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Consumption and Nutritional Patterns of ICRISAT Mandate Crops in India

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ABSTRACT

Consumption and nutritional patterns of ICRISAT mandate crops vis-a-vis their substitutes/complements are analysed using complete demand systems approach. Linear Expenditure Systems are estimated separately for ten rural/urban expenditure groups using pooled time series of cross-sections data published by the National Sample Survey Organization. Efforts are made to link consumption patterns with income distribution explicitly.

In 1973-74, about 63% of rural and 47% of urban populations had incomes below the poverty level. They spend more than half their incomes on cereals alone. Within cereals, rice plus wheat claim about 37% and 34% in rural and urban poor household's budget; while the share of mandate crop aggregates (coarse cereals, pulses and oilseeds) range between 21-32% in rural and 15-33% in urban areas of India respectively.

The expenditure elasticities for food items are quite large and approach unity for poorer households. Both the budget shares and expenditure elasticities decline with income for food items;while they rise for nonfood (luxury) items. This implies that any increase in cereals supply due to technological breakthroughs would be largely absorbed by these poorer segments of the population. There is also the well known shift from staple to processed food and nonfood items with rise in income. The direct price elasticities are more volatile than the expenditure elasticities. Most of them are numerically large implying substantial price response. Quite a few of the cross-price responses are sizable, indicating reallocation of income based on relative prices and justifying the demand systems approach.

An attempt is also made to translate the demand parameters from quantity to nutritional dimension, viz. calorie comsumption. The results broadly reinforce the findings based on quantity estimates. Cereals contribute the highest share in nutrient energy consumption for poorer households. Sorghum supplies more than 10% of calorie intake. Calorie deprivation is higher in urban than in rural areas. Its severity is, however, more in the latter. In both rural and urban areas, other cereals, pearl millet and sorghum are the cheapest sources of nutrient energy. Thus, research strategies aimed at supplying inexpensive food to nutritionally deficient populations should assign highest priority to increase yields of these mandate crops.

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1. INTRODUCTION

Ever since the pioneering works of Engel, Pigou and Schultz on the quantification of consumer behavior, there have been a number of attempts to make this area of research a scientific discipline. Based on the early empirical approaches of studying consumer budgets and the later developments in economic theory, concrete theoretical foundations have been laid by Allen and Bowley (1935), Wold and Jureen (1952) and Prais and Houthakker (1955) to the neoclassical theory of consumer behavior. Wald (1940), Stone (1954) and Frisch (1959) initiated efforts in bridging the gap between well structured preference theory and applied demand analysis. Two approaches are generally used for quantifying consumer behavior. The first relies on (micro) household data collected in sample surveys in a geographical region. The second uses aggregate data based on national accounts at the (macro) country level. In developing countries like India, sample survey information is much more detailed and serves a wider variety of purposes than the national accounts data.

The usefulness of collecting consumer expenditure data and quantifying the implied parameters cannot be overemphasized. In planned economies, knowledge about likely future demand for goods and services by its population is useful for an efficient allocation of resources. Another important and frequently used application of household budgetary data is for the evaluation of social welfare with poverty and nutritional status measurements. Demand parameters in association with knowledge about producer's behavior can also enhance our understanding of how markets work. This in turn helps us in evaluating the effect of changes in technology, economic policy and several such exogenous factors.

Traditional approaches to study consumer behavior have focused on the estimation of Engel functions[1] for one or more commodities based on household budget data. Income elasticities of demand derived from such

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1. The Engel function, in a traditional sense, is a relationship between the quantity consumed of a commodity and the consumer's income or more often total consumption expenditure. While using household data, other household characteristics like size, composition, etc. are also sometimes included as explanatory variables.

studies were the conceptual basis for demand projections. Such an approach undermines the importance of relative prices in the decision making process of the consumer and also leads to inconsistencies in budget allocation. Interdependence among the consumption of various items is also ignored. Systems of demand equations can rectify the above limitations and serve several useful purposes.

ICRISAT has been actively involved in the development of crop and farming systems based agricultural technologies to raise the agricultural productivity and thereby increase the aggregate production of five mandate crops -- sorghum, pearl millet, pigeonpea, chickpea, and groundnut -- in the semi-arid tropical regions of the world. To succeed such an effort calls for a thorough understanding of the socioeconomic environment of the region in general and the production and consumption decisions of the population in particular. The purpose of this paper is to analyze the consumption and nutritional pattern for the five mandate crops vis-a-vis their substitutes/complements in India. We include the entire spectrum of commodities in the consumer budget, although in an aggregated form. Unlike the earlier attempts by Bapna (1976), Binswanger and Swamy (1980), Binswanger, Quizon and Swamy (1982), this study explicitly treats the relationship between the income distribution and the consumption and nutritional pattern.

The paper is organized as follows: In the next section, a brief description of the demand model used in this study is given. Section 3 deals with details of the National Sample Survey Organisation (NSSO) expenditure data, its reorganization, and some of its broad features. Details on price data used in this study are also given in the same section. Empirical results of this study are discussed in Sections 4 and 5 respectively.

2. MODEL

We specify a suitable demand model which allows general substitution among consumer items. Earlier studies [Radhakrishna et al. (1979), Radhakrishna and Murty (1980)] on Indian Consumption Patterns revealed that the Linear Expenditure System (LES) provides a reasonable fit when the range of income variation is small. Further, in analyses where a large number of consumer items with varying budget shares are involved, it is observed that relatively more structured models like the LES or its variants are preferable to more flexible alternatives even in the case of developed countries [Deaton (1975), de Haen et al. (1982)]. In view of the paucity of reliable consumer expenditure data and the problems of estimating large scale models, one is often tempted to adopt hierarchic estimation procedures which in turn demand simple model specifications for reasons of theoretical consistency. All these considerations weighed against the now well known limitations of the LES viz. linear Engel curves and additive utility

specification, tend to support the choice of LES for the present purpose as well.[2]

The LES model has the form:

$$p_{it}\, q_{it} = p_{it}\, c_i + b_i[m_t - \sum_{j=1}^{n} p_{jt}\, c_j] \qquad (1)$$

$$i = 1,2,\ldots n;\ t = 1,2,\ldots T$$

In relation (1), p_{it} and q_{it} represent the price and quantity consumed of i^{th} item in period t; m_t is the total consumption expenditure in period t; and b_i and c_i are the parameters called as the marginal budget shares and the committed quantities respectively. n is the number of commodities in the consumer budget and T is the number of time periods/ observations.

It is clear that the LES model satisfies the adding-up property if $\sum_{j=1}^{n} b_i = 1$. Fulfilment of second order conditions of utility maximization requires that $0 < b_i < 1$ for all i, and $m_t > \sum_{j=1}^{n} p_{jt}\, c_j$ for all t. The expenditure and price elasticities in the LES model are given by

$$\eta_{io} = \frac{b_i}{w_{it}} \quad \text{where} \quad w_{it} = \frac{p_{it}\, q_{it}}{m_t} \qquad (2)$$

$$\eta_{ij} = \begin{cases} -\dfrac{b_i\, p_{jt}\, c_j}{m_t\, w_{it}} & \text{for } j \neq i \\ -1 + \dfrac{(1-b_i)\, p_{it}\, c_i}{m_t\, w_{it}} & \text{for } j = i \end{cases} \qquad (3)$$

For econometric estimation of the model in relation (1), we add a random disturbance, u_{it}, to the right hand side of relation (1) with the following properties:

$$\begin{aligned} E(u) &= 0 \\ E(uu') &= \Omega \otimes I \end{aligned} \qquad (4)$$

where Ω is the variance covariance matrix of residuals common to all time periods and u is the nT vector of u_{it}. A linearised version of the model in relation (1) can be estimated using Zellner's (1962) procedure for

