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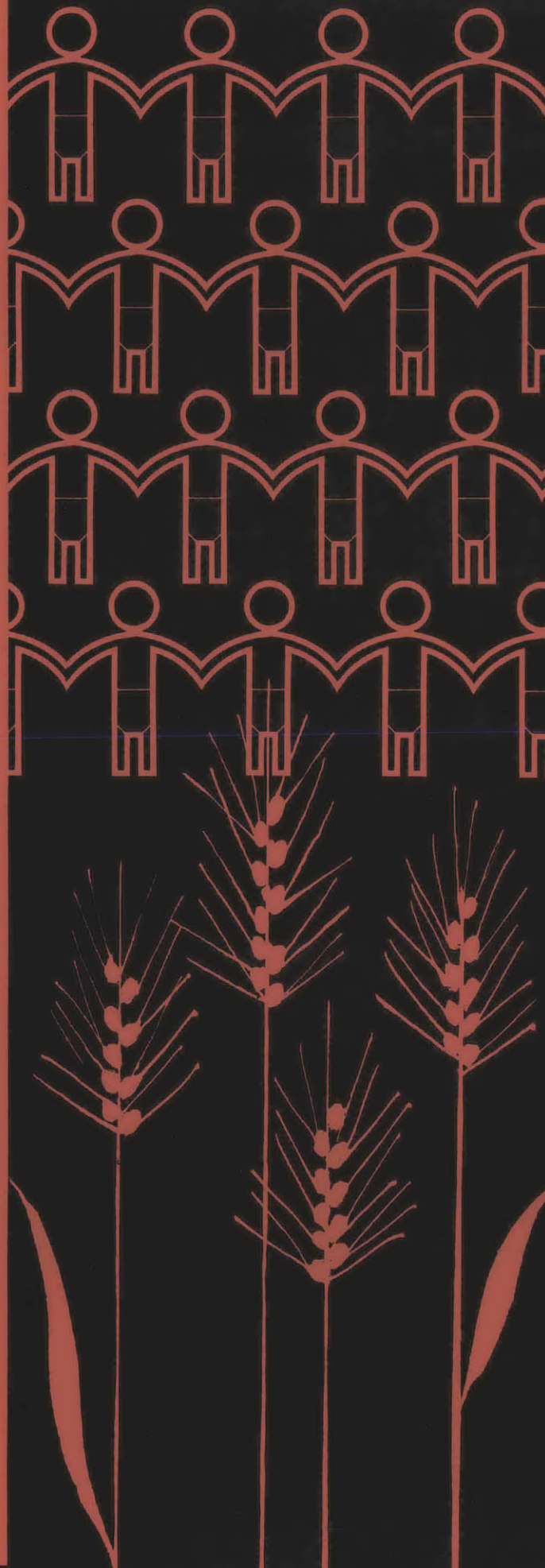
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MIT INTERNATIONAL NUTRITION PLANNING PROGRAM

Discussion
Papers No. 7

Food Demand Supply and Nutrition Planning Implications for Pakistan

F. Desmond McCarthy

FOOD DEMAND SUPPLY AND NUTRITION

PLANNING IMPLICATIONS FOR PAKISTAN

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ABSTRACT

        Policymakers have diverse objectives depending on the particular

milieu in which they operate. If one seeks to improve the welfare of

most groups in a population the focussing on economic growth alone can be

somewhat misleading. This paper seeks to focus on nutrient intake of

various classes as a norm of welfare. Various distributional aspects of

consumption and some features of the class structure of production are in-

corporated into the analysis. This permits some evaluation of the direct

and distributional impact of a range of policies.

        The preliminary results suggest that Pakistan should emphasize stimu-

lation of agriculture by increased availability of water, fertiliser, and

modernization. The tendency towards a negative distributional impact of

these may be averted by, at the same time, introducing policies to improve

tenurial arrangements for the poorer members of the agricultural sector

and provide some form of food coupon system for the landless poor. The

analysis supports the beneficial role of ration shops especially for target-

ing the urban poor. There is a strong indication that a policy mix of this

form should effect a significant increase in protein-calorie intake within

the next five years in Pakistan.

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ACKNOWLEDGEMENT

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FOOD DEMAND SUPPLY AND NUTRITION PLANNING IMPLICATIONS FOR PAKISTAN

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SUMMARY

This paper offers a framework for analyzing the effect of various
policies on food intake for Pakistan. It allows one to evaluate the
impact of many policies which are currently accepted in principal for
both food production and consumption. It also provides a measure of
the impact of other policies which might be of future interest, for
instance, modification in land tenure. The agricultural production
sector has six primary components: two types of wheat cultivation,
irrigated and rainfed; two types of rice, basmati and coarse; sugar-
cane; and the rest of agriculture. Some of the institutional and dis-
tributive features of the organization of agricultural production are
captured by having three classes; owners, tenant farmers and laborers.
This allows one to make a connection between a sectoral policy and its
effect on different income classes. A linkage of this type is essential
to analysis of the distributive impact of policy. Distributive effects
of policies are approximated by considering the effect on six income
categories corresponding to the low, middle, and upper income groups
in both urban and rural areas.

Most of the analytical details are relegated to an appendix

for the benefit of those who are put off by mathematics. While the

qualitative effects of most of the linkages are discussed in the

text, the relative significance of them is best appreciated only when

the appropriate analysis is quantified. The model is essentially an

open one so that in some instances the full impact of policies, on

income, for example, may not be adequately estimated. It is

primarily an aid in short term – one year – planning exercises.

1.0 Introduction

There is an extensive literature on the relative merits of seeking

various objectives in national planning exercises. Besides the

competing interests of political, social and economic groups there

are also the usual considerations in model building of appropriate

trade-off between analytical tractibility and the adequate description

of the salient features of interest.[1] One approach is to seek

to satisfy the "basic needs" of the population. The pitfalls are,

of course, obvious –– who decides? what is the appropriate time

horizon?

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1. Some of these issues are discussed in Blitzer, C.``., Clark, P.B.,
Taylor, L., editors, Economy-Wide Models and Development Planning,
Oxford University Press, 1975. The chapter by Kornai Janos in
particular offers some interesting criticism of some fashionable
approaches. Interesting views on Pakistan are expressed in Gotsch,
C.II., "Technical Change and the Distribution of Income in Rural Areas,"
American Journal of Agricultural Economics, May, 1972, pp. 326-341.

Among this class there is currently a body of opinion which seeks to emphasize nutrition planning. Some would week to justify adequate nutrition on purely economic grounds -- productivity returns, decrease in population growth, but most are now willing to accept that adequate nutrition should be a basic right of each individual.

Nutrition planning is open to a number of different interpretations.[2] In one sense there is an almost endless list of factors which effect some aspect or other of nutrition, ranging from such basic ones as the price of stable foods, availability of trace elements, to local belief patterns. At some local or micro levels, relatively esoteric factors may dominate so that development of policies for nutrition at a macro level requires even more awareness of and sensitivity to, those factors which tend to be obscured by aggregation.

1.1 Nutrition Planning

The somewhat broad and ill-defined area of nutrition planning may be conveniently viewed in three broad categories:

1. protein-calorie malnutrition,

2. specific nutrient deficiencies,

3. other related areas -- includes environment, public health, water supply, sanitation, malabsorbtion.

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2. A number of these are given in Berg, A., The Nutrition Factor, The Brookings Institution, 1973, and Joy, L.,"Food and Nutrition Planning", Journal of Agricultural Economics, Vol. XXIV, No. 1, J' 73.

The three categories would indicate that virtually every
broad facet of economic planning impinges on the nutritional status
of the people.[3] In particular circumstances, the primary problem
for nutritional well-being may be in any one of the areas listed
under "3", for example, so that successful planning at the local
level should encompass all of these factors. The second category
might include vitamin A or iodine deficiency. These problems may be
solved in most instances at relatively low cost. The technology is,
in some cases, currently available for fortification of appropriate
carriers so that once the various institutional arrangements can be
effected, these specific vitamin deficiencies may be eliminated
over a relatively short time span - one or two years.

Much of the economists interest has focused on the first category.
Here, one is concerned with the issues of supply and demand for
various foods to insure adequate levels. While consumption and
production are closely intertwined in general, this becomes more
evident in the case of food. Consumption decisions are to a large

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3. The last comprehensive national nutrition survey of Pakistan was
carried out in the period from February, 1965 - November, 1966, and
its results reported in June, 1970. Further information on nutrition
issues in Pakistan is given in Ali (1966), Jafri et al. (1974),
Lehtrar Applied Nutrition Project (1969), Seminar on Nutritional
Problems of Pakistan (1974) and Undre (1972), Chugtai and Khan (1960).
A more recent analysis has been made by Hruby (1975).

extent conditioned by the structure of production, while the
social organization of production to a large extent determines
income and consumption patterns. This is particularly true for low
income groups where institutional factors tend to limit the
"rational decisions" of the ubiquitous consumer facing the choice
of n goods at their respective prices. A subsistence farmer is most
likely to seek to produce a desired quantity of wheat, for instance,
before experimenting with the possibility of returns from cash
crops. Similarly, a laborour who receives payment in kind of two
maunds of wheat (1 maund = 40 seers = 82.29 lbs), one set of clothing,
and one pair of shoes, has most of his consumption decisions deter-
mined for him by the social organization of the production process.

In order to analyse this interlocked system, it is convenient
first to isolate the feedback effect and seek to consider production
and consumption separately. These are then combined to try and
evaluate the interactions of the two. The production structure is
discussed later. At this point demand is examined; if this is to be
of use in formulating policy for nutrition planning, one must
give adequate consideration to distribution effects.

1.2 Distribution Effects

Ideally, one would like to consider the role of variation in:

1. purchasing power

2. seasonal effects

3. spatial phenomena.

