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REFERENCES

1. C. H. Hanumantha Rao, "Alternative Explanations of the Inverse Relationship between Size and Output Per Acre," *Indian Economic Review*, Vol. I (New Series), No. 2, October, 1966, pp. 1-12.

2. A. M. Khusro, "Returns to Scale in Indian Agriculture," *Indian Journal of Agricultural Economics*, Vol. XIX, Nos. 3 & 4, July-December, 1964, pp. 51-80.

3. Dipak Mazumdar, "On the Economics of Relative Efficiency of Small Farmers," *The Economic Weekly*, Vol. XV, Nos. 28, 29 & 30, July, 1963, Special Number, pp. 1259-1263.

4. Rajkrishna, "Some Production Functions for the Punjab," *Indian Journal of Agricultural Economics*, Vol. XIX, Nos. 3 & 4, July-December, 1964, pp. 87-97.

5. A. P. Rao, "Size of Holding and Productivity," *Economic and Political Weekly*, Vol. II, No. 44, November 11, 1967, pp. 1989-1999.

6. Ashok Rudra, "More on Returns to Scale in Indian Agriculture," *Economic and Political Weekly*, Vol. III, No. 43, October 26, 1968, pp. A-33—A-38.

7. G. R. Saini, "Farm Size, Productivity and Returns to Scale," *Economic and Political Weekly*, Vol. IV, No. 26, June 28, 1969, pp. 119-120.

8. G. R. Saini, "Holding Size, Productivity and Some Related Aspects of Indian Agriculture," *Economic and Political Weekly*. Vol. VI, No. 26, June 26, 1971, pp. A-79—A-85.

9. S. K. Sanyal, "Size of Holding and Productivity," *Economic and Political Weekly*, Vol. IV, No. 33, August 16, 1969, pp. 1345-1347.

10. Amartya Kumar Sen, "Size of Holdings and Productivity," *The Economic Weekly*, Vol. XVI, Nos. 5, 6 & 7, February, 1964, Annual Number, pp. 323-326.

THE ANALYSIS OF DEMAND FOR FOODGRAINS

This paper is an attempt to provide a more complete understanding of the demand relations of foodgrains in India. During the past years efforts have been made to increase foodgrain production by introducing new technology in the farm sector and as a result, foodgrain production has increased considerably. But increase in population and income has exerted upward pressure on prices of these commodities. Population expansion provides for symmetrical expansion of the demand for food items while increase in income results into asymmetrical growth of demand for foodgrains. Knowledge of explicit relationship amongst quantity, prices and income is very essential for better planning of production, trade and distribution. The objective of this study is to provide an empirical estimate of demand functions for wheat, rice, total cereals, gram, pulses and total foodgrains on aggregate basis for the whole country.

This paper is divided into four parts. The first part presents a brief discussion on demand curve and statistical analysis. The second part deals with the model used in this study. The third part deals with the empirical results. The last part contains the implications and conclusion of the study.

Demand Curve and Statistical Analysis

A demand curve represents a functional relationship between price and the amount of a commodity demanded. Individual preference relationships affect the amount of satisfaction derived from a bundle of goods and services. The preference relationship is termed the "utility indicator." While a consumer's purchases of goods and services are governed by his scale of preferences and his total available resources, which are fixed in amount, the purchase of foodgrains or any other item will be closely dependent on the number of goods and services available to him, prices of substitutes and the consumer's income. Suppose a consumer i with given income purchases quantities X_{i1}, $X_{i2}, \ldots,$ X_{in} from a bundle of goods. His utility function can be written as :

$$U_i = U_i \ (X_{i1}, X_{i2} \ldots . X_{in}) \qquad (1)$$

If prevailing prices are $P_1, P_2 \ldots . P_n$ for goods 1, 2. . . . n respectively, his total expenditure on all goods and services would be $P_1 X_{i1} + P_2 X_{i2} + \ldots,$ $P_n X_{in}$. His expenditure on goods and services would be equal to his income γ_1.

$$\gamma_i = P_1 X_{i1} + P_2 X_{i2} + \ldots P_n X_{in} \qquad (2)$$

In this case the problem can be solved by finding the maximum of U $(X_{i1}, X_{i2} \ldots, X_{in})$ subject to equation (2). The choice of commodities consistent with maximization can be derived by using the Lagrange Multiplier Method, set

$$Z_i = U_i(X_{i1}, X_{i2}, \ldots X_{in}) + \lambda_i \, (\gamma_i - P_i X_{i1} - P_2 X_{i2} - \ldots . - P_n \ X_{in})$$

$$i = 1, 2 \ldots S \qquad (3)$$

where λ = undetermined positive lagrangian multiplier.