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2. Notwithstanding the above thesis, attempts have been made to use a more flexible model like the Nasse (1970) extension of the LES. The results indicated violation of the integrability (symmetry) conditions. I am grateful to Prof. R. Radhakrishna for pointing out this to me.

seemingly unrelated regressions.[3]

3. DATA, ITS FEATURES AND ESTIMATION

Data

Consumption data used for the estimation of the demand model here are the time series of cross-sections data on consumer expenditure published in the reports of the NSSO for the rounds 2 through 25 covering the period 1950-51 to 1970-71 [see Radhakrishna and Murty (1980) for details]. Each of the NSSO reports on consumer expenditure provide the per capita monthly expenditure on cereals; milk and milk products; edible oils; meat, eggs and fish; sugar and gur; other food; clothing; fuel and light and other nonfood for 12/13 expenditure classes in each round. In certain of the rounds a further breakdown of two commodity aggregates viz. cereals and other food into rice; wheat; sorghum; pearl millet; other coarse cereals; gram (chickpea); and other pulses is also provided. In order to utilize this published information fully, we resorted to a hierarchical estimation [for similar exercises see Deaton (1975), Radhakrishna and Murty (1980), de Haen et al. (1982)] wherein the LES demand system is first estimated for aggregate commodities and then some of these aggregate commodities are decomposed into individual items through estimation of sub-models. In our case, a nine commodity aggregate model is first estimated and two sub-models involving the cereals and other food aggregates are estimated in the second stage. Linking of these models hierarchically using two-stage budgeting procedure gave us a sixteen commodity demand model which included the five ICRISAT mandate crops. For focusing attention on ICRISAT mandate crops and also to study their substitutability/complementarity to other crops and products in consumption, rather comprehensively, we aggregated this detailed sixteen commodity model into a nine commodity model with the following commodity classification: (1) superior cereals; (2) sorghum; (3) pearl millet; (4) chickpea; (5) other cereals; (6) edible oil; (7) pulses (other than chickpea); (8) other food and (9) nonfood.

In order to overcome the unattractive property of linear income effects implied by the LES model, the NSSO expenditure classes have been stratified into five expenditure groups separately for rural and urban

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3. The method consists of linearising the model around an initial set of parameters and using a Generalised Least Squares (GLS) estimation procedure to update the parameter set. The estimated co-variance matrix of residuals from the previous iteration has been used for the GLS. The iterations are continued until the procedure converges. The estimates so obtained are identical with the maximum likelihood estimates [see Deaton (1975) pp.45-46]. The computer program was written by the author himself on an IBM 360 computer.

areas[4] on the basis of the monthly expenditure classes of the 17th round 1961-62: Rs. 0-8 forming the first group; 8-11, 11-13 the second group; 13-15, 15-18, 18-21, the third group; 21-24, 24-28, 28-34, the fourth group and 34-43, 43-55, 55-75, 75 and above, the fifth. The class boundaries of the above groups have been expressed at the prices of other rounds by using class specific price deflators and then grouping has been made.

Commodity group price indices with the 17th round (1961-62) as base have been compiled from the Economic Advisor's monthly wholesale price relatives. For rural and urban areas, while computing the commodity group price indices separate weights based on the 13th round NSSO data have been used. Separate model has been estimated for each expenditure group using the time series of cross sections data.

Features

Before estimating the model and the underlying demand parameters, a few observations regarding the spending habits of consumers in rural and urban areas can be made. The published information from the 28th round NSSO report corresponding to the year 1973-74 is summarized in Table 1.

The expenditure groups 1, 2 and 3 together cover about 63% of rural population and 47% of urban population in 1973-74. These populations might roughly fall under the category of poor people according to the norms of Planning Commission (Rs. 37 in rural and Rs. 40 in urban areas in 1970-71 prices). These categories in rural areas spend between Rs. 10 and 22 per capita per month on cereals alone which constitute respectively 62% and 52% of their total per capita monthly consumption expenditure. The corresponding figures for the urban poor are Rs. 9 (59%) and Rs. 18 (40%) respectively. Inclusion of pulses adds another 2-4% expenditure in rural areas and 3-4% in urban areas. These percentages indicate that foodgrains is a single major item of expenditure in the consumer budget for poor people. In contrast, the rural rich persons spend between Rs. 33 and Rs. 43 on foodgrains, representing a share of 45% and 23% in their respective total expenditures.

Among cereals rice and wheat together account for the largest share (36-38%) followed by other cereals (6-14%) of the consumer expenditure of the rural poor. Sorghum occupies the third position with a share of 5-8%, the share declining with income, however. Pearl millet contributes about 3% to consumer expenditure. Its absolute consumption varied between Rs. 0.47 and Rs. 3.50 per capita per month across the different income groups. In the urban areas, a typical low income consumer spends about 32-35% on rice and wheat; 3-12% on sorghum; 1-6% on pearl millet

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4. The definition of rural/urban areas in NSSO 28th round is the same as that of 1971 population census. This means, all towns with a population of 5000 and above as well as all other places with a municipality, corporation, contonment board, etc. which are notified as town areas constitute urban areas.

Table 1. Monthly per capita expenditures and their percentage shares in total consumer expenditure on various items in 1973-74.

Expenditure Group No.	Expenditure class in Rs	% population	Monthly Per Capita Expenditure In Rupees on									
			Superior	Sorghum	Pearl millet	Chick-pea	Other cereals	Edible oil	Pulses	Other food	Non-food	Total expenditure
						R U R A L	I N D I A					
1	0-24	6.72	6.07 (36.33)	1.44 (8.62)	0.47 (2.81)	0.04 (0.24)	2.34 (14.00)	0.49 (2.93)	0.39 (2.33)	2.65 (15.86)	2.82 (16.88)	16.71 (100.00)
2	24-34	16.89	10.81 (37.92)	2.26 (7.93)	1.00 (3.51)	0.13 (0.45)	2.66 (9.33)	1.02 (3.58)	1.03 (3.61)	4.85 (17.01)	4.75 (16.66)	28.51 (100.00)
3	34-55	39.53	16.32 (37.54)	2.20 (5.06)	1.37 (3.15)	0.20 (0.46)	2.55 (5.87)	1.73 (3.98)	1.74 (4.00)	9.24 (21.26)	8.12 (18.68)	43.47 (100.00)
4	55-100	29.80	23.83 (32.01)	1.86 (2.50)	1.66 (2.23)	0.40 (0.54)	2.64 (3.54)	2.82 (3.79)	2.94 (3.95)	18.55 (24.92)	19.74 (26.52)	74.44 (100.00)
5	100 and above	7.06	31.22 (16.32)	1.96 (1.03)	1.41 (0.74)	0.71 (0.37)	3.16 (1.65)	5.48 (2.86)	5.01 (2.62)	48.68 (25.44)	93.69 (48.97)	191.32 (100.00)
						U R B A N	I N D I A					
1	0-21	0.91	4.79 (32.67)	1.76 (12.01)	0.85 (5.80)	0.0 (0.0)	1.29 (8.80)	0.53 (3.61)	0.46 (3.14)	1.56 (10.64)	3.42 (23.33)	14.67 (100.00)
2	21-34	11.30	9.44 (35.34)	1.73 (6.48)	0.58 (2.17)	0.06 (0.22)	0.93 (3.49)	1.31 (4.90)	0.99 (3.71)	6.43 (24.07)	5.24 (19.62)	26.71 (100.00)
3	34-55	34.47	14.98 (34.26)	1.41 (3.23)	0.64 (1.46)	0.07 (0.16)	0.55 (1.26)	2.47 (5.65)	1.75 (4.00)	12.00 (27.45)	9.85 (22.53)	43.72 (100.00)
4	55-100	37.13	19.46 (25.95)	1.05 (1.40)	0.59 (0.79)	0.14 (0.19)	0.51 (0.68)	4.45 (5.93)	2.83 (3.77)	24.21 (32.28)	21.76 (29.01)	75.00 (100.00)
5	100 and above	16.19	21.19 (11.21)	0.42 (0.22)	0.15 (0.08)	0.27 (0.14)	0.30 (0.16)	7.44 (3.94)	3.82 (2.02)	63.27 (33.46)	92.22 (48.77)	189.08 (100.00)

Source: 28th Round of National Sample Survey Organisation; Report No.240 - Tables on Consumer Expenditure.