Purchasing power has been established as a significant determinant of nutrient intake. The variations in purchasing power may be accounted for in part by income and wealth. However, among poorer groups, where inadequate nutrition is generally prevalent, the role of institutions is quite significant. Thus, traditionally, laborers in wheat harvesting may receive payment in kind while those involved with sugar may receive payment in cash. Accordingly, one must use data on income judiciously. To capture some of the differences among income classes, this analysis considers three classes: low, middle, and upper, which include apporximately 40, 40 and 20 percent of the population respectively. To capture some of the spatial effects these classes are considered for urban and rural areas. More spatial disaggregation would be desirable to consider different climatic zones, which is reflected in rather diverse wheat and rice growing regions, for example. The urban-rural division does at least yield some of the different expenditure patterns reflecting for instance the higher costs in urban areas for housing and transportation.

For time variations, one would like to analyse the changes from year to year and also within the year. The harvest time is

usually very difficult for the poor, so that policies which might

lead toward better storage or marketing facilities could be based on

analysis which would include these seasonal variations. This

variation is not considered at this stage. However, the computation

of various elasticities does facilitate projection on a yearly basis,

when combined with knowledge of income distribution.

Aims of Analysis

To summarize then, nutrition planning requires analysis which

emphasizes the many facets of distributional effects. In particular,

to design economic policies which will have a beneficial impact

on the poor, one must understand their milieu. This paper examines

some of these features by proposing a framework for analyzing

the effect of policies on protein calorie intake.

2.0 The Basic Framework[4]

The framework seeks to incorporate the following observations:

Real purchasing power[5], to a large extent, determines protein-

calorie intake, at least at the family level, in Pakistan as in

most other countries. Rural poverty in Pakistan has been analyzed

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4. For background information on this and many other aspects of the
world, see McCarthy, F.D., "Working Papers for Pakistan Model,"
PM2 - PM8, Center for International Studies, M.I.T. 1976, these also
list many of the references which are drawn upon.

by Naseem (1976). Purchasing power is typically effected in two
ways. At the input side, one observes that an increase in cash
income, other things being equal, will in general lead to
increased food expenditure and thence to greater protein-calorie
intake. On the other hand, one may also effect an increase in
protein-calories intake at the output side by decreasing the price
to consumers of some foods: wheat, for instance may be supplied at
reduced costs through ration shops. Policies which produce a
similar effect on protein-calorie intake may differ in other respects
such as ease of implementation, cost, etc.

General Outline of Model

A simplified schematic of the framework is shown in Figure 2.1.
Six different income classes are considered, three urban and three
rural, corresponding to the lowest 40%, the middle 40%, and the
upper 20% in each.[6] For rural groups, income is generated from

5. Income distribution studies are difficult to carry out in most
countries, but particularly so in developing countries. For
Pakistan researchers in this area, see Asfar, J., "The Distribution
of Income in Pakistan, 1966-67," paper presented at the XVIth
Pakistan Economic Conference, 1973; Bergan, A., "Personal Income
Distribution and Personal Savings in Pakistan, 1963-64," Pakistan
Development Review, Summer, 1967; Saleman, R.M.U., "Employment,
Income Distribution, and Social Justice," Pakistan Economist
Research Unit.
6. Some corrections at both ends were influenced by Fishlow, A.,
Meesook, A., "Brazilian Size and Distribution of Income," 1960,
Technical Appendix Memo, May, 1972. Much of the recent data was
obtained from Official Publications listed in the Bibliography.

agricultural production, food processing, and what is termed

industry (all other income sources). This third category includes

all other forms of employment primarily manufacturing. Urban

group income comes from food processing and the industry category.

Each class saves some income and also pays taxes. The remainder

is termed expenditure. Some of this expenditure goes to various

foods and this in turn establishes protein-calorie intake.

The model is currently suitable for analyzing short-term

effect of policies. Thus, one may evaluate the effect of a change in

fertiliser subsidy over a twelve-month interval, or price change

in ration shop wheat. It may not be used to evaluate effects over

a multiyear interval at this stage. Some modifications to model the

backward linkage from food consumption to agricultural production

which typically has a one year lag are needed. The various subdivi-

sions of the model are now discussed in some detail.

2.1 Agricultural Production[7]

Agriculture is viewed as producing six commodities:

1. wheat from irrigated land

2. wheat from barani or rainfed areas

3. rice, coarse, IR-Pak

4. basmati rice

5. sugar cane

6. all other agriculture

Figure 2.1

SIMPLIFIED SCHEMATIC OF NUTRITION PLANNING FRAMEWORK
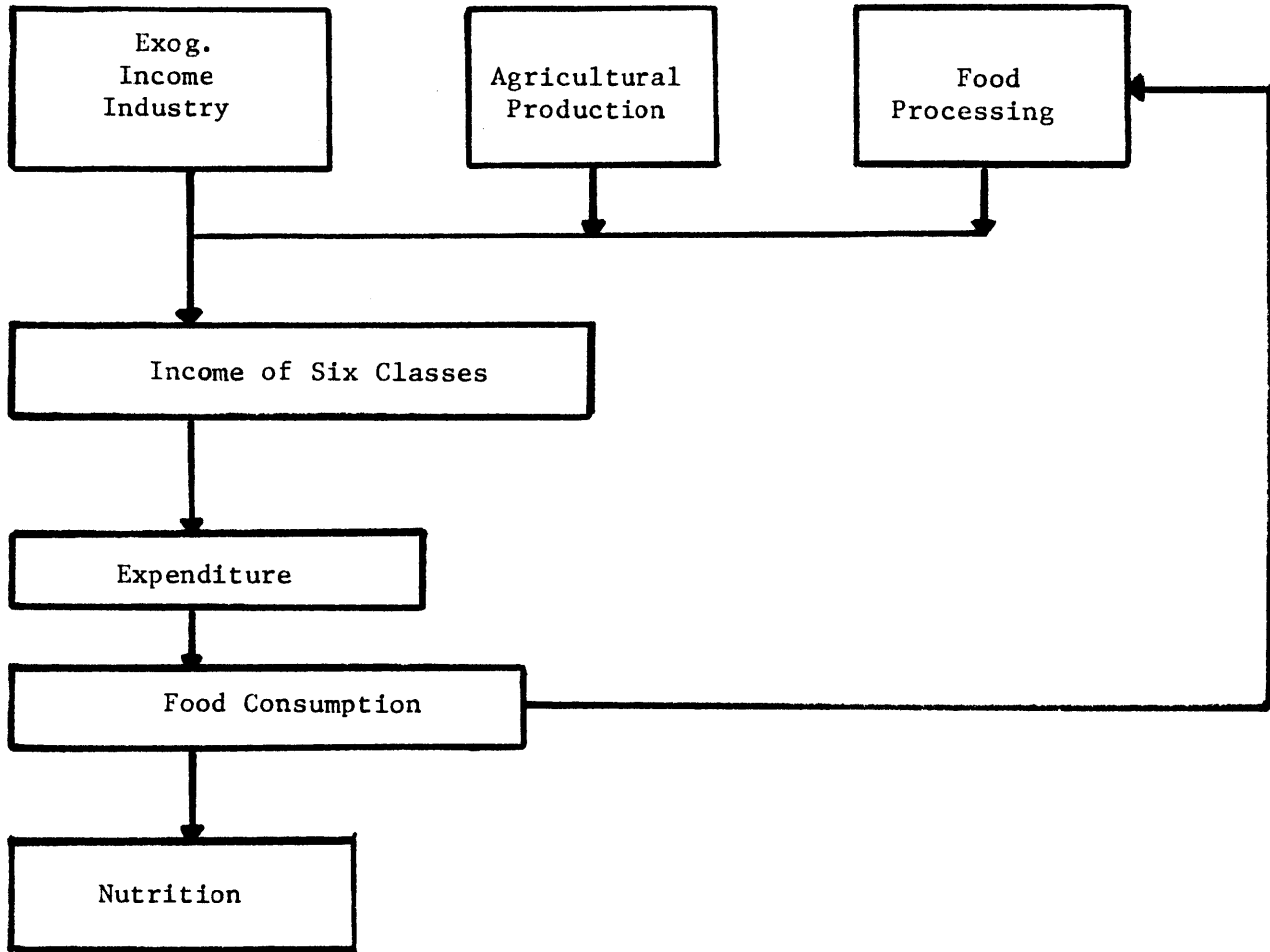
Balance.

Production = Consumption + Exports - Imports
+ Change in Storage + Seed Allowance
+ Losses

The schematic for each one of these is illustrated in Figure 2.2 by choosing commodity "i" as a typical example. Causality is moddelled as; fertilizer price determines fertilizer demand [see Timmer, (1976), for instance]; similarly for water; both of these together with a random-input to model weather, for example, determines yields levels. Production is then determined by the yield, farm-gate price, price of a feasible alternate crop, water effect on area, and then all other effects. This latter category would typically include technical change, water logging, salinity, or effects of variations in tenurial arrangements.

2.1.1 Fertiliser-Water

Currently, the use of fertilisers and water are also strongly effected by supply factors, but the increased domestic production of fertiliser should insure adequate quantities by 1978. The additional Tarbela supplies should significantly increase the availability of water within the next twelve months. Alternately one may consider changes in the inputs by sensitivity analysis.

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7. This section draws heavily on Falcon, W.P., and Papanek, G.F., Development Policy: The Pakistan Experience, Harvard University Press, 1971; Cummings, J.T., "Cultivator Market Responsiveness in Pakistan - Cereal and Cash Crops", The Pakistan Development Review, Autumn, 1975; Gotsch, C.H., "Linear Programming and Agricultural Policy: Micro-Studies of the Pakistan Punjab Food Research Institute Studies", Food Research Institute Studies, Vol. XIV, No. 1, 1975. Much of the data is based on official sources.

