.207	0.275
Non-poor higher income	-0.029	-0.101	-0.119	0.095
All groups	0.016	-0.080	-0.165	0.214

for rural and 4 for urban households, on the basis of the poverty lines adopted by the Planning Commission, Government of India. Consumption patterns also differ significantly across regions. For example, rice is the main staple food in the eastern, north-eastern and southern regions, while wheat is the main staple grains in the northern, northern-hills and western regions. Coarse cereals appear as important food in the western and southern regions. Thus, the food consumption patterns and demand parameters vary across regions, locations (rural, urban) and income groups (*see*, Alderman, 1986 for a review; Kumar, 1998). For estimating demand, household unit level data were grouped into two lifestyles (rural and urban), six regions (eastern, western, northern, southern, north-eastern, and northern-hills), and 4 expenditure (income) groups based on expenditure classes of NSS; households below 75 per cent of the poverty line have been defined as 'very poor', between 75 per cent and poverty line as 'moderately poor', between poverty line and up to 150 per cent above the poverty line as 'non-poor lower income', and above 150 per cent of the poverty line as 'non-poor higher income' class. Per capita expenditure has been considered as a proxy for income, and therefore these were used interchangeably in the study.

Demand Elasticities

Demand elasticities are important parameters for projecting future demand. However, the magnitude of demand elasticity of a commodity largely depends on the model chosen by the analyst. Food characteristic demand system (FCDS) (Bouis and Haddad, 1992), transcendental logarithmic demand system (TLDS), normalized quadratic demand system (NQDS), and linear expenditure demand system (LEDS) are among the models used for computing expenditure and price elasticities for food and non-food commodities (*see*, Kumar, 1998 for a comparison of models). Demand parameters from these models were compared, and the FCDS was selected as it derived the lowest income calorie elasticity of 0.12, followed by LEDS (0.42-0.46), NQDS (0.49-0.53) and TLDS (0.51-0.61). Demand elasticity varied widely across locations, income groups and regions due to changes in production environment and tastes and preferences.

National level estimates of demand elasticities based on FCDS are given in Table 1. Demand elasticities at the disaggregated level have not been presented in the paper due to limited space and are available with the corresponding author. The estimated demand elasticities are consistent with the long-term changes in per capita consumption of cereals, which has declined over time even among the poor households. These elasticities were used to project the demand for each sub-group and were then aggregated to arrive at the national level estimates. Many analysts do not take into account the regional and income distribution effects, absence of which can induce substantial bias in demand estimates.

Income growth is another important factor in demand projections. Growth rates in per capita income were obtained by subtracting population growth rate from economic growth and were used in predicting the per capita consumption. Estimated per capita consumption was multiplied by population, and aggregated by regions, income groups and lifestyles to obtain the total demand. The projected demand was thus given by Equation (1):

$$D_{ijkt} = d_{ijk0} \times N_{ijkt} (1+y \times e_{ijk})^t \quad \dots(1)$$

where, D_{ijkt} is the demand for a commodity for the subgroup of 'i' lifestyle (rural, urban), 'j' region (eastern, western, northern, southern regions of India), 'k' income group (very poor, moderately poor, non-poor lower and

non-poor higher income) in 't' period; d_{ijk0} is per capita consumption for 'i' lifestyle, 'j' region, 'k' income group in the base year (1987-88); N_{ijkt} is population in 't' year belonging to 'i' lifestyle, 'j' region, and 'k' income group; y is growth in per capita income; and e_{ijk} is the expenditure elasticity for the subgroup population belonging to 'i' lifestyle, 'j' region, and 'k' income group. D_t is the aggregate demand in year t, which is the sum up of i, j, k for D_{ijk} . D_t captures income and population distribution effects on consumption pattern. In the absence of these effects, the demand for a commodity can be predicted by using the simple formulation (2):

$$D_{*t} = d_0 \times N_t (1+y \times e)^t \quad \dots(2)$$

where, D_t is the household demand for a commodity in year t; d_0 is the per capita consumption of the commodity in base year, y is growth in per capita income; e is the expenditure elasticity of demand for the commodity; and N_t is the projected population in the year t. Equation (2) is commonly used in demand studies because it requires less information and parameters. However, it does not capture distributional effects of income and population. These effects can be substantial if the consumption behaviour across income groups is skewed and population shifts from low-income to high-income groups, which is natural in the process of economic development. Even the recent demand studies (e.g. by Chand, 2007; Mittal, 2007) have ignored the regional and income distribution effects and have considered only urbanization effects, which has added substantial bias in their projections. We have used Equation (1), which has taken into consideration these effects. Direct household (human) food demand projections have been based on both income and population growth (rural and urban).