The expenditure groups 1,2,...,5 correspond to the per capita monthly total expenditure classes 0-8, 8-13, 13-21, 21-34, 34 and above in 1961-62 rupees respectively. Figures in parentheses are percentage shares.

and 1-8% on other cereals. The share of edible oils is about 3-4% in rural areas and 4-6% in urban areas. Thus, the shares of coarse cereals and pulses which include ICRISAT mandate crops range between 18-28% in the rural poor household's budget and 10-30% in urban low income consumer's budget.

Estimation

A nine commodity LES model has been first estimated separately for each expenditure group using data from 2-25 rounds in rural areas and 3-25 rounds in urban areas. Two submodels for cereals and other food groups are estimated using detailed information from the NSSO reports of (14-20) rounds. The pooled time series of cross section data are grouped into five expenditure groups in rural and urban areas as in the case of the aggregate model. Due to limited number of observations in each of these expenditure groups, we decided to estimate simpler linear expenditure system rather than the Nasse model for these two commodity subgroups.[5] In the case of the lower two urban expenditure groups, plausible estimates of partial expenditure and price elasticities for cereal items could not be obtained separately and hence the data for these two urban expenditure groups have been combined to estimate one common submodel for the cereal group. The partial elasticities for this expenditure group as well as for others have been integrated with the respective elasticities estimated at the higher level to obtain total set of expenditure and price elasticities for each expenditure group. These are presented in Tables A1-A10. We did not compute the structural parameters of the linked model because of aggregation problems. However, derived parameters like budget shares and elasticities should be sufficient to analyze broad patterns in consumption (Tables 2-4).

4. PATTERNS IN CONSUMPTION

Budget Shares

Table 2 contains the average budget shares on all the nine commodities and for all the ten real (or deflated) expenditure groups, both rural and urban. The estimates suggest certain well known patterns. In both rural and urban areas, consumers belonging to the lower and middle income levels spend a major share of their expenditure on food items reaching up to 80%; while those belonging to richer classes spend only about 50% on food commodities.

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5. Two-stage budgeting procedure permits the use of an additive model like the LES at the first stage and a non-additive model like the Nasse model at the second stage, but not vice versa (see for example, de Janvry et al. (1972)). Ignoring the problem of limited number of observations, we tried unsuccessfully to estimate the Nasse model for cereal and other food subgroups. The results did not merit discussion.

Table 2. Estimated Average Budget Shares (W_i).

	Rural Expenditure Classes					Urban Expenditure Classes				
	1	2	3	4	5	1	2	3	4	5
1. Superior cereals	0.325	0.339	0.338	0.281	0.196	0.348	0.315	0.302	0.237	0.136
2. Sorghum	0.081	0.079	0.050	0.031	0.013	0.076	0.069	0.037	0.015	0.004
3. Pearl millet	0.021	0.022	0.025	0.024	0.013	0.019	0.018	0.014	0.008	0.003
4. Chickpea	0.015	0.018	0.014	0.013	0.008	0.014	0.013	0.007	0.004	0.002
5. Other cereals	0.162	0.105	0.071	0.044	0.022	0.044	0.040	0.017	0.009	0.002
6. Edible oil	0.026	0.032	0.031	0.029	0.028	0.036	0.044	0.045	0.044	0.034
7. Pulses	0.027	0.039	0.040	0.039	0.031	0.033	0.040	0.040	0.034	0.022
8. Other food	0.158	0.178	0.201	0.237	0.243	0.208	0.238	0.268	0.307	0.338
9. Nonfood	0.185	0.188	0.230	0.302	0.446	0.222	0.223	0.270	0.342	0.459

Among the food items, cereal expenditure constitutes the largest share up to 43% in rural areas and 48% in urban areas in the case of the poorer households. In contrast the rural and urban rich spend only about 23% and 12% respectively on cereals. Thus, any increase in cereals supply due to technological breakthroughs would be largely absorbed by these poorer segments of the population. Unless their income and purchasing power goes up, there would not be effective demand for cereals and their substitutes.

Sorghum consumption accounts for about 8% of total expenditure in poorer families both in rural and urban areas. Two other mandate crops, namely pearl millet and chickpea (Bengal gram), constitute 1-2% of total consumption in both the areas. Separate data on pigeonpea (red gram), a fourth mandate crop, do not exist; therefore, it is grouped with all other pulses. This commodity group has a share of about 4% of the expenditure budget for both rural and urban households. There is no marked difference in its average share of consumption across income categories or between rural and urban areas. The groundnut share in total consumption together with other edible oils ranges between 3-5%.

Other food and nonfood are the two other major commodity groups in the consumer budget. The average share of consumption on other food, a composite commodity group which includes all food products of animal origin like meat, dairy and other crop products, ranged between 16-24% in rural areas and 21-33% in urban areas. Its share also has a uniformly increasing pattern over income classes. The nonfood group, a catch-all category, has by far the second largest share in consumption in the consumer budget. Its average consumption share varied between 18-47% in rural areas and 22-49% in urban areas. The average budget share rises as incomes increase. Thus, it is clear that the differences in average budget shares across income classes are much more striking than the rural-urban differences for any item in the consumer budget. This shows that the distribution of purchasing power is much more uneven within rural/urban sectors than between them. Any redistribution of purchasing power in favor of the poor would exert excess demand pressure on the grains market.

Expenditure and Own-Price Elasticities

Estimated mean expenditure and own-price elasticities are presented in Tables 3-4. Broadly, these estimates reinforce the patterns observed with respect to average budget shares. There are some additional features conveyed by these estimates relating to income growth and price changes. The magnitudes of the expenditure elasticities close to unity for quite a few food items, particularly for lower income consumers, is alarming and indicates widespread poverty in these consumer groups. As expected the estimates decrease as income rises. To compensate for this decline, the expenditure elasticities for processed other food category and nonfood items increase with income in both rural and urban areas.

Table 3. Estimated Mean Expenditure Elasticities (η_{io}).

	Rural Expenditure Classes					Urban Expenditure Classes				
	1	2	3	4	5	1	2	3	4	5
1. Superior cereals	1.046	0.950	0.807	0.467	0.342	1.067	0.839	0.485	0.199	0.130
2. Sorghum	1.248	1.035	0.400	0.255	0.358	0.697	0.548	0.532	0.094	0.098
3. Pearl millet	1.076	1.220	0.434	0.589	0.358	0.916	0.720	0.326	0.067	0.083
4. Chickpea	0.499	0.790	0.471	0.469	0.073	1.262	0.992	0.254	0.067	0.013
5. Other cereals	0.660	0.579	0.193	0.157	0.141	0.557	0.438	0.228	0.023	0.083
6. Edible oil	1.489	0.852	1.032	0.893	0.953	1.266	1.103	1.015	0.950	0.366
7. Pulses	1.821	1.016	1.035	0.533	0.457	1.475	0.960	0.720	0.437	0.141
8. Other food	1.177	1.130	1.596	1.382	0.693	1.183	1.246	1.394	1.422	0.753
9. Nonfood	0.801	1.204	1.226	1.521	1.594	0.791	1.216	1.390	1.335	1.549

Table 4. Estimated Mean Direct-Price Elasticities.

