India: Demand and Supply Prospects for Agriculture

SWP500

World Bank Staff Working Paper No. 500

October 1981

Prepared by: James Q. Harrison
South Asia Programs Department
Jon A. Hitchings
Treasurer's Department
John W. Wall
South Asia Programs Department

WORLD BANK

Staff Working Paper No. 500

INDIA: PAPERS ON DEMAND AND SUPPLY PROSPECTS FOR AGRICULTURE

October 1981

Since India's foodgrain situation began to improve after the mid-1970s, the World Bank's economic work on Indian agriculture has concentrated on the implications of this development both for foodgrains and for other major agricultural commodities. This volume contains several papers that report on work accomplished so far. Jon Hitchings' paper projects demand for major agriculture commodities through the year 2000 based on consumption expenditure data from the 1973/74 National Sample Survey along with estimates of future population and income growth, rates of urbanization and trends in the distribution of income. The analysis reveals the differential effects of long-run income growth, and other factors, on demand for various crops. The individual commodity papers were prepared to analyze the long-run supply prospects and to compare these with the projected demand. The foodgrain paper, prepared by James Harrison and John Wall, raises the distinct possibility of foodgrain self-sufficiency and even a potential for an eventual exportable surplus. The vegetable oil paper, by John Wall, is less optimistic and projects a persistent domestic shortage of vegetable oils. This underlines the need for greater efforts by the agricultural support institutions to stimulate oilseed production and for an incentive pricing policy. The sugar paper, by James Harrison, analyzes the sugar cycle and stresses the disruptive effects of very large fluctuations around the production trend, which is essentially adequate to meet domestic requirements and provide for some exports. The utility of maintaining a buffer stock of sugar to stabilize year-to-year sugar supply is discussed.

prepared by: James Q. Harrison
South Asia Programs Department

Jon A. Hitchings
Treasurer's Department

John W. Wall
South Asia Programs Department

INDIA

PAPERS ON DEMAND AND SUPPLY PROSPECTS FOR AGRICULTURE

Table of Contents

		Page Number
Part I:	DEMAND PROJECTIONS FOR INDIA . . . . . Jon A. Hitchings	1
Part II:	THE FOODGRAIN ECONOMY. . . . . James Q. Harrison and John W. Wall	51
Part III:	THE VEGETABLE OIL ECONOMY . . . . . John W. Wall	67
Part IV:	THE SUGAR ECONOMY . . . . . James Q. Harrison	109

PART I

DEMAND PROJECTIONS FOR INDIA

Jon A. Hitchings
June 1981

DEMAND PROJECTIONS FOR INDIA

TABLE OF CONTENTS

INTRODUCTION

		Page
I.	Data and Methodology	5
	A. Population Projections	5
	B. Baseline Consumption	7
	C. Estimation Approach	10
II.	Elasticities and Projection Results	12
	A. Comparisons of Expenditure Elasticities	12
	B. Quantity Projections	15
III.	Income Redistribution	21
	A. Gini Ratio Estimation and Comparisons	22
	B. Effects of Income Redistribution on Demand Projections	28
IV.	Sensitivity Analysis	31
	A. Population Growth and Urbanization	31
	B. Expenditure Growth and Redistribution	35
V.	Conclusions	41

APPENDICES

I.	Demand Projections with Moderate Redistribution	44
II.	Gini Ratio Estimation Program	45
III.	Sensitivity Analysis Data	46
IV.	Foodgrain Equivalents	47
V.	List of Consumption Groups and Items	48

REFERENCES 49

LIST OF TABLES AND FIGURES

Tables

Table 1	Population and Urban Share Projections
Table 2	Selection of Base Quantities for Projections
Table 3	Expenditure Elasticity Estimates
Table 4A, 4B	Demand Projections Assuming 3.5% and 5.0% Expenditure Growth
Table 5	Projected Annual Growth Rates of Demand for Selected Commodities
Table 6	Comparisons of Demand Projections
Table 7	Projections of Food Energy Demand
Table 8	International Comparisons of Income Distribution Ordered by the Gini Ratio
Table 9	Some Estimates of Gini Ratios for India
Table 10	Gini Coefficients for Individual Consumption Expenditure
Table 11	Future Expenditure Shares and Gini Ratios Given Redistribution Rates
Table 12	Changes in Quantities Demanded Resulting from Expenditure Redistribution
Table 13	Population and Urban Share Values for Sensitivity Analysis
Table 14	Sensitivity of Projections for Year 2000 to Altered Population and Urban Share Assumptions
Table 15	Sensitivity Comparisons
Table 16	Sensitivity Analysis of Expenditure Growth Rates
Table 17	Elasticities of Projections
Table 18	Correspondence of Multiplicative Factors and Annual Gini Ratio Change Rates

Figures

Figure 1 Distribution of Income at Different Levels of Per Capita GDP

Figure 2 Projection Isoquants for Year 2000

INTRODUCTION

This paper reports a set of demand projections for agricultural commodities in India. The main objective was to assess the effects of income growth, population growth and other non-price variables on the future pattern of consumption of agricultural commodities in India. A second objective was the development of a projection model that would be compact, flexible and fully documented. The model should be capable of projecting demand for any number of commodities and future time periods in a single pass with a minimum of file manipulation. It should also readily accommodate altered assumptions regarding urbanization, expenditure growth, income redistribution and population growth. The resulting model is documented separately. 1/

The 28th Round of the National Sample Survey (1973/74) is the most recent large-scale expenditure survey available. The 32nd Round (1977/78) is also directed to household expenditures, but it has not yet been released. Restricted to this data base, the projections assume relative prices are constant, and model only the demand side of the market.

Projections for 17 commodities at five year intervals, expenditure elasticities, and calorie demand per capita are presented and compared with other research. Changes in income distribution and consequent effects on demand received particular attention. 2/ Sensitivity analysis was performed on expenditure and population growth, expenditure distribution, and urbanization. As a final step in sensitivity analysis, estimates were made of the elasticities of future demand with respect to key assumptions.

I. DATA AND METHODOLOGY

A. Population Projections. Four types of data were required for the projections: population and urban share projections, the starting quantities of consumption, the sectoral distribution of initial consumption, and expenditure data from a household consumption survey. The population and urbanization forecasts that were used are given in Table 1. Historical figures for the urban share of the population show a growth rate of about 0.2% per year. 3/ Projections made by the UN Population Division/Urbanization show a general but bumpy continuation of

---

1/ "Documentation of a Demand Projection Model Prepared for India," Jon Hitchings, Division Paper for ASADB (March 25, 1981). Available from the India Division of the World Bank, Washington, D.C.

2/ Appendix II contains a program for estimating Gini coefficients.

3/ Census estimates for 1951, 1961 and 1971 are 15.9%, 18.0% and 19.9%. (UN Source).

Table 1

Population and Urban Share Projections

	Population (million)	Urban Share ----(%)----
1973/74	595.6	20.6
1979/80	672.2	22.3
1984/85	744.2	24.3
1989/90	820.5	26.9
1994/95	897.7	28.1
1999/2000	973.6	30.0

Sources: For population, World Bank estimates. For urban share, Population Reference Bureau, which interpolated projections from U.N. Population Division/Urbanization. The urban share for 1999/2000 was somewhat arbitrarily lowered from a U.N. projection of 34.0% which implied an abnormally large increase in the last five years of the century. The population forecasts are also reported in Population Projections 1980-2000, World Bank, DEDHR, (July, 1980), p. 212.

this trend and are used without modification by the World Bank and the Population Reference Bureau. Their figures were utilized in this analysis except that the estimate for 1999/2000 has been modified. 1/

The latest World Bank population projections were used in this study. However, provisional 1981 population census data have been released which show higher-than-expected rates of growth during the 1970s. Although the population forecasts have not yet been altered accordingly, the potential implications of the new census data for the demand projections are presented and discussed with other sensitivity analysis issues in Section IV.

B. Baseline Consumption. Estimates of total baseline consumption for 1973/74, the year of the household expenditure survey, are compared in Table 2. The organization of the table follows the expenditure classifications of the NSS survey. A list of commodities in each category appears in Appendix V. World Bank estimates were used whenever available. Total consumption of cereals was allocated to categories such as wheat, maize, etc., using weights implicit in FAO data. Sweeteners were disaggregated using unpublished tabulations from the NSS survey. The quantity of clothing estimate is based on production minus non-fabric uses. 2/ However, using the standard industry conversion rate of 10 m^2/kg, 0.722 million tons of "clothing" corresponds to 7.22 billion square meters of material which is only 6% below an independent industry estimate of 7.68 billion square meters. 3/ The industry estimate for woven textiles includes cotton, synthetic, and blended fabrics. Technically, the projections should be increased by a few percent to better represent expenditures on non-cotton textiles which were recorded in the survey, and which increased the expenditure elasticities. Using the lower base allows the projections to be interpreted more in terms of demand for cotton, but introduces a small downward bias.

1/ See the note on Table 1.

2/ In the expenditure survey, "clothing" includes bedding, upholstery, and other textiles.

3/ See footnote 14/, Table 2.

Table 2

INDIA

SELECTION OF BASE QUANTITIES FOR PROJECTIONS
(Household Demand or Net Food Availability)

	MACGREGOR 15/ 1973-74	FAO 1972-74	IBRD SOURCES 1973-74	NSS IMPLIED 1973-74 13/	SANDERSON/ROY 9/ 1973-74	GROSSING FACTOR 10/	SELECTED BASE
				1,000,000 mt			
ulses, Cereal Substitutes	11.082 6/	8.210	8.71 5/			1.143	8.71
Edible Oils	2.90	2.748	2.667 7/	1.79		1.109	2.667
Meat/Fish/Eggs	--	2.398				1.0	2.398
Vegetables	6.928	33.428				1.0	6.928
Fruits/Nuts	7.182	16.571 4/				1.0	16.571
Sugar/Khandsari	11.621 12/	3.690	4.519 8/	2.64		1.0	4.519
Gur/Other Sweeteners		6.429	7.336 8/	3.53		1.0	7.336
Spices	0.684	0.691				1.0	0.691
Beverages	0.305	0.318				1.0	0.318
Tobacco/Pan/Intoxicants	0.464	---				1.0	0.464
Clothing	0.722 14/	---				1.0	0.722
Milk and Products	24.210	19.748				1.0	19.748
Rice	36.593 2/	38.131		48.31		1.143	40.363 11/
Wheat	23.362 2/	21.283		28.12		1.143	22.536 11/
Maize	3.943 3/	3.848		5.20		1.143	4.036 11/
Sorghum/Millet/Barley	19.596 3/	16.182		23.54		1.143	17.154 11/
All Sugars	11.621	10.119	11.855	6.17			
All Cereals	83.495	79.444	84.09 5/	105.17	96.81		84.09
				1,000,000			
Population		583.9	595.6		588.3		595.6

NOTES: 1/ Implied from a figure of 105.641 for sugar cane converted to sugar at 11% extraction.

2/ 59.956 for rice & wheat, allocated by NSS quantity weights. (These cereals were not disaggregated by MacGreggor.)

3/ 23.539 for other cereals, allocated by NSS quantity weights. (Maize was grouped with the other coarse cereals in the study.)

4/ Cashews, almonds, walnuts, groundnuts, coconuts, and fruit.

5/ 1973-74 average. Excludes Topioca

6/ Includes topioca.

7/ IBRD, ASADB source.

8/ IBRD, ASADB source.

9/ Fred H. Sanderson and Shyamal Roy, Food Trends and Prospects in India (Washington, D. C.: The Brookings Institution, 1979), Table 6.1.

10/ The projections for pulses, cereals, and oils contain a grossing factor shown in this column to represent non-household demand. Seed, feed and waste account for about 12.5% of final demand for foodgrains: 1/(1-.125) = 1.143.

11/ The selected base quantities for cereals were found by allocating the IBRD total for cereals according to proportions implicit in FAO quantities.

12/ Includes gur and other sweeteners.

13/ The NSS implied base figures are inferred from data on quantities consumed per capita.

14/ Refers to residual of production weight of baled cotton minus seed, post-harvest loss, and exports. This is about 6% lower than the estimate of 7.68 billion square meters of cotton, non-cotton, and mixed fibre cloth, assuming ten square meters per kg. This estimate is from the Handbook of Statistics on the Cotton Textile Industry, The Indian Cotton Mills Federation, Bombay (September 1, 1980), p. 35. The 1974 estimated aggregate household consumption was adjusted for 1973/74 average availability (Table 19).

15/ John Macgregor "Agricultural Demand Projections for India," The World Bank, ASADB (Draft Divisional Paper, 1979).

Fixed grossing factors for non-household demand (seed, feed, minimal industrial use, and loss) are shown for foodgrains and edible oils. Future demand for these commodities represents total demand, whereas projections for other items refer only to household demand.

As a consistency check, baseline quantities for food can be compared with the population estimate in terms of calories per capita per day. The conversion from weight to calories utilized foodgrain equivalent factors shown in Appendix IV. The level of food availability implied by the selected baseline quantities is quite consistent with other estimates: 1,952 calories per capita per day (Table 7).

Production indices in 1973/74 for foodgrains contracted somewhat, but were comparable with other below-average years, such as 1970/71 and 1976/77. Cereal production in calendar 1973 was 5% below the surrounding five-year average. However, an increase in net cereals imports in 1973, which partially offset the production shortfall, the reasonableness of the per capita calorie estimate, and the fact that FAO base quantities which were adopted for some commodities were already three-year averages, led to a decision to dispense with more elaborate modifications of the base level of total consumption to adjust for starting period aberrations.

Consumers may have been adjusting expenditures to rapid price increases in 1973/74. Price indices for major agricultural commodities rose rapidly in the early 1970's, particularly 1973-75, in contrast to the more stable price environment of the late 1960's. These considerations highlight a second area of potential sensitivity of the projections to the base year chosen. Set against these precautionary notes is the rather uniform set of expenditure elasticities obtained from various sources and time periods which are compared with estimates from these data in the following section. The similarity suggests typical patterns of demand may not have been too disrupted by these price movements.

Weights for sectoral consumption are required to combine urban and rural demand into a national estimate. Quantity-based weights should be used to avoid price differentials and these were derived from the NSS survey for edible oils, sweeteners, and cereals. Value-based weights without price adjustment were used for the other commodities.

A detailed exposition of the methodology adopted for projections is presented in a separate paper, available from the India Division of the World Bank, "Documentation of a Demand Projection Model Prepared for India." The principal features of the approach are outlined below.

C. Estimation Approach. Cross-sectional survey data from the NSS 28th round were used to estimate expenditure regressions and elasticities. 1/ Generalized least squares (GLS) regressions were run on the expenditure survey data using the ratio semilog inverse functional form. 2/ This form automatically satisfies the Engel aggregation condition of consumer demand theory since the dependent variables are budget shares. 3/ (If this condition were not met, the sum of marginal propensities to consume would not exhaust marginal expenditure which would introduce awkward inconsistencies into a set of demand projections). The functional form also does not impose an a priori relationship between the income level and the elasticity. One regression per commodity or commodity group was used to estimate the elasticity expression for all expenditure classes. The expression yields distinct elasticities for each expenditure class when it is evaluated using that group's mean total expenditure, and mean commodity-specific expenditure. Thus projections for each income level utilize separate elasticities, although they are derived from a single regression. GLS methods are needed to compensate for the heteroscedastic properties of grouped data having different numbers of observations per group. Persons per household times households per class formed the weights.

Future demand was geared to the growth rate of expenditure in the economy, which can be selected at will during a computer projection run. From this growth rate, urban and rural per capita expenditure growth rates were derived for each projection period (base date to projection date) which are consistent with:

a) the selected total rate of expenditure expansion;

b) population growth and urbanization rates;

1/ National Sample Survey Organization, Tables on Consumer Expenditure, 28th Round, No. 240, Department of Statistics (1977), New Delhi.

2/ This form is $Y/X = a + b \ln X + c/X$ where Y is the commodity expenditure and X is the total expenditure. The expenditure elasticity is then $e = (a + b + b \ln X)\, X/Y$.

3/ Price data would be necessary to check the other conditions, namely the negativity of the own substitution effect, the symmetry of cross-substitution effects, and homogeneity of degree zero for the system of demand equations. (The last condition implies that multiplication of prices and income by a constant would leave demand patterns unchanged, i.e., there is no "money illusion" in consumption.)

c) historical rates of growth between the base year and the most recent observation--about 3.5% in real terms from 1973/74 to 1979/80.

Table 3 of the documentation paper provides evidence that since 1961, there has been very little difference between the sectors in nominal per capita expenditure growth rates. Consequently, none is assumed here.

An annual rate of change in the Gini ratio can also be selected during program execution. The effects of redistribution on demand are incorporated through a reallocation rule which satisfies the Gini ratio modification in such a way that changes in expenditure are proportionate to an income group's distance from income equality.

Per capita demand growth for each commodity was projected for every income class, both sectors, and the future time periods of interest given the rate of redistribution and the derived per capita expenditure growth rate. The future periods chosen were five year intervals beginning in 1979/80 (to better coincide with the Plan period) and ending in 1999/2000. Rural and urban population growth factors were applied, the income classes were aggregated, and the sectors combined, using appropriate weights. Since demand growth is expressed as a multiplicative increase, the outcome can be multiplied by grossing factors for non-household demand (for foodgrains and edible oils) and by the base levels of consumption. The result is final demand in quantity terms.

The adopted approach assumes that relative prices are constant through time, and equal for all consumers within same sector, either rural or urban. Non-household demand is neglected except for edible oils and foodgrains. Proportionality assumptions are made to infer non-household demand from household demand for these commodities. Individual household data such as occupational category or educational level of the head-of-household, caste/ethnic group, farm characteristics of farming households, etc., were not available, although they can illuminate consumption patterns. A final important assumption is that real-expenditure growth per capita is equal in the rural and urban sectors. This assumption at least holds in nominal terms since 1961. (Evidence to this effect is presented in the model documentation paper.)

The programs in the model print out the expenditure elasticities, the starting and ending Gini ratios, expenditure shares held by population groups, projected demand for all commodities and time periods under the redistribution and expenditure growth assumptions, and aggregate demand for foodgrains and sweeteners.

II. ELASTICITIES AND PROJECTION RESULTS

A. Comparisons of Expenditure Elasticities. The expenditure elasticities in this study satisfy the Engel aggregation condition for the rural and urban sectors (Table 3): the sum of expenditure elasticities weighted by budget shares equals one. 1/ The lowest adjusted R^2 for the underlying generalized least squares regressions was around 0.95 and most were 0.98 or above. However, the high R^2s are partly the consequence of using observations grouped by income class. 2/ The elasticities for a number of commodities are quite similar to previous estimates. Note, for example, comparisons with estimates from the National Commission on Agriculture (NCA) for pulses, meat/fish/eggs, sugar and khandsari, beverages, clothing, milk and maize. 3/

Although the expenditure elasticities for wheat and rice are higher than found by NCA, the estimates for foodgrains as a whole are consistent with other research. Desai's estimates of the rural and urban elasticities for foodgrains are 0.52 and 0.30 (not shown in Table 3) which are close to the present estimates of 0.63 and 0.39. 4/ Mellor's national estimate is the same as the present urban figure. The national estimate of the expenditure elasticity for foodgrains is 0.59 in the present study, 5/ whereas the middle of the range reported by Scandizzo and Bruce for India is 0.60. The estimates they report use longitudinal data

---

1/ Meeting this condition is an attraction of using the ratio-semilog-inverse form in which budget shares are dependent variables. The weighted expenditure elasticities equalled 1+ 0.001 in each case.

2/ This is an additional reason why the correlation coefficient is not particularly suited for choosing among functional forms even after appropriate weighting and econometric techniques have been applied.

3/ The "Other" category in Table 3 includes fuel and light, footwear, miscellaneous goods and services, rents, taxes, and durable goods. An elasticity for this category must be estimated to check the Engel aggregation condition. The projections for this category are expressed in terms of a multiplicative increase over the base level.

4/ B. M. Desai, "Analysis of Consumption Expenditure Patterns in India," Occasional Paper No. 54, Department of Agricultural Economics, Cornell University (August 1972), Table 3. Found from log-log-inverse regressions on 1963/64 NSS data.

5/ Found by combining the urban and rural estimates with population and expenditure weights.

TABLE 3

EXPENDITURE ELASTICITY ESTIMATES

FOR INDIA

	Present Study 1/		NCA 2/		Mellor	Various
	Rural	Urban	Rural	Urban	National 3/	National 4/
Pulses	0.86	0.81	0.85	0.66	-	0.32
Edible Oils	1.00	1.01	0.88	0.97 5/	1.05	-
Meat, Fish, Eggs	1.15	1.12	1.22	1.07 6/	1.33	-
Vegetables	0.82	0.94	-	-	-	-
Fruits, Nuts	1.36	1.54	-	-	-	-
Sugar, Khandsari	1.51	1.06	1.65	1.11	1.10 7/	-
Gur, Other Sweeteners	1.09	0.53	0.96	0.23	-	-
Spices	0.67	0.50	-	-	-	-
Beverages	1.20	1.43	1.29	1.33 6/	-	-
Tobacco, Pan, Intox.	0.90	0.96	0.72	0.79	-	-
Clothing	1.82	1.68	1.86	1.64 8/	-	-
Milk and Products	1.73	1.43	1.46	1.30	1.60	-
Rice	0.71	0.42	0.41	0.18	-	0.94
Wheat	1.01	0.55	0.67	0.37	-	1.06
Maize	0.03	-0.76	0.01	-0.47	-	-
Sorghum, Millet	0.07	-0.59	-	-	-	-
All Other	1.11	1.28	-	-	-	-
Foodgrains	0.63	0.39	-	-	0.39	0.49-0.71

1/ Found from regressions of the ratio semilog inverse form on NSS 28th Round data (1973/74) weighted for households per income class and persons per household. Elasticities at the mean are reported,

2/ Report of the National Commission on Agriculture, Demand and Supply (1976), Appendix 10.2.

3/ John W. Mellor, "Agricultural Price Policy and Income Distribution in Low Income Countries", World Bank Staff Working Paper No. 214, September 1974. Estimated from NCAER "All-India Consumer Expenditure Survey, 1964/65" using log-log-inverse functional forms.

4/ Various sources using longitudinal data compiled in "Methodologies for Measuring Price Intervention Effects", Pasquale L. Scandizzo and Colin Bruce, World Bank Staff Working Paper No. 394 (March 1980), p. 80.

5/ These elasticities are for vegetable oils. Elasticities for vanaspati are rural: 1.98, urban: 1.48, (reported by NCA).

6/ Budget shares were not reported, so these elasticities are simple averages for commodities (average of tea and coffee for beverages).

7/ Applies to all sweeteners.

8/ These elasticities are for mill-made cotton clothing, and are intermediate between handloom cotton clothing and khadi cotton clothing.

through the mid to late sixties. 1/ The similarity of estimates from longitudinal data, cross-sectional data a decade earlier, and the current analysis, (Desai--1963/64, current--1973/74) indicates stability in the demand pattern for foodgrains and increases confidence in the projections.

Several factors motivated re-estimating the elasticities despite their availability in other sources. Foremost among these is the fact that the elasticities derived here and used in the projections vary between expenditure classes, although they are only shown in Table 3 as they appear after evaluation at the grand mean. Moreover, while many functional forms have this property, the elasticities are usually forced to vary in the same direction across income groups, regardless of the commodity. The derivative of the elasticity with respect to income is negative a priori for certain estimation forms. In the regressions estimated in this study, the direction in which the elasticity changes depends on the commodity. This variation was required since future demand for a given commodity was projected for each expenditure class, and marginal propensities to consume generally are not constant across income groups. Additional advantages of these estimates include more commodity disaggregation, weighting by persons per household and households per income group, and the consistency of Engel aggregation, as already mentioned. Thus the similarity of some elasticities at the overall mean to other estimates does not greatly detract from the fruitfulness of the exercise.

Some of the notable features of this set of expenditure elasticities are:

1) the urban and rural preference for wheat and pulses compared with rice as total expenditure increases (a pattern supported by NCA estimates); 2/

2) higher foodgrains elasticities in rural than in urban areas;

3) very low rural and negative urban elasticities for maize, sorghum, and millet; and

4) high elasticities for clothing, milk, milk products, fruit and nuts.

These relationships among the elasticities foreshadow certain characteristics of the projections and sensitivity analysis, namely:

1/ See Footnote 4/, Table 3.

2/ This preference may have implications for the proportions of wheat and rice the public sector should hold for distribution.

1) the increase in the proportion of wheat and pulses demanded out of foodgrains if expenditure growth is rapid (Table 16);

2) the apparent dampening effect of faster urbanization on the growth in foodgrains consumption (Table 14);

3) the somewhat reduced demand for coarse cereals given accelerated economic growth; and

4) the sensitivity of projections for clothing, milk, and milk products to expenditure growth rates.

B. Quantity Projections. The projections for two rates of expenditure growth, assuming no income redistribution, are given in Tables 4A and 4B. The projections for various foodgrains and edible oils contain grossing factors listed above (Table 2) for non-household demand. Foodgrain demand would more than double by the end of the century under the lower rate of growth, and increase by 220% if 5% expenditure growth were experienced. 1/ Higher expenditure growth adds at least one percent to the growth rate of demand for sweeteners, edible oils, wheat and pulses through 1984/85 (Table 5). Although the growth in demand slackens somewhat after 1984/85 for these commodities, rice, and all foodgrains, it remains well above 3.0% for sugar/khandsari and edible oils even under the lower alternative. Pressures, therefore, may persist either to continue the importation of large volumes of edible oils, or to let prices rise sufficiently to induce a substantial supply response.

1/ These increases are relative to the 1973-74 base year.

TABLE 4A

Demand Projections Assuming 3.5% Expenditure Growth

FOR THE FOLLOWING PROJECTION
TOTAL EXPENDITURE GROWTH ASSUMPTION IS 3.5 PERCENT
GINI RATIO CHANGE RATE IS 0 PERCENT
DEMAND IN MILLION METRIC TONS

	73/74	79/80	84/85	89/90	94/95	99/00
PULSES 3/	8.71	11.36	13.19	15.26	17.64	20.25
EDIBLE OILS	2.67	3.36	3.99	4 75	5.59	6 56
MEAT, FISH, & EGGS	2.40	2 70	3.25	3.91	4 68	5.62
VEGETABLES	6.93	7.84	9.21	10.81	12 59	14 62
FRUITS & NUTS	16.57	18.51	23.13	29 05	36.39	45 91
SUGAR & KHANDSARI	4.52	5.25	6.44	7.89	9.57	11.63
GUR & OTHER SUGARS	7.34	8.33	9.60	10.96	12.61	14.31
SPICES	0.69	0 77	0.89	1.01	1.15	1.30
BEVERAGES	0.32	0.34	0.43	0.56	0.70	0.90
TOBACCO, PAN & INTOX	0.46	0.51	0 60	0.71	0.83	0.98
CLOTHING	0.72	0.83	1.05	1.31	1.67	2.13
MILK	19.75	23 24	28 74	35.48	43.84	54.17
RICE	40.36	52.22	59.31	66 87	75.26	83.51
WHEAT	22.54	29.19	33.97	39 29	45.20	51 47
MAIZE	4.04	5.09	5.50	5 87	6 28	6.59
SORGHUM & MILLET 4/	17.15	21 59	23.52	25.36	27.28	28 84
OTHER 1/	1.00	1.06	1.30	1.61	1.99	2.47
SWEETENERS	11.85	13.58	16.04	18.84	22.18	25.93
FOODGRAINS	92.80	119.46	135.49	152 65	171.66	190.66

TABLE 4B

Demand Projections Assuming 5.0% Expenditure Growth

FOR THE FOLLOWING PROJECTION
TOTAL EXPENDITURE GROWTH ASSUMPTION IS 5 PERCENT
GINI RATIO CHANGE RATE IS 0 PERCENT
DEMAND IN MILLION METRIC TONS

	73/74	79/80	2/ 84/85	89/90	94/95	99/00
PULSES 3/	8.71	11.36	13.92	16.89	20.39	24.29
EDIBLE OILS	2.67	3 36	4.24	5.33	6.56	8 00
MEAT, FISH, & EGGS	2.40	2.70	3.51	4.55	5.86	7.52
VEGETABLES	6.93	7.84	9.71	11.97	14.55	17.55
FRUITS & NUTS	16.57	18.51	25.93	36.45	50.98	71 60
SUGAR & KHANDSARI	4.52	5.25	7.04	9 36	12.27	15.99
GUR & OTHER SUGARS	7.34	8 33	10.18	12.20	14 60	17.00
SPICES	0.69	0.77	0.92	1.08	1.26	1.45
BEVERAGES	0.32	0.34	0.49	0.70	0.99	1.42
TOBACCO, PAN & INTOX	0.46	0 51	0.64	0.81	1 02	1 29
CLOTHING	0.72	0.83	1.21	1.74	2 52	3 62
MILK	19.75	23 24	32.12	43.94	59.81	80.82
RICE	40.36	52.22	61.30	70.72	80 34	88 54
WHEAT	22.54	29.19	35.70	42.91	50 68	58 60
MAIZE	4.04	5.09	5.48	5.78	6.08	6.20
SORGHUM & MILLET 4/	17.15	21.59	23.38	24 91	26 32	27 08
OTHER 1/	1.00	1 06	1.44	1.98	2.71	3.73
SWEETENERS	11.85	13.58	17.22	21.57	26.87	32.99
FOODGRAINS	92.80	119.46	139.78	161 21	183.82	204.71

1/ Multiplicative factors, not million metric tons.

2/ Assumes 3.5% expenditure growth through 1979-80.

3/ Includes cereal substitutes and grams.

4/ Includes barley and other coarse cereals.

TABLE 5

Projected Annual Growth Rates of Demand for Selected Commodities a/

	1979/80 to 1984/85		1984/85 to 1999/2000	
	Low	High	Low	High
	(%)			
Sugar & Khandsari	4.2	6.0	4.0	5.6
Gur & other sweeteners	2.9	4.1	2.7	3.5
Edible oils	3.5	4.8	3.4	4.3
Rice	2.6	3.3	2.3	2.5
Wheat	3.1	4.1	2.8	3.4
Pulses	3.0	4.1	3.0	3.8
Foodgrains	2.6	3.2	2.3	2.6

a/ The "Low" and "High" growth rates assume 3.5% and 5.0% total expenditure growth, respectively.

The reasonableness of the projections can be examined through:

1) comparisons with actual demand (availability) in 1979/80, which is the first projection period;

2) comparisons with other quantity projections;

3) converting food demand to calories per capita and comparing these figures with expected levels of consumption and other calorie projections.

The actual availability of foodgrains for calendar year 1979 is estimated to be 114.11 million tons (103.44 million tons cereals and 10.66 million tons pulses) which can be compared with the projection for fiscal 1979/80 of 119.46 million tons (108.1 million tons cereals, 11.36 million tons pulses), which is about 5% higher. Foodgrain production in 1979/80 was 17% below the previous year's record level and availability in calendar year 1980 was sharply reduced. The projections would therefore further exceed availability if 1979 and 1980 were averaged. Nevertheless, it is to be expected that the decline in incomes and upward pressure on prices following a sharp decline in the production of foodgrains would have dampened demand beneath its forecast level and this undoubtedly explains part of the discrepancy.

Household consumption of sweeteners, averaged for 1978/79 and 1979/80, was 13.1 million tons whereas the projection was 13.6 million tons. 1/ The 1979/80 consumption of edible oils (including non-household consumption) was estimated to be 3.55 million tons compared with a projection of 3.36 million tons. 2/ The projections for these commodities are fairly close to observed and estimated consumption, particularly if allowances are made for the 1979/80 crop year.

Projections for the year 2000 by the National Commission on Agriculture for rice, wheat, foodgrains, sugar and khandsari, edible oils and meat/fish/eggs are very much in line with those in the present study (Table 6). Estimates of demand in 1984/85 for rice from several sources lie in a narrow range. The present projections for sugar also closely match EPD's longitudinal estimates.

Converting food demand to calories per capita allows a determination of whether the projected demand levels for all foods are reasonable in comparison with the population projections. First, the grossing factors were removed (since household consumption alone is relevant here), then quantities were converted to foodgrain equivalents with food energy weights, and finally the cross-commodity summation was expressed in calories per capita per day (Table 7). 3/ The resulting figure of 1,952 calories for 1973/74 is similar to estimates by NCA, The Brookings Institution, FAO, and the World Bank in its World Development Report. 4/ NCA's high projection for 2000 differs by only 22 calories per capita per day from the present analysis, and the low projections are eight calories apart. These differences are negligible in per capita terms. This is a remarkable concurrence considering that different consumption data, population projections, and methodologies were used. Sanderson and Roy's low projection (Brookings Institution Alternative C)

1/ Consumption estimate from U.S.D.A. preliminary figures and "Sugar Situation in India," GOI, (September, 1980 mimeo). Averaging compensated for the reduced cane production in 1979/80. Sweeteners do not contain adjustments for non-household demand.

2/ World Bank, estimate.

3/ The food energy weights and conversion factors are reported in Appendix IV.

4/ Some FAO base figures were adopted which makes this estimate less independent of the present study, but differences in population, foodgrains and some other crops remained which balanced out in terms of calories per capita.

TABLE 6

Comparisons of Demand Projections 1/

	1985		1990		2000	
	Low	High	Low	High	Low	High
	million tons					
Rice						
Present Study	59.31	61.30	66.87	70.72	83.51	88.54
NCA	59.89	64.69	-	-	78.59	84.56
EPD	56.45	-	64.19	-	-	-
USDA	-	62.00	-	-	-	-
Iowa State	57.0	-	-	-	-	-
Wheat						
Present Study	33.97	35.70	39.29	42.91	51.47	58.60
NCA	33.83	38.16	-	-	46.91	52.45
EPD	-	43.02	-	53.61	-	-
USDA	-	41.00	-	-	-	-
Other Cereals						
Present Study	29.02	34.28	-	-	35.43	33.28
NCA	35.35	35.36	-	-	43.19	42.90
Pulses						
Present Study	13.19	13.92	-	-	20.25	24.29
NCA	16.95	20.27	-	-	23.15	28.23
Foodgrains						
Present Study	135.49	139.78	152.65	161.25	190.66	204.71
NCA	146.03	158.25	-	-	192.36	208.14
Brookings	-	-	-	173.30	-	-
Sugar						
Present Study 2/	5.09	5.56	6.23	7.39	-	-
EPD	5.39	-	6.30	-	-	-
Sugar and Khandsari						
Present Study	6.44	7.04	-	-	11.63	15.99
NCA	6.55	8.62	-	-	10.33	13.31
Edible Oils						
Present Study	3.99	4.24	-	-	6.56	8.00
NCA	4.19	5.27	-	-	6.45	8.05
Milk						
Present Study	28.74	32.12	-	-	54.17	80.82
NCA	33.73	44.17	-	-	49.36	64.40
Meat, Fish, Eggs						
Present Study	3.25	3.51	-	-	5.62	7.52
NCA 3/	3.95	5.16	-	-	6.00	8.00

Notes: 1/ The low and high projections reported for "Present Study" assume 3.5% and 5.0% total expenditure growth, respectively, and no income redistribution. The NCA estimates presented for comparison are based on consumer demand, multiplied by constant grossing factors given in Table 2. NCA's gross demand estimates for some commodities actually use increasing factors for non-household demand.

