PN-AAZ-346
ISN [illegible]

Contract No. OTR-0091-C-00-5164-00

FOOD SELF-RELIANCE

AND

FOOD SELF-SUFFICIENCY:

Evaluating the Policy Options

Scott R. Pearson
Timothy E. Josling
Walter P. Falcon

Food Research Institute
Stanford University

Paper Submitted To:

Bureau for Program and Policy Coordination
Office of Policy Development & Program Review
U.S. Agency for International Development
Washington, DC 20523

By:

Aurora Associates, Inc.
1015 Eighteenth Street, N.W.
Suite 400
Washington, DC 20036

June 1986

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY..... 1

A. CONCEPTS AND ISSUES..... 8

Definitions of Alternative Strategies..... 8

Self-Sufficiency in Food..... 9
Self-Reliance in Food..... 11
Trade-Dependence in Food..... 14
The Strategies Compared..... 15
Stability and Security..... 16

The Gains from Trade..... 18

Single-Commodity Case..... 18
Economy-Wide Effects..... 20
Assumptions and Qualifications..... 20

B. MEASUREMENT OF THE EFFECTS OF POLICY OPTIONS..... 27

Accounting Matrix for Efficiency and Policy Analysis..... 30

Private Profitability..... 31
Social Profitability..... 32
Effects of Policy and of Market Failure..... 37

Comparisons among Agricultural Systems Producing Different Outputs..... 41

Private Profitability..... 42
Social Profitability..... 43
Policy Transfers..... 44

Average Cost Curves and Price Policies..... 45

Output Price Policy..... 47
Input Price Policy..... 50
Strengths and Limitations of Price Policy Analysis Based on Budget Data..... 52

Dynamic Comparative Advantage..... 54

Research Plan for Policy and Efficiency Analysis..... 57

Uses and Limitations of the Research Results..... 59

Summary of the Impact of Policy on Efficiency.... 63

TABLE OF CONTENTS (CONT.)

The Impact of Policy Options on Non-Efficiency Objectives..... 64

Income Distribution..... 65
Food Price Stability..... 66
Food Security..... 67

C. POLICY CHOICE MODEL..... 70

The Model..... 70
The "Market Data" Approach..... 71
The "Budget Data" Approach..... 73

Illustration: Food and Agricultural Policy in Indonesia..... 75

Background..... 77
Rice..... 80
Corn..... 86
Cassava..... 87
Macroeconomic Policy..... 89

Model Construction and Results..... 92

Assumptions..... 92
Market Balance..... 95
Budget Data for Agricultural Systems..... 96
Policy Analysis Matrices for Agricultural Systems 99
Model Results.....102

ANNEXES

Annex 1 - Sources of Data.....106

Annex 2 - Software Documentation.....108

EXECUTIVE SUMMARY

The purposes of this paper are threefold: to define three alternative food strategies and to indicate how to evaluate them according to their ability to further multiple government objectives; to suggest two complementary empirical approaches, one based on elasticities and the other on budget cost data, for measuring the effects of the price, macro, and investment policies that constitute each food strategy; and to illustrate the policy choice model with an application to the rice, corn, and cassava agricultural systems that feature prominently in Indonesia's food system. The intention is that the clarification of concepts and strategies, the construction of straight-forward empirical models, and the illustration of the analytical method with an Indonesian case study will aid policymakers in developing countries and officials of donor agencies to sort out the effects of recent policies and to project the likely impacts of changing them.

The three food strategies are defined to reflect a country's decision to reap or to lose the gains from international trade. Emphasis is thus centered on efficiency losses from misallocating scarce resources, which are caused by policies that result in too little or too much foreign trade in food. Countries that carry out a set of policies to restrict food trade (by placing tariffs or quotas on imports or taxes or quotas on exports) are defined to follow a Self-Sufficiency Strategy (SSS). For such countries the net effect of agricultural and macro policies is to subsidize

food production of deficit commodities, thereby creating incentives to expand local production and replace food imports or, conversely, to tax production of food exports to decrease their production and trade.

At the opposite end of the spectrum are countries whose policies have the net effect of taxing domestic food production of deficit commodities and thus of widening the food import gap (usually with the intention of decreasing domestic food prices to consumers) or, conversely, of subsidizing food exports and generating inefficiently produced export supplies. When a country's net policy transfer causes inefficient imports or exports, its food strategy is defined as a Trade-Dependent Strategy (TDS).

An intermediate strategy is neither anti-trade biased, like SSS, nor pro-trade biased, as is TDS. A Self-Reliant Strategy (SRS) is based on policies that follow the trends of efficiency prices and hence do not create efficiency losses from excessive or inadequate levels of domestic production. The idea is to benefit from trade while investing to bring about the desired technical and structural changes necessary for an increasingly efficient and competitive agricultural sector. All three strategies imply activist intervention by government. The intermediate one, SRS, attempts to effect desired change by following a growth path that maximizes gains from trade, minimizes efficiency losses, and thus permits greatest opportunities for long-run growth of the agricultural sector and of the economy at large.

The design of methods follows the definition of strategies. Empirical measures are required for each country to identify the food strategies actually followed in the recent past and to indicate the likely results of pursuing one or another strategy in the near future. A measure of the net transfer effect of price and macro policies is needed to identify the revealed food strategy. Because policy effects are measured in relation to estimated efficiency valuations of products and inputs, analysis of policy also results in identification of efficiency or comparative advantage. Detailed budget data on the costs and returns of agricultural systems for principal food crop technologies and agro-climatic zones are needed to carry out the empirical analysis of efficiency and policy effects. Dynamic comparative advantage can be simulated by projecting future changes in technologies, world price trends for commodities and inputs, and domestic factor prices.

Empirical models for policy analysis, whether based on elasticities or budget data, need to be complemented with a good understanding of the historical, institutional, technical, and resource constraints facing the country. For best informed decisions on policies or investments affecting agriculture, it is essential to understand both the magnitude of transfers created by an existing or proposed set of policies and the efficiency and distributional effects of recent or altered policy. The disaggregated analysis should be carried out for all of the country's principal agricultural systems. Even that degree of detail, however, will not provide all the information required to

evaluate the non-efficiency (income distributional, price stability, and food security) impacts of alternative food strategies. Perhaps the greatest benefit in carrying out budget-based analysis is the amount of understanding of policies and systems gained by policymakers and their staffs as they do the food policy analysis.

Application of the micro computer model developed in this paper to Indonesia's food economy demonstrates the strengths and limitations of this type of empirical analysis. Indonesia has recently been victimized by its own successes in rice policy. In only five years, the country switched from being the world's leading importer of rice to producing a rice export surplus in 1985. This achievement was due to a highly successful combination of policies--dissemination of a Green Revolution technology package through effective research and extension, creation of strong incentives to farmers through maintenance of a floor price to producers and high subsidies on purchased inputs, implementation of price stabilization through a well-functioning public buffer stock program, and institution of macroeconomic decisions favorable to agricultural development, including budgetary support and non-taxing exchange rate policy. But, by substituting for 2 million tons of rice imports and then by exporting another half million tons of rice in a world rice market of only 12 million tons, Indonesia placed strong downward pressure on already weakening world rice prices. In 1985, the world price of rice was less than half its level in 1980, and Indonesian exports required heavy subsidies to be moved.

Consequently, policymakers in Indonesia have attempted to reduce or eliminate exports of rice by freezing the floor price and increasing the fertilizer price by a fourth.

The analytical approach suggested in this paper is intended to guide policymakers in selecting a food strategy and then in shifting course as circumstances require. To illustrate the approach with an Indonesian example, budgets were prepared for 16 representative agricultural systems--12 for rice (four agro-climatic regions each with three technologies), three for corn, and one for cassava. From these budgets and data or assumptions on price changes, policy analysis matrices (PAMs) were constructed for each system. The PAMs show the competitiveness, comparative advantage, and effects of policy for each system during an 11 year-period centered on 1985. With this disaggregated information, policymakers can gauge which regions and technologies are likely to expand (or reduce) output if price incentives are increased (or lessened). In Indonesia, for example, the least competitive rice systems, those most likely to contract because of this year's disincentive price changes, are those producing non-irrigated rice (since no complete Green Revolution package is available for rainfed rice production) in all four regions studied.

The computer model is designed to allow food policymakers to judge the recent and projected effects of the three food strategies--self-sufficiency, self-reliance, and trade dependence. For the five-year projection period, each of these three strategies is further assessed within the context of three alternative scenarios--a stable international price environment,

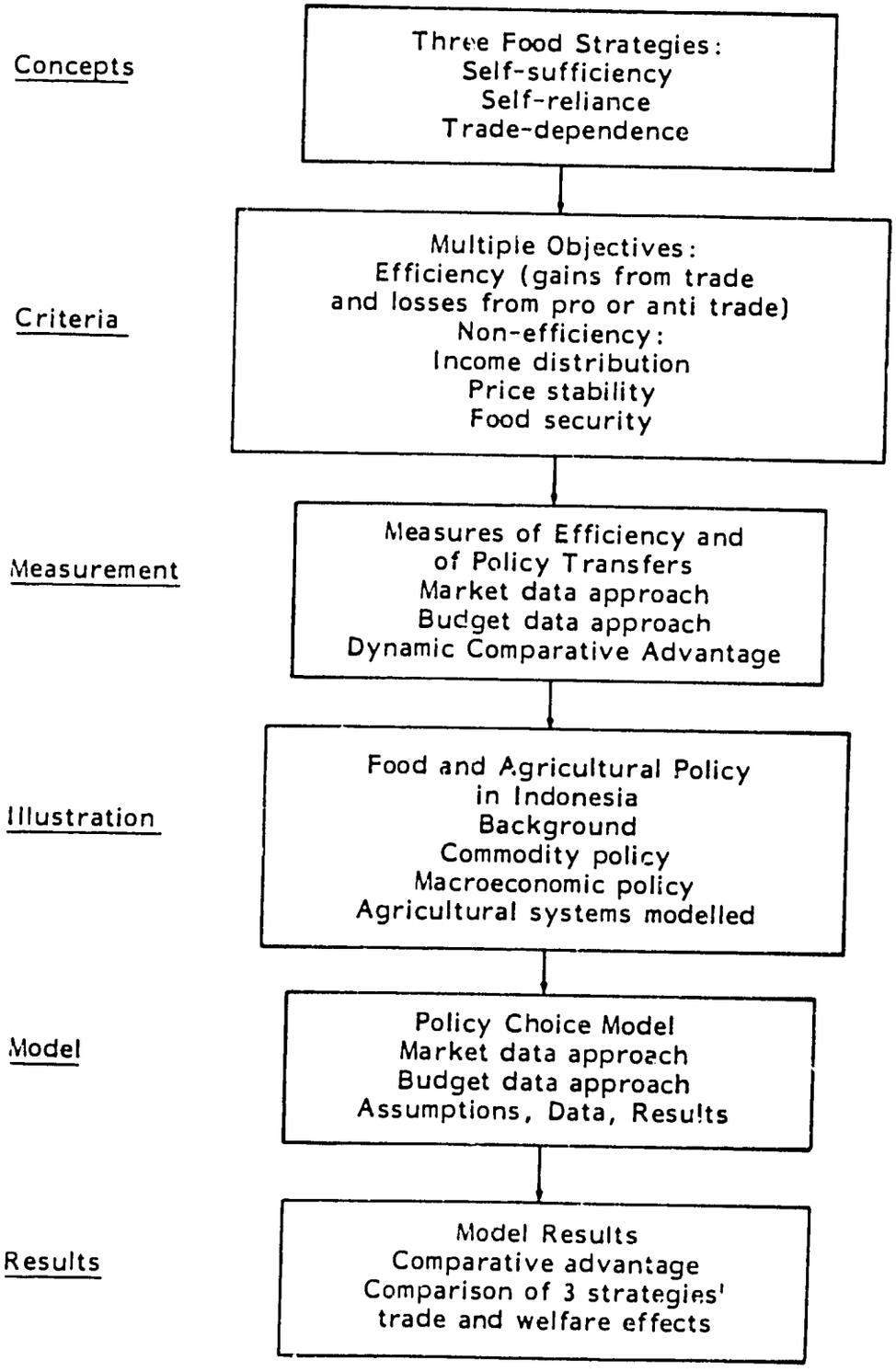
falling world prices for food commodities, and a depreciating exchange rate due to plummeting world oil prices. The empirical results underscore the superiority of the self-reliant strategy in the recent past (1980-85) and under all three future scenarios (1986-90). They point up the costs of Indonesia's unintended departure from stabilizing domestic rice prices around a long-run trend of the world rice price, which led the country to slip into a trade-dependent strategy of subsidizing exports in 1985. Corrections back to a self-reliant strategy will be neither easy politically nor immediate, but the model projections provide useful information to Indonesian policymakers concerned with making the policy adjustments.