	Rural Expenditure Classes					Urban Expenditure Classes				
	1	2	3	4	5	1	2	3	4	5
1. Superior cereals	-1.388	-1.268	-0.690	-0.481	-0.387	-1.230	-1.142	-0.657	-0.287	-0.207
2. Sorghum	-2.295	-1.939	-0.676	-0.574	-0.961	-1.542	-1.528	-1.946	-1.373	-1.160
3. Pearl millet	-2.181	-2.440	-0.740	-1.276	-0.960	-2.110	-2.105	-1.286	-0.996	-0.991
4. Chickpea	-1.033	-1.611	-0.806	-1.058	-0.203	-2.898	-2.894	-1.014	-1.002	-0.153
5. Other cereals	-1.255	-1.141	-0.336	-0.356	-0.385	-1.280	-1.274	-0.903	-0.340	-0.991
6. Edible oil	-0.878	-0.669	-0.460	-0.372	-0.608	-0.817	-0.767	-0.569	-0.523	-0.356
7. Pulses	-1.429	-0.911	-0.630	-0.362	-0.477	-1.067	-0.675	-0.588	-0.385	-0.294
8. Other food	-0.810	-0.925	-0.818	-0.719	-0.552	-0.835	-0.897	-0.872	-0.876	-0.798
9. Nonfood	-0.548	-0.947	-0.659	-0.786	-1.000	-0.592	-0.878	-0.845	-0.839	-1.136

At the middle and higher income levels, the expenditure elasticities are less than unity (inelastic) for food items and greater than unity (elastic) for processed food and nonfood commodities. This documents the well-known shift from staple food to processed food and nonfood categories with increases in income and expenditure.

It is satisfying to notice that commodities like sorghum, pearl millet and other coarse cereals which are traditionally treated as inferior grains i.e. commodities with negative expenditure elasticities, have quite 'high' estimates, close to and exceeding unity in few cases. This implies that aggregating incomes into only one group conceals disparities and blurs the overall picture of consumption expenditure. All the demand parameter estimates based on the means of NSS data suffer from this serious limitation.

The direct price elasticities (Table 4) are more variable and volatile than the expenditure elasticities. All the estimates are of correct sign as theory suggests and the full set of demand parameters (budget shares, expenditure and price elasticities) satisfy the neoclassical properties of consumer utility maximization including convexity.

Most of the direct-price elasticities are numerically large, though not infinitely large, indicating substantial price responsiveness in consumption of all items. Consumers do react to changes in relative prices and allocate their monetary resources, although differently at different income levels. It is clear that at least in the short run, demand management becomes extremely important to facilitate the absorption of available supplies of commodities.

Unlike budget shares and expenditure elasticities, the direct-price elasticities do not indicate systematic patterns over income range. Broadly, they decline with rises in income for all food items; while the opposite is true for the nonfood group. The approximate proportionality between expenditure and direct price elasticities, often referred to as Pigou's law, is supported by these estimates.

Cross-Price Elasticities

A cursory look at the cross-price elasticities (Table A1-A10) indicate that many are sizable with positive and negative values. This shows that there are some complementary and substitution effects justifying the systems of demand-equations approach. These price effects are not income compensated and therefore do not capture the real income effect of a price change; they reflect pure substitution effects.

Overall about 30% of the cross-price elasticities are numerically larger than 0.05, and they are primarily those of cereal items with respect to the prices of other commodities; the percentage being marginally

lower in models for urban areas. To illustrate the point, in the rural lowest expenditure group (Table A1), superior cereals, sorghum, pearl millet, chickpea, and other cereals are gross substitutes for one another; while they are gross complements to edible oil, pulses, other food and nonfood commodities. For example, a 10% increase in the price of superior cereals (rice and wheat) would increase the demand for sorghum by 9%, pearl millet by 8%, chickpea by 4%, and other cereals by 5% so as to compensate a decrease in the consumption of superior cereals by 14%. Moreover, such a price hike reduces the demand for edible oil, pulses and other food by 1.9%, 2.3% and 1.5% respectively.

Looking across the Tables A1 through A10, we find that the degree of substitutability/complementarity among pairs of food items declines with income, implying weaker influence of relative prices on budget allocation among food items. Also the degree of complementariness of nonfood group increases with income. In the rural highest expenditure group (Table A5), only superior cereals have a few stronger substitutes and complements. As we move from the rural lowest expenditure group to the highest expenditure group, the degree of substitutability of sorghum to rice and wheat has declined by about 36% i.e. the cross-price elasticity of sorghum with respect to superior cereals price has declined from 0.937 to 0.596. Similarly, the substitutability of pearl millet to sorghum decreased by 84% (.257 to 0.041).

Tables A6-A10 relating to urban consumer groups broadly reveal similar pattern as that of their counterparts in the rural areas. The cross-price effects of superior cereals on other foodgrains are much stronger for poor urban consumers. This is particularly true for pearl millet and chickpea. However, the cross-price elasticity between pearl millet and sorghum is much smaller than that for rural areas. Unlike in rural areas, the cross-price elasticity of sorghum with reference to superior cereals price increased initially and then declined with income. Apparently, chickpea (gram) turns out to be a moderate to strong substitute, rather than a complement, for rice and wheat in both rural and urban areas, particularly in the consumption budgets of the poor. This perhaps, prompted the NSSO investigators to classify gram as a cereal item.

5. NUTRITIONAL PATTERNS

Introduction

There are two utility based approaches for nutritional status measurements of consumers. The first utilizes the characteristic demand theory pioneered by Ironmonger and later popularised by Lancaster. This approach assumes that commodities are consumed because of the utility derived from their characteristics or properties. For food, these characteristics would include nutrient content, texture, color, taste etc. Since the relationship between commodities and characteristics is essentially a technical one, the usual approach of consumer utility maximization gives us characteristic demand functions in terms of consumer

income and characteristic prices. These relations can be utilized to evaluate the nutritional status of consumers and also analyze the nutritional impact of income redistribution and price policies on low income consumers.

The second approach which we follow estimates commodity demand functions and translates them into nutritional dimensions, using nutrient content coefficients. In particular, we are interested in scaling the income and price elasticities estimated in commodity space into characteristic space. Such a translation would not have any effect if we are dealing with only one commodity, because the estimated elasticity is independent of translation (scaling). However, since we deal, in general, with multi-commodity, multi-nutrient situations involving commodity interactions, the effect is far from trivial. In what follows, we outline the procedure to link demand functions and the derived elasticities defined in commodity space with those in characteristic space for the model discussed in section 2. Here, we limit our discussion to nutrient energy (calories) consumption for two important reasons.[6] First, the documented evidence on nutritional status measurements points out at caloric deficiency and hence the need for its quantification; likewise, the recent literature summarily rejected the 'protein gap' philosophy of mid 60's. Secondly, it can help assess the impact of technology development efforts of ICRISAT aimed at increasing mandate crop yields.

Model

Let k_i be the amount of nutrient (e.g. calories, protein, amino acids, etc.) contained in one unit of the i^{th} commodity consumed. Rewriting equation (1) in terms of the nutrient consumed, and rearranging the terms,

$$k_i q_{it} = k_i c_i - \frac{k_i b_i}{p_{it}} \cdot \sum_{j=1}^{n} p_{jt} c_j + \frac{k_i b_i}{p_{it}} m_t \qquad (5)$$

$$i = 1, 2, \ldots\ldots, n$$

Omitting the time suffix and summing over all commodities containing the nutrient,

$$K = \sum_{i=1}^{nc} k_i q_i = \sum_{i=1}^{nc} k_i c_i - \left(\sum_{j=1}^{n} p_j c_j\right) \sum_{i=1}^{nc} \frac{k_i b_i}{p_i}$$

$$+ \sum_{i=1}^{nc} \frac{k_i b_i}{p_i} \cdot m \qquad (6)$$

Equation (6) can be rewritten as

$$K = \alpha + \beta m \qquad (7)$$

---

6. Our future work plan, however, includes analysis for other nutrients as well.

$$\text{where } \alpha = \sum_{i=1}^{n_c} k_i c_i - \left(\sum_{i=1}^{n} p_i c_i\right) \sum_{i=1}^{n_c} \frac{k_i b_i}{p_i} \qquad (8)$$

$$\beta = \sum_{i=1}^{n_c} \frac{k_i b_i}{p_i} \text{ and } n_c \leq n$$

Equation (7) is the linear nutrient consumption function underlying the LES. The parameter β is the marginal propensity to consume the nutrient. It can be shown from (7), that the income and price elasticities of the nutrient consumption are given by,

$$\eta = \sum_{i=1}^{n} \pi_i \eta_{io} \qquad (9)$$

$$\eta_j = \sum_{i=1}^{n} \pi_i \eta_{ij} \qquad (10)$$

where $\pi_i = k_i \hat{q}_i / \sum_{i=1}^{n_c} k_i \hat{q}_i$, with $\hat{q}_i$ as estimated quantity of i^{th} commodity consumed, η_{io} and η_{ij} $(i,j = 1,2, \ldots, n)$ are the income and price elasticities of demand as defined in equations (2) and (3). Thus, equations (9) and (10) are the counterparts of equations (2) and (3) expressed in nutrient dimension.

