PN-ABF-746
ISN 67500

DATA INTERPRETATION TECHNIQUES AND ANALYTICAL METHODS FOR FOOD POLICY ANALYSIS

A Review of the Experience Generated from Food Policy Studies
Funded by the Office of Nutrition,
U. S. Agency for International Development and
Coordinated by the Nutrition Economics Group,
Technical Assistance Division, Office of International
Cooperation and Development,
U. S. Department of Agriculture

Margaret S. Andrews

Report prepared under Purchase Order No. 40-319R-8-0053

Washington, D. C.

July 1989

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I. SUMMARY

Over the past twelve years a program of applied research related to the effects of agricultural and food subsidy policies on the food consumption behavior of nutritionally at-risk households has been undertaken by the Nutrition Economics Group (NEG)---a unit of the Technical Assistance Division of the Office of International Cooperation and Development at the U. S. Department of Agriculture (USDA). The work, which was supported by the Office of Nutrition of the U. S. Agency for International Development (A.I.D), included a series of food policy studies in developing countries of Africa, Latin America, and Asia.

Although the studies were addressed to specific policy issues and were expected to generate results that would have an effect on the policy process, a major area of concern was the development of methods. Because the work did not deal explicitly with methodological development, there is a need to summarize what was learned about methods from the policy studies. This report addresses that need.

The report focuses on interpretative and analytical methods that can be used with existing data. Documents from forty food policy studies done in 17 countries are reviewed. The types of data sources used and the techniques and analytical methods adopted in those studies are described. In addition to the food policy studies, NEG sponsored some work on conceptual and methodological issues. Findings from this work are incorporated into the general discussion.

The major focus of analysis of the food policy studies has been consumption behavior at the household level. The most accessible

source of household-level consumption data are income and expenditure surveys which are periodically conducted by government agencies for defining the average market baskets used to measure inflation. When these surveys are available, data can be summarized and tabulated to allow comparison of the spending behavior of different groups. The policy studies using these data made tabulations for the average household of different groups defined according to their income level, region of residence, urbanization status, occupation, education level, use of food subsidies, degree of market orientation, and other characteristics.

Household-level data can also be used to explore the nutritional status for the average household of different population groups and to locate the nutritionally at-risk population. Nutritional availabilities at the household-level are estimated by converting the quantities of food available in the household into their calorie, protein, or other nutrient equivalent using ratios obtained from studies that analyze the nutrient contents of common foods.

Regarding the determinants of household food consumption behavior, the major policy-related variables analyzed are food prices and incomes. Price and income elasticities (which show the proportionate response of household food consumption to a change in prices or income) were statistically estimated in studies where appropriate data were available. Various statistical methods for estimating these elasticities were explored. However, problems of estimation remain and no consensus emerged regarding the best method. Because household surveys often measure behavior at a relatively fixed point in time, a

major problem is related to the lack of variation in prices. The studies did converge on the realization that it is important to separately analyze the behavioral pattern of the lowest income households.

Two other issues of importance to household level consumption behavior that have been a focus of NEG work are: 1) the interaction between consumption and production decisions in households producing some of their own food; and 2) the distribution of food within the household. The major constraint on developing methods that jointly analyze production and consumption decisions has been access to household level data that includes observation on both sets of activities. Linear programming models, which require less data, were developed in two studies. In one set of studies, appropriate survey data from Sierra Leone and Nigeria were available, and important advances in the use of statistical methods for jointly analyzing consumption and production data were made. Regarding intrahousehold distribution questions, the major constraint has also been a lack of access to survey data. In the food subsidy study in Sri Lanka, data were available describing individual food intakes within households and several methods for accessing intrahousehold distribution were explored.

In addition to describing and analyzing behavior at the household level, food policy analysis also requires analysis of behavior at the market and economy-wide levels. Partial-equilibrium models were used in several studies to predict how the supply, demand, and price of a key food commodity responded to policy factors. A sector-level linear

programming model was developed in Honduras and used to simulate the effects of changes in price and credit policies. In Indonesia, a multi-market, sector model was used to explore the effects of fertilizer subsidy policy on domestic supply and imports of eight food crops. Macroeconomic models were used in Peru to study trade policy and in Egypt to examine the relationship between government spending on food subsidies and inflation.

The NEG experience suggests that studies involving a substantial modeling component require long-term support. Resources committed to developing models for policy analysis are more likely to influence policy making if an effort is made to develop models that fit within the absorptive capacity of data systems and technical expertise. Flexible formulations that are comprehensible to non-technical administrators and models that can be manipulated in a microcomputer environment are more likely to be used in a decentralized policy making situation.

II. OVERVIEW

In order to place the NEG effort in perspective, this section provides an overview of the NEG's experience with policy analysis through its applied research (as opposed to technical assistance and training) activities. An early focus of NEG's work was its Consumption Effects of Agricultural Policies (CEAP) project. Between 1980 and 1983 NEG commissioned a series of seven, short-term CEAP studies to explore the types of methods that could be used with existing data to generate policy relevant analyses. Another early project, Subsidized Food Consumption, funded four studies aimed at analyzing and evaluating alternative food subsidy schemes.

At the mid-project review of the CEAP project it became clear that substantive and methodological differences in the two projects were not large. Thus, after 1985, NEG activities were consolidated under a single project. A detailed description of NEG's applied research activities is included in Appendix 1.

A. Policy Studies Produced

The remainder of the report will focus on the policy studies that were produced as a result of NEG activities. Table 1 summarizes some important aspects of those studies. Funding sources and levels are indicated in order to put these studies in context and provide an indication of the level of effort involved. Because of the country focus of the CEAP effort, in virtually every case there was support provided by the cooperating USAID mission. This funding, which was frequently provided on an informal, in-kind basis, is not explicitly acknowledged in the Table 1.

Table 1. Description of Policy Studies

I. CEAP SHORT-TERM POLICY IMPACT STUDIES

Country	Investigator*	Policy Being Examined	Duration	Funding**
Cameroon	CRED	Opening border to trade with Nigeria	4/81-9/82	B(1)
Jamaica	NEG, DAC	Export promotion (sugar) vs. import substitution	10/80-12/83	B(1)
Panama	RTI, Sigma One	Promotion of self-sufficiency in basic grains	1/82-3/84	A(1)
Peru	Sigma One	Cheap food policies	10/83-10/85	B(1)
Senegal	CRED	Promotion of increased food crop self sufficiency	10/80-1/83	B(1)
Sudan	RTI, Sigma One, IFPRI	Elimination of wheat price subsidy	10/80-12/82	B(1,4)
Tanzania	RTI, Sigma One, IFPRI	Operation of official and parallel grain markets	10/80-12/83	C(1,3)

II. OTHER CEAP STUDIES

Country	Investigator*	Policy Being Examined	Duration	Funding**
Caribbean Islands	CFNI	Food marketing structure and policies	1/83-3/87	C(1,4,5)
Honduras	ECID, NEG ADAI	(methodological/ institutional)	1/80-3/88	D(1,4,5)
Indonesia	CARD	Fertilizer price subsidy	2/85-11/87	B(2)
Sierra Leone /Nigeria	MSU	(methodological)	6/78-10/82	D(1)
Zambia	FAPRI	Maize pricing policy	5/85-7/87	B(2)

Table 1. continued

III. FOOD SUBSIDY STUDIES

Country	Investigator*	Policy Being Examined	Duration	Funding**
Dominican Republic	Tufts	Price stabilization policies	10/84-3/88	C(2,3)
Egypt	IFPRI	Food subsidy and rationing system	10/80-4/85	D(2,3)
Mali	Tufts	Price policies	10/86-10/88	C(2,3,4)
Sri Lanka	IFPRI	Food stamp program	10/82-10/86	D(2)

* Investigator

ADAI - Forum for Agro-industry, Tegucigalpa, Honduras
CARD - Center for Agriculture and Rural Development, Iowa State University, Ames, Iowa
CRED - Center for Research and Development, University of Michigan, Ann Arbor, Michigan
DAC - Development Assistance Corporation, Washington, D.C.
ECID - Center for Studies of Integration and Development, Central American Common Market Secretariat, Guatemala
FAPRI - Food and Agricultural Policy Research Institute, University of Missouri-Iowa State
IFPRI - International Food Policy Research Institute, Washington, D.C.
MSU - Michigan State University, East Lansing, Michigan
NEG - Nutrition Economics Group, U. S. Department of Agriculture, Washington, D.C.
RTI - Research Triangle Institute, Research Triangle Park, N.C.
Sigma One - Sigma One Corporation, Raleigh, N.C.
Tufts - School of Nutrition, Tufts University, Medford, Massachusetts

** Funding Level and Sources Classification

A - less than $100,000
B - $100,000-$199,999
C - $200,000-$399,999
D - over $400,000
(1) - funds through NEG by Office of Nutrition project
(2) - funds directly from the Office of Nutrition
(3) - funds through USAID mission
(4) - other A.I.D. funds
(5) - other funding sources

B. Data and Methods Used in the Policy Studies

The purpose of this section will be to provide an overview of the data and methods explored in the policy studies. Methods are grouped into two categories: 1) data interpretation methods---or techniques for organizing relevant data in a manner which allows its interpretation according to accepted conceptual relationships and 2) analytical methods---or techniques utilizing data within mathematical structures that describe certain aspects of conceptual relationships. It is thus presumed that analysis is based on an underlying conceptual framework which organizes the understanding of important relationships being examined. A sampling of conceptual frameworks from the general literature is presented in Appendix 2.

Table 2 organizes the NEG experience in methodological development according to the countries studied. Appendix 3, which is also organized by country studied, supplements this table with methodological abstracts of documents produced including detailed descriptions of the types of data analyzed, data collection activities, data interpretation techniques, and analytical methods used. Table 2 serves as a reference for relating subsequent discussions of data interpretation and analytical methods to NEG activities and the policy studies reviewed.

Table 2 and accompanying appendix material indicate that NEG's work has generated a broad range of experience. Several caveats should be stated regarding this material, however. First, the quantity of material abstracted in the Appendix 3 for a given country is sometimes more indicative of the reporting format than it is the level of the

effort. Second, the table and appendix material do not provide indications of the quality of individual efforts. Previous evaluations of the quality of work supervised by NEG can be found in the reports of the mid-project evaluation (Johnson, Evenson 1983, and Roe) and the 1987 NEG project review (Dawson and Kennedy). Although statements regarding quality can be found at various points in the text of this report, the information in Table 2 and Appendix 3 reflects the goal of summarizing and synthesizing the methodological lessons learned from NEG's work.

Table 2. Summary of Data Analyzed and Methods Used in NEG Policy Studies

	COUNTRY STUDIES																
	Cameroon	Caribbean Islands	Dominican Republic	Egypt	Honduras	Indonesia	Jamaica	Mali	Nigeria	Panama	Peru	Senegal	Sierra Leone	Sri Lanka	Sudan	Tanzania	Zambia
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I. PRIMARY DATA COLLECTION	X	X	X	X	-	-	-	-	-	-	-	X	-	X	-	-	-
II. DATA INTERPRETATION																	
Tabulations:																	
Household Consumption Data	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Budget Shares	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	-
Nutrient Availabilities	X	X	X	X	X	X	X	X	-	X	-	X	X	X	X	-	X
Farm Production Data	X	-	-	X	X	-	X	-	-	X	-	X	X	-	-	-	-
Sector-Level Data	X	X	-	X	X	X	X	-	-	X	X	X	-	X	X	X	-
Macroeconomic Data	-	X	-	X	X	-	X	-	-	-	X	-	-	X	X	X	X
Other	-	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-	-
Trend Analysis:																	
Growth Rates	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	X	-
Other	X	X	-	X	X	-	X	-	-	X	X	X	-	X	X	X	-
Measures of Economic Protection:																	
Domestic Resource Cost	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Nominal Protection Coefficient	-	-	-	X	-	-	-	-	-	-	X	-	-	-	X	X	-
Other	-	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-
Descriptions of Policies:	-	X	-	X	X	X	X	-	-	X	X	X	-	X	X	X	X

Table 2. continued

COUNTRY STUDIES

	Cameroon	Caribbean Islands	Dominican Republic	Egypt	Honduras	Indonesia	Jamaica	Mali	Nigeria	Panama	Peru	Senegal	Sierra Leone	Sri Lanka	Sudan	Tanzania	Zambia
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
III. ANALYTICAL METHODS																	
Household Demand Analysis:																	
Engel Curves	-	X	-	X	X	X	-	-	-	X	-	X	-	X	-	-	-
Income and Price Elasticities	X	-	X	X	X	X	-	X	X	-	X	-	X	-	X	X	-
LES/Frisch Technique	-	X	-	X	X	-	-	-	-	-	X	-	-	-	X	X	-
Full Demand System	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-
Singe-equation Model	X	-	X	-	X	-	-	X	X	-	-	-	X	-	-	-	-
Elasticities by Income Group	-	-	X	X	X	X	-	X	-	-	X	-	X	-	X	-	-
Nutrient Consumption Functions	X	X	X	X	X	X	-	X	-	-	-	-	-	X	-	-	-
Household-Firm Model																	
Econometric Formulation	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Linear Programming	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-
Sector Model:																	
Partial-equilibrium	-	-	-	X	-	-	-	-	-	X	-	-	-	-	X	X	-
Multi-market	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Macroeconomic Model:																	
Computable Gen. Equilibrium	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Other	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Model:	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	X	-

III. DATA INTERPRETATION

The NEG experience has shown that careful consideration of available data can greatly improve the relevance of policy analysis by accurate identification of the policy issues or problems which need to be addressed. When inadequate attention is given to interpreting available information, costly efforts at developing more sophisticated or structured information systems can be counterproductive.

For example, a serious problem facing the long-term CEAP effort in Honduras (which included substantial data analysis and quantitative modeling) was the lack of a vision as to what economic problem needed to be addressed (Roe, p. 10). A subsequent NEG effort to more fully use existing data bases was able to achieve a clearer problem focus on four agricultural policy areas (Garcia, Norton, Ponce Cambar and van Haeften).

In addition to aiding in problem identification, it is sometimes possible that interpretation of existing data can be useful in policy evaluation and analysis. An effective use of existing data was made in the food subsidy study in Sri Lanka (Edirisinghe). That study was able to utilize two large-scale household expenditure surveys carried out by the Central Bank of Ceylon. The first was conducted in 1978/79 while the country's forty year old food subsidy program was still in place and the second in 1981/82, two years after a food stamp scheme was enacted to compensate for the removal of subsidies. The survey data was tabulated to show differences in access to subsidies and food spending behavior of target households before and after the change in subsidies.

The remainder of this chapter discusses the major data sources and techniques for interpreting data used in the NEG policy studies. Techniques are not discussed in sufficient detail to allow an unpracticed analyst to apply them. An excellent source for guidelines on constructing simple economic indicators and applying many of the techniques discussed in this chapter can be found in a publication by Norton which was supported by NEG and published and distributed by the U. N. Food and Agricultural Organization (FAO).

The major data sources used in the policy studies include:

* Household Food Consumption Data -- survey data describing expenditures, food consumption and the socioeconomic profile of households;

* Farm-level Production Data -- census and/or survey data on agricultural production, resources, and marketing patterns for representative farm types;

* Sector-level Data -- time series and regional data on agricultural production, foreign trade, food disappearance, prices, and marketing and distribution practices;

* National and International Data -- published data from various government agencies on national and international economic conditions;

* Descriptions of the Policy Environment -- qualitative data on the political and institutional context.

A. Household Food Consumption Data

Because nutritional problems tend to be more prevalent among certain socioeconomic groups, access to household-level data on food consumption emerged as a basic requirement for identifying those groups at greatest nutritional risk and analyzing how their consumption is affected by economic policies. The most widely available source of data on household consumption patterns is income and expenditure (or household budget) surveys. These surveys are conducted periodically to

formulate and revise the average market basket used to construct consumer price indexes. They include household expenditures on a wide range of food and nonfood items and information on income, employment, education, household composition, racial and ethnic status, and place of residence. Existing household income and expenditure surveys were a major data source for the CEAP studies in Honduras, Indonesia, Peru, Sudan, and Tanzania and the food subsidy studies in Mali and Sri Lanka. Existing surveys were used for some components of the food subsidy study in Egypt.

The basic technique for interpreting this survey data is the tabulation of average expenditures on different types of food (or food groups) for various socioeconomic groups in the sample. Average expenditure shares (i.e. the ratio of average spending on a certain item to total spending) for different groups provides a relative dimension. The household types most frequently singled out for analysis are based on sample partitions according to: 1) ranges of the income distribution (quartiles, quintiles, or deciles); 2) urban or rural location; 3) region of residence; 4) household size; and 5) occupational category of the household head. Other household types investigated include sample partitions by: 1) ethnic group; 2) age, gender and employment status of the head of the household; 3) employment status of female adults in the household; and 4) dependency ratio (i.e. the ratio of the number of household members younger than 16 and older than 65 to the number between 15 and 65).

Tabulation of the proportions of the sample population belonging to the various household types provides important information for

policy analysis. Analysis of the distribution of households among income groups is of particular relevance. Because stated income levels do not match reported spending patterns in these surveys, it is customary to measure household income by the level of total expenditures (on all food and nonfood items).