2/ Found from sugar and khandsari projections by assuming 34% of the cane crop was processed into sugar and 9% into khandsari.

3/ A conversion factor of 48g/egg was used.

Sources: NCA - Report of the National Commission on Agriculture, PartIII, Demand and Supply (1976), Table 10.7 (see Footnote 1).

EPD - Economic Analysis and Projections Department, World Bank,

USDA - U.S. Department of Agriculture, Anthony Rojko, et al, Alternative Futures for World Food, 1985, Vol. I (1978), Table 28.

Iowa State - Leroy Blakeslee, Earl Heady, Charles Tramingham, World Food Production Demand, and Trade, Center for Agriculture and Rural Development, Iowa State University (1973), Ames.

Brookings - The Brookings Institution, Fred H. Sanderson and Shymal Roy, Food Trends and Prospects in India, (1979).

TABLE 7

Projections of Food Energy Demand

	BASES				PROJECTIONS				
	1971	1973/74	1975	1977	1979/80	1984/85	1989/90	1994/95	1999/00
	(calories per capita per day)								
Present Study, No Redistribution									
Low (3.5%) 1/		1,952			1,955	2,029	2,104	2,196	2,292
High (5.0%) 1/		1,952			1,955 4/	2,118	2,279	2,453	2,622
NCA Low 2/	2,080					2,200			2,300
NCA High 2 /	2,080					2,480			2,600
Brookings Low 3/			2,212				2,495		2,697
Brookings High 3/			,212				2,733		3,403
FAO (1972-74)		1,967							
WDR				2,201					
Present Study, Redistribution									
3.5% Growth; -0.5% Gini Change		1,952			1,963	2,045	2,128	2,229	2,335

Notes: 1/ Growth rates refer to total expenditure in the economy. Per capita expenditure growth would be 1.6% in the low case and 3.1% in the high case, over the entire projection period. There would be some variation in these figures for sub-periods.

2/ The NCA low case assumes 1% growth in per capita expenditure, and 2% growth in the high case.

3/ The Brookings low case (Alternative C) assumes 1.2% per capita income growth from 1975-80, 1.5% for 1980-90, and 2.0% for 1990-2000. The high case assumes 2.4%, 3.0%, and 4.0% growth for these periods.

4/ A 3.5% expenditure growth rate through 1979/80 was assumed for both the high and low cases, hence this figure is the same as above.

Sources: NCA - Report of the National Commission on Agriculture, Part III, Demand and Supply (1976), Table 10.12.

Brookings - The Brookings Institution, Fred H. Sanderson and Shymal Roy, Food Trends and Prospects for India (1979), Table 7.11

FAO - Food and Agricultural Organization of the U.N., Food Balance Sheets, 1972-74, Rome.

WDR - World Development Report, 1980, The World Bank, Table 22.

is similar to the high case here and in the NCA study. However, their high projection appears to be unrealistic.

Per capita food energy demand would increase by about 15% by year 2000 at a 3.5% expenditure growth rate. 1/ A moderate rate of expenditure redistribution, i.e., a 0.5%/year drop in the Gini ratio, would leave the mean level of food energy demand virtually unaltered. However, a gradual increase in equality might have a more significant effect on the distribution of consumption. The next section presents evidence that the Gini ratio based on personal expenditures has actually been falling at this rate. The sensitivity of the projections to various assumptions is examined in Section IV.

In general, the projections in Tables 4A and 4B appear consistent with actual consumption of some commodities in 1979/80. The projections into the 1980's and 1990's accord well with other research on consumer demand in India, expressed both in terms of quantities and in terms of calories per capita.

III. INCOME REDISTRIBUTION

Since demand is projected for each expenditure class using unique elasticities, income redistribution would alter the aggregate. There are a number of measures of income distribution available to summarize the level of economic equality in a society: the Gini coefficient, Kuznets' Index, Theil's Index, the Pareto coefficient, the equally distributed equivalent, the coefficient of variation, and the standard deviation of the log-normal distribution, to name a few. Atkinson presents an interesting comparison of several of these.2/ Despite the ambiguities of crossing Lorenz curves inherent in the Gini coefficient, it remains the most widely recognized measure, and has been calculated frequently with historical data which facilitates trend comparisons. Since changes in income distribution affect the pattern of consumption, the projection

---

1/ It should be noted that the increase is moderated by the fact that the average energy requirement per capita is also rising slightly. As the population growth rate slows, the age structure of the population matures, and the mean requirement rises.

2/ Anthony B. Atkinson "On the Measurement of Inequality", Journal of Economic Theory, Vol. 2 (1970), pp. 244-257. Atkinson shows that the ranking of countries according to inequality obtained from the Gini ratio, the standard deviation of logarithms, and the coefficient of variation are similar to the rankings found with the equally distributed equivalent measure using a different index of aversion to inequality.

programs were designed to model assumptions about an altered distribution and their impact on demand. Changes in the income distribution are summarized in terms of the Gini coefficient and shares of the total expenditures accounted for by given shares of the population. Redistribution is assumed to be proportionate to a population group's departure from economic equality. Crossing Lorenz curves (which may present problems when countries are compared with one another) are not, therefore, introduced. This section reviews an estimation procedure for the Gini ratio, makes historical and international comparisons, and reports the effects of redistribution on demand. The following section expands on the issue of redistribution in a sensitivity analysis framework, although the commodity focus is narrower.

A. Gini Ratio Estimation and Comparisons. Gini ratios lie in a fairly tight band even when taken from a broad spectrum of countries. Ratios from a selection of countries which are based on similar years and population coverages are shown in Table 8. When countries are ordered by the ratios, a clear inverse pattern emerges between the Gini coefficient and the percent of income held by the least affluent 40% of the population. However, exceptions to this generalization can be found.

Most of the estimates listed in the table rely on household income data. Changes in the distribution of individual consumption expenditure will obviously be related more closely to the demand pattern. Gini ratios derived from these data will be lower since savings behavior is disregarded. The Ranadive Gini ratio estimates for individual consumption in India are, therefore, the most pertinent series for this analysis (Table 9). They indicate an improvement in the distribution evidenced by a 8.3% drop in the Gini ratio over 15 years. Ahmed's figures on Gini coefficients derived from the personal income of individuals support this trend. Some of the series calculated by other investigators are more ambiguous in trend.

TABLE 8

INTERNATIONAL COMPARISONS OF INCOME DISTRIBUTION ORDERED BY THE GINI RATIO

	Year	Population a/	Gini Ratio	Income Share Held By Percent of Population Bottom 40%	Top 20%
Taiwan	1972	HH	0.284	22.3	37.2
Pakistan	1969/70	HH	0.336	20.2	41.8
United Kingdom	1968	HH	0.338	18.5	40.3
Yugoslavia	1968	HH	0.347	18.4	41.4
Korea (Rep. of)	1970	HH	0.372	17.7	44.5
Sri Lanka	1969/70	HH	0.377	17.8	44.9
Indonesia	1971	IR	0.463	17.3	52.0
El Salvador	1969	POP	0.465	12.4	50.8
India	1967/68	HH	0.478	13.1	53.1
Philippines	1971	HH	0.494	11.9	54.0
Chile	1968	HH	0.506	13.0	55.8
Ivory Coast	1970	IR	0.534	10.6	58.5
Mexico	1969	HH	0.583	10.2	63.2
Tanzania	1969	HH	0.597	7.8	63.3
Kenya	1969	IR	0.637	9.5	66.9
Brazil	1970	IR	0.646	8.1	67.3

a/ The coverage is national in all cases. IR: Income Recipient; HH: Household; POP: Population.

Source: Adapted from Shail Jain, Size Distribution of Income: A Compilation of Data (Washington, D.C.: The World Bank, 1975)

TABLE 9

SOME ESTIMATES OF GINI RATIOS FOR INDIA

Year	Ojha and Bhatt		Ahmed	Ranadive			Swamy
	1964	1971	1971	1971	1971	1971	1964
	Personal income households	Personal income individuals	Personal income individuals	Personal income individuals	Personal income households	Consumption expenditure individuals	Consumption expenditure households
1951-52	.	.	.	.	.	.	0.366
1952-53	.	.	.	.	.	.	0.361
1953-54	0.349	0.376	.	0.359-0.374	0.437-0.511	0.336	0.369
1954-55			.	0.399-0.420	.	.	0.390
1955-56	0.341	.	.	0.393-0.419	.	.	0.370
1956-57			0.4527	0.377-0.410	.	0.333	0.407
1957-58	.	.	.	0.371-0.391	0.432-0.540	.	0.398
1958-59	.	.	.	.	.	.	0.383
1959-60	.	.	.	0.355-0.378	.	.	0.385
1960-61	.	.	0.4136	.	.	.	.
1961-62	.	0.385	.	0.356-0.379	.	0.320	.
1962-63	.		.	.	.	.	.
1963-64	.		.	.	.	.	.
1964-65	.	.	0.3873	.	.	0.303	.
1965-66	.	.	.	.	.	.	.
1966-67	.	.	.	.	.	.	.
1967-68	.	.	.	.	.	.	.
1968-69	.	.	.	.	.	0.308	.

Sources P. D. Ojha and V. V. Bhatt: "Pattern of income distribution in an underdeveloped economy: a case study of India", in *American Economic Review* (Menasha (Wisconsin)), Sep. 1964, p. 714; and idem: "Pattern of income distribution in India: 1953-55 to 1961-64" (Paper presented at the Seminar on Income Distribution organised by the Indian Statistical Institute, New Delhi, February 25-26, 1971), p. 5. Mahfooz Ahmed: "Size distribution of personal income in India 1956-57, 1960-61 and 1964-65" (Paper presented at the Seminar . . . , 1971), table 6. K. R. Ranadive: "Pattern of income distribution in India, 1953-54 to 1959-60"; in *Bulletin of the Oxford University Institute of Economics and Statistics*, Aug. 1968, p. 251 (distribution of income of individuals in 1953-54, 1954-55, 1955-56, 1957-58 and 1959-60; ranges are due to estimates based on different assumptions about savings and tax evasion); and idem: "Distribution of income: Trends since planning" (Paper presented at the Seminar . . . , 1971), pp 16, 17 and 33 Subramanian Swamy: "Structural changes and the distribution of income by size: The case of India", in *Review of Income and Wealth* (New Haven (Connecticut)), June 1967, p. 173.

SOURCE: Felix Paukert, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labor Review, Aug.-Sept., 1973, pp. 97-124.

Gini ratios were estimated in the 28th NSS Round for 1973/74, following Kakwani and Podder's approach.1/ A regression fit of the Lorenz curve was found using the following functional form:

$$N = a\gamma^{\alpha}(\sqrt{2}-\gamma)^{\beta}$$

where $N = (P-E)\sqrt{2}$
$\gamma = (P+E)\sqrt{2}$
P = cumulative population shares
E = cumulative expenditure shares

The Gini ratio (G) is twice the area under the curve given by the integral from 0 to $\sqrt{2}$:

$$G = 2a\ (\sqrt{2})^{1+\alpha+\beta}B(1+\alpha,\ 1+\beta)$$

$B(1+\alpha,\ 1+\beta)$ is the Beta function. The program used to find the Gini ratio from the original data is listed in Appendix II.2/ The data from the urban and rural sectors were merged for the economy-wide estimate.

1/ N. C. Kakwani and N. Podder, "Efficient Estimation of the Lorenz Curve and Associated Inequality Measures from Grouped Observations," Econometrica, Vol. 44, No. 1 (January 1976), pp. 137-148.

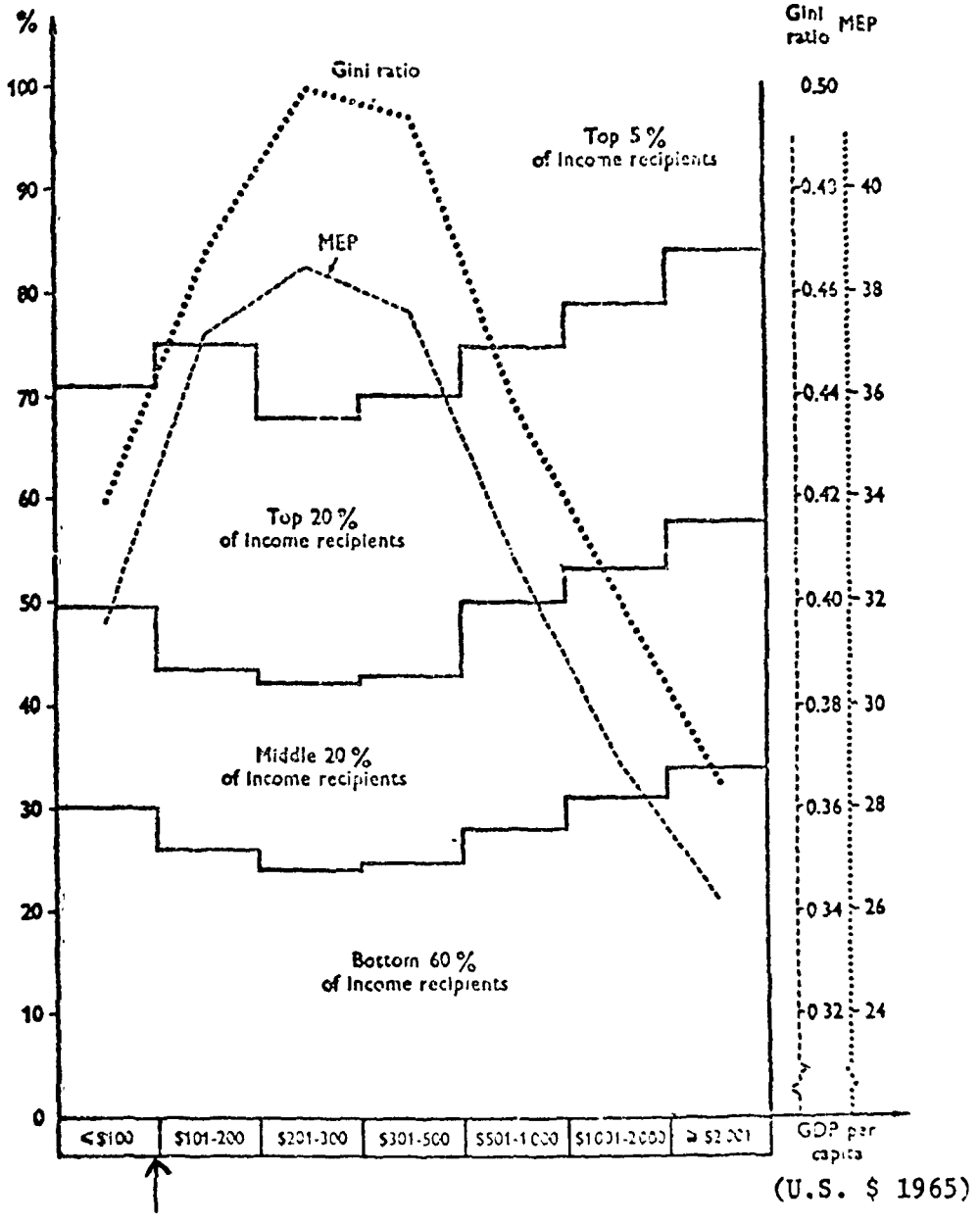
2/ In RAL (Research Analysis Language), the Beta function is not available, but it can be related to the Gamma function which is included in the syntax:

$$B(M,N) = \Gamma(m)\Gamma(n)/\Gamma(m+n)$$

$$\Gamma(m) = \int_0^{\infty} e^{-x}x^{m-1}dx.$$

FIGURE 1

DISTRIBUTION OF INCOME AT DIFFERENT LEVELS
OF PER CAPITA GDP



India GDP per capita
(for 1973-74 in $U.S. 1965)

SOURCE: Cross-sectional data on 56 countries presented by Paukert. (See source on Table 9.)

NOTE: MEP is the maximum equilization percentage defined as the percentage of total income that would have to be shifted between quintiles to achieve equal income distribution.

TABLE 10

GINI COEFFICIENTS FOR INDIVIDUAL CONSUMPTION EXPENDITURE (1973/74)

Rural	Urban	National
0.287	0.320	0.301

The national estimate is very close to the figure from Ranadive (0.308) and indicates a continuation of the trend of increasing equality. Over twenty years (1953/54 to 1973/74), the Gini ratio of individual expenditure has fallen at an annually compounded rate of 0.55%. The pattern is reinforced by observations of the ratio for intermediate years. 1/

An improving distribution is at variance with cross-sectional relationships between GDP per capita and the Gini ratio derived from total income (Figure 1). Countries at income levels similar to India's experience more inequality as income rises. The reconciliation of the longitudinal trend with the cross-sectional pattern probably lies in the difference between consumption expenditure and income. The multi-country study was based on total income. The personal income distribution could be worsening (suggested by Ojha and Bhatt, Table 9), while the consumption distribution improves. Some researchers, however, also show India's income distribution becoming more egalitarian which would make India somewhat unique when viewed against a background of cross-sectional data. 2/ Changes in expenditure shares and Gini coefficients for three

1/ However, Gini ratios for the more recent period 1977/78 were estimated with the same technique using the decile distribution of private consumption from the 32nd NSS Round reported in the Sixth Five Year Plan, 1980-85. The rural, urban, and national ratios were 0.31, 0.34, and 0.32, which would imply a reversal of the trend. However, these estimates may not be comparable since it is not stated whether the deciles are based on the household or the individual population distribution, and biases may have been introduced during interpolation to deciles.

2/ A recent Bank paper on income distribution in India concludes there has virtually been no trend. V. V. Bhanoji Rao, "EPD Income Distribution Project Data on Income Distribution in India," Division Working Paper No. 1980-2, p. 19. However, Ahmend's figures show some improvement through the mid-1960's.

rates of change in the Gini ratio are presented in Table 11. The middle case, -0.5%/year, matches the historical movement. Somewhat over 2.0% of the total income is transferred from the upper 15% of the income distribution to the poorest 45% of the population by 2000 at this modest rate. A faster decline in the Gini ratio, -1.0%/year, would approximately double the size of the transfer.

B. The Effects of Income Redistribution on Demand Projections.

A more egalitarian income distribution would tend to reduce demand for some preferred and luxury items, and expand the consumption of basic commodities, compared with a base case of an unaltered income distribution. 1/ A falling Gini ratio for personal expenditures would dampen the growth of demand for fruits and nuts, beverages, clothing, and milk. The demand for fuel and light, footwear, miscellaneous goods and services, rents and durable goods would also slacken freeing more revenue in the economy for the increased consumption of other goods. Projections for these items, however, are not reported since base-level quantities of consumption for most of these categories were not available or interpretable at a national level. 2/

The demand for clothing is affected more by redistribution than the other commodities studied. Most of the effects of moderate redistribution on consumption are relatively minor. Demand for foodgrains would rise 1.0% and 1.8% by 1984/85 given the present and an accelerated rate of improvement, respectively in the Gini ratio. The increase at the turn of the century would be 2.3 and 4.0%, respectively. Since the Gini ratio for personal consumption expenditures has actually been falling by 0.55% per year, the projection adjustments given in the left-hand columns of Table 12 may prove applicable. The projection tables for a falling Gini ratio, with 3.5% and 5.0% expenditure growth, appear in Appendix I. A more detailed discussion of the sensitivity of demand to income redistribution is contained in the following section.

1/ No distinction is made between income and expenditure for the purpose of this discussion.

2/ Although projections are not given in quantity or value terms, they are presented as multiplicative increases over the 1973-74 level.

TABLE 11

FUTURE EXPENDITURE SHARES AND GINI RATIOS GIVEN REDISTRIBUTION RATES

	RURAL			URBAN		
	Gini Ratio	Bottom	Top	Gini Ratio	Bottom	Top
		-- (%) --			-- (%) --	
Population Share		42.5	16.9		47.6	16.2
1973/74						
Expenditure Share		24.8	33.7		26.3	36.0
Gini Ratio	0.287			0.320		
1999-2000						
Gini Change + 0.5%/Year						
Expenditure Share		22.3	36.1		23.4	38.7
Gini Ratio	0.327			0.364		
Gini Change - 0.5%/Year						
Expenditure Share		27.0	31.7		28.7	33.6
Gini Ratio	0.252			0.281		
Gini Change - 1.0%/Year						
Expenditure Share		28.9	29.8		31.0	31.4
Gini Ratio	0.221			0.246		

Notes: Redistribution followed the rule:

$$S_i^* = S_i - (\Delta G/G)(P_i - S_i)$$

where S_i = starting expenditure share of ith group;

S_i^* = expenditure share after redistribution

$\Delta G/G$ = proportionate change in Gini ratio over the period;

P_i = population share of the ith group.

See Section II.C for further details. To avoid possible interpolation errors, the table is based on population share divisions aggregated from the reported data. (Interpolation would have resulted in exact decile or quintile shares.)

It is demonstrated in the paper documenting the demand model that the redistribution rule satisfies the condition that the new Gini ratio G^*, based on expenditure shares S_i^*, equals $G+\Delta G$.

TABLE 12

CHANGES IN QUANTITIES DEMANDED RESULTING FROM INCOME REDISTRIBUTION a/

	Gini Ratio Declines 0.5%/Year b/		Gini Ratio Declines 1.0%/Year	
	1984/85	1999-2000	1984/85	1999/2000
	(% Change)			
Pulses	0.8	1.8	1.4	3.1
Edible Oils	1.0	2.3	1.8	3.9
Meat, Fish, Eggs	0.3	0.4	0.3	0.7
Vegetables	0.8	1.8	1.5	3.2
Fruits, Nuts	-1.3	-2.5	-2.5	-4.5
Sugar, Khandsari	0.0	0.5	0.2	0.9
Gur, Other Sugars	1.0	2.4	2.1	4.4
Spices	0.0	2.3	1.1	3.8
Beverages	0.0	-3.3	-2.3	-5.6
Tobacco, Pan, Intox	0.0	1.0	0.0	1.0
Clothing	-2.9	-4.2	-4.7	-7.5
Milk	-0.5	-0.7	-0.9	-1.3
Rice	1.2	2.8	2.3	5.0
Wheat	1.1	2.8	2.2	5.0
Maize	0.4	0.6	0.5	1.1
Sorghum & Millet	0.3	0.4	0.4	0.7
Sweeteners	0.7	1.6	1.3	2.8
Foodgrains	1.0	2.3	1.8	4.0

a/ Demand projections compared in this table assume a 3.5% total expenditure growth rate.

b/ This rate corresponds to the historical trend over a 20-year period computed with personal consumption expenditure data.

The effects of redistribution actually reflect changes in the marginal propensities to consume (MPC) at different income levels. Twenty percent of additional income would be spent on clothing in rural areas at 160% the mean income level in the survey (MPC = 0.20) whereas only 6%

would be allocated to clothing at 60% of the mean income level. 1/ Hence redistribution significantly reduces the demand for clothing. The corresponding high and low MPCs for gur and other sweetners are 0.01 and 0.03. This opposite ordering implies an elevated demand would accompany redistribution. Likewise, in a neutral case in which demand was virtually unaltered, the MPCs are similar across a range of incomes. The rural MPCs for meat, fish and eggs at 160% and 60% of the mean income, for example, are 0.027 and 0.034.

IV. SENSITIVITY ANALYSIS

Sensitivity analysis was performed on the projections for foodgrains, edible oils, sweeteners, and the share of wheat in foodgrains by varying the assumptions regarding population growth, urbanization, expenditure growth, and income distribution. The proportions of rice and pulses demanded out of total foodgrains were also considered. The population parameters were altered in a few discrete cases, but sensitivity analysis for expenditure growth and income distribution proceeded from a set of 27 projections with a blend of assumptions. Regressions were then run treating the set of demand levels as observations on a dependent variable. This approach yielded elasticities of future demand with respect to rates of expenditure growth and "income" 2/ redistribution. In most cases, sensitivity analysis was referenced to the projected demand in the year 2000. 3/

A. Population Growth and Urbanization. Population growth rates were varied by +0.1% and +0.05%, and urbanization by +1% of the total population per five years. 4/ A very high rate of urbanization was also tested in which the urban share was 2% higher than the base case per five years of projection. 5/ The span of the assumptions used for sensitivity

---

1/ The income levels selected for the comparison were chosen arbitrarily. The asymmetry of 60% versus 160% is intended to reflect some of the skewness of the income distribution.

2/ Technically, expenditure redistribution is being modeled since data savings behavior were not collected.

3/ The previous section discussed the effects of two rates of income redistribution on the complete set of commodities.

4/ In the "plus" case, for example, the urban share of total population would be 4.0% higher at the end of 20 years.

5/ See the right-hand column of Table 13.

Table 13

POPULATION AND URBAN SHARE VALUES
FOR SENSITIVITY ANALYSIS

Year	Base Case		Population With Growth Rate Varied				Urban Share With Urbanization Rate Varied 1/		
	Population	Urban Share	-0.1%	-0.05%	+0.05%	+0.1%	-1.0%/5 yrs	+1.0%/5 yrs	+2.0%/5 yrs
	--million --------	---(%)----	----------million----------				----------(%)----------		
1973/74	595.6	20.6	595.6	595.6	595.6	595.6	20.6	20.6	20.6
1979/80	672.2	22.3	668.2	670.2	674.2	676.2	21.3	23.3	24.3
1984/85	744.2	24.3	736.1	740.1	748.3	752.4	22.3	26.3	28.3
1989/90	820.5	26.9	807.5	813.9	827.1	833.7	23.9	29.9	32.9
1994/95	897.7	28.1	879.1	888.3	907.2	916.7	24.1	32.1	36.1
1999/00	973.6	30.0	948.7	961.0	986.4	999.2	25.0	35.0	40.0
			----------(%)----------						
Change in 2000			-2.6	-1.3	1.3	2.6	-5.0	5.0	10.0

1/ The adjustment for 1979/80 is spread over more than five years.

analysis is indicated in Table 13. At the extremes, the total population in year 2000 is varied by +2.6% and the urban share by -5% to +10%.

The projections for total foodgrains demand vary in almost the same proportion as population. The composition of foodgrains demanded is hardly affected by altered population growth rates. Demands for sweeteners and edible oils are relatively insensitive to population assumptions compared with demand for foodgrains. These results are rather intuitive.

The effects of urbanization rates are more interesting. Projections for total foodgrains, sweeteners, and edible oils are modified more by a 5% change in the urban share of population than by a 2.6% change in total population. Unfortunately, estimating the future urban share is more difficult and uncertain than forecasting the total population. Rapid urbanization lowers the growth in demand for foodgrains and sweeteners and raises the growth in demand for edible oils. The proportion of wheat demanded in total foodgrains would also increase somewhat, at the expense of demand for coarse cereals. 1/

Overall, the projections for these commodities are fairly insensitive to reasonable variations in population growth and urbanization rates, which supports the approach of using one set of population parameters for the primary presentation of results. 2/ Further testing confirmed that the effects of changing the population and urban share figures were independent and additive, and indicated that the compound result could therefore be inferred from Table 14. For instance, if rapid population growth coincided with faster than expected urbanization, the impact on foodgrain demand would be offsetting, resulting in a -0.3% change from the base case (+1.8% from population growth -2.1% from

---

1/ Caution must be used when interpreting the effects of urbanization since abstracting the differences in demand patterns between urban and rural consumers involves altered relative prices, subsistence consumption opportunities, income, and commodity availability, all of which affect the acquisition of new "tastes and preferences". In addition, urbanization will have unexplored second round effects on patterns of production and distribution, and on prices. To the extent that differences in consumption are explained by differences in income, income growth would have to be faster to allow for the acquisition of urban migration. Yet for the purposes of sensitivity analysis, urbanization and expenditure growth were varied independently.

2/ Therefore, complete sets of alternative projections were not reported in which population parameters were varied simultaneously with expenditure growth rates. The number of cases under consideration was thereby reduced.

Table 14

SENSITIVITY OF PROJECTIONS FOR YEAR 2000
TO ALTERED POPULATION AND URBAN SHARE ASSUMPTIONS 1/

	Year 2000 Base Case	Population Growth Rate Varied (% per year)				Urbanization Rate Varied (% of Total Per 5 Years)		
		-0.1	-0.05	+0.05	+0.1	-1.0	+1.0	+2.0
Foodgrains (mmt)	190.66	187.31	188.98	192.34	194.00	194.71	186.71	182.87
% rice	43.8	43.8	43.8	43.8	43.8	43.9	43.7	43.6
% wheat	27.0	27.1	27.0	26.9	26.8	26.7	27.3	27.7
% pulses	10.6	10.7	10.7	10.6	10.5	10.6	10.7	10.8
Sweeteners (mmt)	25.93	25.85	25.89	25.97	26.00	26.48	25.41	24.91
Edible oils (mmt)	6.56	6.52	6.54	6.59	6.61	6.39	6.73	6.89
		--------(%)----------				----------(%)-------		
Change in foodgrains		-1.8	-0.9	0.9	1.8	2.1	-2.1	-4.1

1/ These projections all assume 3.5% total expenditure growth and no change in income distribution.

urbanization). The effects of population pressure on arable land might lead to the expectation that the rates of population growth and urbanization would be positively related. The foodgrain projections are satisfactorily robust with respect to population assumptions even if trends have a reinforcing effect on demand. Reinforcement would occur if population growth were accelerated and urbanization were retarded, or vice versa.

Provisional census figures have recently been released reporting a population of 683.8 million as of February 1981. 1/ The census implies a higher-than-expected population growth rate of 2.2% over the seventies and about 0.1% higher for the last half of the decade than used in the demand projections. Revised population projections incorporating the census data have not appeared yet, but it is unlikely that they will reflect a 0.1% higher growth rate than earlier projections for the rest of the century. However, if this more rapid trend continues, demand for foodgrains may be 1-2% higher (2-4 million tons) by 2000. 2/

B. Expenditure Growth and Income Redistribution. The projections of foodgrain demand are sensitive to the expenditure growth assumptions. The demand for wheat and pulses as a proportion of total foodgrains in 2000 rises by about one-half of a percent (say 2 million tons) per one-half percent rise in the expenditure growth rate over the projection period. This generalization approximately holds for a wide range of growth rates extending from 2.5% to 6.0%. The proportion of rice in foodgrain demand is more stable and only begins to drop at the higher expenditure growth levels. These trends indicate that rapid economic expansion in real terms would stimulate a marked shift in consumption patterns in favor of wheat (Table 16) by the turn of the century.

Future demand for sweeteners and edible oils is more critically influenced by expenditure assumptions than projected foodgrain consumption (Table 15). The higher expenditure elasticities for these two less essential foods are of course responsible for their sensitivity.

1/ Census of India 1981, Series 1, Provisional Population Totals.

2/ The assumptions regarding urbanization could not be checked against the provisional census figures since the urban population has not yet been reported.

TABLE 15

Sensitivity Comparisons

	Increase in Demand at 6% Expenditure Growth over Demand at 2.5% Growth	
	1984/85	1999/2000
	(%)	
Foodgrains	7.5	17.7
Sweeteners	18.2	76.2
Edible Oils	15.1	58.6

In order to study the interactions of income redistribution and expenditure growth in more detail, a set of 27 projections was produced using a grid of changes in the Gini ratio and expenditure growth rates. 1/ The projected levels of demand in 2000 were then regressed on these parametric variables. The Gini variable was converted to a multiplier over the time period to facilitate interpretation. For example, an original income redistribution variable was -0.5 signifying a 0.5% per year drop in the Gini ratio. The ratio is then 12.2% lower in the year 2000, so the value 0.878 was used in the regression. Expenditure growth was left in percent per year terms. The elasticities are shown in Table 17.

According to these elasticities, if expenditure growth were 20% higher than the mean in the simulation (1.2 x 4.22% = 5%/year) foodgrain demand would increase by about 4% (20% x 0.20 = 4%), relative to the mean projection in the simulation set. This relationship is approximately confirmed by projection runs at 5% expenditure growth and a fixed Gini ratio.

Interpreting the elasticities of demand with respect to Gini ratios is even more direct since the mean of the multiplicative variable in the parametric set is nearly one. 2/ Thus a 10% decrease from the mean in the regressions is in fact a 10% lower Gini ratio in year 2000. This improved distribution would raise foodgrain consumption by about 1.8%. The elasticities of projected demand with respect to modelling variables

---

1/ The previous section discussed the expenditure share implications of changes in the Gini coefficient (Table 11).

2/ This is the rationale behind the change in the variable definition. A multiplier of one of course corresponds to a zero percent change in the Gini ratio.

Table 16

SENSITIVITY ANALYSIS OF EXPENDITURE GROWTH RATES 1/

	Demand in million tons Given Expenditure Growth 2/							
Expenditure Growth (%) 3/	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1984/85								
Foodgrains	132.56	134.04	135.49	136.94	138.37	139.78	141.15	142.50
% rice	43.7	43.7	43.7	43.8	43.8	43.8	43.8	43.8
% wheat	24.7	24.9	25.0	25.2	25.3	25.5	25.6	25.8
% pulses	9.5	9.6	9.7	9.8	9.8	9.9	10.0	10.1
Sweeteners	15.26	15.65	16.04	16.43	16.82	17.22	17.62	18.03
Edible Oils	3.83	3.91	3.99	4.08	4.16	4.24	4.33	4.41
1999/2000								
Foodgrains	177.30	184.31	190.66	196.19	201.02	204.71	207.24	208.67
% rice	43.7	43.8	43.7	43.7	43.5	43.2	42.8	42.3
% wheat	25.8	26.4	26.9	27.5	28.0	28.6	29.1	29.6
% pulses	9.9	10.2	10.6	11.0	11.4	11.8	12.3	13.0
Sweeteners	21.65	23.75	25.93	28.20	30.55	32.99	35.52	38.15
Edible Oils	5.63	6.09	6.56	7.04	7.52	8.00	8.47	8.93

1/ The expenditure distribution is held constant.
2/ Except where demand is indicated as a percent of foodgrains.
3/ After 1979/80. Between 1973-74 and 1979-80, 3.5% growth was used in all cases.

Table 17

ELASTICITIES OF PROJECTIONS

For:	Elasticity of Demand in Year 2000 With Respect to: 1/ Gini Change	Expenditure Growth	Mean Demand In Simulation Set -- million tons --
Foodgrains	-0.18	0.20	197.84
Percent wheat	-0.04	0.17	27.8 1/
Sweeteners	-0.17	0.53	30.68
Edible Oils	-0.12	0.64	7.58
Mean Parametric Values 2/	0.948	4.22	

1/ Percent

2/ Gini ratio change is measured as a multiplier over the period; expenditure growth is measured for the whole economy in percent per year.

compress a volume of sensitivity analysis into a readily interpretable form.

Referring to Table 17, it can be concluded that:

1) A percentage change in the Gini ratio over the entire period would have an opposite and nearly equal effect on the demand for foodgrains as a similar proportionate change in the annual expenditure growth rate. (A 10% fall in the Gini ratio multiplier over the period would have an effect similar to a 10% rise in the mean expenditure growth rate from 4.2% to 4.6%: demand would increase by 2% in year 2000.)

