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Combating Nutrient Deficiency in Pakistan

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To quantify the micronutrient deficiencies and their overtime trends, food quantities reported to be consumed in HIES surveys data during 1991-92 and 2011-12 are converted into major and micronutrients using the FAO Food Composition Table for Pakistan. To see the impact of different price and income support policies on micronutrient consumption, nutrient demand elasticities are estimated for 2011-12 for carbohydrates (energy), protein, calcium, vitamin A, vitamin C, vitamin B_1, vitamin B_2, and Niacin. The Almost Ideal Demand System (AIDS) is applied to estimate the demand elasticities of the eight food groups which are then converted into nutrient demand elasticities using the transformation of Hunag (1996). On average, per capita consumptions of almost all micronutrients are deficient compared to their respective recommended levels. Our analysis suggest that income support to the poor in Pakistan through programmes like BISP would have been much more effective to eradicate nutrient deficiency, if deficient nutrient(s) are targeted and support is provided to those foods having highest demand elasticity for that nutrient. For example, the promotion of wheat and other cereals are important to eradicate energy deficiency, and promotion of vegetables, fruits, and milk are particularly important in eradicating vitamin A, C and iron deficiencies. These commodities are also high value crops for farmers, thus the price support in these crops will also impact micronutrient consumption through income effect.

INTRODUCTION

Estimates of micronutrient deficiencies are alarmingly high in Pakistan, especially among children and women. According to the National Nutritional Survey of Pakistan conducted in 2011-12, two out of every (44 percent) children under five years are stunted, 15 percent have wasting and 32 percent are have underweight problem, while 15 percent of women in the productive age have chronic energy deficiency (low BMIs) all suggesting a serious malnutrition problem among women and children. Micronutrient deficiencies are also very serious: 27 percent women and 44 percent children are iron deficient; 68 percent of women and 54 percent of children under the age 5 are quoted as Vitamin A deficient; over 58 percent of women have calcium deficiency, and 69 percent are vitamin D deficient. Despite an increase in food availability, most of the

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micronutrient deficiency measures have deteriorated overtime since the last survey was conducted in 2011 [NNT (2011)].[1]

Promotion of appropriate food can be an important strategy to overcome targeted nutrient deficiencies. For this purpose, policy makers should know what commodity can be the most effective with a given incentive, in eradicating a particular nutrient deficiency in the population. Although, food composition table does provide nutrient density of various nutrients in different commodities consumed, however, it does not incorporate the income or price response of the commodity. A commodity may be densed in a nutrient but it may not response to the policy incentive thus can play a little role to improve its efficiency. This paper estimates the nutrient demand elasticities at the food group level which indicate the change in the consumption of various nutrients with a given change in price or income support to the consumers. These elasticities can be applied in simulating the impact of various price policies and market shocks in the domestic and international markets.

Poverty or low-income is one of the primary causes of nutrient malnutrition because it has close link with the factors responsible for such malnutrition, like inadequate access to food and lack of knowledge about nutritive importance of various foods. For example, in Pakistan, the incidence of iron deficiency is relatively higher among adults from low-income families [Yaqoob and Abbasi (2002)]. Similarly, highly significant difference in parents' monthly income was found between the children (1-2 years of age) suffered from iron deficiency anemia and those who did not [Ali and Zuberi (2001)]. In rural Hyderabad of India, boys belonging to better income group were having better childhood nutritional status as compared with the boys from lower wage earning families [Satyanaryana, *et al.* (1980)]. Being important in micronutrient deficiency, the analysis in this paper is conducted by income group.

The region in which a household lives also plays an important role in defining micronutrient deficiencies. Normally people lives in urban areas have better access to food compared to those in rural areas as food can travel from many production centres in the urban market while such connection of rural markets is limited. Therefore, this analysis is also conducted by rural and urban regions.

To quantify the effect of policy support on nutrient supply, demand elasticities of 8 food groups and 9 nutrients are estimated. A comprehensive household consumption survey data set collected from throughout Pakistan during 1991-92 and 2011-12 by Federal Bureau of Statistics enabled us to generate the nutrient demand elasticities separately for each year. The large sample effectively allowed us to incorporate the household characteristics in the demand estimation including income of the household.

This study is organised into six sections. The next section provides a brief review on the development of the estimation of commodity and nutrient demand elasticities,

[1]According to the National Nutrition Survey 2001-02 (NNS 2011-12), about 13 percent women pregnant during the time of survey complained the night blindness, which has increased from 10 percent during the last pregnancy. Bitot's spots (a clinical sign of vitamin-A deficiency) were found in 1.2 percent children of below 5 years age during the NNS 2001-02, which increased to 2.0 percent children in the NNS 2011-12. The incidence of anemia as conjunctiva pallor reported among 48.7 percent mothers in NNS 2001-02 was increased to 52 percent in the NNS 2011-12. Anemia was clinically found in 21.9 percent and 29 percent children of age below 5 years in the respective surveys [Pakistan (2002 and 2012)].

followed by a section on the description of methodologies used in this study for estimating the nutrient demand elasticities at food group level. Next is a section on data description and estimation procedures. The results and discussion section covers discussion on consumption patterns, existing status and trends of nutrient availability in Pakistan, and demand and nutrient elasticities of the nine chosen nutrients. The final section concludes at summarising the findings and suggesting policy implications.

REVIEW OF LITERATURE

Lancaster (1966) had first conceptually linked the food choices and nutritional status. However, his approach was considered difficult to implement at that time as it involved non-linear programming to obtain nutritional implications of food consumption [Huang (1996)]. Adrian and Daniel (1976), Basiotis, *et al.* (1983) and Devaney and Fraker (1989) estimated demand for specific nutrients as a function of income and socio-demographic variables. Pitt (1983), Sahn (1988) and Gould, *et al.* (1991) proposed a formulation to calculate nutrient elasticities; however, no information was conferred about underlying derivation of demand model [Huang (1996)].

In this analysis, the Almost Ideal Demand System (AIDS) due to Deaton and Muellbauer (1980) was applied to estimate the demand function for major food groups. The reason is that AID permits a full range of commodities (complementary and substitute goods, normal and inferior goods). Moreover, AIDS has theoretical superiority as being flexible in allowing, but not requiring, the general restrictions of demand theory to hold [Farooq, *et al.* (1999)]. The specification not only helps to estimate the own-price, but also cross- price and income elasticities of demand. Using these demand elasticities and nutritional shares of various food groups in total food, nutritional elasticities are estimated using the transformation of Hunag (1996).