Figure 2.2

PRODUCTION MODEL COMMODITY "i"

i = 1, ..., 6
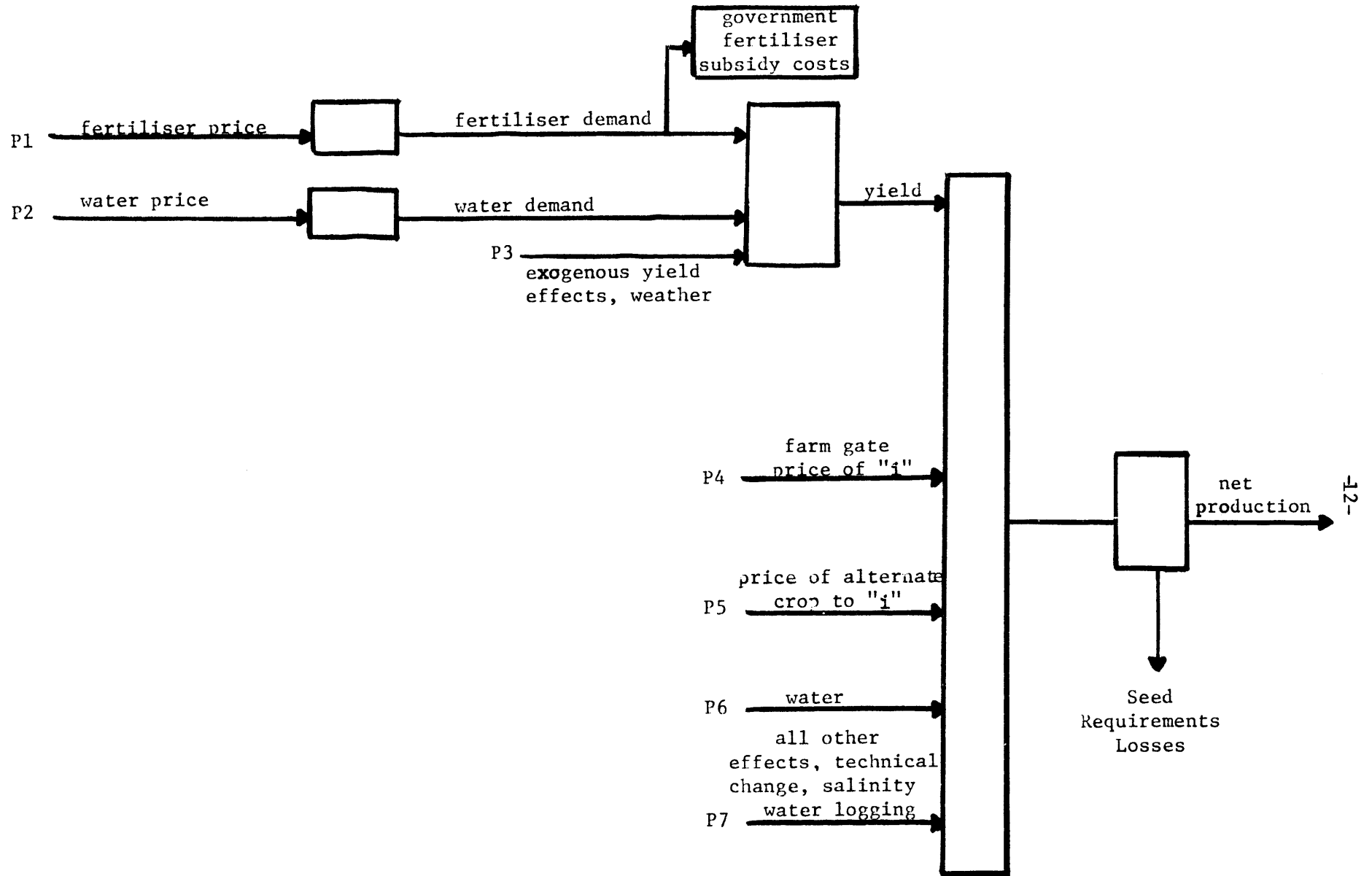
change in fertiliser price will involve some change in government subsidy. Since general fertiliser subsidy may benefit other crops, the leakage is accounted for. Currently, water charges are assessed by acreage for various crops. This does tend to lead to some wastage particularly for rice. This is not so for cotton, where farmers do not customarily waste water. Many advocate better use of water by introducing a more elaborate system of charge by quantity used. While it certainly merits consideration, in some areas the long tradition of water distribution in many parts would be extremely difficult to modify. Water primarily effects wheat through an increased acreage, while the other commodities give largely yield effects.

2.1.2 Output Response

Production levels are then established by yield, price of the commodity "i", price of an alternate crop, water avaialbility, and then a final term to reflect technical change, tenure patterns. A 1% increase in the price of "i" will stimulate an increase of η_i in output of "i". Typical values of η_i range from the relatively low 0.10 for wheat, to 0.20 for rice, and 0.30 for sugar. Hence, even large variations in procurement prices for wheat will not effect too great a percentage change in wheat output. This is partly accounted for by most of the area already suitable to wheat

production being devoted to it, and substition possibilities

being very limited. Thus, during the current year, the procurement

price for wheat was raised 50% -- in real terms, this eventually

amounted to about 42% -- and output went up 10%. Part of this

gain may be attributable to favorable weather, some to yield

improvement, while the price increase would account for about a

5% gain, based on the numbers used in the model which seems

consistent. The relative price of an alternate crop gives a

measure of the degree to which a farmer may avail of substitution

possibilities. Typical substitutes are listed in Table 2.1. Thus,

an increase in sugar cane prices should produce an increase in

output of that crop, but one must also weigh the reduction in rice

acreage involved. Increased water availability will have a

significant effect on wheat acreage. This does, of course, depend

on where the increase occurs. The final input covers all other

factors which effect output. An increased degree of mechanization

may produce higher output, though not necessarily better

distributional effects. Longer term tenure arrangements may

encourage farmers to invest more and hence produce more .

2.1.3 Losses and Seed Requirements

From the output of a given commodity, some is retained for

seed and there are some losses. These issues are discussed in the

TABLE 2.1

SUBSTITUTION POSSIBILITIES IN PRODUCTION

Primary Crop	Substitute
Wheat	Pulses; Cotton, Sugar Cane (irrigated areas)
Rice	Cotton, Sugar Cane
Sugar	Cotton, Oilseed, Wheat
Cotton	Rice, Sugar Cane

working papers. Depending on the particular crop, the government
may gain by excise duty (sugar), revenue from exports (rice), or a
reduction in imports (wheat). Much of the output goes towards
consumption.

In summary, then, the production portion of the model permits
one to introduce changes at the inputs P1...P7 (Figure 2.2) and
to evaluate the repercussions on government subsidies, duties,
foreign exchange, besides the more obvious yield and production
levels .

2.2 Income

In order to analyze some of the distributive effects, it is
desirable to understand the complete economic, social, and
institutional milieu. Some of these are included, but the degree
of disaggregation chosen reflects the usual compromises. Six
classes of people are considered corresponding to the lowest 40%,
middle 40%, and upper 20% in urban and rural areas. The process
of income generation is shown schematically in Figure 2.3. In rural
areas, income comes from agriculture, food processing, and the
residual labelled rural "industry", while urban classes derive their
income from industry and food processing. The income of each class,
adjusted for population growth, PG1...PG6, provides a measure of
per capita income. Currently annual population growth is about 4.8%

for urban and 2.0% for rural areas.[8]

2.2.1 Urban and Rural Industry

Urban and rural industry are treated exogenously. Various
population and per capita productivity growths for each class may
be analyzed. This part of the model has not been developed further
as the primary focus is on the food system, but when other analyses
of basic needs are added, this may be readily modified.

2.2.2 Urban and Rural Food Processing

Within each of the two areas, the total values of a given
food consumed less the production costs is considered food
processing cost, or P.T.D. (processing, transportation, and
distribution costs)[9]. This provides income for each class. The
income is viewed in two components -- direct labor costs and
profit. The labor costs are distributed between classes in
proportion to the number of food processing workers in the class,
while profits are divided according to the number of entrepreneurs

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8. These estimates are based on population surveys 1960, 1972.

9. There are not too many studies of marketing in Pakistan. The
Sind is covered by Qureshi, M.T., Principal Investigator, "Estima-
tion of Marketing Margins and Measurement of Seasonal Price Varia-
tion of Selected Agricultural Commodities in Sind Province of
Pakistan". Sind Agricultural College, 1974.

Figure 2.3

INCOME GENERATION

Each urban class derives income from industry
(exogenous); labor, profits in processing, while
rural classes in addition derive income from
labor, profits and rentals in agriculture.
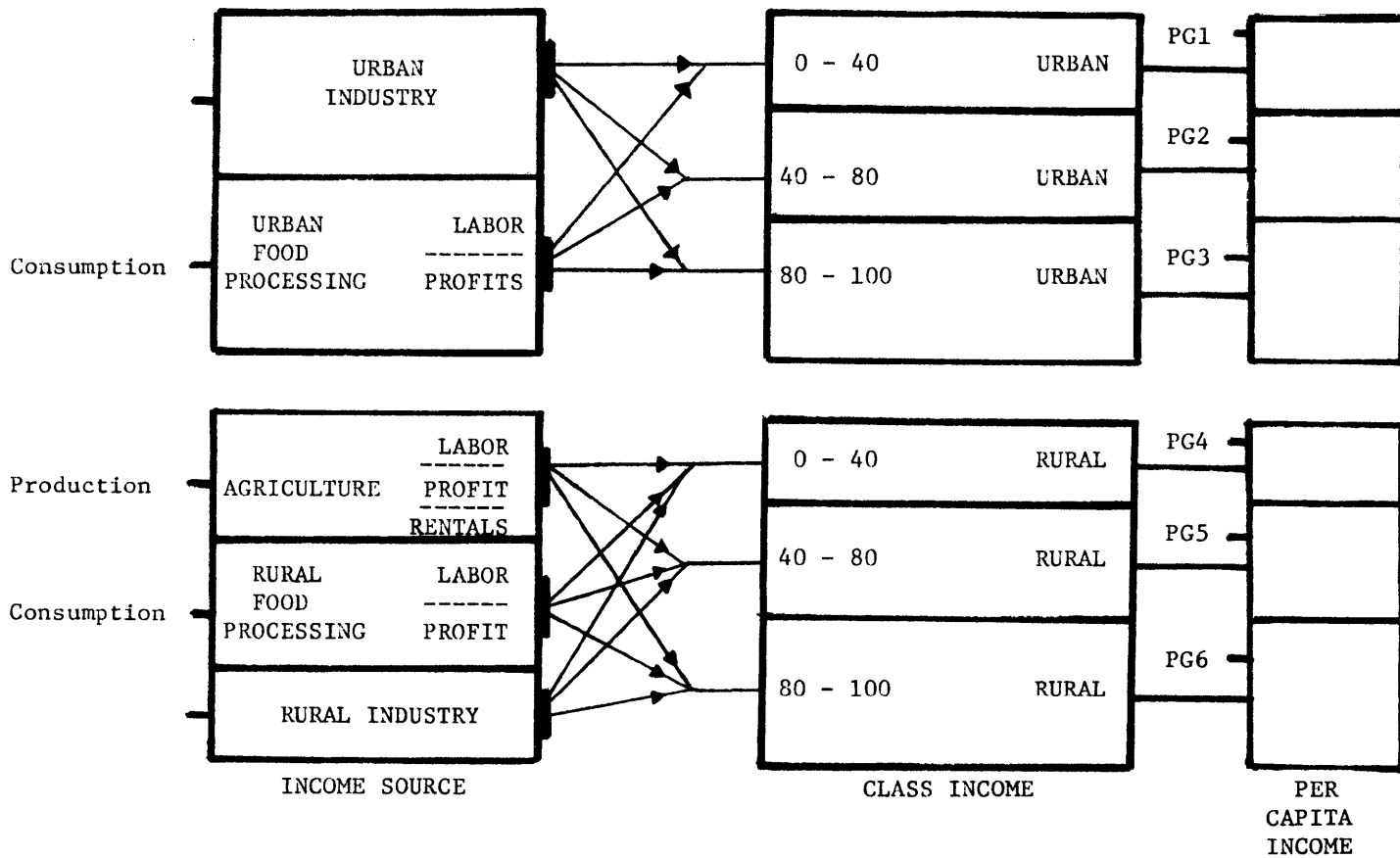
in each class. Thus, an increase in overall income augments