2) The sensitivity of demand for foodgrains, wheat, 1/ sweeteners, and edible oils is fairly similar with respect to changes in the income distribution. (An improved distribution would boost demand among the lower income groups for all items but would decrease demand among upper income groups especially for commodities with high marginal propensities to consume.)

3) The sensitivity of demand with respect to expenditure growth rates, unlike the response to redistribution, varies greatly between commodities, as expected.

Appendix III contains the "data" used in the elasticity calculations, i.e., the set of parameter combinations and projection results.

Graphing isoquants of projected demand against expenditure growth and altered Gini ratios is another approach to interpreting sensitivity analysis (Figure 2). The slopes of the isoquants describe the relative importance of the two modelling variables. The flatter the slope, the less important economic growth is relative to income redistribution since small changes in the Gini coefficient would offset larger changes in total expenditure and leave demand unaltered. The isoquant map conveys results from a large number of projection runs.

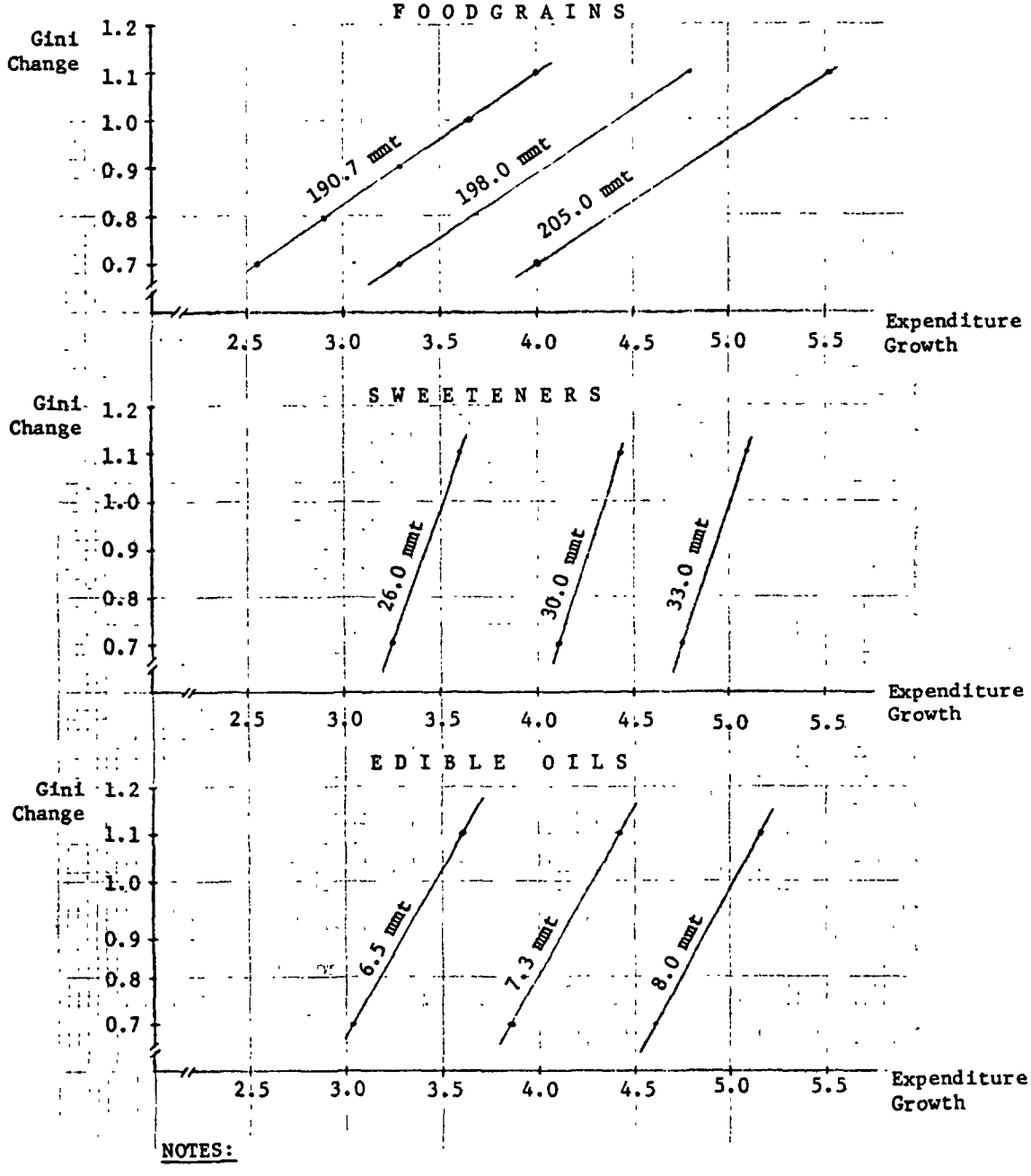
The Gini ratio change scale used in Figure 2 is matched against annual change rates in Table 18. The discussion of historical rates of redistribution in the previous section highlights a scale value of 0.88 (-0.5%/yr) as a likely possibility. Although severe redistribution of income, improving or worsening, would have a decided effect on demand, the probable range of outcomes is narrow. The expenditure growth rate therefore remains the most critical and uncertain parameter in the projection model.

1/ The demand for wheat would respond in a fashion similar to the demand for foodgrains in view of the low elasticity of the percent of wheat in the total.

FIGURE 2

PROJECTION ISOQUANTS

FOR YEAR 2000



NOTES:

Expenditure growth is measured as the annual percentage increase for the entire economy compounded from 1979-80 to 1999-2000.

The change in the Gini ratio is measured as a multiplicative factor over the total period.

The isoquants illustrate constant levels of demand.

TABLE 18

Correspondence of Multiplicative Factors and Annual Gini Ratio Change Rates

Change by 2000	Annual Percentage Change
1.29	1.0
1.14	0.5
1.00	0.0
0.88	-0.5
0.77	-1.0

V. CONCLUSIONS

The absence of prices is the most obvious and important limitation to projections based on cross-sectional expenditure data. Relative prices are necessarily assumed to be fixed, whereas they would respond to changing consumption patterns, production levels, factor prices, trade flows, and government policies in a number of areas.

Not only are relative prices assumed fixed over the projection period, but prices between consumers in the survey should be the same for expenditures to carry a constant quantity interpretation. One step in overcoming this obstacle has been taken: separate urban and rural projections have been combined using quantity weights for some commodities.

Key assumptions were that real per capita expenditure growth would be equal in rural and urban areas, and that any income distribution which did occur would follow a symmetric and proportional re-allocation rule in both sectors.

Projections for 1979/80 for cereals, pulses, edible oils, and sweeteners are comparable with actual consumption if some allowances are made for the poor crop year. Demand in terms of calories per capita was closely aligned with other base period estimates and future projections, projections were fairly robust with respect to moderate variations in population growth and income redistribution.

This study and projections by the National Commission of Agriculture indicate a 15% increase in per capita calorie demand to 2300 calories per day by year 2000 under the low economic growth alternative.

Foodgrain demand would grow by 2.6% through the mid-1980s, and then slow to an average rate of 2.3%. The total increase in the last two decades of the century would be 60-70% if real expenditure growth is 3.5-5.0% per year.

The composition of foodgrains demanded would shift away from maize, sorghum, and millet in favor of wheat and pulses. If foodgrain demand grew by 60-70%, wheat demand would grow by 75-100%, and coarse cereals by 33-16%. There would be less increase in demand for the less preferred grains if expenditure growth were more rapid. The proportion of rice demanded in foodgrains would remain almost fixed at 43-44% under a wide range of economic growth assumptions. At a 5% expenditure growth rate, the proportion of wheat demanded would increase 5% by 2000, and the share of coarse cereals would drop 7%. One percent of foodgrain demand would be 2 million tons in 2000, so the shift would be considerable. Faster urban migration would slightly dampen foodgrain demand, ceteris paribus.

Demand for sugar/khandsari and edible oils is expected to be very buoyant even given slow expenditure growth. In the case of edible oils, this trend has strong implications for future prices and/or imports.

Improvement in the expenditure distribution would affect demand according to differences in marginal propensities to consume at various income levels. These differences cannot be inferred from expenditure elasticities at the mean. 1/ A continuation of the 0.5%/year drop in the Gini ratio would contract demand (relative to the constant ratio case) for fruits and nuts, beverages, clothing, milk and milk products by a few percent and slightly expand demand for edible oils, gur, rice and wheat.

The predominant determinant of the projections and the primary source of uncertainty, is the expenditure growth rate. Elasticities of the projections with respect to the growth rate indicated that demand for foodgrains, sweeteners and edible oils would respectively be 4, 2, and 0.5 million tons higher at the turn of the century for each half of a percent increase in this critical parameter.

1/ The elasticities were one or above for edible oils, sugar/khandsari, and milk/milk products, but redistribution had positive, neutral and negative effects, respectively.

A P P E N D I C E S

APPENDIX I

Demand Projections with Moderate Redistribution

The following tables give the complete set of projections with low and high expenditure growth, and the historical rate of redistribution.

FOR THE FOLLOWING PROJECTION:
TOTAL EXPENDITURE GROWTH ASSUMPTION IS 3.5 PERCENT
GINI RATIO CHANGE RATE IS -0.5 PERCENT
OUTPUT IN MILLION METRIC TONS

	73/74	79/80	84/85	89/90	94/95	99/00
PULSES 3/	8.71	11.40	13 29	15.42	17.89	20.61
EDIBLE OILS	2.67	3.37	4.03	4.81	5.69	6.71
MEAT, FISH, & EGGS	2.40	2.71	3.26	3.92	4.70	5.64
VEGETABLES	6.93	7.88	9.28	10.93	12.77	14.89
FRUITS & NUTS	16.57	18 36	22 83	28.53	35.58	44 74
SUGAR & KHANDSARI	4.52	5.25	6 44	7.91	9 61	11.69
GUR & OTHER SUGARS	7 34	8 38	9.70	11.13	12.86	14.66
SPICES	0.69	0.77	0.89	1.03	1.17	1.33
BEVERAGES	0.32	0.34	0 43	0.54	0.68	0.87
TOBACCO, PAN & INTOX.	0.46	0.51	0 60	0.71	0 84	0.99
CLOTHING	0.72	0.82	1.02	1.27	1.61	2.04
MILK	19.75	23.16	28.59	35.26	43 55	53.78
RICE	40.36	52.58	60.04	68.01	76.94	85.87
WHEAT	22.54	29.37	34.36	39.96	46.21	52 91
MAIZE	4.04	5.10	5.52	5.89	6.31	6.63
SORGHUM & MILLET 4/	17.15	21.62	23 58	25.43	27.38	23.95
OTHER 1/	1.00	1.05	1.29	1.59	1.95	2.42
SWEETENERS	11.85	13.63	16.15	19.03	22.47	26.35
FOODGRAINS	92.80	120 08	136.79	154.71	174.73	194.97

FOR THE FOLLOWING PROJECTION
TOTAL EXPENDITURE GROWTH ASSUMPTION IS 5 PERCENT
GINI RATIO CHANGE RATE IS -0 5 PERCENT
OUTPUT IN MILLION METRIC TONS

	73/74	79/80 2/	84/85	89/90	94/95	99/00
PULSES 3/	8.71	11.40	14.02	17.07	20.70	24.76
EDIBLE OILS	2.67	3.37	4.28	5.40	6 68	8.19
MEAT, FISH, & EGGS	2.40	2.71	3.52	4.57	5.88	7 56
VEGETABLES	6.93	7.88	9.79	12 11	14.78	17.90
FRUITS & NUTS	16 57	18.36	25 60	35 85	49 99	70.04
SUGAR & KHANDSARI	4.52	5.25	7.05	9.38	12.32	16.07
GUR & OTHER SUGARS	7.34	8.38	10.29	12.40	14.91	17.46
SPICES	0.69	0.77	0.93	1.10	1.29	1.48
BEVERAGES	0.32	0.34	0 48	0.68	0.96	1.38
TOBACCO, PAN & INTOX.	0 46	0.51	0.64	0 81	1.02	1 29
CLOTHING	0.72	0 82	1.18	1 69	2.44	3.50
MILK	19.75	23.16	31.97	43 71	59.45	80.30
RICE	40.36	52 58	62 03	71 99	82 28	91.29
WHEAT	22.54	29 37	36 12	43.67	51 90	60.26
MAIZE	4.04	5 10	5.49	5.80	6.11	6.24
SORGHUM & MILLET 4/	17.15	21 62	23.44	24.99	26 38	27.14
OTHER 1/	1.00	1.05	1.42	1.95	2 66	3.66
SWEETENERS	11.85	13.63	17.34	21.78	27.22	33.53
FOODGRAINS	92.80	120.08	141.09	163.53	187.37	209.69

1/ Projections for "Other" are multiplicative factors on a 1973-74 base.

2/ Assumes 3.5% expenditure growth through 1979-80.

3/ Includes cereal substitutes and grams.

4/ Includes barley and other coarse cereals.

NOTE: Grossing factors for non-household demand for foodgrains and edible oils were added.

APPENDIX II

Gini Ratio Estimation Program

The following is a listing of a program to estimate rural, urban, and combined Gini Ratios. The program is called "GINI.EST.PGM" and runs on RAL.

```
   50 FETCH GINI EST
   60 RPS=NUMBERS(14)-NUMBERS(14)
   61 UPS=RPS
   62 RES=RPS
   63 UES=RPS
   70 G=(0,0,0)
  100 RP=WEIGHTRUR*PERSONPERHHR
  200 UP=WEIGHTURB*PERSONPERHHU
  300 RE=RP*SECTORTOTALR
  400 UE=UP*SECTORTOTALU
  500 FOR I = 1 TO 14 DO BEGIN
  600 RPS(I)=SUM(RP(1 TO I))/SUM(RP)
  700 UPS(I)=SUM(UP(1 TO I))/SUM(UP)
  800 RES(I)=SUM(RE(1 TO I))/SUM(RE)
  900 UES(I)=SUM(UE(1 TO I))/SUM(UE)
 1000 END
 1100 TPS=.794*RPS +  206*UPS
 1200 TES=.743*RES + .257*UES
 1300 VARP=("RPS","UPS","TPS")
 1400 VARE=("RES","UES","TES")
 1500 FOR I= 1 TO 3 DO BEGIN
 1600 P=VARP(I)
 1700 E=VARE(I)
 1800 ETA=(#P#-#E#)/SQRT(2)
 1900 FRUITPI=(#P#+#E#)/SQRT(2)
 1950 FRUITPI=FRUITPI(1 TO 13)
 1951 ETA=ETA(1 TO 13)
 2000 RUN MULTREG ON LN(FRUITPI),LN(SQRT(2)-FRUITPI),LN(ETA) &
 2100 OPTIONS= SUPPRESS SAVE(COEFFICIENTS)
 2200 G(I)=2*EXP(COEFFICIENTS(1))*(SQRT(2))** &
 2300 (1+COEFFICIENTS(2)+COEFFICIENTS(3))*GAMMA(1+COEFFICIENTS(2)) &
 2400 *GAMMA(1+COEFFICIENTS(3))/GAMMA(2+COEFFICIENTS(2) &
 2500 +COEFFICIENTS(3))
 2600 END
 2700 DISPLAY G
```

The data called in line 50 give urban and rural population and expenditure shares, RP, UP, RE, and UE. Cumulative shares have variables ending in "S", and the total shares "TPS" and "TES" use weights given in lines 1100 and 1200. The rest of the syntax corresponds to the discussion in Section III, given the following: (Note that lines 60-70 simply load zeros into vectors)

η = ETA

γ = FRUITPI

a = ln(COEFFICIENT(1))

α = COEFFICIENT(2)

β = COEFFICIENT(3)

The "GAMMA" in the program is the gamma function, not the gamma variable used in the text.

APPENDIX III

Sensitivity Analysis Data

The following is a listing of data from file PROJ.2000.

G1	E1	G2	E2	F	WPER	E	S
-1.5	2.5	0.675	1.90	186.52	26.2	5.91	22.51
-1.5	3.5	0.675	2.45	200.99	27.3	6.90	26.93
-1.5	4.5	0.675	3.14	212.48	28.4	7 93	31.75
-1.5	5.0	0.675	3.56	216.52	28.9	8.45	34.32
-1.5	5.5	0.675	4.02	219.33	29.4	8.97	36.91
-1.0	3.5	0.770	2.45	198.29	27.2	6.82	26.67
-1.0	5.0	0.770	3.56	213.48	28.8	8.34	33.96
-0.5	2.5	0.878	1.90	181.08	26.0	5.75	22.00
-0.5	3.5	0.878	2.45	194.97	27.1	6.71	26.35
-0.5	4.5	0.878	3.14	205.71	28.2	7.69	31.06
-0.5	5.5	0.878	4.02	212.23	29.3	8.68	36.10
0.0	2.5	1.000	1.90	177.30	25.8	5.63	21.65
0.0	3.0	1.000	2.16	184.31	26.4	6.09	23.75
0.0	3.5	1.000	2.45	190.66	26.9	6.56	25.93
0.0	4.0	1.000	2.77	196.19	27.5	7.04	28.20
0.0	4.5	1.000	3.14	201.02	28.0	7.52	30.55
0.0	5.0	1.000	3.56	204.71	28.6	8.00	32.99
0.0	5.5	1.000	4.02	207.24	29.1	8.47	35.52
0.0	6.0	1.000	4.55	208.67	29.6	8.93	38.15
0.5	2.5	1.138	1.90	172.55	25.6	5.48	21.23
0.5	3.5	1.138	2.45	185.06	26.8	6.38	25.40
0.5	4.5	1.138	3.14	194.86	27.9	7 30	29.91
0.5	5.0	1.138	3.56	198.43	28.5	7.75	32.31
0.5	5.5	1.138	4.02	200.90	29.0	8.20	34.81
1.0	3.5	1.295	2.45	178.13	26.6	6.16	24.78
1.0	5.0	1.295	3.56	190 41	28.3	7.45	31.52
-0.5	5.0	0.878	3.56	209.69	28.7	8.19	33.53

Each line contains output from a projection run for the year 2000. A large number of projections created a simulation data set which was used to find elasticities of projections with respect to assumptions, and projection isoquants in Section IV, The variable definitions are:

- G1 — Annual rate of change of Gini ratio for personal consumption expenditure, in percentage terms.
- E1 — Annual percentage growth rate in total expenditure.
- G2 — Multiplicative change in Gini ratio by 2000.
- E2 — Multiplicative change in total expenditure by 2000.
- F — Foodgrains projection for 2000, in mmt.
- WPER — Wheat percentage of foodgrains demanded in 2000.
- E — Edible oils projection for 2000, in mmt.
- S — Sweeteners projection for 2000, in mmt.

APPENDIX IV

Foodgrain Equivalents

	Calorie Weights 1/
Pulses	0.97
Edible Oils	2.47
Meat, Fish, Eggs	0.42
Vegetables	0.08
Fruits, Nuts	0.17
Sugar, Khandsari	1.08
Gur, Other Sweeteners	0.98
Milk	0.17
Rice	1.00
Wheat	1.02
Maize	1.00
Sorghum, Millet	0.97

1/ Calorie weights are relative to rice which has about 357 kcals/100 g. Although there is some nutritional value in spices, beverages, and pan, they were assumed to make a negligible contribution to the diet.

Source: FAO, Food Composition Tables for International Use, 1954.

Foodgrain equivalents can be found by replacing the grossing factor vector in line 1380 of COMB.PROJ.PGM with these weights, with zeros inserted for other items. (Grossing factors are, thereby, implicitly assumed to be one since non-household demand is not included in estimates of calories per capita.) Line 1470 is replaced by a vector of ones, and the "Foodgrains" output can then be interpreted as rice equivalents in million tons. Multiplication by 9780.82 and division by the population in millions converts rice equivalents to calories per capita per day.

APPENDIX V

List of Consumption Groups and Items 1/

3.1 In NSS, data on consumer expenditure are usually collected for a large number of items. But in presenting the results similar items have been merged to form 21 homogeneous groups The groups are :(1) cereals, (2) gram, (3) cereal substitutes, (4) pulse and products, (5) milk and products, (6) edible oil, (7) meat, fish and egg (8) vegetables, (9) fruits and nuts, (10) sugar, (11) salt, (12) spices, (13 beverages and refreshments, (14) pan, tobacco and intoxicants, (15) fuel and light, (16) clothing, (17) footwear, (18) miscellaneous goods and services, (19) rents, (20) taxes, (21) durable goods. Results are also presented for (i) food-total, (ii) non-food total and (iii) total consumer expenditure.

3.2 The groups of items of consumption as presented in the table are defined here in terms of their constituents :

1. *Cereals* : rice, wheat, jowar, bajra, maize, barley, small millets, ragi and their products,

2. *Gram* : bengal-gram and its products,

3. *Cereal substitutes* : Cereal substitutes like topioca, pea etc.,

4. *Pulse and products* : arhar, tur, gram, moong, masoor, urd, khesari, pea, soyabin and other pulses, and their products,

5. *Milk and products* : liquid milk (cow, buffalow, goat and others), baby-food milk (condensed powder etc.) ghee (cow and buffalo), butter, dahi, ghol, lassi and other milk products,

6. *Edible oil* : vanaspati, mustard oil, cocoanut oil, gingelly oil, groundnut oil, linseed oil, refined oil, other edible oil and oil seeds,

7. *Meat, fish and eggs* : meat (goat meat, mutton, beef, pork, buffalo meat and other meat), egg, poultry, fish (fresh and dried), bird and others,

8. *Vegetables* : potato, onion, tomato, brinjal, cabbage, cauli-flower, root vegetables (arur radish, etc.) leafy vegetables and other vegetables,

9. *Fruits and nuts* : banana, orange, lemon, mango, cocoanut, guava, pineapple, grapes, other fresh fruits, cocoanut copra, groundnut, cashewnut, dates, raisin, other dry fruits and nuts,

10. *Sugar* : sugar (factory) [illegible] (cane and others), candy, other sugar,

11. *Salt* : sea salt, rock salt and other salt,

12. *Spices* : turmeric, black pepper, pepper, dry chillies, green chillies, garlic, tamarind, ginger, curry powder, other spices,

13. *Beverages and refreshments* tea (no. of cups), tea leaf, coffee (no. of cups), coffee powder, other drinking beverages, biscuits, confectioneries etc., salted refreshments, prepared sweets, cooked meals, pickle, sauce, jams and jellies, other processed food items,

14. *Pan, tobacco and intoxicants* : pan leaf, pan finished, supari (betel nut, other ingredients for pan) biri, cigarettes, leaf tobacco, hookah tobacco, cheroot, snuff, zardah, kimam, surti, other tobacco products, opium, ganja, toddy, country liquor, foreign liquor, other drugs and intoxicants,

15 *Fuel and light* : coke, coal, firewood, electricity, gas, dung cake, charcoal, kerosene, candle, matches, methylated spirit, other fuel and light,

16. *Clothing* : cotton (mill made, power loom, hand-loom, khadi), wool, art silk rayon or any other synthetic textile, pure silk, and others including items of bedding and upholstery,

17. *Footwear* : boot, shoe, slipper, sandle, chappal, wooden sandal etc.,

18. *Miscellaneous goods and services* : amusements (cinema, theatre etc.) education, medicine, toilet articles, sundry articles, consumer services, conveyances, etc.,

19. *Rents*: rents on residential house, residential land and other consumer goods (no computation of rent for residential houses owned by the sample household was made),

20. *Taxes* : licence fees for keeping gun, radio, cycle, motor car etc , and other consumer taxes like the municipal taxes, road taxes etc., but does not include income tax,

21. *Durable goods* : furniture, musical instruments, ornaments, utensile and other equipment and their repairing expenses including the maintenance of residential houses.

1/ This is the original set of definitions for the expenditure survey, reproduced from the 28th Round of the National Sample Survey document.

REFERENCES

Atkinson, Anthony B., "On the Measurement of Inequality," Journal of Economic Theory, Vol. 2 (1970), pp. 244-257.

Blakeslee, Leroy, Heady, Earl, and Tramingham, Charles, World Food Production, Demand and Trade, Center for Agriculture and Rural Development, Iowa State University, Ames (1973).

Census of India 1981, Series 1, Provisional Population Totals, GOI, New Delhi (1981).

Desai, B. M., "Analysis of Consumption Patterns in India," Occasional Paper No. 54, Department of Agricultural Economics, Cornell University (August 1972).

FAO, Food Balance Sheets, 1972-74, Rome.

FAO, Food Composition Tables for International Use, Rome (1954).

Hitchings, Jon, "Documentation of a Demand Projection Model Prepared for India," The World Bank ASADB (Divisional Paper, March 1981).

Jain, Shail, Size Distribution of Income: A Compilation of Data, The World Bank (1975).

Kakwani, N. C., and Podder, N., "Efficient Estimation of the Lorenz Curve and Associated Inequality Measures from Grouped Observations," Econometrica, Vol. 44, No. 1, (January 1976), pp. 137-148.

Macgregor, John, "Agricultural Demand Projections for India," The World Bank, ASADB (Draft Divisional Paper 1979).

Mellor, John W., "Agricultural Price Policy and Income Distribution in Low Income Countries," World Bank Staff Working Paper No. 214, (September 1974).

National Commission on Agriculture, GOI, Demand and Supply, Part III, Delhi (1976).

National Sample Survey Organization, Department of Statistics, GOI, Tables on Consumer Expenditure, 28th Round, No. 240, New Delhi (1977).

Paukert, Felix, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labor Review, (August-September 1973), pp. 97-124.

Ranadive, K. R., "Pattern of Income Distribution in India, 1953/54 to 1959/60, "Bulletin of the Oxford University Institute of Economics and Statistics, (August 1968).

Rao, V. M., Food, Second India Studies, Delhi, Bombay: The MacMillan Co. of India, Ltd., (1975).

Rao, V. V. B., "EPD Income Distribution Project, Data on Income Distribution in India," The World Bank, (Division Working Paper No. 1980-2).

Rojko, Anthony, et al, Alternative Futures for World Food, 1985, Vol. I, United States Department of Agriculture (1978).

Sanderson, Fred H., and Roy, Shyamal, Food Trends and Prospects in India, Washington, D.C.: The Brookings Institution (1979).

Scandizzo, Pasquale L., and Bruce, Colin, "Methodologies for Measuring Price Intervention Effects," World Bank Staff Working Paper No. 394 (March 1980).

World Development Report 1980, The World Bank, (August 1980).

PART II

THE FOODGRAIN ECONOMY

James Q. Harrison and John W. Wall
South Asia Programs
July 1981

The Foodgrain Economy

Table of Contents

Page

Introduction, Summary and Conclusions 53

Supply-Demand Balances 57

Government Projections 58

Implications 61

Table Annex 1 65

Table Annex 2 66

The Foodgrain Economy

Introduction, Summary and Conclusions. Foodgrains dominate Indian agriculture in their share of the value of crop output, area cultivated and area irrigated (see Table 1), and in their overriding importance in Indian diets, particularly the diets of the poor. Developments in the foodgrain economy during the 1970s have raised hopes that a basic constraint limiting development in India -- domestic scarcity of staple food -- may have eased. In the last half of the 1970s, foodgrain production met domestic consumption, government stocks grew large, small quantities of grain were exported, and foodgrain prices fell relative to other prices in the economy. It is important to know whether this situation is a temporary result of unusually good weather or whether it is a lasting result of forces stimulating foodgrain production and controlling demand growth.

Table 1

Pattern of Land Use and Output Mix by Major Crops
(percent)

	Percent of Crop Share in:			
	Gross Value of Crop Output	Total Area Cultivated	Total Area Irrigated	Percent of Crop Area Irrigated
	(1977/78)	(1977-79)	(1978)	(1978)
Foodgrains	59.3	74.4	78.7	27.3
Oilseeds a/	10.1	9.8	2.8	7.5
Sugarcane	6.3	1.8	5.6	79.9
Cotton	4.2	4.5	3.8	21.8
Other	20.1	9.5	9.1	24.7
Total	100.0	100.0	100.0	

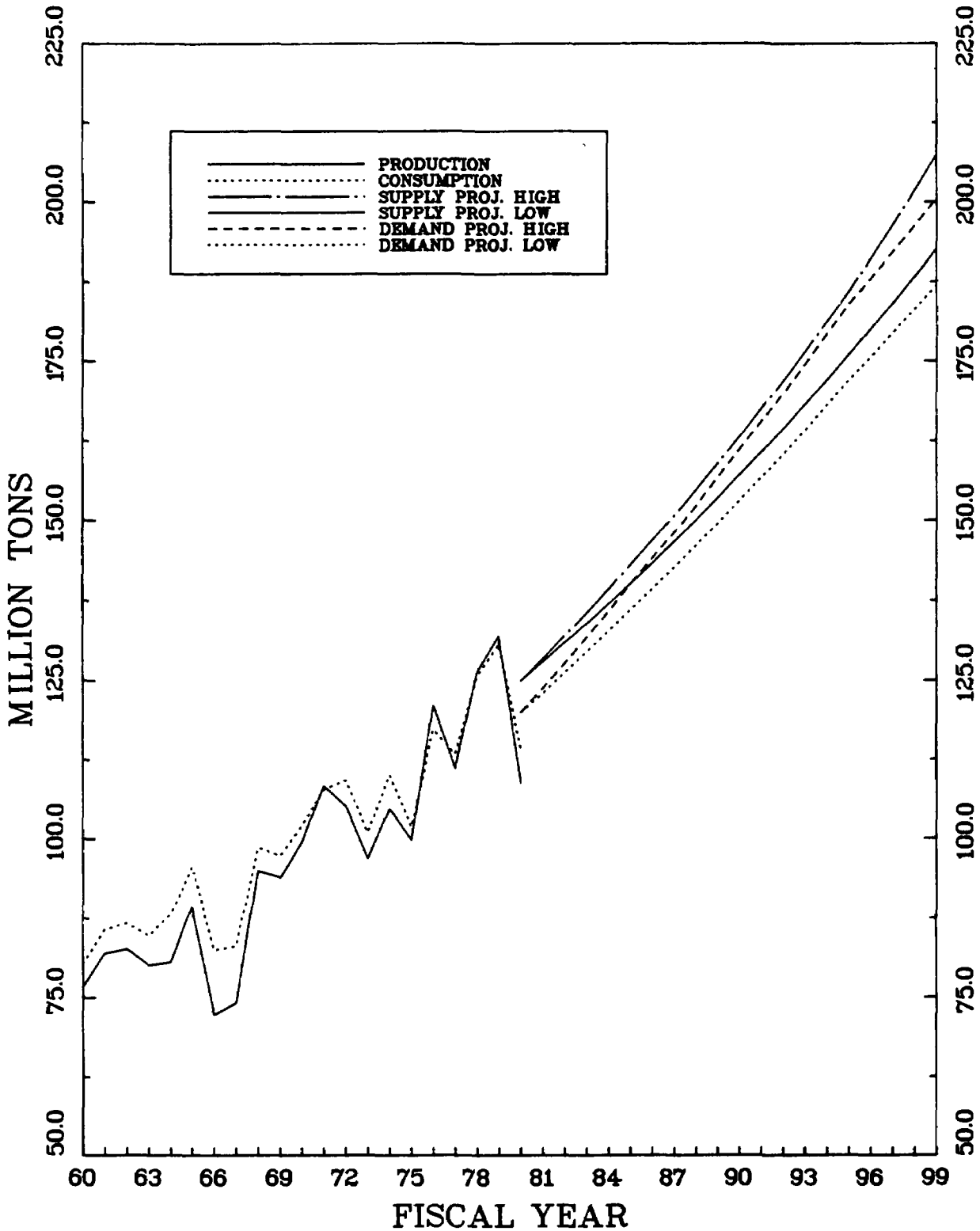
a/ Excluding cotton seed which appears separately in this table as cotton.

Sources: Central Statistical Organization and Ministry of Agriculture.

Graph 1 presents actual production and apparent consumption for the past twenty years along with alternative projections of supply and

Graph 1

FOODGRAIN PRODUCTION AND APPARENT CONSUMPTION



demand for foodgrains for the next twenty years.1/ The historical data reveal a convergence of the supply and demand lines in the last half of the 1970s. The projections suggest the possibility of continued self-sufficiency or even an emerging surplus in foodgrains in the future. Nevertheless, bad weather in 1979/80 resulted in a drop of 23 million tons or 17% from the record production of foodgrains achieved in 1978/79. Through the judicious use of foodgrain stocks built up over the past several years, the Government was able to contain the worst effects of the drought -- preventing serious famine, moderating foodgrain price increases, avoiding foodgrain imports, even managing to export a modest amount of grain. As creditable as this achievement is, the drop in production which made it necessary should serve as a reminder that the balance between the supply and demand for foodgrain is still precarious. While the performance of the recent past and the probable future trends point to India's self-sufficiency and emerging export potential in foodgrains, the balance remains delicate and a succession of poor monsoons could still result in a need for foodgrain imports to maintain consumer supplies or adequate buffer stocks.

In this context, the decision to resume imports in 1981/82 to rebuild stocks drawn down following the 1979 drought was a prudent measure to avoid speculative price pressures. The weaknesses of the 1981 monsoon made the need for imports even clearer. The resort to imports to maintain foodgrain supplies indicates the Government's continued commitment to use market mechanisms for this purpose rather than resorting to administrative controls on foodgrain movement and compulsory procurement.

