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Consumption Pattern and Nutritional Intake of Pulses by Segregated Income Groups in India

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Abstract

The changes in consumption pattern of different pulses and consequently in nutrient intake arising due to price and income changes at household level have been analysed using the consumer expenditure survey data for the year 2011-12. The share of expenditure on red gram in the total food expenditure has been found higher as compared to other pulses, irrespective of the income levels of households. The consumption of most of pulses has been observed more responsive to changes in the income of all the income households. Income elasticity for most of the pulse commodities were positive. The price elasticities for most pulses have been observed to be high, indicating high responsiveness to small changes in their own prices. Strong substitutability has been observed between red gram with masur and peas; green gram with masur and peas in low-income households, and between red gram and peas; and green gram and peas in middle-income households. The intake of protein and energy through the consumption of pulses has been found lower in middle and high income households vis-à-vis low-income households. In the case of income elasticity of nutrients, all nutrients were income elastic. The study has concluded that an increase in prices of pulses would result in reduced intake of both protein and fat in low, middle and high income households. Therefore, there is a need to increase the production and availability of pulses by adopting innovative measures to ensure food and nutritional security in the country.

Key words: Pulses, prices, nutrients, consumption pattern, nutritional security, income levels

JEL Classification: Q1, Q11, E21, I12

Introduction

Pulses constitute an important food category for humans and are typically incorporated in various forms into most traditional diets around the globe. India is the largest producer (26%), consumer (nearly one-third) and importer of pulses in the world (FAO, 2014). During 2014-15, pulses were grown in an area of 25.23 million hectares with a total production of 17.38 million tonnes and consumption of 22.68 million tonnes. The gap between the demand and supply is met mainly through the import of pulses. The total import during 2014-15 was of 4.58 million tonnes (Ministry of Agriculture, 2014-15). The share of area under pulses in the country's gross cropped area was 13.28 per cent during 1990-91 which decreased to 12 per cent in 2013-14. The net per capita per day availability of pulses decreased from 61 grams in 1951 to 47 grams in 2014. Pulses make important contributions in terms of protein and energy provision to populations in the developing world. As a food group, pulses have several appealing attributes; high nutritional value, long preservation period outside the cold chain, high dietary fibre content and low lipid content besides presence of various biologically active compounds (Dilis and Trichopoulou, 2009). Pulses have high contents of protein (20-25%), carbohydrates (55-60%), calcium and iron.

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Nearly, 43 per cent of Indian population is vegetarian; pulses constitute an important source of protein in their diet. The composition of the food basket in India has become slightly skewed towards cereals (29%) in 2013-14, with protein share going down to 31 per cent compared to a cereal-protein mix of 24: 34 per cent in the period 2007-2012. Indians still consume more cereals but protein intake has not grown significantly. The primary reasons being growth in pulse production has stagnated and the area under pulses has remained at 22-25 million hectare level for the past 40 years. Lack of new varieties, poor innovations in processing and marketing, and the resource constraints of pulses farmers are the major obstacles both in terms of improving yields and providing nutritional gains to the population at large (Shukla, 2015). Increasing the supply of protein-rich pulses and the consequent lowering of their prices will help in achieving a balanced and protein rich diet for Indian families in rural as well as urban India. The greater involvement of private sector in processing and developing value-added protein products will enhance protein intake among the Indian households.

Over the years, due to expanding urbanization and sedentary lifestyle, there has been an increase in diet of fat and sugars and a reduction in intake of carbohydrate, dietary fibres and essential micro nutrients (Popkin, 2009). Similarly, Deaton *et al*. (2009) has indicated a sustained decline in the percapita consumption of energy, protein and other nutrients but it was not applicable to fat consumption which has increased steadily during this period. These changes in the food consumption pattern in India are due to the demographic and socioeconomic changes, which include a rise in income, changes in relative prices of commodities, dietary changes, emerging middle income class, increasing numbers of working women, changes in lifestyles, fast urbanization, improvements in transportation and storage facilities, rise of supermarkets and rising importance of single person households. The most significant strategy of households is the substitution of low-price food commodities to high-price commodities with high nutritional content. However, this strategy in most cases is inefficient to maintain a healthy diet. It is in this context,that an attempt has made in this paper to estimate the elasticities of demand for different pulses and nutrient elasticity at low, middle and high income-households in India.

Data

The data collected by the NSSO for the 68th round (2011-2012) have been used for estimating the demand elasticity. For analysis the chosen pulses are: red gram, bengal gram, green gram, masur, black gram, and peas. The quantities of nutrient and calorie intake by the household was calculated by multiplying the total consumption of a particular pulse commodity with conversion factors given by Gopalan *et al*. (1996). This procedure has been used by NSSO in arriving at the calories consumed. In this paper, price response of demand is obtained on the basis of unit values. The unit price of a particular food commodity was derived by dividing the value of the food item by total quantity consumed by a particular respondent households in a region. Price for the food item which was not consumed by the respondents in a region was given the average price of the corresponding region. The use of a unit value price of a food item has been thoroughly examined by Deaton (1997) and more recently by Kedir (2005).

We used state-wise poverty line to classify the entire sample size as low, middle and high income classes. For this, poverty estimates, released by the Planning Commission, Government of India for 2004-05 and 2011-12 were used for each individual state. Accordingly, the 'low' income class comprised households who have income level below the poverty line (BPL), between BPL and up to 150 per cent of BPL was grouped as 'middle income' and households having per capita income above 150 per cent of BPL were categorized as 'high income' group.