The above procedure of arriving at nutritional elasticity from commodity elasticities appears deceptively simple. In fact, it involves a fairly complicated procedure with precise data requirements. This procedure for nutrient energy is outlined below:

Data

Since the bio-chemical measurements of nutrient content of common food stuffs are quantity based, precise data on the quantity consumed of each food item in consumer budget are required. Such information is particularly difficult to gather in the case of composite commodity groups for which value information is only usually available. Fortunately for India, the National Sample Survey Organization publishes both quantity and value of consumption of certain items in a few of the rounds. From this data, it is possible to calculate the item-wise calories consumed as well as the amount of calories obtained from different sources for a unit value of one rupee. This latter information along with the corresponding price indices and the amount spent on each item in any

year enables us to compute the itemwise calories consumed in that year. We then calculate itemwise calorie consumption shares and hence the weighted averages of commodity income and price elasticities to give us nutrient elasticities with respect to income and commodity prices.

One important use of nutritional parameters is to evaluate the nutritional status of various consumer groups and changes therein. We analyze the calorie consumption pattern of rural/urban consumer groups that have already been defined in earlier sections. The earlier commodity grouping is also retained. Radhakrishna (1982) has analyzed the calorie consumption pattern of the above consumer groups for the year 1970-71.. His estimates are up-dated here for 1973-74. We also use a suitable commodity classification which enables us to answer technology and policy questions relating explicitly to the ICRISAT mandate crops.

In order to quantify the calories consumed by each of the ten rural/urban consumer groups, we took the quantity and value of consumption of various food items published in 17th and 28th round reports of NSSO. The published data is on a per capita monthly basis for fourteen expenditure classes. The estimated number of persons in each of these expenditure classes is also given. Based on the cereal consumption details given in 28th NSS round, and the per capita daily calorie consumption estimates given in Radhakrishna (1982) for items like edible oil, pulses and other food, the sourcewise per capita daily calorie intake is calculated and presented in Table 5. The calorie conversion estimates given in Gopalan et al. (1976) for cereal items were used. The estimated number of persons in each expenditure class is used as a weight for computing averages.

Results

Cereals contribute a large proportion of total nutrient energy consumed in both rural and urban areas. Their contribution ranged from 87-64% in rural areas and 73-43% in urban areas, the percentage declining with rise in income. The cereal contribution to calorie consumption is higher in rural areas than in urban areas. Among cereal items, superior cereals contribute the highest share, while other cereals in rural areas and sorghum in urban areas occupy the second position. It is worth noting that sorghum supplies 12-14% of calorie intake in rural India and 11-6% in urban India in poorer households. Other food commodities contribute proportionately more for richer households and compete with rice and wheat consumption. The distribution of calorie intake is clearly depicted in Table 6. The values are interpolated through graphical method from the estimates given in Table 5. It is clear that calorie deprivation (as measured by percentage of population consuming at least 1600 calories per capita per day) is higher in urban areas compared to rural areas although its severity is more in rural areas. This supports the conclusion arrived at by Rao and Vivekananda (1979) as well. Figure 1 illustrates this point.

Table 5. Per capita daily calorie intake by source in 1973-74.

Expenditure Group No.	Monthly per capita exp. class in rupees	Estimated percentage population	Per capita daily calorie intake (in k.cal)									
			Superior cereals	Sorghum	Pearl millet	Chick-pea	Other cereals	All cereals	Edible oil	Pulses	Other food	All food
						RURAL INDIA						
1	0-24	6.72	544 (43.1)	175 (13.9)	71 (5.6)	3 (0.2)	307 (24.3)	1100 (87.2)	19 (1.5)	19 (1.5)	124 (9.8)	1262 (100.0)
2	24-34	16.89	844 (47.6)	216 (12.2)	111 (6.3)	10 (0.6)	289 (16.3)	1470 (83.0)	36 (2.0)	42 (2.4)	224 (12.6)	1772 (100.0)
3	34-55	39.53	1156 (50.9)	202 (8.9)	142 (6.2)	13 (0.6)	258 (11.4)	1771 (78.0)	60 (2.6)	66 (2.9)	375 (16.5)	2272 (100.0)
4	55-100	29.80	1534 (51.9)	162 (5.5)	170 (5.7)	22 (0.7)	243 (8.2)	2131 (72.0)	92 (3.1)	102 (3.5)	634 (21.4)	2959 (100.0)
5	100 +	7.06	1892 (47.6)	159 (4.0)	203 (5.1)	40 (1.0)	264 (6.6)	2558 (64.3)	142 (3.6)	136 (3.4)	1142 (28.7)	3978 (100.0)
						URBAN INDIA						
1	0-21	0.91	600 (50.7)	134 (11.3)	31 (2.6)	1 (0.1)	97 (8.2)	863 (72.9)	35 (2.9)	34 (2.9)	252 (21.3)	1184 (100.0)
	21-34	11.30	785 (51.4)	177 (11.6)	80 (5.2)	3 (0.2)	92 (6.0)	1137 (74.4)	58 (3.8)	45 (2.9)	289 (18.9)	1529 (100.0)
3	34-55	34.47	1077 (54.4)	118 (6.0)	61 (3.1)	3 (0.1)	56 (2.8)	1315 (66.4)	109 (5.5)	73 (3.7)	482 (24.4)	1979 (100.0)
4.	55-100	37.13	1256 (49.5)	87 (3.4)	54 (2.1)	5 (0.2)	52 (2.1)	1454 (57.3)	190 (7.5)	104 (4.1)	791 (31.1)	2539 (100.0)
5.	100 +	16.19	1269 (40.0)	40 (1.3)	21 (0.7)	12 (0.4)	27 (0.8)	1369 (43.2)	255 (8.0)	105 (3.3)	1442 (45.5)	3171 (100.0)

Source: 28th Round of National Sample Survey Organization; Report No. 240 - Tables on Consumer Expenditure.
The figures in parentheses are percentage shares to the total.

Table 6. Distribution of calorie intake

	FAO/WHO Recommended per capita daily calorie intake*	Percentage of population consuming below					
		2400 k.cal	2200 k.cal	2000 k.cal	1800 k.cal	1600 k.cal	1400 k.cal
Rural India	1910	72.5	56.5	37.0	24.5	16.5	10.5
Urban India	1910	78.0	65.5	48.0	29.0	15.5	7.5

* Adjusted to account for individual variability.