RESEARCH METHODOLOGY

Demand Analysis

Almost Ideal Demand System (AIDS)

The estimation of AIDS has been carried out using a system of equations comprising household budget shares for the food group. For the *I*th[2] food group, the budget share equation used for empirical estimation was,

$$\omega_I = \alpha_I + \sum_{i=1}^{n} \gamma_I \ln p_I + \beta_I \ln\left(\frac{M_I}{PI_I}\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where ω is the budget share of the *I*th food group, $\alpha_I = \alpha_I^* + \sum_{h=1}^{s} \delta_{ih,I} H_h$, p is price, M_I is the total food consumption expenditure on the *I*th food group, H_h pertains to the

[2]In the subsequent text, I, J and i,j refers to food groups and individual commodities/sub-groups within a food group, respectively.

household characteristics, and PI_I is the price index for the food group under consideration, defined by:

$$\ln PI_I = \alpha_{o,I} + \sum_{i,I=1}^{n} \alpha_{i,I} \ln p_{i,I} + \tfrac{1}{2} \sum_{i,I=1}^{n} \sum_{j,I=1}^{n} \gamma_{ij,I} \ln p_I \ln p_I \quad \ldots \quad \ldots \quad (2)$$

The α^*, γ, β, δ are parameters, to be estimated, with the following restrictions:

$$\text{Adding up:} \quad \sum_{iI=1}^{n} \alpha_I = 1 \quad \sum_{I=1}^{n} \beta_I = 0 \quad \sum_{I=1}^{n} \gamma_I = 0 \quad \sum_{I=1}^{n} \delta_I = 0 \ (h=1\ldots.s) \quad \ldots \quad (3)$$

$$\text{Homogeneity:} \quad \sum_{I=1}^{n} \gamma_I = 0 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$\text{Symmetry:} \quad \gamma_{ij,I} = \gamma_{ji,I} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Since the budget shares add up to unity, therefore, during estimation one share equation was arbitrarily dropped to make the system non-singular. Equation (1) along with restrictions (3) and (5) were estimated using full information maximum likelihood method by following the iteration sequence as described by Fan, *et al.* (1995). Following Blanciforti, *et al.* (1986), the uncompensated income, own-price and cross-price elasticities were computed from the parameter estimates using the following expressions.

$$\text{Income elasticity:} \quad \eta_{i,I} = \frac{\beta_{i,I}}{\omega_{i,I}} + 1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

$$\text{Own-price elasticity:} \quad \varepsilon_{ii,I} = -1 + \frac{\gamma_{ij,I}}{\omega_{i,I}} - \frac{\beta_{i,I}\alpha_{i,I}}{\omega_{i,I}} - \frac{\beta_{i,I}}{\omega_{i,I}} \sum_{J,I} \gamma_{ij,I} \ln p_{j,I} \quad \ldots \quad (7)$$

$$\text{Cross-price elasticity:} \quad \varepsilon_{ij,I} = \frac{\gamma_{ij,I}}{\omega_{i,I}} - \frac{\beta_{i,I}\alpha_{i,I}}{\omega_{i,I}} - \frac{\beta_{i,I}}{\omega_{i,I}} \sum_{J,I} \gamma_{ij,I} \ln p_{j,I} \quad \ldots \quad (8)$$

Nutrient Elasticities Estimation

Following Huang (1996), income and price elasticities were estimated as follows:

$$d\phi_k / \phi_k = \sum_{j=1}^{n} \left(\sum_i \varepsilon_{ij} a_{ki} X_i / \phi_k \right) dp_j / p_j + \left(\sum_i \eta_i a_{ki} X_i / \phi_k \right) dM/M$$

$$d\phi_k / \phi_k = \sum_{j=1}^{n} \pi_{kj}\, dp_j / p_j + \rho_k\, dM/M \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

where ϕ_k represents the total amount of *k*th nutrient obtained from various foods, $\pi_{kj} = \sum_i \varepsilon_{ij} a_{ki} X_i / \phi_k$ symbolises the weighted average effect on the availability of the *k*th nutrient in response to a change in the price of the *j*th food group through the effect of all own and cross-price elasticities,[3] and $\rho_k = \sum_i \eta_i a_{ki} X_i / \phi_k$ is an income elasticity

[3]The $a_{ki}X_i/\phi_k$ is the share of the *i*th food group in total amount of the *k*th nutrient available to the household, whereas ε_{ij} is own and cross price elasticities of the commodity.

measuring the effect of changes in income on the *k*th nutrient availability. The general calculation of nutrient elasticity matrix consisted of l nutrients and n foods can be obtained as follows:

$$N = S \times D \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Where N is the $l \times (n + 1)$ matrix of nutrient elasticities (the first n columns are price elasticities while the last column is for income elasticities), S is the $l \times n$ matrix of food shares with rows indicating food shares of a particular nutrient, and D is the $n \times (n + 1)$ matrix of demand elasticities. Each element in nutrient elasticities matrix N, indicates the extent and direction of quantitative change in the intake of a certain nutrient, when the market price of a food group changes or income of the consumer alters. The nutrient price elasticity indicates the percentage change in the availability of that nutrient with one percent change in the price of *i*th food group through own- and cross-price elasticity effects. This implies that the nutrient price elasticity contains the total effect of the change in the price of the food group under consideration as well as the cross effects (substitution and complementary) of other groups.

DATA AND ESTIMATION PROCEDURES

Data Sources

The data from the Household Income and Expenditure Surveys (HIES) for the years 1991-92 and 2011-12 are used for this study. Conducted by the Pakistan Bureau of Statistics, the households are randomly selected using two stage stratified random sampling approach. The data includes monthly consumption of food and non-food items with some details of food items, monthly expenditure on each item, family structure, income from all sources, and selected socioeconomic characteristics of the family. About 150 food items were found consumed in raw/fresh, semi-prepared and fully prepared forms.

A small sample who did not consume one or more of the food group was excluded from the analysis. Thus, a 14,036 household out of the total of 14,594 from 1991-92 survey, while 12,705 out of 15,807 households from 2011-12 survey are used in this study. These households were then grouped on the basis of income and regional location in order to obtain a clearer understanding of how household consumption and food expenditure patterns have changed within each stratum over the time period of twenty year.

All food items consumed by a family were transformed into per capita availability and classified into eight broad groups, i.e. wheat, other cereals, meats, pulses, milk products and fats, fruits, vegetables and miscellaneous. Details of these food group classifications are presented in Annexure 2.