Population Projections

According to the Registrar-General of Census, Government of India (2006), the total population of the country is likely to increase from 1079 million in 2004 to 1192 million in 2011, to 1269 million in 2016 and further to 1340 million in 2021 (Table 2). Population by region and income groups in rural and urban areas has been projected using sample population data from the 61st NSS round, and was used for demand projections.

Income Growth

Based on recent trends, it was assumed that the Indian economy would grow at an average rate of 9

Table 2. Base year and projected population

(million)			
Year	Rural	Urban	Total
2004	770.2	308.9	1079.1
2011	809.7	382.8	1192.5
2016	840.1	428.8	1268.9
2021	885.5	454.2	1339.7

Source: Government of India (2006)

per cent per year over the next 15 years. Netting out the population growth rates during different Five-Year Plans from the GDP, growth provides us a growth rate of 7.57 per cent in per capita income during the XIth Plan, 7.75 per cent during 2011-16 and 7.91 per cent during 2016-21. Rate of growth in per capita income of urban population is likely to be 3-times of the growth in per capita income of rural population (Table 3).

Table 3. Projected growth rates in income

(% per annum)			
Particulars	2004-11	2011-16	2016-21
Net national product at factor price	9.0	9.0	9.0
Per capita income			
Rural	3.46	3.52	3.58
Urban	11.81	12.01	12.19
All India	7.57	7.75	7.91

Demand for Foodgrains

Direct Demand as Food

The trends in per capita consumption of foodgrains for rural and urban consumers during 1983 to 2004-05 have been depicted in Table 4. Per capita consumption of foodgrains (as direct demand) in 2004-05 by region and income group separately for rural and urban population was used as baseline consumption for projecting the future per capita consumption. Cereal consumption has shown a decline in both rural and urban areas. The decline is sharper in the rural than urban areas. Per capita consumption of coarse cereals has shown much steeper decline than by rice and wheat. Per capita consumption of cereals has been projected to decline from 139.9 kg in 2004-05 to 125.3 kg in 2011-12 and 122.6 kg in 2021-22. Consumption of pulses is likely to be around 9.5 kg during the XIth Plan and would

Table 4. Trends in per capita consumption of foodgrains in India

(kg/year)

Commodity	Estimated based on NSS			Projected		
	1983	1993-94	2004-05	2011-12	2016-17	2021-22
Rural						
Rice	80.7	85.4	79.7	72.4	72.2	72.4
Wheat	54.3	53.5	52.2	47.9	49.0	48.1
Coarse cereals	45.1	24.3	15.5	14.9	14.7	14.5
Total cereals	180.1	163.3	147.4	135.2	135.9	135.1
Pulses	11.07	9.3	8.6	8.7	9.2	9.5
Foodgrains	191.1	172.5	156.0	143.9	145.1	144.6
Urban						
Rice	64.7	64.2	59.0	48.8	48.2	47.8
Wheat	58.6	57.4	56.5	51.2	49.8	46.6
Coarse cereals	14.1	7.7	4.4	4.4	3.9	3.6
Total cereals	137.5	129.3	119.9	104.4	101.9	98.0
Pulses	12.40	10.5	10.4	11.0	12.3	13.5
Foodgrains	149.9	139.8	130.3	115.4	114.2	111.6
Rural + Urban						
Rice	76.9	79.9	73.8	64.8	64.1	64.1
Wheat	55.3	54.6	53.5	49.0	49.2	47.6
Coarse cereals	37.8	19.8	12.6	11.5	11.0	10.8
Total cereals	169.9	154.2	139.9	125.3	124.4	122.6
Pulses	11.7	9.6	9.0	9.5	10.2	10.9
Foodgrains	181.6	163.8	148.8	134.8	134.6	133.4

Table 5. Total demand for foodgrains as household food: 2004-05 to 2021-22

(million tonnes)

Commodity	2004-05	2011-12	2016-17	2021-22
Rice	79.5	87.4	92.0	97.4
Wheat	57.7	67.2	71.9	73.5
Coarse cereals	13.4	14.2	14.5	15.1
Total cereals	150.7	168.7	178.2	185.8
Pulses	9.8	12.5	14.3	16.1
Foodgrains	160.5	181.2	192.6	202.0

increase only marginally afterwards. By multiplying the projected per capita consumption with projected population, we arrived at the direct household demand for foodgrains as 181.2 million tonnes (Mt) towards the end of XIth Plan (Table 5), with a grain mix of 87.4 Mt rice, 67.2 Mt wheat, 14.2 Mt coarse grains, and 12.5 Mt pulses. The direct household demand for foodgrains would increase to 202 Mt by 2021-22,

comprising 97.4 Mt of rice; 73.5 Mt of wheat; 15.1 Mt of coarse grains and 16.1 Mt of pulses.