Income and expenditure survey data can also be used to describe the composition of the diet and nutrients available from the household's purchased food supply. Nutrient availabilities are estimated by converting the quantities of foods purchased by the household into calories, proteins, or other nutrients using estimates of the average nutrient content of foods. The nutrient conversion ratios are taken from tables reporting the nutrient composition and content of foods. Such tables are usually published at the national or regional level by government agencies. For example, in the food subsidy study in the Dominican Republic, nutrient conversion ratios were taken from four different food composition tables published by 1) the Division of Nutrition of the Public Health and Social Welfare Ministry in the Dominican Republic; 2) the National Nutrition Institute in Mexico; and 3) the U. S. Department of Agriculture. In the NEG policy studies, the range of nutrients considered was usually restricted to calories and proteins. However, in the Indonesia study iron, vitamin A, and thiamine were considered as well.

Data on the quantities of foods purchased and estimates of nutrient availabilities at the household level can be used to examine the average daily availabilities of important foods, food groups, and nutrients from the purchased food supply for different household types.

The percentage of calories or proteins coming from different foods or food groups can also be tabulated for specific groups. For the studies reviewed, the food or nutrient availabilities were frequently reported on a per capita or per adult equivalent basis. (Household size on an adult equivalent basis is calculated by weighting household members according to ratios based on calorie requirements for different age and sex categories.) Adjustment to a per capita or per adult equivalent basis facilitates the comparison of nutrient availabilities with recommended intakes.

The conversion of quantities of foods purchased into average nutrient availabilities and the comparison of these availabilities with household requirements also allows the classification of households according to nutritional attainment. In the Sri Lanka food subsidy study (Edirisinghe), a sample partition for the ultra-poor (i.e. those households spending more than 80 percent of their income on food and purchasing less than 80 percent of required calories) was analyzed. In one of the studies done in Egypt (Alderman and von Braun), the percentage of households failing to acquire the recommended level of calories and proteins was tabulated by expenditure quartile and rural-urban location. In Indonesia (Center for Agricultural and Rural Development 1987a) households were grouped into four strata according to per capita calorie availabilities, and in Sudan (Pinstrup-Andersen, von Braun, Uy and Floro), households were grouped according to attainment of recommended intakes.

Another strategy for nutritional analysis is the comparison of diets observed from the survey with a standard, or minimum basic diet.

One of the reports from the Honduras study (Permanent Secretariat of the General Treaty of Economic Integration of Central America 1983b) elaborated a minimum basic diet based on nutritional standards, estimated its cost, and compared it with average per capita diets and expenditures for various socioeconomic groups from the survey. In Panama, the survey sample was stratified according whether food expenditures exceeded the cost of a basic food basket elaborated by the Ministry of Health.

When food prices from different regions or market sources are available, as they were in the Dominican Republic and Mali, a measure of the nutritional efficiency of different food sources can be computed. This was done by using the prices and nutrition conversion ratios to calculate calories and proteins supplied per currency unit spent on a given food in a given region or market source. The Zambia study included a table comparing the costs of providing 100 calories and 5 grams of proteins from frequently consumed food sources (Center for Agricultural and Rural Development 1985).

In general, surveys conducted for other purposes rarely include the full set of data needed for policy analysis. Some of the problems encountered with use of household expenditure surveys in the policy studies reviewed were that: 1) they did not measure prices; 2) they did not include food consumed from home production and changes in food stocks and therefore were an incomplete measure of consumption; and 3) individual intakes were not available so that food distribution within the household could not traced. Not all of the surveys suffered from these defects.

Other sources of household food consumption data used are the dietary component of nutrition surveys and consumption measures from special purpose surveys. The CEAP study in Panama used household food consumption and expenditure data from a special nutrition survey and the methodological work done at Michigan State used two surveys conducted in conjunction with other project evaluation work. Primary data collection was still necessary in the some cases and surveys were conducted in Cameroon, the Dominican Republic, Egypt, Senegal, and Sri Lanka. Because of the central importance of household food consumption behavior, the possibilities for more timely and cost effective methods for collecting food consumption and expenditure data have been a more recent focus of NEG efforts (Bonnard, Zalla).

B. Farm-Level Production Data

The most widely available data for accessing the production patterns of representative farm types are agricultural censuses. These data are collected as a regular component of official census efforts and are generally not available for individual households. However, published documents contain tabular material showing crop production patterns, yields, available resources (land, capital and livestock holdings), family and hired labor use, fertilizer and pesticide use for the average farm of a given region, farm-size category, or tenure arrangement. Tabular information regarding sales, income, operator characteristics (age, race and ethnic background, family composition, education) is also available. Census material was used effectively in several reports from the Honduras study. (See Permanent Secretariat of

the General Treaty of Economic Integration of Central America 1984b and Garcia, Norton, Ponce Cambar, and van Haeften.)

Farm level sample surveys collecting data on agricultural production, consumption, and marketing practices provide the ideal data base for examining consumption effects of agricultural policies, but they rarely exist. Several studies conducted sample surveys to obtain data on production and consumption at the farm level (Cameroon, Egypt, Panama, Senegal and Sierra Leone). Data were used to tabulate the average levels of production, sales, and use for home consumption for important crops in different regions and for different farm types. Two studies (Sierra Leone/Nigeria and Panama) created an index (defined as the ratio of total value of agricultural sales to total value of agricultural production) to indicate the level of market integration for a particular household. (See Smith et al., 1979; Smith, Strauss, Schmidt, and Whelan; Smith, Strauss, and Schmidt; Smith, Whelan, and Schmidt; and Franklin, Shearer, and Arcia.)

C. Sector-Level Data

Government agencies associated with the ministry of agriculture usually assemble a variety of data. The types of data typically available on an annual or quarterly basis include production levels of different crops; land areas cultivated and harvested in different crops; producer, wholesale, and retail prices; fertilizer use, access to irrigation water, and other input use. Generally these statistics are national in scope, but there may be regional disaggregation according to provincial or administrative district boundaries. Ideally, they would be assembled for specific agroclimatic zones---

i.e. geographical areas sharing similar ecological conditions, cropping techniques and rotation patterns, yields, and market infrastructure (Timmer, Falcon and Pearson, p. 111).

The major interpretative techniques used with these data are: 1) regional disaggregation to compare average land use, production patterns, or prices among different areas; or 2) trend analysis of the changes over time in the national or regional averages. Calculations of annual rates of growth is one measure of trend that was used in the Honduras, Indonesia, and Zambian studies. Partial productivity indexes, based on ratios of outputs to inputs, were defined in Jamaica to compare labor productivity in rice and sugar production. Estimates of yields and nutrient conversion ratios were also used in Jamaica to compute a nutrient productivity index for rice and sugar comparing calories and proteins produced per acre for the two crops. Indexes of the terms of trade for agricultural producers can be defined using weighted ratios of producers' prices to retail, input, or import prices. Such indexes were used in Honduras, Tanzania, and Zambia. (See Norton, pp 20-24, for a general discussion of index number problems.)

Government statistics for food imports, exports, and disappearance are another sector-level data source widely used for nutrition analysis. Food balance accounts estimate food available for human consumption at the national level as the residual of total food produced and imported less use of food as feed or seed, changes in inventories, and exported food. Nutrient conversion ratios and population estimates can be applied to the raw data to express food availabilities in calories (or other nutrients) per capita per day.

Food balance estimates in this form can be found annually in the FAO's Food Production Yearbook. They were used in the Caribbean Food and Nutrition Institute's study in St. Vincent and Antigua (McIntosh). However, despite their availability, the usefulness of these indirect indicators is limited because they ignore the distribution of food among regions, income groups, and within families. (See O'Brien-Place and Frankenberger.)

Another important use of sector-level data is to determine the level of distortion caused by agricultural and other economic policies. In cases where market intervention is directly observed through government procurements, the calculation of government procurements as a proportion of production for the affected crops is useful. This was done in Egypt (von Braun and de Haen) and Tanzania (Keeler, Scobie, Renkow and Franklin). An indicator of the reliance on imported foods was computed in Egypt by taking the ratio of domestic production to domestic use (von Braun and de Haen). Other interpretative techniques which have been useful are the computation of nominal (or effective) protection coefficients and domestic resource costs. (These measures are discussed in detail in Norton, pp. 94-115.)

Economic protection coefficients measure the extent to which domestic prices for a particular agricultural product deviate from international levels. The computation of nominal protection coefficients requires data on the domestic and international price of the product, and the exchange rate. Coefficients can be computed for the administered and/or black market domestic prices; official exchange rate or specific exchange rate for a particular type of product if such

exchange rates exist and are available. Nominal protection coefficients were computed in Egypt (von Braun and de Haen) for six commodities for a fifteen year period. The effective protection coefficient requires additional information on inputs used per unit output, their prices, and any subsidy or tax on the output or inputs. Nominal and effective protection coefficients were computed in Peru (Franklin, Leonard and Valdes) for cotton and rice for various regions and years.

The domestic resource cost coefficient is an indicator which helps identify those products having a comparative advantage in domestic production. It measures how much of an economy's domestic resources must be spent to earn (for exported commodities) or save (for imported commodities) a unit of foreign currency. Computing the domestic resource coefficient for a particular crop requires data on input-output ratios, yields, equilibrium input and output prices and exchange rates, and estimates of the extent to which inputs are traded in the international market or only available domestically. This indicator was computed in the studies in Jamaica, Panama, Sudan, and Tanzania.

A major problem in application of this technique is access to accurate data, particularly data on equilibrium prices and exchange rates. Equilibrium prices are not observable, but are notional prices which would exist in the absence of distortions. In practice, some of the data used to compute the domestic resource coefficient are estimated based largely on educated guesses. The study in Sudan (Youngblood and Leonard) addressed the problem of uncertainty about the

accuracy of their data by examining the sensitivity of their computations to changes in the estimated prices, exchange rates and input-output ratios.

D. National and International Data

At the economy-wide level, the types of data useful in the policy studies include: 1) national income and product accounts (including input-output accounts and social accounting matrices); 2) macroeconomic price data (i.e. interest rates, exchange rates, and inflation measures); 3) population and labor force figures; 4) foreign exchange and Central Bank reserves; 5) government spending estimates; and 6) external trade. The principal interpretative techniques relate to: 1) determining the share of the agriculture sector (or food subsidies) in aggregate income, investment, external trade, the labor force, government spending or 2) trend analysis of changes in the macroeconomic data. The studies in Egypt (von Braun and de Haen, Scobie 1983, and Scobie 1984), Peru (Franklin, Leonard, and Valdes), and Tanzania (Keeler, Scobie, Renkow, and Franklin) made extensive use of these data.

E. Descriptions of the Policy Environment

The NEG experience suggests that quantitative data should be supplemented with information on the political and institutional context. In at least two of the policy studies reviewed in this report, substantial insights were obtained by a careful description of the operations of policies. In the first CEAP study in Tanzania (Keeler, Scobie, Renkow, and Franklin), a description of policies associated with the government-sponsored National Milling Corporation

focused attention on differences between official policy regarding grain sales and the operations of parallel markets. A lack of access by certain segments of the population to official markets the for National Milling Corporation grain was thus exposed as a major consumption effect of agricultural policies. In the Egypt food subsidy study, a careful description of the operation of the subsidy system was defined as the first task of a longer-term research effort. This effort (Alderman, von Braun, and Sakr) allowed the definition of subsequent research questions regarding: 1) the effects of subsidies on inflation, government spending, and exchange rates; 2) the interactions between food policy and agricultural production; and 3) the effects of subsidies on welfare and nutrition of consumers.

IV. ANALYTICAL METHODS

This chapter reviews analytical methods used in the NEG policy studies for studying behavior at the household, sector, and macroeconomic levels. The general methodological approach involves the construction of models. A model is defined as an abstract representation of certain aspects of reality expressed in mathematical form. It can be used to explain observed behavior and to predict how behavior will change in response to a policy change.

Models may include a single equation showing how a particular variable (e.g. household expenditure on food) responds to changes in other variables (e.g. income or prices). More generally, models are composed of many equations. In some cases, they are represented by a set of simultaneous equations showing how endogenous variables (e.g. the domestic output and market price of corn) are simultaneously determined by exogenous variables (e.g. disposable income, import quotas on corn, weather, and other factors). In linear programming models, an equation representing the objective function (e.g. a farm profit function) is maximized subject to a set of constraints on behavior expressed as inequalities (e.g. a constraint showing how land used in production must be less than or equal to land available.)

The process of model development involves definition of the equations in an abstract form based on a conceptual understanding of how the variables of interest relate to each other. The model is then applied to a particular situation by expressing the equations in numerical form using data describing that situation. Statistical (or econometric) analysis of data is an important method for generating

parameters needed to numerically specify a model. Parameters can also be estimated by non-statistical data analysis methods such as expert opinion. Once a model is specified, it can be used to make numerical projections of how behavior responds to changes in policy variables.

Any model is incomplete in that it will only represent those aspects of reality critical to the understanding of a particular behavior under consideration. Because of this, one cannot expect models to give definitive answers for real world policy decisions. Rather, analytical models can be viewed as instruments for providing additional points of view to policy decisions. By using models, actors in the policy process can systematically study relationships that otherwise are difficult to understand.

A dialogue between policy makers and model builders regarding problems of concern and tools which can be applied to them facilitates the development of a model that can be used in decision making. The model building effort associated with the study in Zambia (Center for Agricultural and Rural Development, 1987b) is one instance where particular attention was given to tailoring the model to fit the specific needs of actors in the policy-making process. In this case a model was designed to be used by personnel in the planning division of the Ministry of Agriculture and Water Development to project maize imports and government costs that would be associated with policy decisions regarding producer price support levels.

A. Household-Level Models

The central variables used to explain food consumption behavior at the household-level are household income and prices. The importance

of these variables is suggested by standard economic demand theory. (See Deaton and Muellbauer for a comprehensive review of economic analysis of consumer behavior.) According to that theory, the household chooses to consume the set of food and nonfood items that gives maximum utility. Prices of the different commodities and household income determine the constraints which define the feasible consumption possibilities for the household.

Because the amounts of all commodities consumed are determined simultaneously in the utility maximization process, the household-level demand of any particular commodity depends not only on its own price, but on the price of all other commodities and the income available for consumption. Economists frequently summarize demand relationships by using elasticities which indicate how the household varies its consumption of each commodity as prices and income change. An own-price elasticity shows (in percentage terms) how much the consumption of a given commodity will respond to a change in its own price, and a cross-price elasticity shows how much consumption will change in response to a change in the price of some other good. Income (or expenditure) elasticities show how consumption of a good changes when income (or expenditure) changes. While standard theory suggests that income is the relevant variable for analysis, in practice, the level of total expenditures as measured in household budget surveys is frequently used as the empirical measure of income. Expenditure elasticities refer to income elasticities estimated using expenditure as a proxy for income.

1. Techniques for Estimation

Household demand functions and associated elasticities can be estimated from household-level data on expenditures, income, and prices. In theory, the entire set of price and income parameters should be estimated simultaneously from the same set of data and they should be used to specify a simultaneous equation model of household consumption behavior. However, in practice, estimation of a full system of demand parameters is difficult due to limitations imposed theoretically and by the available data. (See Johnson, p. 29, and volume II of Alderman 1984 for further discussion.)

One problem in simultaneous estimation of price and income parameters is that the major data source on household consumption patterns (the household budget survey) does not always collect price data. Even when it does, the data seldom embody sufficient price variation from household to household to infer differences in household behavior attributable to price differences.

Household budget surveys do provide good variation in consumption patterns for households at a variety of income levels. Thus, they can be used to estimate Engel curves which are single-equation models showing the relationship between consumption levels for a given commodity and household income, assuming prices are constant across households. Fngel curves were estimated in the studies in the Caribbean Islands, Egypt, Honduras, Indonesia, Senegal, and Sri Lanka. In all cases except Egypt (Alderman and von Braun) and Honduras (Garcia, Norton, Ponce Cambar and van Haeften) household-level survey data were used in the estimations. For these two exceptions, the Engel

curves were estimated based on average income and expenditures for grouped survey data.

The form of the function used to estimate Engel curves varied among the studies. In general the functions conformed with a pattern known as Engel's Law which predicts that the proportion of income spent on food will decline as income rises. In the Sri Lanka study (Edirisinghe, pp. 34-37), however, the form of the Engel curve allowed for there to be ranges of income where the proportion of income spent on food might increase as income increased. This proved to be the case for the lowest income households when the Engel function was estimated using 1978/79 and 1980/81 household data.

The relative ease of estimation of Engel curves implies that estimates of income elasticities are more easily generated. However, for most of the policy issues examined in the CEAP studies, accurate estimates of both price elasticities and income elasticities were needed. This proved to be difficult. In addition to the estimation problems associated with a lack of variation in prices, problems also occurred because the number of parameters to be estimated is large. For every commodity, an own-price elasticity, a cross-price elasticity with respect to every other commodity, and the income elasticity are needed. Because of estimation problems, some of the studies used methods to estimate price elasticities which allow a full set of own-price, cross-price, and income elasticities to be generated from household expenditure data (even when prices are unavailable) by imposing restrictive assumptions about the nature of the household's utility function. Two methods employing these assumptions, the Linear

Expenditure System (LES) and the Frisch Technique, were used to estimate price and income elasticities from cross section data in several of the CEAP studies---Egypt (von Braun and de Haen), Honduras, Peru, Sudan, and Tanzania. (See Klein and Clements for a further discussion of these methods.)