Finally, using nutrient content information from Food Composition Table for Pakistan [Pakistan (2001)], per capita nutrient intake and nutrient shares of various food groups are estimated. The weighted average per capita nutrient requirements are estimated using household mean of age and sex composition information from our data and age and gender specific Recommended Dietary Allowances (RDAs) from Food and Nutrition Board (1989). The nutrient analysis pertains to nine essential nutrients and

micronutrients. These are carbohydrates (energy), protein, calcium, vitamin A, vitamin C, vitamin B_1, vitamin B_2, and Niacin.

RESULTS AND DISCUSSION

This section is divided into three sub-sections. First the descriptive statistics are discussed. The remaining two subsections discuss demand and nutrient elasticities, respectively.

Characteristics of the sample households

As shown in Table 1, some of the household characteristics used in this study included average family size, average age of household head, percentage of household in possession of a refrigerator and percentage of households with radios and/or television sets.

Table 1

Sample Household Characteristics by Income and Region

	Average Family Size (Number)		Head Age		Possession of Refrigerator (%)		Possession of Radio/TV (%)	
	1991-92	2011-12	1991-92	2011-12	1991-92	2011-12	1991-92	2011-12
Low-Income	5.6	5.39	42.96	43.62	3.35	21.98	9.05	47.15
High-Income	7.68	7.52	46.46	49.1	24.36	62.81	15.98	76.72
Rural Region	6.47	6.67	44.56	45.95	4.5	27.15	11.79	48.3
Urban Region	6.83	6.4	44.82	47.35	28.26	63.2	13.42	80.85
Overall	6.61	6.55	44.66	46.56	13.54	43.73	12.41	63.27

There has been a slight overall decline in the average household size over the two rounds of surveys with average household size of higher income households remains significantly larger. With respect to region, however, the previously observed trend of larger households found in the urban sector has been reversed in 2011-12. Moreover, while the average household size in the urban region has decreased, in the rural areas it has increased.

The average age of household head has increased over the time period of 1991-92 to 2011-12 as access to health facilities has increased. An interesting statistic to note is that while the percentage of households reporting ownership of refrigerators has increased, it still remains at about 63 percent even for the higher income group. For the overall population, more than half the population still lack proper food storage facilities.

Consumption Patterns

Table 2 presents average daily per capita consumption quantities of the eight food groups, with respect to income and region while Table 3 gives the respective shares of each.

The average daily per capita quantity of food consumed has remained stagnant at around one kilogram over the two time periods. The composition of this intake however is observed to have changed significantly.

Table 2

Table 3

There has been a decrease in wheat, pulse and vegetables consumption. While the decline is wheat consumption may be attributed to less strenuous life style, decrease in pulses implies a loss of good protein source and decreasing of vegetable consumption implies loosing of a good vitamin and mineral source.

The biggest increase has been in the consumption of fruits, from about 22 grams to 96 grams per person per day on average. Consumption of meat and poultry has also increased, followed by miscellaneous food items. However, looking the composition of different meats consumed, the consumption of poultry has increased while that of red meat has decreased, again has a consequences on the availability of micronutrient iron.

While the daily food intake of higher income household has increased between 1991-92 and 2011-12, it has decreased by 4.6 percent for the low income household over the same period. The decline in the consumption of vegetables and pulses by low income group has been more dramatic than by the high income group. This indicates overtime deteriorating food security situation for the lower income group. A similar trend is also observed been rural and urban regions, with the average daily consumption of urban areas increasing while that of rural areas declining. This latter trend however could be attributed to changes in work patterns in the rural sectors, which may not require extensive manual labour and subsequent energy demand.

Consumption Expenditures

The expenditure on food has increased by almost six times from Rs 294 in 1991, to Rs 1718 in 2011, as depicted in Table 4. The highest increase has been in the expenditure of meat and poultry. Surprisingly, the per capita expenditure on pulses has decreased significantly between the two time periods. This also corresponds with the fall in per capita consumption of pulses, as previously discussed.

Table 4

Average per capita Monthly Expenditure

	Monthly Expenditure (Rs.)									
	Low-income		High-income		Rural		Urban		Overall	
Food Groups	1991-92	2011-12	1991-92	2011-12	1991-92	2011-12	1991-92	2011-12	1991/92	2010/11
Wheat	45.1	251.3	44.0	245.2	45.8	261.4	42.5	231.7	44.6	248.1
Other Cereals	16.7	69.5	18.2	91.3	17.9	80.1	16.7	82.3	17.4	81.1
Pulses	9.4	1.3	10.4	1.5	9.6	1.4	10.4	1.5	9.9	1.4
Milk Products and Fat	82.5	567.3	97.0	707.1	88.0	611.5	92.0	678.4	89.5	641.6
Meats	20.3	183.8	43.4	292.1	24.2	194.7	43.4	298.3	31.5	241.4
Fruits	7.1	38.4	15.7	82.8	8.3	45.0	16.1	82.8	11.3	62.0
Vegetables	26.9	153.7	31.6	165.8	27.2	155.6	32.3	165.8	29.1	160.2
Miscellaneous	50.1	250.3	70.8	310.3	51.7	253.4	73.8	317.4	60.1	282.2
Total	258.0	1,515.7	331.2	1,896.1	272.7	1,602.9	327.2	1,858.2	293.5	1,718.0

Table 5 presents the respective expenditure shares of each food group as a percentage of total expenditure. The highest expenditure share, over both the periods, across income groups and regions, has been on milk products and fats while the overall lowest expenditure share was for pulses. As seen in the preceding paragraph, the highest decrease in budget share has been for pulses while the expenditure share on meat group has increased the most. This suggests that there has been a shift away from a cheaper source of protein to meat and poultry, which is a more expensive source.