The following normal equations can be obtained after differentiation of equation (3).

$$\frac{\partial Z_i}{\gamma X_{ij}} - \lambda_i P_j = 0, \quad i=1, 2, \ldots S, \quad j=1, 2, \ldots n. \qquad (4)$$

$$\gamma_i - P_j X_{ij} = 0$$

The necessary condition for constrained maximization of utility is as follows:

$$\frac{\partial Z_i}{\partial X_{i1}} \Big/ \frac{\partial Z_i}{\partial X_{in}} = \frac{P_1}{P_n} \qquad (5)$$

The ratio of marginal utility must equal the price ratios for a maximum. It is assumed that second order condition is satisfied (see, 4, pp. 14-19).* The system (4) provides S(n+1) equations in S(n+1) unknowns (X_{ij}, λ_i), provided that commodity prices and income are given. One can solve for the quantities that provide the individual with the highest possible level of his preference relationship. The solution will be of the form :

$$D_j = X_j \quad (P_1, P_2, \ldots P_n, \gamma_i) \quad , \qquad (6)$$

The relationship in (6) represents a set of demand functions. The quantity of each commodity demanded is expressed as a function of its price, price of other goods and consumer's income. In this study, the demand for individual commodities has been studied in relation to their prices and consumer's income.

Statistical analysis of demand was late in its development because of its dependence upon both economic and statistical theory which were previously unrelated to each other (2). The statistical derivation of demand curve was developed by Moore (7) and one or two others. At present, work in applied demand analysis can be classified into three groups. The first group carries on in the tradition of Moore (7), using the single-equation least-squares approach. Some researchers use short cut graphic method as a complementary or substitute for the least-squares approach. The second group centres around the methods developed by Frisch (3). These analysts supplement the least-squares approach with the use of bunch map analysis to select variables and to find out the inter-correlation among explanatory variables. The third group uses a multiple equation approach involving demand, supply and related variables. This group emphasizes upon the simultaneous equation approach. This approach has limited application to demand analysis. Single-equation approach, in special case, gives an unbiased estimate of the demand curve.

Model

As we have already seen, the demand for a commodity is based on its price, price of related goods and the consumer's income. Due to high interdependence between prices of commodities and their substitutes, in the present analysis, only prices of individual commodities and consumers' income were included. This model can be written as :

$$D_i = f(P_i, \gamma) \quad , i=1, 2, 3, \ldots 6 \quad , \qquad (7)$$

where D_i = per capita demand for i^{th} commodity expressed in grams per day.

P_i =wholesale price index of i^{th} commodity, and,

γ =consumers' income expressed as per capita income.

* Figures in brackets denote references cited at the end.

The consumers base their purchases on retail prices. But there is a close relationship between wholesale prices and retail prices. In the absence of a representative retail price index, the wholesale price index has been used. The per capita income estimates on the aggregate level have been used as a proxy for consumers' income. It is assumed that there is 'money illusion' and with increase in money income people feel better off. Therefore, the per capita income at current prices has been used in the analysis. The data for this study were obtained from published sources. They relate to the years 1951 through 1968.

The data on the per capita net availability of foodgrains on aggregate basis for the whole country were used to approximate per capita demand for individual grains. The net availability of grains was taken from a publication of the Directorate of Economics and Statistics, Government of India (4). The net availability of these grains was equal to the net production of these grains plus net import or export and changes in the government stock. In obtaining the net production figures, an allowance had been given for feed, seed requirements and usual wastage of these grains. The net production in respect of rice, wheat and gram was 92.4, 87.9 and 97.9 per cent respectively. However, the net availability which is calculated on per capita basis is not strictly equal to the level of consumption in the country. They do not take into consideration the changes in the stock available with the businessmen, producers and consumers. But it can be assumed, without the loss of generality that net balances with these groups do not affect the availability and there is a tendency on the part of traders and producers to maintain the same level of stock every year. However, a better estimate could be obtained if we knew the changes in stock at all levels. The unit of measurement was grams per day.

In the analysis, the economic advisors' index numbers of wholesale prices of commodities were used. The base period was 1952-53. Since there is a direct correspondence between ruling prices at the wholesale level and retail level, only wholesale prices of individual foodgrains were selected. Moreover, representative data for retail prices of commodities under study were not available and could not be used.

The per capita income was included in the regression analysis. It relates to income at current prices. It was not deflated for the price changes on the assumption that people base their consumption on their money income rather than real income. The annual per capita income was expressed in rupee terms.

Empirical Analysis

Equations were estimated for wheat, rice, total cereals, gram, pulses and total foodgrains. These are based on the relationship specified in equation

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(7). The per capita demand for the above-mentioned grains as measured by their net availability was regressed on the wholesale price indices and the per capita income measured on current prices. All variables were transformed into the log form. The least-squares technique was applied under the usual assumptions (6, pp. 106-112). Table I gives the estimated equations.