Although these methods (particularly the Linear Expenditure System) have been widely applied in demand analysis, their application imposes preconditions on the types of elasticities that will be derived. In particular, income elasticities estimated in this way will always be positive (i.e. it will not be possible for consumption of any good to decline as income increases as would be the case for less-preferred staples or inferior goods) and all cross-price elasticities will also be positive (i.e. consumption of a good can never increase when the price of some other good increases). Some experts argue that the estimated price effects are only disguised income effects and that they are nearly proportional to income effects. Overall, it is now generally agreed that methods such as the Frisch technique and the Linear Expenditure System are reasonable only when commodities are grouped into a few main categories of expenditure and price variations within these groups are small. However, such large groupings are seldom amenable to agricultural policy analysis.

There are empirical procedures for estimating a full system of demand functions that do not suffer from the same limitations. In the Indonesia study, regional price data were used together with household expenditure survey data to estimate two alternative complete demand systems---the Almost Ideal Demand System (AIDS) and the Multinomial

Logit Model. (A detailed explanation of these system methods is included in Center for Agricultural and Rural Development 1987a.)

A substantial amount of demand analysis had been done in Indonesia prior to this study. Ten prior studies were reviewed, nine of which had estimated demand elasticities from one of several cross section household expenditure surveys conducted between 1967 and 1984. In the different studies, estimates made for various sample subgroups by income levels, urbanization and region, reflected a wide degree of variation. Own-price elasticities for rice ranged from -.15 to -2.05 and expenditure elasticities for rice from .03 to 3.02 depending on the group, area, or income level. With this degree of variation, no single study is likely to result in a definitive set of demand parameters. However, the progressive application of new techniques for estimation to new data sets leads to the discovery of consistent patterns in parameters. Because of their stability and recurrence, these patterns then set boundaries and cross-check norms against which the results of any one study can be compared.

The tendency for price and income elasticities to be larger for the lower income groups has been of concern to the work of NEG. Although the inverse relationship between expenditure level and income elasticities for food is unquestioned, the pattern of change in food price elasticities is still under investigation.

In the CEAP study in Sudan a controversy emerged regarding the price elasticity for bread. Elasticities estimated by the Frisch technique from household survey data in Khartoum showed the poorest groups to have a higher income elasticity for bread, but a lower price

elasticity than the other groups (Youngblood, Harrell, Demousis, and Franklin). An alternate procedure used the Linear Expenditure System and prices inferred from quantity and expenditure data in the household survey. The estimated elasticities showed a substantially higher price elasticity for bread for the poor and a marked tendency for the price elasticity to decrease with income strata levels (Pinstrup-Andersen, von Braun, Uy, and Floro). The differences in price elasticities estimated by the two methods were large enough in to affect the policy analysis.

Subsequent to the study in Sudan, NEG supported a review of research on patterns of price and income elasticities (Alderman 1984 and Alderman 1986). Fifteen studies conducted since 1976 with estimates of price elasticities by income group were reviewed. The review suggested a consistent pattern between income levels and compensated own-price elasticities (i.e. own-price elasticities adjusted to exclude effects of price change on buying power of income). Rules-of-thumb were derived for adjusting price elasticities estimated from data sources that do not measure differences in buying behavior of income groups (Alderman, 1984, pp. 45-71).

No patterns with regard to cross-price elasticities were identified by the Alderman review. It was suggested, however, that even though cross-price elasticities are difficult to estimate, they are necessary to fully evaluate changes in consumption among low-income households. This is so because poor households are likely to make large swings in consumption toward less preferred staples when price changes threaten threshold consumption levels.

Some of the studies estimated price elasticities using single-equation demand functions (as opposed to a simultaneous demand system). One reason for doing this is to correct for statistical bias that occurs when some of the surveyed households choose not to consume some of the food commodities being analyzed. In such cases, the assumption of random distribution of the variable describing the level of consumption is violated. The studies done in the Dominican Republic, Mali, and Sri Lanka addressed this problem by using a two-step procedure which first estimated the probability that a household would consume a certain food, and then used this relationship to compute a correction factor that was included in the demand function.

2. Using Elasticities for Policy Analysis

Analyzing the effects of a policy change on the consumption behavior of a certain household type not only requires a full set of own-price, cross-price, and income elasticities of demand, but also estimates of how the policy change under consideration can be expected to alter prices and income. Some types of sector and macroeconomic models that can be used to estimate these policy impacts are discussed in section IV.B.

Figure 1 indicates the basic flow of analysis necessary to trace the effect of a change in the price of rice on food consumption and calorie intake. NEG has supported the development of a microcomputer spreadsheet framework for making the required calculations. The software program, known as PICNIC (Price and Income Changes and Nutritional Impact on Consumers), was developed using Lotus 1-2-3 on an IBM compatible microcomputer. The required parameters for analysis

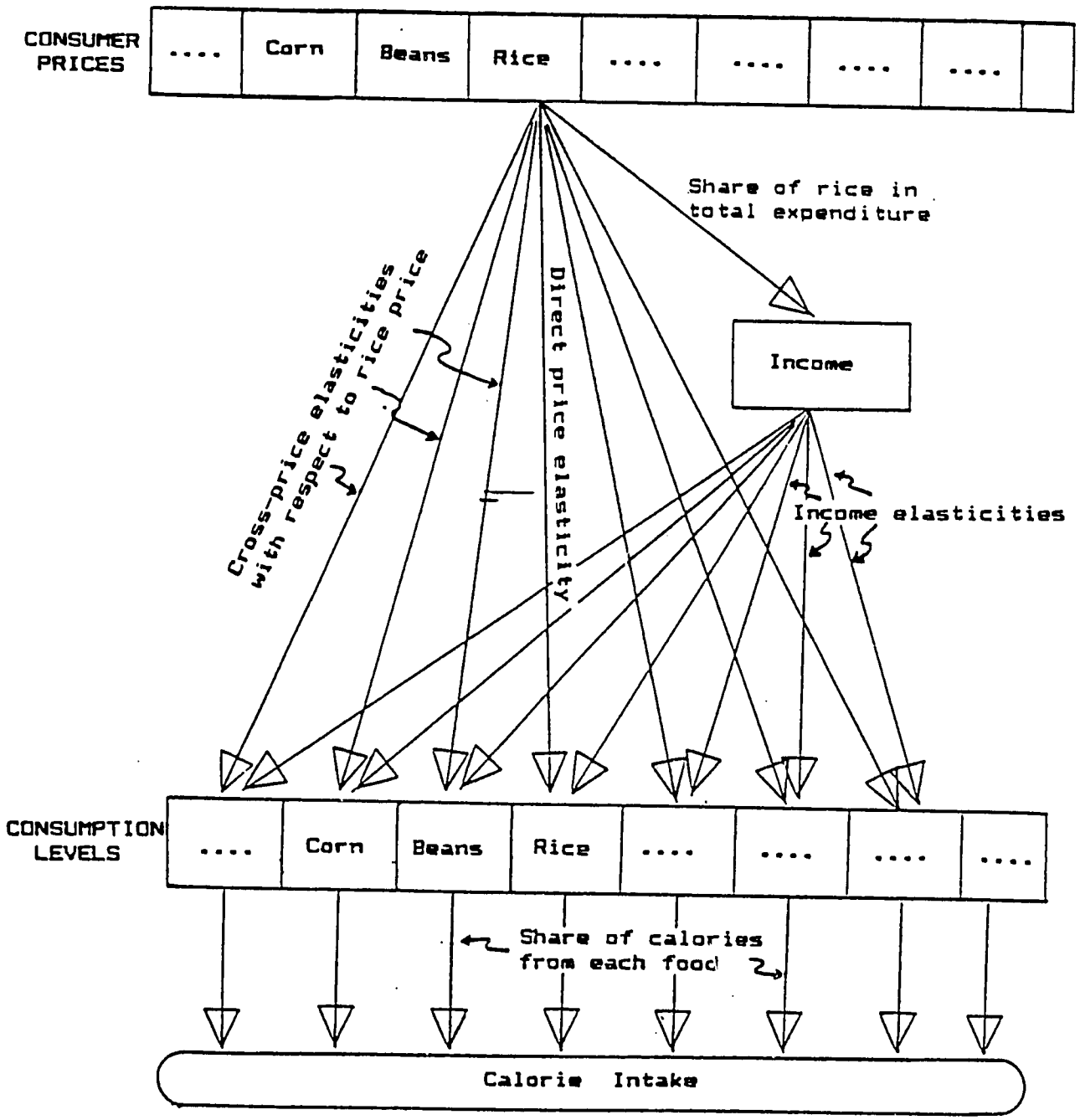

Figure 1. Schematic representation of PICNIC program for computing consumption effects of a change in rice price, (Ariza-Nino).

include: 1) direct-price, cross-price, and income elasticities for each food; 2) the share of each food in total expenditure; and 3) nutrient conversion ratios. After entering necessary consumption parameters into the specified cells on the spreadsheet, policy changes are simulated by entering the estimated changes in food prices and incomes that are expected to be caused by the policy change. PICNIC then computes the percent changes in the quantities of each food consumed and translates those changes into nutrient terms.

Basic guidelines for using the program and sample applications for Brazil and El Salvador can be found in Ariza-Nino (1987). Included are suggestions for targeting the study population and for estimating the required elasticities when they are not available. Overall, the program provides a useful framework for organization of the information necessary to assess policy impact at household level, particularly for those households not directly involved in food production.

3. Nutrient Consumption Functions

An alternative method for estimating the household's nutritional response to changes in incomes and prices, is to use elasticities that directly show the percentage change in nutrients available in the household given a percentage change in income or price. The nutrient elasticities are derived from nutrient consumption functions estimated from household expenditure, or dietary survey data. Although these surveys do not directly measure calories, proteins or other nutrients available from a household's food supply, estimates of aggregate nutrient availabilities can be made for each household. This is done by multiplying the quantity of each food observed in the survey by its

calorie, protein or other nutrient content and then summing the nutrients supplied by each food.

In the Dominican Republic study (Rogers and Swindale) calorie and protein consumption functions were estimated to show how per capita consumption of these nutrients depended on the level of total expenditure, prices of the ten most important foods in the diets, household size and composition, region, inflation and access to home production. The estimations showed that calorie and protein elasticities tend to decline as income rises. Nutrient consumption functions were also estimated in Cameroon, Caribbean Islands, Egypt (Alderman, von Braun and Sakr), Honduras (Garcia, Norton, Ponce Cambar and van Haeften), Indonesia, and Sri Lanka studies. (See Alderman (1984) for a review of evidence on patterns in calorie and protein elasticities.) In Sierra Leone, nutrient elasticities were obtained indirectly using nutrient conversion ratios with price and income elasticities.

4. Household-Firm Models

Semi-subsistence rural households are often one of the groups most at risk of nutritional inadequacy. To adequately determine how an agricultural policy change affects food intake in such households, the policy's impact on production and marketing decisions needs to be considered. However, unlike the standard household demand analysis (which has been subject to empirical investigation since the mid-nineteenth century), the simultaneous empirical analysis of production and consumption activities at the household level has only been seriously pursued in the last fifteen years.

The development of methods to analyze the behavior of semi-subsistence households was an early goal of NEG work. Among the earliest studies (e.g. those in Senegal, Honduras and Sierra Leone) the development of household level models that jointly analyzed production and consumption choices was an explicit task.

Two broad categories of methods have been used to model household production-consumption: linear programming optimization methods and econometric methods. The linear programming models determine the allocation of resources that optimize a household objective function for a representative household. They are constructed by specification of a set of production, marketing, and consumption activities available to the representative households and the resource, time, and accounting constraints that limit those activities. The traditional source of data for linear programming models is farm budget data, a reflection of the method's antecedents as a farm management tool. Other data sources must be employed to describe consumption and marketing possibilities.

The linear programming model constructed for a typical peasant farm in the Casamance region in Senegal (Center for Research on Economic Development, pp. 285-331) was singled out at the mid-project review for providing an innovative method of integrating production and consumption interactions at the household level (Roe, p.29-30). Unlike previous efforts, this model allowed for analysis of the effects of marketing margins in determining the allocation of a typical farm's crop production between home consumption and market sales. Price and income elasticities from other studies were used to incorporate per capita consumption functions for rice and sorghum into the model.

Production, sales, and market purchase activities were included for groundnuts, rice and sorghum with constraints on land, irrigated land, and family labor.

The econometric methods used for the household-firm model are similar to procedures used for household demand analysis. Instead of a single system of demand equations, however, the full analysis of household production suggests that maximization of household utility should yield a system of product supply and input demand equations for home production activities, labor supply functions for household members, along with the usual system of demand equations for purchased goods. Conceptually, the entire production-consumption system should be estimated simultaneously, but in practice such an effort is intractable.

The econometric approach to estimating the full household production model taken in some of the studies done at Michigan State was to combine elasticities estimated from separate systems on the demand and production sides. This approach (as reported in Strauss, Smith, and Schmidt and Strauss, Smith, Schmidt, and Whelan) resulted in methodological developments of lasting significance. Despite problems with the data (e.g. small sample size, a lack of direct observations on food intake, and limited price variations), application of the approach allowed analysis of the tradeoff between higher profits and higher food costs which comes about when the price of a good that is both produced and consumed by the household increases. In particular, the study showed that when profit and food cost effects are both included, the own-price elasticities of demand for root crops and less preferred

cereals are positive for the lowest expenditure group. This implies that for the low expenditure group consumption of these crops increases when their price increases. In general, however, own-price effects on consumption remained negative when profit effects were included. Price elasticities for calorie availability were generally positive (indicating that increases in food prices tended to increase calorie availability among low-income households), but the responses were small.

Various aspects of the work done in Sierra Leone were subsequently published in academic journal articles (Strauss 1982; Strauss 1984a, and Strauss 1984b) and in several chapters of a collection of papers on agricultural household models edited by Singh, Squire, and Strauss. These publication outlets and the reports prepared for NEG have given the methods developed through this project wide exposure. The work is frequently cited by economists as an important innovation in the analysis of consumption decisions of semi-subsistence farmers. Application of the methods developed requires a fairly high degree of econometric skill, and is constrained by a lack of survey data with adequate information on household production, consumption, and time allocation activities.

In summary, the NEG experience has had substantial impact on the development of methods for jointly analyzing the production and consumption behavior of low-income rural households. Nevertheless, a standard approach for applying these methods has not yet been defined. The advantage of the econometric approach is that model specification is based on a probabilistic representation of the population and

therefore should have more accurate predictive power than a linear programming model. However, the complexity of production possibilities faced by farmers, the lack of data on farm-level prices, and other data limitations tend to favor the linear programming approach.

The mid-project reviewers seemed to favor an approach which combined econometrically estimated household demand parameters with a production structure modelled using linear programming techniques. (See Roe, p. 38.) Such an approach (as described in Ahn, Singh and Squire) can be used to derive production and marketing elasticities similar to those derived econometrically.

5. Intrahousehold Distribution and Other Non-Economic Factors

The previous sections on analytical methods have concentrated on methods that derive explicitly from economic theory. The exclusive focus on the household as a decision making unit and the failure of the theory to address questions of distribution of resources within the household raises questions concerning the applicability of standard economic analysis. Economists have made some attempts to expand household analysis to intrahousehold questions, but much remains to be done in this area. NEG produced a publication on the subject that reviewed the literature and contributed to conceptualization of the issue (Nutrition Economics Group). This publication received wide distribution and has been cited in academic journals.

The policy study in Sri Lanka developed methods for analyzing intrahousehold distribution questions, using data from a special household survey that reported individual food intake for all household members. From this data, Edirisinghe and Hettiaratchi estimated an

equity index based on the ratio of the average calorie adequacy of preschoolers in the household to the average adequacy of all other members. Separate calorie consumption functions for preschool children and for all other household members were estimated.

Behavior related to seasonality, food habits and taboos, and non-capitalistic social structures can have strong implications for food consumption and nutritional adequacy. These issues have also been given inadequate treatment by methods based on traditional economic theory. The development of formal methods to consider these questions and the wider social, political, psychological, and cultural determinants of household behavior is a formidable problem, but one that deserves consideration.

B. Modeling Behavior Beyond the Household Level

In addition to predicting household behavior, food policy analysis requires estimates of the effects of policy changes on market behavior. A review of the types of agricultural policies that might be considered indicates the extent of the modeling problem. Possibilities for analysis include: 1) price and marketing controls; 2) tariffs, taxes and restrictions on imports and exports; 3) irrigation, fertilizer, or credit subsidies; 4) land use controls or land reform; and 5) food consumption subsidies. Each type of policy change requires a somewhat different approach. This section reviews a few of the possible modeling options.

1. Sector Models

At the sector level, two types of models are common: 1) a single-market equilibrium model that considers the supply and demand

for a single commodity 2) a multi-market equilibrium model that simultaneously considers market adjustments for some combination of output and input markets associated with the food sector.

Partial-equilibrium models portray equilibrium in a single market. Construction of such models requires the estimation of parameters that describe the supply and demand functions for a particular product along with net import functions. Analysis is usually performed at the national level, but can be done at regional levels in areas were markets are not highly integrated. Supply and demand and net import equations can be estimated simultaneously from time series data on prices and quantities. Where reliable data are unavailable, expert opinion along with sensitivity analysis can be used to adopt reasonable supply and demand parameters. In most cases imports can be assumed to be in infinite supply at the world price.

Partial-equilibrium models can give some insights into how pricing and procurement policies or import or export measures for a particular commodity affect supply, demand, and net imports of that commodity. They also indicate how the equilibrium price in that market will adjust to policy changes. Partial-equilibrium models were used in the analysis of corn pricing and procurement policies in Tanzania (Renkow, Leonard, and Franklin), maize pricing and imports in Zambia (Center for Agricultural and Rural Development 1987b), and wheat imports in Sudan (Youngblood, Harrell, Demousis, and Franklin).