Successful food and agricultural policy requires much more than appropriate technology, incentive prices, and a computer model to test their interactions. In Indonesia, several contributing dimensions aided the impressive expansion of rice and corn production, both of which doubled during the past 15 years. These key ingredients in managing macroeconomic and food policies include: political stability to permit making difficult short-run adjustments within the context of a consistent, long-run strategy; continuity of economic policymakers and staffs; importance of institutional and analytical capacity; understanding of the use and limitations of economic policy and its analysis; appreciation of the limits of the appropriate substitution of public for private activity; public investments in research for agricultural technology and infrastructure; and

orientation toward the use of private sector domestic marketing and of world markets and prices in guiding domestic decisions.

The approach and structure of this paper are illustrated summarily in Chart 1. The chain of logic begins with concepts (the three food strategies), moves on to criteria with which to evaluate the strategies (multiple government objectives), then considers techniques of measuring comparative advantage and the effects of policy in furthering objectives (the market and budget data approaches), and finally illustrates a case study of largely successful food policy (Indonesia) by using a computer model (the policy choice model) that provides interesting empirical results (comparative advantage, policy transfers, and trade and welfare effects of the three food strategies under alternative future international environments). The paper thus integrates all three levels of applied economic analysis--conceptual reasoning (theory), methods of measuring (computer software), and empirical application (case study)--to suggest a useful tool for food policy analysis.

Chart 1


Concepts
Three Food Strategies:
Self-sufficiency
Self-reliance
Trade-dependence
Criteria
Multiple Objectives:
Efficiency (gains from trade
and losses from pro or anti trade)
Non-efficiency:
Income distribution
Price stability
Food security
Measurement
Measures of Efficiency and
of Policy Transfers
Market data approach
Budget data approach
Dynamic Comparative Advantage
Illustration
Food and Agricultural Policy
in Indonesia
Background
Commodity policy
Macroeconomic policy
Agricultural systems modelled
Model
Policy Choice Model
Market data approach
Budget data approach
Assumptions, Data, Results
Results
Model Results
Comparative advantage
Comparison of 3 strategies'
trade and welfare effects

SECTION A

CONCEPTS AND ISSUES

Definitions of Alternative Strategies

The aim of this paper is to clarify the policy dilemma faced by most developing countries on the extent to which basic foodstuffs should be imported from abroad. Other things being equal, all countries would prefer to provide essential foods for their population from domestic sources. But "other things" are rarely equal: using resources for domestic food production has a cost to the country which may exceed the cost of imports. The government can make the choice that bearing this extra cost is acceptable, in terms of perceived benefits. But that policy decision involves a trade-off among objectives--since the cost reduces available income in the economy. This paper attempts to clarify the issue of the measurement of costs and benefits of using trade to a greater or lesser extent in meeting domestic food needs. The goal is to assist countries to choose a strategy on the continuum between full "self-sufficiency" and excessive "trade dependence".

The initial step in considering this measurement problem is to clarify the terms and concepts used in the debate over food trade policy. Three concepts at the center of that debate are self-sufficiency, self-reliance, and trade-dependence. In addition, the concepts of price stability, food security, and comparative advantage are central to any discussion of these issues. Each can be defined in a variety of ways. What follows

is an attempt to give a consistent and analytical meaning to each concept for use in the discussion of food trade policy.

Self-Sufficiency in Food

Self-sufficiency refers to a situation where all food needs are met from domestic production. By extension, the degree of self-sufficiency is the proportion of national consumption covered by the country's own production. The use of the term self-sufficiency, however, goes far beyond its technical meaning as a market indicator. It is widely used as a short-hand phrase for a particular type of strategy--that of reducing the level of food imports (or exports). A strategy of self-sufficiency emphasizes increases in agricultural production and, by implication, a restriction of consumption by means of either direct taxes on food or controls on food imports. The strategy can be long-term--through research and infrastructure investment in agriculture, medium-term--through price signals, or short-term--through the use of quantitative controls. The aim can be self-sufficiency at all times, in "normal" years, or in periods of hardship. Self-sufficiency objectives can be limited to basic foodstuffs, apply to all foodstuffs, or include non-food products and inputs into food production. In practice, the definition of the objective of the strategy of self-sufficiency is often left ambiguous, perhaps because some governments prefer not to be specific in stating policy goals.

For the purpose of contrasting a self-sufficiency strategy with those that emphasize the continuing use of international trade, it is useful to define this strategy more precisely. In

this paper a self-sufficiency strategy (SSS) is considered to include the following elements:

- restrictions on the importation of foodstuffs from abroad (not related to public health standards) so as to make the domestic price of such importables measurably above their comparable "world prices;"
- prices of farm commodities to producers significantly greater than the equivalent of imported commodities, together with the provision by the public sector, if necessary, of adequate domestic marketing institutions to bring the goods to market;
- prices of products to consumers which discourage consumption of imported commodities or restrictions on access by consumers to imports; and
- rationing of foreign exchange so that importation of food-stuffs is made more difficult.

This strategy of self-sufficiency is often espoused by countries that are concerned with the continuity of food supplies from abroad. Countries with large populations, and hence food requirements that are significant relative to the volume of trade on world markets, feel more vulnerable to both economic and political events if they depend heavily on imports. Such countries often express concern that the major exporters might exert leverage over them in domestic and foreign policy matters. The notion that national sovereignty and independence are compromised by substantial food imports could appear exaggerated at a time when grains and other basic foods are in plentiful supply on world markets, but fears of shortages and high prices still exist.

Large countries tend to have higher degrees of self-sufficiency. In part this reflects strategic decisions. But one would expect any large geographically diverse area to have a high

proportion of internal to external trade. The chance of the food supply for any particular urban area coming from within a country is greater the larger and more diverse is the nation itself. In such cases the self-sufficiency choice is not so much whether to be, say, 60 percent or 90 percent self-sufficient but whether to produce 96 or 98 percent of domestic consumption. That choice is still important, however, to the country and to the rest of the world. The same concern that leads large countries to look mainly to domestic sources for food supplies--the absolute size of their food requirements--makes any policy decisions by these countries of international significance. By the same token, the costs of mistakes are likely to be high in human as well as in financial terms. The contribution of trade to food policy needs to be analyzed even in situations where a self-sufficiency strategy appears to be dictated by a country's large size.

Self-Reliance in Food

Self-reliance refers to a strategy where food needs are met from a deliberate combination of domestic production and imports and where such imports of food are paid for on a commercial basis by export earnings (from agricultural or other exports). This strategy is distinguished from self-sufficiency, where imports are discouraged, and from trade-dependency, where the cost of food imports are subsidized to provide low prices to consumers. As with self-sufficiency, the self-reliance strategy can be long-term or short-term and can refer to basic foods or all agricultural commodities and production inputs.

The central advantage of a strategy of self-reliance is that a country both avoids the potential extra costs of self-sufficiency arising from inefficient domestic production and reduces the possible risks associated with trade dependency. Depending upon those costs and risks, a self-reliance strategy could result in either a high or a low degree of self-sufficiency. The level of imports is not in itself a complete measure of the extent to which a country follows a self-reliant strategy; the capacity to earn or save foreign exchange also needs to be taken into account.

In this paper a self-reliant strategy (SRS) is defined to comprise the following elements:

- low restrictions on the importation of foodstuffs leading to domestic price levels roughly "in line" with the trend levels of (normal) world prices;
- farm prices not elevated on average much beyond the levels indicated by availability of imported commodities;
- consumer prices not tilted in favor of domestic goods and quantitative restrictions not placed on imported supplies; and
- allocation of adequate foreign exchange by the government authorities to allow importation of foodstuffs.

The essence of this strategy is to take full advantage of the existence of world markets for agricultural goods while at same time paying domestic producers the full value of their production. Just as self-sufficiency has a particular appeal to countries concerned with their international vulnerability, so self-reliance has been emphasized by countries that have enjoyed an increase in export earnings in recent years. Additional

foreign exchange from non-food exports does not, however, always lead to more food imports. The notion of self-reliance through trade is that the relative scarcities of goods on world markets determine the domestic production pattern. For many countries self-reliance involves increases in production, and perhaps exports, of certain agricultural products. Specialization within agriculture as well as between agriculture and other sectors is a common phenomenon of a trade-oriented strategy.

Countries with little agricultural land or with land poorly suited to staple crop production have little choice but to engage heavily in agricultural trade. For these economies the issue is not whether to trade, but how to develop the capacity of the human and physical resources of the country to increase the benefits from trading. Whether agricultural or food production fits in to the best pattern of specialization will depend on the nature of the resource base and the alternative uses of labor and scarce capital.

The nature of the vulnerability of such open economies to world market events differs according to the size of the country. Small and medium-sized countries are less likely to experience supply difficulties with grains and other traded foodstuffs. There is little chance of political strings attached to trade flows when small lots can be purchased readily in the marketplace. Price variations, however, hit both small and large importers alike. Countries that engage extensively in trade will tend to make use of a range of instruments, including foreign exchange reserves, food reserve stocks, and trading on commodity

futures markets, to avoid the disruption that might otherwise come from fluctuations in world prices.

Trade-Dependence in Food

It is useful to distinguish between the strategy of self-reliance, as described above, and a situation of excessive imports of foodstuffs relative to capacity to pay in foreign exchange. Trade-dependence might not often be articulated as a policy by governments, but many countries find themselves to a greater or lesser extent dependent on other countries to provide finance for imports of basic food supplies. Self-reliance entails a dependence upon the existence of international markets for food and for foreign exchange. Trade-dependence, in contrast, implies a dependence upon particular foreign countries (or the international community in general) to provide either supplies of food or the finance to purchase such supplies.

A trade-dependence situation (TDS) can be thought of as involving:

- prices to domestic producers lower than world prices;
- subsidized prices to consumers of imported commodities which shift demand away from domestic products otherwise adequately available;
- reliance on concessional import supplies for a significant portion of food consumption; and
- borrowing of foreign exchange to maintain imports of foodstuffs.

Trade-dependence might develop as a result of an attempt to keep food prices low in urban areas, through direct food subsidies and administered market prices, or from the taxation of agricultural production to generate revenue for other types of

development. It might also happen not as a result of deliberate policy, but as a consequence of an overvalued exchange rate that in effect subsidizes imports and taxes exports. All agricultural commodities that enter into international trade are taxed by macroeconomic policies that create inappropriate exchange rates.

The lure of readily available food at concessional terms might also prompt governments to neglect domestic agriculture and rely unduly on imported food. Unless concessional food can be relied on for all import needs--at no political price--it makes sense for food aid recipients to act as if imported produce were at commercial rather than concessional prices and to treat the difference as a transfer payment.