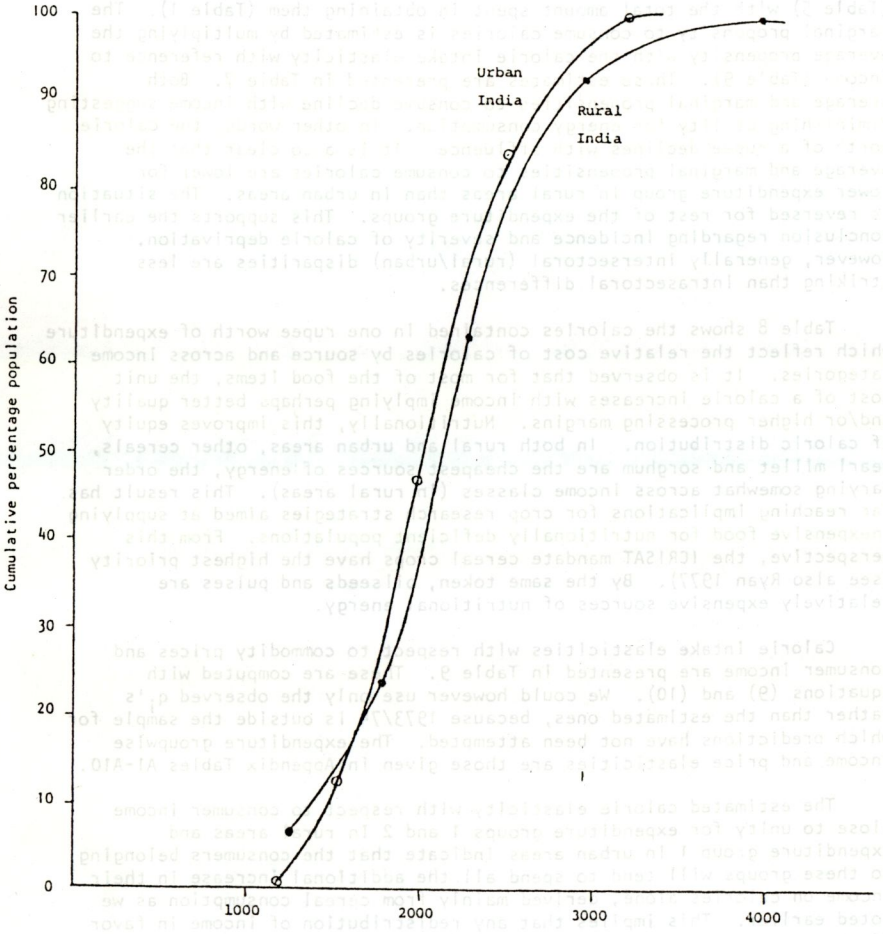

Figure 1. Per capita calories consumed.

In order to look more closely at inter sectoral (rural/urban) and intrasectoral patterns in calorie consumption, we have estimated the average and marginal propensities to consume calories across expenditure groups and separately for rural/urban areas. The average propensity to consume calories is obtained by dividing total daily calorie consumption (Table 5) with the total amount spent in obtaining them (Table 1). The marginal propensity to consume calories is estimated by multiplying the average propensity with the calorie intake elasticity with reference to income (Table 9). These estimates are presented in Table 7. Both average and marginal propensities to consume decline with income suggesting diminishing utility for energy consumption. In other words, the calorie worth of a rupee declines with affluence. It is also clear that the average and marginal propensities to consume calories are lower for lower expenditure group in rural areas than in urban areas. The situation is reversed for rest of the expenditure groups. This supports the earlier conclusion regarding incidence and severity of calorie deprivation. However, generally intersectoral (rural/urban) disparities are less striking than intrasectoral differences.

Table 8 shows the calories contained in one rupee worth of expenditure which reflect the relative cost of calories by source and across income categories. It is observed that for most of the food items, the unit cost of a calorie increases with income implying perhaps better quality and/or higher processing margins. Nutritionally, this improves equity of caloric distribution. In both rural and urban areas, other cereals, pearl millet and sorghum are the cheapest sources of energy, the order varying somewhat across income classes (in rural areas). This result has far reaching implications for crop research strategies aimed at supplying inexpensive food for nutritionally deficient populations. From this perspective, the ICRISAT mandate cereal crops have the highest priority (see also Ryan 1977). By the same token, oilseeds and pulses are relatively expensive sources of nutritional energy.

Calorie intake elasticities with respect to commodity prices and consumer income are presented in Table 9. These are computed with equations (9) and (10). We could however use only the observed q_i's rather than the estimated ones, because 1973/74 is outside the sample for which predictions have not been attempted. The expenditure groupwise income and price elasticities are those given in Appendix Tables A1-A10.

The estimated calorie elasticity with respect to consumer income close to unity for expenditure groups 1 and 2 in rural areas and expenditure group 1 in urban areas indicate that the consumers belonging to these groups will tend to spend all the additional increase in their income on calories alone, derived mainly from cereal consumption as we noted earlier. This implies that any redistribution of income in favor of the poor would generate demand for cereals, particularly coarse cereals like sorghum, pearl millet and other cereals which are relatively

Table 7. Estimated average and marginal propensities to consume calories.

Expenditure group	Average propensity		Marginal propensity	
	Rural India	Urban India	Rural India	Urban India
1	2266	2423	2293	2476
2	1865	1717	1749	1487
3	1568	1352	1284	988
4	1193	1016	774	645
5	624	503	283	217

Table 8. Calories contained in one Rupee worth of expenditure by source in 1973/74.

Expenditure group no.	Monthly per capita expenditure class in Rs.	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food
				RURAL INDIA					
1	0-24	2288	3121	3422	1967	3466	921	1136	1120
2	24-34	2284	2825	3279	2184	3269	1036	1177	1096
3	34-55	2121	2759	3119	1977	3011	1036	1136	1021
4	55-100	1989	2605	3078	1888	2830	1017	1096	939
5	100 +	1993	2495	3241	1842	2747	940	974	820
				URBAN INDIA					
1	0-21	2483	2709	3304	1357	3390	1070	1568	1362
2	21-34	2255	2865	3051	1339	3214	1206	1154	1031
3	34-55	2134	2533	2948	1380	3019	1304	1241	1032
4	55-100	1958	2429	2719	1036	2878	1323	1132	912
5	100+	1855	2260	2735	1437	2519	1129	849	723

Table 9. Calorie intake elasticity with respect to commodity prices and consumer income.

Expenditure group	Calorie elasticity with respect to the price of										Calorie elasticity w.r.t. consumer income
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	All cereals	Edible oil	Pulses	Other food	Non-food	
Rural India											
1	-0.322	-0.161	-0.084	0.003	-0.201	-0.765	-0.016	-0.014	-0.118	-0.099	1.012
2	-0.399	-0.117	-0.107	0.011	-0.132	-0.744	-0.024	-0.026	-0.132	-0.012	0.938
3	-0.346	-0.056	-0.042	-0.000	-0.064	-0.508	-0.026	-0.031	-0.166	-0.089	0.819
4	-0.245	-0.022	-0.040	0.006	-0.032	-0.333	-0.023	-0.027	-0.187	-0.078	0.649
5	-0.151	-0.019	-0.030	-0.002	-0.018	-0.220	-0.027	-0.019	-0.187	-0.000	0.454
Urban India											
1	-0.478	-0.099	-0.022	0.038	-0.076	-0.637	-0.031	-0.028	-0.213	-0.112	1.022
2	-0.415	-0.085	-0.073	0.038	-0.038	-0.573	-0.038	-0.031	-0.191	-0.032	0.866
3	-0.316	-0.026	-0.021	0.004	-0.013	-0.374	-0.045	-0.032	-0.232	-0.049	0.731
4	-0.183	-0.016	-0.009	0.004	-0.006	-0.210	-0.051	-0.027	-0.282	-0.064	0.635
5	-0.101	-0.003	-0.001	-0.001	-0.003	-0.109	-0.037	-0.013	-0.366	0.094	0.431

inexpensive. Such redistribution should accompany necessary increases in supplies to prevent prices from rising. The income effects on calorie consumption decline by about 50% with rises in income. In the higher income brackets, about 50% of the additional income is spent on goods and services other than calories. The intersectoral (rural/urban) differences in calorie elasticities are small compared to intrasectoral disparities.