TABLE I—COEFFICIENTS AND STATISTICAL VALUES FOR DEMAND EQUATIONS†

Equation	Constant (Log ∝)	Regression coefficients		R^2	Number of observations
		Price index (B_1)	Per capita income (B_2)		
Rice	29.450	—0.754** (0.166)	0.936** (0.220)	0.57	17
Wheat	0.445	—0.216 (0.129)	1.060** (0.182)	0.87	17
Total cereals	42·320	—0.499** (0.103)	0.787** (0.143)	0.67	17
Gram	5.491	—0.705** (0.173)	0.824* (0.374)	0.65	17
Pulses	34.270	—0.489** (0.135)	0.324 (0.269)	0.73	17
Total foodgrains	70.200	—0.477** (0.997)	0.707** (.148)	0.61	17

†Equation form : $\text{Log } D_i = \log \alpha + B_i \log P_i + B_2 \log Y$

Note: Values in parentheses are standard errors of the coefficients.

* Significant at the .05 level.
** Significant at the .01 level.

It is evident from Table I that prices and per capita income explained from 57 per cent to 85 per cent of variations in the dependent variables. The coefficients associated with price variable were negative as expected in all cases. These coefficients were statistically significant in all but one equation and their size varied from 0.216 to 0.705, being minimum for wheat and maximum for gram. However, the coefficients were less than one in all equations. In other words, the demands for grains under investigation were inelastic with respect to their prices. With one per cent change in the indices of wholesale prices of wheat and rice the quantity taken will change in the opposite direction by 0.2 per cent and 0.75 per cent respectively. For similar reason, the changes in the demand for total cereals, gram, pulses and total foodgrains would be 0.49, 0.70, 0.49 and 0.47 per cent respectively.

The coefficients associated with per capita national income were statistically significant at the 0.01 or 0.05 level in all but one equation. These coefficients were positive indicating that with an increase in income there is a likelihood of rising demand for foodgrains in the nation. The income elasticity was less than one for rice, total cereals, grams, pulses and total grains. It was little more than one in the case of wheat The study of these coefficients indicates that with one per cent increase in per capita national income, the demand for these grains would rise. The extent of increase would be 1.06 per cent for wheat, 0.93 per cent for rice, 0.78 per cent for total cereals, 0.82 per cent for gram, 0.32 per cent for pulses and 0.70 per cent for total foodgrains.

It is interesting to note that the coefficient of income elasticity of demand for pulses in Asia and Far East (excluding Japan) was 0.3. Similarly, in this region, the income elasticity for cereals was 0.5. These income elasticities were negative in North America, Oceania, European Economic Community, United Kingdom and Japan (8).

Implications

This study shows that if there is an increase in the prices of foodgrains, per capita demand for them will fall. The extent of decline will be the same for total foodgrains, total cereals and pulses. However, it will differ for individual grains. The extent of decline will be maximum for rice followed by gram and wheat. If there is an increase in the per capita income, the per capita demand for grains will increase. The amount of increase will be the highest for wheat followed by rice, gram, total cereals, total foodgrains and pulses. Since the income elasticity and price elasticity of demand are high in the case of rice, gram and total cereals, it is likely that price rise will be moderate when expansion in demand for these commodities is not immediately followed by their increased production.

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APPENDIX

Correlation Matrix

Simple correlation coefficients are given in this appendix. Table 1 shows correlation matrices of variables used in the estimation of equations shown in the text.

Table 1—Correlation Matrix

	D_i	P_i	Y
Rice			
D_i	1.000		
P_i	—0.265	1.000	
Y	0.012	0.931	1.000
Wheat			
D_i	1.000		
P_i	0.726	1.000	
Y	0.910	0.883	1.000
Total cereals			
D_i	1.000		
P_i	0.152	1.000	
Y	0.418	0.939	1.000
Gram			
D_i	1.000		
P_i	—0.738	1.000	
Y	—0.525	0.904	1.000
Pulses			
D_i	1.000		
P_i	—0.844	1.000	
Y	—0.713	0.919	1.000
Total foodgrains			
D_i	1.000		
P_i	—0.146	1.000	
Y	0.134	0.935	1.000

REFERENCES

1. *Eastern Economist*, Vol. 49, Annual Number, 1969.

2. K. A. Fox : The Analysis of Demand for Farm Products, Technical Bulletin No. 1081, U.S.D.A., Washington D.C., 1953.

3. Ragnar Frisch: Statistical Confluence Analysis by Means of Complete Regression Systems, Oslo, 1934.

4. Government of India: Bulletin on Food Statistics, 1972 and 1969, Ministry of Food and Agriculture, New Delhi.

5. R. E. Henderson and J. M. Quandt : Micro-Economic Theory, Second edition, McGraw-Hill Book Co., New York, 1971.

6. J. Johnston : Econometric Methods, McGraw-Hill Book Co., New York, 1963.

7. H. L. Moore: Forecasting the Yield and Price of Cotton, New York, 1917.

8. United Nations, Food and Agriculture Organization: Agricultural Commodities Projections for 1970, FAO Commodity Review Special Supplement, Rome, 1962.