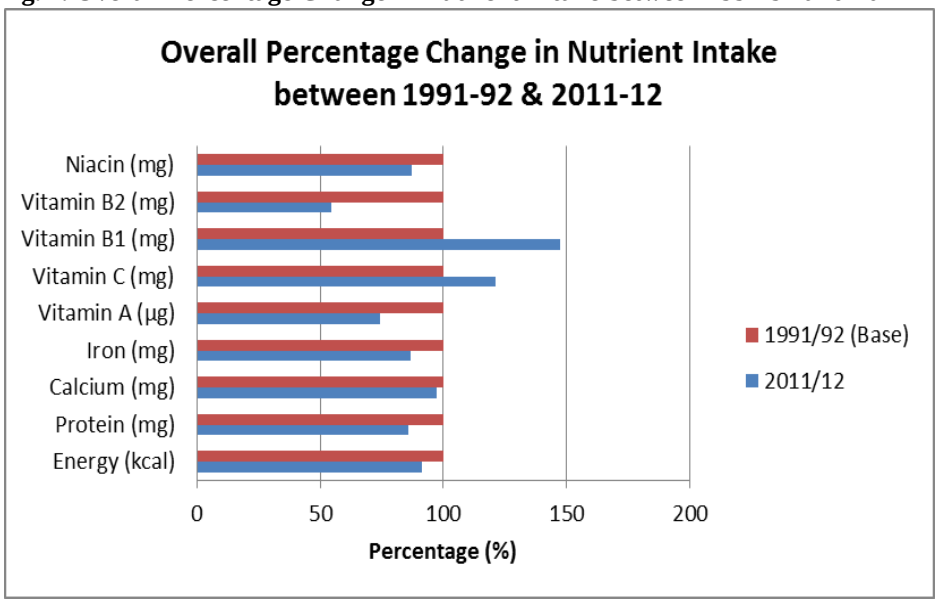
Table 5

Interestingly, while there has been a significant increase in consumption of fruit, its share in total food expenditure has in fact decreased by 6 percent. In addition, while the consumption of other cereals food group has declined overall by about 50 percent, only a 20.5 percent reduction in its budget share is observed.

Nutrients Availability

Tables 6 and 7 present average daily per capita nutrient availability by income and regions respectively. An overall picture of the changes in nutrient availability between the two time periods is shown in Figure 1.

Fig. 1. Overall Percentage Change in Nutrient Intake between 1991-92 and 2011-12



With the exception of Vitamin-C and Vitamin B_1, all other nutrients were found to be consumed below their respective daily Recommended Dietary Allowances (RDA). The high-income households were less deficient in all nutrients as compared to their counterparts in both time periods.

Region wise, rural households recorded a significantly higher intake of calcium and protein in both time periods. Iron intake, though higher for rural households in 1991-92 reduced for both the regions and now stands equal.

Analysing percentage changes in nutrient intake over the two time periods, aside from vitamin-C and Vitamin-B_1, intake of all nutrients has decreased, with the low income households performing worse than higher income one's for all nutrients.

The percentage contribution of each food group in total nutrient supply is given income wise in Table 8 and region wise in Table 9. Overall, the highest source of energy and protein, Vitamin B_1 and Niacin is wheat. Milk and fats are the highest source of calcium and Vitamin B_2. Vegetables provide the highest source of Vitamin A while for vitamin C, fruits are the leading source.

Table 6

Table 7

Table 8

Percent Contribution of Various Food Groups in Total Nutrient Supply by Income Class for the Years 2011-12

Income / Food Groups	Wheat	Other Cereals	Pulses	Milk & Fats	Meats	Fruits	Vegetables	Miscellaneous
Low Income								
Energy	51.51	5.34	1.01	24.43	1.87	2.04	1.76	12.04
Protein	59.09	4.83	2.92	18.10	7.91	1.40	3.68	2.08
Calcium	14.53	1.29	2.00	64.96	1.12	3.11	8.40	4.59
Iron	40.16	12.99	6.18	8.11	8.90	1.60	5.18	16.89
Vitamin A*	0.00	1.11	0.19	15.11	2.24	32.66	47.35	1.30
Vitamin C	0.00	12.40	0.47	3.91	0.02	36.56	43.71	2.93
Vitamin B1	60.46	5.00	1.99	7.08	1.40	9.81	5.84	8.42
Vitamin B2	32.75	3.37	3.00	38.28	6.63	3.65	8.63	3.68
Niacin	63.14	8.27	2.40	4.49	10.52	2.87	5.30	2.89
High Income								
Energy	47.08	5.58	1.06	26.30	2.99	3.16	1.77	12.06
Protein	52.19	4.93	2.94	19.62	12.23	2.09	3.57	2.42
Calcium	12.18	1.20	1.87	66.08	1.67	4.49	7.51	5.00
Iron	34.27	12.70	6.02	8.39	13.16	2.35	4.71	18.42
Vitamin A	0.00	0.93	0.19	11.65	2.63	43.07	40.37	1.13
Vitamin C	0.00	9.48	0.54	3.64	0.03	47.05	36.99	2.27
Vitamin B1	53.52	4.89	2.09	7.61	2.25	14.57	5.74	9.34
Vitamin B2	27.72	3.13	2.93	39.65	9.63	5.21	7.87	3.86
Niacin	55.84	7.93	2.56	4.80	16.38	4.24	5.20	2.88
Overall								
Energy	49.24	5.46	1.04	25.39	2.45	2.61	1.77	12.05
Protein	55.50	4.89	2.93	18.89	10.16	1.76	3.62	2.26
Calcium	13.28	1.24	1.93	65.56	1.42	3.84	7.92	4.81
Iron	37.04	12.83	6.10	8.26	11.15	1.99	4.93	17.70
Vitamin A	0.00	1.01	0.19	13.21	2.46	38.37	43.53	1.21
Vitamin C	0.00	10.78	0.51	3.76	0.02	42.40	39.97	2.57
Vitamin B1	56.85	4.94	2.04	7.36	1.84	12.28	5.79	8.90
Vitamin B2	30.08	3.24	2.96	39.01	8.22	4.48	8.23	3.78
Niacin	59.34	8.09	2.48	4.65	13.57	3.59	5.25	2.89

*Vitamin A was estimated as B-Carotene.

Table 9

Percent Contribution of Various Food Groups in Total Nutrient Supply by Region for the Years 2011-12