The calorie elasticities with respect to commodity prices are quite interesting. The cereals price effect is the largest among all price effects for low income consumers. For example, a 10% increase in cereal price would force the low income consumers to reduce their calories consumption by 7-8% of which about 5% is from coarse cereals. Thus, cereal price movements are critical for the nutritional well-being of the rural and urban poor. Any increase in cereals supply, particularly coarse cereals, would have two positive effects - one a direct price effect and an indirect income effect through employment - on the welfare of rural and urban poor.

In Table 10, we present the estimates of per capita and aggregate nutritional energy gap/surplus and the income growth necessary to bridge the nutritional deficiency. Hypotheses 1 and 2 assume 2240 k.cal. and 1910 k.cal. as recommended energy requirements uniformly for all consumer groups in India. The energy gap/surplus in calories is measured in grain equivalents. The aggregate gap/surplus is also provided because size of population vary across expenditure groups. It can be seen that at both per capita and aggregate levels, the extent of energy deficiency is small and can possibly be bridged with available supplies. The apparent inadequate energy status for large segments of population seems to stem from inequitable distribution and lack of purchasing power. The income growth necessary for bridging the energy gap also seem to be moderate. However, when income transfers take place, there would be additional demand over and above the recommended levels from beneficiery populations requiring additional supplies. There would also be expansion in demand for other non-cereal products and services as a result of an increase in purchasing power. If such supplies are not forthcoming redistribution of income might only lead to providing benefits to some at the cost of others (Murty and Radhakrishna 1982).

Table 10. Per capita energy gap/surplus (grain equivalents) and income growth necessary to bridge the energy gap

Yearly per capita expenditure class in Rs.	Per capita daily intake in k.cal.	Energy Gap/Surplus per year: Per capita in KGs		Aggregate in mil. metric tons		Income growth	
		Hyp. 1	Hyp. 2	Hyp. 1	Hyp. 2	Hyp.1	Hyp.2
				R U R A L I N D I A			
0-288	1262	-102	-68	-3.12	-2.07	77	51
288-408	1772	-48	-14	-3.75	-1.11	28	8
408-660	2272	3	38	0.60	6.79	-	-
660-1200	2959	75	109	10.17	14.84	-	-
1200 +	3978	181	216	5.83	6.93	-	-
				U R B A N I N D I A			
0-252	1184	-113	-76	-0.13	-0.09	87	60
252-408	1529	-74	-40	-1.06	-0.57	54	29
408-660	1979	-27	7	-1.19	0.31	18	-
660-1200	2539	31	66	1.47	3.09	-	-
1200+	3171	97	132	1.99	2.70	-	-

Note: 1) Grain equivalents are converted at 3.5 thousand k calories per kilogram

2) Hypotheses 1 and 2 assume 2240 and 1910 k calories per capita per day as recommended energy requirements respectively.

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Table A1. Estimated Mean Price Elasticities (n_{ij}). Rural India : Group 1

	n_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other	Non-food
1. Superior cereals	-1.388	0.249	0.054	0.009	0.185	-0.003	0.002	-0.051	-0.102
2. Sorghum	0.937	-2.295	0.064	0.011	0.220	-0.004	0.002	-0.061	-0.122
3. Pearl millet	0.808	0.257	-2.181	0.010	0.190	-0.004	0.002	-0.053	-0.105
4. Chickpea	0.375	0.119	0.026	-1.033	0.088	-0.002	0.001	-0.024	-0.049
5. Other cereals	0.496	0.157	0.034	0.006	-1.256	-0.002	0.001	-0.032	-0.065
6. Edible oil	-0.187	-0.032	-0.012	-0.016	-0.148	-0.878	0.003	-0.073	-0.146
7. Pulses	-0.229	-0.040	-0.014	-0.020	-0.181	-0.006	-1.429	0.276	-0.178
8. Other food	-0.148	-0.026	-0.009	-0.013	-0.117	-0.004	0.065	-0.810	-0.115
9. Non-food	-0.101	-0.017	-0.006	-0.009	-0.080	-0.003	0.001	-0.039	-0.548

Table A2. Estimated Mean Price Elasticity (n_{ij}).

	n_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-1.268	0.184	0.065	0.027	0.093	-0.010	-0.008	-0.021	-0.012
2. Sorghum	0.759	-1.939	0.071	0.030	0.101	-0.011	-0.009	-0.023	-0.013
3. Pearl millet	0.894	0.237	-2.440	0.035	0.120	-0.013	-0.010	-0.027	-0.016
4. Chickpea	0.579	0.153	0.054	-1.611	0.077	-0.008	-0.007	-0.018	-0.010
5. Other cereals	0.425	0.112	0.040	0.017	-1.141	-0.006	-0.005	-0.013	-0.007
6. Edible oil	-0.077	-0.013	-0.001	-0.006	-0.050	-0.669	-0.007	-0.019	-0.011
7. Pulses	-0.091	-0.016	-0.001	-0.007	-0.059	-0.011	-0.911	0.094	-0.013
8. Other food	-0.101	-0.018	-0.001	-0.008	-0.066	-0.012	0.016	-0.925	-0.015
9. Non-food	-0.108	-0.019	-0.002	-0.008	-0.070	-0.013	-0.010	-0.027	-0.947

Table A3. Estimated Mean Price Elasticities (η_{ij}).

Rural India : Group 3

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-0.690	0.031	0.019	0.013	-0.008	-0.014	-0.018	-0.051	-0.088
2. Sorghum	0.349	-0.676	0.009	0.006	-0.004	-0.007	-0.009	-0.025	-0.044
3. Pearl millet	0.379	0.017	-0.740	0.007	-0.004	-0.008	-0.010	-0.028	-0.047
4. Chickpea	0.411	0.018	0.011	-0.806	-0.005	-0.008	-0.011	-0.030	-0.051
5. Other cereals	0.169	0.007	0.004	0.003	-0.336	-0.003	-0.004	-0.012	-0.021
6. Edible oil	-0.228	-0.042	-0.021	-0.012	-0.068	-0.460	-0.023	-0.066	-0.113
7. Pulses	-0.229	-0.043	-0.021	-0.012	-0.068	-0.018	-0.630	0.098	-0.113
8. Other food	-0.353	-0.066	-0.032	-0.019	-0.105	-0.028	-0.003	-0.818	-0.171
9. Non-food	-0.271	-0.050	-0.025	-0.014	-0.080	-0.021	-0.027	-0.078	-0.659

Table A4. Estimated Mean Price Elasticities (η_{ij}).

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior	-0.481	0.030	0.068	0.027	0.018	-0.009	-0.014	-0.050	-0.056
2. Sorghum	0.327	-0.574	0.037	0.015	0.010	-0.005	-0.008	-0.027	-0.030
3. Pearl millet	0.756	0.037	-1.276	0.034	0.022	-0.011	-0.018	-0.063	-0.070
4. Chickpea	0.603	0.030	0.068	-1.058	0.018	-0.009	-0.014	-0.050	-0.056
5. Other cereals	0.201	0.010	0.023	0.009	-0.356	-0.003	-0.005	-0.017	-0.019
6. Edible oil	-0.205	-0.025	-0.017	-0.009	-0.037	-0.372	-0.027	-0.095	-0.107
7. Pulses	-0.122	-0.015	-0.010	-0.005	-0.022	-0.010	-0.362	0.077	-0.064
8. Other food	-0.317	-0.039	-0.026	-0.014	-0.057	-0.026	-0.020	-0.719	-0.165
9. Non-food	-0.348	-0.043	-0.028	-0.016	-0.062	-0.029	-0.047	-0.162	-0.786

Table A5. Estimated Mean Price Elastlcities (η_{ij}).