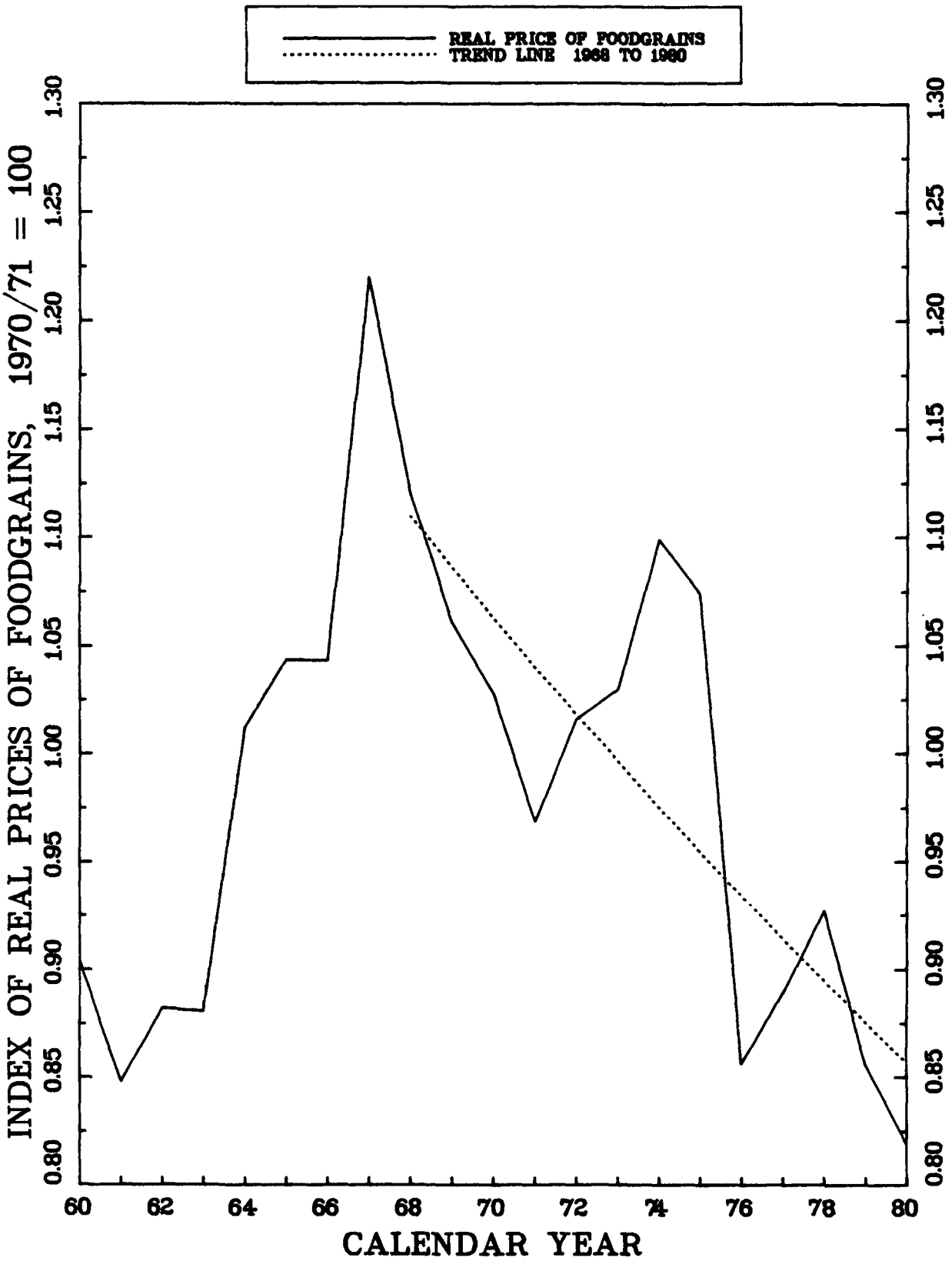
Changes in foodgrain prices will cause these projections to vary. The projections in Graph 1 have been made for illustrative purposes assuming prices remain essentially constant in real terms. In reality, prices will operate on both the supply and demand side, shifting both to offset persistent large imbalances. As can be seen in Graph 2, the real prices of foodgrain have varied in the past. They rose in real terms from the early 1960s (a period during which relative prices of agricultural commodities were among the lowest since Independence) through the unprecedented drought years early in 1967. They then fell in response to the Green Revolution until the spate of bad weather and constrained imports of the early 1970s, when they again began to rise. Good weather beginning in 1975, along with a well-designed pricing policy backed up with a large public stocks, initiated a fall in the real foodgrain price

---

1/ Apparent consumption is defined here as gross availability of foodgrains in the economy -- gross production plus net imports less changes in public stocks.

Graph 2

REAL PRICE OF FOODGRAINS



INDEX OF WHOLESALE PRICE OF FOODGRAINS DIVIDED BY THE WHOLESALE PRICE INDEX OF ALL NON-FOODGRAIN COMMODITIES

that has continued through 1980 despite bad weather and a short crop in 1979/80. The trend rate of decline of the real prices from 1968 through 1980 is 2.2% per annum.

A continuation of a low, and even falling, real price of foodgrains is one option facing India. A lower real price has a beneficial impact on equity of consumption, as foodgrains occupy a dominant place in the consumption budget of the poorest families in India. By the same token, lower prices will stimulate demand and dampen the production increase so that the projected surplus would disappear.

Supply-Demand Balances. Historical trend rates of growth of foodgrain production vary considerably from as low as 2% to as high as 3%, depending on the time periods chosen for calculating the rates. Finding rates as low as 2% is a result of including a very bad year at the end of the period and rates as high as 3% is a result of including a very good year at the end, as well as a bad year at the beginning. The supply lines in Graph 1 are based on two alternative trend rates, 2.3% per annum and 2.7% per annum. The lower rate is slightly below that calculated over the period 1967/68 through 1977/78, both fairly good years.1/ The high rate is that calculated over 1949/50 through 1979/80, a period which incorporates all of the information available. 2/

The demand projections presented in Graph 1 are taken from Jon Hitchings' "Demand Projections for India", the first paper in this volume. The method of projection and underlying assumptions are discussed in detail there. The main difference between the low and high cases is the assumed rate of growth of total consumption expenditure. The low case is based on a 3.5% per annum growth, which is just below the historical trend. The high case is based on a 5% per annum growth in total consumption expenditure, a rate roughly consistent with the Sixth Plan projections and achievable under stimulative economic policies.

1/ If production in 1978/79, a very good year, is added to the period of calculation, the trend rate becomes 2.7% per annum. If production in 1979/80, a very bad year, is added, the trend rate drops to 2.1%. If production in 1980/81 is taken to be 133 million tons and added, the trend rate is again 2.3%.

2/ This is also the rate calculated for the period 1960/61 through 1978/79. If production for the year 1979/80 is added, the rate falls to 2.6%. If production for 1980/81 (assumed to be 133 million tons) is added, the rate remains 2.6%. This indicates that the sensitivity in the rates to individual years falls as the period is lengthened.

It should be noted that the high demand line probably is not economically consistent with the low supply line. Foodgrain production is such a large proportion of the value of agricultural output (c.60%) and agriculture constitutes such a significant portion of value added in the economy (c.40%) that to generate a 5% per annum growth in consumption expenditure in practice depends on a fairly rapid growth in foodgrain production. Slowly growing production of foodgrain dampens the rise in total income, and consumption expenditure, in proportion to its weight in value added. It also causes the price of India's main wage good (grain) to rise, dampening demand and raising costs of producing other goods so that overall growth is constrained. Moreover, foodgrain imports, when needed, take priority over other imports necessary for sustained rapid growth elsewhere in the economy. The Sixth Plan, which projects a 4.7% per annum growth in consumption expenditure through 1984/85 and 5% per annum from 1984/85 through 1994/95, projects foodgrain output to rise between 3.1% and 3.7% through 1984/85 and between 2.9% and 3.5% from 1984/85 to 1994/95. These are the rates of growth for foodgrain production internally consistent with the target rates of growth of expenditure. While it is logically conceivable for the economy to grow rapidly while foodgrain production lags, the history and structure of the Indian economy make this unlikely. Consequently, the relevant supply line to compare with the high demand line is the high supply projection, as it is probably not possible to reach the high demand line if production is as low as on the low supply line.

Government Projections. Government supply projections are higher than either of the trend lines discussed above (see Table 2). The National Commission on Agriculture (NCA) and the Planning Commission both project foodgrain production based on an analysis of projected land use, irrigation availability, technological potential and fertilizer consumption. In the cases of NCA supply projections, rough rules of thumb were used to convert these factors into expected foodgrain production. 1/ The production targets from the Sixth Five Year Plan 2/ are based on the production technology and inputs expected to be available during the Plan period, although the Plan document is not explicit about the methods used in the projections.

1/ In the NCA projections, one additional hectare of area under irrigation is assumed to add 0.5 tons of foodgrain production and one additional ton of fertilizer applied to foodgrains is assumed to yield 10 additional tons of grain. (Report of the National Commission on Agriculture, 1976, Part III, pp. 96-98.

2/ Sixth Five Year Plan, 1980-85, p. 25 and p. 119.

The NCA supply projections assume little change in the total area under foodgrains from the 1970/71 base period to the year 2000, but the proportion of foodgrain area irrigated is assumed to rise from about 25% in 1970/71 to 42% by the year 2000. It is notable that while virtually all of the projected increase is from an increase in average yields rather than area, the yield increases are expected to be generated primarily by applying increased inputs of water and fertilizer, rather than by any substantial change in technology itself or any increased efficiency in input use. The assumed rates of growth of fertilizer (7% to 8% per annum) and irrigation (1.5 million hectares per year) are well below actual achievements in recent years. The two NCA projections differ in assumed rates of growth of fertilizer consumption between 1970/71 and 1984/85, with the low path assuming a rate of growth of 7.2% and the high path a rate of 10.2% per annum. For the entire 1970/71 to 2000 period, the rate of growth of fertilizer consumption is projected to be 6.3% to 7% per annum. Both of NCA's supply paths converge by the year 2000.

The Sixth Plan targets, while lower than the NCA projections, are higher than past trends. The lower target of 149 million tons implies a rate of growth of 3.1%. While such growth rates have been achieved in past periods, as noted above such periods usually included a base year well below trend or an end year well above trend. The links between Government policies, programs and input supplies on the one hand and output on the other are not explicit in the Plan document. The Plan targets for agricultural input use are quite ambitious, with irrigated area expected to rise an average of 2.7 million hectares per year, fertilizer consumption to rise 12.9% per annum, gross cropped area to rise 10 million hectares and total area under high yielding varieties of foodgrains to rise more than 20 million hectares. Other agricultural support programs are expected to increase their coverage similarly.

The NCA demand projections are considerably higher than those of Hitchings. The NCA projections are based on growth in consumption expenditure at lower rates than Hitchings' (NCA high: 4.7% per annum through 1980 and 3.5% per annum from 1980 through 2000; NCA low: 3.0% per annum through 1980 and 2.8% per annum from 1980 through 2000). Nevertheless, the projected quantities are higher due to a much higher starting base and a much greater provision for animal feed than in Hitchings' projections. The base year chosen for the NCA projections, 1971, had one of the highest per capita consumption levels in recent times. Starting from that base the NCA projects demand in 1979/80 at 133 (low) to 140 million tons (high). Hitchings' projections used 1973/74 as a base and project 1979/80 consumption at 120 million tons. Apparent availability (gross production plus net imports minus change in stock) was 114 million tons in 1979/80, well below trend due to the drought. Actual consumption no doubt was higher than 114 million tons, allowed by some drawdown of private stocks. Although the extent of drawdown of private stocks is not known, trend consumption cannot be much greater than the

Table 2

Alternative Projections of Foodgrain Supply and Demand through 1990/2000
(in million tons)

	1979/80	1984/85	1989/90	1994/95	1999/2000
Supply Projections					
National Commission on Agriculture					
High	143	163	185	207	230
Low	135	150	176	203	230
Sixth Plan					
High	128	154	-	205	-
Low	128	149	-	205	-
Trend					
High (2.7% per annum)	125	143	163	186	213
Low (2.3% per annum)	125	140	157	176	197
Demand Projections					
National Commission on Agriculture					
High	140	163	183	204	225
Low	133	150	168	187	205
Hitchings					
High	120	140	161	184	205
Low	120	136	153	172	191

Sources: National Commission on Agriculture, Planning Commission and Jon Hitchings', "Demand Projections for India".

trend of availability. Trend availability in 1979/80 would be the same as trend production (125 million tons), given the lack of imports. Consumption in 1979/80 will be below trend due to the fall in income. Consequently, actual consumption in 1979/80 is likely to have been much closer to Hitchings' projected 1979/80 base of 120 million tons than the NCA's 133 to 140 million tons.

The NCA projections incorporate provision of foodgrain for animal feeding, derived from an accelerated and modernized animal development program contained in the NCA report, that grows to reach 20 to 25 million tons by the year 2000. World Bank estimates, based on animal husbandry sector work, suggest animal feed requirements considerably lower than this, perhaps less than half. The Hitchings demand estimates presented here incorporate an allowance for seed, feed and waste of 12.5% of gross production. The provision for animal feed from this is generally placed at 5%, or 9.5 million tons and 10.2 million tons for the low and high projections, respectively, by the year 2000. The NCA also makes a slightly greater allowance for wastage, 4% (8 to 9 million tons by 2000) than Hitchings' allowance of 2.5% (4.8 to 5.1 million tons).

In summary, it is unlikely that foodgrain consumption will reach the levels projected by the National Commission on Agriculture. The Sixth Plan's projection of demand for 1984/85 of 150 million tons is similarly unlikely in light of Hitchings' demand analysis. Consumption is likely to reach the levels projected under Hitchings' high demand alternative only if growth of foodgrain production is also fairly high. The high supply projection easily meets Hitchings' high demand projection, just as the low supply projection covers his low demand projection. Government projections of supply lie considerably above either of the supply projections. Although the Government's demand projections also lie considerably above Hitchings', they are probably even less plausible than those for supply.

Implications. The projections suggest the real possibility of India moving into a period of sustainable foodgrain self-sufficiency or surplus. This outlook is substantially more optimistic than many past projections. As a new conclusion, it deserves to be treated with caution and interpreted with perspective. Foodgrain production will still depend on the moonsoon and a failure of the monsoon could lead India to import grain. As Graph 1 indicates, actual foodgrain production has fluctuated significantly around the trend. In some years, weather conditions are likely to make it necessary to draw down stocks and/or import, while in years of good monsoons stocks are likely to be replenished and/or some grain exported. The analysis contains new projections based on the prospects for population growth, household expenditure patterns and production which lead one to the optimistic conclusion as far as market supply/demand balances are concerned. The optimism of this conclusion should not translate into complacency about the prospects for eliminating

poverty and undernutrition in India by the year 2000. The projections imply rising per capita consumption of foodgrains, and this, together with the possibility of falling real prices for foodgrains discussed below, would have a beneficial impact on poverty and nutrition. But the projected rise in per capita consumption would take place from a base which is very low on average and pitifully low for the poorer segments of the population. Nor should there be complacency that the projected supply/demand balances will come about without continued efforts on the supply side to develop the technological base, input supply system, irrigation infrastructure and incentives needed for sustained production growth and, on the demand side, to moderate the rate of growth of population.

Foodgrain self-sufficiency or surplus, if it comes about, will be an impressive achievement of a long standing goal of Indian economic development. It indicates that India, by continuing its major efforts in agriculture, may be in the desirable position of having a range of options which were not available during the period when domestic foodgrain supplies were inadequate. Among these options are the following:

(a) Increase Consumption. A slowly falling real price of foodgrains would absorb a greater quantity of foodgrains in household consumption and slow production growth, so that the projected surpluses would not arise. The past several years have already seen a modest decline in real foodgrain prices and rise in per capita consumption, and the current level of household foodgrain consumption is approximately equal to a caloric-sufficient quantity, on average, for the Indian population. With unequal distribution of this consumption, this means undernutrition for lower income groups. It is the lowest income groups, who spend the greatest proportion of their income on foodgrains, for whom lower real prices are the most important. Effects of lower price on producer incentives are also important but so far at least technical change has offset the decline in producer prices and has kept profits sufficiently high to encourage greater production.

(b) Exports of Foodgrains. The Bank projections are not reliable enough to predict exports, which are a small residual between two very large and fluctuating variables, demand and supply. Nevertheless, the prospects of foodgrain exports are real ones. The Sixth Plan projects the export of 3 million tons of rice by 1984/85 which, on the basis of the Bank projections, appears feasible from the point of view of domestic supply, keeping in mind the caveats concerning fluctuations in individual years. The prices at which the Government procures foodgrains relative

to world market prices become important in this regard. Currently, Indian procurement and market prices for rice are not higher than world market prices, and rice could be exported without losses to the Government.

(c) Diversification in Agriculture. The demand projections contained in the first section of the paper indicate the demand for several other important agricultural commodities will grow faster than for foodgrains (see Table 3). Most farmers grow a variety of crops in which foodgrains are dominant (Table 1). Changes in foodgrain production technology or prices can increase the relative profitability of foodgrains, causing farmers to plant a greater proportion of their area to them. Alternatively, farmers who see greater profit opportunities in other crops can apply yield-increasing technology to meet their own foodgrain needs on less area, thereby freeing land for other crops. The introduction of shorter duration varieties of foodgrains (especially paddy) gives farmers greater opportunities for planting a second crop. Relatively small shifts in foodgrain area can mean substantial shifts in area and production of other crops. For example, 1% of the foodgrain area is equivalent to 8% of the oilseed area, 17% of the cotton area or 40% of the sugarcane area. Thus management of foodgrain supply and demand is of central importance for both foodgrains and for most other agricultural commodities as well. Moreover, if the foodgrain situation is under control, India's substantial agricultural infrastructure, with its technical (research and extension), physical (irrigation and other investments), logistical (input supply and distribution) and economic (pricing policy, procurement and distribution) dimensions, has more flexibility to meet the needs of other crops.

Table 3

Projected Annual Growth Rates of Demand for Selected Commodities
(in percent)

	1979/80 to 1984/85		1984/85 to 1999/2000	
	Low	High	Low	High
Total Sweetners a/	3.4	4.9	3.3	4.4
Edible Oils	3.5	4.8	3.4	4.3
Clothing	4.8	7.8	4.8	7.6
Foodgrains	2.6	3.2	2.3	2.6

a/ Sugar, khandsari, gur and other sweetners.

Source: Jon Hitchings "Demand Projections for India".

None of these options will be available to India without sustained efforts to raise foodgrain yields. Any significant slackening of the rate of growth of productivity would return the foodgrain economy to its previous, unhappy position of scarcity, fluctuating prices and large cereal imports. Continued work on basic and adaptive research, seed development, irrigation and extension will be required to fulfil the promise of an emerging foodgrain self-sufficiency or surplus.

AREA, PRODUCTION AND YIELD OF FOODGRAINS, 1949/50 TO 1979/80

(Area - '000 Hectares
Production - '000 Tons
Yield - Kg per Hectare)

	RICE			WHEAT			COARSE CERALS			PULSES			TOTAL FOODGRAINS		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
1949/50	30519	23542	771	9758	6391	655	38836	16824	433	20167	8159	405	99280	54916	553
51	30810	20576	668	9746	6462	663	37674	15376	408	19091	8411	441	97321	50825	522
52	29830	21300	714	9471	6183	653	38885	16093	414	18775	8420	448	96961	51996	536
53	29969	22899	764	9828	7501	763	42446	19612	462	19845	9189	463	102088	59201	580
54	31289	28214	902	10681	8017	750	45366	22972	506	21729	10618	489	109065	69821	640
55	30764	25219	820	11259	9043	803	43921	22823	520	21914	10950	500	107858	68035	631
56	31521	27557	874	12367	8760	708	43456	19488	448	23216	11045	476	110560	66850	605
57	32277	29037	800	13524	9403	695	42019	19864	473	23316	11551	495	111136	69855	629
58	32298	25525	790	11730	7998	682	42914	21226	495	22538	9562	424	109480	64311	587
59	33172	30847	930	12617	9958	789	44664	23187	519	24311	13149	541	114764	77141	672
60	33820	31676	937	13380	10324	772	43790	22873	522	24833	11799	475	115823	76672	662
61	34128	34574	1013	12927	10997	851	44963	23743	528	23563	12704	539	115581	82018	710
62	34694	35663	1028	13570	12072	890	44725	23216	519	24243	11755	485	117232	82706	705
63	35695	33217	931	13590	10776	793	44294	24630	556	24265	11528	475	117844	80151	680
64	35809	36998	1033	13499	9853	730	43927	23718	540	24186	10073	416	117421	80642	687
65	36462	39308	1078	13422	12257	913	44353	25374	572	23875	12417	520	118112	89356	757
66	35470	30589	862	12572	10394	827	44343	21420	483	22718	9944	438	115103	72347	629
67	35251	30438	863	12838	11393	887	45092	24053	533	22121	8347	377	115302	74231	644
68	36437	37612	1032	14998	16540	1103	47337	28798	608	22649	12102	534	121421	95052	783
69	36967	39761	1076	15958	18651	1169	46241	25183	545	21264	10418	490	120430	94013	781
70	37680	40430	1073	16626	20093	1209	47241	27287	578	22023	11691	531	123570	99501	805
71	37592	42225	1123	18241	23832	1307	45949	30547	665	22534	11818	524	124316	108422	872
72	37758	43068	1141	19139	26410	1380	43575	24596	564	22151	11094	501	122623	105168	858
73	36688	39245	1070	19463	24735	1271	42211	23139	548	20915	9907	474	119277	97026	813
74	38286	44051	1151	18583	21778	1172	46242	28828	623	23427	10008	427	126538	104665	827
75	37889	39579	1045	18010	24104	1338	43152	26129	606	22024	10014	455	121075	99826	824
76	39475	43740	1235	20454	28846	1410	43798	35409	808	24454	13039	533	128181	121034	944
77	33511	41917	1088	20922	29010	1387	46940	28879	615	22983	11361	494	124356	111167	894
78	40282	52671	1308	21456	31749	1480	42280	30014	710	23497	11973	510	127515	126407	991
79	40480	53770	1328	22640	35510	1568	42230	30440	721	23660	12180	515	129010	131900	1022
80	38980	42190	1082	21960	31560	1437	41220	26730	648	21750	8370	385	123910	108850	878
Annual % Rates of Growth															
1949/50 - 1979/80	0.9	2.6	1.7	2.8	5.9	3.0	0.2	1.8	1.6	0.3	0.4	0.1	0.8	2.7	1.9
1949/50 - 1964/65	1.3	4.0	2.6	2.6	4.2	1.6	0.9	2.8	1.9	1.7	2.4	0.7	1.4	3.4	2.0
1967/68 - 1979/80	0.5	1.8	1.2	3.0	5.3	2.3	-0.9	0.9	1.8	0.5	-0.6	-1.1	0.4	2.1	1.7
1967/68 - 1978/79	0.5	2.4	1.7	3.2	5.7	2.5	-0.8	1.3	2.1	0.8	0.5	-0.3	0.5	2.6	2.1

Sources: Estimates of Area and Production of Principal Crops in India, 1978-79, published by Directorate of Economics and Statistics, Ministry of Agriculture; and, Economic Survey, 1980-81, published by Government of India.

Annex Table 2

FOODGRAIN AVAILABILITY

Calendar Year	Foodgrain Production d/	Net Imports	Changes in Public Stocks	Gross Availability a/	Net Availability b/	Per Capita Net Availability c/
	Thousand Tons					Grams per Day
1950	54916	2160	-870	57946	51082	390
51	50825	4800	590	55035	48682	365
'52	51996	3930	620	55306	48807	360
'53	59201	2040	-480	61721	54321	394
54	69821	830	200	70451	61723	440
'55	68035	600	-740	69375	60871	426
56	66850	1390	-600	68840	60484	415
'57	69855	3630	860	72625	63893	429
58	64311	3210	-270	67791	59752	393
'59	77141	3860	490	80511	70868	456
60	76672	5130	1400	80402	70818	446
'61	82018	3490	-170	85678	75426	465
62	82706	3640	-360	86706	76368	460
63	80151	4550	-20	84721	74702	440
64	80642	6260	-1240	88142	78062	449
65	89356	7450	1060	95746	84577	475
66	72347	10340	140	82547	73504	404
67	74231	8660	-260	83151	73872	396
68	95052	5690	2040	98702	86821	455
69	94013	3850	460	97403	85651	439
70	99501	3580	1120	101961	89523	448
71	108422	2030	2570	107882	94329	461
72	105168	-490	-4690	109368	96222	461
73	97026	3590	-310	100926	88798	417
74	104665	4830	-400	109895	96812	445
75	99826	7390	5560	101656	89178	402
76	121034	6440	10270	117204	102075	451
77	111167	410	-1250	112827	98931	429
78	126407	-1000	-270	125677	109876	468
'79	131900	-940	360	130600	114113	475
'80	108850	-420	-5670	114100	100494	410

a/ Gross production plus net imports minus stock changes.
b/ Gross production minus 12.5% allowance for seed, feed and waste plus net imports minus stock changes.
c/ Net availability divided by mid-year population divided by 365 days.
d/ Fall-harvested crops of the previous year are added to the Spring-harvested crops of the calendar year shown.

Part III

THE VEGETABLE OIL ECONOMY

John W. Wall
June 1981

The Vegetable Oil Economy

Table of Contents

Page No.

Introduction 69

Supply Trends 70

Demand Conditions 71

Supply/Demand Balance 71

Supply Prospects 74

Oilseeds Production 74

Oilseeds Processing 76

Pricing Policy 78

Medium-Term Management of the Vegetable Oil Economy and the Plan 82

Annex Tables 86

Introduction. Oilseeds constitute one of the most important groups of agricultural commodities in India. Oilseeds (including cottonseed and coconut) occupy about 15% of gross cropped area and contribute about 10% of the value of output from agriculture. The oilseeds group contains a large number of field crops: groundnut, rape and mustard, castor, sesame, linseed, niger, safflower, sunflower, cottonseed and soyabean. In addition vegetable oil is extracted from rice bran and a variety of tree crops: coconut, oil palm and various forest seeds such as sal and neem. Vegetable oil is an item of mass consumption in India and is the main source of the basic human requirement for essential fatty acids. Most vegetable oil is consumed directly as food, although the demand for vegetable oil for soaps and paints is rising more rapidly than for food purposes. A growing proportion of edible oil, reaching about 17% in 1979, is consumed in the form of hydrogenated oil, mainly in urban areas and northern parts of India. The remainder is consumed as either unrefined or refined liquid oil. Total consumption of vegetable oils of around 6 kg per capita is low compared with over 25 kg per capita in developed countries and over 10 kg per capita for the world average.

Oilseeds and vegetable oils loom large in India's foreign trade. India is a traditional exporter of oilseed cakes and meals, particularly deoiled groundnut and cottonseed meals; of speciality oils such as castor and linseed; and of handpicked, selected (HPS) groundnuts. Recently, deoiled rice bran has become a major export. During the period 1975/76 to 1978/79, exports of oilseeds and their derivatives averaged over US$200 million per year, about 14% of all agricultural exports and 3% of all exports. Since 1976/77, imports of vegetable oils have grown large, to 1 million tons or more per year with import values of US$600-800 million through 1979/80. Next to petroleum vegetable oils have been the largest item in the import bill, replacing cereals, which had been the largest item of food imports up to 1975/76.

Almost half of all vegetable oil produced in India is derived from groundnut (see Table 1). Groundnut is grown mainly as a rainfed crop in semi-arid areas of western and southern India--particularly Gujarat, Tamil Nadu, Andhra Pradesh and Karnataka--in the kharif (June to October) season. About 11% of groundnut area and about 19% of groundnut produced is planted in January and February and harvested in May (hot weather or summer groundnut). Rape and mustard seed is the next largest source of oil. Rape/mustard is grown in the rabi season (October to April) in the northern and eastern parts of India, particularly in Uttar Pradesh, which alone accounts for more than half of total area. Cotton is grown mainly in Gujarat, Punjab, Maharashtra and Karnataka in the kharif season, mainly for cotton fiber and only secondarily for the seed. A lower proportion of cottonseed is crushed for oil than other oilseeds as a higher proportion of the seed is fed directly to cattle. Nevertheless an increasing proportion of cottonseed is being processed to extract its oil. Coconut is a perennial crop grown in tropical coastal areas of India, mainly in Kerala, which accounts for more than half of total coconut production, followed by Tamil Nadu and Karnataka. Linseed is grown mainly in Uttar Pradesh, Madhya Pradesh and Maharashtra. Castor is grown mainly in Gujarat and Andhra Pradesh.

Table 1: OILSEEDS AND VEGETABLE OIL PRODUCTION BY SOURCE, 1978/79 (in %)

	% of Oilseed Cropped Area /a	% of Gross Cropped Area	% of Domestic Oil Production	Oilseed Yields kg/ha	Oil Yields kg/ha
Groundnut	28	4.4	47	846	201
Rape/Mustard	13	2.1	18	528	161
Sesamum	9	1.4	5	221	82
Safflower	3	0.4	1	301	104
Niger	2	0.4	1	243	n.a.
Soyabean	2	0.3	1	800 /c	120 /c
Sunflower	1	0.1	1	800 /c	275 /c
Cottonseed	30	4.7	8	336	44
Coconut	4	0.6	5	5,126 /b	615
Linseed	7	1.2	5	254	88
Castor	2	0.3	3	528	183
Rice Bran	n.a.	23.2	2	n.a.	n.a.
Tree Crops	n.a.	n.a.	3	n.a.	n.a.

/a Excludes area planted to rice and tree crops other than coconut.
/b Nuts per hectare.
/c Yield per hectare assumed to be 800 kg of seed.
Source: Ministry of Agriculture, World Bank Estimates.

Supply Trends. The growth in production of oilseeds has tended to slow over the last decade (see Table 2). Through the mid-1960s oilseeds yields grew very little and almost all growth in production was due to growth in area. Since then, the rate of growth of yields has improved, but not enough to offset the much slower growth in area.

Table 2: ANNUAL GROWTH RATES OF AREA, PRODUCTION AND YIELD OF OILSEEDS 1949/50-1978/79 (in %)

		1949/50-1978/79	1949/50-1964/65	1967/68-1978/79
Oilseeds				
Area	(A)	1.28	2.65	0.24
Yield	(Y)	0.49	0.19	1.25
Production	(P)	2.13	3.14	1.61

Source: Based on index numbers of area, production and yield of the oilseed group as given in "Estimates of Area and Production of Principal Crops in India 1978-79", Directorate of Economics & Statistics, Ministry of Agriculture, Government of India, 1980. The oilseed group contains groundnut, sesamum, rapeseed and mustard seed, linseed, castorseed, safflower, nigerseed, coconut and cottonseed.

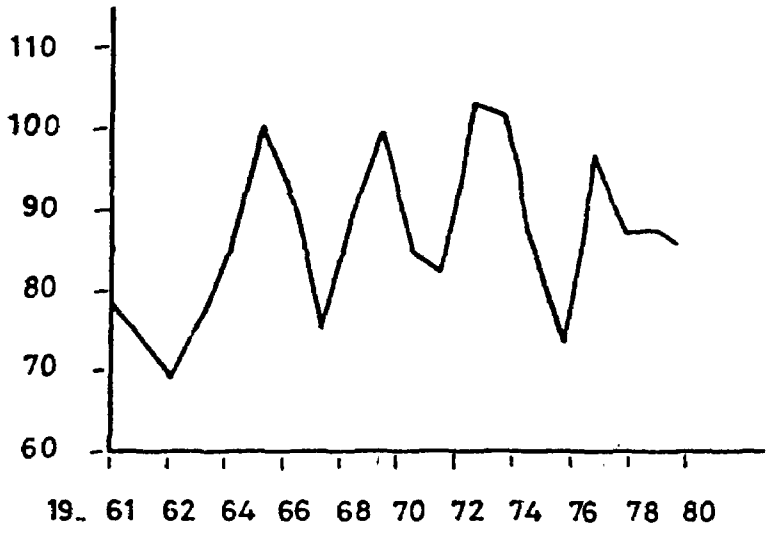
During the period 1967/68 to 1978/79, domestic production of vegetable oil grew on average by 2.5% per annum, substantially faster than total supply of oilseeds. This is due to several factors. An increasing proportion of some oilseeds, mainly cottonseed, has been processed for oil. The introduction of solvent extraction methods has meant an increasing proportion of the oil in the seed has become available for use. Finally, there has been a growing extraction of oil from sources other than those included in the above definition of oilseeds. These other sources are minor oilseeds of tree origin such as sal, neem and kusum, and rice bran.

Demand Conditions. Household consumption data indicate that demand for vegetable oils for food increases at roughly the same rate as income, providing relative prices are constant. The growth in consumption would be dampened by a relative price rise since households would substitute other goods. With per capita income growing at 1.5% per annum and population growing at 2% per annum or more, growth in total demand would exceed 3.5% per annum, assuming no relative price movements. However, from the early 1960s through the mid-1970s, growth in demand of vegetable oils was constrained by growth in supply, which was lower than 3.5% per annum. Vegetable oil imports were insignificant between 1960/61 and 1975/76, so fluctuations in domestic production directly caused fluctuations in domestic supply and domestic prices. In years of short harvests, prices rose rapidly to choke demand back to available supply. Through the mid-1970s, there was a tendency for relative prices of vegetable oils to rise, although the fluctuations were so wide as to obscure any strong trend. These relationships can be seen in Graphs 1, 2 and 3.

Starting in 1976/77, large scale imports of edible oil allowed demand to rise by more than domestic supply. Imports in the oil year (November to October) of 1976/77 through 1979/80 were one million tons or more per year, comprising one-fourth or more of domestic supply. Per capita availability rose from an average of five kg for the period 1974 to 1976 to an average of over six kg for period 1977 to 1980. These imports of vegetable oil kept the vegetable oil prices from rising significantly relative to other commodities despite low oilseed production during this period. Indeed some have argued that the large scale import of vegetable oils had adversely affected the production of oilseeds by keeping their prices low. The imports now also contribute to India's very large trade deficit which must be reduced.

Supply-Demand Balance. Assuming stable relative vegetable oil prices and based on past trends, World Bank projections of demand lie above projections of supply for the foreseeable future (see Graph 3). The supply projection is based on a simple extrapolation of past trends. DL, the low demand projection, is based on a 3.5% per annum rate of growth in total expenditure. DH, the high demand projection, is based on a 5% per annum growth in total expenditure. With either demand line the gap between supply and demand becomes quite large. By 1990, filling the gap through imports would mean spending between US$3-4 billion (6-8% of total imports) and absorbing between 8-10% of total projected world exports of vegetable oils. The alternative to importing to fill the gap is to increase the rate of growth of domestic supply and decrease the rate of growth of demand. Decreasing the rate of growth of demand in a country with such low per capita consumption as in India would not be desirable in itself but a consequence of pursuing other policies.