Model Specification

The Almost Ideal Demand System (AIDS) is a popular method of estimating consumer demand systems and its upgraded versions such as Linear Approximate AIDS (LA/AIDS) and Quadratic AIDS (QUAIDS) models prevail predominately in the literature. This study has used QUAIDS as it allows non-linear Engel curves (Banks *et al*., 1997) and tests the restriction of homogeneity and symmetry through restriction of fixed parameters (Deaton and Muellbauer 1980). Since there is a chance to have zero expenditure on some of the commodities, we have followed the two-step estimation procedure given by Shonkwiler and Yen (1999) to estimate the elasticities of income and price. Accordingly, in the first stage, a probit function was used to capture the choices of income allocation to different kinds of pulse commodities that were available to households. In the second stage, the level of allocation of total food expenditure across different pulse groups was captured by using the QUAIDS demand model.

Estimation Procedure

In first step, the total food expenditure function was regressed on its determinants and a residual error term was obtained to solve the endogeneity problem of total pulse expenditure variable in the estimation of the QUAIDS model. The exact form of the function is given by Equation (1):

$$\ln x_h = \theta_0 + \sum_j \theta_{ij} \ln p_j + \theta_1 HHS_h + \theta_2 RSE_h + \theta_3 R_h + \theta_4 S_h + \theta_5 OWL_h + + \theta_6 Age_h + \theta_7 V_h + \theta_8 DU_h + \theta_9 MPE_h + \mu_i \quad \ldots(1)$$

The second step involved estimating a probit regression function to estimate the probability of consumption of a particular food commodity and the function is expressed by Equation (2):

$$d_{ih} = \theta_0 + \sum_j \theta_{ij} \ln p_j + \theta_x \ln x_h + \theta_1 HHS_h + \theta_2 RSE_h + \theta_3 R_h + \theta_4 S_h + \theta_5 OWL_h + \theta_6 Age_h + \theta_7 V_h + \theta_8 DU_h + \theta_9 MPE_h + \mu_i \quad \ldots(2)$$

where, d_{ih} = 1 if the h[th] household consumes i^{th} food commodity and 0 if the household does not. ln p_j' are the prices of seven pulses, and x_h is the total household consumption expenditure on food commodities. The variables HHS, RSE, R, S, OWL, V, DU and MPE represent household size, regular salary earners, location of households (rural/urban), gender of household-head, presence of vehicle, presence of dwelling unit and monthly per capita expenditure, respectively. The third step involved in estimation of the QUAIDS was in the form of Equation (3):

$$w_{ih} = \Phi(\hat{z}_{ih}\hat{\theta}_i)\left\{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{x_h}{a(p)}\right] + \frac{\lambda_i}{b(p)} \cdot \left\{\ln\left[\frac{x_h}{a(p)}\right]\right\}^2 + \tau_i \hat{e}_h\right\} + \delta_i \phi(z'_{ih}\hat{\theta}_i) + \xi_{ih} \quad \ldots(3)$$

where, $w_{ih} = \frac{p_{in}q_{in}}{x}$ = the i[th] pulses, expenditure share for consumer h; p_i = the price of pulse i; q_i = quantity of pulse i; x= total pulse expenditure; $\hat{e}_h$ is the residual of the total food expenditure regression; and $\Phi(\hat{z}_{ih}\hat{\theta}_i)$ and $\delta_i \phi(z'_{ih}\hat{\theta}_i)$ were obtained from the first-stage probit regression. The parameters of the QUAIDS model were estimated using Poi's Stata routine (Poi, 2008). Adjustments were made in the original routine to include additional control variables in order to capture endogeneity and selectivity problems as appropriate.

The following restrictions are econometrically imposed on the parameters of the QUAIDS equation system (3):

$$\sum_{i=1}^{n} \alpha_i = 1; \sum_{i=1,j=1}^{n} \gamma_{ij} = 0; \sum_{i=1}^{n} \beta_j = 0; \sum_i \lambda_i = 0 \quad \ldots(4)$$

$$\sum_j \gamma_{ij} = 0 \quad \ldots(5)$$

$$\gamma_{ij} = \gamma_{ji} \quad \ldots(6)$$

The equalities in (4) are the adding-up restrictions. They express the property that the sum of the budget shares equals 1 (i.e. Σw_{ih} = 1). The restriction in Equation (5) expresses the prediction that the demand functions are homogenous of degree zero in prices and income. Satisfaction of the restriction in Equation (6) ensures that Slutsky symmetry would hold true.