Income / Food Groups	Wheat	Other cereals	Pulses	Milk & Fats	Meats	Fruits	Vegetables	Miscellaneous
Rural								
Energy	51.36	5.71	0.97	24.52	1.92	2.13	1.70	11.69
Protein	58.27	5.19	2.75	18.86	8.05	1.45	3.52	1.91
Calcium	14.20	1.35	1.86	65.82	1.13	3.26	8.01	4.38
Iron	39.69	14.20	5.85	8.35	9.01	1.67	5.02	16.20
Vitamin A*	0.00	1.17	0.18	14.91	2.17	34.50	45.88	1.16
Vitamin C	0.00	11.84	0.47	3.99	0.02	38.86	42.15	2.67
Vitamin B1	60.09	5.36	1.91	7.29	1.44	10.59	5.66	7.66
Vitamin B2	32.25	3.58	2.82	39.10	6.67	3.80	8.32	3.46
Niacin	62.66	8.70	2.28	4.62	10.84	2.99	5.14	2.60
Urban								
Energy	46.26	5.11	1.14	26.60	3.17	3.29	1.86	12.55
Protein	51.69	4.46	3.18	18.93	13.07	2.18	3.76	2.74
Calcium	12.07	1.11	2.01	65.22	1.79	4.61	7.81	5.38
Iron	33.57	11.04	6.42	8.13	13.96	2.41	4.81	19.66
Vitamin A	0.00	0.82	0.20	11.12	2.82	43.13	40.63	1.27
Vitamin C	0.00	9.55	0.56	3.49	0.03	46.49	37.44	2.45
Vitamin B1	52.46	4.37	2.22	7.44	2.38	14.58	5.97	10.58
Vitamin B2	27.24	2.80	3.14	38.89	10.26	5.37	8.10	4.19
Niacin	54.82	7.27	2.75	4.70	17.28	4.40	5.40	3.27
Overall								
Energy	49.24	5.46	1.04	25.39	2.45	2.61	1.77	12.05
Protein	55.50	4.89	2.93	18.89	10.16	1.76	3.62	2.26
Calcium	13.28	1.24	1.93	65.56	1.42	3.84	7.92	4.81
Iron	37.04	12.83	6.10	8.26	11.15	1.99	4.93	17.70
Vitamin A	0.00	1.01	0.19	13.21	2.46	38.37	43.53	1.21
Vitamin C	0.00	10.78	0.51	3.76	0.02	42.40	39.97	2.57
Vitamin B1	56.85	4.94	2.04	7.36	1.84	12.28	5.79	8.90
Vitamin B2	30.08	3.24	2.96	39.01	8.22	4.48	8.23	3.78
Niacin	59.34	8.09	2.48	4.65	13.57	3.59	5.25	2.89

*Vitamin A was estimated as B-Carotene.

Demand Elasticities

The demand elasticities for eight food groups were estimated using Almost Ideal Demand System. The parameter estimates of the AIDS model were incorporated into equation (11) to (13) for estimating uncompensated price and income elasticities. For each income, region and overall strata, 64 own- and cross-price and 8 income elasticities were estimated, as reported in Tables 10 and 11. All own-price elasticities had correct (negative) signs.

Table 10

Demand Elasticities of Major Food Groups by Income Class for the Years 2011-12

Income/ Food Group	With Respect to the Price of								
	Wheat	Other Cereals	Pulses	Milk and Fats	Meats	Fruits	Vegetables	Miscellaneous	Income
Low Income									
Wheat	-0.55	-0.07	0.00	0.27	-0.13	-0.01	-0.05	-0.01	0.56
Other cereals	-0.23	-0.20	-0.09	0.28	-0.22	0.00	-0.28	-0.11	0.85
Pulses	-0.04	-0.25	-0.44	0.35	-0.59	0.03	0.08	-0.07	0.94
Milk & Fats	0.02	0.03	0.02	-1.25	-0.02	-0.01	0.05	-0.04	1.18
Meats	-0.47	-0.22	-0.20	-0.20	-0.08	0.00	-0.22	-0.18	1.58
Fruits	-0.31	-0.04	0.02	-0.17	0.01	-0.82	-0.16	0.00	1.46
Vegetables	-0.18	-0.25	0.03	0.34	-0.19	-0.03	-0.53	-0.09	0.90
Miscellaneous	-0.06	-0.05	-0.01	0.03	-0.03	0.02	-0.04	-0.69	0.83
High Income									
Wheat	-0.38	-0.13	0.02	0.29	-0.04	-0.02	0.00	-0.18	0.43
Other cereals	-0.30	-0.19	-0.04	0.17	-0.27	0.02	-0.24	0.22	0.64
Pulses	0.08	-0.13	-0.41	0.33	-0.67	0.02	0.07	-0.06	0.77
Milk & Fats	0.01	0.00	0.01	-1.22	-0.02	0.00	0.04	0.03	1.15
Meats	-0.20	-0.20	-0.15	-0.15	-0.35	-0.02	-0.17	-0.19	1.42
Fruits	-0.28	-0.05	-0.01	-0.22	-0.10	-0.87	-0.21	-0.04	1.78
Vegetables	-0.05	-0.24	0.02	0.33	-0.21	-0.06	-0.47	-0.13	0.81
Miscellaneous	-0.25	0.07	-0.01	0.13	-0.10	0.02	-0.07	-0.76	0.96
Overall									
Wheat	-0.43	-0.10	0.01	0.27	-0.10	-0.02	-0.01	-0.10	0.49
Other cereals	-0.28	-0.20	-0.07	0.22	-0.24	0.01	-0.26	0.08	0.73
Pulses	0.03	-0.18	-0.43	0.33	-0.64	0.02	0.07	-0.06	0.85
Milk & Fats	0.01	0.01	0.02	-1.23	-0.01	0.00	0.05	0.00	1.16
Meats	-0.34	-0.21	-0.17	-0.16	-0.24	-0.01	-0.20	-0.20	1.52
Fruits	-0.35	-0.04	0.00	-0.24	-0.05	-0.84	-0.21	-0.03	1.77
Vegetables	-0.08	-0.25	0.03	0.33	-0.21	-0.05	-0.49	-0.11	0.84
Miscellaneous	-0.18	0.02	-0.01	0.08	-0.06	0.02	-0.06	-0.72	0.90