Indirect Demand for Foodgrains

Besides direct demand, there is also an important component of total demand which includes seed, feed, industrial uses and wastage, and has been termed as 'indirect demand'. Conventionally, the indirect demand is assumed to be 12.5 per cent of the total foodgrain production — an assumption being used since 1950s for all official estimates. Recently, Kumar *et al.* (2007) have computed the shares of seed, feed, wastage and other food uses as 9.5 per cent of the total production of rice, 13.5 per cent of wheat, 41 per cent of coarse cereals, and 10.8 per cent of pulses. These parameters were used in the present study, and the seed, feed, industrial use and wastage allowances have been projected as 36.9 Mt in 2011-12; 39.0 Mt in 2016-17 and 41.1 Mt in 2021-22, which constitute about 16 per cent of the total foodgrains production in the country (Table 6).

Table 6. Projected demand for foodgrains in India
(million tonnes)

Commodities	2004-05	2011-12	2016-17	2021-22
Direct household demand for foodgrains				
Rice	79.5	87.4	92.0	97.4
Wheat	57.7	67.2	71.9	73.5
Coarse cereals	13.4	14.2	14.5	15.1
Cereals	150.7	168.7	178.2	185.8
Pulses	9.8	12.5	14.3	16.1
Foodgrains	160.5	181.2	192.6	202.0
Indirect demand				
Seed, feed & wastage and other uses				
Rice	8.3	9.4	10.2	11.0
Wheat	9.4	10.6	11.5	12.3
Coarse cereals	13.9	14.5	14.8	15.1
Cereals	31.7	34.5	36.5	38.5
Pulses	2.3	2.4	2.5	2.6
Foodgrains	34.0	36.9	39.0	41.1
Home away demand of foodgrains				
Rice	4.0	4.4	4.6	4.9
Wheat	2.9	3.4	3.6	3.7
Coarse cereals	0.7	0.7	0.7	0.8
Cereals	7.5	8.4	8.9	9.3
Pulses	0.5	0.6	0.7	0.8
Foodgrains	8.0	9.1	9.6	10.1
Total indirect foodgrain demand				
Rice	12.3	13.8	14.8	15.9
Wheat	12.3	14.0	15.1	16.0
Coarse cereals	14.6	15.2	15.5	15.9
Cereals	39.3	42.9	45.4	47.8
Pulses	2.7	3.0	3.2	3.4
Foodgrains	42.0	46.0	48.6	51.2
Total domestic demand for foodgrain				
Rice	91.9	101.1	106.8	113.3
Wheat	70.0	81.1	86.9	89.5
Coarse cereals	28.0	29.4	30.1	31.0
Cereals	190.0	211.6	223.6	233.6
Pulses	12.6	15.5	17.5	19.5
Foodgrains	202.5	227.1	241.2	253.2

Note: Assumption: Seed, feed, wastage and industrial uses were taken as 9.50 per cent of rice, 13.48 per cent of wheat, 41 per cent of coarse cereals and 16.85 per cent of pulses production (Kumar *et al.*, 2007). Home away demand was assumed to be 5 per cent share in total household demand for rice, wheat, coarse cereals and pulses.

Sustained rise in per capita income, fast-growing urban population and increasing employment opportunities for urban women are causing significant rises in 'home away demand' for foodgrains. Though there are no authentic estimates available for 'home away demand', based on some guessestimates we have assumed 5 per cent of the total direct demand as 'home away demand'. The 'home away demand' for foodgrains has been estimated to be 9.1 Mt in 2011-12 and 10.1 Mt in 2021-22 (Table 6). Thus, the total indirect demand for foodgrains, including home-away demand is expected to be around 46 Mt by the end of XIth FYP and 51.2 Mt by the end of XIIIth FYP. The indirect demand thus constitutes about 21 per cent of the total production which seems quite a credible estimate. According to Chand (2007), the indirect demand for foodgrains would be around 64 Mt in 2011-12 and 101 Mt in 2020-21, which seems to be on a higher side, leading to an overestimation of total foodgrain demand, i.e. around 235 Mt by the end of XIth Plan and 281 Mt by the end of XIIIth Plan, inspite of a lower estimate of direct household demand by 8.5 Mt as compared to our estimates.