the value of food processing components, and this in turn produces

increments to income through labor and profit. Since entrepreneurs

tend to be distributed more towards the high incomes, the income

of the upper class will be more sensitive to change in profits.

2.2.3 Agricultural Income

Agricultural income is viewed as coming from three sources:

direct labor, profits, and rentals. In order to evaluate these, one

considers three price levels per unit of each commodity -- the price

(cost) of production, farm-gate price, and consumer price.[10]

The production cost has three primary components -- direct labor,

imputed land rental, and all other "cash" costs. This latter

category includes fertilizer, water, power, seed costs. The farm-

gate price also includes the profit (if any). The income

accrueing to direct labor is allotted to each income class (rural)

in proportion to the numbers of agricultural workers in each. The

rentals are allotted to each class in proportion to the area of

land owned by that class. The allocation of the third component

of income, profits, is based on the tenure system. Thus, the

lower class members (0-40) typically are share croppers or cash

tenants, so that only about 50% of the profits accrue to them

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10. There is also a world price which affects trade balances.

from the land they work. Many of the large land holders, on the
other hand, do not receive all the profits from their land because
of the portion they give to sharecroppers. Thus, the income of
each class from agriculture has three components: an equalitarian
direct-labor portion, rental portion heavily biased toward the
upper income, and a profit portion whose distribution is between
these two. This link is critical in determining the distributive
effects of various agricultural policies. Thus, a policy which
stimulates wheat production (large labor share) would be expected
to induce relatively more income increase for the lower groups
then possibly sugar. Similarly, increased consumption of food
by all classes with high profit portions in their processing --
sugar, for example -- will produce relatively more income to the
upper class. This is simply because of the larger share of the
entrepreneurs who capture profits, in this class.

2.3 Food-Nutrient Demand

The food-nutrient demand for each of the six classes follows
the schematic shown in Figure 2.4. The income of a class after
readjustment for population, savings, and taxes yields the
expenditure per capita for a member of that class. This, in turn,
determines the expenditure on each of the eleven foods considered.

The expenditure on each food is itself divided between quantity
and quality. Suppose one spends x rupees on m seers of milk, for
example, and that the lowest price for m units of milk in the
market is y rupees. The approach used here is to say that x-y
rupees are spent on quality. This quality, to a large extent,
reflects the cost of processing, transportation, and distribution,
and does not necessarily have any bearing on the nutrient content.
Nutrient intake is then determined by the quantity of each food
consumed.

The quantity and quality of a given food consumed are determined
by expenditure, price of that food, and price of an alternate food.

Policy in Consumption Analysis

Just as changes in monetary income can effect a consumer's
purchasing power at the "input" side, so also can changes in
food prices effect it on the other side. The typical policies
that may be analyzed here are changes in consumer prices of various
foods. In particular, it is of interest to assess the distributional
impact of ration shops and the relevant cost of this type of subsidy.
Similarly, the impact of individual food prices on the intake of calr-
ories and protein by various classes may be evaluated. Since the
consumption pattern for many foods is biased toward either the high
or low income groups, the distributional impact of price changes

Figure 2.4

FOOD-NUTRIENT DEMAND FOR CLASS "j"
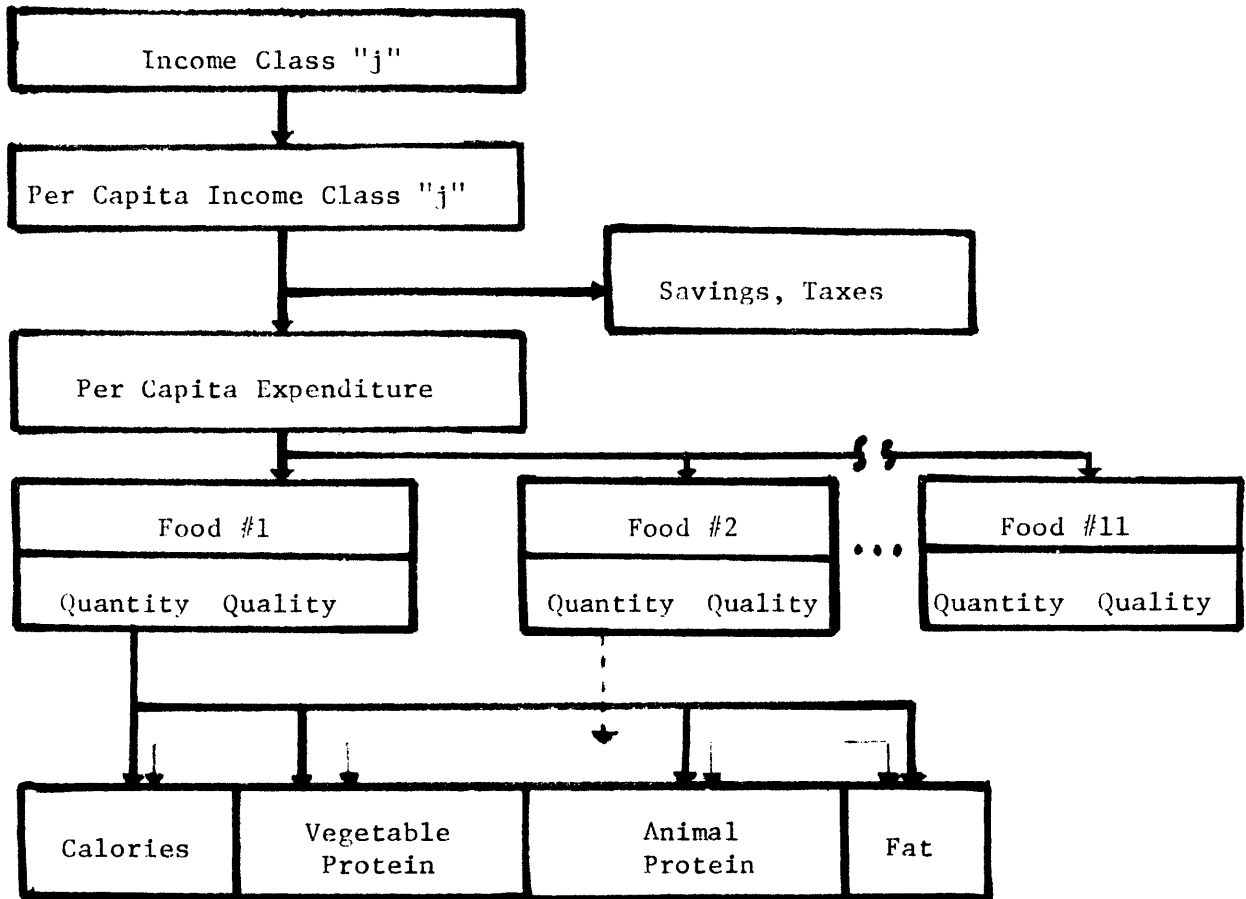
is quite significant. The patterns for wheat and grain indicate
that these tend to be favored by the poor, while mutton is very
much a rich person's food.[11] Rather surprisingly, milk, butter,
and ghee consumption patterns tend to be oriented toward upper-
income groups. This implies that even if one decides on intervention
at the consumer price level, the particular foods chosen can have
very different distributional impact.

2.4 Final Balances

The final phase of the model contains the various balance
relationships. In particular, a balance is derived for each of the
five foods analyzed in the production phase: two wheat, two rice,
and one sugar. The balance equation for each is

PRODUCTION = CONSUMPTION + EXPORTS - IMPORTS + CHANGE IN STORAGE +

SEED ALLOWANCE + LOSSES.

There are a number of problems in setting up an "equation"
of this form. They may be divided into two broad categories:
(1) measurement of each item; (2) comparability of unit of measure.

The issue of comparability arises between measures for
production and consumption, for instance. The former is at the

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11. Bussink (1970) and McCarthy (1975) have made estimates for the
various elasticities by income, class, and urban-rural location.

farm gate while the latter is after processing. The conversion

factor for raw wheat into consumable wheat is taken at 0.9. For

rice a typical estimate is 0.7 while 1 ton of refined sugar re-

quires about 11 tons of sugar cane. These estimates can vary from

one location to another depending on water content for instance or

the particular type of processing used. By increased capital

investment extraction rates for wheat and rice can be improved. The

trade off is obvious.

Even after allowing for differences there are some anomalies

in the data. Most of the consumption data is based on household

surveys. Here the recall technique used tends to give an over-

estimate. Preliminary results from recent field work[12] indicates

that a 24 hour recall gives an overestimate of about 15-25% when

compared with prorated amounts consumed, deduced from monthly quan-

tities obtained.