Graph 1



Vegetable oils

Relative Price Index [1]

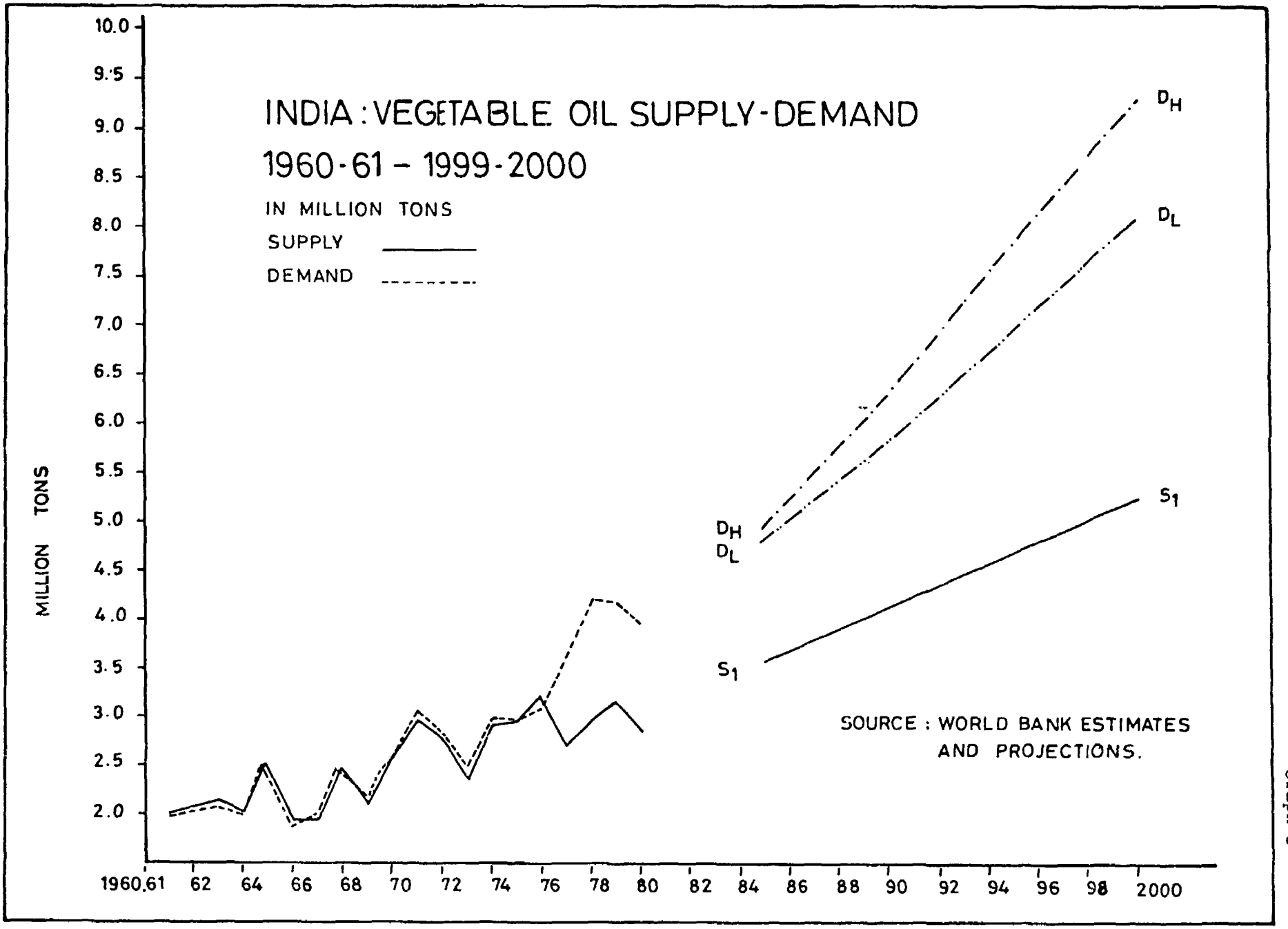
1970/71 = 100

[1] INDEX OF WHOLESALE PRICES OF VEGETABLE OILS DIVIDED BY INDEX OF WHOLESALE PRICES OF ALL COMMODITIES.

Graph 2

Consumption of Vegetable oils per capita in kg/year

SOURCE: WORLD BANK ESTIMATES


INDIA : VEGETABLE OIL SUPPLY-DEMAND
1960-61 – 1999-2000
IN MILLION TONS
SUPPLY
DEMAND
MILLION TONS
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1960.61
62
64
66
68
70
72
74
76
78
80
82
84
86
88
90
92
94
96
98
2000
D_H
D_L
S_1
SOURCE : WORLD BANK ESTIMATES AND PROJECTIONS.

Graph 3

Table 3: VEGETABLE OIL SUPPLY-DEMAND GAP 1985-2000
(in million tons)

	1985	1990	1995	2000
High Demand	5.0	6.2	7.6	9.2
Low Demand	4.8	5.7	6.8	7.9
Supply (past trend)	3.6	4.1	4.6	5.3
Gap				
High Demand	1.4	2.1	3.0	3.9
Low Demand	1.2	1.6	2.2	2.6

Source: World Bank Projections.

Supply Prospects. India has under-utilized potential for raising domestic supply of vegetable oils. There is scope to increase the supply of traditional oilseeds by increasing cropped area and by increasing yields through use of better land, improved varieties, good seed, pest protection and more effective cultural practices. There is also the possibility of introducing new oilseeds, such as soyabean, that could contribute significantly to India's oil supply. Improvements in the organization of oilseeds processing can yield extra oil from under-utilized sources such as rice bran, cottonseed and a variety of oilseed expeller cakes not yet processed in solvent extraction plants. Finally, an increasing proportion of minor oilseeds of tree origin, such as sal and neem can be collected and utilized for oil extractions.

Oilseed Production. Although the rate of growth of cropped area under oilseeds has been very low since 1969/70, it could be increased with appropriate policies. Farmers in India shift their cropping patterns in ways that reflect the relative profitability of crops. As the technology of producing oilseeds has been fairly stagnant, prices farmers receive have been particularly important in determining cropped area devoted to oilseeds. 1/

Despite the relatively slow improvement in oilseeds varieties there is considerable scope to increase yields from their present levels. Yields in India are generally much lower than in many other large countries (see Table 4). A fundamental reason for the low yields is that oilseeds are grown on marginal lands without assured moisture. Hence oilseeds compete with other low-yielding crops, such as sorghum and millets, which can better withstand moisture stress. On better quality and irrigated land oilseeds currently lose

1/ Karam Singh, "Oilseeds in India--Paradox of Price or Rains." The findings were based on regression analysis analysing the relative effects of rainfall, prices and time on area, production and yield of the five major oilseeds (groundnut, rape/mustard, sesame, castor and linseed). Area cropped was found to be very sensitive to the previous year's price, along with a time trend. Yield was affected relatively little by prices but very significantly by rainfall.

out to other crops such as cotton, paddy and sugarcane. Only about 8% of oilseed area is under irrigation. Irrigated summer groundnut yields are virtually double those of rainfed kharif groundnut, 1,500 kg versus 800 kg per hectare. The irrigated yield potential already realized on some farms is 2,500 kg per hectare.

Table 4: YIELDS OF OILSEEDS IN SELECTED COUNTRIES, 1979
(in kg/ha)

Crop	Brazil	China	India	Nigeria	USA
Groundnut in Shell	1,612	1,187	806	1,035	2,922
Rape/Mustard	n.a.	668	528	n.a.	1,333 /a
Sesame	556	417	208	311	706
Linseed	600 /a	624	254	n.a.	835
Castor	925	632	528	n.a.	663

/a Grown on very small area, 10,000 hectares or less. Canadian mustard yields were 1,359 kg per hectare in 1977 and 1,035 kg in 1979.

Source: FAO Yearbook, 1980.

Improved varieties of some oilseeds exist in India but dramatic gains in yields are not yet in sight. Improved groundnut varieties exist that have the potential to yield perhaps 25% more than traditional varieties. Some early maturing rape/mustard seed varieties exist that have encouraged farmers to insert them in a crop rotation where they did not fit before. Hybrid coconut trees have the potential to yield two or even three times as many nuts per tree as traditional varieties. Coconut trees take six years or more to yield nuts after planting. In the case of all of these crops supplies of the improved seeds or hybrid seedlings are in short supply.

Significant yield increases are however possible through improved cultural practices and disease and pest control. For example, in the case of groundnut 20-30% yield increases are probably possible as a result of using effective techniques to raise the plant population in the fields. Agriculturalists concerned with groundnut consider that, with a combination of good quality improved seed and sound cultural practice, it is possible to raise groundnut yields by 50%, from 800 kg to 1,200 kg per hectare as a practical matter over large areas. Many states in India are improving the organization of their extension services in ways that should enable progress in oilseed production, along with other crops.

The Government has tried to introduce several non-traditional oilseeds in India. In the early 1970s the Government promoted the introduction of both sunflower and soyabean in various areas of India. The growing of sunflower presented several problems, such as poor seed-filling and pest damage, that have so far limited its spread, although researchers are optimistic that solutions to the problems have been found. Results from introducing soyabean have been more encouraging, as it found a place in the cropping pattern in the hilly areas of Madhya Pradesh and Uttar Pradesh in the kharif (June to November) season. Area sown to soyabean has increased very rapidly since it was first introduced and now is about half a million hectares. Yields are

fairly low, about 800 kg per hectare and the oil yield per hectare is considerably lower than groundnut or rape and mustard. However, much of it is now grown in hilly areas which otherwise would lie fallow. Therefore, any increase in such areas represents a net addition to India's oil supply.

Oilseed Processing. The growth in the production of vegetable oil has exceeded growth in oilseed production because an increasing proportion of oil potentially available has been extracted due to improvements in the organization of oilseed processing. Animal-powered wooden village oil presses have given way increasingly to electric-powered mechanical presses that are able to expel a higher proportion of oil in the seed, although some oil is still left in the oil cake. An increasing proportion of oil cake has been processed in modern solvent extraction plants, which extract most of the remaining oil left in the cake. Solvent extraction plants also are necessary to extract oil from rice bran and other seeds which have a relatively low oil content, such as soyabean, sal and other forest seeds. As the number of solvent extraction plants has grown, an increasing proportion of the previously under-utilized oil-bearing material has been processed for oil. There is currently excess solvent extraction capacity in the aggregate, although most of this capacity is concentrated in a few areas, such as Bombay. Nevertheless, there is scope to increase the oil extraction of under-utilized sources by changing certain policies and by further improving the organization of processing.

One policy that restricts the solvent extraction of expeller oil cake and rice bran is the restriction on the export of deoiled meals. Such restrictions were placed on exports during years when domestic supplies were short due to bad weather. The domestic market for deoiled meals in India is limited by the extent of the market for compound feed, which is very small. Most Indian farmers feed their animals a diet formulated of feedstuff--mainly straw, stalks, cane and oil cakes--available in the village or nearby towns. Farmers are said to prefer oil cakes to deoiled meals as feeds because they feel their animals need the oil residual in the cake. In any case, a domestic market has not developed for deoiled meal beyond the very small one provided by compound feed manufacturers. After that market is satisfied, solvent extraction of the oil in expeller oil cake occurs only when the deoiled meal can be exported. Only then can a solvent extractor make a profit by buying oil cake, solvent extracting the oil and selling the oil and meal.

The Government restricts the export of various oilseed products to increase their domestic availability. Exports of groundnut, cottonseed and rice bran deoiled meals are restricted, although not soyabean meal. This increases domestic availability and reduces the domestic price of oil cakes. The oil left in the cake is used by animals as a high grade source of calories to produce milk, butter fat, eggs and poultry, expensive sources of fat when compared with vegetable oil. The Government also restricts the export of hand-picked, selected (HPS) groundnuts and linseed oil to increase the domestic availability of vegetable oil. Paradoxically these restrictions actually reduce India's vegetable oil supply.

Table 5 presents calculations of the net effect of the export of oilseeds and their derivatives on domestic vegetable oil supply. The year 1976/77 is taken as it reflects a period when the export of oilseeds products was relatively unrestricted and in fact when the exports of HPS groundnut,

castor oil and linseed oil were much higher than they have been since. It was also a record year for the export of groundnut meal and deoiled rice bran. Exports of oilseeds reduce oil supply by the recoverable oil content of seeds exported. Export of deoiled meals increases domestic oil supply by the amount of oil recovered from expeller cake by the solvent extraction method. This solvent extraction would not take place if the export market for the meal did not exist. In 1976/77, the export of oilseed products resulted in a net addition to Indian vegetable oil supply as the extra oil produced due to the solvent extraction to produce deoiled meals slightly exceeded the oil exported in the form of seeds and oil. In addition, as indicated in the last column, the export of oilseed products could finance many times the oil exported. At 1980 prices, the export of HPS groundnut could finance the import of ten times the oil content of nuts exported. The export of specialty oils, which are considered inedible, could finance at least the same quantity of edible oils, and usually more.

The easing of restrictions on exports of deoiled meals, expansion of the market for compound feeds and farmers' increased acceptance of deoiled meals as animal feeds will increase the solvent extraction of vegetable oils now left in the cakes. Other improvements in the organization of oilseed processing also will lead to an increased proportion of the potentially available vegetable oil being produced. Perhaps the most important of these is in the organization of rice milling to increase the availability of rice bran for oil extraction.

Rice bran contains up to 15% oil which is recoverable through solvent extraction. In 1978/79 if all the potentially available rice bran oil had been recovered in India it would have amounted to 590,000 tons of oil. Recovery of a large portion of this is a long way off. Only about 12-15% of the available oil is recovered at present. Much of the paddy in India is still processed in hullers, which yield about two-thirds of paddy in the form of rice and one-third in a mixture of hulls, bran, broken rice and foreign matter. The hull/bran/brokens mixture is unsuitable for solvent extraction mills, as the oil percentage is only about 5%. It is also unsuitable for animal feed, given the high hull content. Paddy processed in huller-and-sheller and modern rice mills, which first separate hulls from the unpolished rice using rubber rollers, yields a high quality rice bran suitable for solvent extraction. Modern mills have the added advantage of having a higher daily outturn, which expedites the collection of bran for shipment to extraction plants. One way to increase the production of rice bran oil is to encourage an increased proportion of rice or rice bran to be processed in modern mills. Several Government policies work against this, particularly the levy procurement of rice from modern mills at below market price, which smaller rice processors escape. At the moment, levy prices of rice are not far below market prices in surplus areas but the continuation of the levy itself discourages investment in modern rice mills.

Table 5: EXPORTS OF OILSEEDS AND THEIR PRODUCTS, 1976/77
QUANTITIES IN THOUSAND TONS, VALUE IN RS. MILLION

Export Item	Quantity	Addition (+) Subtraction (-) to India's Oil Supply /a	Value	Quantity of Palm Oil Imports Financed
HPS Groundnuts	136	-61	652	149
Other Whole Seeds	21	- 7	59	14
Linseed Oil	42	-42	184	42
Castor Oil	41	-41	220	50
Other Oils	12	-12	81	19
Rice Bran	411	62	231	53
Groundnut Meal	1,234	93	1,684	385
Cottonseed Meal	103	3	126	29
Other Deoiled Meals	392	30	459	105
Total		25	3,698	845

/a Export of deoiled meal calculated to contribute the quantity of oil extracted from expeller cake by solvent method on assumption that such solvent extraction would not take place without export market for meal. This assumption reflects market conditions.

Source: DCIS Trade Data. World Bank estimates of oil content/recovery.

Forest oilseeds such as sal, neem and mahua would hold some promise for contributing to India's total supply of vegetable oil, if their collection and processing were better organized. Altogether these naturally occurring forest products could contribute an estimated one million tons of vegetable oil if all the seeds were collected and their oil were extracted. Full utilization probably will never be possible. So far less than 10% of this potential has been realized (see Table 6). Two-thirds of the total potential lies with sal alone. Sal is also the seed experiencing the fastest growth in oil extraction. It has a ready market within India as one of many vegetable oils for soap production. However, it has a much higher-value use as cocoa butter extender in the international market. The main constraint to the production of sal seed oil is the collection of seeds. The seeds fall in forested areas far from roads and organized labor; moreover, their collection is not yet well organized.

Pricing Policy. A supportive pricing policy is an important element of any effort to raise agricultural production. In the case of rice and wheat, the Government has developed an effective pricing policy (along with the facilities to implement it) which recently has succeeded in maintaining sufficient incentives for farmers even in years of heavy production, while keeping real prices to consumers fairly stable, even in years of greatly reduced production. This has encouraged farmers to grow more wheat and rice while protecting low income consumers.

The oilseed and vegetable oil economy would benefit similarly from a judicious pricing policy. Oilseed prices fluctuate more widely than many other crops because, as mainly rainfed crops, their production fluctuates more. Although vegetable oils take up a much smaller portion of the budgets of consumers, particularly of low income consumers, than foodgrains, price fluctuations in oilseeds are nevertheless disruptive and contribute to inflation. The average levels around which prices fluctuate are also important in their effect on production through the response of cropped area and on demand management.

Table 6: POTENTIAL AND ACTUAL PRODUCTION OF FOREST OILSEEDS 1970/71-1978/79 IN '000 TONS OF OIL

	Ultimate Potential	1970/71	1974/75	1978/79
Mahua	171	25	28	20
Neem	84	20	28	30
Karanj	30	7	8	8
Kusum	30	3	3	4
Sal	688	3	6	21
Total	1,023	59	75	86

Source: J. C. Rao, "Oilseeds Processing Industry in India: A Sub-Sector Study," Industrial Finance Corporation of India, January 1978 and World Bank Estimates.

The Agricultural Prices Commission recommends support prices for soyabean, sunflower and groundnut and the Government of India subsequently adopts a set of support prices. However, an effective nationwide system to maintain these support prices through procurement, storage and disposal does not yet exist. The National Agricultural Cooperative Marketing Federation (NAFED) has been appointed agent for the Government of India to procure soyabean and sunflower as a price support operation. NAFED has been able to accomplish this in the so far quite limited areas in which these two oilseeds are grown. The price support for soyabean has been quite important in popularizing the crop among farmers and NAFED has purchased significant proportions of the crop in the first years after its introduction. NAFED is still active in the soyabean markets. Outside of the soyabean area NAFED's procurement organization is weak and needs to be strengthened. There is no institution corresponding in size and reach to the Food Corporation of India to procure groundnut in the many and widely spread areas in which it is grown. The support price historically has been far enough below the harvest prices in most areas to make the lack of procurement capability largely an academic matter.

The Government needs to proceed with caution in further developing its oilseed pricing policy. On the one hand there is a need to provide some meaningful price support to guard farmers against sharp price falls when the nation's oilseed crop is very large. In addition there is a need to provide a guaranteed market at incentive prices in areas where the Government hopes

to introduce a new crop. On the other hand the Government must be careful not to set the price too high so that it is required suddenly to buy large quantities in the face of a good harvest. There are two important considerations to bear in mind at the present. The first is that weather conditions for oilseeds production have been poor for the past two years and harvest prices are higher than they otherwise would be, considering the edible oil imports. A return to good weather should increase the crop and reduce harvest prices. The second is that there is no tested system to procure, store and subsequently dispose of oilseeds across India should the support price become effective in a large number of markets. If the market prices fell below the support prices at the moment, the Government would be hard pressed to maintain the support price level.

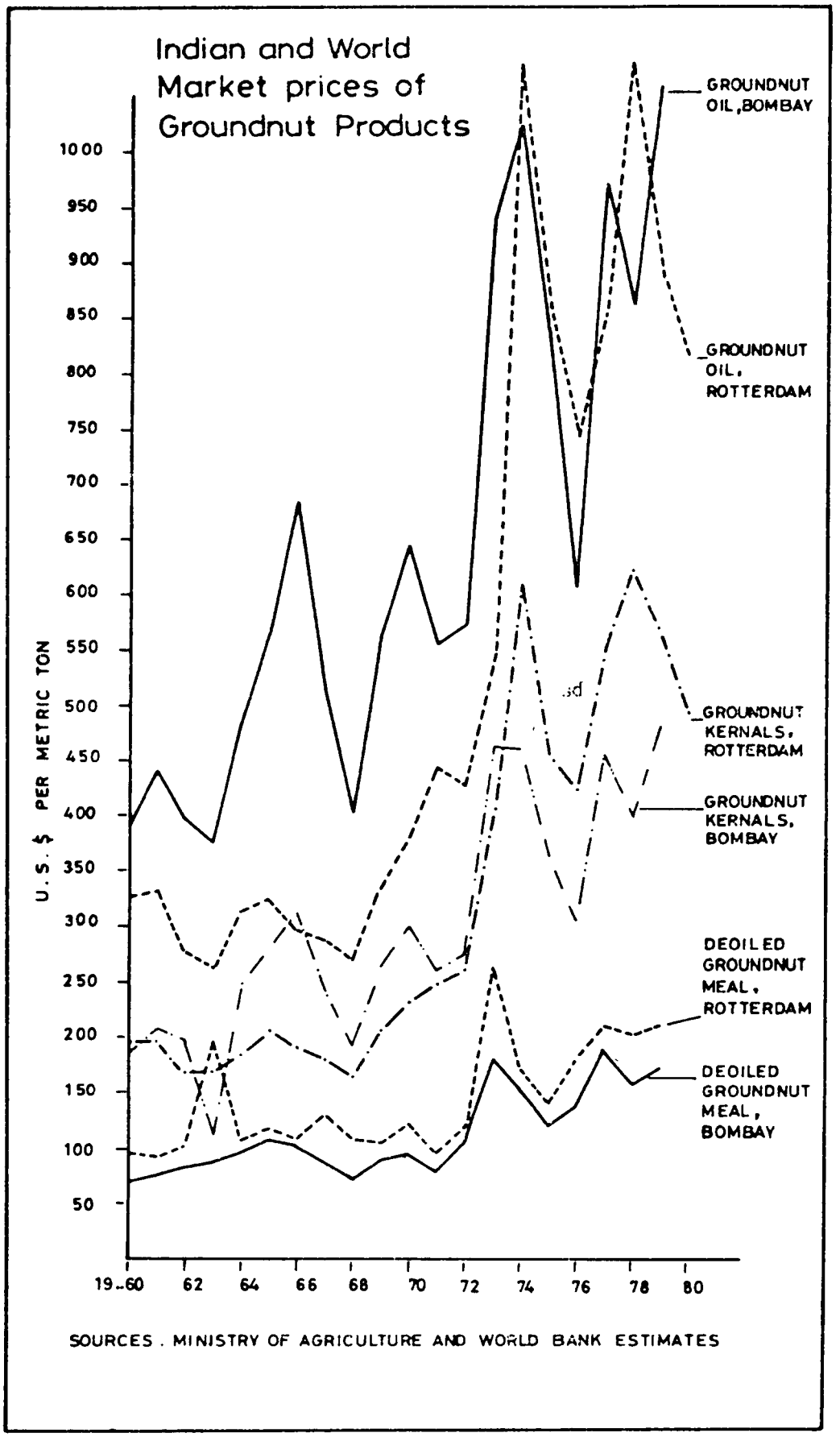
These considerations argue for only gradual increases in the support prices of oilseeds to the extent warranted by the desire to avoid price fluctuation, while keeping close watch over market developments. Should market prices approach the support prices in certain markets, the Government should make adequate arrangements to procure some of the crop in those markets if necessary. The Government's procurement agent, NAFED, for instance, would need to be alert and responsive to these market conditions. If, over time, certain areas became heavily and chronically surplus in a particular oilseed and Government procurement were heavy, then a more permanent arrangement for Government procurement would become necessary. However, it is not yet necessary to build a nationwide system, such as the Food Corporation of India has for foodgrains, for oilseeds. Some experience with the higher support prices in good years and bad is first required.

The Government also affects the prices farmers receive by its import and export policies for the crop. In the case of oilseeds, the effect of Government trade policies has been important in the last several years. The Government has imported large quantities of vegetable oil--one-quarter of domestic supply for several years--and restricted the export of oilseed products. The imported vegetable oil has been released to vanaspati manufacturers and through the fair price system at prices somewhat below those prevailing in the market, although still above the even lower import prices. These policies no doubt have kept domestic prices of vegetable oil and oilseeds lower than they would have been otherwise.

Nevertheless the prices of vegetable oils in India are currently higher than those in international markets. Graph 4 compares the Bombay and Rotterdam prices for groundnut oil, the oil for which the price differential is least among oils common in India; for other oils, such as rape and mustard, the Indian prices exceed international prices by a greater margin.

The prices of oilseeds and deoiled meals have been generally lower in India than in international markets since 1974. The paradox of Indian prices of oil being higher and of seeds and meals being lower than international prices is, at least partially, explained by different demand patterns for oilseed products. In India demand is relatively small for animal products, and the protein meals and cakes used to feed animals, compared with that in developed countries, and demand is therefore relatively greater for vegetable oils for direct human consumption. The situation would seem to provide an excellent opportunity for India to gain from an increased trade in oilseed products, selling more seeds and meals while importing oil, if necessary.

Graph 4


Indian and World
Market prices of
Groundnut Products
U.S.$ PER METRIC TON
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
19..60
62
64
66
68
70
72
74
76
78
80
GROUNDNUT OIL, BOMBAY
GROUNDNUT OIL, ROTTERDAM
GROUNDNUT KERNALS, ROTTERDAM
GROUNDNUT KERNALS, BOMBAY
DEOILED GROUNDNUT MEAL, ROTTERDAM
DEOILED GROUNDNUT MEAL, BOMBAY
SOURCES . MINISTRY OF AGRICULTURE AND WORLD BANK ESTIMATES

Allowing more exports of seeds and meals would tend to strengthen oilseed prices, calling forth more production. As this would result in more production of vegetable oil, it would be a way of increasing oilseed prices while easing vegetable oil prices. Whether or not the vegetable oil prices would end up below the level that would have prevailed without the increased exports would depend on the level of vegetable oil imports. Even if total oil availability did not increase, there would be foreign exchange savings from the reduced level of oil imports.

If imports of vegetable oils of the magnitude discussed earlier are to be avoided, prices will have to rise to encourage increased production and to dampen demand growth. However, this prospect raises the perplexing question of at what cost are imports to be avoided. Table 7 presents Indian and world market prices of selected vegetable oils. It is clear vegetable oils, such as soyabean and palm oil, are available on the world market at considerably lower prices than current market prices in India. World market prices of these oils are projected to rise only slightly in real terms over the foreseeable future. This suggests that if it is not possible to significantly reduce the costs of production of oilseeds and vegetable oils in the long run by improved productivity, India would be better off in relying on more imports for supplying domestic demand. This situation simply underlines the need to bring about the increased productivity that is possible by raising oilseed yields.

Table 7: INDIAN AND WORLD MARKET PRICES OF VEGETABLE OILS SPOT MARKET PRICES, NOVEMBER 1980
US$ per Metric Ton

Groundnut	Bombay	1,338	Europe	1,090
Rape/Mustard	Rohtak	1,637	-	-
Palm Oil	-	-	Malaysia	595
Soyabean	-	-	Dutch Ports	579
Coconut Oil	Cochin	2,586	New York	686

Sources: International Financial Statistics, January 1981, and Economic Times, November 30, 1980.

Medium-Term Management of the Vegetable Oil Economy and the Plan. Expanding the domestic production of oilseeds and supply of vegetable oils by the appropriate set of policies and programs is a longer-term solution which will take some time to show results. In the meantime India faces an existing supply-demand gap, the closing of which is currently absorbing an unduly large amount of India's dwindling foreign exchange reserves. The broad outlines of the medium-term strategy have been clarified somewhat by the Sixth Plan and by Government indications on the vegetable oil import strategy. Briefly the strategy can be characterized as one of taking such measures as are possible both to increase vegetable oil supply in the short- and medium-term and to progressively limit vegetable oil imports. The Plan adopts the objective of complete self-sufficiency in vegetable oils by 1984/85. This will be difficult to achieve and some price rises in vegetable oils no doubt will be necessary to close what remains of the supply-demand gap.

The main thrusts in the Sixth Plan to increase oilseed production through 1984/85 are to increase the area under groundnut in irrigated areas in the summer season (January to May) and to increase area under soyabeans. The Plan anticipates an increase in summer groundnut cropped area from 800,000 hectares in 1979/80 to 1.4 million hectares by 1984/85. It also expects yields to increase from an average of 2 tons per hectare of groundnut in the shell to 2.5 tons per hectare. This would increase summer groundnut production from 1.6 million tons to 3.5 million tons - an increase of 119%. Area under soyabean is expected to increase from about 430,000 hectares in 1979/80 to 1.1 million hectares by 1984/85. Yields are expected to increase from 0.8 tons to 1 ton per hectare. This is an increase from 0.4 million tons to 1.0 million tons of soyabean, or 225%. Yields of kharif groundnut are expected to rise as well. Some oilseeds, such as castor, linseed and nigerseed, are expected to increase in production only modestly. Overall production of oilseeds is expected to grow by 5% per annum over the five years of the Plan.

These are quite optimistic projections. The trend rate of growth of oilseeds production was only 1.6% per annum over the period 1967/68 to 1978/79. There have been efforts in the past to promote summer groundnut cultivation in selected irrigated areas but these have met with only limited success. In these areas groundnut must compete with paddy, which is a profitable crop in which farmers are well experienced and which benefits from a program of Government support including an assured, incentive price through Government procurement operations. Summer groundnut also must fit into an irrigation system that up to now handles mainly paddy. This is impossible where paddy is irrigated by field-to-field irrigation, because groundnut plants would drown under so much water. Only where water is distributed by channels is groundnut growing possible. Water releases in the rabi season are generally regulated to suit paddy, although adjustments to suit groundnut are sometimes possible. The Government intends to localize parts of canal commands for groundnut (i.e., delineate areas in which farmers are supposed to grow groundnut) and release water to these areas on a schedule suitable for groundnut. The Government has localized areas in the past for dry crops without complete success. The fact that farmers in many areas pay only token amounts for rights to irrigation (and nothing for using extra water) further enhances the relative profitability of paddy, which requires far more water than irrigated groundnut. The increase in soyabean area has been quite rapid since its introduction. The expected increase, although quite large, may be possible, depending on the availability of suitable, otherwise fallow areas in Madhya Pradesh and Uttar Pradesh.

Pricing policy will be quite important in this effort. While it is very difficult to force a farmer to grow a crop which he does not want to, it is equally difficult to stop him growing it when it is more profitable than competing ones. Maintaining special procurement mechanisms for soyabean and offering an incentive price were important parts of the strategy to encourage the introduction of soyabean. Perhaps a special arrangement to procure groundnut at incentive prices in the summer season in selected irrigated areas would be helpful in encouraging farmers to adopt groundnut cropping. This would have its main value as a temporary measure while private marketing channels have a chance to develop. Another policy measure that should be taken is to remove restrictions on the export of oilseed products. Removing restrictions on the export of deoiled rice bran and solvent extracted oilseed meals has the dual

benefit of raising domestic availability of vegetable oil and increasing foreign exchange earnings. These benefits would outweigh the burden of the somewhat higher cost of animal feeding within India. Removing the restrictions on the export of HPS groundnut and speciality oils increases the foreign exchange earnings by more than the increased import cost of replacing the oil exported.

Short-term measures to increase the supply of oilseeds and vegetable oils are only part of a program to manage the vegetable oil economy. Some policy with regard to imports is also required. A policy progressively reducing the volume of imports in consideration of the balance of payments situation can be expected. It is clear that a complete elimination of oil imports, which now supply one-fourth of total availability, before domestic production picks up would raise prices precipitously. Nevertheless some curtailment combined with increases in domestic production and some increase in price to further stimulate production and dampen demand do seem necessary.

Table 8 presents a supply-demand projection through 1984/85 that incorporates increased domestic supply along the lines expected in the Plan and alternative demand projections that are dampened by a mild price rise and volume imports that either remain constant or decline slightly, depending on the growth of total expenditure. Total supply of vegetable oils is projected to rise by the Plan's 5% target growth rate for oilseed production. Demand projections presented earlier are dampened by a 1% per annum rise in the relative price of vegetable oils. The high demand projection is related to a 5% growth rate in total income while the low projection is related to a 3.5% annual increase, which is approximately equal to the historical trend. Under the high demand alternative the continuation of 1 million tons of vegetable oil imports would close the remaining gap. Under the low demand alternative, the volume of imports would decline to 700,000 tons by 1984/85. Imports could decline further if higher price rises were projected.

These projections contain many uncertainties and are useful mainly for illustrative purposes. The supply projections may well prove optimistic, given past rates of growth. Nevertheless the projections in Table 8 suggest that reducing imports below their current level of 1 million tons may well result in rises in vegetable oil prices higher than the overall rate of inflation. Such price rises are probably desirable to stimulate production and dampen demand and should be considered as corrective in nature rather than unfortunate. In any case they may be necessary to manage India's deteriorating balance of payments situation.

Table 8: MEDIUM-TERM PROJECTIONS OF SUPPLY, DEMAND, IMPORTS FROM 1980/81 THROUGH 1984/85 (OIL YEARS)

	1979/80 (E)	1980/81 (PE)	1981/82 (P)	1982/83 (P)	1983/84 (P)	1984/85 (P)
Domestic Production /a	2.8	3.1	3.4	3.6	3.8	4.0
Demand - High /b	4.0	4.1	4.4	4.6	4.8	5.0
Demand - Low /b	4.0	4.1	4.3	4.4	4.6	4.7
Imports - High	1.2	1.0	1.0	1.0	1.0	1.0
Imports - Low	1.2	1.0	0.9	0.8	0.8	0.7

/a Assumes a 5% per annum growth from a weather-normal base of 3.1 million tons. For 1979/80 and 1980/81 actual estimates are used.

/b Assumes the 1984/85 demand projections from Table 6.6 are reduced by a 1% annual rise in relative prices of vegetable oil (i.e., that vegetable oil prices rise by 1% more than the average of all other commodities). The high demand in 1980/81 is constrained to 4.1 million tons (rather than 4.2 million tons). The demand-price elasticity is taken to be -0.3.

Note: (E)=Estimated; (PE)=Provisional Estimate; and (P)=Projected.

Source: World Bank estimates and projections.

Annex TABLE 1A Domestic Availability of Vegetable Oils

1960 to 1980

Calender Year	Edible Oils b/ (million kgs)	Non-Edible Oils b/ (million kgs)	Total b/ (million kgs)	Population a/ (millions)	Per Capita Availability of Vegetable Oils: Edible Oils (kgs)	Non-Edible Oils (kgs)	Total (kgs)
1961	1954	109	2063	443.935	4.402	0.246	4.647
1962	1986	150	2136	454.379	4.371	0.330	4.701
1963	1996	132	2128	465.093	4.292	0.284	4.575
1964	1891	115	2006	476.091	3.972	0.242	4.213
1965	2370	166	2536	487.324	4.863	0.341	5.204
1966	1862	116	1978	498.831	3.733	0.233	3.965
1967	1887	109	1996	510.536	3.696	0.214	3.910
1968	2355	158	2513	522.555	4.507	0.302	4.809
1969	1999	104	2103	534.895	3.737	0.194	3.932
1970	2247	219	2466	547.569	4.104	0.400	4.504
1971	2711	252	2963	560.119	4.840	0.450	5.290
1972	2468	284	2752	571.613	4.318	0.497	4.814
1973	2166	224	2390	583.429	3.713	0.384	4.096
1974	2715	288	3003	595.579	4.559	0.484	5.042
1975	2622	297	2919	608.072	4.312	0.488	4.800
1976	2899	284	3183	620.440	4.672	0.458	5.130
1977	2789	270	3059	631.726	4.415	0.427	4.842
1978	3845	382	4227	643.896	5.971	0.593	6.565
1979 c/	3864	440	4304	658.066	5.872	0.669	6.541
1980 c/	3640	357	3997	672.235	5.415	0.531	5.946

a/ World Bank estimates.

b/ This may not tally strictly with the figures given in Table IA due to rounding off errors.

c/ Calculated by assuming edible oil imports wer 1130 million kgs in 1978/79 and 1200 million kgs in 1979/80 and assuming no non-edible oil imports.

Sources for Tables 1A through 1D: Ministry of Agriculture, DCGIS Trade Data and World Bank estimates.