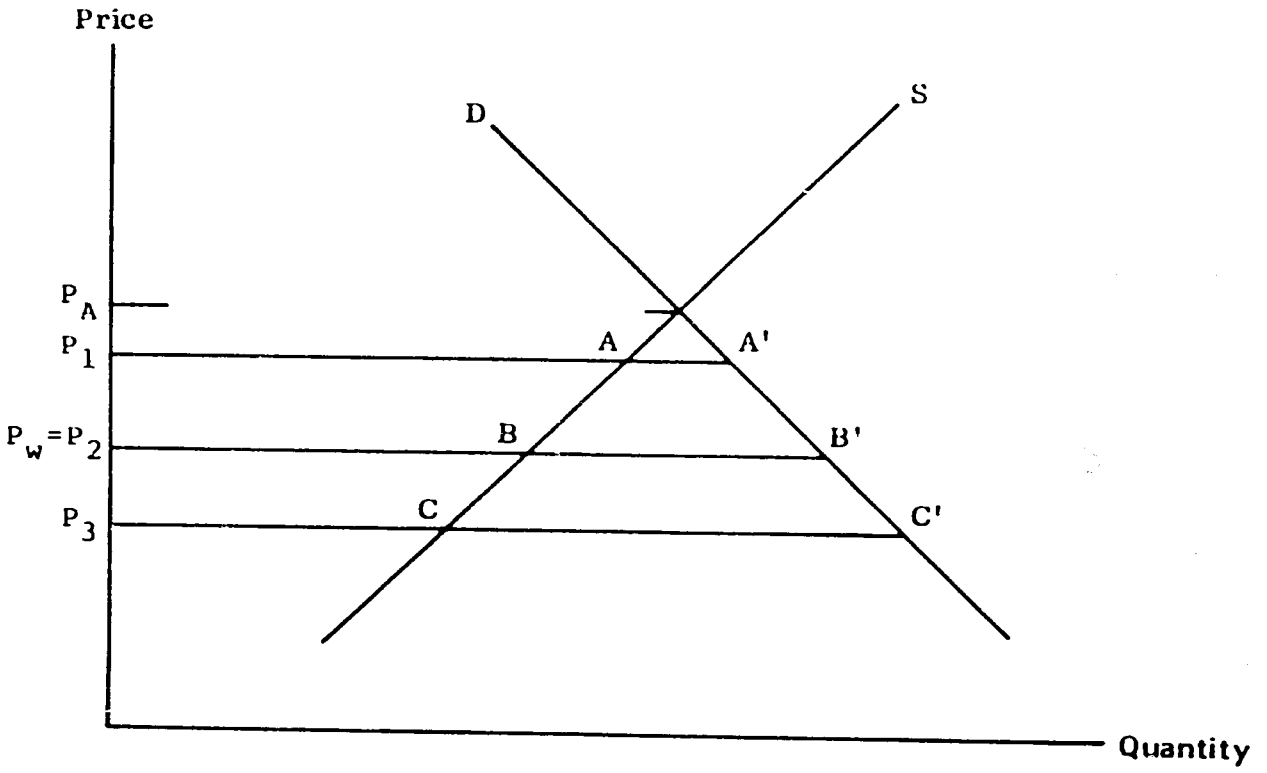
Trade-dependency shows up in both large and mostly self-sufficient countries, where domestic agriculture is directly or indirectly taxed, and in small, open economies where export performance is weak. For such countries the critical issue is how dependence on food and non-food imports should be reduced--by expanding domestic food production, by restricting imports and consumption, by changing exchange rate policy, or by shifting resources into export sectors or into activities that reduce the need for imports. For these countries the two models of self-sufficiency and self-reliance beckon as alternative strategies.

The Strategies Compared

The three strategies can be illustrated in a diagram of the market for a major traded staple foodstuff. Figure 1 shows the relationships among the three strategies. The highest domestic price level, P_1, denotes a tendency toward self-sufficiency, with prices significantly above the level of world prices, P_w.

Figure 1

Representation of Three Alternative Strategies in a Staple Food Market



P_1 = Self-sufficiency

P_2 = Self-reliance

P_3 = Trade-dependence

Complete self-sufficiency in the short-run in this commodity would require price level P_A, the autarchy (no trade) price. A combination of a price level P_1 and an attempt over time through investment and technical change to shift the supply curve to where A' can be produced at that price level is a dynamic representation of this strategy. Self-sufficiency could also be achieved, in principle, by somehow moving demand back to A to match domestic production, or by failing to provide any foreign exchange for imports, in which case the price would rise to P_A.

Self reliance is represented in the diagram by the choice of a domestic price level, P_2, at roughly the level of international prices. Trade-dependence, on the other hand, is likely to be associated with a price level on domestic markets, P_3, which is significantly below that level. Imports at CC' are higher than under the other two strategies and likely to grow over time if investment in the sector is restricted. The representation of the three strategies in this way allows one to measure their associated costs and benefits. This requires that one has an acceptable measure of such results. The next section describes such a measure in the context of the gains from trade.

Stability and Security

The choice of strategies needs to take into account instabilities and uncertanties in both domestic and international conditions. One factor that appears to drive countries toward higher levels of food self-sufficiency is the reality of unstable price levels on world markets. Under such conditions, it might be considered risky to expose the economy to the shocks of

internaticnal price fluctuations. But domestic production of foodstuffs can also vary. When domestic variability exceeds international instability, consumers can enjoy enhanced stability in food supplies and prices through the trade option.

In practice, both the self-sufficient and self-reliant strategies are tempered due to stability considerations. Self-sufficient countries import foodstuffs when domestic output drops significantly even if to do so they have to be import-dependent for a time. Similarly, self-reliant countries enact price stabilization policies to insulate their own consumers and producers from undesired fluctuations in world prices.

This question of stability of policies and security of supplies raises deeper issues. Domestic investment decisions in agriculture need a reasonable degree of assurance as to future prices and profits. Similarly, a country needs to have a view on trends and levels of world prices in order to make strategic decisions involving productive investment. The world market prices for most food commodities have shown a tendency to fall slowly in real (inflation-adjusted) terms but to fluctuate dramatically on occasion. Depending upon how recent the last price rise was, governments seem to change their views about the medium- and long-term price trends. A long-term decline in real food prices suggests that countries choosing a trade-oriented self-reliance strategy will reap increasing benefits over time. Self-sufficiency, by contrast, would prove to be a policy with a growing cost if future increases in world food supplies continue to outpace new demands for food.

The Gains from Trade

Because countries differ in their cost structures and patterns of demand, simple commercial self-interest points toward some degree of trade. Some foods will be produced more cheaply abroad and can be imported to advantage; others will be more expensive on world markets and can profitably be exported. This mutual exchange is referred to as making use of a country's absolute cost advantage. It is advantageous to consumers of the imported product and to the producers of the exported good. By contrast, consumers of the exportable and producers of the importable will be adversely affected because of the impact of trade on domestic prices.

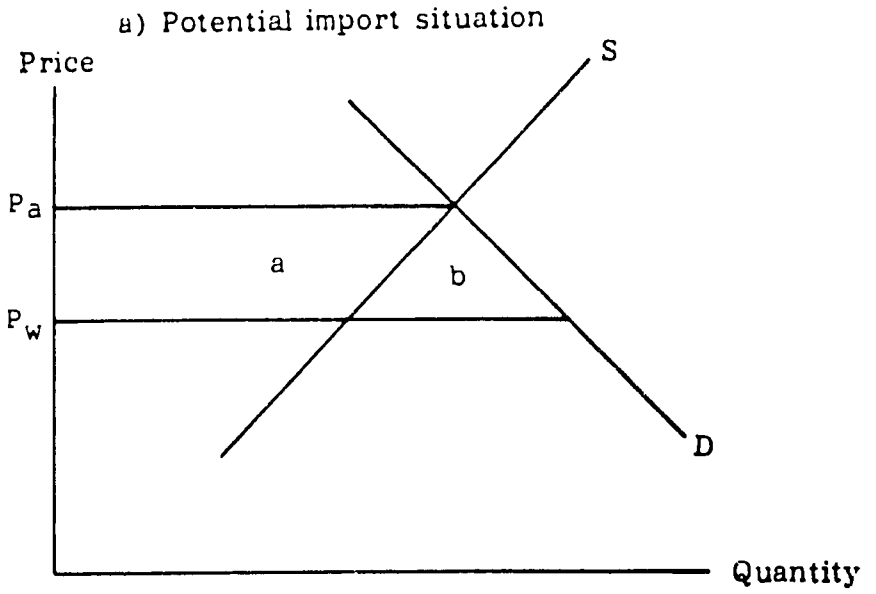
Single Commodity Case

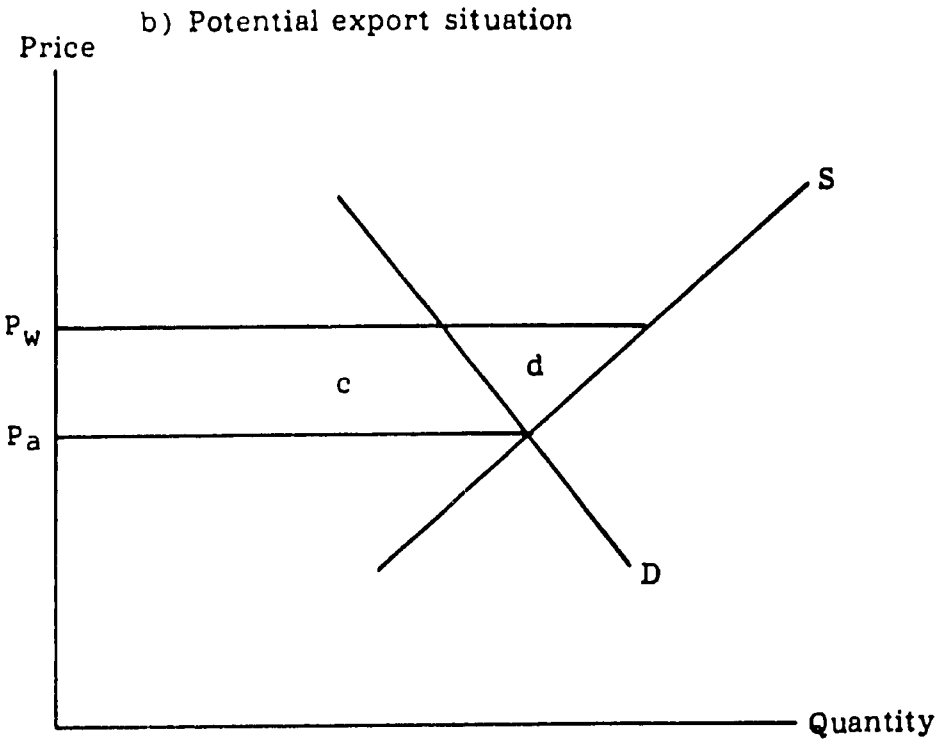
The potential benefits from trade will in general outweigh the costs. In the single commodity case, as illustrated in Figure 2, the world price (P_W) differs from the domestic price (P_a) in the absence of trade. In Figure 2a, before trade, the domestic price is above the world price. Imports of the commodity will eventually lower the internal price to the world price level -- assuming that the country's purchases are not large enough to push up the world price. Similarly, in Figure 2b, the domestic (autarchy) price is below the world price and will rise to meet that price if exports are allowed.

The interests of both producers and consumers in such markets are illustrated -- at least approximately -- by areas on the graphs. Consumers enjoy a "consumer surplus" whenever their total benefits or satisfaction from a commodity exceed the total money cost that they pay. Because the demand curve traces out

Figure 2

Representation of Gains from Trade in a Commodity-by-Commodity Model





their perceived benefit from additional consumption, the area under that curve represents their accumulated benefits. The area under the price line is the cash cost to consumers. Therefore, the surplus is the area above the price line and below the demand curve. The combined area a + b in Figure 2a gives a reasonable measure of the increase in consumer surplus as the price drops from P_a to P_w due to the opening of trade. By the same reasoning, area c in Figure 2b is a measure of the negative impact on consumers of the country's decision to permit exports of this good.

A somewhat analogous argument can be used to measure producer benefits in this single-commodity case. The supply curve represents the rising costs of additional output, and producers expand output until the last unit of production is barely profitable. The area under the supply curve therefore accumulates these additional costs of expansion. The difference between expansion costs and sales receipts is known as "producer surplus" and corresponds roughly to the return to fixed assets. In the figure, it is shown by the area above the supply curve but below the price line. Consequently, producers of the importable lose area a in Figure 2a and those of the exportable gain areas c+d in Figure 2b.

These measures of gains and losses to producers and consumers can be compared to find the net gains from trade. Area b in Figure 2a is the country's net gain from importing, since consumers gain more than producers lose; area d in Figure 2b is the country's net benefit from exporting, because producer gains

exceed consumer losses. So long as one gives roughly equal weights to the welfare of both consumers and producers, the economy benefits from trade. The country has an absolute advantage in the production of the exportable and an absolute disadvantage in the production of the importable. If a country follows a self-sufficiency strategy to exclude imports or to reduce exports, the gains from trade are lost.