Models of this type require specification of relatively few behavioral and accounting equations and they are easily adaptable to spreadsheet-type software programs for microcomputers. The

disadvantage of these models is that they give a one-dimensional, first approximation of policy effects. They do not account for the fact that whenever the price and market conditions for any one good changes, there will be repercussions throughout the economy. Input demands and prices will adjust. The supply and demands of other goods will adjust as input prices change and resources are reallocated. Some of these wider equilibrium effects can be captured in multi-market models that have endogenous prices and analyze the simultaneous equilibria of several markets.

One type is the sector-level linear programming model which simulates sector equilibrium by using an objective function maximized by the unique price level equating supply with demand. Because of the greater flexibility in specification of the production structure, these models are particularly useful for engaging in policy experiments related to technological change. They also have the advantage of generating shadow prices for scarce resources (such as irrigated land), which can be used in project level cost-benefit analysis. One disadvantage of large linear programming models has been that, until recently, they have required a mainframe computer capability for efficient use.

A sector-level linear programming model was developed in Honduras (Permanent Secretariat of the General Treaty of Economic Integration of Central America 1984b) and used to estimate the responsiveness of: 1) supply of corn and beans to changes in crop prices; and 2) credit demands to changes in the interest rates. The responses of small and medium-size producers were compared. In Egypt (von Braun and de Haen),

a sector-level linear programming model was used to predict the changes in crop supplies which would occur when price distortions were removed across the board.

Price-endogenous equilibrium models of the agricultural sector can also be constructed from econometric estimates (or expert opinion). These models include simultaneous equations describing the supply and demand for agricultural outputs and inputs. Policy analysis is incorporated by numerically specifying a model and then solving it to derive multipliers showing how market-clearing outputs, inputs and prices respond to factors controlled by government policy. An existing policy model of this form was used in India during a technical assistance assignment (Evenson, 1986.)

When prices are set by government policy, multi-market models can be adapted by allowing equilibrium to be restored by quantity adjustments. This was the case of a model developed in Indonesia (Center for Agricultural and Rural Development 1987c) to study fertilizer subsidies. This model uses basic supply and demand parameters (own-price, cross-price elasticities of demand and supply, and income elasticities of demand) estimated from other studies to show how prices (set by the government or the international market) affect area harvested and yield of different crops, domestic consumption, and domestic supply. Equilibrium is restored by allowing net imports to adjust to any discrepancy between domestic supply and demand. Rural incomes and government costs of the subsidies for fertilizer, rice, and wheat are also determined endogenously. The core of the Indonesia model includes 12 equations which describe area, yield, domestic

consumption, and disappearance for each of eight food crops. It is easily adaptable to a spreadsheet format and policy experiments can be done on a microcomputer.

2. Macroeconomic Models

When the CEAP project was organized, it was not expected that macroeconomic analysis would be an important component. However, at the mid-project review the need for this analysis was clearly expressed (see Roe, pp. 2-6). The study in Tanzania (Keeler, Scobie, Renkow, and Franklin) illustrated that the distortions induced by trade, exchange rate, monetary, and fiscal policies often exercise more influence on agriculture than sector policies.

A macroeconomic policy stance typical of that encountered is one in which trade, exchange rate, and price controls are all applied in a manner that serves to tax the agriculture sector. The alleged purpose of such a policy is to protect domestic industry and to provide low and stable food prices. The result is to discourage domestic agricultural production and exports and invite dependence on food imports. Furthermore, budget deficits and inflationary monetary expansion are required to sustain the situation.

Macroeconomic models describe the economy-wide determination of levels of employment and output (including net-exports) and the interaction among the level of output, financial and/or exchange rate markets. One class of macroeconomic models widely used for macroeconomic food planning and agricultural policy analysis in the last ten years is a computable general equilibrium (CGE) model.

In all applications, a multisectoral production structure is used and food consumption is disaggregated by socioeconomic group. The models include: 1) supply and demand balances by sector; 2) equations for income determination for each socioeconomic group; 3) consumption functions by income group; and 4) savings and investment, trade deficit and government deficit balances. The financial sector is ignored.

The models can be solved for multipliers or policy experiments can be executed to determine how the average food consumption of different socioeconomic group responds to policy changes. Estimates of changes in food consumption calculated by these models incorporate feedbacks between the agriculture and non-agriculture sector which are not captured by sector models.

A small CGE model of the Peruvian economy focusing on trade relationships was employed in one of the CEAP studies to illustrate the manner in which agricultural sector policies were relatively unimportant compared to the complex structure of tariffs, quota restrictions and other commercial policies which protected domestic manufacturing from import competition (Franklin, Leonard, and Valdes.) The model's production structure divided the economy's economic activity into two major sectors (agriculture and nonagriculture) with subsectors for those activities subject to import competition, export, or no foreign competition. The consumption structure specified demands for the products of these five subsectors by five socioeconomic groups. The model compared the effects of trade policy interventions with the effects of direct food price subsidies.

Macroeconomic models based on the monetary theory of the balance of payments were used in the Egyptian subsidy study to show the impact of changes in the level of government spending on food subsidies on domestic inflation and the unofficial (black-market) exchange rate (Scobie 1984.) A domestic money market model consisting of supply and demand equations for domestic currency and foreign exchange was estimated.

V. CONCLUSION

When NEG activities began in 1977, the focus on consumption was unique. At that time, most agricultural professionals concerned with hunger problems were placing emphasis on food shortages and supply-side aspects of agricultural policies. Thus, a major contribution of NEG's efforts is the cumulative demonstration that it is possible to use available data, theory, and methods to generate policy-relevant information linking changes in agricultural policies to food consumption of nutritionally at-risk groups.

However, food policy analysis has not yet reached the stage where an off-the-shelf method can be applied in the manner in which an engineer can look up technical coefficients. Systematic review of data at the household, sector, and macroeconomic levels is needed to describe the dimensions of each situational context.

Several techniques for data interpretation, not requiring a full-scale model building effort, have proven to be useful in many of the policy studies managed by NEG. The most fundamental of these is the tabulation of average expenditures, budget shares, and nutrient consumption patterns for different household types (by income, occupational, regional, and urbanization status) from existing household survey data. This exercise allows some first round analysis of distributional effects of price and income changes on different types of households.

The basic components of formal policy analysis shown to be useful in the NEG studies were: 1) price and income demand elasticities by income group; and 2) sector and/or macroeconomic models for projecting

impacts of policy changes on prices and household income. Given access to existing demand parameters and sector or macroeconomic models, it is reasonable to expect that a policy analysis team could apply the methods developed in the NEG studies to perform short-turnaround, policy impact analysis. However, when models need to be developed, longer-term effort is necessary.

The NEG experience contributed to notable methodological advances in at least two instances. New statistical (econometric) methods for jointly analyzing the production and consumption aspects of household decision making were developed in a study using survey data from Sierra Leone and Nigeria. Also, the cumulative experience of several NEG studies helped establish the importance of allowing for differences in the price responsiveness of food consumption decisions for the very poor. NEG also contributed to the conceptualization of the problem of intrahousehold food distribution.

APPENDIX 1: AN INSTITUTIONAL HISTORY

The Nutrition Economics Group was formed in 1977 with guidance and support from the Office of Nutrition, U. S. Agency for International Development (A.I.D.), through a Resources Support Services Agreement (RSSA) agreement. NEG provided assistance to A.I.D. in organizing a program of applied research and technical assistance related to food consumption and nutrition. As a part of its applied research program, NEG supported the development of methods for determining the effects of government policies and programs on the food consumption patterns and nutrient intakes of nutritionally at-risk groups.

NEG's initial work was organized in terms of three projects. The first project, Economic Analysis of Agricultural Policies (931-1171), provided general support for the group and was the funding mechanism for a longer-term study carried out by Michigan State University. The Consumption Effects of Agricultural Policies (CEAP) (931-1274) was the group's second project. A third project dealt with substantive issues related to the evaluation of food subsidy programs, the Subsidized Food Consumption (931-1275) project. In the review below the first two projects are treated as CEAP.

A. Consumption Effects of Agricultural Policies: 1977-83

The CEAP project was organized to pursue initiatives in three areas: 1) conceptualization of linkages between agricultural policy and food consumption; 2) development of improved analytical techniques and field tests of the methods in LDC policy making units; and 3) provision of technical assistance in developing data sources and policy analysis capacity in countries as needed. Staff members at NEG provided technical advice to the Office of Nutrition and coordinated activities in these areas. Training activities were later incorporated into the project.

CEAP activities were designed to have a country focus and activities were meant to follow an add-on approach. The country emphasis was consistent with A.I.D.'s commitment to field support activities and host country priorities and it reflected a desire to develop techniques that would be pragmatic and adapted to actual policy making situations. The add-on approach was a strategy for building on existing data collection and policy analysis efforts.

The first sub-project under CEAP, the Short-Term Policy and Project Impact Studies, examined the feasibility of developing relatively simple methods using existing data. Although the major objective was exploratory (to identify technical problems and to provide preliminary analytical guidelines), the case studies were addressed to specific policy questions with the expectation that the studies would also yield information relevant to the policy dialogue.

In late 1978 and early 1979 scopes-of-work were developed for short-term impact studies in four Latin American nd six African countries. The studies were selected based on expressions of interest by USAID missions and site visits by NEG staff and consultants. When the contracting process was initiated in mid-1980, four contracts were

offered for bids---one for Jamaica, one for Bolivia, one for Cameroon and Senegal, and one for Botswana, Sudan and Tanzania. The Bolivia study was cancelled, but contracts for the other studies were signed by the end of September 1980. A time frame of less than a year was imposed in an attempt to constrain contractors to work within the bounds of available data and to use methods accessible to policy analysts and planners in developing countries.

The Botswana study was canceled by the USAID mission in July 1981, and Panama was selected as a substitute study site. NEG staff participated in developing a scope-of-work in Panama. There were cost-overruns and dissatisfaction with initial drafts of the study in Jamaica. NEG hired and supervised the work of an independent consultant to complete a satisfactory study.

At about the same time as the scopes-of-work for the short-term impact studies were being prepared, two longer-term CEAP sub-projects were put in process, based on unsolicited proposals received from two other institutions. Michigan State University (MSU) proposed to develop methods for explaining food demand of low-income, agricultural households. The Central American Common Market's Center for Studies on Integration and Development (ECID) proposed to develop and test methods using Central American data in an ongoing planning environment.

The MSU proposal was funded on a preliminary basis in June 1978 under the Economic Analysis of Agricultural Policies project to determine whether the quality of the data (survey data from Sierra Leone) selected for analysis was sufficient to support the proposed plan for methodological research. A formal project review in early 1980 judged the quality of data acceptable and approved release of additional funds if three conditions were met. The proposal had to be revised to allocate more time to descriptive analysis, to analyze additional survey data from Kano State, Nigeria, and to reduce the scope of a proposed economy-wide model.

The original ECID proposal for work in Central America was modified to define a more specific country focus. Honduras was suggested as a test site in March 1979 and an agreement was drafted between ECID, A.I.D.'s Regional Office for Central America and Panama (ROCAP) and the Honduran National Planning Council (CONSUPLANE). The project's purpose was: 1) to modify and refine agricultural planning methods currently used in Central America for analyzing the impacts of government policies on the food consumption patterns of various socioeconomic groups; 2) to demonstrate applicability of these methods within the Honduran national planning system; and 3) to encourage adoption of the methods by agencies responsible for agricultural planning and nutrition in all Central American governments. The project was approved for a two year funding cycle in early 1980, but implementation was delayed because of staffing difficulties.

The last of the short-term policy impact studies was designed in response to an expression of interest in the CEAP project from the USAID mission in Peru and an unsolicited proposal. The study, which focused on the impact of cheap food trade policies in Peru, was initiated in July of 1983 for an anticipated duration of eighteen months.

A mid-project review was held in November 1983. Forty-three participants from the United States and seven developing countries reviewed the evidence from nine studies to evaluate the CEAP project's progress and develop guidelines for a second phase of activities. Three prominent economists (Evenson 1983, Johnson, and Roe) presented evaluation papers dealing with policy content and methodological issues associated with the CEAP studies and a NEG staff member (Smith) prepared a discussion of the actual and potential relevance of the studies in host countries.

A number of guidelines emerged from the mid-project evaluation suggesting that:

1) The policy focus be expanded to incorporate common policy patterns and to include macroeconomic and food subsidy policies as they are connected to agricultural policies;

2) Investments be made in improving the data bases for CEAP analyses including a better definition of what data is needed for particular types of analysis, a strategy for improving income and expenditure surveys, and special surveys to analyze consumption-production linkages of small farm households;

3) NEG's contribution to methodological developments had been sufficient to warrant consideration of further support for research-oriented activities as they fit within A.I.D. objectives;

4) a staged analysis approach be adopted which would include data collection as a prerequisite to analysis and on-the-job training for host country analysts.

B. Subsidized Consumption: 1977-83

The Subsidized Food Consumption project was the second applied research effort envisioned in the original RSSA agreement. This project's goal was to determine the desirability, feasibility, and cost effectiveness of various types of subsidized consumption systems. At the first project paper review in 1978, the scope of the project was broadened to include consideration of the effects of consumer food price subsidies on food production, food consumption of various socio-economic groups, employment, income distribution, and the rural/urban terms of trade. These modifications tended to obscure the differences between this project and the CEAP project (see discussion below). The project paper, which provided for financing for studies in at least four countries in different geographical regions, was approved in June 1979.

In 1980 NEG participated in an effort to develop a scope of work and implementation plan for the first subsidized consumption study in Egypt. A four-person team collaborated with personnel from the USAID mission and the Government of Egypt and a grant agreement was signed with the International Food Policy Institute (IFPRI) in September to undertake the study. The study addressed eight objectives related to Egypt's costly food subsidy and rationing scheme ranging from policy descriptions and evaluation, estimation of policy effects, and development and testing of analytical procedures. The study was

initiated in February 1981, and a two year time horizon was set for the analytical activities.

The second subsidized consumption case study in Sri Lanka was also undertaken through a grant agreement with IFPRI. The research study design was developed in cooperation with the USAID mission and staff from the planning ministry in Sri Lanka. The purpose of the study was to evaluate the effectiveness of Sri Lanka's food stamp program including its impacts on real income, food consumption and nutritional status of low-income consumers. Work on the study began in October 1982 and was scheduled to be completed by December 1985.

Though neither of these subsidized consumption studies was directly a part of the NEG portfolio, NEG did provide technical and administrative guidance to IFPRI on behalf of the Office of Nutrition. (See Table 1).

C. NEG Activities: 1984-1989

Subsequent to the mid-project CEAP review, the similarities of substantive content in the activities undertaken under the various projects were acknowledged. A new project paper, written in 1985, consolidated activities of pre-existing projects supported by the RSSA. The document outlined the new priorities and directions which guided NEG's efforts after the CEAP mid-project review.

Although the early CEAP studies showed that the development of policy-relevant analytical information was sometimes within the bounds of a short-term effort, success often depended on the conceptual and analytical skills of a particular investigator or on a fortuitous blend of interests among study contractors, USAID mission personnel and host country policy makers. Replication of successes in other country contexts was not readily guaranteed. The new directions outlined for policy impact studies acknowledged that the development of policy analysis which would be relevant to the policy-making process would require a longer term commitment.

In 1984 NEG provided funding to the Caribbean Food and Nutrition Institute (CFNI), a non-profit, international research institute associated with the Pan-American Health Organization (PAHO). The funds helped support a study of the impact of food price and subsidy policies on agricultural production, marketing, and food consumption, and ultimately the impact of these policies on nutrition and health status. Other donors to the study were A.I.D.'s Office of Rural Development, PAHO, and the Canadian International Development Research Centre. NEG consultants provided technical assistance in methods of analysis.

Cooperative agreements were also negotiated in 1984 by the A.I.D. Office of Nutrition with researchers from: 1) Iowa State University and the University of Missouri; and 2) Tufts University to carry out further policy impact studies under the CEAP and subsidized food consumption projects. In order to encourage collaborative interactions, the country sites for the studies and the policy questions were developed based on established professional contacts among USAID mission personnel, the university researchers and host country analysts.

Researchers associated with the Iowa State - University of Missouri cooperative agreement proposed a staged procedure designed to encourage host-country analysts to adopt the methods developed under the project and to continue to utilize them as ongoing policy analysis tools. The chosen study sites, Indonesia and Zambia, were selected because of the relevance of their food policy problems as well as the access to established collaborative relationships. Studies in the Dominican Republic and Mali were developed under the Tufts cooperative agreement in conjunction with ongoing USAID mission needs and initiatives. Again, NEG provided technical and administrative guidance to these Office of Nutrition sponsored studies (Table 1).

Another result of the mid-project review was the recognition that, in cases where adequate household consumption data is unavailable, a two or three year effort in survey design, data collection, and preliminary analysis is a necessary prerequisite for consumption analysis. NEG thus expanded its program of activities for providing technical assistance to countries wanting to improve procedures for collecting, processing, or analyzing such survey data. NEG used cooperative agreements to: 1) develop a project in Jamaica with the University of Missouri to process and analyze existing survey data collected by the Jamaican Statistical Institute; 2) provide technical assistance from Iowa State University to the USAID mission and host-country investigators in Haiti for the design and implementation of a national income and expenditure survey; and 3) develop a project in Liberia with Purdue University to explore rapid appraisal survey techniques for collecting policy-specific household expenditure data.