TABLE 1B

UNIT: THOUSAND TONNES

ESTIMATED PRODUCTION OF VEGETABLE OILS 1960/61 - 1978/79

OIL YEAR	GROUND NUT OIL	RAPE/MUSTARD OIL	SESASUM OIL	SAFFLOWER OIL	NIGER OIL	SOYABEAN OIL	SUNFLOWER OIL	COTTONSEED OIL	COCOANUT OIL	PALM OIL	SUBTOTAL EDIBLE OILS	LINSEED OIL	CASTOR OIL	RICEBRAN OIL	TREECROP OIL	GRAND TOTAL
1960 / 61	1,089	431	99	-	-	-	-	121	188	-	1,928	119	37	-	-	2,084
1961 / 62	1,131	431	115	-	-	-	-	105	185	-	1,967	130	38	-	-	2,144
1962 / 63	1,146	417	153	-	-	-	-	120	197	-	2,033	129	35	-	-	2,197
1963 / 64	1,214	275	136	-	-	-	-	124	182	-	1,931	111	36	-	-	2,078
1964 / 65	1,394	458	150	-	27	-	-	130	175	-	2,334	147	37	-	-	2,518
1965 / 66	961	393	132	28	25	-	-	105	165	-	1,809	97	28	-	-	1,934
1966 / 67	1,006	378	129	29	22	-	-	117	164	-	1,845	73	38	-	-	1,956
1967 / 68	1,324	489	138	31	27	-	-	128	164	-	2,301	130	42	-	-	2,473
1968 / 69	1,044	418	131	38	25	-	-	120	173	-	1,949	95	40	-	-	2,084
1969 / 70	1,171	489	139	57	27	-	-	105	184	-	2,172	140	43	-	50	2,405
1970 / 71	1,413	633	175	62	36	-	-	114	190	-	2,623	141	47	21	59	2,891
1971 / 72	1,429	456	140	52	32	5	-	79	187	-	2,380	159	54	30	65	2,688
1972 / 73	918	590	120	33	26	4	32	180	181	-	2,084	127	50	25	65	2,351
1973 / 74	1,345	545	150	76	38	6	65	175	173	-	2,573	151	80	24	70	2,898
1974 / 75	1,157	715	119	85	37	7	96	200	178	-	2,594	170	73	23	74	2,934
1975 / 76	1,516	616	136	84	43	15	72	175	181	-	2,838	180	50	36	78	3,182
1976 / 77	1,192	479	161	43	25	20	58	186	170	-	2,334	125	62	70	81	2,672
1977 / 78	1,400	500	160	37	30	10	62	230	160	-	2,589	150	80	80	88	2,987
1978 / 79	1,428	569	177	41	29	31	38	262	162	-	2,737	161	81	101	94	3,174
1979 / 80	1,323	438	116	45	20	44	38	254	162	-	2,440	77	81	105	94	2,797
DOMESTIC AVAILABILITY OF VEGETABLE OILS																
1960 / 61	1,081	431	99	-	-	1	-	121	188	34	1,955	113	4	-	-	2,064
1961 / 62	1,108	431	115	-	-	2	-	106	186	38	1,986	138	12	-	-	2,136
1962 / 63	1,075	417	153	-	-	1	-	121	201	29	1,997	128	4	-	-	2,129
1963 / 64	1,135	275	136	-	-	2	-	124	183	36	1,891	110	5	-	-	2,006
1964 / 65	1,385	458	150	-	27	18	-	132	175	25	2,370	146	20	-	-	2,536
1965 / 66	959	392	132	28	25	43	-	111	165	7	1,862	97	20	-	-	1,979
1966 / 67	1,005	378	129	29	22	32	-	117	164	11	1,887	73	36	-	-	1,996
1967 / 68	1,324	489	138	31	27	50	-	128	164	5	2,356	130	28	-	-	2,514
1968 / 69	1,044	417	131	38	25	51	-	120	173	1	2,000	95	9	-	-	2,104
1969 / 70	1,171	489	139	57	27	74	1	105	184	N.S	2,247	140	29	-	50	2,466
1970 / 71	1,413	633	175	62	36	85	3	114	189	N.S.	2,710	141	31	21	59	2,962
1971 / 72	1,429	457	140	52	32	94	-	79	187	1	2,471	159	29	30	65	2,754
1972 / 73	918	596	120	33	26	57	32	180	181	24	2,167	127	7	25	65	2,391
1973 / 74	1,345	566	150	76	38	55	65	175	173	72	2,716	146	49	24	70	3,005
1974 / 75	1,158	717	119	85	37	19	96	200	178	15	2,624	148	52	23	73	2,920
1975 / 76	1,521	626	136	84	43	40	72	175	181	21	2,899	147	23	36	77	3,182
1976 / 77	1,224	592	161	43	25	172	65	186	175	145	2,788	93	27	70	79	3,057
1977 / 78	1,467	852	160	37	30	357	91	230	176	444	3,844	150	66	80	85	4,225

TABLE 1C

IMPORTS OF VEGETABLE OILS 1960/61 - 1978/79
ON OIL YEAR BASIS (i.e July - June basis) a/

Unit: THOUSAND TONNES

OIL YEAR (July-June) (1)	GROUND NUT OIL (2)	RAPE & MUSTARD OIL (3)	SOYBEAN OIL (4)	PALM OIL d/ (5)	COCONUT OIL (6)	COTTONSEED OIL (7)	SUNFLOWER OIL (8)	SESAME OIL (9)	SAFFLOWER OIL (10)	NIGERSEED OIL (11)	SUBTOTAL EDIBLE OILS (2) to (11) = (12)	LINSEED OIL (13)	CASTOR OIL (14)	RICEBRAN OIL (15)	TREECROP OIL (16)	GRAND TOTAL (12) to (16)
1960 / 61	N.S.	-	0 5	33.7	-	0.3	-	-	-	-	34.5	-	-	-	-	34.5
1961 / 62	0.1	-	1.7	37 8	1.1	1.0	-	-	-	-	41 7	-	-	-	-	41.7
1962 / 63	N.S.	-	0.7	29.2	3.6	0.6	-	-	-	-	34.1	-	-	-	-	34.1
1963 / 64	N.S.	0.1	2.1	35.5	1.1	-	-	-	-	-	38 8	N.S.	-	-	-	38.8
1964 / 65	-	0.4	17.6	24 6	0.1	2.0	-	-	-	-	44 7	N.S.	-	-	-	44.7
1965 / 66	-	0.4	42.9	6.9	-	6.1	N.S.	-	-	-	56.3	N.S.	-	-	-	56.3
1966 / 67	-	0.3	31.9	10.6	-	-	N.S.	-	-	-	42 8	N.S.	-	-	-	42.8
1967 / 68	-	0.3	49.8	5.0	-	-	-	-	-	-	55.1	-	-	-	-	55.1
1968 / 69	-	0 1	50.7	0.6	-	-	N.S.	-	-	-	51 4	N S.	-	-	-	51.4
1969 / 70	-	0.1	74.1	0.3	0.4	-	0 9	-	-	-	75.8	N.S.	-	-	-	75.8
1970 / 71	-	N.S.	84.6	0 5	1.1	-	2.8	-	-	-	89 0	0 1	-	-	-	89 1
1971 / 72	-	N.S.	88.7	0.7	-	-	-	-	-	-	89 4	0.3	-	-	-	89.7
1972 / 73	-	7.1	52.8	24.2	-	-	-	-	-	-	84.1	0 2	-	-	-	84.3
1973 / 74	-	21 0	49.0	72.3	-	-	-	-	-	-	142 3	0.2	-	-	-	142 5
1974 / 75	0.5	1 5	12.0	14 9	-	-	-	-	-	-	28.9	0 3	-	-	-	29.2
1975 / 76	6.2	10 0	24 6	21.3	N.S.	-	-	-	-	-	62.1	0.5	-	-	-	62 6
1976 / 77	35 2	113.2	152.4	145 0	5.3	-	7.1	-	-	-	458.2	0.8	-	-	-	459.0
1977 / 78	66 9	352.6	347.0	444.4	16 5	0.1	29 1	-	-	-	1256.6	1.0	-	-	-	1257 6
1978 / 79	b/ 8.1	213.2	331.2	375.0	2.8	-	23.0	-	-	-	953.3	N.A	N A.	N.A.	N A.	N.A.
1979 / 80	c/ 3.0	88 7	250.0	282.3	-	-	-	-	-	-	624.0	N.A.	N.A.	N.A.	N.A.	N.A.

a/ See Table 1D.

b/ Calculated by multiplying the imports during the periods April 1978 - March 1979 and April 1979 - February 1980 by 0.75 and 0.273 respectively and then adding them. In other words, the figures for the period April 1979 to February 1980 were blown up by a factor (12 ÷ 11 = 1.0909) to get the figures for the financial year 1980 (i.e. April 1979 - March 1980).

c/ Relates to the period April 1979 - February 1980.

d/ Includes palm kernel oil.

TABLE 1D EXPORTS OF VEGETABLE OIL (ON OIL YEAR BASIS, i e , JULY - JUNE) a/ Unit: Thousand Tonnes

OIL YEAR (1)	GROUND NUT OIL (2)	RAPE/MUSTARD OIL (3)	SESAME OIL (4)	SAFFLOWER OIL (5)	NIGERSEED OIL (6)	SOYBEAN OIL (7)	SUNFLOWER OIL (8)	COTTONSEED OIL (9)	COCONUT OIL (10)	SUBTOTAL EDIBLE OILS (2) to (10) (11)	LINSEED OIL (12)	CASTOR OIL (13)	RICEBRAN OIL (14)	TREECROP OIL (15)	GRAND TOTAL (11) to (15) = (16)
1960/ 61	8.15	0.20	N.S.	-	-	-	-	-	N.S.	8.35	5.65	41.25	-	0.03	55.28
1961/ 62	22.75	0.20	N.S.	-	-	-	-	-	N.S.	22.95	0.80	26.20	-	0 02	49.97
1962/ 63	70.83	0 20	N.S.	-	-	-	-	-	N.S.	71.03	1.03	31.43	-	0.02	103 51
1963/ 64	78.60	0.23	N.S.	-	-	-	-	-	0.03	78.86	0.88	31.38	-	0.04	111.16
1964/ 65	8.53	0 38	N.S.	-	-	-	-	-	0.13	9 04	0.93	17.23	-	0.02	27.22
1965/ 66	1.50	0.53		-	-	-	-	-	0.20	2.23	0.30	8.30	-	0.02	10 85
1966/ 67	0.75	0.30	0.10	-	-	-	-	-	0.18	1 33	N.S.	1.85	-	N.S.	3.18
1967/ 68	0.25	0.38	0.10	-	-	-	-	-	0.10	0.83	N.S.	14.23	-	N.S.	15.06
1968/ 69	0.10	0.58	N.S.	-	-	-	-	-	0.10	0.78	0.05	30.78	-	-	31.61
1969/ 70	0.13	0.43	N.S.	-	-	-	-	-	0.10	0 66	0.15	14.10	-	-	14 91
1970/ 71	0.18	0.28	N.S.	-	-	-	-	-	0.08	0.54	N.S.	16.18	-	-	16 72
1971/ 72	0.10	0.80	N.S.	-	-	-	-	-	0.02	0.92	N.S.	24 85	-	-	25 77
1972/ 73	0.10	1.33	N.S.	-	-	-	-	-	0.48	1.91	N.S.	43.05	-	0.01	44.97
1973/ 74	0.10	0.20	N.S.	-	-	-	-	-	0 10	0.40	4.91	31.43	-	0.15	36.85
1974/ 75	0 10	0.20	0.15	-	-	-	-	-	0.10	0.55	22.06	21.00	-	0.58	44 19
1975/ 76	0.93	0.18	0.45	-	-	-	-	-	0.08	1.64	32.50	27.35	-	1.12	62.61
1976/ 77	2.63	0.13	0.10	-	-	-	-	-	N.S.	2.86	31.58	34 98	-	2.30	71.66
1977/ 78	0.33	0 15	0 15	-	-	-	-	-	-	1.03 c/	N.S.	14.00	-	2.69	17.72
1978/ 79	b/ 0.43	N.S.	0.01	-	-	-	-	-	-	2 42 c/	N.S.	5.36	-	1.85	9.63

a/ Obtained by multiplying the export figures for the financial years t and t + 1 by 0.75 and 0.25, respectively, and adding them For example, to get the figures for oil year 1960/61, we multiply the export figures for the financial years 1960/61 and 1961/62 by 0.75 and 0.25, respectively, and then adding them,

b/ relates to the financial year 1978-79,

c/ includes exports of palm oil.

Table 2A

INDIA - Oilseeds Production - Groundnut

		Area	Production	Yield
		Thousand hectares	Thousand tons (in the shell)	kg/hectare
1949/50		3979	3433	863
1950/51		4494	3481	775
1951/52		4917	3192	649
1952/53		4795	2929	611
1953/54		4247	3445	811
1954/55		5541	4245	766
1955/56		5133	3862	752
1956/57		5532	4369	783
1957/58		6420	4710	734
1958/59		6251	5178	828
1559/60		6442	4562	708
1960/61		6463	4812	745
1961/62		6889	4994	725
1962/63		7283	5064	695
1963/64		6886	5298	769
1964/65		7376	6004	814
1965/66		7698	4263	554
1966/67		7299	4411	604
1967/68		7553	5731	759
1968/69		7088	4631	653
1969/70		7125	5130	720
1970/71		7326	6111	834
1971/72		7510	6181	823
1872/73		6990	4092	585
1973/74		7024	5932	845
1974/75		7063	5111	724
1975/76		7222	6754	935
1976/77		7043	5264	747
1977/78		7029	6087	866
1978/79	(Revised)	7433	6208	835
1979/80	(Final)	7238	5772	797
Compound Growth Rates		%	%	%
1949/50-1978/79		1.8	2.0	0.2
1949/50-1964/65		3.9	4.0	0.1
1967/68-1978/79		-0.2	1.3	1.5
1949/50-1979/80		1.7	1.9	0.2
1967/68-1979/80		-0.1	1.2	1.3

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2B

INDIA - Oilseeds Production - Rape & Mustard Seed

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1949/50	1935	806	417
1950/51	2071	762	368
1951/52	2401	943	393
1952/53	2105	858	408
1953/54	2244	872	389
1954/55	2439	1037	425
1955/56	2556	860	336
1956/57	2539	1043	411
1957/58	2412	933	387
1958/59	2447	1042	426
1559/60	2910	1063	365
1960/61	2883	1347	467
1961/62	3168	1346	425
1962/63	3127	1303	417
1963/64	3046	915	300
1964/65	2910	1474	507
1965/66	2913	1298	446
1966/67	3006	1228	408
1967/68	3244	1568	483
1968/69	2870	1347	469
1969/70	3172	1564	493
1970/71	3323	1976	594
1971/72	3614	1433	396
1872/73	3319	1808	545
1973/74	3457	1704	493
1974/75	3680	2252	612
1975/76	3339	1936	580
1976/77	3129	1551	496
1977/78	3584	1650	460
1978/79 (Revised)	3544	1860	525
1979/80 (Final)	3475	1433	412

Compound Growth Rates	%	%	%
1949/50-1978/79	1.9	3.1	1.3
1949/50-1964/65	3.0	3.4	0.4
1965/66-1978/79	1.3	2.6	1.3
1967/68-1978/79	1.0	1.7	0.7
1949/50-1979/80	1.8	2.9	1.1
1965/66-1979/80	1.2	1.8	0.6
1967/68-1979/80	0.9	0.8	-0.2

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2C

INDIA - Oilseeds Production - Sesamum

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1949/50	2046	438	214
1950/51	2204	445	202
1951/52	2405	452	188
1952/53	2377	471	198
1953/54	2570	563	219
1954/55	2626	603	230
1955/56	2293	467	204
1956/57	2172	438	202
1957/58	2094	359	171
1958/59	2250	514	228
1559/60	2136	370	173
1960/61	2169	318	147
1961/62	2252	372	165
1962/63	2552	492	193
1963/64	2412	439	182
1964/65	2486	484	195
1965/66	2509	424	169
1966/67	2794	416	149
1967/68	2654	445	168
1968/69	2423	422	174
1969/70	2309	448	194
1970/71	2433	562	231
1971/72	2392	449	188
1872/73	2288	385	168
1973/74	2386	485	203
1974/75	2234	392	176
1975/76	2170	479	221
1976/77	2279	422	185
1977/78	2384	520	218
1978/79 (Revised)	2389	514	215
1979/80 (Final)	2384	371	156
Compound Growth Rates	%	%	%
1949/50-1978/79	0.1	0.0	-0.1
1949/50-1964/65	0.3	-0.9	-1.2
1965/66-1978/79	-1.1	0.9	1.9
1967/68-1978/79	-0.7	0.7	1.6
1949/50-1979/80	-0.1	-0.1	-0.2
1965/66-1979/80	-0.9	0.2	1.1
1967/68-1979/80	-0.6	0.1	0.4

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2D

INDIA - Oilseeds Production - Linseed

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1949/50	1521	418	275
1950/51	1403	367	262
1951/52	1380	333	241
1952/53	1362	372	273
1953/54	1387	385	278
1954/55	1361	390	287
1955/56	1529	420	275
1956/57	1682	390	232
1957/58	1283	259	202
1958/59	1595	452	283
1559/60	1974	446	226
1960/61	1789	398	222
1961/62	1977	463	234
1962/63	1904	430	226
1963/64	1995	379	190
1964/65	2042	494	242
1965/66	1723	331	192
1966/67	1495	260	174
1967/68	1777	438	247
1968/69	1697	329	194
1969/70	1803	469	260
1970/71	1897	474	250
1971/72	2064	529	256
1872/73	1726	428	248
1973/74	2038	504	247
1974/75	2071	564	272
1975/76	2119	598	282
1976/77	1888	419	222
1977/78	2010	527	262
1978/79 (Revised)	2092	535	256
1979/80 (Final)	1641	270	165
Compound Growth Rates	%	%	%
1949/50-1978/79	1.4	1.2	-0.2
1949/50-1964/65	2.9	1.2	-1.6
1967/68-1978/79	1.5	2.5	1.0
1949/50-1979/80	1.3	0.8	-0.4
1967/68-1979/80	0.7	0.1	-0.6

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2E

INDIA - Oilseeds Production - Castorseed

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1949/50	590	130	220
1950/51	555	103	186
1951/52	582	108	186
1952/53	536	104	194
1953/54	545	105	193
1954/55	555	124	223
1955/56	574	125	218
1956/57	569	124	218
1957/58	447	89	199
1958/59	458	112	245
1559/60	492	115	234
1960/61	466	107	230
1961/62	486	109	224
1962/63	469	99	212
1963/64	484	102	211
1964/65	441	107	242
1965/66	405	80	199
1966/67	401	110	274
1967/68	439	121	276
1968/69	394	116	294
1969/70	402	123	306
1970/71	439	136	310
1971/72	453	154	340
1872/73	426	145	341
1973/74	546	229	419
1974/75	590	210	356
1975/76	375	143	381
1976/77	496	179	361
1977/78	380	217	572
1978/79 (Revised)	447	229	512
1979/80 (Final)	438	233	532

Compound Growth Rates	%	%	%
1949/50-1978/79	-1.0	2.1	3.1
1949/50-1964/65	-1.8	0.7	1.1
1967/68-1978/79	0.6	5.9	5.4
1949/50-1979/80	-0.9	2.3	3.2
1967/68-1979/80	0.4	5.9	5.5

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2F

INDIA - Oilseeds Production - Five Major Oilseeds
(Groundnut, Rape/Mustard Seed, Sesamum,
Linseed and Castorseed)

		Area	Production	Yield
		Thousand hectares	Thousand tons	kg/hectare
1949/50		10071	5225	519
1950/51		10727	5158	481
1951/52		11685	5028	430
1952/53		11175	4734	424
1953/54		10993	5370	488
1954/55		12522	6399	511
1955/56		12085	5734	474
1956/57		12494	6364	509
1957/58		12656	6350	502
1958/59		13001	7298	561
1559/60		13954	6556	470
1960/61		13770	6982	507
1961/62		14772	7284	493
1962/63		15335	7388	482
1963/64		14823	7133	481
1964/65		15255	8563	561
1965/66		15248	6396	419
1966/67		14995	6425	428
1967/68		15667	8303	530
1968/69		14472	6845	473
1969/70		14811	7734	522
1970/71		15418	9259	601
1971/72		16033	8746	546
1872/73		14749	6858	465
1973/74		15451	8854	573
1974/75		15638	8529	545
1975/76		15225	9910	651
1976/77		14834	7834	528
1977/78		15386	9001	585
1978/79	(Revised)	15904	9347	588
1979/80	(Final)	15175	8078	532
Compound Growth Rates		%	%	%
1949/50 - 1978/79		1.3	2.0	0.7
1949/50 - 1964/65		2.7	3.3	0.6
1967/68 - 1978/79		0.2	1.5	1.3
1949/50 - 1979/80		1.3	1.9	0.6
1967/68 - 1979/80		0.1	1.1	0.9

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2G

INDIA - Oilseeds Production - Cottonseed

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1949/50	4926	914	186
1950/51	5882	1014	172
1951/52	6556	1090	166
1952/53	6359	1111	175
1953/54	6987	1372	196
1954/55	7546	1479	196
1955/56	8086	1391	172
1956/57	8019	1638	204
1957/58	8014	1651	206
1958/59	7964	1623	204
1559/60	7295	1223	168
1960/61	7610	1865	245
1961/62	7978	1614	202
1962/63	7730	1842	238
1963/64	8221	1912	233
1964/65	8365	2000	239
1965/66	7962	1614	203
1966/67	7836	1803	230
1967/68	7995	1967	246
1968/69	7596	1848	243
1969/70	7731	1890	244
1970/71	7605	1621	213
1971/72	7800	2363	303
1872/73	7679	1950	254
1973/74	7574	2146	283
1974/75	7562	2439	323
1975/76	7350	2027	276
1976/77	6885	1987	289
1977/78	7866	2483	316
1978/79 (Revised)	8119	2734	237
1979/80 (Final)	8078	2643	327
Compound Growth Rates	%	%	%
1949/50-1978/79	0.6	2.7	2.1
1949/50-1964/65	2.4	4.5	2.7
1967/68-1978/79	0.2	2.8	3.0
1949/50-1979/80	0.6	2.7	2.1
1967/68-1979/80	0.2	2.9	2.9

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2H

INDIA - Oilseeds Production - Coconuts

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1949/50	569	3448	5785
1950/51	622	3582	5759
1951/52	630	3606	5724
1952/53	651	4498	6909
1953/54	663	4649	7012
1954/55	641	4409	6878
1955/56	647	4226	6532
1956/57	657	4383	6671
1957/58	666	4455	6689
1958/59	690	4589	6651
1559/60	715	4734	6621
1960/61	717	4639	6470
1961/62	723	4478	6194
1962/63	798	5017	6288
1963/64	798	4725	5920
1964/65	848	5043	5950
1965/66	884	5035	5698
1966/67	893	5192	5814
1967/68	924	5321	5760
1968/69	988	5546	5613
1969/70	1033	5859	5670
1970/71	1046	6075	5811
1971/72	1088	6124	5626
1872/73	1099	5997	5456
1973/74	1102	5851	5309
1974/75	1116	6030	5401
1975/76	1070	5829	5449
1976/77	1075	5765	5366
1977/78	1057	5413	5121
1978/79 (Revised)	1067	5471	5127
1979/80 (Final)	n.a.	n.a.	n.a.
Compound Growth Rates	%	%	%
1949/50-1978/79	2.5	1.6	-0.8
1949/50-1964/65	2.0	2.0	0.0
1965/66-1978/79	1.5	0.6	-0.9

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2I

INDIA - Oilseeds Production - Nigerseed

		Area	Production	Yield
		Thousand hectares	Thousand tons	kg/hectare
1964/65		487	97	199
1965/66		522	91	173
1966/67		473	79	166
1967/68		468	98	209
1968/69		441	89	203
1969/70		482	98	203
1970/71		489	128	261
1971/72		494	116	235
1972/73		467	93	198
1973/74		552	136	246
1974/75		621	132	213
1975/76		615	151	245
1976/77		568	113	199
1977/78	(Revised)	609	148	243
1978/79	(Revised)	612	147	240
1979/80	(Final)	576	96	167
Compound Growth Rates		%	%	%
1964/65-1978/79		2.1	3.9	1.8
1967/68-1978/79		3.1	4.1	0.9
1964/65-1979/80		1.9	2.9	1.0
1967/68-1979/80		2.7	2.5	-0.2

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2J

INDIA - Oilseeds Production - Safflower

		Area	Production	Yield
		Thousand hectares	Thousand tons	kg/hectare
1965/66		462	69	149
1966/67		478	72	151
1967/68		513	78	152
1968/69		578	94	162
1969/70		580	142	245
1970/71		588	154	262
1971/72		598	131	218
1972/73		423	82	193
1973/74		614	191	311
1974/75		648	212	327
1975/76		674	238	354
1976/77		683	220	322
1977/78	(Revised)	707	188	266
1978/79	(Revised)	703	209	297
1979/80	(Final)	708	231	326
Compound Growth Rates		%	%	%
1965/66-1978/79		3.0	9.4	6.4
1967/68-1978/79		2.7	8.6	5.9
1965/66-1979/80		2.9	9.0	6.1
1967/68-1979/80		2.6	8.2	5.5

Source: Estimates of Area and Production of Principal Crops in India 1978-79, Ministry of Agriculture and World Bank estimates.

Table 2K

INDIA - Oilseeds Production - Sunflower

	Area	Production	Yield
	Thousand hectares	Thousand tons	kg/hectare
1977/78	385	160	416
1978/79	390	165	423
1979/80	350	150	429

Source: World Bank estimates of Area and Production of Principal Crops in India.

Table 2L

INDIA - Oilseeds Production - Soyabean

	Area Thousand hectares	Production Thousand tons	Yield kg/hectare
1969/70	24	11	458
1970/71	30	18	600
1971/72	32	20	625
1972/73	35	25	714
1973/74	90	30	333
1974/75	90	35	389
1975/76	100	70	700
1976/77	200	150	750
1977/78	225	180	800
1978/79	275	220	800
1979/80	400	300	750
Compound Growth Rates	%	%	%
1969/70-1978/79	2.9	3.4	0.5
1969/70-1979/80	2.9	3.4	0.5

Source: World Bank estimates.

TABLE 2N

Summary Table Giving the Annual Average Growth Rate[a] - By Type of Oilseeds (In Percentage)

Type of Oil Seed		←PERIOD→ 1949/50 to 1964/65	1967/68 to 1978/79	1949/50 to 1978/79	1967/68 to 1979/80	1949/50 to 1979/80
Ground Nut	Area	3.9	-0.2	1.8	-0.1	1.7
	Production	4.0	1.3	2.0	1.2	1.9
	Yield	0.1	1.5	0.2	1.3	0.2
Rape & Mustard	Area	3.0	1.0	1.9	0.9	1.8
	Production	3.4	1.7	3.1	0.8	2.9
	Yield	0.4	0.7	1.3	-0.2	1.1
Sesamum	Area	0.3	-0.7	0.1	-0.6	0.1
	Production	-0.9	0.7	0.02	-0.1	-0.1
	Yield	-1.2	1.6	-0.1	0.4	-0.2
Linseed	Area	-2.8	1.5	1.4	0.7	1.2
	Production	1.2	2.5	1.2	0.1	0.8
	Yield	1.6	1.0	-0.2	-0.6	-0.4
Castor Seed	Area	-1.8	0.6	-1.0	0.4	-0.9
	Production	-0.7	5.9	2.1	5.9	2.3
	Yield	-1.1	5.4	3.1	5.5	3.2
Five Major Oilseeds	Area	2.7	0.2	1.3	0.1	1.3
	Production	3.3	1.5	2.0	1.1	1.9
	Yield	0.6	1.3	0.7	0.9	0.6
Cocoa Nut	Area	2.0	0.9	2.5	NA	NA
	Production	2.0	-0.1	1.6	-DO-	
	Yield	n.s.	-1.0	-0.8	-DO-	
Cotton Seed	Area	2.4	-0.2	0.6	0.02	0.6
	Production	4.5	2.8	2.7	2.9	2.7
	Yield	2.1	3.0	2.1	2.9	2.1
Saf-flower	Area		2.7		2.6	
	Production		8.6		8.2	
	Yield		5.9		5.5	
Niger-Seed	Area		3.1		2.7	
	Production		4.1		2.5	
	Yield		0.9		-0.2	
Soya-Bean[c]	Area		29.0		29.0	
	Production		34.0		34.0	
	Yield		5.0		5.0	

a/ Annual growth rates obtained by fitting a least square exponential curve to data on area, production, and yield of oil seeds.

Annex Table 3A Wholesale Prices of Groundnut Kernels and Oil 1960-1980
Indian a/ and International Markets (Rs/ton and US$/ton)

Calendar Year	Bombay Groundnut Rs/ton	Bombay Groundnut US$/ton	CIF Rotterdam Groundnut US$/ton	Bombay Groundnut Oil Rs/ton	Bombay Groundnut Oil US$/ton	CIF Rotterdam Groundnut Oil US$/ton
1957	660.4	139	-	1491.5	313	-
1958	698.7	147	-	1479.7	311	-
1959	758.5	159	-	1567.1	329	-
1960	878.2	184	197	1858.8	390	326
1961	981.7	206	196	2078.8	437	331
1962	908.8	191	171	1875.4	390	275
1963	562.5	118	172	1787.1	375	268
1964	1161.3	244	187	2288.8	481	315
1965	1312.5	276	206	2707.1	568	324
1966	1906.7	311	190	4175.0	681	296
1967	1770.8	236	180	3851.0	513	283
1968	1420.0	189	167	3023.3	403	271
1969	1973.3	263	207	4246.3	566	332
1970	2240.8	299	230	4831.3	644	379
1971	1928.0	257	249	4148.3	553	441
1972	2069.2	272	261	4353.3	573	426
1973	3583.3	463	393	7271.3	939	546
1974	3741.7	462	607	8312.7	1026	1077
1975	3049.2	364	452	6978.8	833	857
1976	2722.5	304	424	5431.3	606	741
1977	3975.0	455	551	8295.8	949	852
1978	3257.5	398	621	7085.8	865	1079
1979	3823.3	471	565	8625.0	1061	888
1980	4544.1	576	493 (E)	10058.4	1274	863

a/ The average price for the year is based on average of month-end prices in Indian market.

(E) Estimate.

Sources: Ministry of Agriculture and World Bank.

Annex Table 3B Wholesale Prices of Groundnut (Deoiled) Oilcake Indian a/ and International Markets (Rs/ton and US$/ton)

Calendar Year	Bombay Groundnut Oilcake (Decorticated) Rs/ton	Bombay Groundnut Oilcake (Decorticated) US$/ton	CIF Rotterdam Ground-nut Meal US$/ton
1957	217.8	46	-
1958	269.5	57	-
1959	318.6	67	-
1960	336.8	71	98
1961	358.3	75	93
1962	388.5	82	102
1963	398.6	84	196
1964	460.7	97	108
1965	513.3	108	119
1966	626.4	102	111
1967	653.7	87	127
1968	546.1	73	112
1969	676.6	90	111
1970	714.3	95	123
1971	573.9	77	98
1972	803.0	106	122
1973	1420.4	183	266
1974	1273.3	157	174
1975	1032.5	123	140
1976	1142.9	136	178
1977	1645.0	188	218
1978	1307.3	160	204
1979	1416.7	174	210
1980	1574.6	199	220

a/ The average price for the year is based on average of month-end prices in Indian market.

Sources: Ministry of Agriculture and World Bank.

Annex Table 3C Wholesale Prices of Rape/Mustard Seed Cake Indian [a] and International Markets (Rs/ton and US$/ton)

Calendar Year	Kanpur Mustard Seed Cake Rs/ton	Kanpur Mustard Seed Cake US$/ton	FOB Ex-Mill Hamburg Rape Seed Meal US$/ton
1957	293.1	62	-
1958	297.6	62	-
1959	286.9	60	-
1960	265.8	56	-
1961	279.5	59	-
1962	295.5	62	-
1963	313.7	66	72
1964	430.6	90	71
1965	470.0	99	74
1966	464.5	76	68
1967	552.1	74	70
1968	576.6	77	73
1969	562.1	75	75
1970	515.8	69	84
1971	533.4	71	71
1972	616.5	81	90
1973	755.8	98	178
1974	1029.2	127	143
1975	705.8	84	128
1976	801.6	89	154
1977	1206.7	138	169
1978	916.3	112	168
1979	1143.3	141	177
1980	1400.0 [b] [c]	177	204

a/ The average price for the year is based on average of month-end prices in Indian Market.

b/ Based on data for 11 months of the year, the date for the month of June 1980 being "not recorded".

c/ Data for May 1980 relates to last but one week.

Sources: Ministry of Agriculture and World Bank.

Annex Table 3D Wholesale Prices of Rape and Mustard Seed and Oil Indian [a/] and International Markets (Rs/ton and US$/ton)

Calendar Year	Kanpur Rape/ Mustard Seed (Yellow)	Rape/ Mustard Seed (Yellow)	CIF European Ports Canadian Rapeseed	Kanpur Mustard Oil	Mustard Oil	FOB Ex-Mill Dutch Rapeseed Oil
	Rs/ton	US$/ton	US$/ton	Rs/ton	US$/ton	US$/ton
1957	942.3	198	-	2210.0	464	-
1958	850.1	179	-	1878.9	395	-
1959	833.5	175	-	1813.0	381	-
1960	862.7	181	160	2029.5	426	219
1961	960.8	202	165	2144.4	450	280
1962	1013.7	213	127	2385.2	501	221
1963	970.9	204	146	2186.7	459	215
1964	1322.2	278	134	3157.5	663	252
1965	1489.9	313	123	3420.5	718	263
1966	1637.4	267	130	3761.9	614	244
1967	2003.8	267	122	4671.4	623	206
1968	1588.9	212	106	3749.1	500	161
1969	1756.9	234	111	4051.4	540	200
1970	1960.0	261	142	5082.0	678	293
1971	2023.0	270	142	4802.4	640	295
1972	2136.7	281	132	5167.6	680	232
1973	2746.7	355	254	6631.4	857	395
1974	3820.0	471	261	9420.8	1163	745
1975	2466.7	294	293	5841.7	697	551
1976	2564.2	286	246	5918.3	661	415
1977	4316.6	494	312	10310.0	1180	584
1978	4101.7	501	297	9420.0	1150	597
1979	3818.3	470	313	9508.3	1170	635
1980	4959.1	628	311	12422.7	1574	570

a/ The average price for the year is based on average of month-end prices in Indian market.

Sources: Ministry of Agriculture and World Bank.