Economy-Wide Effects

The above analysis discussed the gains from trade as a result of differing absolute cost conditions between countries. However, a given country might have lower (or higher) absolute costs for all or most commodities. The cost that is ultimately important to an economy is the amount of food that cannot be produced because resources are instead being employed in another activity. This foregone output is the opportunity cost of using the resources to produce the other good. The allocation of such resources is only efficient if each earns at least enough return to cover its opportunity cost. This principle resolves the dilemma of one country having all absolute costs higher or lower than other countries. Trade is advantageous when the opportunity cost of production at home differs from the price level abroad (or at the border). This is the notion of comparative advantage, which explains why there will always be some commodities that can profitably be exported even if costs are generally high in a country.

Assumptions and Qualifications

The world is, of course, more complex than this simplified analysis would suggest. The qualifications to the conclusion

that trade is beneficial fall under two broad headings--conditions in individual international commodity markets, and relationships among commodities and sectors in the domestic economy.

The single-commodity analysis is based on the following assumptions:

- goods are produced and marketed under competitive conditions, i.e., there are many buyers and sellers none of whom individually has the power to affect prices in his favor;
- reasonable certainty and stability exists in the markets so that one can meaningfully talk about a price level or supply function;
- no transport costs or other trade impediments exist; and
- non-efficiency objectives do not override the calculations of market gains and losses.

The assumption of competition is necessary to ensure that the price in a market reflects adequately both the value to consumers and the cost to producers. For an import commodity, the representation of the gains from trade given above assumes that producers and consumers on the domestic market act competitively and that foreign suppliers have no market power.

But what if these competitive assumptions are not valid? A domestic monopoly buyer may be able to force down the supply price below the competitive level and hence reap monopsony rents. Trade offers, paradoxically, some hope to the exploited domestic industry in such cases. The monopoly buyer cannot exploit the world market, since the world price is not depressed by cutting imports. The world price thus puts a floor under the market for the domestic supplier, unless the buyer can also prevent export

sales and keep domestic prices below those on world markets. The same result is even more evident in the case of a monopoly supplier on the domestic market. The opening of the market to imports can be an effective way of preventing exploitation of consumers. Rather than trade being less useful because of domestic violations of the competitive assumption, trade is itself a way of limiting the degree of inefficiency in an otherwise non-competitive domestic market.

The situation of non-competitive world markets is different. Actual world prices are almost never the result of free market, competitive equilibria. Because of the distortions occasioned by trading countries' policies, the majority of agricultural markets are not perfectly competitive. However, the option facing an individual country is whether or not to trade at the prevailing world price however that price is determined. The fact that in some different circumstance the world price would be higher or lower is not of immediate relevance to that country. The world market for the most important food crops tends at present to be distorted by suppliers anxious to export more to relieve domestic pressures. Under such circumstances monopoly restraints on exports seem remote. But there have been examples of large exporters attempting to restrict supplies to world markets in times of domestic scarcity and rising prices or in hopes of achieving international political objectives. Countries contemplating an import-dependent strategy would certainly need to evaluate the probability of such occurrences in the future.

The issue of competitiveness in world commodity markets is closely related to that of price instability. To the importer it is of little consequence whether a world price rises because of poor crops abroad or because of market exploitation. A high degree of instability in world prices will raise the real cost of importing relative to a stable price at the same average level. This does not in itself remove the advantage of importing from world markets. It could be rational to buy from world markets in low price years, for instance to replenish domestic stocks, even if on average the price were not attractive. The problem is really one of developing a strategy toward domestic producers (and consumers) to give a clear signal to guide production (and consumption) decisions. The absence of such a strategy could well push up costs at home, implying a bias toward trade in those products whose foreign markets are most unstable.

Transport costs are an important fact of life and significantly influence the analysis of trade strategies. Such transport costs act as "natural protection" for domestic producers when supplies are scarce, but also allow domestic prices to fluctuate within a wide range when supplies are adequate. As sources of production are located further from a port, the range within which domestic prices can move will tend to increase. If transportation and marketing facilities are poor or if the commodity in question is perishable, the product will not enter international trade and so is defined as being nontradable.

Typically, the import and export prices differ even at the port. A country that trades small quantities of a product might

find that international traders and merchants require a premium to deliver imports and demand a discount to collect irregular export supplies relative to prices charged or paid in larger and more regular countries. Imperfect markets in the shipping, unloading and handling of cargo can also cause the same phenomenon. The location at which import and export prices are the same is somewhere outside the countries' borders. On such occasions, the product is even more likely to be nontradable.

Finally, the analysis of a single commodity market assumes that the calculation of producer and consumer gains and losses adequately captures the benefits and costs to society. This condition will not be met if there is some overriding non-efficiency objective not expressed in either supply or demand conditions or if there are reasons why either producers or consumers carry unequal weights.

The "non-efficiency" argument can change the evaluation of gains and losses from trade in two respects. First, a country might have a concern about the political implications of trading in foodstuffs, specifically that food imports give another country some leverage over its national policies. This possibility is greatest when the importing country is large enough to be a significant factor on world markets. Most small countries have a choice among suppliers. In a period of abundant supplies the political power rests, if anywhere, with the importer. Second, a country might put a political premium on the provision of low-priced food for urban workers, civil servants,

or military personnel. This might tilt the food trade policy further toward imports.

The "income distribution" qualification is of particular significance in food trade discussions. A decision to import does disadvantage some groups in society. If those groups either control policy or are targeted for costly government assistance, policy makers might decide that the unrestricted level of trade is too high. Although it is easy to explain any trade or domestic policy with reference to individual group interests, a number of significant distributional implications have to be faced by policy makers. Whether the producers benefiting from trade are large farmers or small and whether the imported commodities are consumed by the poor or the middle-class are critical aspects of food trade policy.

Other assumptions relate to the relationships among sectors within the domestic economy. These include the following conditions:

- resources move freely among occupations as a result of changes in their relative prices; and
- exchange rates adjust to balance the demand for and supply of foreign exchange.

The assumption that resources can move between sectors is crucial to the analysis. If contraction of one sector in the face of imports releases labor and capital that are not absorbed elsewhere, the benefits from trade are much diminished or removed altogether. Unemployment is never a good outcome for a policy either in political or economic terms. The argument for trade requires that the preconditions exist or can be put in place for internal factor movements. In practice, this can be difficult to

achieve in developing countries, where fully integrated labor and capital markets are often absent. But each sector within a developing country has an internal dynamic that allows changes in factor use over time. Direct transfer of factors at any particular point in time might be less important than differential relative growth of factor use in different sectors. If a large part of investment is controlled by the government, this process of differential expansion can be quite rapid--for example, if capital-intensive industry is favored over labor-intensive agriculture.

In many countries, development appears to be hindered by shortages of foreign exchange. Few governments allow private traders access to foreign exchange for imports without some degree of control. The assumption of adequate supplies of foreign exchange does not mean that such foreign exchange is not scarce. The true scarcity value of foreign exchange is often understated by governments, who accordingly discourage exports and encourage imports. A "correct" exchange rate recognizes the scarcity of foreign exchange. Importers need to pay the scarcity price of imports by being forced to use a correct exchange rate to translate the costs of foreign food supplies into domestic currency. What is necessary is that no artificial impediment through quantitative control or licensing be implemented. When exchange control exists, the appropriate trade policy for food is more difficult to specify.

SECTION B

MEASUREMENT OF THE EFFECTS OF POLICY OPTIONS

A clear identification of issues and concepts is the first step in food policy analysis. Measurement of the approximate effects of policy options is the second step. Only rarely is an issue so clear cut that logic alone can provide convincing directions for policy. Most questions of food and agricultural policy require an analysis of data within a conceptual framework and a careful interpretation of the results before helpful policy advice can be given. The main purpose of this section, therefore, is to suggest the kinds of quantitative information needed for measurement of food policy options.

Much of the discussion surrounds the measurement of comparative advantage, a key result for policy analysis. As shown in Section A, the concept of comparative advantage is central to an evaluation of the food strategies of self-reliance, self-sufficiency, and trade-dependence. Static comparative advantage in producing a commodity is the ability to compete without any assistance from distorting policy during a defined, brief period of time. Dynamic comparative advantage is the ability to remain competitive without policy transfers over a long period of time during which changes occur in world prices of commodities and inputs, domestic prices of factors of production (labor and capital), and technologies of production. To evaluate alternative food strategies, one requires ways of measuring both kinds of comparative advantage, usually starting with a static

measure in some base year and then moving on to a dynamic measure based on projected changes in prices and technologies.

In practice, analysts rarely measure comparative advantage directly. Most information on costs and returns in production is instead collected in actual market prices, and the resulting measures of profits thus reflect the distorting effects of government policies. The efficiency prices needed to measure comparative advantage are then found by making corrections to the distorted actual prices. As explained in this section, the difference between valuations in actual prices and in efficiency prices is the effects of policy, including both distorting policy that causes resources to be used inefficiently and efficient policy that offsets a failure of a commodity or factor market. Hence, the order of research tasks in identifying comparative advantage is to measure profits in actual prices, re-measure them in corrected, efficiency prices, and then analyze the effects of policies that cause the two results to differ.

An agricultural system consists of a technology of farming in one agro-climatic zone plus the post-farm activities of processing and transporting the foodstuffs to a wholesale market. The linear, upward-sloping supply schedules, depicted in the diagrams of Section A, are assumed to reflect the marginal costs of all agricultural systems that produce an identical crop. Complete data on all of the systems producing a crop in a country are almost never available. Practical constraints on empirical research (usually budget and time) limit the measurement of costs of production to a few, selected agricultural systems that are assumed to be representative of the principal technologies and

agro-climatic zones. The approach to measuring comparative advantage, which is outlined in this section, can thus be thought of as an attempt to approximate the supply curve of Section A. A reconciliation of the two approaches is presented near the end of this section.

An exclusive focus on comparative advantage, reflecting the efficient use of a country's resources, would, however, miss the central point of policy analysis. Governments typically wish to promote a number of often conflicting objectives of food policy--efficiency (to maximize growth of national income), income distribution (to allow particular groups to benefit), food price stability (to reduce uncertainty for producers and consumers), and food security (to ensure that consumers have access to adequate food supplies). Policy analysis involves an evaluation of the tradeoffs among these objectives. A comparison of the food strategies of self-reliance, self-sufficiency and import dependence requires examination of their relative influences on such objectives. The second main purpose of this section is thus to indicate a straightforward way of measuring the impacts of a set of policies on these four principal objectives of food policy.

Most of this section is concerned with the development of a simplified analytical framework, the policy analysis matrix (PAM). The primary goals of the PAM approach are to measure the degree to which an agricultural system exhibits comparative advantage and the economic benefits and costs of alternative policy choices in terms of the efficiency of resource use. This

section explains the construction of the PAM, derives the measures of efficiency used in agricultural policy analysis, reconciles the PAM method with that introduced in Section A, introduces methods to analyze dynamic comparative advantage, discusses a research plan for PAM analysis, and outlines the uses and limitations of the research results. Measurement of the effects of food policy options on the three non-efficiency objectives is then discussed. The PAM framework and the complementary analyses are integrated and illustrated in Section C, with an empirical model of the choice among the three alternative strategies.

Accounting Matrix for Efficiency and Policy Analysis

The PAM is a combination of two accounting identities--one defining profitability as the difference between receipts and costs, and the other measuring the effects of policy as the difference between observed parameters and parameter levels that might exist if distorting policies were removed. By filling in the elements of PAM for an agricultural system, an analyst can simultaneously obtain answers to two central issues of policy--the degree of economic efficiency, or comparative advantage, of the system, and the extent of policy transfers, net taxes or subsidies, occasioned by the entire set of policies acting on the system.

Profitability is a basic concept of economic analysis. Profits are defined as the difference between total (or per unit) sales receipts and costs of production. This definition of profitability is the first identity of the accounting matrix. In PAM, profitability is measured horizontally, across the

columns of the matrix, as demonstrated in Chart 2; profits, shown in the right-hand column, are found by subtracting costs, given in the middle columns, from receipts, indicated in the left-hand column. Each of the column entries is thus a component of the profitability identity, receipts less costs equals profits.