Production may also have some errors due to underestimates be-

cause of possible taxation repercussions or smuggling leakages.

Storage and losses are difficult to assess. Existing storage

capacity is estimated by McQuilty (1976) at 1.6 million tons with an

additional 10 million tons permanent storage capacity expected by 1978.

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12. Micro-Nutrient Field Study for Pakistan 1976. Conducted by
    Government of Pakistan, Nutrition Cell in conjunction with M.I.T.
    International Nutrition Planning Program.

The question of losses is intricately connected with storage. Total

post-harvest losses are probably about 5-20%. Chaudhry (1974) estimates

that winnowing and harvesting add a further 5-10%. The whole area

of storage and losses is very much in need of more careful analysis.

The potential gains are evident[13] but some guidance is needed on

how limited resources may be best deployed - the appropriate mix of

large and small scale storage, the trade off between reduction of grain

losses by mechanical threshing and the concomitant loss of the straw

by-product for buffalo feed.

Seed allowances are a few per cent for wheat and rice but can be

of the order of 15-20% for sugar cane.

Closing of Model

As the model is presently constructed exports are used to close

for wheat. This, to some degree, reflects a reality. The government

estimates the shortfall and then decides on the appropriate import

level. This includes PL480. Food exports at the moment are rice.

Basmati rice in particular produces a substantial amount of revenue.

However, current markets are essentially limited to the Middle East

and Iran so that it is not clear what the growth possibilities might

be and whether some other land use should be encouraged. Nevertheless,

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13. For a more detailed analysis of grain reserves and the benefits
which might result see Sarris, A.H., Abbott, P.C., and Taylor L.,
"International Grain Reserves and Food Aid", Report prepared for the
Overseas Development Council, October 1976.

this does provide an important source of revenue for the government. For both rice and sugar, trade is assumed unchanged and any variation is reflected in stores adjustment.

The seemingly poor estimates for some of these elements is primarily reflected in the quality of estimates for absolute values. However, the model is primarily designed to analyze the effect of change in the various policy variables. The estimates for direction and in some instances quantity of resulting changes may be more reliable. This model should best be used interactively - with a good measure of common sense! Some of the policies are now discussed.

3.0 Policy Analysis

Preliminary Remarks

The word policy should be interpreted in a rather loose sense. Perhaps perturbation of input variables would be more accurate. A number of different input configurations are analyzed. Since there is no obvious way to anticipate which may produce "interesting" effects a priori there is a certain amount of learning by doing involved. The results suggest a number of areas of interest and also highlights some aspects of the model which could benefit from either modification or further development.

The primary thrust of the model is to develop insight into what the aggregate and distributional impact of various policies may be. From the sensitivity analysis one gets a certain qualitative appreciation

for some of the salient parameters and the degree to which they may or may not produce significant impact. The sensitivity of a number of the variables in the model to various input changes is first discussed. Some general observations are then made.

3.1 Sensitivity to Input Changes

The outcome for 18 different scenarios are summarized. A summary of results for the first 9 are in Tables 3.1 and 3.2 while the other 9 are in Tables 3.3 and 3.4. The distributional aspects are represented by change in cal/cap/day and by percentage change in income/cap. These show differential effects on urban-rural groups and between classes in each. Changes %, in the production of the six agricultural categories studied are listed together with changes in consumption for the three primary sources of calories. Some aggregate statistical estimates are also listed; volume and foreign exchange cost of wheat subsidy costs, sugar excise tax, private savings and income tax.

All of the changes studies are for a twelve month period with 1975-76 as the base year. The standard approach, 1, is the norm against which one might make comparisons. This seeks to reflect a continuation of policies without any major shifts. The primary features of the standard approach are:

a) urban and rural population growth rate of 4.8% and 2% respectively

b) per capita growth rate for exogenous industry of 1%

c) Increase in agricultural output of 1% due to technical change, know-how

d) Import price c.i.f., of wheat $144/ton

All of the other scenarios are modifications of this norm.

1. <u>Standard Approach</u>. Each urban class gains about 1% income. Rural classes gain little because production gain is largely negated by population growth. From c above there is a general production gain of 1%. Consumption rises because of population growth and expenditure increases. Caloric gains are small in urban areas due again to low expenditure increases and also the low expenditure elasticities for calories among urban groups. Increased consumption of wheat and sugar increases both the wheat subsidy and the sugar excise tax. The difference between wheat consumption and net production is made up by imports of 1.23 million tons at a cost of about 177 million dollars.

The increase in both rice and sugar production does not keep pace with increases in consumption. The adjustment is a drawing down of stores of 20,000 tons and 126,000 tons (cane) respectively. There is a gain indicated for basmati of 5,000 tons. This is because basmati rice is not consumed in the model. The increases in savings and income taxes of 294 and 83 million rupees arises from the population and income increases primarily in the upper income urban group.

TABLE 3.1

SENSITIVITY OF ASSORTED VARIABLES TO INPUT CHANGES 1-9

INPUT CHANGE

	1	2	3	4	5	6	7	8	9
								Farm Gate	Farm Gate
		10%	10%				Agr.	Wheat	Sugar
	Standard	Increase	Increase	Good	Bad	Tech.	Wage	Price	Price
	Approach	Fertiliser	Water	Weather	Weather	Change	+10%	+20%	+20%
INCOME/CAP/%									
URBAN 0-40	1.026	1.026	1.026	1.026	1.026	1.026	1.026	0.996	1.020
40-80	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.006	1.026
80-100	1.001	1.001	1.001	1.001	1.001	1.001	1.001	0.932	0.997
RURAL 0-40	0.105	0.960	2.88	0.982	-0.771	0.543	0.113	-0.029	0.017
40-80	-0.134	0.877	3.45	0.984	-1.251	0.425	-0.133	-0.285	-0.218
80-100	-0.096	0.830	3.25	0.945	-1.138	0.424	-0.102	-0.276	-0.172
PRODUCTION CHANGE %									
WHEAT	1.0	1.99	11.0	3.0	1.0	2.0	1.0	3.0	0.67
WHEAT (BARANI)	1.0	2.49	21.0	3.0	1.0	2.0	1.0	3.0	1.00
RICE	1.0	6.94	7.0	3.0	1.0	2.0	1.0	0.33	0.33
RICE (BASMATI)	1.0	6.94	7.0	3.0	1.0	2.0	1.0	-0.34	-0.34
SUGAR	1.0	9.91	10.0	3.0	1.0	2.0	1.0	1.00	7.00
REST OF AGR.	1.0	3.97	5.0	3.0	1.0	2.0	1.0	-0.005	-0.005
CONSUMPTION CHANGE 10^5 T									
WHEAT	2.77	3.05	3.72	3.07	2.48	2.92	2.77	2.73	2.75
RICE	0.26	0.28	0.32	0.28	0.24	0.27	0.26	0.26	0.26
SUGAR	0.30	0.35	0.50	0.36	0.23	0.33	0.30	0.29	0.29

TABLE 3.2

SENSITIVITY OF ASSORTED VARIABLES TO INPUT CHANGES
1-9

I N P U T   C H A N G E

	1 Standard Approach	2 10% Increase Fertiliser	3 10% Increase Water	4 Good Weather	5 Bad Weather	6 Tech. Change	7 Agr. Wage +10%	8 Farm Gate Wheat Price +20%	9 Farm Gate Sugar Price +20%
CHANGE IN									
CAL/CAP/DAY									
URBAN 0-40	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.72	3.81
40-80	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.13	2.17
80-100	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.05	2.19
RURAL 0-40	0.82	7.48	22.40	7.65	-6.01	4.23	0.88	-0.23	0.13
40-80	-0.99	6.99	25.54	7.28	-9.26	3.15	-0.99	-2.11	-1.61
80-100	-0.45	3.83	15.02	4.37	-5.26	1.96	-0.47	-1.28	-0.80
WHEAT IMPORTS 10^6 Tons	1.23	1.19	0.58	1.13	1.33	1.18	1.23	1.09	1.25
F_x WHEAT COST 10^7 $	17.77	17.12	8.30	16.24	19.18	16.98	17.77	15.72	17.95
CHANGE IN									
RICE STORES 10^4 Tons	-2.02	7.73	7.18	1.07	-5.10	-0.48	-2.02	-3.10	-3.12
RICE S(BASMATI) 10^4 Tons	0.51	3.53	3.56	1.53	-0.51	1.02	0.51	-0.17	-0.17
SUGAR 10^5 Tons	-1.26	17.03	15.61	2.28	-4.80	5.13	-1.26	-1.15	11.55
WHEAT SUBS. 10^7 Rs	4.01	4.15	4.51	4.17	3.86	4.09	4.01	65.10	4.00
SUGAR EXCISE 10^7 Rs	1.62	1.93	2.70	1.96	1.28	1.79	1.62	1.56	1.59
PR SAVINGS 10^8 Rs	2.94	3.31	4.28	3.36	2.53	3.15	2.94	2.85	2.91
INCOME TAX 10^8 Rs	0.83	0.91	1.09	9.11	0.74	0.87	0.83	0.81	0.82

2. **Fertiliser increase.** This adjustment is made by lowering the price (by subsidy) sufficiently to increase usage for wheat production by 10%. This tends to produce somewhat different effects on other crops. It gives an income increment of about 1% to each rural class; because of their relatively higher calorie expenditure elasticities it tends to favor the nutritional intake of the poorer groups. There is a slight improvement in wheat imports but a market improvement in sugar and rice stores.

3. **Water Increase 8-10%.** Since it is very possible that this may actually be achieved during the near future it is interesting to note the rather substantial effects. It should produce sizable income gains 3.5% above standard for middle and upper income rural groups and just about 2.7% for the low income rural class. Production gains in wheat of 11% will help to halve those import needs while rice and sugar will have sizable surpluses. The nutritional impact on rural groups should be strikingly positive.

4-5. **Good and Bad Weather.** These are 2% and -2% effects on yield. The outcomes are what one might expect but with assymetric results. This is due in part to the positive technical change effect as seen in production and the reduced losses (in absolute value) which is reflected in storage changes.