Table 11

Demand Elasticities of Major Food Groups by Region for the Years 2011-12

Income/ Food Group	With Respect to the Price of								
	Wheat	Other Cereals	Pulses	Milk and Fats	Meats	Fruits	Vegetables	Miscellaneous	Income
Rural									
Wheat	-0.64	-0.12	0.01	0.32	-0.10	-0.01	-0.04	0.03	0.54
Other cereals	-0.32	-0.19	-0.05	0.27	-0.25	0.02	-0.26	-0.01	0.80
Pulses	0.01	-0.15	-0.35	0.31	-0.65	0.03	0.09	-0.16	0.88
Milk & Fats	0.03	0.02	0.01	-1.28	-0.02	-0.01	0.05	-0.06	1.24
Meats	-0.37	-0.24	-0.20	-0.12	-0.12	0.01	-0.23	-0.16	1.42
Fruits	-0.27	0.00	0.01	-0.21	0.03	-0.81	-0.21	-0.07	1.52
Vegetables	-0.14	-0.25	0.03	0.39	-0.22	-0.04	-0.56	-0.05	0.83
Miscellaneous	-0.02	-0.01	-0.03	0.01	-0.04	0.01	-0.03	-0.73	0.83
Urban									
Wheat	-0.29	-0.09	0.01	0.29	-0.13	-0.03	0.00	-0.20	0.43
Other cereals	-0.24	-0.17	-0.08	0.20	-0.28	0.00	-0.26	0.15	0.67
Pulses	-0.01	-0.20	-0.48	0.37	-0.59	0.02	0.06	0.03	0.81
Milk & Fats	0.03	0.01	0.02	-1.19	-0.03	0.00	0.04	0.04	1.08
Meats	-0.31	-0.19	-0.14	-0.25	-0.24	-0.02	-0.17	-0.21	1.54
Fruits	-0.33	-0.07	-0.01	-0.25	-0.10	-0.88	-0.21	-0.01	1.87
Vegetables	-0.06	-0.24	0.02	0.27	-0.20	-0.06	-0.43	-0.16	0.85
Miscellaneous	-0.26	0.04	0.00	0.14	-0.09	0.03	-0.08	-0.73	0.96
Overall									
Wheat	-0.43	-0.10	0.01	0.27	-0.10	-0.02	-0.01	-0.10	0.49
Other cereals	-0.28	-0.20	-0.07	0.22	-0.24	0.01	-0.26	0.08	0.73
Pulses	0.03	-0.18	-0.43	0.33	-0.64	0.02	0.07	-0.06	0.85
Milk & Fats	0.01	0.01	0.02	-1.23	-0.01	0.00	0.05	0.00	1.16
Meats	-0.34	-0.21	-0.17	-0.16	-0.24	-0.01	-0.20	-0.20	1.52
Fruits	-0.35	-0.04	0.00	-0.24	-0.05	-0.84	-0.21	-0.03	1.77
Vegetables	-0.08	-0.25	0.03	0.33	-0.21	-0.05	-0.49	-0.11	0.84
Miscellaneous	-0.18	0.02	-0.01	0.08	-0.06	0.02	-0.06	-0.72	0.90

Quantitatively, the own-price elasticities of fruits, meats, milk products and fats, and other cereals food group are greater than one. The same can also be observed across income groups and across regions.

Positive cross-price elasticity suggests that the two commodities are gross substitutes while negative cross-price elasticity implies that they are complementary to one another. Overall, out of 56 cross-price elasticities (off-diagonal elements), 18 were positive. Milk products and fats, fruits and pulses groups appeared to have most substitution relations while meat and poultry have a complementary relationship with its counterpart food groups.

All income elasticities have correct (positive) sign. The income elasticity of fruits and miscellaneous food groups are relatively higher in high-income households and urban households as compared with low-income households and rural households as shown in Table 11.

High expenditure elasticities ($\eta > 1$) were observed for milk products & fats, signifying them as luxuries. Similar observations can be made across income groups and regions in Tables 10 and 11 respectively.

Nutrients Elasticities

Nutrient elasticities were estimated by multiplying the matrices of demand elasticities (Tables 10 and 11) and nutrient shares for the nine nutrients (Tables 8 and 9). These nutrient elasticities are presented in Tables 12 and 13 for income groups and regions respectively.

Table 12

Nutrient Elasticities of Major Food Groups in Pakistan by Income Groups for the Years 2011-12

Income / Food Groups	Wheat	Other cereals	Pulses	Milk and Fats	Meats	Fruits	Vegetables	Miscellaneous	Income
Low Income									
Energy	-0.317	-0.056	-0.007	-0.147	-0.099	-0.023	-0.050	-0.111	0.810
Protein	-0.384	-0.081	-0.026	-0.050	-0.124	-0.020	-0.072	-0.053	0.811
Calcium	-0.101	-0.023	0.004	-0.740	-0.063	-0.032	-0.029	-0.073	1.058
Iron	-0.319	-0.109	-0.054	0.067	-0.142	-0.016	-0.105	-0.164	0.842
Vitamin A	-0.196	-0.135	0.017	-0.085	-0.093	-0.282	-0.303	-0.063	1.139
Vitamin C	-0.221	-0.150	0.007	0.074	-0.110	-0.311	-0.324	-0.074	1.109
Vitamin B1	-0.398	-0.081	-0.010	0.096	-0.119	-0.088	-0.093	-0.082	0.774
Vitamin B2	-0.241	-0.064	-0.018	-0.360	-0.098	-0.038	-0.071	-0.071	0.961
Niacin	-0.438	-0.105	-0.034	0.137	-0.137	-0.033	-0.109	-0.063	0.781
High Income									
Energy	-0.238	-0.074	0.001	-0.163	-0.078	-0.033	-0.028	-0.165	0.779
Protein	-0.247	-0.111	-0.018	-0.080	-0.115	-0.029	-0.042	-0.126	0.768
Calcium	-0.072	-0.041	0.0013	-0.747	-0.066	-0.045	-0.024	-0.054	1.047
Iron	-0.244	-0.100	-0.043	0.052	-0.168	-0.024	-0.083	-0.206	0.816
Vitamin A	-0.149	-0.124	0.000	-0.107	-0.148	-0.400	-0.281	-0.075	1.282
Vitamin C	-0.182	-0.128	-0.004	-0.008	-0.161	-0.430	-0.293	-0.060	1.265
Vitamin B1	-0.287	-0.098	-0.003	0.071	-0.097	-0.136	-0.072	-0.171	0.793
Vitamin B2	-0.155	-0.083	-0.016	-0.386	-0.108	-0.055	-0.054	-0.093	0.948
Niacin	-0.288	-0.133	-0.025	0.110	-0.140	-0.049	-0.075	-0.144	0.744
Overall									
Energy	-0.264	-0.067	-0.002	-0.159	-0.093	-0.030	-0.033	-0.141	0.790
Protein	-0.298	-0.099	-0.021	-0.070	-0.125	-0.027	-0.051	-0.095	0.786
Calcium	-0.084	-0.033	0.002	-0.744	-0.062	-0.039	-0.027	-0.063	1.050
Iron	-0.273	-0.105	-0.048	0.055	-0.159	-0.021	-0.090	-0.187	0.827
Vitamin A	-0.180	-0.129	0.006	-0.112	-0.124	-0.344	-0.300	-0.074	1.256
Vitamin C	-0.213	-0.138	-0.001	0.012	-0.137	-0.374	-0.316	-0.069	1.236
Vitamin B1	-0.327	-0.092	-0.006	0.074	-0.114	-0.114	-0.078	-0.133	0.789
Vitamin B2	-0.189	-0.075	-0.017	-0.376	-0.105	-0.048	-0.061	-0.085	0.955
Niacin	-0.346	-0.122	-0.029	0.118	-0.145	-0.043	-0.086	-0.109	0.762