Private Profitability

The data entered in the first row permit a measure of private profitability. In the PAM method, the term, private, refers to observed data on receipts and costs, reflecting actual market prices received or paid by farmers or merchants in the agricultural system. The private or actual market prices thus incorporate the underlying economic costs and valuations plus the effects of all policies that create transfers in the system. The first step in the empirical application of PAM is to calculate the private profitability of a number of representative agricultural systems in some base year. In Chart 2, private profits, defined as D, are found as the difference between receipts (A) and costs (B+C), and all four entries in the top row are measured in observed prices. These data are usually entered in PAM as local currency per physical unit, although the analysis can also be done using a foreign currency per unit.

The results of private profitability calculations show the extent of actual competitiveness of the agricultural systems, given current technologies, output values, input costs, and policy transfers. The normal cost of equity capital, defined as the approximate minimum after-tax return that owners of capital require to maintain their investment in the system, is included

Chart 2

Accounting Matrix for Efficiency and Policy Analysis

	Receipts	Costs		Profits
		Tradable inputs	Domestic factors	
Private prices	A	B	C	D[1]
Social prices	E	F	G	H[2]
Effects of policy and of market failures	I[3]	J[4]	K[5]	L[6]

1 Private profits, D, equals A minus B minus C.

2 Social profits, H, equals E minus F minus G.

3 Output transfers, I, equal A minus E.

4 Input transfers, J, equal F minus B.

5 Factors transfers, K, equal G minus C.

6 Net transfers, L, equal D minus H; L also equals I plus J plus K.

in domestic costs (C). Hence, profits (D) are "excess" profits, above-normal returns to equity capital, and reflect the return to all fixed factors, that is, "producer surplus" as defined in Section A. If private profitability is negative (D<0), investors are earning a sub-normal rate of return and thus can be expected to abandon this agricultural system unless something changes to increase profits at least to a normal level (where D=0). Alternatively, positive private profits (D>0) are an indication of super-normal returns to invested capital and should lead to future increases of investment in the system, if the farming area can be expanded and unless substitute crops are even more privately profitable.

Social Profitability

The second row of the accounting matrix contains social prices, as indicated in Chart 2. The term, social, refers to valuations that attempt to measure comparative advantage or efficiency in the agricultural production systems. In this context, efficient outcomes are achieved when an economy's resources are used in activities that create the highest levels of output and income. Social profitability, defined as H, is an efficiency measure because outputs (E) and inputs (F+G) are valued in prices that reflect scarcity values or social opportunity costs. Social profit, like its private analogue, is the difference between receipts and costs, all measured in social prices (H=E-F-G).

The principles of social valuation and their empirical application can be complicated; only the main elements of the approach are summarized here. For outputs (E) and inputs (F)

that are traded internationally (as defined in Section A), the appropriate social valuations are given by world prices--cif import prices for goods or services that are imported or fob export prices for exportables. World prices serve as appropriate measures of social opportunity costs for efficiency analysis because the use of world prices results in maximal domestic output and income. World prices represent the government's choice to permit its economy to import or export or to produce domestically; the social value of additional domestic output is thus the foreign exchange saved by reducing imports or earned by expanding exports, or for each unit of production, the cif import or fob export price. The appropriate world prices to use are trend values rather than the ones observed in the base year chosen for the study.

The services provided by the primary domestic factors of production--labor, capital, and land--do not have world prices because the markets for these services are domestic, not international. The social valuation of each factor service is found by estimating the national income that is foregone because the factor is not employed in its next best alternative use. For example, labor and capital used to produce wheat cannot simultaneously provide services elsewhere in agriculture or in other sectors of the economy. Their social opportunity costs are measured by the national income that is given up because potential alternative activities are deprived of the labor and capital services that are instead applied to wheat production.

Estimation of the social opportunity costs--or shadow prices--of primary factors can only be approximate in practice due to limitations imposed by the availability of information. The actual practice of shadow pricing begins by drawing a distinction between mobile and fixed factors of production. Mobile factors include those, usually capital and labor, that can move easily from employment in agricultural activities to uses in other sectors of the economy, such as industry, services, and energy. For such mobile factors, actual market prices are--and hypothetical shadow prices should be--determined by underlying supply and demand forces in the national economy. As a result, the shadow prices of capital and labor are usually established nationally and not solely within the agricultural sector, because alternative uses for these factors are found throughout the economy.

For labor (which is usually differentiated by skill levels), the national income foregone by employing laborers in producing wheat rather than in some other activity, such as rural industry or an urban service, can be approximated by the actual wage rate paid to each worker so long as no policy significantly distorts the observed wage rates. However, if an enforced minimum wage law, for example, raises the market wage above what it would have been in the absence of policy, the observed wage level is higher than the social opportunity cost of labor. To find the shadow price of capital, the other mobile factor, one would begin with the actual interest rate and adjust for the effects of distorting policies, such as interest ceilings and credit subsidies.

Fixed or immobile factors of production are defined as those whose private or social opportunity costs are determined within a given sector, such as agriculture. The value of agricultural land (except for that located near cities or towns) for use in producing one crop is determined by the land's worth in growing alternative crops.

It is convenient in assessing farming activities to reinterpret profits as rents to land and other fixed factors (management, ability to bear risk) per hectare of land used. This is done by including private (and social) returns to land as parts of D (and H). "Profitability" per hectare is then interpreted as the ability of a farming activity to cover its variable costs, in either private or social prices, or as a return to fixed factors (such as land, management skill, and water resources).

Because domestic factors are used in all production processes, the difficult exercise of estimating shadow prices always arises. Each matrix in PAM contains two cost columns, one for tradable inputs and the other for domestic factors. Some domestic factors are used directly in the production system; farmers, for example, employ their own and often hired labor and their own equity as well as borrowed capital. The costs of these factors are entered in the domestic factor column in PAM--private factor costs in element C and social factor costs in G.

Complications arise with the handling in PAM of intermediate inputs--materials, like fertilizer, pesticides, purchased seeds, compound feeds, electricity, transportation, and fuel, used in

agricultural systems. Many of these intermediates are traded internationally and thus have world prices to serve as social valuations. But some, such as electricity and transportation, are nontradable and hence do not have world prices. Even the tradable intermediates cannot be entered directly into PAM, because they incur domestic marketing (handling and transportation) costs after importation or before exportation. The cif import or fob export prices are calculated at the port whereas the relevant PAM prices need to apply to the location of production; hence, domestic marketing charges are added to cif import prices or subtracted from fob export prices in order to find social valuations applicable to specific locations of agricultural systems.

Intermediate inputs are decomposed into the two cost categories of the accounting matrix, tradable inputs and domestic factors. This process of disaggregation of intermediate goods or services can be complicated in practice. Essentially, the decomposition process involves the separation of intermediate costs into four categories--tradable inputs (which go into element F in PAM), domestic factors (entered as the indirect part of G in the matrix), transfers (taxes or subsidies that are set aside in social evaluation), and nontradable inputs (which themselves have to be further disaggregated so that ultimately all component costs are classified as tradable inputs, domestic factors, or transfers).

An example illustrates the process of decomposing intermediate goods or services. Fertilizer is for most countries a tradable intermediate; if the country in question is a net

importer of fertilizer, the social valuation of a specific kind of fertilizer for an agricultural system is given by the cif import price for that fertilizer plus the social costs of moving the input to the representative location of the system. Finding the import price is usually straightforward, so long as a long-run trend value rather than the current year value for the world price is used. The social valuation of the domestic marketing costs is another story, however. It is necessary to study the transportation industry--road and rail--and disaggregate the costs into labor, capital, fuel, and so forth. The fuel costs, for example, then need to be further broken down through use of an appropriate world price and estimate of local transportation costs.

Effects of Policy and of Market Failures

The second identity, defining the accounting matrix, concerns the differences between private and social valuations of receipts, costs, and profits. For each entry in the matrix--measured vertically, down the rows--any divergence between the observed private (actual market) price and the estimated social (efficiency) price is explained by the effects of policy or by the existence of market failures. This critical relationship of policy analysis follows directly from the concept of social prices. To estimate social prices, one corrects for the effects of distorting policies, those that lead to an inefficient use of resources and thus lower than potential levels of output and income.

But not all policies distort the allocation of resources. Some policies are enacted expressly to improve efficiency by correcting for the failures of product or factor markets to operate properly. Market failures occur whenever monopolies or monopsonies, externalities, or factor market imperfections prevent an unrestricted market from creating an efficient allocation of products or factors. Market failures thus reduce potential producer income and output and consumer satisfaction. Hence, the need arises to distinguish distorting policies, which cause losses of potential income, from efficient policies, which offset the effects of market failures and thus create greater income.

In the absence of market failures affecting the product markets, all divergences between private and social prices of tradable output and inputs are due to the effects of distorting policy. Because the principles are identical for all tradable products, the matrix entries for receipts (tradable outputs) and tradable inputs can be considered together. Output transfers (I=(A-E)) and input transfers (J=(F-B)) arise from two kinds of policies--commodity specific policies and exchange rate policy--that cause divergences between observed and world product prices.

Policies that apply to specific commodities include taxes or subsidies, trade restrictions, and price or margin controls. Producer receipts per unit can be raised by producer subsidies (called deficiency payments in agriculture), tariffs or import quotas on outputs (which raise domestic prices), or domestic price supports enforced by government stockpiling (which requires a complementary trade restriction for tradable products).

a complementary trade restriction for tradable products). Commodity specific policies on inputs also affect private profitability. For example, producer costs per unit can be lowered by direct input subsidies, subsidies on imported inputs, or effective price controls on inputs.

Exchange rate policies can also have an impact on product prices. Typically, the PAM accounting is done in domestic currency, but world prices are quoted in foreign currency. Hence, a foreign exchange rate is needed to convert world prices into domestic equivalents. (The analysis could instead by carried out in foreign currency, but then an exchange rate would be required to convert domestic factor costs from local currency into that foreign currency.) The correct exchange rate to use in converting world prices is one that balances the country's demands for and supplies of foreign exchange without resorting to rationing controls. Overvaluation, which arises from a government's failure to adjust its exchange rate enough to offset the effects of domestic inflation on international competitiveness, creates an implicit tax on producers of tradable products because too little domestic currency is earned by exports or paid for imports. In the absence of commodity policy, the world price of a tradable determines the domestic price for that good. When the exchange rate is overvalued, the domestic price is lower than its efficiency level and domestic producers are effectively taxed by this policy. Correction for this distortion in PAM is done by converting world prices (E and F in the matrix) at the appropriate exchange rate rather than at the official rate.

The social prices of domestic factors (G) are given by determination of social opportunity costs, which reflect underlying supply and demand conditions in domestic factor markets. In the short run, these social prices are largely unchanged by either macro or commodity policies. In the longer run they will change with economic growth and structural development. The government can, however, enact tax or subsidy policies on one or more of the factors (capital, labor, or land) which create a divergence between private costs (C) and social costs (G), resulting in a subsidy to the system or a tax on the system. In addition, factor market imperfections, arising from imperfect information or underdeveloped institutional structures, are characteristic of most developing countries.

The net transfer from policy and market failures (L in the matrix) is found by summing the separate effects from the factor and product markets (L=(I+J+K)). The net transfer from distorting policy is the sum of all factor, commodity, and exchange rate policies (apart from efficient policies that offset market failures). The total net transfer is also found by comparing private and social profits. This transfer must by definition be identical in the double entry accounting matrix (L=(I+J+K))=(D-H). Disaggregation of the total net transfer shows whether distorting policy, on balance, taxes or subsidizes the system and whether efficient policy offsets market failures. The PAM approach thus permits comparison of distorting and efficient policies with remaining market failures for the entire set of commodity and macro (factor and exchange rate) policies.

In the short- and medium-runs (less than 1 and up to about 5 years), policies that do not correct market failures create distortions by causing additional gaps between social and private receipts, costs, and profits. But such policies cannot change the social valuations of products (unless the country has international market power to influence world prices through its buying or selling decisions) or of domestic factors. However, in the long-run (more than about 5 years), macro policy in particular can influence the relative costs of factors (for example, by achieving rapid development that causes real wage rates gradually to rise relative to real interest rates), and investments in research can speed technical change. In all time periods, policies are usually the cause of most divergences between private and social profits. In effect, governments attempt to pursue objectives by using commodity and macro policies to induce agricultural producers, who base decisions on the policy-affected private prices, to alter their production levels.