The need for more attention and resources for follow-on analyses, collaborative efforts with host country analysts, and comparative and integrative studies was another outcome of the mid-project review. In response to this need, follow-on activities with personnel involved in the original Honduras project were organized to better utilize the methodological and policy analysis capital developed in the initial project and to specifically address policy issues related to Honduran agriculture. Researchers at IFPRI were commissioned to summarize the state-of-the-art in estimating income and price elasticities. A cooperative agreement with Iowa State University was used to explore the possibility of producing a set of resource materials, or handbooks, to provide explicit examples of methods which could be applied to the policy analysis of food consumption and nutrition issues in developing countries. Two papers were commissioned to classify and summarize: 1) the types of data; and 2) available methods for food and agricultural policy analysis.

Regarding short-term efforts, a focus on rapid reconnaissance, on the development of methods for adding a consumption perspective to the design, implementation, and evaluation of agricultural projects was identified. Nutrition in Agriculture, a cooperative agreement with the Universities of Arizona and Kentucky was signed to develop a more broad-based social science approach to these issues.

APPENDIX 2. CONCEPTUAL FRAMEWORKS

This appendix reviews several conceptual frameworks from the general literature. These conceptual frameworks help explain the diversity of data and methods that have been applied in the policy studies reviewed. They also underscore the need for a theoretical orientation in policy analysis. Because a conceptual framework is a first step in systematic organization of thought about a problem, it is an important prerequisite to the choice of methods and identification of data requirements. Each of the conceptual frameworks presented highlights important linkages, but none is definitive. Referencing a problem from the different perspectives illustrated by these frameworks is important for attaining a clear problem definition.

A. Household Consumption Behavior

The linkages among household income, prices, and food consumption have been a central area of focus. Figure 2 presents a conceptual framework suggested by Kennedy and Pinstrup-Andersen. In this framework, emphasis is placed on the price and income effects of agricultural interventions and how they interact to determine the ability of the household to acquire food. Traditionally, these relationships have been investigated through the estimation of household demand functions (see section IV.A.). Also illustrated in this framework is the fact that household food consumption is only an intermediary locus in the flow of effect from projects and policies to individual nutritional status.

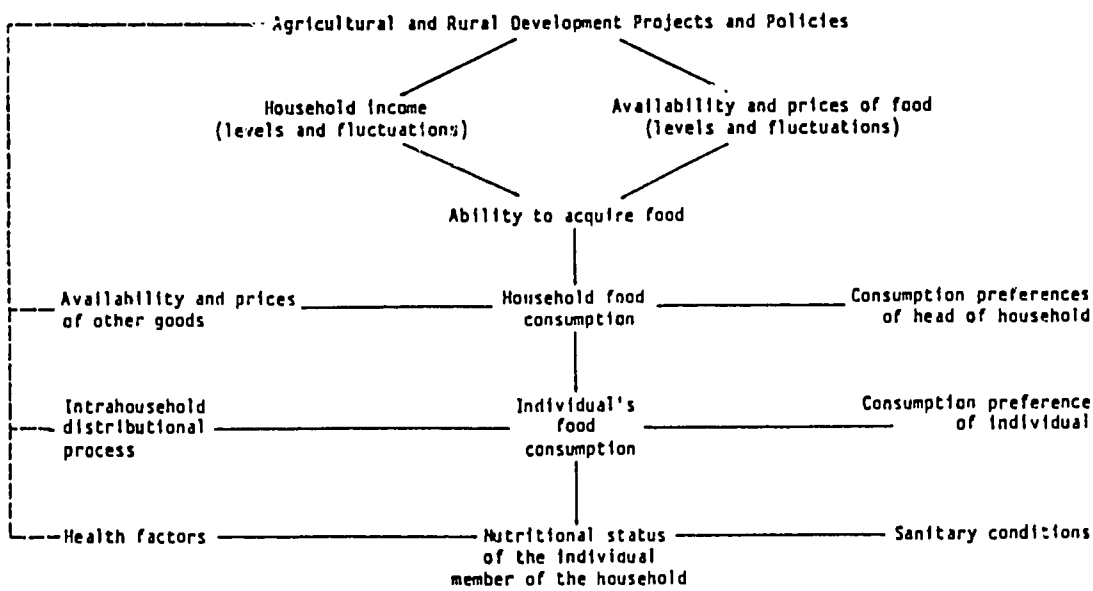

Figure 2. Linkages among agricultural projects and policies and food consumption, (Kennedy and Pinstrup-Anderson).

B. Consumption-Production Interactions

An important factor lacking in the framework presented in Figure 1 is the contributions to home food supply that come directly from the household's food production activities. The interaction between food production for home use and household expenditure for food in determining daily food consumption is well illustrated by a conceptual framework suggested by Harper and shown here as Figure 3. This framework clarifies the important dual nature of poor rural households as both production and consumption units, but does not deal with the relationship of policy interventions to food consumption and important feedbacks such as that between crop sales and household income. This framework is a result of work supported through NEG and the Office of Nutrition.

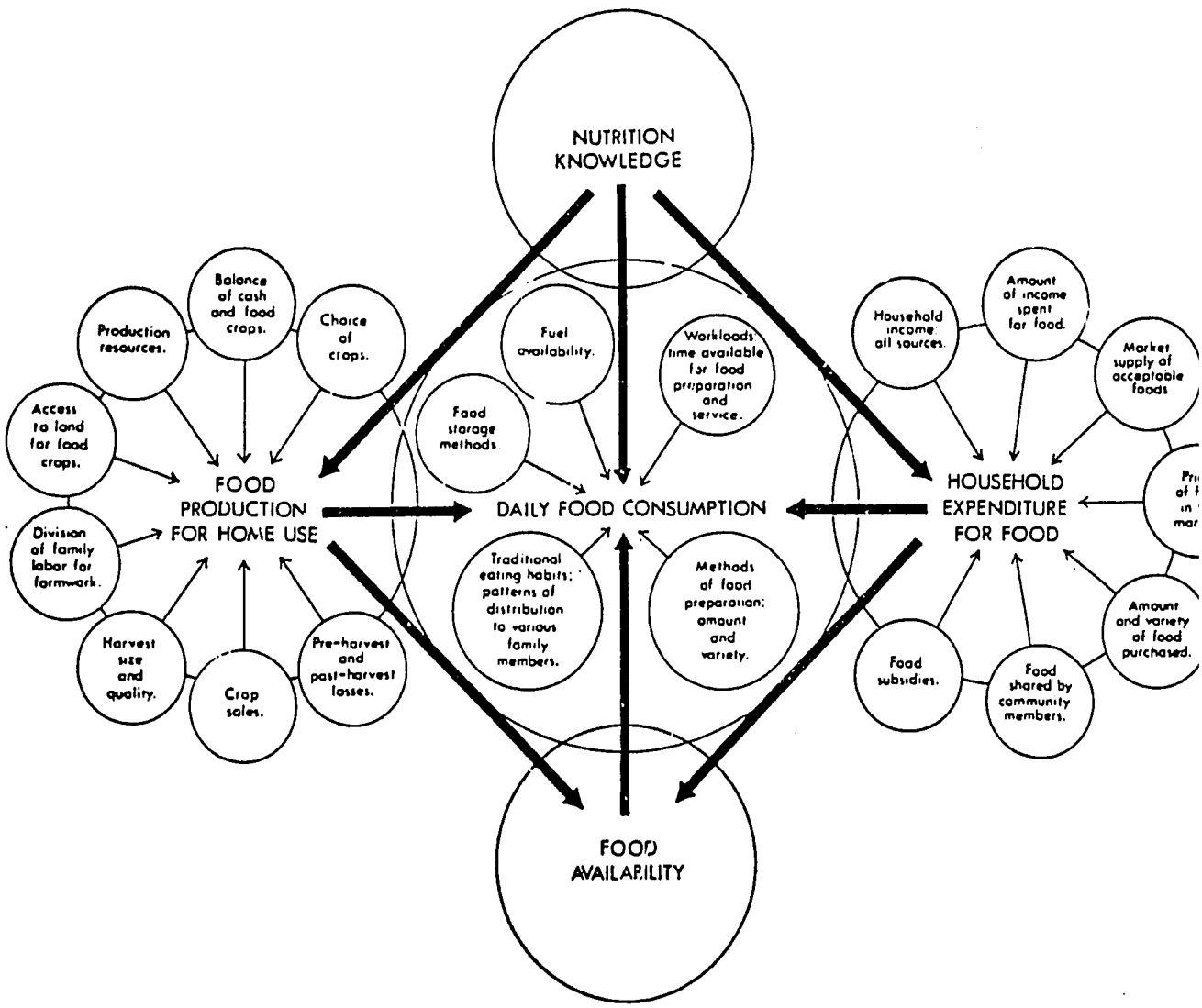

Figure 3. Factors affecting household food consumption, (Harper, p.349).

C. Market Behavior

Both of the frameworks discussed in sections III.A and III.B concentrate the analysis at the household level, which is the appropriate setting for private consumption decisions. However, because most policies have economy-wide effects, the interactions among households through the market must be captured at the sectoral and national levels. This level of analysis is also necessary to understand how a given policy variable will impact on the factors that households consider in making their decisions. A framework presented by Taylor does a good job of capturing relationships among policies, markets and households within the agricultural sector. That framework is presented in Figure 4.

Arrows one through eleven deal specifically with factors that determine the output of the agricultural sector of the economy. Included are: 1) market prices of outputs and inputs and the policies that alter them (e.g. water and fertilizer subsidies, agricultural price policies including official restrictions on cropping patterns and compulsory deliveries); 2) other factors such as the available production technology, the rural sociopolitical environment, rural wealth and income distributions; and 3) government policies such as rural investment programs and farm credit. Arrows 13 through 16 show how marketing policies such as buffer stocks, storage, fortification, and distribution outlets can influence the quantity and quality of food on the market. The interaction of cash income with market prices, available foods on the market, foods produced on farm, international market factors, feeding subsidy, and nutrition education programs, as shown in arrows 19 to 26, determine household food consumption patterns.

D. Macroeconomic Context

The typical pattern of overvalued exchange rates, inflationary budget deficits, and subsidized food imports which is seen in developing country contexts has strong implications for food consumption patterns in both urban and rural areas. In many contexts it is these macroeconomic relationships that are pivotal. A conceptual framework from Timmer, Falcon and Pearson reproduced here in Figure 5 shows some of the major macroeconomic connections among fiscal and monetary policies, macro price policies and food prices. What is not illustrated here, however, are the connections of fiscal and monetary policies to levels of exchange rates, inflation, interest rates, employment, and output.

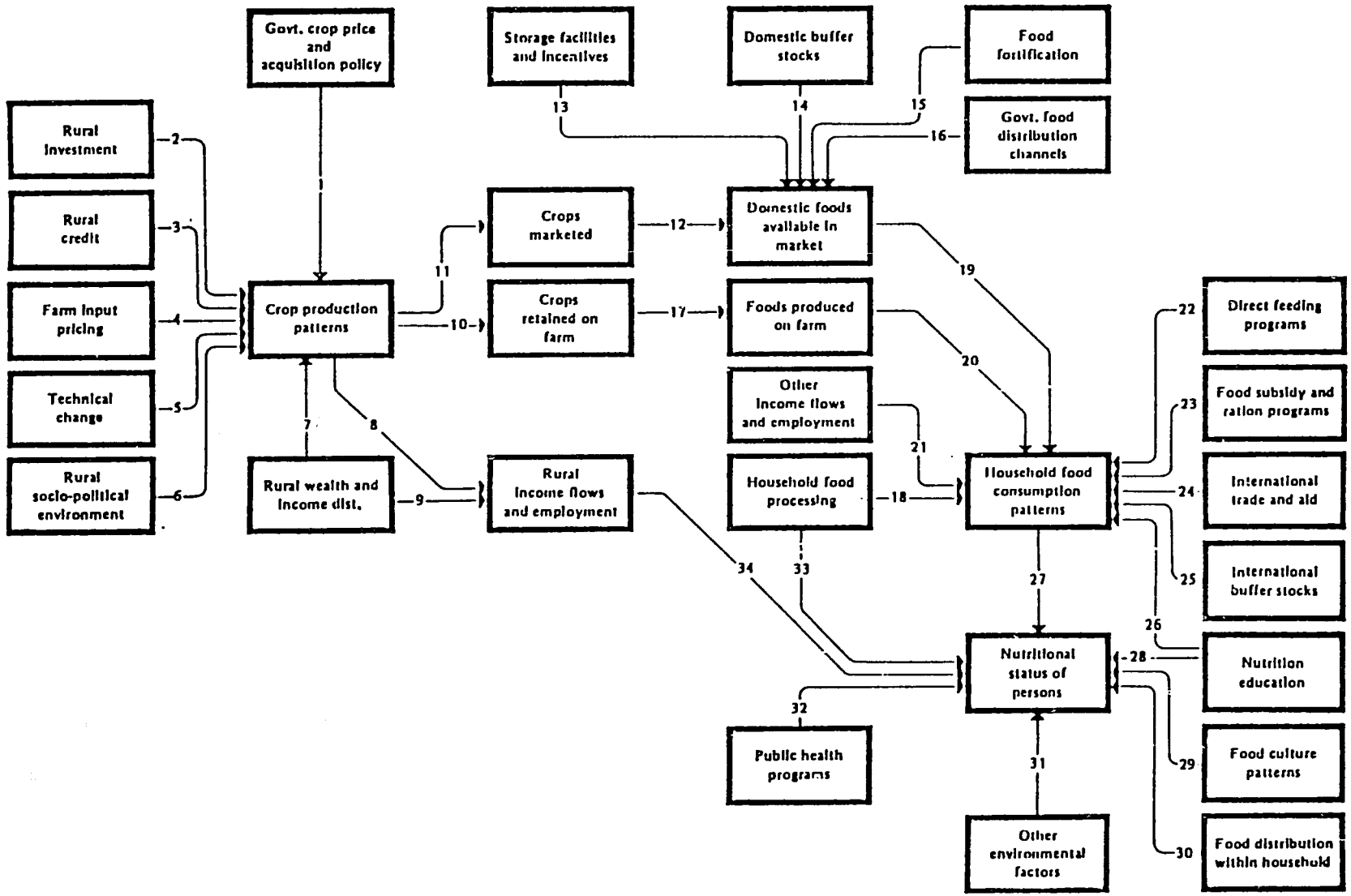

Figure 4. Linkages among agricultural, food processing and nutritional variables, (Taylor).

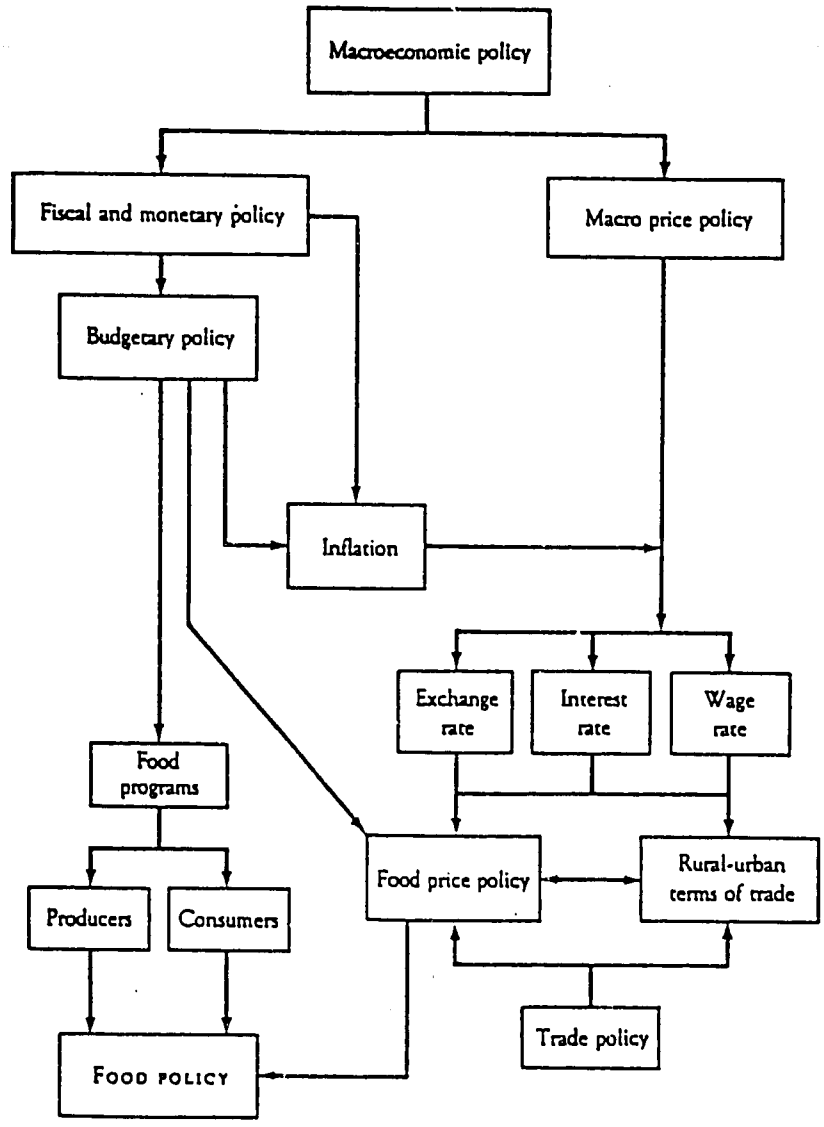

Figure 5. Linkages among macroeconomic, food and agricultural policies, (Timmer, Falcon and Pearson).