6. **Technical Change.** The value of the historical increase 1% is doubled. There are no surprises. There are some rural income gains slightly biased in favor of upper income groups. The gains are small partly because of population growth.

7. Agricultural Wage. An increase in the agricultural wage of 10% produces a transfer from upper to lower income rural groups. Profit margins are reduced for all.

8. Farm Gate Wheat Price. An increase of 20% at the farm gate is postulated while holding ration shop and open market prices constant. There is a spectacular increase in government subsidy cost (increase of about 66%). The wheat production rises about 3% but substitution effects in other production produces little effect on rural income. There is a small loss in urban income because of the reduction the value added component. Wheat imports fall by about 140,000 tons saving about $20 million in foreign exchange.

9. Farm Gate Sugar Price. An increase of 20% with retail price unchanged produced sharp increase in sugar production, 7%, but substitution effect results in little income gain to each class. There is a net increase of 1.155 million tons of cane.

10. Redistribution of Land. The ownership of 10% of the land of the upper class is transferred to the lower class. This results in a transfer of rentals and some profits towards the lower groups.

11. Increase Share Croppers Portion. If share croppers were to receive 60% rather than the average 50% of the returns from the land they farm these would again result in a small transfer from upper to lower income rural classes.

TABLE 3.3

SENSITIVITY OF ASSORTED VARIABLES TO INPUT CHANGES 10-18

I N P U T   C H A N G E

	10 Redist. 10% of Land of Upper to Lower Class	11 Increase Share-croppers Portion 50% to 60%	12 Remove Wheat Subsidy	13 Move 10% Land From Trad. to Modern Ag.	14 Ban Urban -Rural Migration	15 Pop. Growth Rate Falls 26%	16 High Growth Exog. Industry 3%	17 Low Growth Exog. Industry 3%	18 Growth As During Recent Past
INCOME/CAP %									
URBAN 0-40	1.026	1.026	0.88	1.026	1.006	1.014	4.11	-3.08	-1.02
40-80	1.031	1.031	0.91	1.031	1.010	1.019	4.12	-3.09	1.02
80-100	1.001	1.001	0.67	1.001	0.982	0.990	4.01	-3.01	2.96
RURAL 0-40	0.144	0.125	-0.24	2.671	-0.198	0.322	1.739	-2.09	-0.12
40-80	-0.126	-0.127	-0.44	3.164	-0.522	0.144	1.144	-1.83	-0.14
80-100	-0.130	-0.118	-1.01	2.979	-0.459	0.162	1.181	-1.79	-0.10
PRODUCTION CHANGE %									
WHEAT	1.0	1.0	1.0	11.2	1.0	1.0	1.0	1.0	1.0
WHEAT (BARANI)	1.0	1.0	1.0	11.2	1.0	1.0	1.0	1.0	1.0
RICE	1.0	1.0	1.0	4.0	1.0	1.0	1.0	1.0	1.0
RICE (BASMATI)	1.0	1.0	1.0	4.0	1.0	1.0	1.0	1.0	1.0
SUGAR	1.0	1.0	1.0	9.5	1.0	1.0	1.0	1.0	1.0
REST OF AGRICULTURE	1.0	1.0	1.0	5.7	1.0	1.0	1.0	1.0	1.0
CONSUMPTION CHANGE 10^5T									
WHEAT	2.78	2.78	-0.88	3.64	2.68	2.15	3.20	2.22	2.8
RICE	0.26	0.26	0.22	0.32	0.25	0.20	0.30	0.21	0.26
SUGAR	0.30	0.30	0.12	0.48	0.28	0.24	0.41	0.15	0.30

TABLE 3.4

SENSITIVITY OF ASSORTED VARIABLES TO INPUT CHANGES 10-18

I N P U T   C H A N G E

	10	11	12	13	14	15	16	17	18
	Redist. 10% of Land of Upper to Lower Class	Increase Share-croppers Portion 50% to 60%	Remove Wheat Subsidy	Move 10% Land From Trad. To Modern Ag.	Ban Urban -Rural Migration	Pop. Growth Rate Falls 26%	High Growth Exog. Industry 3%	Low Growth Exog. Industry 3%	Growth As During Recent Past
CHANGE IN									
CAL/CAP/DAY									
URBAN 0-40	3.83	3.83	-34.96	3.84	3.76	3.79	15.37	-11.53	-3.81
40-80	2.18	2.18	-35.87	2.18	2.13	2.16	8.73	-6.55	2.16
80-100	2.20	2.20	1.47	2.20	2.16	2.18	8.82	-6.63	6.51
RURAL 0-40	1.12	0.97	-24.70	20.81	-1.54	2.51	13.54	-16.26	0.93
40-80	-0.93	-0.94	-32.50	23.41	-3.86	1.06	8.47	-13.58	-1.01
80-100	-0.60	-0.53	-30.47	13.77	-2.12	0.75	5.46	-8.28	-0.48
WHEAT IMPORTS 10^6 Tons	1.23	1.23	0.84	0.64	1.22	1.16	1.28	1.11	1.23
F_x WHEAT COST 10^7 $	17.72	17.71	12.08	9.23	17.57	16.75	18.37	16.9	17.8
CHANGE IN									
RICE STORES 10^4 Tons	-2.02	-2.02	-1.48	2.20	-1.94	-1.17	-2.58	-0.96	-1.71
RICE S(BASMATI) 10^4 Tons	0.51	0.51	0.51	2.03	0.51	0.51	0.51	0.58	0.58
SUGAR 10^5 Tons	-1.26	-1.26	0.71	14.72	-1.09	-0.60	-0.25	0.80	-0.84
WHEAT SUB. 10^7 Rs	4.01	4.01	-	4.47	2.84	3.05	4.31	3.61	3.97
SUGAR EXCISE 10^7 Rs	1.62	1.62	0.68	2.61	1.54	1.30	2.22	0.80	1.60
PR. SAVINGS 10^8 Rs	2.93	2.94	2.46	4.17	2.28	2.39	4.59	0.75	3.62
INCOME TAX 10^8 Rs	0.83	0.83	0.72	1.07	0.61	0.67	1.28	0.22	1.00

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12. <u>Removal of Wheat Subsidy</u>. Some estimate of the effect of removing the wheat subsidy may be obtained from the model. Because the model is not a closed one the income effects are most probably underestimated. All classes lose income because of the reduction in processing transportation distribution activity. However, the cumulative effects of expenditure and price produce a strong negative effect on the caloric intake of all classes except the urban rich. While the immediate burden of the wheat subsidy would be removed, wheat imports would be reduced by only one-third or 400,000 tons. The deflationary effect on the economy would also be seen in lower savings and excise taxes.

13. <u>Modernization of Agriculture</u>. This is considered by analyzing the effect of 10% of the land going from traditional to modern agriculture. The impact of modernization and technological change on agriculture has been studied by Qureshi (1974). This produces rather spectacular results. About a 3% average income gain, 2.5% lowest class. Wheat production increases 11.2% which is more than enough to compensate for the increased consumption. The effect on wheat import, reduction by 600,000 tons is more than with removal of wheat subsidy and without the accompanying deflationary effect on the economy. Sugar excise taxes, savings and income taxes all rise sharply. There is a small offset due to higher wheat subsidy costs. The positive nutritional impact is directly opposite to the losses which would ensue from removal of subsidy. There is also the problem of how the farmers, especially the low income farmers, might be motivated to change.

Qazi (1975) discusses some of the issues and notes in particular the impact of radio on the lower socio-economic groups who have little direct contact with extension workers.

14. Ban Rural Urban Migration. All classes, urban and rural are assumed to have a growth rate of 2.7%. The extra population pressure in rural areas produces slight falls in per capita income. The lower population growth in the urban does not produce corresponding per capita income gains. This is because of the manner in which exogenous industry growth rate enters the model - see Appendix A, equation 4.1. Changes in population growth rates are considered homogeneous across all members of a class and not just variations in birth rate which does take a somewhat longer time to effect production levels. Heavy migration out of the country is one possible generating mechanism. There is a substantial fall in national savings and tax returns. Wheat subsidy costs fall.

15. Fall in Population Growth Rate by 25%. Rural population benefits but there is little effect on urban per capita income for similar reasons to those advanced in the previous case. Again there is a substantial fall in national savings and tax returns because of the decrease in those who contribute significantly in this area - the high income urban group. Again wheat subsidy costs fall.

16-17. High and Low Exogenous Income Growth. These levels were taken at 3% and -3% respectively. The income for urban classes responds rather directly. Rural classes are effected to a lesser degree because of the correspondingly smaller portion of their income coming from

exogenous industry. The progressive effect of high growth on caloric

intake is manifest and vice versa. Savings, income and excise tax

are quite sensitive to growth rate swings.

18. <u>Growth as in recent years</u>. Analysis of recent trends in income

distribution suggests a slight deterioration in urban areas with

little change in rural areas. If this trend continues nutrient intake

of the urban poor will become worse. There will be some gain in savings

and income tax.

3.2 <u>General Observations</u>.

The large exogenous income component tends to reduce the impact

of most agricultural policies when they are viewed at the broad class

levels considered. Within classes it is evident that some groups may

benefit more than others. Thus, share croppers obtaining 60% rather

than 50% would benefit more than low income non-agricultural rural

workers. These effects are not evident from the model results. Some

broad characteristics may be deduced. These are indicated qualitatively

in Table 3.5.

From a nutritional point of view removal of the wheat subsidy

would have a serious negative impact on all low income groups. Balanced

high growth would benefit both. The nutritional intake of the rural

poor would benefit from modernization, increased availability of water

and fertiliser. The interaction of growth and distribution is interesting.

TABLE 3.5

QUALITATIVE EFFECTS OF SOME "POLICIES"

T A R G E T

POLICY	Average Income	Urban Income Distrib.	Rural Income Distrib.	Wheat Production	Wheat Imports	Rice Store	Nutrition Low Income Class Urban	Rural
1. Standard	=	=	=	=	=	=	=	=
2. Fertiliser Increase	P	=	=	PP	P	PP	=	P
3. Water Increase	PP	=	N	PP	PP	PP	=	PP
8. Farm Gate Wheat Price Inc	=	=	=	PP	P	NN	=	N
10. Land Redistribution	=	=	P	=	=	=	=	=
12. Removal of Wheat Subsidy	NN	P	P	=	PP	N	NN	NN
13. Modernisation	PP	=	N	PP	PP	=	=	PP
14. High Growth Balanced	PP	=	P	=	=	N	PP	PP
15. Growth as in Recent Past	=	NN	=	=	=	PP	N	=

Standard is considered normal = .