Comparisons among Agricultural Systems Producing Different Outputs

The entries in the PAM matrix suffice for making comparisons among agricultural systems that produce identical outputs, either within a single country or across two or more countries. In the accounting matrix, all measures are given as monetary units per physical unit of some commodity. Comparisons can readily be drawn by constructing PAM entries for two or more different systems that produce the same quality of wheat (if necessary, premiums or discounts can be used to correct for

quality differences). If interest focuses solely on comparing one wheat system with another, therefore, the matrix entries provide all information necessary for the analysis.

Comparisons between wheat and barley--or apples and oranges--are another story, however. Appropriate ratios permit comparisons among systems producing different outputs. Both the numerator and the denominator of each ratio are entries in PAM defined in domestic currency units per physical unit of commodity. Therefore, the ratio itself is a pure number that is free of any commodity or monetary designation, because the currency per commodity unit labels cancel out. The task, then, is to define ratio indicators to substitute for the whole number indicators in the PAM matrix.

Private Profitability

For comparisons of systems producing identical outputs, private profits (D=(A-B-C)) indicate competitiveness under existing policies. Construction of a ratio is required to permit comparisons of the one system with those producing other commodities (or non-agricultural goods or services). Direct inspection of the data for private profits is not sufficient. Profitability results are residuals and might have come from systems using very different levels of inputs, including equity capital, to produce outputs with widely varying prices. This difficulty might not be apparent in a wheat versus corn example, but it would arise in a comparison of a wheat system with one producing a high value crop, such as strawberries, with a capital-intensive technology. This ambiguity is inherent in

comparing private profits of systems producing different commodities with differing capital intensities.

The problem is circumvented by constructing a private cost ratio (PCR), defined as the ratio of domestic factor costs (C) to value added in private prices (A-B), that is, PCR=C/(A-B). Value added is the difference between the value of output and the costs of tradable inputs; it shows how much the system can afford to pay domestic factors (including a normal return to capital) and still remain competitive, that is, break even after earning normal profits (where (A-B-C)=D=0). Clearly, the entrepreneurs in the system prefer to earn excess profits (D>0), and they can achieve this result if their private factor costs (C) are less than their value added in private prices (A-B). They thus try to minimize the private cost ratio by holding down factor costs and material input costs in order to maximize excess profits.

Social Profitability

Social profits measure efficiency or comparative advantage. To compare identical outputs, results can be taken directly from the second row of the PAM matrix--social profits equal social receipts less social costs (H=(E-F-G)). When social profit is negative, a system could not survive without the assistance of distorting policy. As discussed in Section A, such systems waste scarce resources by producing at social costs that exceed the costs of importing. The choice is clear for efficiency-minded economic planners: enact new policies--or remove existing ones--to provide private incentives for systems that generate social profits, subject to non-efficiency objectives.

When systems producing different outputs are compared for relative efficiency, a ratio is needed to get around the problems of dissimilar commodities and technologies. The domestic resource cost ratio (DRC), defined as G/(E-F), serves as a proxy measure for social profits. No new information beyond social receipts and costs is required to calculate a DRC. The DRC plays the same substitute role for social profits as does the PCR for private profits; in both instances, the ratio is = 1 if its analogous profitability measure is = 0. Minimizing the DRC is thus equivalent to maximizing social profits. In cross-commodity comparisons, DRC ratios replace social profit measures as indicators of relative degrees of efficiency or of comparative advantage.

Policy Transfers

Policy transfers are shown in the third row of the PAM matrix. Efficient systems earn excess profits without any help from the government, and subsidizing policy (L>0) substantially increases the final level of private profits. Subsidizing policy is necessary to permit inefficient systems to survive, but the consequent waste of resources needs to be justified in terms of non-efficiency objectives.

Comparisons of the extent of policy transfers between two or more systems with different outputs also requires formation of ratios (for reasons analogous to those offered above in the discussions of private and social profits). The effective protection coefficient (EPC) is one indicator of incentives. EPC is defined as the ratio of value added in private prices (A-B) to value added in world prices (E-F), or EPC=(A-B)/(E-F). This

coefficient measures the degree of policy transfer from product market--output and tradable input--policies, but it ignores the transfer effects of factor market policies. Hence, EPC is not a complete indicator of incentives.

A better incentive indicator is the subsidy ratio to producers (SRP), defined as SRP=L/E=(D-H)/E. The SRP shows the net policy transfer as a proportion of total social receipts, or the proportion of receipts in world prices that would be required if a single subsidy or tax were to be substituted for the entire set of actual commodity and macro policies. The SRP permits comparisons of the extent to which policy subsidizes all agricultural systems. The SRP measure can also be disaggregated into component transfers to show separately the effects of output, input, and factor policies.

Average Cost Curves and Price Policies

For convenience, the diagrams in Section A were illustrated with the familiar assumptions of increasing marginal costs and upward-sloping supply curves. However, the budget data used to construct PAM are generally based on average, not marginal, costs. Marginal costs are rarely observable. Average costs are defined as total production costs divided by the quantity of output produced, whereas the definition of marginal cost is average cost plus the change in average cost that occurs when output expands by one unit. The purpose of this section is to introduce the use of average cost curves (ACC) as a way of approximating the analysis of commodity price policy based on marginal cost curves (MCC).

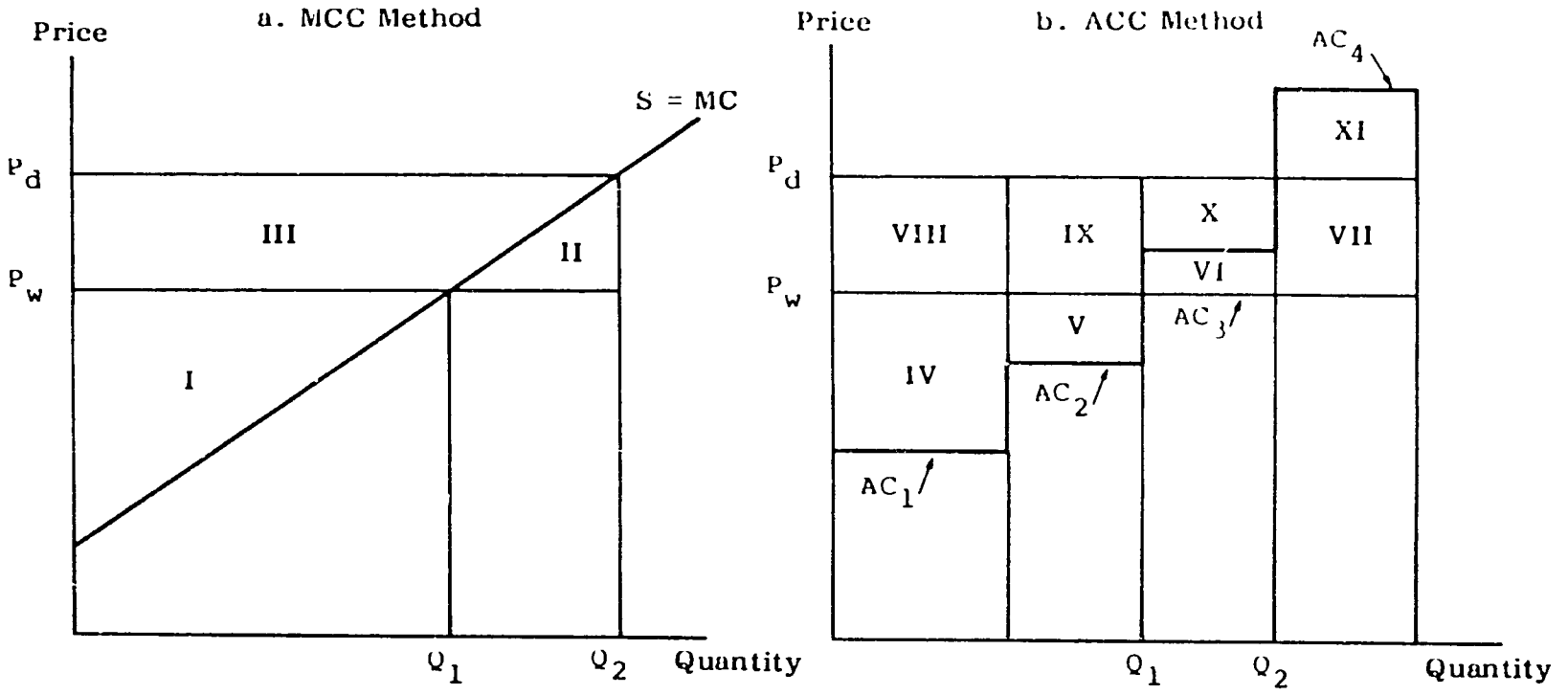
Primary focus is placed on the "effects of policy" row of PAM and especially on the matrix entries that measure the transfer effects of commodity price policies -- output transfers (I) and tradable input transfers (J). Interest in this section is exclusively with "distorting policy," that is, government interventions that prevent market forces from creating an efficient allocation of productive resources. "Efficient policy" (that introduced to offset the effect of market failures) and residual market failures (those not offset by efficient policy) are set aside to permit full attention to the impacts of distorting policy on agricultural systems characterized by average cost measures.

The time frame for this analysis of price policy is the medium-to long-run, perhaps one to 10 years. During this length of time, production agents--farmers, merchants, and processors--will need to replace much of their depreciable capital assets. Given the nature of the data collected in most PAM budgets, the ACCs represent constant long-run costs of production. Although it would be useful to collect budget data for short-run ACCs (less than one year) and, where possible, for long-run and short-run MCCs, the availability of detailed cost information typically prevents attaining this goal. As a general rule, therefore, one can assume that the cost entries in PAM represent constant, long-run ACCs. Unavoidable errors are introduced to the extent that the ACCs of observed systems are in fact not at a minimum and thus not equal to MCCs.

Output Price Policy

A graphical illustration showing the transfer effects of a trade restriction on an importable output is presented in Figure 3. Two diagrams are shown in the figure; the one on the left incorporates an assumption of increasing marginal costs and an upward-sloping supply curve, as in Section A; the other, on the right, is based on the PAM assumption of constant, long-run ACCs. In the MCC diagram, without policy, production of Q_1 occurs at point 1 on the supply curve, private and social profits are equal, (shown by area I), and there are no policy transfers. When an import restriction is imposed to raise the domestic market price above the world price (e.g., a tariff of (P_d - P_w) per unit), production moves to point 2, output expands to Q_2 replacing (Q_2-Q_1) of imports, and a production efficiency loss (PEL), shown by (area II), is incurred because the costs of incremental domestic production exceed the costs of the foregone imports. The PEL is the opposite of the gains from trade; it is the loss from not trading. This PEL also represents negative social profit from the incremental production; marginal social costs (MSC), given by the supply curve, are greater than marginal social returns (MSR), represented by the world price, for all output to the right of point 1 (where MSC = MSR). The output policy transfer from consumers to producers is shown by areas II and III. Total private profit with policy is the sum of the initial private profit (area I) plus part of the transfer, (area III), whereas post-policy social profit is made up of the initial

Figure 3. Restriction on Imports, under Marginal and Average Cost Methods



Before trade policy

D = H = area I
L = O

After trade policy

D = areas I + II
H = areas I - II
L = areas II + III

Before trade policy

D = H = areas IV + V
L = O

After trade Policy

D = areas IV + V + VIII + IX + X
H = areas IV + V -VI
L = areas VI + VIII + IX + X

social profit (area I) less the social loss on incremental output (area II).

When ACCs are introduced for PAM analysis, the directions of the results are similar, but the magnitudes typically alter. The comparison is made in the right-hand diagram in Figure 3. As noted earlier, agricultural production in most countries is marked by incomplete specialization, so not all production of a commodity occurs with identical agro-climatic zones, technologies, and costs. The ACC diagram portrays four different production systems, ordered from left to right according to lowest constant, long-run ACCs. Before the trade restriction is imposed, all four systems face an identical output price set by the world price, P_w (A = E in PAM). Since it is assumed that no policies or market failures influence input costs (J=K=0), the average social cost curve is identical to the average private cost curve for all four systems. Given an absence of divergences, private and social profits are identical in all systems (D = H), as shown by area IV for system 1, the most efficient producer, and area V for system 2, the second best producer. Neither systems 3 nor 4 are profitable without policy and so neither operates; costs exceed returns by area VI for system 3 and by areas VII plus XI for 4.