APPENDIX 3: METHODOLOGICAL ABSTRACTS OF FOOD POLICY STUDIES

Country	Pages
Cameroon	61
Caribbean Islands	62
Dominican Republic	63-64
Egypt	65-68
Honduras	69-72
Indonesia	73-74
Jamaica	75-76
Mali	77
Panama	78
Peru	79
Senegal	80
Sierra Leone/Nigeria	81-84
Sri Lanka	85-87
Sudan	88-89
Tanzania	90-91
Zambia	92-93

CAMEROON

Center for Research on Economic Development, University of Michigan, Consumption Effects of Agricultural Policies: Cameroon and Senegal," August 1982.

Data Collection:

Household survey (8 villages, 72 households) with questionnaires on household demographics, daily food consumption and expenditures, seasonal variations, farm sales and cropping activities, off-farm income and other socioeconomic indicators.

Data Interpretation:

Cross-section: Proportion of land in different use categories, area cultivated and crop distribution by region, market flows and regional exports, prevalence of chronic undernutrition by region.

Survey: Frequency distribution for measured crop fields from survey; sex, age and employment distribution of sample population; average daily intake of main foods and nutrients; percentage shares of foods by weight, calories, protein and village; distribution of per capita energy and protein requirements, intakes, and energy balance ratios per capita and per man equivalent; average energy and protein intakes, requirements, and energy balance ratios by village per capita and per man equivalent; contribution of selected crops to farm income; relative contribution of corn, beans, and potatoes to calorie and protein intake; proportion of sales of corn, beans, and potatoes by village; sources of household income by village.

Other: Graphical presentations of projected food surplus and deficits; estimated costs and return to rice and bean trade.

Analytical Methods:

Household Level: Price and income elasticities (single-equation), calorie and protein elasticities; simulations of calorie and protein response to price changes.

CARIBBEAN ISLANDS

McIntosh, Curtis E. "Markets, Prices and Nutrition: Experiences from Antigua, Barbuda, St. Vincent and the Grenadines," September 1986.

Data Collection:

Household expenditure, dietary intake, nutritional status and marketing survey of farmers, fishermen, food shops, supermarkets, importers/wholesalers, informal vendors, consumers and butchers on islands of Antigua and St. Vincent.

Data Interpretation:

Time Series: Food imports and exports, 1960-82; gross domestic product at factor cost 1960-80, CPI, production of selected crops and livestock, 1974-83; food prices for selected food groups, 1970-82; monthly retail food price index, 1969-81.

Cross-Section: Nutritional status (anthropometric measures) tabulated from various surveys, food availability (sources from different foods) from FAO food balance estimates.

Survey: Knowledge of and participation in subsidy programs by occupational category and island; age and sex composition of respondents; household income, food expenditures, per capita calorie and protein intake by occupational category; sources of calories and proteins in average diet by food items; weight for height status of respondents by age and sex; energy and protein adequacy levels by occupational category; marketing distribution channels for selected imported and local foods as proportion of distributor sales by island; calculation and tabulation of concentration ratios for food distribution sectors; competitive strategies and price-setting methods by type of distributor.

Other: Policy descriptions of producer and consumer subsidies; tabulation of local and imported commodities with controlled prices; budget allocations to agriculture; market structure, conduct and performance analysis.

Analytical Methods:

Household Level: Single-equation regression models with individual intake as a function of per capita income (or food expenditures), age and sex of individual estimated by occupational group and island; nutrient elasticities for calories and proteins estimated, double-log form gave elasticities of about .5; marginal propensities to consume on different food types estimated using linear expenditure system.

DOMINICAN REPUBLIC

Beatrice Lorge Rogers and Anne J. Swindale, "Determinants of Food Consumption in the Dominican Republic," volumes I and II, April 1988.

Data Collection:

Household survey conducted on a stratified, cluster sample of 144 households with 10 waves of data collection between January and November 1986. Survey questionnaire gathered data on household composition, socioeconomic and demographic characteristics; household cash expenditures; consumption from home production; income sources and levels; agricultural resources and production; employment, wages and earnings of household members.

Data Interpretation:

Survey Data: Tabulations from survey of per capita means and standard deviations for consumption levels of selected food items, total calories and proteins, and food expenditures for total population, expenditure class and region; average daily calories and protein per adult equivalent by expenditure class and region; 10 major food sources of calories and proteins (percentages) by expenditure class and region; percent of food expenditures, calories and proteins (and standard deviations) from main food groups by region, expenditure group, adequacy category, source of food, access to home consumption and subsidized food outlet; percent of households with zero consumption of major foods; protein and calorie adequacy by expenditure group; sources of calories and proteins by food groups, food source, expenditure group, region and adequacy category; income and expenditure distribution by region, source of income and occupational status; mean household and per capita expenditures by occupational status and gender of household head; average household size, work status of household members, and gender, age and educational level of household head by region and expenditure group; water source, sanitary facilities, access to garbage collection and electricity, and primary fuel by region and expenditure group; weighted average food prices (and standard deviations) by region; calories and proteins per currency unit for selected foods by region and expenditure group; purchase prices (and standard deviations) for selected foods by retail source; breakdown of survey sample by region. Graphical analysis of percent of calories and protein from different food groups by expenditure class, region, and access to home consumption; protein and calorie adequacy by expenditure group, region and access to home consumption; monthly prices of selected foods by region.

Analytical Methods:

Household Demand Analysis: Complete matrix of expenditure, own-price and cross-price elasticities estimated for sample quartiles using two-stage procedure with quadratic expenditure term. Probit analysis used as first step to estimate probability of consumption of a given

DOMINICAN REPUBLIC (continued)

food item and inverse of "Mills ratio" then used in double-logarithmic household demand model. The single-equation model estimated per capita consumption of eleven major food groups as a function of per capita expenditure, household size and composition (adult equivalents), commodity prices, an inflation index, and dummies for region and access to home produced food.

Reduced form calorie and protein response functions estimated in double logarithmic form with consumption per adult equivalent per day estimated as a function of monthly per capita expenditure and expenditure-squared, prices of ten most important foods, household size and composition (adult equivalent ratio), inflation index and dummy variables for region and access to home consumption. Similar calorie and protein equations estimated with separate terms for income sources from farm sales and home consumption.

EGYPT

(1) Alderman, Harold, Joachim von Braun, and Sakr Ahmed Sakr, "Egyptian Public Food Program Study: Report on Task I - Egypt's Food Subsidy and Rationing System: A Description," November 1982.

Data Interpretation:

Time Series: Tabulations of government expenditures by category, food subsidies as share of outlay, subsidies by commodity, and profits of government supply operations; production, imports and shares under government distribution by product; consumer price indexes and rationed food prices, 1970-81; graphical analysis of annual percentage changes in wheat consumption.

Cross-Section: Regional breakdown of subsidized commodities and area, domestic production, producer prices, trade, consumption and degree of self sufficiency (from unpublished data).

Survey: Per capita rural and urban calorie intake from three family budget surveys; survey of farm households in rural areas used to measure access of rural households to subsidized food, market prices of subsidized and rationed foods, expenditures, production, sales, and degree of self sufficiency for wheat, rice, and maize; proportions of calories from subsidized foods.

Other: Marketing channels for subsidized commodities, institutional descriptions of agencies involved in policy and operational decisions related to food subsidies; descriptions of agricultural procurement and production policies.

Analytical Methods:

Household Level: Calorie-income elasticity from grouped budget data.

Sector Level: Cross-sectional regression analysis of the regional distribution of cereal as function of local production, degree of urbanization, and regional wages.

(2) Alderman, Harold and Joachim von Braun, "Egyptian Public Food Program Study: Report on Tasks 2 and 3 - The Effects of the Egyptian Food Ration and Subsidy System on Income Distribution and Consumption," July 1984.

Data Collection:

Rural survey of 1389 households in 77 villages with production and income questionnaire administered to male head of household and food purchase and consumption (24 hour recall) questionnaire for female head of household; urban survey of 980 households in 50 census tracts of food purchases and consumption with some questions on land ownership and food received from agricultural sources, village background questionnaires in rural areas.

EGYPT (continued)

Data Interpretation:

Survey: Access to ration shops by region and size of village for respondents and villages sampled; availabilities and shares of households purchasing subsidized commodities by urban-rural location; budget shares and characteristics of households by expenditure quartile and location; monthly purchases of food commodities by market source, expenditure quartile, and location; average rations per capita, food purchases and prices on open markets and in cooperatives, per capita calorie and protein consumption and share of households below recommended intakes by expenditure quartile and location; shares of cereals used for human and animal consumption from own production by farm size and product.

Other: Cropping patterns.

Analytical Methods:

Household Level: Expenditure elasticity for total food expenditures estimated by budget share equation where food budget share is regressed on monthly expenditures, expenditures squared, household size and dummies for location and region.

Accounting model used to estimate income transfers to or from sample households. Transfers on the consumption side based on household consumption patterns, subsidy levels, and prices; transfers on production side by production and consumption patterns. Average transfers by expenditure quartile, location, employment group, product, and government channel; equity indexes calculated based on relative shares of different groups in transfers, population, and expenditures.

Regression models estimated to explain household level income transfers in production and consumption as a function of household expenditure, farm size, employment category, age of household head, household composition, membership in cooperatives and number of ration cards, village size, distance to capital, and urbanization status.

Other: Probit analysis of probability of calorie and protein inadequacy as a function of income, and other socioeconomic and demographic variables.

(3) von Braun, Joachim and Hartwig de Haen, "Egyptian Public Food Program Study- The Effects of Food Price and Subsidy Policies on Egyptian Agriculture," November 198?.

Data Interpretation:

Time series: Tabulations of land distribution, planned vs. actual plantings, self-sufficiency and procurement of food crops as percent of production, net returns by crop, 1965-80; tabulations and graphical trend analysis of nominal protection coefficients for wheat, rice, beans, lentils, cotton, and beef, 1965-80; input subsidies nominal and

EGYPT (continued)

real; graphical trend analysis of deficits, revenues, structure of government expenditure, share of agricultural investment and input subsidies in total expenditure, public investment in agriculture by type of project, 1965-80; procurement, open market, consumer prices and shares of procurement and consumer prices in open market price for major food commodities, 1965-80.

Cross-section: Share of agriculture in GDP, investment, employment; official and black market exchange rates; public investment in agriculture by type.

Other: Typical cropping pattern.

Analytical Methods:

Sector Level: Sector linear program with 18 field crops and five animal products, with activities for production, marketing, international trade, fertilizer response, water allocation and restrictions on seasons, input use, crop rotation, market capacity and subsistence demand used to simulate production effects of different price regimes.

Partial-equilibrium models for markets of crops, feed, and input markets used to estimate consumer and producer loss due to price distortions assuming forced deliveries; producer loss composed of loss through forced deliveries, distorted markets, and reduced production through misallocation; elasticities of production response given removal of price distortions, procurement and input subsidies calculated from linear programming simulations; demand elasticities obtained from linear expenditure system estimated from pooled household expenditure data from three surveys; "aggregate burden of sector" estimated by sum of welfare gains and losses to producers calculated for 15 year period.

Regression model used to explain determinants of the "aggregate burden of sector" as a function of international prices, government revenues and food subsidy expenditures.

Other: Regression model analyzing times series data on determinants of the share of procurement in wheat production in terms of ratio of procurement price to import price at the official exchange rate and the level of real government revenues.

Regression model defined to predict share of agriculture sector in government budget. Parameters used to derive agricultural expenditure and agricultural investment expenditure elasticities.

(4) Scobie Grant M., "Egyptian Public Food Program Study - Report on Task 5: Food Subsidies and the Government Budget in Egypt," January 1984.

Data Interpretation:

Time Series: GDP and government revenue by sources, composition of final demand, share of food subsidies in GDP, government expenditures on subsidies, budget deficits, foreign exchange reserves,

EGYPT (continued)

money supply, net factor income as a proportion of GNP, private savings and investment, net foreign investment.

Cross-Section: balance sheet of Central Bank and commercial banking sector.

Other: Description of political and economic setting.

Analytical Methods:

Economy-wide Model: Financial programming model to determine changes in domestic credit and/or food subsidies which would have been required to maintain balance of payment equilibrium; parameters of structural equations estimated by two-stage least squares using time series data on foreign exchange reserves, total foreign exchange available, national income, and monetary base; domestic credit multiplier for net foreign assets estimated.

(5) Scobie, Grant M., "Egyptian Public Food Program Study - Report on Task 6 - Food Subsidies in Egypt: Their Impact on Foreign Exchange and Trade," August 1983.

Data Interpretation:

Time Series : Tabulations of government expenditures on food subsidies, net imports of basic food grains and pulses; growth rates of subsidies; tabulations and graphical presentation of real subsidies and real food imports per capita, money supply, net foreign assets, inflation rate, food and nonfood exchange rates, black market exchange rates, industrial output, gross fixed investment in industry, raw materials, basic manufactured goods, machinery and transport equipment, manufacturing imports; tabulations of import expenditures and unit import prices for food and nonfood sectors.

Cross-section: Share of imports in basic food supply.

Analytical Methods:

Sector Model: Regression models estimated relating industrial output and investment to imports of raw materials, basic manufactured goods and machinery and transport equipment; system of import demand equations for food and nonfood sectors; import expenditure and cross-price elasticities used with elasticities from industrial output-investment model to derive an elasticity of industrial output with respect to price of imported food and elasticities of industrial output and investment with respect to changes in foreign exchange supplies.

Economy-wide Model: Domestic money market model consisting of money demand, balance of payments, domestic inflation, and black market exchange rate equations estimated using two-stage least squares from annual data, 1947-81; reduced form multipliers derived to show impact of changes in spending on food subsidies on the inflation rate, balance of payments, black market exchange rate, and demand for money.

HONDURAS

(1) Permanent Secretariat of the General Treaty of Economic Integration of Central America (SIECA), "Patterns of Expenditure and Food Consumption in Honduran Households," Document No. 31 A/82, October 1982.

Data Interpretation:

Survey: Description of the income, expenditures and food consumption patterns by socioeconomic groups and regions using data from the 1978/79 Income, Expenditure and Food Consumption Survey; description of survey.

(2) SIECA, "Productive and Nutritional Relationships in a Linear Programming Model at Farm Level," Document No. 36A/83, March 1983.

Data Interpretation:

Cross-Section: Description of production structure and geophysical characteristics of Southern Region from census data
Survey: Description of average diet pattern for rural areas in the Southern region from household survey data; descriptions of cropping calendars and input usage patterns by crops for small and large farms from 1977 cost of production survey data.

Analytical Methods:

Household Level: A farm level linear programming model including production and consumption activities is estimated for typical small farm in the Southern Region; model includes ten production activities, off-farm labor, sales and home consumption, other food, food balance, and input use; resource restrictions on land and family labor; balance equations for labor, land, protein and calorie consumption, and net family income; objective to maximize gross income less production and foodstuff costs. A similar large farm model incorporates commercial crops and risk aversion coefficients. Both models are used to simulate policy changes that would 1) reduce interest rates from 50 to 20%, 2) provide a 50% subsidy on inputs, 3) provide 50% subsidy on foodstuffs, and 3) increase land availability.

(3) SIECA, "Food Consumption and Nutrients Intake by Socioeconomic Groups in Honduras Households," Document No. 42A/83, October 1983.

Data Interpretation:

Survey: Tabulation of data from the 1978/79 household survey relating foodstuff consumption patterns and implicit nutritional levels to region, income group, occupational category; elaboration of a minimum basic diet and comparison with observed regional diets, average diets by occupation, education level and income; comparison of

HONDURAS (continued)

expenditures with cost of basic market basket by income levels and years of education.

(4) SIECA, "Elasticities of Consumption Expenditures in Honduras," Document No. 391/83, October 1983.

Analytical Methods:

Household Level: Extended linear expenditure system was estimated on 1978/79 household survey data for different occupational groups and income groups; marginal budget shares, savings propensities, average and marginal propensities to consume, expenditure elasticities, subsistence consumption, and own- and cross-price elasticities reported by occupational and income group.

(5) SIECA, "Price and Income Elasticities of the Principal Food Commodities in Honduras (Final Report)," Document No. 44A/84, March 1984.

Analytical Methods:

Household Level: Income and price elasticities by region and income strata were estimated for basic food commodities in the Honduran diet---grains, beef, pork, chicken, fish and milk; own-price and income elasticities were estimated from single-equation OLS models, the full matrix of price and income elasticities was estimated using the Frisch technique with a money flexibility of -1.55 estimated by using the extended linear expenditure system.

(6) SIECA, "Sectoral Model of Linear Programming for National Production of Basic Grains," Document No. 48A/84, July 1984.

Data Interpretation:

Time Series: Tabulations of central bank data on average prices paid for main crops.

Cross-Section: Tabulations of census data on cultivated area by farm size; land area, population, land use, number and average size of farms, cultivated area of main crops, production of main crops, main and secondary markets by region.

Survey: Tabulations from special survey of cattle raising of data on livestock distribution by farm size and region; marketing channels for cattle.

Other: Descriptions of cultivation practices for domestic foodstuffs, export crops and livestock; graphical representation of marketing chains from Honduran Agricultural Marketing Institute; descriptions of agro-climatic regions included in analysis.