Estimation of Elasticities

Using the method adopted by Green and Alston (1991) and Hayes *et al.* (1990), the expenditure elasticity was estimated as per Equation (7):

$$\varepsilon_{i,x} = \frac{x}{q_i}\frac{\partial q_i}{\partial x} = \frac{1}{w_i}\left\{\beta_i + \frac{2\lambda_i}{b(p)} \ln x - lxa(p)\right\} + 1 \quad \ldots(7)$$

The uncompensated own price and the cross price elasticities were estimated using Equations (8) and (9), respectively:

$$\varepsilon_{i,p} = \frac{1}{w_i}\left\{\gamma_{ii} - \left\langle\left(\alpha_i + \sum_{k=1}^{n} \gamma_{kj} \ln p_k\right)\left[\beta_i + \frac{2\lambda_i}{b(p)}(\ln x - \ln a(p))\right] + \frac{\beta_i}{b(p)} \lambda_i [\ln x - \ln a(p)]^2\right\rangle\right\} - 1 \quad \ldots(8)$$

$$\varepsilon_{i,p_j} = \frac{1}{w_i}\frac{p_i}{p_j}\left\{\gamma_{ii} - \left\langle\left(\alpha_i + \sum_{k=1}^{n}\gamma_{kj}\ln p_k\right)\left[\beta_i + \frac{2\lambda_i}{b(p)}(\ln x - \ln a(p))\right] + \right.\right.$$

$$\left.\left. + \frac{\beta_i}{b(p)}\lambda_i\left[\ln x - \ln a(p)\right]^2\right\rangle\right\} \quad ...(9)$$

The standard-error of the elasticities was calculated by using the Delta method (Oehlert, 1992), which allows us to obtain the appropriate standard errors of any smooth function of the fitted model. The QUAIDS model analyses were accomplished using the statistical software, *Stata 13.1* version.

In order to estimate income elasticity, Engel curve analysis was conducted and elasticity was estimated (Chern, 2000). The quadratic form of the Engel function is expressed as:

$$\ln fx_h = \alpha_0 + \alpha_1 \ln x_h + \alpha_2(\ln x)^2 + \beta \ln P + \sum_k \gamma_k HHS_k + \upsilon \quad ...(10)$$

where, x is expenditure on food and non-food consumer goods and services, υ is random disturbances assumed with zero mean and constant variance, and *P* is Laspeyres price index for the aggregate food that can be defined by:

$$\ln(P) = \sum_i \overline{w_i}\ln(P_i) \quad ...(11)$$

The quadratic form of Engel function is also useful to validate whether the QUAIDS model can be properly applied to pulse demand analysis. Following Deaton and Muellbauer (1980), Equation (10) was estimated via ordinary least squares (OLS).

Blundell *et al*. (1993) indicated that the responsiveness of expenditure on aggregate food by income change in Equation (10) can be computed as,

$$e_y = \alpha_1 + 2\alpha_2 \ln x \quad ...(12)$$

Based on the formulae of Chern (2000), the income elasticities of demand for aggregate food from Equations (10) and (12) are useful to convert the expenditure elasticities from QUAIDS to income elasticities for the pulse commodities. Income elasticity on the basis of QUAIDS model is computed as under:

$$\eta_i = e_y * \varepsilon_{i,x} \quad ...(13)$$

Estimating Nutrient Elasticity

The technique used by Huang (1996) and Akinleye (2007) was adopted to explore the linkage of demand model to nutrient intake. The equation representing the consumption of the household is given by (14):

$$\Phi_k = \sum_i d_i\, q_i \quad ...(14)$$

where, d_i is the amount of k^{th} nutrient in one gram of the i^{th} pulse, Φ_k is the total amount of that nutrient from various pulses, and q_i is the quantity of the i^{th} pulse consumed

The values of d_i's for non-pulses were assigned zero. Thus, the terms associated with non-pulse disappeared. Equation (14) provides the transformation of demand for pulses into nutrient intake. By substituting a demand equation for the quantitative variable (q_i) in Equation (14), we obtained the change in consumer nutrient intake using Equation (15):

$$d\Phi_k = \sum_i d_{ki}\left[\sum_j\left(\delta_{qi}/\delta_{pi}\right)dp_i + \left(\delta_{qi}/\delta_m\right)dm\right] \quad ...(15)$$

The relative change in consumer nutrient availability was expressed as a function of the relative change in food prices and per capita income as indicated below:

$$\frac{d\Phi_k}{d\Phi} = \sum_j\left(\frac{\sum_i e_{ij}d_i q_i}{\Phi k}\right)dp_j p_j + \frac{\left(\frac{\sum_i \eta_i d_i q_i}{\Phi k}\right)dm}{m}$$

$$= \frac{\sum_j \Pi_{kj}\mathrm{dp_j}}{p_j} + \rho_k dm/m \quad ...(16)$$

where, $\Pi_{kj} = \Sigma_i\, e_{ij}\, d_i q_i / \Phi_k$ is a price elasticity measure relating the effect of the j^{th} pulse price on intake of the k^{th} nutrient, and ρ_k represents the effect of income on intake of that nutrient. This measurement (Π_{kj}) represents the weighted average of all own and cross price elasticities (e_{ij}'s) in response to the j^{th} price with each weight expressed as the share of each food's contribution to the k^{th} nutrient ($d_i q_i / \Phi_k$'s). Similarly, the measurement of ρ_k represents the weighted average of all income elasticities (η_i's) with each weight again expressed as the share of each food's contribution to the k^{th} nutrient. Thus, the general calculation of nutrient elasticity matrix, say N, for the case of – *l* nutrients and n foods can be obtained as a product of S by D as represented in Equation (17):

$$N = S * D \qquad \ldots(17)$$

where, N is the $l \times (n+1)$ matrix of nutrient elasticities in response to changes of pulse prices and income, S is the $(l \times n)$ matrix with entries of each row indicating a pulses share of a particular nutrient, and D is the $n \times (n + 1)$ matrix of demand elasticities.