The picture alters after a tariff raises the domestic price from P_w to P_d The increase in private return without any change in cost gives excess profits to the existing producing systems, of area VIII to 1 and of IX to 2. This policy also allows system 3 to cover its costs and make a private profit of area X, incurring a PEL or negative social profit of area VI. But system

4 remains unprofitable and out of business because costs still exceed returns by area XI. The total net policy transfer (L) consists entirely of output transfers (I) because the tariff was the only policy introduced; total L is made up of areas VIII, IX, VI, and X.

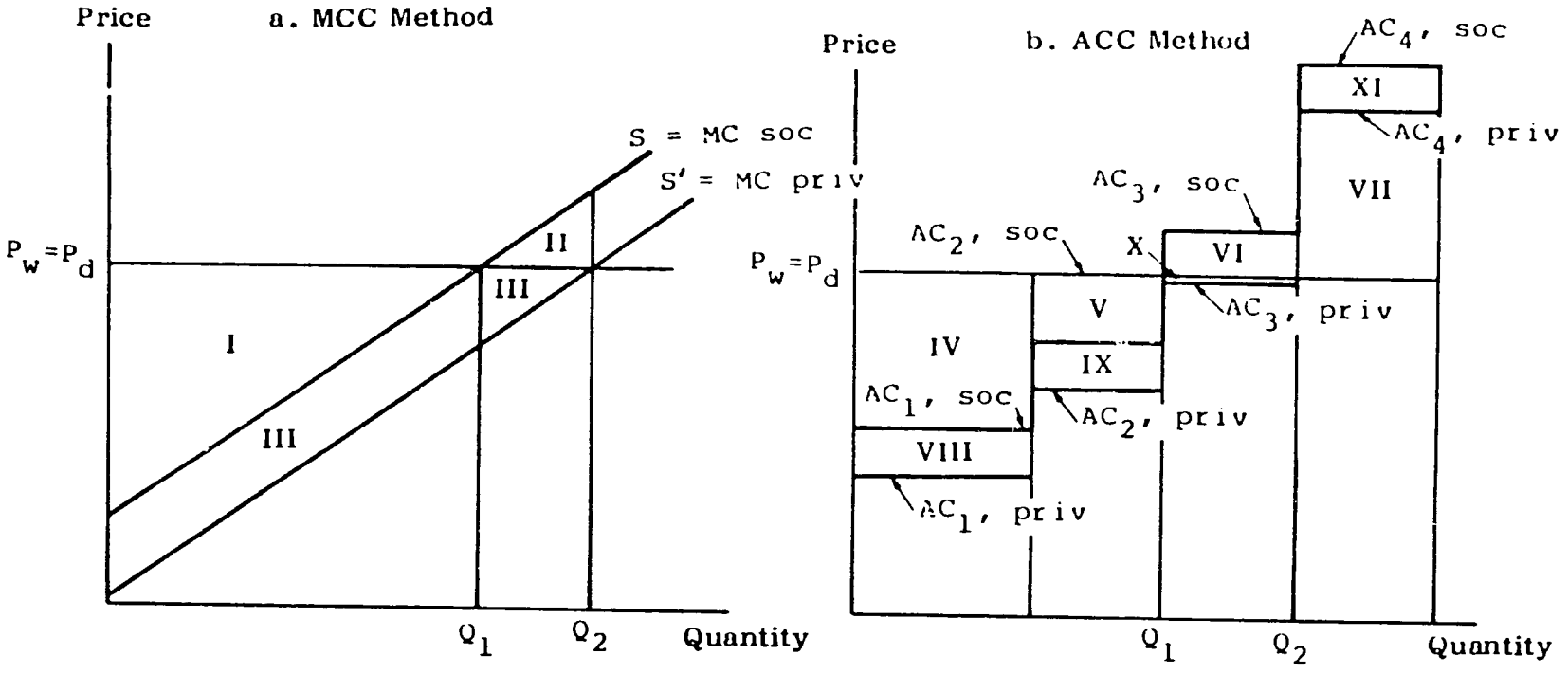
In short, the policy-induced increase in the output price transfers excess profits to the two efficient systems, while permitting system 3 to produce inefficiently with some excess profit. If, instead, the output price policy were to cause a reduction in the domestic price sufficient to make it privately unprofitable for an efficient system (either system 2 or 1, whose ACC (social) is less than the world price) to produce, a different PEL would arise because socially profitable production would be lost. Therefore, in the absence of market failures, output price policy causes efficiency losses in production for incremental systems that achieve (or lose) private profitability and additions (or reductions) to excess profit for efficient systems that continue to operate. This result can be demonstrated diagrammatically in Figure 3 by moving the horizontal, domestic price line either above or below the world price line enough to cause the number of operating systems to change. While this procedure is somewhat mechanistic, it does capture the essence of how transfers from output price policies influence the number of systems that operate, the private profitability of each system, and the private and social profitability of total production of the commodity.

Input Price Policy

Figure 4 contains a similar graphical comparison of the effects of input price policy under the assumptions of either MCC or ACC in supply. In both diagrams, market failures are assumed away and no output price policy exists (so that $P_w = P_d$). Before any policy is imposed, the situation is identical to the "no policy" case in Figure 3. The introduction of a subsidy on tradable inputs (for example, on fertilizer) creates a distortion between the social and private costs of production; for each unit of output, the subsidy reduces the private cost, causing a downward, vertical shift in both MCC and ACC.

In the MCC diagram (4a), providing an input subsidy causes the private supply curve to make a parallel downward shift; the vertical distance between the social and private supply curves is the amount of private cost reduction provided by the input subsidy. Since the subsidy on a tradable input is the only policy permitted in this illustration, the input transfer (B-F=J) accounts for the entire net policy transfer (L). Following the subsidy-induced reduction in private costs, output expands from Q_1 to Q_2 and production moves from point 1 to point 2. The net policy transfer (L) is shown by areas II + III, which together form the parallelogram that measures the budget cost of the subsidy. Since domestic resources are drawn into production inefficiently (the domestic costs of producing (Q_1-Q_2) exceed the cost of foregone imports), there is a production efficiency loss or a negative social profit of area II. Pre-policy private profit, area I, is augmented by area III because of the input subsidy. But the initial total social profit, also area I, is

Figure 4. Subsidy on Tradable Inputs, under Marginal and Average Cost Methods



Before input subsidy policy

D = H = area I
L = O

After input subsidy policy

D = areas I + III
H = areas I - II
L = areas II + III

Before input subsidy policy

D = H areas IV + V
L = O

After input subsidy policies

D = areas IV + V + VIII + IX + X
H = areas IV + V + VI
L = areas VI + VIII + IX + IX + X

reduced by the PEL shown by area II. The policy transfer is thus divided between excess profits to former and new production (area III) and a PEL (area II) which is paid out to inefficiently used inputs.

The principles hold, though the diagram and magnitude differ, when an input subsidy is analyzed under ACC, shown in Figure 4b. As in Figure 3, four agricultural systems are portrayed with system 1 having the lowest, and system 4 the highest, average social costs. Once again, before policy is introduced, only systems 1 and 2 operate, generating private and social profits of areas IV and V, respectively. Enactment of a subsidy on a tradable input creates a divergence between social and private average costs. For each system, the private ACC is shifted downward by the amount of cost reduction per unit associated with the subsidy. For simplicity, it is assumed that all four systems have identical input-output coefficients for the subsidized input; if these differed across systems, the private cost reductions would also differ according to the intensity of use of the subsidized input.

The results of the input subsidy are: to create excess profits for the two efficient systems (numbers 1 and 2 that would operate without help from policy), shown by areas VIII and IX; to permit system 3 to produce with private profits (area X) but social losses (area VI, which is also the PEL since average social costs exceed social returns, i.e., ACC_3 social is above the world price line); and not to affect system 4, which needs larger subsidies to become privately profitable. In effect, the

total net policy transfer for the three operating systems, shown by areas VI + VIII + IX + X, is paid entirely from the government treasury. The input subsidy gives extra private profits to efficient systems and is divided between private profits and payments to inefficiently used resources (the PEL) for incremental systems. This inefficient result arises because all policy transfers create inefficiencies unless they offset market failures.

Strengths and Limitations of Price Policy Analysis Based on Budget Data

The practical assumptions typically made in constructing PAM budgets result in collection of cost data that represent constant, long-run average costs. The budget for each agricultural system yields a segment of the long-run ACC for a commodity output. When these segments are ordered left to right from lowest to highest cost, they together make up a step-function representation of the long-run marginal cost. To carry out policy analysis, one begins by comparing the social ACCs (those free of the influences of distorting policy) with the world price of output (the marginal and average social return for countries that cannot influence world prices). For each system, the difference between P_W and ACC shows social profit--positive, zero, or negative. These social profits remain fixed unless world prices, social prices of domestic factors, or technologies change. These possible changes are discussed below as elements of dynamic comparative advantage.

The comparisons, made above, of analyzing output and input price policy with either MCC or ACC data show many similarities.

In both instances, private and social profit, before policy, can be measured so long as supply functions are known. Moreover, both concepts of profit plus the policy transfer effects can be measured to show the effects of introducing trade or tax/subsidy policies that affect tradable outputs and inputs. The use in price policy analysis of budget data that are meant to measure constant, long-run ACC of agricultural systems suffers from two important limitations, however.

In empirical practice, one is rarely sure that the collected numbers are truly minimum cost data, needed for the assumptions of constant, long-run ACC, and some systems that produce the commodity could be overlooked in data gathering. If so, the steps in the long-run ACC schedule might not in fact be perfectly horizontal, and some steps might be missing. In this event, the changes in quantities produced domestically due to policy cannot be measured accurately with ACC information. If actual marginal costs are increasing (as in the MCC diagram) or some systems are omitted, the use of PAM assumptions limits the interpretation of policy effects. It is usually possible to be confident in interpreting consequences for the systems for which data are available, but total effects are not measurable unless data omissions can be filled. This limitation could, in principle, be overcome -- by obtaining sufficient budget information to permit estimation of long-run MCCs and to include all major systems.

Additionally, because the PAM approach is designed to focus on agricultural systems, the supply side of the food sector, no attempt is made to measure consumer responses. Accordingly, changes in quantities traded internationally and consumption

efficiency losses are not captured in the PAM framework. A separate analysis is need to estimate consumer impacts of policies.

Dynamic Comparative Advantage

Comparative advantage, the ability of an agricultural system to compete without government assistance, can be strengthened or eroded by changes in economic conditions. Dynamic comparative advantage refers to shifts in a system's competitiveness that occur over time because of changes in one or more of three categories of economic parameters--long-run world prices of tradable outputs and inputs, social opportunity costs of domestic factors of production (labor, capital, and land), and production technologies used in farming or marketing. Together, these three parameters determine social profitability and comparative advantage. The term, dynamic, denotes a passage of time sufficient to permit changes to occur in any or all of these fundamental variables.

The appropriate world prices for measuring efficiency or comparative advantage are long-run equilibrium levels that approximate best guesses of future price trends. If the country's decisions to buy or sell on world markets will not have any measurable effect on world price levels, those prices will not be influenced by its policy decisions. Hence, world prices can be considered as exogenous and, once arrived at, can be taken as given for all domestic agricultural systems. The world prices remain as the correct indicators of social valuation of tradable commodities even if a country's decisions to buy or sell

internationally do affect the world price of a good; in this circumstance, where a large country has market power, the analyst needs to take into account the impact of trading decisions on world prices.

Costs of factor services in any country can be expected to change with time. Cyclical variations in wage and interest rates (in real terms, after adjustments for inflation), associated with swings in macroeconomic policy, are not the primary focus of PAM analysis. Instead, interest centers on long-run trends in costs of labor, capital, and land. As economies achieve higher levels of national income, real wages rise, both absolutely and relative to real costs of capital and of land. For agricultural systems, the social opportunity costs of labor and of capital are often determined in economy-wide integrated factor markets, not within agriculture. Therefore, these factor prices are taken as exogenous to agriculture, and future projections of real wages and capital costs need to consider changes in the national environment for investment and growth, as influenced by expected directions of macro policy. Land rental rates are endogenous to agriculture, but will be constrained by changes in world prices and in real wage and interest rates, because payments to land and other permanently fixed factors must come out of profits. Analysis of projected comparative advantage, therefore, includes both the future pressures that changing real factor prices might exert on existing agricultural systems and influences of likely world prices for tradable outputs and inputs. The results identify systems that can readily expand in contrast to those that will have to contract or change in order to survive.