HONDURAS (continued)

Analytical Methods:

Sector Level: Planning model for agricultural sector based on linear programming framework with aggregation of regional representative farm models and objective function which imposes market equilibrium; risk factors investigated using risk aversion coefficients; production submatrix includes 224 production activities for basic grains for each type of producer in seven regions; input and resources submatrix with accounting for seeds, fertilizers and chemicals regionally and land and labor by groups of producers; sales submatrix including demand equations based on price elasticities, expected prices and base quantities; risk submodel computes income deviations; model was validated to simulate national production and price patterns to within 10% (except sorghum prices) of observed levels; variation in price of corn and beans used to simulate production response and estimate supply elasticities; variations in interest rate used to simulate credit demand curves; relative impact of policies on small and medium size producers assessed.

(7) Garcia, Magdalena U., Roger D. Norton, Mario Ponce Cambar and Roberta van Haeften, "Agricultural Development Policies in Honduras A Consumption Perspective," February 1988.

Data Interpretation:

Time Series: growth rates and trend analysis of sectoral and aggregate GDP; population; per capita GDP; price indexes; categories of final demand; urban-rural breakdown of economically active population; area planted, production and yields of major crops; agricultural foreign trade; total and per capita apparent consumption (production minus net imports) of important crops and livestock products; retail and relative consumer prices of foods; farmgate food prices; consumer-producer price ratios for major crops.

Cross-Section: Proportions of total value of agricultural production contributed by major crops and livestock; proportions of agricultural employment by crops, livestock, forestry and fisheries products; relative contribution of farm and nonfarm income by size of farm; cropping and livestock land-use pattern by farm size; average yields by farm size; sources of farm income by farm size; estimates for different farm size groups of income effects of increase in wages, product prices, devaluation, corn price increases.

Survey: Tabulations from 1978/79 household survey of consumption of calories and proteins per capita by income group; income distribution and distribution of total calories and proteins among income groups; sources of nutrition by type of food for different income strata for urban and rural areas; proportions of consumption from home produced foods for rural areas and farm households.

HONDURAS (continued)

Other: Description of BANASUPRO government retail outlets for subsidized food.

Analytical Methods:

Household Level: Calorie and protein availability equations estimated from cell means of household survey data; income elasticities for corn, wheat, rice estimated by single-equation OLS from cell means.

Sector Level: Estimation of income and price elasticity of wheat from time series data on GDP and real price of wheat, estimation of various equations relating wholesale prices of corn and sorghum to government procurement levels and support price policies.

INDONESIA

(1) Center for Agricultural and Rural Development, Iowa State University, "Evaluating Food Policy in Indonesia using Full Demand Systems," February 1987.

Data Interpretation:

Time Series: Rates of growth of food crops by region; rates of growth of yields and area harvested for rice; trends in imported and domestic prices, price margins, production, consumption, imports, procurement and milling operations for rice; rates of growth in fertilizer use.

Cross-Section: Distribution of value added in agriculture, per capita food consumption by crop and region, proportions of food budget allocated to different crops by region and income group, nutritional adequacy by region, income group, and location.

Survey: description of 1980 multipurpose household survey, computation of Gini coefficient and graphical presentation of Lorenz curve, conversion of nonspecific quantities to volume measures, computation of nutrient availability and adult equivalents in household , tabulations of food expenditure and expenditure shares by location, region, and income group; tabulations of per capita availability of nutrients by expenditure group, region and calorie consumption group; distribution of household heads by education, age, calorie consumption, main occupation, and expenditures.

Other: Estimates of degree of fertilizer subsidy, description of past estimations of demand parameters.

Analytical Methods:

Household Demand Analysis: Estimation of a nonprice "Engel curve" version of the Almost Ideal Demand System (AIDS) demand model with regional dummy for urban and rural subsamples; computation of price indexes from survey data at regional level; estimation of own-price, cross-price, expenditure, and household size elasticities using a linear version of the AIDS model with weak separability assumed and aggregation used to avoid zero values (no test of demand theory restrictions); estimation of same elasticities with multinomial linear logit model; comparison of estimated elasticities with each other and previous studies; estimation of nutrient consumption functions (Engel curves and simultaneous equation estimates) for calories, protein, iron, vitamin A and thiamine with elasticities for expenditure, prices, household size, region, education and main occupation for urban and rural subsamples; comparison with previous estimates of calorie-income elasticities; use of estimated elasticities to simulate impacts of a 10 percent increase in price of rice on food commodity expenditures for low and high income groups.

INDONESIA (continued)

(2) Center for Agricultural and Rural Development, Iowa State University, "An Evaluation of Crop and Fertilizer Price Policies in Indonesia: A Policy Model Exercise," September 1987.

Analytical Methods:

Sector Model: Development of a food policy model designed to operate on micro-computer. Model includes supply (yield and harvested area) and demand equations for rice, corn, cassava, soybean, sweet potatoes, and sugar. Crop area harvested depends on own and competing crop prices; yields depend on own-price, fertilizer price (except peanuts and sugar), and irrigated area (rice only); rural and urban food demand depend on separate income, own and cross-price effects. Supply and demand elasticities taken from previous studies and expert opinion. Data are required for marketing margins, waste and spoilage, cost of production, distribution of population between urban and rural areas, exchange rate, government stocks for wheat and rice and growth rates of population, prices, yields, area harvested, and income. Given baseline values for all variables, the model computes a time path for domestic supply (production, net imports, and changes in stocks) and consumption for each crop; government costs for fertilizer, rice and wheat subsidies; and rural incomes. Rural wages depend on rice price and farm income depends on output prices, production levels, and fertilizer price; farm food demand is linked to farm income computations. The major policy variables are the rate of growth of rice and fertilizer prices. Simulations are made for two policy options: 1) reduction of fertilizer subsidy by 60 percent with no increase in rate of growth of rice prices and 2) same reduction of fertilizer subsidy with increase in rate of growth of rice prices.

JAMAICA

(1) van Blarcom, Bonni J., "Consumption Effects of Jamaican Sugar and Rice Pricing Policies, " July 1983.

Data Interpretation:

Time Series: Tabulation of GDP and composition of agricultural sector output, production value and acreage of principal crops, calorie and protein availability, agricultural imports and exports, quantity and nominal unit value of rice imports, sugar production and productivity measures, domestic rice supply and proportion from domestic production, sugar production and exports, international and domestic prices for sugar, import and consumer prices of rice, rice consumption per capita.

Cross-Section: Composition of diets from two periods; tabulation of estimated calorie and protein adequacy and sources by income quartile, incidence of malnutrition among children, costs of production of rice and sugar from farm management records, rice yields in other countries.

Other: Description of agricultural policy environment, rice and sugar projects and policies and projected market developments; descriptions of cultivation, processing and marketing conditions for sugar and rice; estimates of official payments, actual costs, and employment for raw and finished sugar; comparison of domestic sugar and rice production costs with international prices and domestic consumer prices; calculation of domestic resource cost, foreign exchange earnings per unit of land, and resource gain or loss per foreign dollar for sugar and rice; comparison of labor benefits (man-years per acre, output per man-year, profit per man-year, average income per employee) for sugar and rice; comparisons of calories and proteins produced per acre for sugar and rice.

(2) van Blarcom, Bonni, "Economic Analysis and Nutritional Considerations of the Cassava Industry in Jamaica," February 1983.

Data Interpretation:

Time Series: Acreage output, production and yields of cassava.

Cross-Section: Tabulations of farm size-distribution, production and marketing patterns for cassava from agricultural census; world production data for cassava from FAO statistics.

Survey: Tabulations of regional and farm-size distribution of acreage and production from existing cassava industry survey.

Other: Estimation of number of acres of cassava needed to satisfy calorie needs; estimation of costs of production and profit/loss for cassava from data from 14 sources including cassava factory officials, extension agent, farmers, Ministry of Agriculture reports, and credit bank records; comparison of costs of production and profit/loss with other root crops from Ministry of Agriculture data;

JAMAICA (continued)

tabulation of cassava demand, operating costs, and plant usage from cassava flour processing plant; descriptions of cassava production and export in Thailand; description of potential international demand for cassava as source of starch, ethyl alcohol, fermentation to produce protein; description of government policy in cassava; estimation of calorie availability from cassava by region; comparison of root crops in terms of calories and proteins supplied per pound, costs per pound of calories and proteins.

MALI

Beatrice Lorge Rogers and Melanee L. Lowdermilk, "Food Prices and Food Consumption in Urban Mali," October 1988.

Data Interpretation:

Survey Data: Tabulations from 1985-86 World Bank funded household expenditure survey on per capita daily calorie consumption by region, expenditure quartile, and survey wave; regional averages (over survey waves) of monthly household and per capita expenditures, percentages of expenditures on food, cereal consumption, rice, other food groups, percentage of home consumption in total consumption, household income distribution; percentage of expenditure by food group, and income quartile, and region; patterns of regional food expenditure by quartile and survey wave; calories and percentages per capita by cereal group, region, and survey wave; monthly per capita food quantities purchased by region, quartile, and survey wave; percentage of households with home consumption by food group, quartile, and region; food prices per kilo and milling costs by region and survey wave; calories per 100 currency unit purchase by food group and region. Graphical analysis of per capita calorie consumption by region, expenditure quartile, and survey wave; percentage of calories from different foods by region and quartile; prices of rice and millet/sorghum by region and survey wave; per capita quantities of rice, millet, and beef purchased and from home consumption by region and survey wave.

Analytical Methods:

Household Demand Analysis: Two-stage estimation of own-price, cross-price, and income elasticities using probit analysis of probability of consumption and single-equation, double-log per capita demand model for rice, millet/sorghum, peanut butter, and beef; dummies included for seasonal effects (survey wave), economies of scale (household size), household composition, and access to gift or home consumption food. Per capita (purchased) calorie functions used to estimate calorie-expenditure and price elasticities; dummies included for season, household size and composition, and access to home produced rice and millet.

PANAMA

Franklin, David, Eric Shearer and Gustavo Arcia, "The Consumption Effects of Agricultural Policies: The Case of Market Intervention in Panama," January 1984.

Data Interpretation:

Time Series: Trend analysis of rice and corn yield estimates; official, international, and retail prices of rice and corn; production, availability and prices of beef and poultry.

Cross-Section: Computation of domestic resource costs for rice and corn with three estimates for land rent.

Survey: Calorie, protein and expenditure shares for urban and rural households from 1980 nutrition evaluation survey, proportions of calories and proteins from animal sources, computation of market connectedness index (ratio of value of farm sales to value of total production, stratification of sample according to ability to purchase minimum food basket.

Other: Description of input subsidies and price supports.

Analytical Methods:

Household Demand Analysis: Income elasticities for corn, beans, rice, poultry, beef, and milk indirectly estimated by separate OLS regressions for food expenditure as function of income and quantity consumed as function of food expenditure, family size, market connectedness, education of head of household, land size, off-farm income.

Sector Model: OLS estimates of price elasticities for rice and corn from time series production and price data.

PERU

Franklin, David L., Jerry B. Leonard and Alberto Valdes, "Consumption Effects of Agricultural Policies: Peru - Trade Policy, Agricultural Prices and Food Consumption: An Economy-wide Perspective," October 1985.

Data Interpretation:

Time Series Analysis: Nominal rate of protection, effective rate of protection estimated for various years and various locations for cotton and rice; national accounts statistics were used to divide the value added (gross domestic product) of the agricultural sector into three subsectors (export, import competing, and non-traded) and to divide non-agricultural value added into traded and import-competing subsectors; compatible price indexes were calculated from secondary sources, a time series of expenditure shares for these goods for five income groups was estimated based on reported data from a 1977 household expenditure survey and the national accounts data.

Other: Description of food, agricultural, trade, and general economic policies.

Analytical Methods:

Economy-wide Model: Econometric estimates of long run supply and cross supply elasticities and own-price, cross-price and income elasticities of demand were made. A simple, computable general equilibrium model was developed. Cobb Douglas production functions were assumed with two factors of production: labor and manufactured goods. Demand elasticities for five different social groups were estimated from household survey data (which had been aggregated to conform with the producing sectors), and time series data on prices, agricultural production, and value added data from the national accounts. A linear-expenditure demand system was used. The model was used to simulate three policy scenarios based on Peru's historical policies of industrial protection.

SENEGAL

Center for Research on Economic Development, University of Michigan, "Consumption Effects of Agricultural Policies: Cameroon and Senegal," August, 1982.

Data Collection:

Household survey in three villages of 72 households conducted over a 12 week period. Data collected on farming activities, employment, income, food expenditures, dietary intake, and anthropometric measurements.

Data Interpretation:

Time Series: Production, acreage, yields and producer prices of selected crops; rainfall index, net rice imports.

Cross-Section: Acreage, production, and yields in peanut producing areas; cropping calendars.

Survey: Income distribution, demographic, and employment profiles of sample population; nutrient intake by income level and village; area cultivated by crop for surveyed households; average planted and fallow area, field size and distance to fields by village and soil type; off-farm employment by activity, season, and village; labor inputs by crop, village and labor category (family, hired, communal); cattle ownership and fertilizer and manure use by crop and village; average production, yields, and sales by crop and village; location of sales and income from sales by crop, season, and village; farm income (by crop) and non farm income sources and percentages by village; food expenditures and shares on individual items by village; average consumption of rice, millet, and other food items by village nutrient intakes.

Other: Descriptions of policies and of government and private institutions operating in rural areas; identification of policies with likely effects on consumption; cropping calendars by village; nutritional values of common food items and recommended nutrient intakes.

Analytical Methods:

Household Level: Engel functions in per capita form estimated for rice, millet, and total grain; Chi-square tests of relationship between calorie and protein intake and income levels.

Farm-Firm Level: Linear programming farm model with production consumption linkages estimated for peasant farm in Casamance region. Cropping, sales, and purchase activities for groundnuts, rice, and millet/sorghum with constraints on land, irrigated land, family labor availability; per capita consumption functions for rice and millet/sorghum derived from previous food consumption studies. Sensitivity analysis done for off-farm income, family size, and prices of rice and groundnuts.

SIERRA LEONE/NIGERIA

(1) Kolasa, Kathryn, "The Nutritional Situation in Sierra Leone," October 1978.

Data Interpretation:

Survey Data: Tabulations of incidence of malnutrition in children, meal patterns, nutritional problems of pregnant and lactating women and other adults from several nutrition surveys.
Other: Tabulation of nutritional status (weight for age) of children by region from CARE nutrition program and Catholic relief services data.

(2) Smith, Victor, Sarah Lynch, William Whelan, John Strauss, and Doyle Baker, "Household Food Consumption in Rural Sierra Leone," 1979.

Data Interpretation:

Survey Data: 1974-75 survey conducted by the Rural Employment Research Project, Njala University College, Sierra Leone for 328 households including consumption and farm production data. Tabulations for sample income, household size distribution, quantity consumed, percentage produced at home, percentage of households consuming by food; annual consumption per household, per capita, and per consumer equivalent by commodity group; annual consumption per consumer equivalent by income level, household size, dependency ratio (i.,e. ratio of the number of household members less than 16 and more than 65 to number between 16 and 65), region, percent of labor devoted to upland rice, and market orientation index (value of total sales as a percent of output).

Analytical Methods:

Other: Parametric and non-parametric tests of differences in mean expenditures according to interview frequency and length of recall.

(3) Smith, Victor, John Strauss, Peter Schmidt, and William Whelan, "Non-Price Factors Affecting Household Food Consumption in Sierra Leone," 1980.

Data Interpretation:

Survey Data: Expenditure sample of 1974-75 survey. Cross tabulations made for rice, other cereals, cassava, palm oil, groundnuts, and alcoholic beverages per consumer equivalent classified by income, ethnic group, percentage of labor devoted to upland rice, number of wives of household head, market orientation and dependency ratio indexes.

SIERRA LEONE/NIGERIA (contin d)

Other: Description of differences in total sample and usable sample.

Analytical Methods:

Other: t-Tests for differences in means between full sample and usable consumption sample .

(4) Smith, Victor, John Strauss, and Peter Schmidt, "Single-Equation Estimation of Food Consumption Choices in Rural Sierra Leone," 1981.

Data Interpretation:

Other: Tabulations of average food prices by commodity and region based on weighted 1974/75 survey data for purchases and sales.

Analytical Methods:

Household Demand Analysis: Single-equation regression models used to explain quantities consumed and share of expenditures for twenty individual foods and six food groups. Explanatory variables include expenditure level, prices, size and composition of household, dependency ratio, number of wives, the age of the household head in years, farm production characteristics, and market orientation. Models estimated on full sample and on sample partitions by region, expenditure class, percentage of labor on upland rice.

(5) Strauss, John, Victor Smith, and Peter Schmidt, "Determinants of Food Consumption in Rural Sierra Leone: Application of the Quadratic Expenditure System to the Consumption-Leisure Component of a Household-Firm Model," 1981.

Data Interpretation:

Survey: Tabulation of expenditure shares by commodity and expenditure group from 1974/75 survey; mean values of variables included in demand analysis .

Analytical Methods:

Household Demand Analysis: Estimation of complete demand system for the household-firm model for six food categories, nonfood, and household labor using a quadratic expenditure system; household characteristics incorporated through translating; uncompensated and compensated price elasticities calculated from estimated parameters for mean expenditure and three expenditure groups.

SIERRA LEONE/NIGERIA (continued)

(6) Strauss, John, Victor Smith, Peter Schmidt, and William Whelan, "Joint Determination of Food Consumption and Production in Rural Sierra Leone: Estimates of a Household-Firm Model," 1981.