Table 13

Nutrient Elasticities of Major Food Groups in Pakistan by Region for the Years 2011-12

Income / Food Groups	Wheat	Other cereals	Pulses	Milk and Fats	Meats	Fruits	Vegetables	Miscellaneous	Income
Rural									
Energy	-0.354	-0.076	-0.004	-0.131	-0.088	-0.022	-0.042	-0.091	0.808
Protein	-0.420	-0.106	-0.019	-0.031	-0.112	-0.017	-0.065	-0.027	0.797
Calcium	-0.097	-0.029	0.003	-0.762	-0.062	-0.036	-0.027	-0.079	1.091
Iron	-0.342	-0.116	-0.043	0.083	-0.144	-0.014	-0.098	-0.139	0.813
Vitamin A	-0.164	-0.120	0.016	-0.081	-0.099	-0.301	-0.326	-0.070	1.144
Vitamin C	-0.200	-0.129	0.011	0.067	-0.115	-0.331	-0.343	-0.073	1.113
Vitamin B1	-0.440	-0.100	-0.004	0.117	-0.103	-0.091	-0.090	-0.057	0.768
Vitamin B2	-0.250	-0.077	-0.014	-0.361	-0.094	-0.038	-0.068	-0.061	0.965
Niacin	-0.481	-0.131	-0.026	0.172	-0.127	-0.029	-0.102	-0.028	0.750
Urban									
Energy	-0.195	-0.056	-0.005	-0.161	-0.116	-0.038	-0.031	-0.177	0.779
Protein	-0.214	-0.092	-0.029	-0.078	-0.148	-0.035	-0.046	-0.144	0.785
Calcium	-0.060	-0.032	0.0020	-0.720	-0.082	-0.045	-0.026	-0.051	1.015
Iron	-0.229	-0.092	-0.054	0.046	-0.178	-0.027	-0.086	-0.227	0.848
Vitamin A	-0.177	-0.131	-0.002	-0.135	-0.141	-0.403	-0.267	-0.076	1.333
Vitamin C	-0.203	-0.136	-0.009	-0.033	-0.157	-0.429	-0.283	-0.065	1.316
Vitamin B1	-0.248	-0.081	-0.013	0.070	-0.138	-0.142	-0.074	-0.189	0.816
Vitamin B2	-0.142	-0.072	-0.021	-0.378	-0.125	-0.058	-0.056	-0.100	0.951
Niacin	-0.256	-0.113	-0.038	0.094	-0.169	-0.057	-0.078	-0.168	0.785
Overall									
Energy	-0.264	-0.067	-0.002	-0.159	-0.093	-0.030	-0.033	-0.141	0.790
Protein	-0.298	-0.099	-0.021	-0.070	-0.125	-0.027	-0.051	-0.095	0.786
Calcium	-0.084	-0.033	0.002	-0.744	-0.062	-0.039	-0.027	-0.063	1.050
Iron	-0.273	-0.105	-0.048	0.055	-0.159	-0.021	-0.090	-0.187	0.827
Vitamin A	-0.180	-0.129	0.006	-0.112	-0.124	-0.344	-0.300	-0.074	1.256
Vitamin C	-0.213	-0.138	-0.001	0.012	-0.137	-0.374	-0.316	-0.069	1.236
Vitamin B1	-0.327	-0.092	-0.006	0.074	-0.114	-0.114	-0.078	-0.133	0.789
Vitamin B2	-0.189	-0.075	-0.017	-0.376	-0.105	-0.048	-0.061	-0.085	0.955
Niacin	-0.346	-0.122	-0.029	0.118	-0.145	-0.043	-0.086	-0.109	0.762

72 price and 9 income elasticities of nutrient intakes were calculated for each stratum. Overall, only 6 were carrying positive sign. This implies that lowering prices of any food group would help alleviating micronutrient deficiency. The number of positive sign carrying elasticities was 7 and 8 in low- and high-income groups, respectively. This suggests that lowering prices of any food group would enhance the consumption of majority of micronutrients with almost similar impacts on both income classes (Table 12).

Comparing nutrient elasticities across food groups revealed that fruits and vegetables have much higher nutrient price elasticities than other food groups for vitamin A and vitamin C suggesting highly significant role of vegetables in alleviating the deficiency of these micronutrients when their prices are reduced through technological innovations. The magnitude of nutrient price elasticities for vitamin B_1 from vegetables is third highest in rank, suggesting that vegetable can also be important in controlling the deficiency of this micronutrient. Milk products and fats are most important in alleviating the deficiency of calcium and vitamin B_2.

The nutrient elasticities with respect to change in income are also quite high (> 0.7) for all micronutrients. A 10 percent rise in the per capita household income would lead to more than proportionate consumption of calcium, vitamin A, and vitamin C, and

between 7–10 percent enhancement in the consumption of all other nutrients. Considering the facilitative role of vitamin C and niacin in proper utilisation of vitamin B_1 and B_2 with their significantly high nutrient elasticities further strengthen the role of vegetables in alleviating the micronutrient deficiency in Pakistan. The same can be observed across income groups (Table 12) and thus it can be concluded that lowering the prices of vegetables through appropriate policies and technological interventions would significantly help alleviating the deficiency of majority of nutrients.

SUMMARY AND SUGGESTIONS

The widespread nutrient deficiency in Pakistan and its implications on human health and productivity signify the need of appropriate strategy for their control. In the food-based approach, increased consumption of nutrient-rich foods carries significant role in mitigating these deficiencies. For this to be more effective, however, the information on nutrient density as well as consumers' response to various income and price policies is required.

While food composition table does provide densities of various nutrients in different food items, information on the responsiveness of various nutrients and micronutrients to prices of different food groups and income of the consumers are normally lacking. The present study is thus aimed at fulfilling this information gap for the case of Pakistan. The results of this exercise will help policy-makers in selecting appropriate food group most responsive to the given policy in eradicating the targeted nutrient.