Results and Discussion

Share of Nutrients of Different Pulses in Household Consumption

The quantity of pulses consumed determines the quantity of intake of different nutrients by the households. It is estimated that high-income households obtained 198.63 grams of protein in a month through consumption of pulses and pulse products (Table 1). It was higher as compared to the middle (143.92 grams) and low income (108.20 grams) households. Likewise, the intake of fat and energy through consumption of pulses was higher by high-income households than the middle- and low-income households. Red gram was the most important source of protein and energy for all income categories of households contributing more than 25 per cent of the total protein consumption through pulses. After red gram, masur and peas were the major sources of protein for low-income households. In the case of middle and high income households, green gram, masur and black gram contributed to total protein intake, after red gram.

Expenditure, Price and Cross Price Elasticity of Demand

Low-income Households

The estimated expenditure, price and cross price elasticity of demand for various pulses and their expenditure proportion in the total pulses expenditure at low, middle and high income households are presented in Tables 2, 3 and 4, respectively. In low

Table 1. Share of nutrients in different pulses in low, middle and high income households in India

(grams/kg)

Nutrients	Red gram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses	Total nutrients
				Low-income households				
Protein	32.91	3.93	10.12	26.37	12.34	17.24	5.3	108.20
	(30.42)	(3.63)	(9.35)	(24.37)	(11.40)	(15.93)	(4.90)	(100.00)
Fat	2.51	1.06	0.5	0.74	0.72	0.96	0.29	6.77
	(37.06)	(15.63)	(7.33)	(10.86)	(10.63)	(14.22)	(4.27)	(100.00)
Energy	494.37	70.3	143.73	360.31	178.35	275.62	81.89	1604.57
	(30.80)	(4.38)	(8.96)	(22.46)	(11.12)	(17.18)	(5.10)	(100.00)
				Middle-income households				
Protein	51.83	7.72	23.08	27.59	19.4	7.71	6.6	143.92
	(36.00)	(5.36)	(16.04)	(19.17)	(13.48)	(5.36)	(4.59)	(100.00)
Fat	3.95	2.08	1.13	0.77	1.13	0.43	0.36	9.85
	(40.10)	(21.12)	(11.47)	(7.82)	(11.47)	(4.37)	(3.65)	(100.00)
Energy	778.54	138.09	327.82	377.01	280.42	123.23	102.05	2127.17
	(36.60)	(6.49)	(15.41)	(17.72)	(13.18)	(5.79)	(4.81)	(100.00)
				High-income households				
Protein	72.2	14.78	37.8	24.49	33.07	4.65	11.63	198.63
	(36.35)	(7.44)	(19.03)	(12.33)	(16.65)	(2.34)	(5.86)	(100.00)
Fat	5.5	3.98	1.85	0.68	1.93	0.26	0.63	14.84
	(37.09)	(26.81)	(12.48)	(4.60)	(13.00)	(1.75)	(4.27)	(100.00)
Energy	1084.64	264.35	536.94	334.73	478.2	74.37	179.73	2952.97
	(36.73)	(8.95)	(18.18)	(11.34)	(16.19)	(2.52)	(6.09)	(100.00)

Note: The figures within brackets denote per cent share in total nutrients consumed through pulses

Table 2. Price elasticity, cross price elasticity, expenditure elasticity, income elasticity and expenditure share of pulses in low-income households in India

Pulses	Red gram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses	Expenditure elasticity	Income elasticity	Expenditure share
Red gram	-1.838*** (-0.166)	0.212*** (-0.057)	-0.159 (-0.201)	1.137*** (-0.313)	-0.471** (-0.195)	2.684*** (-0.768)	0.637** (-0.305)	2.591*** (-0.119)	4.100*** (-0.195)	31.65
Bengal gram	0.857*** (-0.098)	-1.100*** (-0.068)	-0.565*** (-0.154)	-0.23 (-0.157)	0.126 (-0.154)	-0.697 (-0.534)	-1.861*** (-0.216)	1.052*** (-0.071)	1.663*** (-0.079)	10.13
Green gram	-0.469*** (-0.083)	-0.003 (-0.05)	-2.860*** (-0.256)	1.081*** (-0.183)	0.584*** (-0.143)	3.562*** (-0.566)	1.143*** (-0.227)	-0.741*** (-0.195)	-1.173*** (-0.056)	9.17
Masur	-0.101 (-0.147)	0.04 (-0.056)	1.576*** (-0.196)	-0.43 (-0.341)	-0.019 (-0.182)	-4.408*** (-0.881)	-2.212*** (-0.258)	-0.141 (-0.231)	-0.223*** (-0.011)	18.63
Black gram	-0.577*** (-0.072)	0.118** (-0.053)	0.771*** (-0.148)	-0.024 (-0.169)	-1.115*** (-0.224)	-3.653*** (-0.528)	2.244*** (-0.224)	0.249 (-0.19)	0.394*** (-0.019)	9.38
Peas	0.026 (-0.097)	-0.218*** (-0.051)	1.433*** (-0.133)	-0.383* (-0.218)	-0.553*** (-0.134)	-5.404*** (-0.997)	1.570*** (-0.217)	7.227*** (-1.077)	11.436*** (-0.544)	9.30
Other pulses	-0.560*** (-0.093)	-0.192*** (-0.039)	0.991*** (-0.166)	-1.449*** (-0.164)	1.300*** (-0.16)	0.51 (-0.424)	1.035** (-0.412)	-2.741*** (-0.379)	-4.336*** (-0.206)	11.74