Total Domestic Demand for Foodgrains

The total demand for foodgrains has been projected to be 227.1 Mt in the terminal year of the XIth FYP, and it would rise to 241.2 Mt by the end of XIIth Plan and to 253.2 Mt by the end of XIIIth Plan (Table 6). In 2011-12, the demand for foodgrain has been projected to be 101.1 Mt for rice, 81.1 Mt for wheat, 29.4 Mt for coarse cereals, and 15.5 Mt for pulses. Total cereal demand is likely to be 211.6 Mt. The year-wise projections for 2008-09, 2009-10 and 2010-11 have been shown in Table 7. A perusal of Table 7 reveals that in 2008-09, the demand of foodgrains would be of 216.1 Mt, comprising 97.1 Mt of rice, 76.2 Mt of wheat, 28.8 Mt of coarse cereals, and 14.2 Mt of pulses (Table 7).

Table 7. Year-wise demand projections for foodgrains in India : 2008-09 to 2010-11

(million tonnes)			
Commodities	2008-09	2009-10	2010-11
Rice	97.1	98.4	99.8
Wheat	76.2	77.8	79.4
Coarse cereals	28.8	29.0	29.2
Cereals	202.1	205.2	208.4
Pulses	14.2	14.6	15.0
Foodgrains	216.2	219.8	223.5

Table 8. Yield target projections for the years 2011-12, 2016-17 and 2021-22

Commodities	Base year TE 2005-06		Required yield level (kg/ha)		
	Area (Mha)	Yield (kg/ha)	2011-12	2016-17	2021-22
Rice	42.7	2056	2368	2500	2651
Wheat	26.5	2645	3063	3282	3380
Coarse cereals	29.6	1183	993	1015	1046
Cereals	98.8	1952	2141	2262	2364
Pulses	22.9	604	677	765	853
Foodgrains	121.7	1698	1866	1981	2080
Increment required to meet future demand					
Rice	42.7	2056	15.2	21.6	29.0
Wheat	26.5	2645	15.8	24.1	27.8
Pulses	22.9	604	12.1	26.8	41.2

Policy Scenario to Meet Future Demand

Given the recent trends in production, meeting future demand for foodgrains through domestic production alone appears to be difficult, but not impossible. The incremental demand and thereby production has essentially to come from productivity improvements as the potential for area expansion, by and large, has exhausted. Besides, increasing demand for high-value food commodities like fruits and vegetables, is likely to cause a shift in area from staple food crops. Also, agricultural lands are being increasingly diverted towards non-agricultural uses. To meet the future demand, the required levels of yield targets were estimated for the years 2011, 2016 and 2022 and have been presented in Table 8.

To meet the foodgrain demand in 2011-12, the yields of different commodities must be raised to a minimum of 2.37 t/ha for rice, 3.07 t/ha for wheat, and 0.68 t/ha for pulses. By 2021-22, yields must further be improved to 2.65 t/ha for rice, 3.38 t/ha for wheat and 0.85 t/ha for pulses. In terms of percentage increase, by 2011-12 the average yield of rice and wheat must increase by 15-16 per cent, and of pulses by 12 per cent. By 2021-22, further improvements are required in yields of rice and wheat by 28-29 per cent, and of pulses by 41 per cent. Improving yield levels would require serious efforts to sustain and improve the total factor productivity through research and development efforts.

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Annex Table 1: Projected food demand for India by different studies

							(in million tonnes)
Source	Year	Rice	Wheat	Total cereals	Pulses	Foodgrains	
P.C. Bansil (1996)	2020					241.4	
Surabhi Mittal (2006)	2010			175.5	18.8	194.3	
	2020			215.7	27.2	243.9	
Ramesh Chand (2007)	2011			218.9	16.1	235.0	
	2021			261.5	19.1	280.6	
Rosegrant <i>et al.</i> (1995)	2020	-	-	237.3	-		
Kumar <i>et al.</i> (2007)	2015	98.1	74.7	210.2	17.8	228.0	
	2025	106.6	79.9	226.1	20.2	246.3	
Govt. of India, Planning Commission (2006)	2011			224.0	20.0	244.0	
Kumar <i>et al.</i> (Present study)	2011	101.1	81.1	211.6	15.5	227.1	
	2016	106.8	86.9	223.6	17.5	241.2	
	2021	113.3	89.5	233.6	19.5	253.2	