P, PP, N, NN indicate positive, strongly positive, negative, strongly negative.

A fall in wheat imports is considered positive.

While water and modernization produce strong overall growth they also induce some deterioration in rural income distribution. The deflationary effect of removal of the wheat subsidy is accompanied by a slight improvement in distribution. One observes a similar phenomenon under poor weather conditions or low exogenous growth.

A number of policies are available for boosting wheat production. Reduction of (considered positive) wheat imports though an increased farmgate price for wheat may produce a strong negative effect on rice stocks due to substitution in production.

While some mix of policies is perhaps best these preliminary results do support policies aimed at increasing water and modernization. Some of the negative distribution effects might be compensated for by some land redistribution or improvement in tenurial status for low income groups. While these negative effects would be important for the low income group on average, they would be even worse for those members of the class who do not have any tenants rights. This means that migrant workers, landless laborers, and that whole plethora of low income rural workers in non-agricultural work are particularly vulnerable.

4.0 Conclusions

To analyse the broader aspects of protein calorie intake it is desirable to try to model the complete food supply demand system. The distribution of different classes by purchasing power urban-rural location,

productive activity plays a major role in determining income. The
price of foods together with income strongly effects protein-calorie
intake.

The sensitivity of income and nutrient intake of six income classes
to variations in input parameters is estimated. The more obvious
conclusions are that removal of wheat subsidy would have a strong
negative effect not only on nutrition but on the economy as a whole.
Improvement in water, fertiliser availability and modernization of
agriculture offer desirable possibilities both for improved nutrition
and reduction in foreign exchange costs for wheat imports. Some
accompanying deterioration in rural income distribution necessitates
that these policies be accompanied by measures to assist the low income
non-land-owning groups. In urban areas this may be done through
the ration shops. It may be corrected by improvement in tenurial
arrangements for some low income rural groups. The remaining low
income rural groups could benefit from some form of food coupon (subsidy)
system. Absence of land ownership might be used as a criterion.
Some of the salient features of policies of the form for Pakistan
are discussed in McCarthy (1976). This should be viewed as a first step
and as other policies become of interest the model may be refined to
try and yield some insight about possible implications.

Neither should this detract from efforts to push other policies
to alleviate Protein Calorie Malnutrition which often results from poor
sanitary conditions or disease superimposed on marginal diets.

BIBLIOGRAPHY

1. Ali, S.M., "A Nutritional Survey in Hunza Pakistan", Journal of Medical Research, April 1966.

2. Asfar, J., "The Distribution of Income in Pakistan, 1966-67". Paper presented at XVIth Pakistan Economic Conference, 1973.

3. Berg, A., "The Nutrition Factor", The Brookings Institution, 1973.

4. Bergan, A., "Personal Income Distribution and Personal Savings in Pakistan 1963/64", Pakistan Development Review, Summer 1967.

5. Blitzer, C.R., Clark, P.B., Taylor, L., "Economy-Wide Models and Development Planning", published for the World Bank by Oxford University Press, 1975.

6. Bussink, W.C.F., "A Complete Set of Consumption Coefficients for West Pakistan", The Pakistan Development Review, Vol. X, Number 2, Summer 1970.

7. Chaudhry, M.A., (Project Leader), "Produce Losses in Wheat During Threshing and Winnowing in the Punjab Province", University of Agriculture, Lyallpur, Pakistan, January 1974.

8. Chughtai, M.I.D., and Khan, A.W., "Nutritive Value of Food Stuffs and Planning of Satisfactory Diets in Pakistan", Punjab University, 1960.

9. Cummings, J.T., "Cultivator Market Responsiveness in Pakistan - Cereal and Cash Crops", The Pakistan Development Review, Autumn 1975.

10. David, Christina C., A Model of Fertilizer Demand of Asian Rice Farms: A Micro-Macro Analysis, unpublished PhD. Dissertation, Stanford University 1975.

11. Falcon, W.P., and Papanck, G.F., "Development Policy II The Pakistan Experience", Harvard University Press, 1971.

12. Fishlow, A., Meesook, A., "Brazilian Size Distribution of Income, 1960", Technical Appendix Memo, May 1972.

13. Gotsch, C.H., "Linear Programming and Agricultural Policy: Micro Studies of the Pakistan Punjab", Food Research Studies, Vol. XIV, No. 1, 1975.

14. Gotsch, C.H., "Technical Change and the Distribution of Income in Rural Areas", American Journal of Agricultural Economics, May 1972, pp. 326-341.

15. Hruby, Jiri, "Report to the Government of Pakistan on Food and Nutrition Planning", No. TA 3317, F.A.O., Rome 1975.

16. Jafri, N., et al., Working Paper of the Pakistan Subgroup, Third Nutrition Planning Workshop, M.I.T., July 1974.

17. Joy, L., "Food and Nutrition Planning", Journal of Agricultural Economics, Vol. XXIV Number 1, January 1973.

18. Lehtrar Applied Nutrition Project, Ministry of Health, Labour Social Welfare and Family Planning, Government of Pakistan, September 1969.

19. McCarthy, F.D., "Nutrition, Food and Prices in Pakistan", M.I.T. International Nutrition Planning Program, June 1975.

20. McCarthy, F. Desmond, "Nutrition Planning in Pakistan Analysis of Some Policy Options", Center for International Studies, M.I.T., 1976.

21. McCarthy, F. D., "Working Papers for the Pakistan Model", PM2-PM8, Center for International Studies, M.I.T., 1976.

22. McQuitty, J.B., "Emergency and Longer-Term Food Grain Storage Alternatives in Pakistan 1976", Department of Agricultural Engineering, University of Alberta, Canada.

23. Naseem, S.M., "Rural Poverty and Landlessness in Pakistan - Dimensions and Trends (1960-75)", June 1976. (To be published in Landlessness and Poverty in Rural Asia, edited by Keith Griffin and A.R. Khan, I.L.O., Geneva.)

24. "Nutrition Survey of West Pakistan", a report, Ministry of Health, Labour and Family Planning, Government of Pakistan, June 1970.

25. Qazi, Z.I., "Grooming the Punjab Farmers for a Green Revolution", Punjab Board of Economic Inquiry, No. 158, 1975.

26. Qureshi, M.T., Principal Investigator, "Estimation of Marketing Margins and Measurement of Seasonal Price Variation of Selected Agricultural Commodities in Sind Province of Pakistan", Sind Agricultural College, 1974.

27. Qureshi, M.T., Principal Investigator, "Impact of Technological Changes on Per Unit Cost and Returns in Agriculture in Sind Province of Pakistan", Sind Agricultural College, 1974.

28. Seminar on Nutritional Problems of Pakistan, Planning Commission, Government of Pakistan, August 1974.

29. Suleman, R.M.U., "Employment, Income Distribution and Social Justice", Pakistan Economist Research Unit, Karachi.

30. Timmer, C.P., "Fertiliser and Food Policy in LDC's", Food Policy, Vol. 1, Number 2, February 1976.

31. Undre, H.R., "A Pilot Study for the Solution of Nutritional Problems of Pakistan", Pakistan Journal of Medical Research, Vol. XI, No. 3, July 72.

OFFICIAL PUBLICATIONS

(This is a partial list of those used.)

Central Statistics Office

Pakistan Statistical Yearbook, 1974

Household Income and Expenditure Surveys, 1968-1972

Monthly Statistical Bulletin up to July and August, 1975

National Accounts, 1971-72 to 1974-75

Labour Force Surveys, 1968 to 1972

Census of Manufacturing Industries

Key Economic Indicators

Ministry of Food and Agriculture

Yearbook of Agricultural Statistics, 1975-76

Ministry of Finance

Pakistan Economic Survey (issued annually)

Taxation Structure of Pakistan, June 1976

Planning Commission

Annual Plan, 1975-76, 1974-75

Pakistan Year Book, 1975 (published by East and West Publishing Company)

State Bank of Pakistan

Banking Statistics of Pakistan, 1975-76

Government of the Punjab

Development Statistics of the Punjab, October 1975

APPENDIX A

Analytical Details for Model

In this section, the equations are listed according to the primary subdivisions of the model. The individual variables are listed in Appendix B. In some instances, equations given here are a simplified form of those in the actual model. This is done where detail may be reduced without affecting the general structure.

A.1 Production

$$\hat{f}_i = \epsilon_{fp_i} \hat{p}_{f_i} \qquad 1.1$$

$$\hat{w}_i = \epsilon_{wp_i} \hat{p}_{w_i} \qquad 1.2$$

$$\hat{y}_i = \epsilon_{yf_i} \hat{f}_i + \epsilon_{yw_i} \hat{w}_i + \hat{r}_i \qquad 1.3$$

$$\hat{x}_i = \eta_{iy} \hat{y}_i + \eta_{ip_i} \hat{p}_{g_i} + \eta_{ip_{alt}} \hat{p}_{a_i} + \eta_{iw} \hat{w}_i + \hat{t}_{c_i} \qquad 1.4$$

$$\Delta C_{ifs} = (\hat{f}_i - \hat{p}_{f_i}) a_{r_i} f_i s_f \qquad 1.5$$

In this section, changes (%) in price of fertiliser, water, produce changes in fertiliser, water demand 1.1, 1.2. These, with weather changes, affect yield 1.3. This, together with farm gate price, alternate crop, water and technical change, gives output change 1.4. In 1.5, change in fertiliser subsidy is obtained.

A.2 Production Costs

$$P_{p_i} = w_d L_i + RS_i + KS_i \qquad\qquad 2.1$$

$$KS_i = FS_i P_{f_i} + WS_i P_{w_i} + OCS_i \qquad\qquad 2.2$$

$$P_{g_i} = P_{p_i} + \Pi_{f_i} \qquad\qquad 2.3$$

The production cost per unit of output has three primary components: labor, rental of land (imputed), cash costs 2.1. This latter includes fertiliser, water, seed, power 2.2. The farm gate price includes profit, if any 2.3.