Note :***,** and * indicate the significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Table 3. Price elasticity cross price elasticity, expendituture elasticity, income elasticity and expenditure share of pulses in middle-income households in India

Pulses	Red gram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses	Expenditure elasticity	Income elasticity	Expenditure share
Red gram	-0.668*** (-0.082)	0.271*** (-0.044)	-0.265** (-0.11)	0.198 (-0.159)	-0.972*** (-0.092)	1.258* (-0.718)	-0.405*** (-0.152)	1.005*** (-0.01)	1.133*** (-0.065)	33.52
Bengal gram	0.434*** (-0.075)	-1.353*** (-0.05)	-0.980*** (-0.097)	-1.510*** (-0.167)	0.550*** (-0.119)	2.613*** (-0.476)	2.084*** (-0.213)	1.273*** (-0.037)	1.434*** (-0.083)	12.03
Green gram	-0.098* (-0.059)	-0.04 (-0.04)	-2.203*** (-0.139)	2.408*** (-0.152)	0.058 (-0.07)	1.951*** (-0.434)	-1.317*** (-0.167)	1.157*** (-0.041)	1.304*** (-0.075)	14.24
Masur	0.150** (-0.068)	-0.001 (-0.05)	1.967*** (-0.123)	-0.588** (-0.234)	-0.521*** (-0.098)	-3.582*** (-0.539)	-3.050*** (-0.183)	1.263*** (-0.068)	1.424*** (-0.082)	13.66
Black gram	-0.568*** (-0.054)	0.134*** (-0.036)	0.025 (-0.073)	-0.731*** (-0.126)	-1.043*** (-0.105)	-1.063** (-0.43)	2.907*** (-0.167)	0.969*** (-0.021)	1.092*** (-0.063)	10.78
Peas	0.065 (-0.053)	-0.178*** (-0.041)	0.206*** (-0.064)	-0.706*** (-0.103)	-0.149*** (-0.057)	-1.929*** (-0.718)	1.480*** (-0.181)	0.168 (-0.284)	0.189*** (-0.011)	2.91
Other pulses	-0.334*** (-0.065)	-0.177*** (-0.035)	0.084 -0.079)	-0.751*** (-0.165)	1.315*** (-0.114)	0.377 (-0.303)	-0.735*** (-0.177)	-0.417*** (-0.141)	-0.470*** (-0.027)	12.86

*Note:****,** and * indicate the significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Table 4. Price elasticity, cross price elasticity, expenditure elasticity, income elasticity and expenditure share of pulses in high-income households in India

Pulses	Red gram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses	Expenditure Elasticity	Income Elasticity	Expenditure share
Red gram	0.057	-0.369***	-0.452**	-0.601	-0.769***	0.245	0.173	1.311***	1.546***	31.96
	(-0.145)	(-0.09)	(-0.18)	(-0.409)	(-0.151)	(-0.666)	(-0.272)	(-0.072)	(-0.08)	
Bengal gram	0.209**	-1.170***	-0.930***	-1.387***	0.597***	0.879	1.446***	1.274***	1.503***	13.56
	(-0.091)	(-0.096)	(-0.148)	(-0.389)	(-0.128)	(-0.546)	(-0.32)	(-0.095)	(-0.078)	
Green gram	-0.438***	-0.083	-0.901***	3.123***	-0.273**	3.678***	-1.802***	0.383***	0.452***	16.16
	(-0.091)	(-0.086)	(-0.201)	(-0.369)	(-0.117)	(-0.728)	(-0.245)	(-0.116)	(-0.024)	
Masur	-0.607***	0.449***	1.783***	1.225**	-0.841***	-3.708***	-2.063***	-1.385***	-1.633***	8.49
	(-0.111)	(-0.102)	(-0.215)	(-0.551)	(-0.156)	(-0.792)	(-0.339)	(-0.38)	(-0.085)	
Black gram	-0.414***	-0.03	-0.135	-1.037***	-0.533***	-0.484	2.186***	1.430***	1.686***	13.22
	(-0.085)	(-0.083)	(-0.138)	(-0.324)	(-0.153)	(-0.58)	(-0.285)	(-0.111)	(-0.088)	
Peas	-0.044	0.039	0.670***	-0.598***	-0.140*	-0.665	-0.404***	0.886*	1.045***	1.42
	(-0.059)	(-0.055)	(-0.11)	(-0.198)	(-0.078)	(-0.585)	(-0.139)	(-0.519)	(-0.054)	
Other pulses	-0.193**	-0.052	-0.315***	0.444*	0.629***	-0.943*	-1.089***	1.613***	1.903***	15.19
	(-0.085)	(-0.06)	(-0.098)	(-0.234)	(-0.107)	(-0.557)	(-0.266)	(-0.303)	(-0.099)	

Note:***,** and * indicatethe significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

income households, the expenditure share was highest for red gram (31.65%) followed by masur (18.63%) and bengal gram (10.13%). The expenditure elasticity for all pulses was positive and significant. It was more than one for red gram (2.59), bengal gram (1.05) and peas (7.22) indicating that consumption of these pulses were more responsive to small changes in the income of the low-income households, whereas, expenditure elasticity was less than one (inelastic) for green gram (-0.74), masur (-0.14), and black gram (0.24), implying that proportionate changes in the quantity consumption of these commodities was less than the proportionate changes in the income of households. Income elasticity for most of the pulse commodities were positive and more than one, whereas, it was negative for green gram, masur and other pulses.