Annex Table 4: FARM HARVEST PRICES OF FIVE MAJOR OILSEEDS (Rupees Per Tonne)

	Groundnut			Rape and Mustard		Sesamum			Linseed		Castor Seed
	Gujarat	Andhra Pradesh	Tamil Nadu	Uttar Pradesh	Rajasthan	Uttar Pradesh	Rajasthan	Tamil Nadu	Uttar Pradesh	Madhya Pradesh	Gujarat
1962/63	586.00	542.20	501.70	741.30	878.20	851.50	927.00	911.60	605.50	538.40	564.00
1963/64	569.30	578.90	584.40	905.40	1,114.60	893.00	1,109.50	1,037.70	702.40	651.10	634.50
1964/65	727.50	825.20	744.60	1,007.30	1,429.40	1,249.50	1,431.50	1,138.60	819.10	779.70	761.60
1965/66	1,022.60	1,180.90	984.40	1,199.10	1,599.40	1,487.80	1,704.40	1,580.60	1,190.40	1,265.10	1,114.70
1966/67	1,247.70	1,342.60	1,031.50	1,663.00	1,841.30	1,804.00	1,858.90	1,882.00	1,609.60	1,726.90	1,431.10
1967/68	954.20	955.10	964.50	1,244.60	1,479.00	1,670.80	1,603.80	1,673.70	1,027.60	1,020.30	1,107.50
1968/69	1,074.70	1,089.90	976.80	1,344.60	1,449.00	1,561.00	1,730.60	1,722.40	1,197.20	1,186.70	1,034.90
1969/70	1,378.80	1,280.20	1,307.10	1,469.00	1,640.20	1,654.60	2,027.90	2,024.90	1,418.10	1,533.90	1,402.70
1970/71	1,408.00	1,314.20	1,184.30	1,588.00	1,715.20	2,065.50	2,092.40	2,030.20	1,473.90	1,416.60	1,337.80
1971/72	1,324.40	1,220.70	1,187.10	1,691.90	1,816.80	2,059.30	2,228.90	2,134.60	1,489.10	1,395.20	1,251.90
1972/73	1,663.00	1,849.80	1,311.40	1,844.30	2,202.10	2,562.60	2,898.30	2,719.90	1,769.90	1,786.30	2,209.40
1973/74	2,318.80	2,233.70	2,172.70	3,122.70	2,674.30	3,200.70	3,578.70	3,373.60	3,034.50	2,964.10	2,374.40
1974/75	2,388.20	2,590.60	3,128.50	2,310.30	2,555.10	3,456.50	4,172.00	3,541.20	2,128.00	2,195.50	1,977.30
1975/76	1,660.10	1,454.90	2,386.70	1,632.10	1,760.60	2,681.10	2,878.90	2,888.20	1,596.50	1,580.20	1,531.10
1976/77	1,817.20	2,347.10	2,830.30	3,344.60	3,324.30	3,559.80	3,400.70	3,368.10	3,077.80	3,056.70	2,329.30
1977/78	2,215.10	2,085.50	2,905.30	3,102.60	3,144.60	4,114.00	4,082.10	3,291.10	2,734.50	2,546.10	2,097.00
1978/79	n/a	1,998.70	1,242.20	n/a	3,231.00	n/a	3,810.00	n/a	n/a	2,553.40	n/a

Source: Agricultural Situation in India, Various Issues

PART IV

THE SUGAR ECONOMY

James Q. Harrison
June 1981

The Sugar Economy

Table of Contents

	Page No.
The Role and Scope of the Sugar Economy	111
Market Structure and Public Policies	111
Short-Term Market Instability	113
Long-Term Supply and Demand Trends	116
Sugar Production and Export	122
Policy Implications	124
Annex	126
Annex Tables	130

THE SUGAR ECONOMY

1. The Role and Scope of the Sugar Economy. India is the world's largest producer of sugarcane. Although sugarcane covers only 1.8% of India's gross cultivated area, it is one of the most important non-foodgrain crops, for it contributes about 6.3% of the gross value of agricultural output, about 3.5 times as much per hectare as the average of all other crops. About 80% of the sugarcane area is irrigated which is equivalent to about 5.6% of India's total irrigated area. Fertilizer used on cane was about 84 kg of nutrients per hectare in 1975/76, about four times the average for all crops. While sugarcane is grown in nearly every state, its greatest concentrations are in U.P. and Maharashtra where 45% and 14%, respectively, of India's cane is produced. Sugarcane is cultivated by about 25% of India's 80 million farmers, on farms of all sizes, though the proportion of area devoted to cane is somewhat higher on the smaller farms.

2. Sugarcane processing, including the production of mill sugar, khandsari and gur, is a major industry. It employs nearly 8% of all manufacturing workers and about 3.6% of the capital invested in manufacturing to produce about 2% of the total value added in manufacturing. Throughout the two decades before 1980, India has been an exporter of sugar, but exports were generally low before 1974/75, when they rose rapidly, peaking at levels of over 1 million tons in 1975/76, providing 12% of India's foreign exchange earnings. Since then exports have been much lower and highly volatile. In 1980, India is likely to be a net importer of sugar. Sugar is a large item of personal consumption accounting for about 5% of private consumption expenditures. The 7.7% weight of sugar products in the wholesale price index suggests its sensitive role. In 1979/80, the rise in the prices of sugar products alone accounted for about 30% of the entire 20% rise in the wholesale price index of all commodities. Rising prices of sugar thus provoke sharp consumer reactions and give rise to considerable political controversy. The high volatility of output and prices which often characterizes the sugar economy in India (and other countries as well) is thus a matter of serious concern. The underlying importance and visibility of the sugar economy have led to extensive and varied Government interventions in its operations.

3. Market Structure and Public Policies. Virtually all sugar products in India are based on sugarcane. The structure of the market for sugarcane and its products and the network of public policies governing sugar production strongly influence the performance of the sugar economy. In contrast with many countries, sugarcane is not grown in large blocks on plantations as a monocrop, but rather in relatively small patches forming a part of the cropping pattern of millions of individual farmers. Thus cane production is scattered rather widely among vast numbers of independent farmers who grow a range of other crops. Sugarcane production is highly seasonal with the bulk of the crop in most areas harvested in the December-March period. The sugar content of cane in most areas drops sharply with the onset of warmer weather. The sugar content and weight of cane drop rapidly after harvesting, making it necessary to process the cane as soon as possible, usually within two days of cutting. The production of sugar products is thus also highly seasonal with 70% of sugar being produced between December and March. Cane is a relatively long-duration crop, standing in the field 9 to 18 months between planting and

harvesting. It is a common practice to allow a second or ratoon crop of cane to grow from the stubble of a harvested field. Thus there is a considerable time lag between the decision to plant an area under cane and the full effect of that decision on the supply of cane.

4. An estimated 11-12% of the cane crop is used for seed, animal feed and direct human consumption, or disappears as post-harvest loss. On average, about 46% of the crop is used to produce gur, which consists of condensed and solidified cane juice produced with very simple equipment in rural areas, often by farmers themselves. Gur typically weighs about 10% of the weight of the cane used to produce it and contains about 60-65% sucrose. It is by far the most important sweetener, particularly for the rural population and for low income consumers. Gur's weight in the wholesale price index is more than twice that of sugar and nearly ten times that of khandsari, yet it has attracted the least direct public intervention, a pragmatic recognition that efforts to control such large numbers of tiny scattered units would be impractical. About 8-9% of the cane crop is used for khandsari, a white crystal sweetener similar to mill sugar but produced through a smaller-scale, less technically efficient process. The quality of khandsari is generally considered inferior to mill sugar and this is reflected in the 15-20% price differential between the two products. An average of about 34% of cane crop is used by large-scale sugar mills to produce sugar, often referred to as "mill sugar" to distinguish it from other sweeteners. Sugar mills are much larger in scale than khandsari units (the average sugar mill produces about 20,000 tons of sugar a year while a large khandsari unit produces about 750 tons), and more efficient physically, extracting 9.5-10.5% of the weight of cane as sugar compared with 6-7% for khandsari units.

5. Gur and khandsari units are virtually free from controls on the prices they pay for their cane or the prices they charge for their products. Gur production is not taxed and while khandsari is taxed, it is at much lower effective rates than mill sugar (in 1977/78, excise tax revenues on khandsari were Rs 93 per ton compared with Rs 466 per ton of sugar). Although the sugar mills are neither the largest consumers of cane nor the major producers of sweeteners, the importance of their product on the urban market, their size and their manageably small numbers, have made them the main focus of government intervention in the sugar economy. The primary instruments of government control have been: (a) setting a minimum price for cane purchased by the mills; (b) varying controls over the monthly releases; (c) requiring mills to sell to the Government a fixed proportion of their production at a fixed price, usually below the market price; and (d) imposition of excise taxes of varying levels and partial excise tax rebates. The blend of these various policies has changed significantly at least ten times since 1960/61 and many more times than that if one counts changes in the formulae for calculating the fixed sugar prices or excise taxes. The present policy, and the one which was dominant through most of the 1970s, is partial control: minimum prices which mills must pay for their cane are set by the Central Government and

often augmented by State Governments; mills must sell the bulk of their production (usually and at present 65%) to the Government at fixed prices, 1/ while the remainder is sold in the free market, with the Government controling the monthly releases of both levy and free market sugar. The levy sugar is sold in government fair price shops at the same fixed price all over India, with this retail price based on the average ex-factory price plus some allowances for transportation and distribution.

6. Short-Term Market Instability. The aspects of market structure discussed above help explain the large fluctuations in the production of sugarcane and sugar products over the past several years. Variations in weather combine with the lagged response of cane production to prices (see para 3 above) to produce oscillations in the production of cane. A short crop sends prices up, but the full impact on production is felt only one to two years later due to the long time between planting and harvesting, and the practice of ratooning. These oscillations, however, are amplified by the controls on sugar mills so that the fluctuations in sugar production are even more violent than those in cane production. The reason for this is clear: in years of a short crop, gur and khandsari producers are able to offer higher prices to farmers, and since the prices of gur and khandsari are not controlled, pass the cost on to the consumers. Sugar manufacturers lack this flexibility since the price of the bulk of their output is fixed and since their profit margins are already under pressure due to high excise taxes. Consequently, in such years farmers sell as much cane as they can to the gur and khandsari producers, causing mill sugar production to fall proportionally more than cane production. When the cane crop is large the reverse takes place. The cane price drops, and the gur and khandsari units, unbound by the statutory minimum cane price, pay as little as the market will bear. Since they are competitive, much of the cane cost reduction is passed on to consumers. The mills, in contrast, are bound to pay the statutory minimum price, so farmers clamor to sell as much of their cane to the mills as possible. In such years the mills are often obligated to extend the crushing season into unprofitable months and to build up stocks which are a drain on profits. The relationship between the size of the cane crop and the proportion of it that is crushed by sugar mills emerges clearly in Graph 1. 2/ A measure of the instability in sugar production generated by this set of policy instrumunts is that while the standard deviation of cane production is only about 18% of its mean, for sugar production it is 31% of its mean.

1/ These ex-factory selling prices for levy sugar are calculated separately for each of 16 sugar zones, adding to the zone's average cane cost (including cane purchase taxes if any) and the zone's average cost of converting cane to sugar, a fixed return equal for all zones. In 1979/80 these prices ranged from Rs 2.44/kg in Gujarat to Rs 3.06 in South Bihar. Rs 0.23/kg was calculated "return" for all zones.

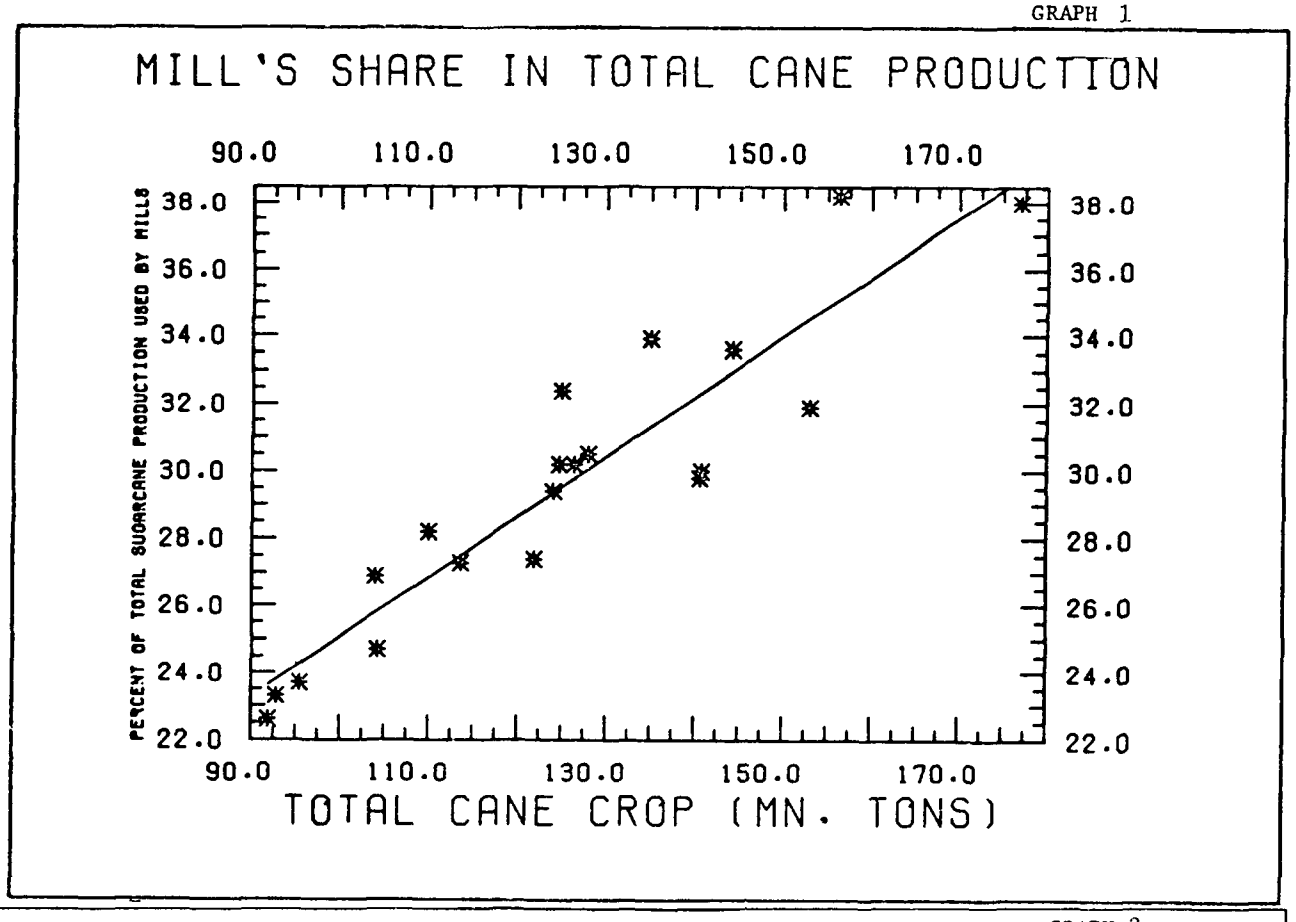
2/ The asterisks in the graph are data points and the diagonal solid line is an equation fitted to those points relating the total cane (TC) crop (in million tons) to the percentage of cane sold to the mills, PMC. The equation (PMC = 7.3 + 0.18TC) explains 84% of the variation in PMC. See Annex.

7. Cane production rose very rapidly after 1974/75. As expected, prices of khandsari and gur began falling from 1975 and 1976, respectively, reflecting the emergence of excess supplies of cane. This should have reduced the average prices cane farmers received, but this signal was obscured by two factors: farmers increased the proportion of cane sold to mills (since the fixed statutory minimum price was much higher than the open market price offered by gur and khandsari units), and reinforcing this, a number of state governments required the mills to pay "state advised prices" which were substantially above the minimum. The results can be seen in Graph 2. Even though the index of gur prices was falling after 1976, the index of average realized cane prices 1/ fell only slightly in 1975/76 and rose to a then record level in 1976/77. Thus, even though gur prices fell sharply in 1977, farmers were encouraged by the cane price signals (and excellent weather in the 1977 planting season) to plant a record area and achieve a record production of 177 million tons in 1977/78. This was 16% higher than the 1976/77 crop of 153 million tons which itself had been substantially higher than any previous crop. Naturally, with gur and khandsari prices already falling, farmers made every effort to sell the greatest possible quantity of their cane to the mills.

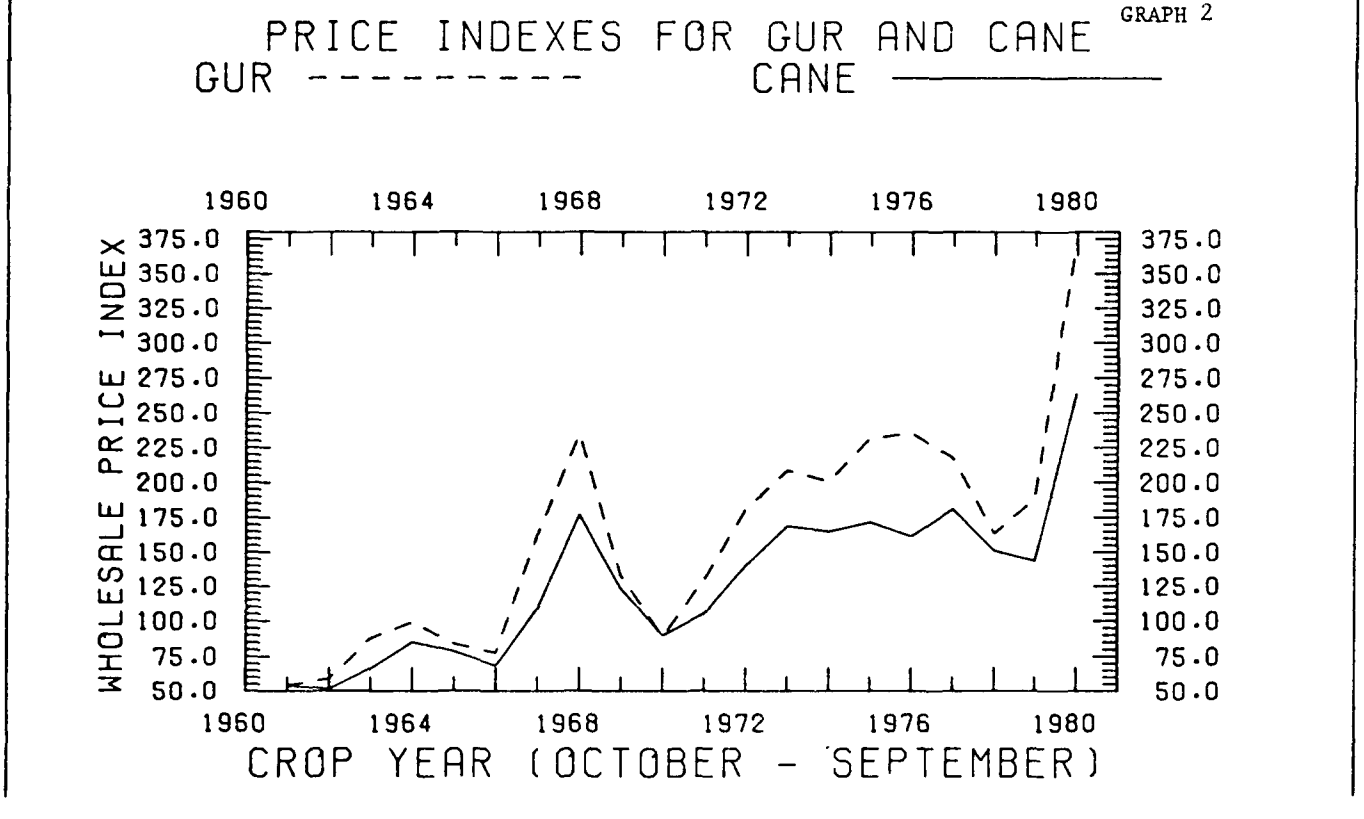
8. Urged by State and Central Governments, the mills extended the crushing season and produced 6.46 million tons of sugar in 1977/78--33% more than the previous year, and about 16% above rated capacity. Despite this, farmers average cane realization fell sharply because of the very low prices offered by gur and khandsari units. In some areas farmers reported prices of about Rs 40 per ton, while in others they were not able to sell their cane at all either burning it or leaving it in the ground for next year. Even farmers selling to mills did not get full payment because as the mills' stocks of unsold cane peaked over the year to 4.6 million tons, many mills simply did not have the funds to pay for the cane, despite obtaining large and costly bank advances against these stocks. As this large sugar glut emerged, in August 1978, the Government announced the complete decontrol of sugar. Sugar prices dropped 18% over the next six months as many mills sought to liquidate their stocks before the price dropped further. This was possible since the Government had also lifted all restrictions on monthly sales. For a while, sugar was sold at less than the levy price, and even substantially below cost. In March 1979, the sugar industry introduced voluntary distribution controls and by June 1979, the Government had reintroduced controls on releases followed by full price control in September 1979. Due to low prices, internal consumption of sugar in 1978/79 was a record 6.2 million tons, necessitating a large drawdown in stocks, despite production of a near record 5.8 million tons of sugar in that year. By the end of the 1979 season, stocks of sugar were down to 2.05 million tons.

1/ Since the official wholesale price index reflects only the statutory minimum price, an index of "average realized cane prices" was calculated as an average of the gur price index at harvest time and the index based on the statutory minimum price, weighted by the proportion of cane sold to the mills. This index does not reflect the state advised prices or the higher prices offered by cooperatives. Some states require mills to pay 20%-30% higher than the statutory minimum. Where cooperatives operate, mill profits are normally passed on to grower members as higher cane prices since agricultural income is not taxed. Both these factors further distort the prices perceived by farmers.

GRAPH 1



GRAPH 2



9. Meanwhile, the farmers reacted to the low 1978 cane prices by planting little new area to cane and relying mainly on a ratoon crop, bringing cane production down to 156 million tons in 1978/79. This was still a large crop, and with gur and khandsari prices still low, farmers sold a record 38.2% of their crop to the mills. Their average realizations, however, were lower than in 1978. There were signs of gur prices beginning to rise but these were not as clear as they might have been due to the unusually high availability of unusually cheap mill sugar. The full impact of the effective cane price reductions was felt at the time of planting the 1979/80 crop. With little new planting the previous year, there was little scope for a ratoon crop and little incentive for new planting. Weather conditions were unfavorable. Area and yield both dropped sharply, resulting in a crop of 128 million tons, the lowest in seven years, and 38% below the 1977/78 record. By harvest time, gur and khandsari prices had risen sharply, resulting in only 30% of the crop being sold to the mills. Mill sugar production fell to 3.9 million tons, 40% below the 1977/78 record. During the year the full price controls on sugar were lifted and partial controls (65% levy, 35% open market) went into effect December 1979 and continue to date. From November 1979 through most of 1980, sugar prices rose at unprecedented rates and on occasion sugar disappeared entirely from the open market. While sugar prices rose by 52% between September 1979 and September 1980, gur prices rose 110%. Although there was press speculation of unfair trade practices in the sugar industry, the far more rapid and significant rise in gur and khandsari prices --where trade is decentralized and competitive--suggests the real reason for the price increase was a severe shortage of cane, a shortage brought on, paradoxically, by the glut two years earlier. The rise in prices of sweeteners alone accounts for 35.2% of the rise in the general wholesale price index during that period.

10. With cane prices high in the planting season for the 1980/81 crop, cane production is expected to recover to about 155 million tons. Poor weather conditions at planting time (February-March 1980) probably prevented a more rapid recovery. With even higher statutory prices and high gur and khandsari prices in the early months of 1981, 1/ one can expect the 1981/82 crop to be even larger--possibly on the order of the 1977/78 record. The following sections assess the longer-term supply and demand prospects. It is worth noting, however, that the structural causes of the volatility in the cane and sugar products markets remain. Without an appropriate balance between the price of cane and its products and between the price of cane and alternative crops, it is difficult to see how these wide oscillations can be avoided. Ways of obtaining such balance are discussed below in the section on policy implications.

11. Long-Term Supply and Demand Trends. The production of sugarcane has grown significantly over the past two decades. As Table 1 indicates, however, the aggregate growth trends have varied among regions and between decades. Graph 3 shows very sharp year-to-year fluctuations around these longer-term trends. Over the past twenty years as a whole, the rate of growth of cane production has been 2.70% per annum. Over the last decade, it has

---

1/ The Government raised the statutory minimum price of cane by 25% in 1979/80 and by another 4% in 1980/81. The price index for gur in December 1980 was about 50% higher than it was a year earlier.

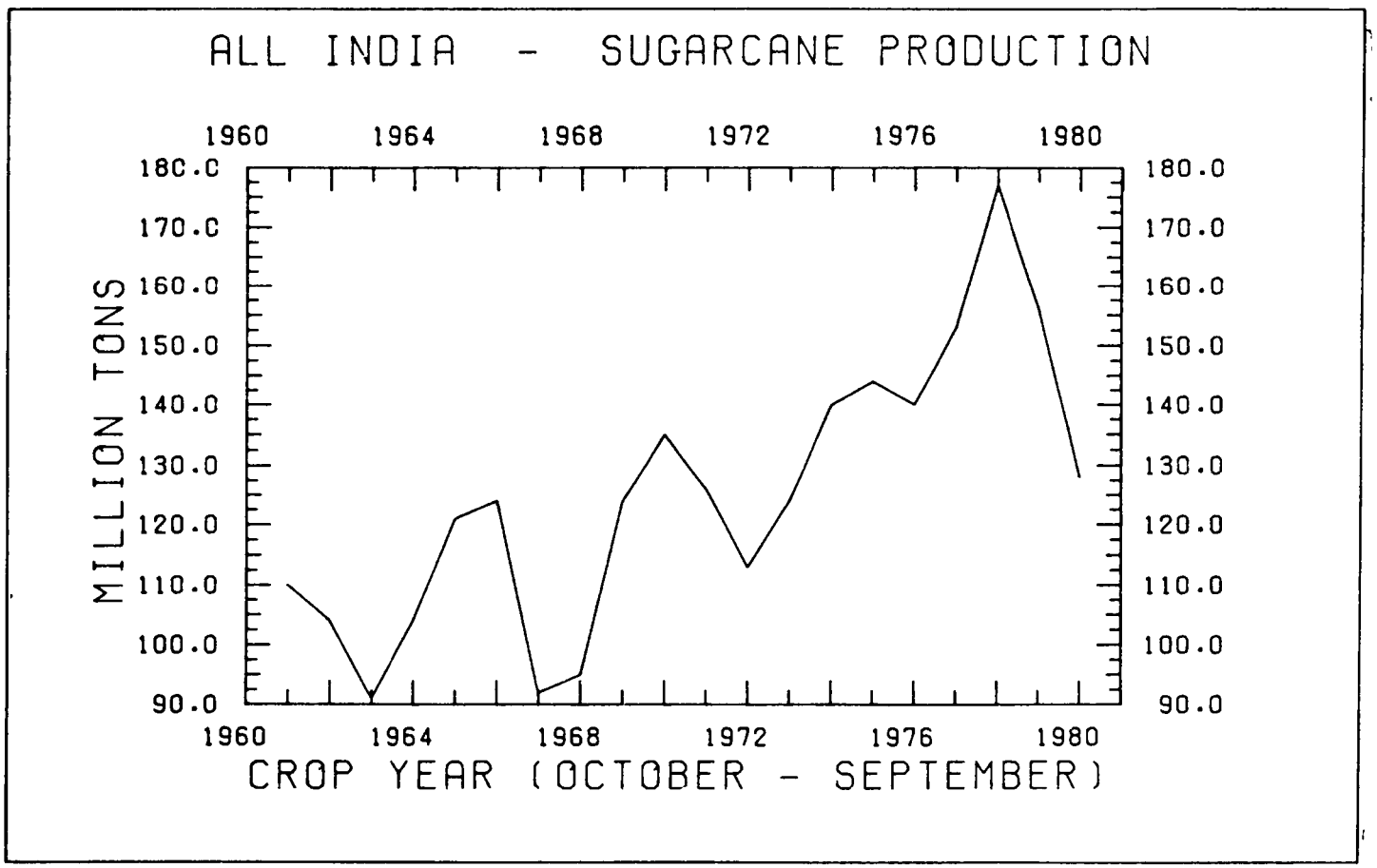
accelerated to 3.78% per annum. The increase in the rate of growth, however, has been due to an increase in the growth of area from 1.44% per annum to 2.75% per annum, while growth in yield has been somewhat lower in the past 10 years than for the 1960/61-1978/79 period as a whole. It is particularly disturbing that yields have virtually stagnated in U.P. and the tropical states other than Maharashtra, which together account for 70% of India's cane production.

Table 1: GROWTH TRENDS IN SUGARCANE AREA, YIELD AND OUTPUT

Region	% of All-India Production (1978/79)	Growth Rates (% p.a.) 1960/61-1978/79 Area	Yield	Output	1967/68-1978/79 Area	Yield	Output
All-India	100%	1.44	1.27	2.70	2.75	1.05	3.78
Uttar Pradesh	40%	1.14	0.74	1.94	3.33	0.35	3.79
Other Sub-Tropical	16%	0.13	1.48	1.61	1.24	1.41	2.64
Maharashtra	14%	2.66	1.42	4.08	2.54	4.19	6.72
Other Tropical	30%	3.86	0.41	4.26	3.12	0.17	3.29

Source: Ministry of Agriculture.

GRAPH 3



12. The profitability of sugarcane cultivation has been a major force behind its rapid growth. Farm management studies in the late 1960s and early 1970s show sugarcane earning two to five times more than most competing crop combinations, more than enough to compensate for sugarcane's longer duration (9-18 months). Notable technological advances in some alternative crops--mainly foodgrains--and a gradual, although not statistically significant, decline in cane prices relative to some competing crops, have tended to narrow sugarcane's competitive edge somewhat. Still, partial cost of cultivation and crop budget data, combined with the continued strong growth in cane production even during the green revolution period, indicate that sugarcane is substantially more profitable than most other crop combinations in most years.

13. There are striking regional differences in cane production trends. Cane is grown in two broadly different zones--sub-tropical (predominately UP) and tropical. Over the past two decades, production in the tropical zone has grown more than twice as fast as in the sub-tropical zone. Growing conditions in the tropical zone are technically superior for cane cultivation, as Table 2 suggests. Cane growers in the south enjoy a longer productive growing season giving more cane per unit of land and more sugar per unit of cane. The apparent technical superiority of the tropical belt, however, does not tell the whole story. Although available cost of cultivation data are fragmentary, they suggest that the much higher costs of growing cane in the tropical zone substantially offset the region's greater technical efficiency. The duration of a significant portion of tropical zone cane crop is 12-18 months, versus 9-10 months in the sub-tropical zone. Much of the cane grown in the sub-tropical zone is grown in relatively fertile soil requiring little or no irrigation.

Table 2: CANE YIELDS, SUGAR CONTENT AND SUGAR YIELDS
(Average for 1976/77-1978/79)

	World	All-India	U.P.	Maharashtra
Cane Yield (tons/ha)	56.1	53.20	43.30	92.10
Sugar Content (%)	10.0	9.76	9.38	10.89
Sugar Yield (tons/ha)	5.6	5.20	4.10	10.00

Source: Food and Agriculture Organization and Ministry of Agriculture.

14. This point is brought out in Table 3 which compares cost of production and net return estimates for Maharashtra and Uttar Pradesh. In recent years the cost of cultivation in Maharashtra has been about twice the U.P. level so that net returns are not significantly different, given the inexact nature of the data. To some extent the cost of production data may overstate the economic production costs both because of the methodology used (e.g., labor valued at market wages) and because those providing the data (the farmers) may know they are used to justify increases in the minimum sugarcane price. On the other hand, other costs, particularly water, may not be valued at their full opportunity cost. This would further reduce Maharashtra's apparent comparative advantage since the Maharashtra crop requires substantially more water because of its longer duration and the soils and climate in which it is grown.

Table 3: SUGARCANE PRODUCTION COSTS AND RETURNS 1976/77

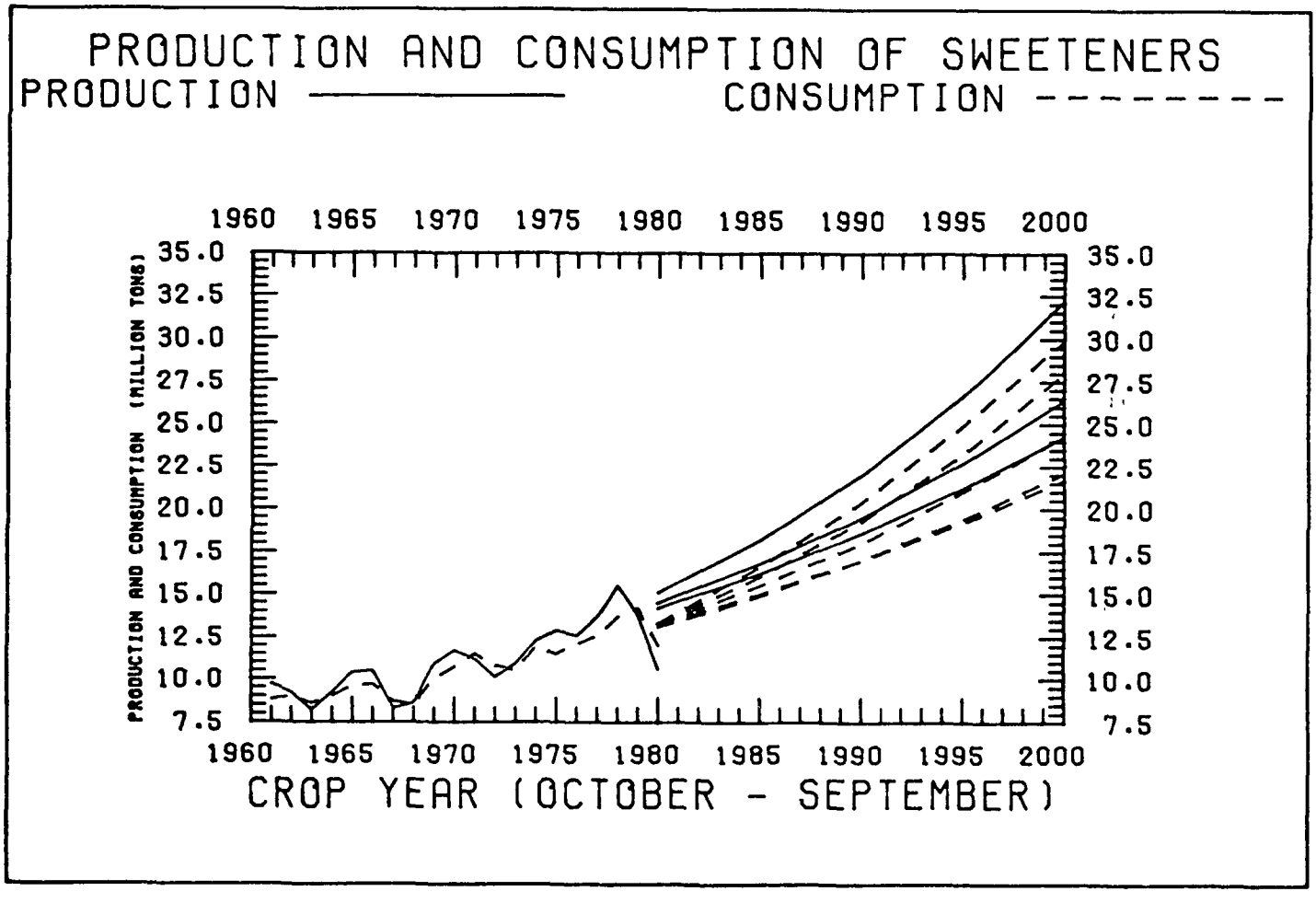
	Maharashtra	Uttar Pradesh
Gross Returns (Rs/ha)	8,939	5,576
Costs (Rs/ha)	4,164	1,849
Profit (Rs/ha)	4,775	3,727
Yield (tons/ha)	65.9	41.9
Costs (Rs/ton)	63.2	44.1
Profit (Rs/ton)	72.5	89.0

Source: Ministry of Agriculture.