A.3 Income Shares

$$L_{ij} = w_d PR_j L_i X_i \qquad , \quad L_j = \Sigma L_{ij} \qquad\qquad 3.1$$

$$R_{ij} = r_j RS_i x_i \qquad , \quad R_j = \Sigma R_{ij} \qquad\qquad 3.2$$

$$G_{ij} = t_j GS_i x_i \qquad , \quad G_j = \Sigma G_{ij} \qquad\qquad 3.3$$

$$LP_{kj} = WP_j P_{au_k} LV_k \qquad , \quad LP_j = \Sigma LP_{kj} \qquad , \quad j = 1,2,3 \qquad 3.4$$

$$GP_{kj} = rP_j P_{au_k} GV_k \qquad , \quad GP_j = \Sigma GP_{kj} \qquad , \quad j = 1,2.3 \qquad 3.5$$

$$LP_{kj} = WP_j P_{ar_k} LV_k \qquad , \quad LP_j = \Sigma LP_{jk} \qquad , \quad j = 4,5,6 \qquad 3.6$$

$$GP_{kj} = rP_j P_{ar_k} FV_k \qquad , \quad GP_j = \Sigma GP_{kj} \qquad , \quad j = 4,5,6 \qquad 3.7$$

$$Y_j = L_j + R_j + G_j + LP_j + GP_j + YX_j \qquad\qquad 3.8$$

Each class, j, obtains its income from six primary sources:
direct labor 3.1, rentals 3.2, profits 3.3 from each of the six
agricultural productions items; direct labor 3.4, 3.6, profits
3.5, 3.7, from the processing transportation and distribution of
wheat, rice and sugar in both urban and rural areas; and finally
from all other "industry." The base year estimate for this final
item is derived from a study of income distribution data.

A.4 Change in Expenditure

$$\hat{YX}_j = (1 + \hat{g}_j) (1 + \hat{POP}_j) - 1 \qquad 4.1$$

$$e_j = (1 - s_j) (1 - tx_j) Y_j/POP_j \qquad 4.2$$

$$\hat{e}_j = (1 - sm_j) (1 - tm_j) (\hat{Y}_j - \hat{POP}_j) \qquad 4.3$$

Change in income from other industry is determined by growth rate
of that sector and population growth rate 4.1. Expenditure per capita
adjusted by average savings and income tax rates 4.2, while changes
in expenditure per capita require adjustment of per capita income
change by marginal savings and tax rates 4.3.

A.5 Consumption

$$\hat{q}_{kj} = \varepsilon_{Y_{kj}} \hat{e}_j + \varepsilon_{p_{kj}} \hat{p}_{r_j} + \varepsilon_{p_{alt_{kj}}} \hat{p}_{ra_j} \qquad 5.1$$

$$\hat{Q}_{kj} = \hat{q}_{kj} + \hat{POP}_j \qquad 5.2$$

$$\Delta Q_k = \Sigma \Delta Q_{kj} \qquad 5.3$$

$$\hat{v}_{kj} = \varepsilon_{Yv_{kj}} \hat{e}_j + \varepsilon_{pv_{kj}} \hat{p}_{r_j} + \varepsilon_{paltv_{kj}} \hat{p}_{ra_j} \qquad 5.4$$

$$\hat{V}_{kj} = \hat{v}_{kj} + \hat{POP}_j \qquad\qquad 5.5$$

$$\Delta Pau_k = \sum_{j=1}^{3} \Delta V_{kj} \qquad\qquad 5.6$$

$$\Delta Par_k = \sum_{j=4}^{6} \Delta V_{kj} \qquad\qquad 5.7$$

$$\Delta SUB = \Sigma\Delta Q_{1j} \; TAR_{1j} \; SU \qquad\qquad 5.8$$

$$\Delta EXC = \Sigma\Delta Q_{5j} \; TAR_{5j} \; EX \qquad\qquad 5.9$$

Change in per capita consumption is determined by change in expenditure, retail price and retail price of substitute 5.1. This change with population change gives change in consumption by class 5.2, and for total population 5.3 for each food. The change in value added per capita (or quality of P.T.D. component) is determined by change in expenditure, price and alternate price 5.4. The total change in value added, urban 5.6 and rural 5.7, is obtained for each food. Change in wheat subsidy cost 5.8, and sugar excise revenue 5.9 are estimated.

A.6 Nutrient Intake

$$\hat{NUT}_{kj} = \epsilon_{YN_{kj}} \hat{e}_j + \epsilon_{P_{kj}} \hat{P}_{kj} \qquad\qquad 6.1$$

Change in per capita nutrient intake is determined by change in per capita expenditure and price change.

A.7 Balance

$$\Delta WI = - \Delta_{x1} - \Delta_{x2} + \gamma_1 \Delta Q_1 + \Delta LS_1 + \Delta SEED_1 \qquad\qquad 7.1$$

$$FXI = (WI + \Delta WI)\ PW \qquad\qquad 7.2$$

$$\Delta RS = \Delta x_3 - \gamma_3\ \Delta Q_3 - \Delta LS_3 - \Delta SEED_3 \qquad\qquad 7.3$$

$$\Delta RBS = \Delta x_4 - \Delta LS_4 - \Delta SEED_4 \qquad\qquad 7.4$$

$$\Delta SS = \Delta x_5 - \gamma_5\ \Delta Q_5 - \Delta LS_5 - \Delta SEED_5 \qquad\qquad 7.5$$

Change in wheat imports is reflected by the net domestic production-consumption, losses, seed requirement change 7.1. This in turn gives foreign exchange cost 7.2. Rice 7.3, basmati rice 7.4, and sugar 7.5 adjustment is made at the storage level.

APPENDIX B

List of Variables

B.1 Production.

Six commodities are considered denoted by the subscript i,

$i = 1, \cdots, 6$

1	wheat (irrigated)
2	wheat (barani)
3	rice coarse, IR-Pak
4	rice - basmati
5	sugar cane
6	other agriculture

hat (^) denotes percentage change in a variable

f_i, w_i, x_i fertiliser, water, output of i (quantity)

p_{f_i}, p_{w_i} fertiliser, water prices

ε_{fp_i}, ε_{wp_i} fertiliser, water, price elasticities

ε_{yf_i}, ε_{yw_i} yield elasticities for fertiliser and water

η_{iy}, η_{ip_i}, $\eta_{ip_{alt}}$, η_{iw} yield, own price, alternate crop price, water output elasticities (these are farm gate prices)

$\hat{r}_i$ change in yield due to weather

$\hat{t}_{c_i}$ change in output due to technical change

s_f total fertiliser subsidy

a_{r_i} fraction of fertiliser subsidy to crop i

ΔC_{ifs} change in fertiliser subsidy costs to crop i

B.2 Production Costs

p_{p_i} production cost per unit

w_d wage rate

L_i direct labor per unit

RS_i rental services costs per unit

KS_i "cash" input costs per unit

FS_i, WS_i, OCS_i fertiliser (quantity), water (quantity), Other Cash

costs per unit

Π_{f_i} farmer profit

B.3 Income Shares

There are six classes: 3 urban j = 1, 2, 3; 3 rural j = 4,5,6.

L_{ij}, R_{ij}, G_{ij}, LP_{ij}, GP_{ij} income from commodity i accruing to

class j from direct labor, rental,

profits in agriculture; labor,

profits in processing.

PR_j, r_j, t_j, WP_j, rP_j fraction in class j of agricultural

worker, land holdings, farm operators,

P.T.D. workers, P.T.D. entrepeneurs.

LV_k, GV_k Labor and profit portion of processing for commodity k

L_j, R_j, G_j, LP_j, GP_j, YX_j income to class j from direct labor

in agriculture, rentals, farmer profits,

direct labor in processing, profits

in processing, exogenous industry

(all other sources).

B.4 Change in Expenditure

$\hat{YX}_j$, $\hat{g}_j$, $\hat{POP}_j$ exogenous income, growth per capita,

population growth for class j.

e_j, $\hat{e}_j$ expenditure and per cent change in

expenditure per capita for class j.

s_j, sm_j, tx_j, tm_j average and marginal saving and

tax rates.

B.5 Consumption

q_{k_j} consumption of k by class j per capita

$\epsilon_{Y_{kj}}$, $\epsilon_{P_{kj}}$, $\epsilon_{P_{alt_{kj}}}$ expenditure, price, cross price,

quantity elasticities for k by

member of class j

$\hat{P}_{r_j}$, $\hat{P}_{ra_j}$ per cent change in retail price of own and alternate

(substitute) goods

ΔQ_k total change in demand for k

$\hat{v}_{ij}$ per cent change in "quality" (value added) per unit

of i as consumed by class j per capita

$\epsilon_{Y_{v_{ij}}}$, $\epsilon_{P_{v_{ij}}}$, $\epsilon_{P_{alt}v_{ij}}$ expenditure, price, cross price,

quality elasticities for i by member

of class j

P_{au_i} , P_{ar_i} total quality content of commodity i in urban, rural

areas

ΔSUB, ΔEXC change in wheat subsidy and sugar excise tax

TAR_{1j}, TAR_{5j} fraction of wheat subsidy or sugar tax to j class

B.6 Nutrient Intake

Four nutrients are considered calories, vegetable protein,

animal protein, fat. These are k = 1, 2, 3, 4 respectively.

$\hat{Nut}_{kj}$ per cent change in intake of nutrient k by a member

of j class

$\epsilon_{Y_{kj}}$, $\epsilon_{P_{kj}}$ expenditure and price elasticities for nutrient k

by member of j class

B.7 Balance

ΔWI increase in wheat imports

Δx_i, ΔQ_i, ΔLS_i, $\Delta SEED_i$ increase in production, consumption,

losses and seed requirements commodity i

FXI   foreign exchange cost of wheat imports

ΔRS, ΔRBS, ΔSS increase in rice, basmati rice, sugar stores

γ_i units of produced commodity to make 1 unit of consumed

(processed) commodity