The values for own price elasticity of demand for red gram, bengal gram, green gram black gram and peas were highly elastic, indicating that these commodities were more responsive to small changes in their own price. The majority of the cross price elasticities were statistically non-significant. Strong substitutability was observed between red gram and masur; red gram and peas; green gram and masur; and green gram and peas in low-income households.

Middle-income Households

As seen in low-income households, the middle-income households also spent a larger proportion of their total pulse expenditure on red gram, followed by green gram, masur and bengal gram (Table 3). Expenditure elasticity was found to be more than one for red gram (1.01), bengal gram (1.27), green gram (1.15), and masur (1.26). The expenditure elasticity was less than one (inelastic) for black gram (0.96) and peas (0.16), implying that expenditure on these pulses would change less than proportionately with increase in income. These pulses are seen as the necessities in the dietary pattern of middle-income households. Income elasticity of all pulses were positive and highly elastic, except for peas and other pulses.

The values for own price elasticity were observed to be negative and significant for red gram, bengal gram, green gram, masur, black gram, and peas, indicating high responsiveness of these pulses to small changes in their price (Table 3). The cross price elasticities indicated that increase in the price of the red gram would increase the consumption of peas. Similarly, increase in the price of bengal gram and green gram would increase the consumption of peas and masur, respectively in middle-income households.

High-income Households

The expenditure share of high-income households was also highest on red gram (31.96%), followed by green gram (16.16%), bengal gram (13.56%) and black gram (13.22%). The estimated expenditure elasticity was more than one in red gram (1.31), bengal gram (1.27), and black gram (1.43), whereas, it was less than one in green gram (0.38), and peas (0.88). Income elasticity of all pulses was positive and highly elastic, except in masur.

The own price elasticities were negative and statistically significant at one per cent level for most pulses. The inelastic nature of estimated elasticities implied that the high-income households were less responsive to changes in own prices of pulses commodities.

Nutrient Composition of Pulses

Pulses constitute an essential part of Indian diet for nutritional security. The nutritional importance of pulses is significant and the energy content of most pulses (Table 5) is between 3150 kcal (peas) and 3720 kcal (bengal gram). The vegetable proteins in pulses are a substitute to animal proteins to a large extent. Masur has the highest protein content (251 g/kg) among the pulses, followed by green gram (245g/kg), black gram (240 g/kg) and red gram (223 g/kg). Bengal gram provides around 56 g/kg of fat, whereas, masur provides less than 10 g fat per kg.

Table 5. Nutrient composition of different pulses

Pulses	Protein (gram/kg)	Fat (gram/kg)	Calories (kcal/kg)
Red gram	223	17	3350
Bengal gram	208	56	3720
Green gram	245	12	3480
Masur	251	7	3430
Black gram	240	14	3470
Peas	197	11	3150
Other pulses	220	12	3400

Source: Gopalan*et al*. (1996)

Nutrient Elasticities with respect to Income and Pulse Prices

Nutrient elasticities were estimated (using Equation 17) to examine the changes in nutrient intake in response to changes in price and income. Nutrient elasticity indicates how a one per cent increase in the price of a particular pulse commodity, holding other prices and income as constant would affect the amount of nutrient intake through the interdependent demand relationships among pulse products. For instance, a one per cent increase in the price of red gram would reduce the intake of protein by 0.69 per cent, 0.29 per cent and 0.20 per cent in low, middle and high income households, respectively. Since red gram forms the major portion of the total pulse expenditure, the intake of protein would be more responsive to increased price of red gram, followed by black gram in all income groups.

The increase in price of red gram and black gram would affect significantly the quantity intake of protein among all households, irrespective of income levels. In the case of fat, the increase in price of red gram, bengal gram, black gram and peas, would reduce the quantity intake of fat in low-income households. Likewise, increase in price of red gram, bengal gram, green gram, masur and black gram would reduce the fat intake in the middle-income households. The increase in price of red gram, bengal gram, green gram, masur and black gram would reduce the fat intake in high-income households. The intake of energy would be more influenced by changes in the price of peas in low-income households, black gram in middle and high-income households.

The expenditure elasticity was found to be positive for the intake of protein, fat and energy in all income categories of households, indicating that as per capita income increase, there would be increase in the quantity consumption of all these nutrients, irrespective of the level of income of households. Expenditure elasticity of protein and energy was less than one for middle and high-income households, while it was more than one in the case of low income households. The estimates of income elasticity of nutrients indicated that all nutrients were income elastic, specifically, demand for protein, fat and energy were highly elastic with respect to changes in income among low income households. This implied that the proportionate increase in the

Table 6. Price, expenditure and income elasticity of different nutrients from pulse commodities at low, middle and high income households in India