Rural India : Group 5

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-0.387	0.039	0.040	0.003	0.022	-0.004	-0.008	-0.047	-0.000
2. Sorghum	0.596	-0.961	0.041	0.003	0.023	-0.004	-0.008	-0.049	-0.000
3. Pearl millet	0.596	0.041	-0.960	0.003	0.023	-0.004	-0.008	-0.049	-0.000
4. Chickpea	0.121	0.008	0.008	-0.203	0.005	-0.001	-0.002	-0.010	-0.000
5. Other cereals	0.235	0.016	0.016	0.001	-0.385	-0.002	-0.003	-0.019	-0.000
6. Edible oil	-0.147	-0.009	-0.010	-0.008	-0.019	-0.608	-0.021	-0.131	-0.000
7. Pulses	-0.070	-0.005	-0.005	-0.004	-0.009	-0.005	-0.477	0.119	-0.000
8. Other food	-0.107	-0.007	-0.007	-0.005	-0.014	-0.008	0.008	-0.552	-0.000
9. Non-food	-0.245	-0.016	-0.016	-0.013	-0.033	-0.018	-0.035	-0.219	-1.000

Table A6. Estimated Mean Price Elasticities (η_{ij}).

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-1.230	0.157	0.059	0.065	0.062	-0.007	-0.002	-0.054	-0.117
2. Sorghum	0.841	-1.542	0.038	0.043	0.041	-0.005	-0.001	-0.035	-0.076
3. Pearl millet	1.105	0.135	-2.110	0.056	0.053	-0.006	-0.002	-0.046	-0.100
4. Chickpea	1.522	0.185	0.069	-2.898	0.073	-0.009	-0.002	-0.064	-0.138
5. Other cereals	0.671	0.082	0.031	0.034	-1.280	-0.004	-0.001	-0.028	-0.061
6. Edible oil	-0.140	-0.054	-0.010	-0.004	-0.036	-0.817	-0.002	-0.064	-0.139
7. Pulses	-0.163	-0.063	-0.012	-0.004	-0.042	-0.010	-1.067	0.047	-0.162
8. Other food	-0.131	-0.050	-0.010	-0.003	-0.033	-0.008	0.017	-0.835	-0.130
9. Non-food	-0.088	-0.034	-0.006	-0.002	-0.022	-0.005	-0.002	-0.040	-0.592

Table A7. Estimated Mean Price Elasticities (η_{ij}).

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-1.142	0.178	0.064	0.069	0.074	-0 009	-0.012	-0.029	-0.031
2. Sorghum	0.898	-1.528	0.042	0.045	0.048	-0.006	-0.008	-0.019	-0.021
3. Pearl millet	1.180	0.152	-2.105	0.059	0.064	-0.008	-0.010	-0.025	-0.027
4. Chickpea	1.625	0.210	0.075	-2.894	0.088	-0.011	-0.014	-0.035	-0.037
5. Other cereals	0.717	0.093	0.033	0.036	-1.274	-0.005	-0.006	-0.015	-0.016
6. Edible oil	-0.148	-0.048	-0.010	-0.005	-0.031	-0.767	-0.015	-0.038	-0.041
7. Pulses	-0.129	-0.042	-0.009	-0.004	-0.027	-0.010	-0.675	-0.029	-0.036
8. Other food	-0.167	-0.054	-0.011	-0.005	-0.035	-0.013	-0.016	-0.897	-0.047
9. Non-food	-0.163	-0.053	-0.011	-0.005	-0.034	-0.013	-0.017	-0.042	-0.878

Table A8. Estimated Mean Price Elasticities (η_{ij}).

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-0.657	0.177	0.038	0.013	0.030	-0.010	-0.012	-0.032	-0.033
2. Sorghum	1.420	-1.946	0.042	0.014	0.033	-0.011	-0.013	-0.035	-0.036
3. Pearl millet	0.871	0.119	-1.286	0.009	0.020	-0.007	-0.008	-0.022	-0.022
4. Chickpea	0.677	0.092	0.020	-1.014	0.016	-0.005	-0.006	-0.017	-0.017
5. Other cereals	0.608	0.083	0.018	0.006	-0.903	-0.005	-0.006	-0.015	-0.015
6. Edible oil	-0.226	-0.027	-0.012	-0.006	-0.015	-0.569	-0.025	-0.067	-0.068
7. Pulses	-0.161	-0.019	-0.008	-0.004	-0.011	-0.015	-0.588	0.134	-0.048
8. Other food	-0.311	-0.037	-0.016	-0.008	-0.021	-0.028	-0.007	-0.872	-0.094
9. Non-food	-0.310	-0.037	-0.016	-0.008	-0.021	-0.028	-0.034	-0.092	-0.845

Table A9. Estimated Mean Price Elasticities (η_{ij}).

	η_{ij}								
	Superior cereals	Sorghum	Pearl millet	Chickpea	Other cereals	Edible oil	Pulses	Other food	Non-food
1. Superior cereals	-0.287	0.077	0.032	0.015	0.010	-0.004	-0.005	-0.015	-0.020
2. Sorghum	1.274	-1.373	0.015	0.007	0.005	-0.002	-0.002	-0.007	-0.009
3. Pearl millet	0.910	0.026	-0.996	0.005	0.003	-0.001	-0.002	-0.005	-0.007
4. Chickpea	0.910	0.026	0.011	-1.002	0.003	-0.001	-0.002	-0.005	-0.007
5. Other cereals	0.309	0.009	0.004	0.002	-0.340	-0.001	-0.001	-0.002	-0.002
6. Edible oil	-0.201	-0.013	-0.008	-0.004	-0.008	-0.523	-0.025	-0.073	-0.096
7. Pulses	-0.093	-0.006	-0.004	-0.002	-0.004	-0.010	-0.385	0.109	-0.044
8. Other food	-0.301	-0.020	-0.012	-0.005	-0.012	-0.031	-0.022	-0.876	-0.143
9. Non-food	-0.283	-0.019	-0.011	-0.005	-0.011	-0.029	-0.035	-0.102	-0.839

Consumption and Nutritional Patterns of
ICRISAT Mandate Crops in India

ABSTRACT

Consumption and nutritional patterns of ICRISAT mandate crops vis-a-vis their substitutes/complements are analysed using complete demand systems approach. Linear Expenditure Systems are estimated separately for ten rural/urban expenditure groups using pooled time series of cross-sections data published by the National Sample Survey Organization. Efforts are made to link consumption patterns with income distribution explicitly.

In 1973-74, about 63% of rural and 47% of urban populations had incomes below the poverty level. They spend more than half their incomes on cereals alone. Within cereals, rice plus wheat claim about 37% and 34% in rural and urban poor household's budget; while the share of mandate crop aggregates (coarse cereals, pulses and oilseeds) range between 21-32% in rural and 15-33% in urban areas of India respectively.

The expenditure elasticities for food items are quite large and approach unity for poorer households. Both the budget shares and expenditure elasticities decline with income for food items;while they rise for nonfood (luxury) items. This implies that any increase in cereals supply due to technological breakthroughs would be largely absorbed by these poorer segments of the population. There is also the well known shift from staple to processed food and nonfood items with rise in income. The direct price elasticities are more volatile than the expenditure elasticities. Most of them are numerically large implying substantial price response. Quite a few of the cross-price responses are sizable, indicating reallocation of income based on relative prices and justifying the demand systems approach.

An attempt is also made to translate the demand parameters from quantity to nutritional dimension, viz. calorie comsumption. The results broadly reinforce the findings based on quantity estimates. Cereals contribute the highest share in nutrient energy consumption for poorer households. Sorghum supplies more than 10% of calorie intake. Calorie deprivation is higher in urban than in rural areas. Its severity is, however, more in the latter. In both rural and urban areas, other cereals, pearl millet and sorghum are the cheapest sources of nutrient energy. Thus, research strategies aimed at supplying inexpensive food to nutritionally deficient populations should assign highest priority to increase yields of these mandate crops.