For the present exercise, food consumption data from household surveys for the years 1991-92 and 2011-12 are used. On the basis of average monthly income, the sample households were grouped into low- and high-income classes whereas about 150 food items were classified into eight food groups: wheat, other cereals, pulses, milk and fat products, meats, fruits, vegetables, and miscellaneous. The households are divided into rural and urban region based on the prescription of region in the survey. Using the commodity specific nutritional information from FAO Food Composition Table, the total availability of carbohydrates, protein, calcium, iron, vitamin A, vitamin C, vitamin B_1, vitamin B_2 and niacin are then estimated. The Almost Ideal Demand System (AIDS) is applied to obtain demand and income elasticities of each food group which are then converted into nutrient demand elasticities using the conversion of Huang (1996).

The average per capita consumption of food has remained stagnant at around one kilogram over the two time periods. However, there is a significant change in the mix of food consumed overtime. The consumptions of pulses and vegetables have significantly declined which was compensated with a significant increase in the consumption of fruits. The intakes of milk, meat and miscellaneous food items have also increased but the change was relatively small. Looking in more detail, the poultry consumption has significantly increased while the consumption of red meat has declined. A small decline in the consumption of wheat and other cereals is also observed.

The consumption pattern and the changes in this pattern have consequences on the intake of major and micronutrients. With the exception of Vitamin-C and Vitamin B_1, all other nutrients are found to be consumed lower than their respective daily Recommended

Dietary Allowances (RDA) during 2011-12. The high-income households are less deficient in all nutrients as compared to their counterparts in both time periods. Region wise, rural households record a significantly higher intake of calcium and protein in both time periods. Iron intake, though higher for rural households in 1991-92, has become almost equal at lower level in both the region. Analysing percentage changes in nutrient intake over the two time periods, intake of all nutrients, except vitamin-C and Vitamin-B_1, has decreased with the low income households performing worse than their higher income counterpart.

Comparing nutrient elasticities of various nutrients revealed that income elasticities are greater than one for calcium, Vitamin A, and vitamin C. The income elasticity are also quite high (> 0.7) for all other micronutrients. This suggests that a 10 percent rise in per capita household income, would lead to more than 10 percent increase in the consumption of calcium, vitamin A, and vitamin C, while the consumption of other nutrient will increase between 7-10 percent.

Comparing the price elasticities across food group, fruits and vegetables have much higher nutrient price elasticities than other food groups for vitamin A and vitamin C suggesting highly significant role of fruits and vegetables in alleviating the deficiency of these micronutrients when their prices are reduced say through price support or technological innovations. The research allocation for these crops will be most effective in mitigating vitamin A and C deficiencies. The magnitude of nutrient price elasticities for vitamin B_1 from vegetables is third highest in rank, suggesting that vegetables can also play important role in mitigating the deficiency of this micronutrient. Milk products and fats are most important in alleviating the deficiency of calcium and vitamin B_2. Iron deficiencies can be mitigated most effectively by lowering the price of wheat meat. However, bioavailability of iron from wheat is low, therefore, banking on wheat for improving iron deficiency must be coupled with strategies of improving its bioavailability.

ANNEXURE 1

Model Selection

Study and Year	Country	First Stage Analysis	Second Stage Analysis
Radhakrishna and Murthy (1973)	India	Linear Expenditure System (LES)	Frisch's Method
Haden (1990)	Japan	Linear functional form with one year lagged budget shares as habit	Almost Ideal Demand System (AIDS)
Fan, *et al*. (1995)	China	Linear Expenditure System (LES)	Almost Ideal Demand System (AIDS)
Wu, *et al.* (1993)	China	Almost Ideal Demand System (AIDS)	Almost Ideal Demand System (AIDS)
Wu, *et al.* (1995)	China	Almost Ideal Demand System (AIDS)	Almost Ideal Demand System (AIDS)
Gao, *et al.* (1995)	United States of America	Gamma-Tobit-Model	Combination of Rotterdam, Central Bureau of Statistics (CBS) model and AIDS
Gao, *et al.* (1996)	China	Almost Ideal Demand System (AIDS)	Generalised Linear Expenditure System (GLES)
Wang, *et al*. (1996)	United States of America	Double-hurdle model	Combination of Rotterdam, Central Bureau of Statistics (CBS) model and AIDS
Han, *et al*. (1998)	China	Linear Expenditure System (LES)	Linear Approximate Almost Ideal Demand System (LA/AIDS)
Ali (2000)	Taiwan	Linear Expenditure System (LES)	Almost Ideal Demand System (AIDS)
Weinberger (2001)	India	Linear Expenditure System (LES)	Almost Ideal Demand System (AIDS)

ANNEXURE 2

Classification of Various Food Groups

Food Groups	Commodities Grouped
Wheat	Wheat and wheat flour,
Other cereals	Rice, rice flour, maize, maize flour, barley, barley flour, '*sooji*', other cereals like porridges, vermacilies etc.
Pulses	Gram flour, black gram dal, white gram whole, mash (whole and *dal*), mung (whole and *dal*), lentil (whole and *dal*), pigeon pea '*arhar*' (*dal*) and other pulses.
Meats	Mutton, beef, dry meat, fish (fresh, frozen and dry), prawns (fresh, frozen and canned), chicken, eggs and other poultry.
Dairy products and fat	Liquid milk, butter milk '*lassi*', curd, milk cream, packed milk, dry milk, infants milk, adult milk, concentrated milk, butter, cheese, butter oil, ice cream, '*kheer*', vegetable ghee, mustard oil, cooking oil and other fats
Fruits (fresh and dry)	Banana, orange, apple, pomegranate, grapes, mango, melons, apricot, jaman, lemon, dates, guava, other fresh fruits, almond, walnut, chilgoza, pistatio, peanuts, raisin and other dry fruits.
Vegetables	Tomato, cauliflower, brinjal/eggplant, okra, peas, green pods of radish '*moongra*', green chilies, red chilies, onion, garlic, turnips, radish, carrot, ginger, Cabbage, spinach, mustard leaves, bottle gourd, cucumber, round gourd, Pumpkin, other vegetables, and canned vegetables
Miscellaneous	Biscuit, bread, cakes, patties, '*poori*', '*samosa*', other baked and fried products, table salt, caraway, cardamom, turmeric, coriander seed, clove, other spices, white sugar, brown sugar, brown sugar clods '*gur*', honey, syrups, chocolate, '*burfi*', '*jalebi*', '*halwa*', other sweets, black tea, green tea, coffee, soft drinks, squashes, sugarcane juice, other juices, cigarette, '*biri*', tobacco, chewing leaves and its accessories, chewing tobacco, readymade food, breakfasts, lunches, dinners*, snacks, jams, jellies, ketchup, vinegar, pickle, yeast and ice

* outside and take-home meals.

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