Nutrients	Red gram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses	Expenditure elasticity of nutrients	Income elasticity of nutrients
				Low-income households					
Protein	-0.69	0.00	0.41	0.20	-0.24	-1.20	0.25	1.77	2.80
Fat	-0.67	-0.12	0.14	0.30	-0.26	-0.47	0.29	1.99	3.15
Energy	-0.68	-0.01	0.41	0.20	-0.24	-1.18	0.29	1.88	2.97
				Middle-income households					
Protein	-0.29	0.02	-0.10	0.09	-0.50	-0.01	-0.39	0.98	1.10
Fat	-0.25	-0.18	-0.39	-0.15	-0.39	0.81	0.26	1.01	1.13
Energy	-0.29	0.00	-0.12	0.07	-0.49	0.06	-0.32	0.97	1.09
				High-income households					
Protein	-0.20	-0.19	-0.21	0.26	-0.45	0.25	-0.14	0.83	0.98
Fat	-0.07	-0.44	-0.47	-0.28	-0.24	0.50	0.36	1.08	1.28
Energy	-0.19	-0.21	-0.24	0.21	-0.43	0.26	-0.09	0.86	1.01

nutrient intake through pulse consumption is more than the increase in income among low income households, while middle and high-income households would consume these nutrients at less than the income increment. This leads to the conclusion that among the poor, as income rises, households prefer to purchase nutritional foods. However, Behrman and Deolalikar (1987) and Behrman *et al*. (1988) found that poor income households did not prefer nutritional foods as income increases.

Conclusions

Pulses make an significant contributions in terms of protein and energy provision to the households in India. The pulse imports are on the increase mainly to meet the domestic demand. The consumption expenditure on red gram has been found higher than on other pulses in all the three income categories of households. The low-income households consume larger amounts of masur and peas due to higher price of red gram and green gram, respectively. Similarly, increase in the price of red gram, bengal gram and green gram would lead to increase in consumption of peas and masur in the middle-income households. Overall, an increase in the price of pulses would reduce the intake of protein and fat, irrespective of the income levels of households. The intake of nutrients would increase more than the increase in income among low income households, while middle and high-income households would consume these nutrients at less than the income increment. There is a need to increase the production and availability of pulses by adopting innovative measures to ensure nutritional security.

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Appendices

	Redgram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses
A1. Results of QUAIDS model at low-income households							
Constant	0.215***	-0.314***	0.197***	0.269***	0.186***	0.140***	0.306***
	(-0.024)	(-0.044)	(-0.015)	(-0.022)	(-0.019)	(-0.039)	(-0.046)
Income	0.495***	-0.009	-0.211***	-0.118***	-0.072***	0.120***	-0.205***
	(-0.038)	(-0.018)	(-0.024)	(-0.029)	(-0.02)	(-0.021)	(-0.021)
ln Price of redgram	-0.181***	0.072***	-0.056**	0.136***	-0.071***	0.090***	0.01
	(-0.056)	(-0.017)	(-0.025)	(-0.044)	(-0.023)	(-0.018)	(-0.02)
ln Price of bengal gram	0.072***	-0.030*	0.001	0.015	0.035***	-0.049***	-0.045***
	(-0.017)	(-0.018)	(-0.015)	(-0.017)	(-0.014)	(-0.012)	(-0.01)
ln Price of green gram	-0.056**	0.001	-0.258***	0.117***	0.052***	0.104***	0.040***
	(-0.025)	(-0.015)	(-0.031)	(-0.024)	(-0.016)	(-0.014)	(-0.015)
ln Price of masur	0.136***	0.015	0.117***	0.025	-0.028	-0.064***	-0.202***
	(-0.044)	(-0.017)	(-0.024)	(-0.044)	(-0.02)	(-0.022)	(-0.018)
ln Price of black gram	-0.071***	0.035***	0.052***	-0.028	-0.026	-0.063***	0.100***
	(-0.023)	(-0.014)	(-0.016)	(-0.02)	(-0.022)	(-0.011)	(-0.015)
ln Price of peas	0.090***	-0.049***	0.104***	-0.064***	-0.063***	-0.064***	0.046***
	(-0.018)	(-0.012)	(-0.014)	(-0.022)	(-0.011)	(-0.019)	(-0.011)
ln Price of other pulses	0.01	-0.045***	0.040***	-0.202***	0.100***	0.046***	0.050**
	(-0.02)	(-0.01)	(-0.015)	(-0.018)	(-0.015)	(-0.011)	(-0.025)
ln Income square	0.026***	0.064***	0	-0.073***	-0.022***	-0.002	0.007
	(-0.008)	(-0.007)	(-0.007)	(-0.008)	(-0.006)	(-0.004)	(-0.005)
e^	0.279***	0.116***	-0.184***	-0.021	-0.078***	0.119***	0.232***
	(-0.04)	(-0.019)	(-0.025)	(-0.031)	(-0.021)	(-0.022)	(-0.022)
PDF	-0.548***	-1.975***	-0.061*	0.180***	0.029	0.185***	-2.190***
	(-0.053)	(-0.153)	(-0.033)	(-0.036)	(-0.037)	(-0.051)	(-0.143)
A 2. Results of QUAIDS model at middle-income households							
Constant	0.596***	5.676***	0.251***	0.215***	0.200***	0.205***	-6.142***
	(-0.02)	(-1.495)	(-0.013)	(-0.019)	(-0.01)	(-0.035)	(-1.484)
Income	-0.003	0.063***	0.021***	0.027***	-0.003	-0.012***	-0.094***
	(-0.004)	(-0.009)	(-0.005)	(-0.007)	(-0.004)	(-0.004)	(-0.009)
ln Price of redgram	0.100***	0.114***	-0.027	0.041**	-0.150***	0.015	-0.094***
	(-0.025)	(-0.012)	(-0.017)	(-0.019)	(-0.014)	(-0.012)	(-0.013)
ln Price of bengal gram	0.114***	0.276**	0.005	0.016	0.044***	-0.025***	-0.430***
	(-0.012)	(-0.121)	(-0.011)	(-0.013)	(-0.009)	(-0.009)	(-0.123)
ln Price of green gram	-0.027	0.005	-0.165***	0.278***	0.007	0.028***	-0.127***
	(-0.017)	(-0.011)	(-0.02)	(-0.017)	(-0.01)	(-0.007)	(-0.014)
ln Price of masur	0.041**	0.016	0.278***	0.053**	-0.073***	-0.059***	-0.256***
	(-0.019)	(-0.013)	(-0.017)	(-0.026)	(-0.013)	(-0.009)	(-0.015)
ln Price of black gram	-0.150***	0.044***	0.007	-0.073***	-0.006	-0.018***	0.196***
	(-0.014)	(-0.009)	(-0.01)	(-0.013)	(-0.014)	(-0.007)	(-0.013)
ln Price of peas	0.015	-0.025***	0.028***	-0.059***	-0.018***	-0.014	0.072***
	(-0.012)	(-0.009)	(-0.007)	(-0.009)	(-0.007)	(-0.009)	(-0.012)