15. As noted earlier, the longer-term growth in India's sugar production is marked by sharp year-to-year fluctuations. Measures to reduce such instability are discussed below. Here an effort is made to discuss the level and adequacy of the long-term growth rates. Graph 4 shows actual production and domestic consumption of all sweeteners from 1960 to 1980 and alternative projections of production and domestic demand from 1980 to 2000. The three production projections are based on extrapolations of: (a) the higher historical growth rate (3.8%) in cane production experienced since 1967/68 (the high production projection); (b) the lower growth rate (2.7%) experienced over the period since 1960/61 (the low projection); and (c) an equation relating cane production to a time trend and lagged cane prices relative to prices of competing crops (the medium projection). The consumption projections are based on: (a) an extrapolation of the historical growth rate in consumption (2.44%) (the lowest projection); (b) estimates of per capita expenditure elasticity of demand for sweeteners based on NSS cross-sectional survey data and World Bank population projections assuming, alternatively, 5% and 3.5% rates of growth in total expenditures; and (c) estimates of expenditure and price elasticities for sweeteners derived from time series data, again assuming 5% and 3.5% as alternative expenditure growth rates. 1/

1/ Data and methodology underlying the projections are given in the Annex.

GRAPH 4



16. The projections suggest that if past growth rates in cane production can be sustained, serious chronic shortages of sweeteners are not likely to emerge. 1/ The projection of recent growth in cane production more than covers even the highest demand scenario. The two highest demand projections assume an unprecedented growth in expenditure of 5% per annum sustained over 20 years and may be assumed to represent the upper limit to likely demand. Even if the highest demand projection is taken as given, cane prices would need to rise relative to competing crops by only about 0.4% per annum above present levels to bring the medium production projection into balance with

---

1/ It should be emphasized that this statement refers to average trends. If the wide fluctuations in production described above in paras 6 to 10 remain, there will be years of acute shortage (as well as years of excess supply).

this very high demand projection. 1/ If the lower expenditure growth assumptions are taken as more probable--and they certainly are more consistent with historical behavior--then the situation would be even more comfortable.

17. The tapering off of yield growth, particularly in the main cane producing areas (para 13 above), is a cause for concern and raises the question whether the future scope for expanding production is great enough to allow past trends to continue. Nevertheless, even if sugarcane only maintains its share of irrigated area (5.6%) and yields do not increase at all, the 13.6 million ha additional irrigation projected for the Sixth Plan would imply cane production increases by 1984/85 greater than the highest production projection on the graph. Moreover, an analysis of present cane yields and cultivation practices suggests there is ample scope for further yield increases and/or cost reducing innovations which would maintain the relative profitability of cane production, stimulating both higher production per hectare and further area growth as well. A range of fairly well-tested simple techniques are known which would substantially increase yields of both newly planted and ratooned cane. These include careful selection and treatment of planting material, appropriate spacing, weeding, combined with moderate doses of fertilizer and, for the ratoon crop, close shaving, trash burning and gap filling. When such techniques were systematically adopted by farmers in Chambal, Rajasthan, an area not specially suited for cane cultivation, yields rose over 45%. 2/ Research findings suggest substantial water savings can be obtained through skip-furrow irrigation. While farmers who do not pay for water on a volumetric basis may have little incentive to adopt this practice, many farmers who irrigate with private pumps can cut costs substantially. Research also indicates that inter-cropping with such crops as oilseeds, potatoes and wheat gives virtually a full yield of each crop and helps control weeds during the early stages of cane growth. The joint profitability of the crops is substantially enhanced. 3/ These and a number of other promising innovations have yet to be widely adopted and adapted to farmers' field conditions.

18. This suggests strongly that where a strong link can be established between farmers, extension workers and research, cane yields and profits can rise. Unfortunately, as the yield growth data suggest, in some areas this is not happening. Research stations often have useful results on hand which have not reached farmers. Yet some of the farmers' constraints are not fully reflected in research stations, and a disproportionate research effort is often devoted to topics (e.g., sugarbeet) which have little relevance to most farm conditions. In some of the most important cane growing areas, the link between extension agents, research and the farmers on technical matters is very weak. There are good reasons for this as virtually all the time of

---

1/ Such a rise in cane prices would also tend to reduce demand implying that an equilibrium would be reached without cane prices rising even that much.

2/ Government of Rajasthan, Increased Sugarcane Production in Chambal Command Area, 1977-78, p.2.

3/ Sugarcane Research Institute, Shahjahanpur; Indian Institute of Sugar Research, Lucknow.

special cane development staff is taken up in necessary administrative and logistical matters (such as organizing cane deliveries). In one major cane growing area none of the farmers interviewed had received technical advice on improved techniques and varieties. Moreover, since cane is only one of many crops grown by the farmers, an extension service focussing on cane alone is not ideal for the job. Fortunately, most states in India are in the process of reorganizing extension services to provide a strong channel for effective technical advice to farmers and feedback to research. Such a reform should strengthen the technical basis for growth not only of sugarcane but also for all other crops. The Plan program for improving the technological base of cane cultivation should be designed to reinforce these extension reforms rather than strengthening special schemes dealing with cane alone. One way to do this would be to use funds earmarked for centrally designed demonstrations for field trials adapted to local conditions. Where the extension reforms are operative in major cane areas, consideration could be given to adding a technical subject matter specialist in sugarcane to the subject matter specialists already in place.

19. Sugar Production and Export. The present profitability and future technical possibilities make it probable that sugarcane production can continue to grow at rates similar to those in the recent past. If so, cane production can exceed domestic demand, offering export possibilities. To give an approximate idea of the orders of magnitude of potential exports, the gaps between two alternative production and demand scenarios are given in Table 4 These figures are not meant to indicate projections of actual exports--they are simply not that precise. Moreover, the gap between supply and demand on which they are based is not likely to be closed only by exports--some fall in relative sugar prices and consequent increase in demand and slower supply growth would also narrow the gap. As the projections are pushed further into the future, the mix of developments which will bring about equilibrium becomes increasingly speculative.

Table 4: SUGAR EXPORT POTENTIAL
(million tons)

Production Projection:	High Growth	Medium Growth
Demand Elasticity:	NSS	Time Series
Expenditure Growth:	5% p.a.	3.5% p.a.
Year		
1985	1.8	1.9
1990	1.7	2.5
1995	1.5	3.0
2000	1.7	4.3

Source: World Bank estimates. (See Annex, para 6.)

20. The table does suggest that India's objective of bringing sugar exports to a level of one million tons per year by 1985 is feasible in terms of total balances of supply and demand for sweeteners. The high NSS demand estimate, combined with the increasing proportion of sugar in total sweetener consumption, suggest an upper limit to domestic demand for sugar of about

6.8-6.9 million tons in 1985. This is consistent with the targeted increase in installed sugar mill capacity to about 8.04 million tons by 1984/85. The targeted investment of about Rs 8,050 million would increase total crushing capacity by about 171,250 tons of cane per day, with about 60% of new capacity to be from new plants and 40% from expansions of existing mills. While this is higher than the 150,000 tpd capacity strictly needed to reach 8.04 million ton production level, it is probably wise to allow for some slippage and cost increase. Most of the investment is likely to be in the cooperative sector since government policy offers cooperatives highly favorable financing terms. If Plan resources are constrained, incentives to encourage a higher proportion of private investment could be considered. Careful consideration should also be given to increasing the proportion of expansions of existing plants in the total increase in capacity. Expansions cost 40% less than new plants per ton of capacity, and probably involve shorter gestation periods and fewer logistical problems. The locations of new plants will have to be selected carefully to ensure adequate cane supplies. The reintroduction of incentives for new mills and mill expansion 1/ combined with the recovery of sugar prices has increased the attractiveness of investments in this sector substantially, but the violent fluctuations in cane supplied to the mills will remain a major disincentive unless remedial measures are taken.

21. The volatility of sugar both in India and in the world market makes it difficult to project the competitiveness and profitability of India's sugar exports. Both Indian and world sugar markets appear cyclical and the profitability of India's sugar exports depends on India's cycle being in or out of phase with the world market. Prior to 1973/74 the unit value of India's exports was generally below both domestic market prices and the ex-factory levy prices. In 1974 and 1975 world market prices were high and resulted in sharp increases in the volume and value of India's sugar exports. Between 1976 and 1979 world prices were generally lower than Indian domestic price but higher than ex-factory levy prices (which exclude excise taxes). In 1980 world sugar prices were high and are expected to remain well above Indian production costs through 1981. Indian cane yields and sugar production costs appear fairly competitive with other suppliers. From the Annual Survey of Industries 1977/78 and from the calculations used to determine the ex-factory levy price, Indian sugar production costs appeared to be about US$171-208 per ton of D-29 sugar in 1977/78, a year when developing country sugar production costs were estimated at US$220-310 per ton for raw sugar of lower quality. 2/ World market prices for raw sugar in 1985 are estimated at US$412 per ton in 1980 dollars compared with 1980 Maharashtra production costs of about US$320 for a more refined grade of sugar. 3/ Continued improvements in cane productivity, such as those discussed earlier, would help ensure the continued

---

1/ New plants and expansions of existing plants intially are allowed to sell a greater proportion of their sugar in the free market, with the proportion falling gradually over several years to the same level as that of existing plants. Moreover, they face lower excise taxes intially.

2/ IBRD, Price Prospects for Major Primary Commodities, January 1980.

3/ IBRD, Commodity Price Forecasts - Updating, November 12, 1980, p. 4.

competitiveness of India's sugar exports by keeping costs down. The availability of a buffer stock would give India greater control over the timing of sugar exports to take advantage of fluctuations in world market prices.

22. Policy Implications. Sugarcane and sugar products policy in India has been the subject of many detailed studies, each of which called for a long-term, stable policy. The very volatility of the sugar economy, however, has prevented this, and as noted earlier, sugar policies in India have been changed frequently and substantially. As the sugar economy emerges from the acute shortage and rapid price rises of the past year it is difficult to look ahead to implementing longer-run policies. Yet successful implementation of longer-term policies could also contribute to resolving the short and medium-term problems of supply management.

23. Sugarcane price policy is clearly central to the sugar economy. The recent past has suggested that the prices set by the Agricultural Prices Commission (APC) provided a reasonable stimulus to cane production. The price, which has been uniform across states but linked to the sugar content of cane, helps promote locational efficiency. The state advised prices and cooperative profits distribution to cane growers, however, counteracted the APC efforts and encouraged excess production in 1977/78 which led directly to the shortages and price rises in 1980. Hopefully, this experience will lead to greater reliance on the APC's technical judgment and a realization that unrealistically high cane prices do not really benefit most farmers in the long run. While it will be difficult to resist political pressures from farm groups to raise prices, avoiding excessively high minimum support prices will be essential if the 1977/78 experience is to be avoided in the near future.

24. A well executed cane price policy is an essential element but only one element in a longer-term policy. Weather and price variations in other sugarcane uses will continue to cause year-to-year variations around longer-term trends in cane production. Due to the duration of the cane crop and ratooning, these variations will tend to take time to even themselves out by which time new shocks will have destabilized the system. A buffer stocking policy implemented at a suitable time would offer the Government a useful tool for controlling supply variations and dampening the price swings, thereby reducing one of the sources of instability in cane production. Moreover, a buffer stock could give the Government flexibility in the timing of its export sales to take advantage of world market conditions. The suggestion of a buffer stock dates back at least as far as the 1965 Sugar Enquiry Commission Report and is included in the Sixth Plan. Concern over the cost of such a policy has been one major reason why it has not been tried. Also, without an appropriate cane price one could envision ever-increasing stocks of sugar accumulating with the Government. With an appropriate cane price policy, however, the costs of such a buffer stock could be kept reasonably low. By keeping the stocks with the mills themselves (which managed stocks over 4 million tons in 1978) the Government could restrict its financial outlay to the interest charges. Since India is just emerging from a sugar shortage, now is obviously not the time to start a buffer stock. Next year, however, the cane crop is likely to be much larger, perhaps approaching the 1977/78 level. World market prices may be such that excess sugar production could be profitably exported, but ISA quotas may limit such possibilities. In any case it

would seem to make sense for the Government to be ready from next year to start establishing a buffer stock, should the domestic crop be large enough.

25. In years of a short cane crop, mills will continue to have difficulties in competing with gur and khandsari units since controls on sugar prices put effective limits on prices mills can offer for cane. In this context and after building up a sugar buffer stock, the possibility of gradually relaxing and eventually removing the sugar levy system should be considered carefully. While the rather disastrous experience with the recent decontrol may make it difficult to advocate decontrol now, it is clear in retrospect that the timing (when sugar stocks were over 4 million tons) and abruptness (including decontrol of monthly releases) of the 1978 decontrol had more to do with the results than decontrol itself. If the Government maintained buffer stocks plus controls on monthly releases, such wild market fluctuations would not be possible. In addition to allowing mills to compete more effectively for cane, such a decontrol would remove some of the locational inefficiencies built into the present levy price system which pays higher prices for levy sugar to mills located in areas with higher cane costs and which have higher conversion costs. With decontrolled prices, mills would face the same prices, which would encourage new investment in low cost areas. In striving for better locational efficiency the Government should also consider whether the present system of greater investment incentives (in the form of lower proportions of levy sugar) in areas with lower sugar recovery is in the long-term interest of the sugar industry. 1/

26. The mix of policies--an appropriate minimum price for cane, buffer stocking, and gradual relaxation of the levy system--would go far in reducing the year-to-year fluctuations in cane production and cane available to the sugar mills. This would reduce the market risks faced by farmers and mills alike and would help to ensure that the Plan's investment goals in this industry are met. Under this system the mills would be more certain of a steady supply of cane and would not bear the entire burden of excessive stock buildup should it develop in years of a large crop. The reciprocal instability in the gur and khandsari sectors, which mirrors the instability in sugar would also be reduced. By reducing the proportion of levy sugar gradually, incentives for shifts to more efficient locations would build up gradually so that such shifts would also be gradual, avoiding the hardship of a rapid dislocation.

27. The long-term competitiveness of India's sugar economy depends on its technical base. Continued emphasis should be placed on improving research and extension efforts in both the cane production and the cane processing fields. The general programs now underway to improve agricultural research institutions and extension services in most states in India should continue to receive high priority.

1/ It is by no means clear where locational advantages really lie. We have seen that Maharashtra's high yields and sugar recovery may be offset by higher costs. Moreover, changes in technology and relative prices may cause locational advantage to shift over time.

THE SUGAR ECONOMY
ANNEX

Supply and Demand Projections for Sugarcane

1. Sugarcane Production:

Three equations were estimated to project sugarcane production:

(i) an estimation of the rate of growth achieved over the 1967/68-1978/79 period:

$$\ln(SCP) = \underset{(84.67)}{4.65520} + \underset{(5.066)}{.03785}(T); \quad R^2 = .69$$

where SCP equals sugarcane production in millions of tons and T = time (1967/68 = 1,...). Figures in parentheses are t statistics.

ii) an estimation of the rate of growth over the 1960/61-1978/79 period:

$$\ln(SCP) = \underset{(88.49)}{4.5447} + \underset{(5.995)}{.02700}(T); \quad R^2 = .66$$

where T = time (1960/61=1,...)

iii) an equation including the response of production to relative prices as well as its trend rate of growth:

$$\ln(SCP) = \underset{(77.7)}{4.455} + \underset{(7.10)}{.02995}(T) + \underset{(3.086)}{.4487}(\ln(Pc)); \quad R^2 = .72$$

where T = time (1960/61=1,...) and Pc = an index of the average realized cane price for the preceding two years deflated by the price index of major competing crops (foodgrains, oilseeds, cotton). The average realized cane price index was constructed by calculating a weighted average of the index of statutory minimum cane prices (the official cane price index) and the price index for gur during the main harvest months (December-March). The weights were the proportion of cane crushed by mills and the proportion crushed by gur and khandsari units. For projection purposes, the 20 year average value for Pc was used (1.122). The value for Pc as of January 1981 was about 1.3183. This would imply a 1981/82 crop of over 180 million tons. Using the 20 year average Pc(1.122) shifts the production projections down from what they would have been had present price levels been used. Thus this projection has an implicit assumption of a 15% fall in relative cane prices.

2. Sweetener Production

To relate a given level of cane production to production of sweeteners, the following equation was estimated:

$$TSP = \underset{(218.14)}{.08774}\ SCP; \quad R^2 = .9996$$

although this equation gives an excellent fit to the historical data it is somewhat conservative to use it in the projections because the proportion

of sugarcane being used for mill sugar is rising and mill sugar production has higher extraction rates in terms of sugar (sucrose) than gur and khandsari. Thus the sucrose content in the total volume of sweeteners would tend to rise. Moreover, technical improvements in the sugar content of cane and in extraction rates are probable during the projection period. Consequently, the use of this fixed coefficient gives a somewhat downward bias to the sweetener supply projections.

3. Sweetener Consumption

Total consumption for all sweeteners was estimated in several different ways:

i) The historical trend was estimated using the equation:

$$\ln(TSC) = \underset{(293.6)}{9.006} + \underset{(9.54)}{.02444}(T); \quad R^2 = .83$$

where TSC is total sweetener consumption and T is time (1960/61=1).

ii) Estimates of the relationships between total consumption of sweeteners, total expenditures on all commodities and real prices of sweeteners. These estimates were based on time series data for the 1960/61-1978/79 period:

$$\ln(TSC) = \underset{(26.74)}{5.01182} + \underset{(23.10)}{.7631}\ \ln(E) - \underset{(9.07)}{.2178}\ \ln(Ps); \quad R^2 = .98$$

where E is total private consumption expenditure in billions of 1970/71 Rupees (from CSO, National Accounts Statistics) and Ps is the weighted average price index for sweeteners deflated by the price index for all other commodities. For projection purposes, E was assumed to grow alternatively at 5% and 3.5% from its 1976/77-1979/80 average base of Rs. 356 billion. Ps was assumed to be at its 20 year average of 1.294 whereas its actual 1979/80 value was 1.395. Using the 20 year average Ps shifts the demand projections up somewhat.

iii) The projections given in Tables 4A and 4B of Jon Hitchings' paper, Demand Projections for India, were used to provide another set of demand projections after adjustments. The figures in Tables 4A and 4B of that paper were used to calculate separate growth factors for sugar and khandsari and gur. Khandsari consumption (about 1 million tons in 1973/74) was substracted from sugar and added to gur. The growth factors were then applied to the 1973/74 base figures of 3.52 million tons sugar and 8.35 million tons gur and khandsari. The total sweetener demand projections thus calculated were then adjusted

downward slightly to be consistent with the 13.1 million ton 1979/80 demand estimated from equation 3(ii) above. The adjusted projections are given below in paragraph 5.

4. Sugar Consumption

The share of sugar in total sweetener consumption is growing, reflecting changing consumer preferences. To project the quantity of sugar in total consumption the following equation was estimated from 1960/61-1980/81 historical data:

$$\ln(SPTSC) = \underset{(27.06)}{-1.4034} + \underset{(4.80)}{.02076}\ T; \quad R^2 = .54$$

where SPTSC is sugar as a percent of total sweetener consumption. This yields the following proportions of sugar for the future:

1985	41.3%
1990	45.8%
1995	50.8%
2000	56.4%

5. Production and Consumption Projections

The above equations and assumptions yield the following projections for production and consumption.

PRODUCTION OF SWEETENERS
(million tons)

	RECENT TREND	LONGER TERM TREND	LONG TERM TREND WITH PRICE EFFECT
	(equation 1(i))	(equation 1(ii))	(equation 1(iii))
79/80	15.1	14.2	14.5
84/85	18.2	16.2	16.8
89/90	22.0	18.6	19.5
94/95	26.6	21.2	22.7
99/00	32.2	24.3	26.4

CONSUMPTION OF SWEETENERS
(million tons)

	Historical Trend (equation 3(i))	Time Series (equation 3(ii)) Expenditure Growth		NSS (para 3(iii)) Expenditure Growth	
		3.5%	5.0%	3.5%	5.0%
1979/80	13.3	13.1	13.1	13.1	13.1
1984/85	15.0	14.9	16.0	15.4	16.4
1989/90	17.0	17.0	19.3	18.0	20.3
1994/95	19.2	19.4	23.2	21.0	25.1
1999/00	21.7	22.1	28.0	24.4	30.5

6. Export Projections

Alternative projections of sweeteners available for export were estimated by a) subtracting the NSS high consumption projection from the "recent trend" production projection (equation 1(i) less 3(iii)) and b) subtracting the time series, 3.5% expenditure growth demand projection from the "long term trend with price effect" supply projection (equation 1(iii) less 3(ii)). Total domestic sugar consumption was estimated by applying the proportions of sugar to total sweeteners estimated in paragraph 4 above to the total domestic sweetener consumption projection. This amount was then added to the export projection to given an estimate of total sugar production requirements, for comparison with planned sugar production capacity.

Annex Table 1

Sugarcane Production

(Area - '000 hectares)
Yield - tons per hectare
Production - million tons)

Crop	All-India			Uttar Pradesh			Other Sub-Tropical b/			Maharashtra			Other Tropical c/		
Year	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
1960/61	2415	45.5	110.0	1330	41.0	54.5	624	36.5	22.8	155	78.1	12.1	306	67.3	20.6
1961/62	2455	42.3	104.0	1362	37.7	51.3	655	31.5	20.6	154	71.4	11.0	284	74.3	21.1
1962/63	2242	41.0	91.9	1262	34.2	43.2	564	31.2	17.6	135	79.3	10.7	281	72.6	20.4
1963/64	2249	46.3	104.2	1229	38.7	47.5	529	35.5	18.8	137	83.9	11.5	354	74.6	26.4
1964/65	2603	46.8	121.9	1390	40.4	56.2	629	37.8	23.8	159	68.6	10.9	425	72.9	31.0
1965/66	2836	43.7	124.0	1490	38.0	56.6	752	33.5	25.2	171	64.3	11.0	423	73.8	31.2
1966/67	2301	40.3	92.8	1190	33.1	39.4	603	29.5	17.8	161	62.1	10.0	347	73.8	25.6
1967/68	2047	46.7	95.5	998	38.0	37.9	490	34.9	17.1	165	63.6	10.5	394	76.1	30.0
1968/69	2532	49.2	124.7	1203	42.0	50.5	631	35.3	22.3	190	66.3	12.6	508	77.4	39.3
1969/70	2749	49.1	135.0	1376	44.1	60.7	680	38.7	26.3	222	65.0	14.4	471	71.3	33.6
1970/71	2615	48.3	126.4	1345	40.6	54.7	624	39.7	24.8	217	68.0	14.8	429	74.8	32.1
1971/72	2390	47.5	113.6	1274	38.7	49.4	516	37.6	19.4	182	63.2	11.5	418	79.7	33.3
1972/73	2452	50.9	124.9	1308	43.4	56.7	536	39.9	21.4	146	81.6	11.9	462	75.5	34.9
1973/74	2752	51.1	140.8	1473	41.3	60.8	576	41.5	23.9	165	78.6	12.9	538	80.3	43.2
1974/75	2894	49.9	144.3	1492	41.2	61.5	641	39.6	25.4	185	92.8	17.2	576	69.8	40.2
1975/76	2762	50.9	140.6	1441	40.5	58.4	611	42.1	25.7	212	89.1	18.9	498	75.5	37.6
1976/77	2866	53.4	153.0	1456	42.9	65.2	621	41.4	25.7	241	89.2	21.5	548	74.1	40.6
1977/78	3151	56.2	177.0	1637	46.9	76.8	658	43.8	28.8	246	94.8	23.3	610	78.9	48.1
1978/79	3119	50.2	156.4	1635	38.3	62.6	654	38.7	25.3	244	92.1	22.5	586	78.5	46.0
1979/80a/	2700	47.4	128.0	1442	-	-	546	-	-	236	-	-	476	-	-

a/ Preliminary estimate.
b/ Includes Andaman and Nicobar Islands, Assam, Bihar, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Rajasthan, Tripura and West Bengal.
c/ Includes Andhra Pradesh, Gujarat, Kerala, Karnataka, Orissa, Pondicherry, Goa Daman and Diu and Tamil Nadu.

Source: Estimates of Area and Production of Principal Crops in India, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, various years from 1960-1980.

Annex Table 2

Production and Consumption of Sweeteners

Crop Year	Percentage of Cane used by Mills	Mill Sugar: Opening Stocks ('000 tons)	Production ('000 tons)	Exports ('000 tons)	Imports ('000 tons)	Total Consumption ('000 tons)	Per Capita Consumption (kgs)	Gur and Khandsari: Production/ Consumption ('000 tons)	Per Capita Consumption (kgs)
1960/61	28.2	742	3021	194	-	2087	4.67	6687	14.95
1961/62	26.9	1482	2729	354	-	2601	5.68	6432	14.05
1962/63	22.6	1256	2139	566	-	2502	5.34	6074	12.96
1963/64	24.7	327	2573	243	-	2326	4.85	6667	13.90
1964/65	27.4	331	3232	267	-	2437	4.96	7205	14.68
1965/66	29.4	859	3541	392	-	2792	5.56	6911	13.75
1966/67	23.3	1216	2151	235	-	2595	5.04	6125	11.91
1967/68	23.7	537	2248	139	-	2211	4.20	6305	11.98
1968/69	30.2	435	3559	79	-	2609	4.84	7346	13.63
1969/70	33.9	1306	4262	217	-	3261	5.91	7401	13.41
1970/71	30.2	2090	3740	395	-	4025	7.15	7437	13.22
1971/72	27.3	1410	3113	144	-	3780	6.59	6998	12.19
1972/73	32.4	599	3873	97	-	3511	6.00	7030	12.01
1973/74	30.0	864	3948	415	-	3519	6.08	8336	14.39
1974/75	33.6	878	4797	924	-	3457	5.68	8063	13.24
1975/76	29.8	1294	4262	1021	-	3691	5.94	8367	13.47
1976/77	31.9	844	4840	312	-	3750	5.92	8841	13.95
1977/78	38.0	1622	6461	202	-	4591	7.10	9088	14.05
1978/79	38.2	3290	5841	863	-	6222	9.44	7936	12.04
1979/80a/	30.5	2046	3900	290	192	5300	7.88	6700	9.97

a/ Preliminary estimate.

Source: Cooperative Sugar Directory and Yearbook, 1979, National Federation of Cooperative Sugar Factories, Ltd., 1980.

Annex Table 3

Population, Expenditure and Price Data

Crop Year	Population (June, millions)	Private Final Consumption Expenditure (Rs billion, 70/1 prices) a/	Wholesale Price Index (FY 1970/71 = 100)								
			All Commodities	Sugarcane	Adjusted Sugarcane b/	Competing Crops (Prior Year) c/	Sugar	Gur	Khandsari	Sweeteners d/	Non-Sweeteners e/
1960/61	447.2	212.0	55.8	58.6	54.0	48.3	64.4	54.2	-	57.5	55.7
1961/62	457.8	216.0	56.0	58.6	51.5	47.6	64.6	58.9	63.8	61.0	55.6
1962/63	468.5	220.4	58.8	58.6	66.6	49.1	67.6	88.1	76.7	81.1	57.1
1963/64	479.6	226.1	63.8	67.3	85.3	51.0	74.2	99.2	96.1	91.4	61.6
1964/65	490.9	245.7	70.0	67.8	78.7	60.0	76.8	83.9	87.1	82.0	69.1
1965/66	502.6	238.4	77.4	67.8	68.5	70.9	80.0	77.8	92.7	79.5	77.2
1966/67	514.4	243.8	89.0	75.6	109.2	78.1	86.8	162.8	154.2	139.2	85.1
1967/68	526.5	262.7	91.9	100.1	176.8	99.1	98.9	234.4	231.4	193.2	84.0
1968/69	538.9	270.6	92.8	100.1	122.8	99.7	100.4	132.4	157.8	124.4	90.3
1969/70	551.7	280.8	97.4	100.1	89.9	94.6	99.7	88.9	101.0	93.0	97.7
1970/71	562.7	298.4	102.6	100.0	105.3	100.2	106.2	129.8	107.1	121.1	101.2
1971/72	574.0	307.0	109.8	101.1	140.1	99.4	137.3	180.7	161.8	166.3	105.4
1972/73	585.4	300.7	125.7	118.9	168.9	106.6	160.6	208.5	213.7	194.6	120.3
1973/74	579.1	308.8	160.1	115.2	165.0	128.6	160.0	200.6	233.7	190.5	157.7
1974/75	609.1	310.9	177.0	121.8	171.7	169.4	173.3	231.5	250.8	214.9	174.0
1975/76	621.3	334.5	171.4	126.3	161.6	188.2	169.8	235.4	231.1	215.6	168.0
1976/77	633.7	331.9	183.5	125.2	181.2	149.8	167.6	217.8	212.0	202.2	182.0
1977/78	646.7	366.5	184.5	124.9	131.1	166.9	154.6	163.6	160.9	160.7	186.4
1978/79	659.3	384.3	197.3	147.5	143.9	172.3	153.0	188.4	148.0	174.6	199.1
1979/80	672.2	366.4	237.1	184.5	265.6	173.6	211.6	375.9	348.3	321.6	230.5

a/ Fiscal year data.

b/ Represents the sum of the result of multiplying the WPI of sugarcane by the proportion of cane used by mills plus the result of multiplying the WPI of gur (December-March) by the remainder of one minus the proportion of cane used by mills.

c/ Represents a weighted average of the WPIs of foodgrains (82%), oilseeds (13%), and cotton (5%), lagged by one year.

d/ Includes sugar, gur and khandsari.

e/ Represents WPI for all commodities except sugar, gur, and khandsari.

Sources: Index Numbers of Wholesale Prices, Weekly Data, Economic Intelligence Service; Wholesale Price Statistics, 1947-1978, Volume II, by H. L. Chandhok, Economic and Scientific Research Foundation; National Accounts Statistics, Central Statistical Organization; "Quick Estimates", CSO, January 27, 1981; World Bank estimates.

Annex Table 4

Sugar Trade Data

Crop Year	Sugar Exports (000 tons)	Sugar Exports (Rs million)	Exchange Rate	Sugar Exports (US$ million)	Sugar Exports Unit Value ($/ton)	Calendar Year	World (ISA daily) Price, f.o.b. major Caribbean parts ($/ton)	Weighted Average Price ($/ton)b/	Average Levy Ex-Factory Price ($/ton)c/
1960/61	56.0	24.8	4.762	5.2	92.9	1961	69	214.7	-
1961/62	284.8	145.7	4.762	30.6	107.4	1962	60	213.7	-
1962/63	418.0	170.1	4.762	35.7	85.4	1963	61	216.7	-
1963/64	432.3	257.3	4.762	54.0	124.9	1964	184	230.3	-
1964/65	282.1	189.2	4.762	39.7	140.7	1965	127	252.3	-
1965/66	314.1	115.1	4.762	24.2	77.0	1966	44	256.3	-
1966/67	356.7	167.0	7.000	23.9	67.0	1967	40	183.7	-
1967/68	228.0	159.8	7.500	21.3	93.4	1968	42	189.4	-
1968/69	100.0	102.1	7.500	13.6	136.0	1969	42	213.8	-
1969/70	82.0	85.5	7.500	11.4	139.0	1970	71	212.1	-
1970/71	348.0	276.0	7.500	36.8	105.7	1971	81	210.8	-
1971/72	317.0	302.2	7.444	40.6	128.1	1972	99	240.5	-
1972/73	102.0	133.0	7.706	17.3	169.6	1973	160	301.6	186.8
1973/74	252.5	426.9	7.791	54.8	217.0	1974	208	321.5	185.5
1974/75	695.0	3390.0	7.976	425.0	611.5	1975	654	330.2	196.8
1975/76	1201.0	4723.0	8.653	545.8	454.5	1976	449	313.3	172.3
1976/77	580.0	1481.0	8.939	165.7	285.7	1977	255	306.8	165.4
1977/78	70.0	195.0	8.563	22.8	325.7	1978	179	302.7	181.7
1978/79	738.0	1319.0	8.206	160.7	217.8	1979	172	290.0	207.9
1979/80a/	564.6	1199.0	8.100	148.0	262.1	1980	213	313.9	231.5

a/ Preliminary estimate.
b/ Calculated from calendar year Wholesale Price Index for sugar by dividing index number by a factor of 0.063 which represents the relationship between the WPI and the weighted average of the market prices used to estimate the WPI.
c/ For D-29 grade sugar, ex-Maharashtra factories.

Source: Cooperative Sugar Directory and Yearbook, 1979, National Federation of Cooperative Sugar Factories, Ltd., 1980.

RECENT PAPERS IN THIS SERIES

No.	TITLE OF PAPER	AUTHOR
470	Industrial Country Policy and Adjustment to Imports from Developing Countries	J.M. Finger
471	The Political Structure of the New Protectionism	D. Nelson (consultant)
472	Adjustment to External Shocks in Developing Countries	B. Balassa
473	Food Policy Issues in Low-Income Countries	E. Clay (consultant)
474	Energy, International Trade, and Economic Growth	A. Manne (consultant)
475	Capital-Importing Oil Exporters: Adjustment Issues and Policy Choices	A.H. Gelb
476	Notes on the Analysis of Capital Flows to Developing Nations and the 'Recycling' Problem	R.C. Bryant (consultant)
477	Adjustment Experience and Growth Prospects of the Semi-Industrial Countries	F. Jaspersen
478	Trade Policy Issues for the Developing Countries in the 1980s	I. Frank (consultant)
479	Trade among Developing Countries: Theory, Policy Issues, and Principal Trends	O. Havrylyshyn (consultant) M. Wolf
480	Trade in Services: Economic Determinants and Development-Related Issues	A. Sapir (consultant) E. Lutz
481	International Migrant Workers' Remittances: Issues and Prospects	G. Swamy
482	Private Bank Lending to Developing Countries	R. O'Brien (consultant)
483	Development Prospects of the Capital Surplus Oil-Exporting Countries	R. Hablutzel
484	Private Capital Flows to Developing Countries and Their Determination	A. Fleming
485	International Adjustment in the 1980s	V. Joshi (consultant)

No.	TITLE OF PAPER	AUTHOR
486	Adjustment in Low-Income Africa	R. Liebenthal
487	A Comparative Analysis of Developing Country Adjustment Experiences in the 1970s: Low-Income South Asia	C. Wallich
488	Developments in and Prospects for the External Debt of the Developing Countries: 1970-80 and Beyond	N. Hope
489	Global Energy Prospects	B.J. Choe A. Lambertini P. Pollak
490	Sociocultural Aspects of Developing Small-Scale Fisheries: Delivering Services to the Poor	R. B. Pollnac (consultant)
491	The Educational Use of Mass Media	S. Futagami et al
492	The Political Market for Protection in Industrial Countries	T. Anderson R. Baldwin
493	On Protectionism in the Netherlands	K. Koekkoek
494	Patterns of Barriers to Trade in Sweden	L. Lundberg
495	Social Infrastructure and Services in Zimbabwe	R. Faruqee
496	Economic Aspects and Policy Issues in Groundwater	I. Carruthers R. Stoner (consultants)
497	Labor Productivity: Un Tour D'Horizon	S. Horton (consultant) T. King
498	The Determinants of Labour Earnings in Developing Metropoli: Estimates from Bogota and Cali, Colombia	R. Mohan