Data Interpretation:

Survey: Tabulations of mean values of production-related data; production, consumption, and marketed surplus of food commodities by expenditure group; marginal income shares of food groups, nonfoods, and leisure by expenditure group for 1974/75 sample of 138 producing households.

Analytical Methods:

Farm Level Production: Output-supply and labor demand equations for multiple food crop outputs estimated from a constant elasticity of transformation-Cobb Douglas (CET-CD) multiple output production function; price and output elasticities for two regional groups derived from estimated parameters and sample averages; "profit-effects" elasticities estimated for food groups, nonfoods, and labor by expenditure group; total quantity (consumption) elasticities with respect to price estimated by summing uncompensated demand elasticities with profits effects elasticities for food groups, nonfoods, and labor by expenditure group; elasticities of total calorie consumption derived based on total demand elasticities for food groups and calorie conversion ratios.

(7) Smith, Victor, John Strauss, David Trechter, William Whelan, Peter Schmidt, and James Stapleton, "Food Flows and Simulations: Rural Sierra Leone," report prepared under contract No. AID-DSAN-C-0008, 1981.

Data Interpretation:

Survey Data: Survey data collected in 1974-75 for a rural employment research project were used together with census data on population to make estimates of consumption, production, and consumption from home production, for 24 food commodity groups for the rural population for eight ecological zones in rural Sierra Leone.

Other: Estimates of production and consumption were organized into food accounting matrices which show the flows of food and calories within the rural sector between production activities, market activities, rural household consumption, and all other activities; separate tables report activities broken down by region and by expenditure class.

SIERRA LEONE/NIGERIA (continued)

Analytical Methods:

Sector Model: Elasticities of output, consumption, and marketed surplus from the household firm model described in (6) together with the accounting relationships defined by the Food Accounting Matrix are used in a simulation model which shows how production, consumption and quantities available to other sectors respond to policy experiments that change output prices and input costs.

(8) Smith, Victor, William Whelan, and Peter Schmidt, "Food Consumption Behavior in Three Villages of Northern Nigeria," 1982.

Data Interpretation:

Survey: Data from a field survey of three villages in Kano State, northern Nigeria used to describe patterns of food consumption including quantities consumed and percentages from home consumption; sample averages for household characteristics, farmgate prices, and expenditures tabulated; quantities consumed estimated by disappearance method.

Analytical Methods:

Household Level: Single-equation models for sorghum, early millet, late millet, corn, rice, cowpeas, palm oil, nono, and tomatoes were used to examine relationships among consumption levels, household production pattern, and market orientation; basic model estimated total quantity consumed from all sources as function of total expenditure, relative prices, household composition and socioeconomic characteristics, and food sources; analysis was complicated by differing recall periods for two samples; expenditure, own- and cross-price elasticities estimated from regression coefficients; calorie consumption equation estimated as function of expenditure, household characteristics, and sources of food.

SRI LANKA

(1) Neville Edirisinghe and Nimal Hettiaratchi, "Child Nutrition and its Determinants, Including Government Transfers and Intra-Familial Food Allocations: Evidence from the Kandy District, Sri Lanka," June 1986.

Data Collection:

Household survey of 480 households; questionnaires used to gather data on expenditures and food consumption, household decision-making, child feeding practices and beliefs, and food intake of preschool-aged children. Anthropometric data collected by trained public health officials.

Data Interpretation:

Survey: Tabulations for subsample (191 households) with preschool aged children: distribution of sample by average age, weight, height, and sex; per capita daily calorie consumption by age group and food expenditure quintile; weaning age by mother's education; percent of female household heads reporting foods as "nutritious" by food and education category; percent of preschool children's calories provided by various food items by mother's education; total expenditure, household size, food stamp allotment (total, per capita and as percent of total expenditure), per capita calories (preschool children's and all others), calories due to food stamps (preschool and all others) by expenditure quartile; calorie consumption of preschoolers in households receiving supplementary food aid and all others; sources of preschooler's calories by food group, expenditure quartile, and food stamp participation status; calorie adequacy ratios for preschoolers and all others by expenditure quartile. Computation and tabulation of "Z-scores" and percent of children nutritionally at-risk from anthropometric measures by age group, sex, and expenditure quintile; percent of nutritionally at-risk by level of calorie adequacy; average household size, adult equivalents, child dependency ratios, mother's education, and birth order by per capita expenditure group and Z-score level; Chi square analysis of relation between weaning age and Z-score; percent of preschoolers (supplementary food recipients and others) by Gomez and Z-score classification. Computation of equity measure based on ratio of preschoolers calorie adequacy ratio to that of all others.

Analytical Methods:

Household Demand Analysis: Calorie response functions (per capita) by expenditure group for 1) preschool children and 2) all other household members in food stamp receiving households as a function of per capita expenditure, level of mother's education, age and birth order of child, and child dependency ratio. Similar calorie consumption functions with dummy for supplementary food.

SRI LANKA (continued)

Other Regression Model: Weaning age estimated as a function of years of mother's education, per capita food expenditure, birth order, and birth interval. Logit model analyzing probability of finding observed Z-scores for a particular child estimated for full sample and lowest half by income as a function of child's per capita calorie consumption, adult per capita expenditure level, mother's education, child's age, household dependency ratio, and dummy's for participation in food stamp, supplementary feeding programs, and for availability of toilet facilities.

(2) Edirisinghe, Neville, "The Food Stamp Scheme in Sri Lanka: Costs, Benefits, and Options for Modification," March 1987.

Data Interpretation:

Time Series Analysis: Tabulations of Central Bank Annual Report data on fiscal costs of food subsidy programs 1966-84 for rice, flour, sugar, other foods, food and kerosene stamps; value of total subsidies in nominal and real terms and as a share of government expenditures and GNP; projections of fiscal costs 1979-84 under different assumptions about program parameters. Calculations of changes in domestic availability of rice using food balance sheets.

Survey Data: 1978/79, 1980/81 and 1981/82 Central Bank "Consumer Finances and Socioeconomic Surveys" (CFS) used to compute food subsidies by commodity group, expenditure quintile, and sector (urban, rural, estate); food stamp receipts by expenditure quintile and value of food stamps as share of general food subsidy, rice ration subsidy; subsidies as a share of total expenditures by sector, expenditure quintile, and occupational status; percent of households receiving food stamps, general food subsidy, and rice ration by per capita and total household income quintile, sector, region, ethnic group; distribution of food stamp and total subsidy payments by expenditure quintile and sector; mean household income by quintile; proportion of expenditures allocated to food by sector and expenditure quintile; calculation of gini ratios and income shares by quintile with and without food subsidies; calculation of apparent per capita household calorie consumption by expenditure decile and sector and percent of households in "ultra -poor" category (i.e. consuming less than 80 percent of recommended calorie allowance although spending more than 80 percent to purchase food) by expenditure quintile and agricultural occupation using calorie conversion ratios from the Sri Lanka Medical Research Institute; derivation of food prices, budget shares, and price indexes for food and nonfood commodities by expenditure quintile; calculation of a calorie efficiency index based on the ratio of a calorie price and food price index by expenditure quintile and sector.

SRI LANKA (continued)

Analytical Methods:

Household Demand Analysis: Engel curves estimated from CFS 1978/79 and 1981/82 using double-log functional form allowing for positive segment in Engel curve. Household calorie consumption functions estimated to test the equality in the marginal propensity to consume calories from subsidy and other sources of disposable income; expenditure elasticity of demand for calories estimated from calorie consumption function from 1980/81 CFS and used to calculate the contribution of food stamps to calorie consumption by quintile; simulation of the effects suggested food stamp reallocations on poorest 40 percent of the population.

SUDAN

(1) Youngblood, Curtis E., Marielouise W. Harrell, Michael P. Demousis, and David L. Franklin, "Consumption Effects of Agricultural Policies: Bread Prices in the Sudan," April 1983.

Data Interpretation:

Time Series: Tabulation of GNP per capita; wheat production, imports, and domestic disappearance with three year moving average for net availability; apparent wheat flour consumption total and per capita; nominal, real, and relative prices of bread and sorghum grain.

Survey Data: Tabulation of average monthly household expenditures and average budget shares for food, major food groups, and nonfood by expenditure group from 1978/79 Household Budget Survey and 1982 Minihousehold Survey of Khartoum; average bread consumption for households with and without women in labor force for three expenditure strata; computation of daily calorie intake and tabulation of average percentage of calories from different food sources for three expenditure groups using data from the minihousehold survey.

Analytical Methods:

Household Demand Analysis: Expenditure and price elasticities of demand for five food groups and nonfood group estimated by Linear Expenditure System, Nested Linear Expenditure System and the Frisch technique for three income strata; estimate of own-price elasticity for bread from time series data used to determine value of money flexibility (Frisch) and the level of subsistence expenditure (LES).

Sector Model: Policy simulation model for wheat import requirements developed; regression analysis of time series data on per capita wheat flour consumption as function of per capita GNP, real price of bread, and real price of sorghum grain; regression parameters used to estimate own-price elasticity of demand for wheat flour and cross-price elasticity with respect to sorghum grain price; wheat acreage response model estimated by regressing wheat acreage on lagged acreage, lagged world wheat price, and time; determinants of commercial wheat imports estimated by regressing wheat imports on world wheat price and domestic production; given baseline estimates of wheat flour consumption, production levels, income growth and inflation, econometric estimates of own-price elasticity of demand, wheat acreage response and commercial import relationships used to make policy simulations.

SUDAN (continued)

(2) Youngblood, Curtis E., and Jerry B. Leonard, "Resource Allocation in the Gezira Scheme: A Sensitivity Analysis," April 1983.

Data Interpretation:

Cross-Section: Tabulation of border and producer prices at different exchange rates; costs of production and yield distribution at different levels of technology with probabilities of occurrence for major crops; estimation and probabilistic sensitivity analysis of domestic resource cost, value added, foreign exchange dependence and private profitability coefficients for five crops.

Other: Description of Gezira irrigation project and export promotion scheme; description of cropping patterns of four crops.

Analytical Methods:

Sector Model: Linear programming model developed for Gezira irrigation district to maximize net foreign exchange earnings subject to constraints on water availability, availability of foreign exchange to purchase imported inputs, and constraints on private profitability (solutions were trivial).

(3) Pinstrup-Andersen, Joachim von Braun, Tongjit Uy and Winifreda Floro, "Impact of Changes in Incomes and Food Prices on Food Consumption by Low-Income Households in Urban Khartoum, Sudan with Emphasis on the Effect of Changes in Wheat Bread Prices, April 1983.

Data Interpretation:

Survey Data: Tabulations of data from the 1978/79 household budget survey in urban Karthoum made for two sample population stratifications: 1) a four group stratification made on the basis of level of household calorie consumption relative to household requirements and 2) a five group expenditure stratification; tabulations made for consumption and socioeconomic characteristics, sources of income, food expenditures, budget shares, sources and price of calories for the two stratifications described above; individual food items compared in terms of food expenditure and calorie shares.

Analytical Methods:

Household Demand Analysis: Linear expenditure system used to estimate price and income elasticities of demand for each of the five expenditure strata. Quantity data for sorghum used to derive household prices,and other prices relative to bread derived from sample data. Elasticities used to simulate the impact of a change in bread prices on the calorie deficiency of the poorest stratum and the real incomes of all strata.

TANZANIA

(1) Keeler, Andrew G., Grant M. Scobie, Mitchell A. Renkow, and David L. Franklin, "The Consumption Effects of Agricultural Policies in Tanzania," January 1982.

Data Interpretation:

Time Series Analysis: Tabulation of consumer price index, international inflation index, official and parallel market exchange rates, volume of exports, government sector deficits and expenditures in real and nominal terms and as a percent of GNP, money supply, real and nominal foreign exchange reserves, trade balance in nominal and real prices and as a percentage of GNP, composition of imports; per capita and total production indexes for food and agriculture; trend analysis and computation of rates of growth of agricultural production; tabulations and trend analysis of export and producer prices for coffee and cotton; export earnings for main export crops in real terms; computations of ratio of tax revenues from coffee export to export earnings; imports and official domestic procurement of grain crops and drought staples by region; real producer prices for food grains and drought staples; estimations of regional surplus and deficits of grains and percentages of urban grain needs met by sales in official markets.

Cross-Section: Comparison of proportions of coffee earnings going to producer, marketing costs, export tax and tax due to overvalued exchange rate for two periods; computation of domestic resource costs for cotton and maize by region; ratios of parallel market to official market prices for grains; computation of income of hypothetical small farmer selling on official market and parallel market; computation of percentage of urban workers' income needed to purchase cereals at official and parallel prices for three years.

Survey: Tabulation of budget shares for cereal grains and food for urban and regional areas from income and expenditure survey

Other: Descriptions of trade, monetary, exchange rate and export pricing policies; marketing patterns by region; descriptions of programs promoting food production, official procurement and pricing policies for grains, and the functioning of parallel markets for grain; graphical presentation of intra-year price movements of grain.

(2) Renkow, Mitchell A., Jerry B. Leonard and David L. Franklin, "The Potential Effects of Alternative Structures and Pricing Policies in the Markets for Maize in Tanzania," February 1983.

Data Interpretation:

Survey Data: Subsample of 1976/77 household expenditure survey used to estimate average consumption and diet patterns by region, tabulation of diet composition by region; tabulations of production estimates from special FAO study and from crop monitoring project

TANZANIA (continued)

Other: Description of procurement and pricing policies for maize; regional estimates for previous three years of total consumption of major staple foods in urban and rural areas made by applying regional population growth rates to average consumption data; on-farm consumption, official and unofficial marketings estimated by combining regional consumption estimates with data on production and official purchases; net deficits of maize, sorghum and millet, and rice and marketable surpluses of maize estimated at regional level; unexplained residual of maize disappearance graphically presented and discussed.

Analytical Methods:

Household Demand Analysis: Income and price elasticities of demand for urban areas estimated with semi-log equation and Frisch technique with assumed money flexibility of -1.0.

Farm Level Production: Household production models for seven regions estimated to assess impact of changes in real prices on household production and marketing pattern; farm budget data from farming systems studies used to estimate labor cost shares, percentage of production retained for home production, and purchased input shares for food and cash crops; representative own-price elasticities of demand and elasticities of substitution of capital for labor chosen by assumption; effects of a 10 percent increase in real price of food crops simulated and own-price marketed food supply price elasticities estimated; tradeoff between food and cash crops estimated.

Sector Model: Marketed food supply elasticities from household production model and demand elasticities from demand analysis used to estimate supply-demand market model for maize. Model was used to estimate price and quantity impacts of removal of maize subsidy and removal of restrictions on private trade; simulations made for high and low supply elasticity assumptions.

ZAMBIA

(1) Center for Agriculture and Rural Development, "Policy Issues, Project Design and Implementation Plan: Final Research Strategies Based on Host Country Review," September 1985.

Data Interpretation:

Time Series: Tabulations of import and export prices and terms of trade indexes, domestic price trends, government subsidies and capital expenditures from World Bank data.

Cross-Section: Agricultural GDP by type of activity; imports and exports of major crops, costs of calories and proteins from frequently consumed food items, average calorie and protein intakes by season, nutrient adequacy ratios by region and occupation, diet composition by region, level and composition of food aid.

Survey: Tabulation of estimates of calorie and protein intake and average expenditures from household surveys.

Other: Summary descriptions of major macroeconomic, agricultural, food consumption and nutrition policy issues; description of existing economic situation and general policy context; descriptions of types of agricultural producers, land tenure, and production patterns; descriptions of marketing channels and organizations including operation of National Grain Marketing Board.

(2) Center for Agriculture and Rural Development, "Zambia Maize Policy Model," May 1987.

Data Interpretation:

Other: Description of available supply utilization data.

Analytical Methods:

Sector Model: Policy simulation model for maize with three primary economic relationships (area planted, mill sales, and marketings); yields are exogenous to price and determined by trend growth rate; producer and consumer prices set by policy; model uses spreadsheet format in nine steps: 1) recommended producer price support levels and cost of production estimates generated given information on variable and capital inputs and interest rates, 2) data on prices, population, GDP, international corn prices, and exchange rates converted to format for use in model; 3) maize area planted estimated given own-price and fertilizer price elasticities and prices, trend growth, lagged area planted; 4) given data on beginning stocks, lagged production and lagged marketed production, domestic supply and ending stocks estimated (percent of production marketed estimated based on producer and consumer price differential); 5) data on producer price, marketed production, international price, and exchange rate used to compute mill price support level and import price for maize; 6) given price and income elasticity of demand for

ZAMBIA (continued)

maize and data on consumer price, CPI, and GDP per capita estimates of per capita maize sales and total mill sales made; 7) necessary imports estimated given previous model estimates of marketed production and estimated mill sales; 8) estimates of price and domestic supply from model used to estimate per capita maize consumption; 9) government costs for maize subsidies computed given model price, import, and mill sales estimates.

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ACKNOWLEDGEMENTS

This report benefited from the views and comments of many people. Special thanks are given to John Hyslop and Arlene Mitchell of the Office of International Cooperation and Development, U. S. Department of Agriculture, and Nicolaas Luykx of the Office of Nutrition, U. S. Agency of International Development. Among those people contacted, Harold Alderman, Francis Davidson, Eileen Kennedy, Hope Sukin, and Roberta van Haeften were particularly generous with their time. Helpful comments on an earlier draft of this report were given by Carol Kramer, Bea Rogers, and Patricia O'Brien Place. I am also grateful to Mildred Konan for editorial assistance.