Contd...

	Redgram	Bengal gram	Green gram	Masur	Black gram	Peas	Other pulses
ln Price of other pulses	-0.094***	-0.430***	-0.127***	-0.256***	0.196***	0.072***	0.639***
	(-0.013)	(-0.123)	(-0.014)	(-0.015)	(-0.013)	(-0.012)	(-0.124)
ln Income square	-0.002**	0	-0.001	-0.001	0.001	0	0.004**
	(-0.001)	(0)	(-0.001)	(-0.001)	(-0.001)	(0)	(-0.002)
e^	-0.168***	0.148***	0.097***	0.106***	-0.022***	-0.012**	0.149***
	(-0.007)	(-0.011)	(-0.008)	(-0.01)	(-0.006)	(-0.005)	(-0.011)
PDF	0.419***	18.639***	0.049**	0.110***	-0.014	0.264***	19.467***
	(-0.046)	(-5.183)	(-0.022)	(-0.028)	(-0.022)	(-0.046)	(-5.182)
A3. Results of QUAIDS model at high-income households							
Constant	0.615***	-1.105***	0.02	0.021	0.309***	0.148***	0.993***
	(-0.025)	(-0.192)	(-0.028)	(-0.036)	(-0.029)	(-0.031)	(-0.176)
Income	0.048*	0.116***	-0.081***	-0.178***	0.068***	0	0.027
	(-0.026)	(-0.025)	(-0.019)	(-0.029)	(-0.021)	(-0.01)	(-0.023)
ln Price of redgram	0.396***	-0.055**	-0.128***	-0.167***	-0.091***	0.004	0.042*
	(-0.047)	(-0.023)	(-0.027)	(-0.032)	(-0.025)	(-0.013)	(-0.022)
ln Price of bengal gram	-0.055**	-0.100***	-0.022	0.100***	0.012	0.017	0.047**
	(-0.023)	(-0.033)	(-0.02)	(-0.023)	(-0.02)	(-0.011)	(-0.023)
ln Price of green gram	-0.128***	-0.022	0.014	0.246***	-0.046**	0.069***	-0.133***
	(-0.027)	(-0.02)	(-0.029)	(-0.031)	(-0.02)	(-0.014)	(-0.019)
ln Price of masur	-0.167***	0.100***	0.246***	0.164***	-0.133***	-0.066***	-0.144***
	(-0.032)	(-0.023)	(-0.031)	(-0.042)	(-0.025)	(-0.014)	(-0.024)
ln Price of black gram	-0.091***	0.012	-0.046**	-0.133***	0.097***	-0.009	0.170***
	(-0.025)	(-0.02)	(-0.02)	(-0.025)	(-0.025)	(-0.011)	(-0.021)
ln Price of peas	0.004	0.017	0.069***	-0.066***	-0.009	0.005	-0.019**
	(-0.013)	(-0.011)	(-0.014)	(-0.014)	(-0.011)	(-0.009)	(-0.009)
ln Price of other pulses	0.042*	0.047**	-0.133***	-0.144***	0.170***	-0.019**	0.037*
	(-0.022)	(-0.023)	(-0.019)	(-0.024)	(-0.021)	(-0.009)	(-0.022)
ln Income square	-0.035***	0.041***	0.006	0	-0.001	0.001	-0.012***
	(-0.009)	(-0.008)	(-0.006)	(-0.008)	(-0.007)	(-0.003)	(-0.004)
e^	0.023	0.091***	-0.036*	-0.113***	0.029	-0.007	-0.014
	(-0.025)	(-0.022)	(-0.019)	(-0.03)	(-0.019)	(-0.008)	(-0.023)
PDF	0.383***	-4.902***	-0.299***	0.103***	0.064	0.175***	-4.475***
	(-0.065)	(-0.652)	(-0.056)	(-0.037)	(-0.06)	(-0.046)	(-0.625)

Note : Figures within the parentheses are standard errors; ***,** and * indicate the significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

e^ -Error-term obtained from food expenditure function, PDF- Propability Density Function obtained from probit function.