Changes over time in factor and commodity prices can also influence agricultural technologies, the combinations of inputs employed to produce given outputs. Technological change permits commodities to be produced with reduced costs. Such change leads to rising agricultural incomes, growing farm productivity, and faster increases in national income, and it depends on investment in knowledge and in new inputs. The term, "dynamic comparative advantage," thus refers to the social profitability of production under projected changes in world prices, relative factor costs, and technologies.

Technical changes arise when farmers apply new cost-reducing methods. Technological change is a response especially to differing patterns over time of relative factor prices. Farmers are induced to innovate by finding new ways of using less of those factors that become relatively more expensive (usually labor) and more of other inputs. Empirical analysis of intra-system change requires application of partial budgeting, a technique in which individual cost-saving changes are analyzed within the matrix for the initial system.

Technological changes in agriculture spread because changes in the opportunity to make private profits (resulting from differing world prices, domestic factor costs, and policies affecting them) and the ability to make investments cause farmers to shift away from current practices by adopting different, more productive systems already being used by other farmers in the region. One can envision a spectrum of increasingly more investment-intensive but also more cost-efficient systems. As

economic conditions, knowledge, risk, and access to investable funds permit, farmers gradually move from the lower to the higher technologies (that is, from less to more efficient systems). Analysis of the diffusion of technological change is mainly an adding up exercise of shifting the proportional weights attached to the various agricultural systems within a region.

Research Plan for Policy and Efficiency Analysis

There are usually six data inputs into the PAM approach--private receipts (A), private costs of tradable inputs (B), private costs of domestic factors (C), social receipts (E), social costs of tradable inputs (F), and social costs of domestic factors (G). Subtraction within the matrix then yields six research outputs--private profits (D=(A-B-C)), social profits (H=(E-F-G)), output transfers (I=(A-E)), input transfers (J=(F-B)), factor transfers (K=(G-C)), and net policy transfers (L=(D-H)=(I+J+K)). This logic is correct. But the double-entry nature of the matrix--which requires that the profitability identity be satisfied for calculations across the columns and that the policy effects identity be met for calculations down the rows--provides the analyst with some flexibility in research strategy.

The goal is to find entries for all twelve elements in the matrix. Gathering information on any six entries will permit solution of the entire matrix (so long as no more than three entry inputs are in the same row and no more than two are in the same column). In actual practice, filling in the twelve entries in the accounting matrix is done pragmatically, using any information that is readily available. In almost every instance,

data on private receipts (A) and costs (B,C) are gathered first. These data are usually observable, though rarely available in precisely the desired form. In addition, manipulation of the data in private prices to find comparable social valuations requires an understanding of the technologies (input-output coefficients) of farming, marketing, and processing that are employed in each agricultural system. Once private budgets are complete, the calculation of private profitability (D) is an easy first research output, completing the entries in the first row of the matrix.

Completion of the second and third rows of each PAM is usually pragmatic and rather ad hoc in nature. The researcher takes information from any available sources that are of reliably good quality. Data are sought for three pairs of entries--social receipts (E) and output transfers (I), social costs of tradable inputs (F) and input transfers (J), and social costs of domestic factors (G) and factor transfers (K).

Usually, the world prices of outputs (E) are easier to find than are the transfer effects of output policy (I), especially when these transfers are from (or to) consumers to (or from) agricultural producers. But when the output transfers are in the form of subsidies paid from the government treasury, one occasionally has better data on these subsidy payments than on the relevant world prices. In this instance, it is preferable to enter the per unit subsidy, the output transfer (I), as a research input and then to calculate the implied world price as a residual (E=(A-I)). Similarly, if better information exists on

treasury costs of fertilizer subsidies than on the appropriate world price for fertilizer, the fertilizer part of J becomes a data input and that of F a research output. Further, in the unlikely event that an interest subsidy creates the entire divergence between private and social costs of capital, data on the subsidy per unit could be entered as the capital component of K and the shadow price of capital needed for G could be found by subtraction (G=(K-C), for the capital component only). The important point is to use the best quality information to fill in the matrix and not to worry about whether components of E or I, F or J, and G or K are research inputs or outputs. In actual practice, therefore, social valuations and measures of policy transfers are often arrived at in an iterative fashion to incorporate all useful information.

Uses and Limitations of the Research Results

The PAM approach provides three principal research results--measures of competitiveness, efficiency (comparative advantage), and policy transfers. Competitiveness under a given set of policies is demonstrated if the agricultural system has private profits of zero or greater ($D=(A-B-C)\geq 0$). Profits in PAM are excess profits, that is, returns to fixed factors above the normal returns required to maintain investment; hence, at zero private profits the system is competitive because capital earns a normal return. Positive private profits are a sign that policy, on top of the system's underlying ability to compete without policy transfers, is creating excess profits or private economic rents--returns that are greater than the amount required to pay

all material input costs and to provide domestic factors a normal return, one that will ensure continuing employment in the system.

Competitiveness of a system is a primary concern of all who invest in, work in, or politically represent that system. Negative private profits cannot typically be sustained, because owners of capital will disinvest when they do not earn their normal returns; exceptions occasionally arise with part-time or very elderly farmers who perceive advantages to staying on their farms, which are outside the usual economic calculus. The relative degree of competitiveness of various systems will have a major impact on which systems survive.

A second result of the PAM research methodology is efficiency of agricultural systems. The existence of zero or positive social profit ($H=(E-F-G)\geq 0$) indicates that a system would be competitive against domestic and international competition in the absence of all distorting transfers. This measure of efficiency at world prices, or comparative advantage, means that the activity contributes to efficient growth of national income. Governments sometimes enact policies to offset market failures. But all other policies, whether imposed to further non-efficiency objectives or enacted in the mistaken hope of speeding growth, distort the optimal allocation of resources, create inefficiencies, and result in rates of growth of national output and income that are less than those that could be achieved in the absence of distorting policy. Measures of social profitability are not based on the assumption that governments will actually remove all distorting policies; distributional and other non-efficiency objectives typically will prevent drastic

change. But efficiency measures are nevertheless extremely useful, because they identify underlying economic strengths and weaknesses, that is, the basic ability of systems to compete or not without government assistance.

The essence of economic growth is to identify and promote systems that have the highest social profitability. Governments must judge whether the efficiency costs incurred by distorting policies are bearable if the policies bring desirable results for other objectives. Social profitability measures are the first step in this analysis of tradeoffs between competing objectives. If a government does not know how much it is losing in terms of efficiency, it can never know whether or not its gains in terms of other objectives are worthwhile. Hence, social profits are key measures for national economic planners.

The PAM approach to policy analysis gives a third principal research result, the level of transfers brought about individually by each policy affecting receipts or costs and collectively by the entire set of commodity specific, factor, and exchange rate policies. The measurement of policy transfers (including the effects of market failures) follows directly from the definitions of private and social valuations; private prices include the effects of existent policies whereas social prices exclude all impacts of distorting policies. The policy transfers indicate the incentive structure that is the net outcome of policy. In the absence of market failures, all of the net policy transfer (L) is caused by distorting policy. Positive entries for L (or for any of the components of L,(I,J, and K)) denote a

net subsidizing effect of policy, negative third row entries show a net tax (or disincentive policy), and zero entries indicate an absence of distorting policy or an exact offsetting of taxing and subsidizing policies.

In the absence of distorting policy and market failures, private and social profits are equal. If governments give positive incentives (subsidize with policies that cause $L>0$), they either create extra private profits for socially profitable systems or offset private losses and perhaps permit private profits for socially unprofitable systems. Alternatively, if governments choose to discourage production in a system (tax with policies that cause $L<0$)), they either reduce private profits, perhaps to negative levels, for socially profitable systems or cause even larger private losses for socially unprofitable systems. In effect, governments use policy to alter the composition of production by creating differences between the array of efficient systems that would operate in the absence of policy and the pattern of producing systems, some efficient and others inefficient, that is occasioned by policy.

This discussion of incentives or disincentives and of subsidizing or taxing policies is related only indirectly to corporate income tax policies (or to personal income taxes affecting farmers, merchants, or processors who are owner-operators of their businesses). Income taxes are usually paid on all profits measured in private prices; government income tax legislation is rarely concerned with distinctions between normal and excess profits. Firms and individual entrepreneurs typically consider their normal profit rates (those required to maintain

investment) to be defined exclusive of corporate income taxes. Normal profits, which are entered into C in the matrix as private factor costs, are thus after-tax profits, and hence, all income taxes are paid out of excess profits, entry D in PAM. Although governments might wish to tax away most or all excess profits, this task is very difficult, especially if the income tax legislation applies quite uniformly to different economic activities.

The method, as described so far, has several apparent limitations. If the analysis refers only to a single base year, it is static and cannot incorporate dynamic changes that might be expected to occur with the passage of time. Such static analysis is based on fixed technical coefficients, which directly contradict much empirical evidence of investment leading to widespread technical change in agriculture. Moreover, the PAM approach focuses mainly on efficiency objectives. Below, the analysis is extended to incorporate multiple government objectives, and Section C focuses on dynamic applications and technical change.

Summary of the Impact of Policy on Efficiency

The central purpose of PAM analysis is to measure the impact of government policy on the private profitability of agricultural systems and on the efficiency of resource use. Farmers, processors, and merchants will increase output only if it is profitable for them to do so. The degree of incentives provided by policy is measured relative to two alternative standards. The first contrasts private profitability, occasioned by actual or

projected policy, with underlying efficiency or static comparative advantage, as measured by social profitability at world prices. The second comparison is a measure of dynamic comparative advantage which shows how efficient existing agricultural systems might be in the face of projected future changes in world prices for commodities and inputs, in the social opportunity costs of labor and capital, and in agricultural technologies.

Private profitability and competitiveness are likely to be uppermost in the minds of those concerned specifically with agricultural incomes. Social profitability and efficiency can be expected to be emphasized by economic planners whose concern is with the allocation of resources among sectors and the growth of aggregate income in the economy. Both sets of issues are ultimately concerned with the incentive effects of policy--the difference between private and social profitability--and how such policy incentives might be altered. Through evaluation of private and social receipts and costs, the PAM method is designed to illuminate these three related issues of agricultural policy analysis.

The Impact of Policy Options on Non-Efficiency Objectives

In addition to economic efficiency, governments typically have three other primary objectives of food policy--concerns with the distribution of income, the stability of domestic food prices, and the security of food supplies to consumers. A number of other government goals can be subsumed within the four primary objectives. An investment in structural improvements that reduces or removes market failures has already been noted as an

"efficient" policy; since this kind of intervention increases efficiency, its effects can be measure with PAM indicators (changes in social profitability or in the DRC ratio). The creation and distribution of employment opportunities is best interpreted as an adjunct to income distribution objectives, while the government's desire to avoid international dependence on external food supplies can be seen as an integral dimension of food security. These relationships are described below.

Income Distribution

Two main influences on the distribution of income arise from a government's choice of food policy parameters. The distributional impact of policy on food producers is captured by the PAM approach, but that on food consumers is not. A well established inverse relationship exists between food prices and food consumption; the purchasing power of consumers is enhanced by lower food prices and reduced by higher ones. Food price and trade policy leading to sustained increases in food costs to consumers thus reduces their real incomes, leads them to shift to lower priced substitutes, and can cause desperately poor consumers to suffer from inadequate levels of nutrition. For this reason, policies that raise food prices to provide incentives to producers often need to be accompanied by targeted food subsidies to the poorest consumers who are at risk nutritionally.

Information in the PAM framework permits measurement of the distributional and employment effects of policy options and estimation of any tradeoffs between potential national income and

the policy-induced pattern of income distribution. The contribution of a system to national income is given by social profits (H). A policy set that encourages expansion of the system (L>0) will create private returns to factors (labor and capital) that could differ from the social returns. If, for example, the policy gives extra private profits, the owners of the enterprise (farmers, traders, and millers) will benefit. Or if, instead, policy permits the entrepreneurs to pay higher factor costs without making extra profits, suppliers of factor services will benefit (when the system is large enough to influence factor prices). Employment effects depend on the labor intensity of the system under study relative to that of the displaced system (the one that would operate if the existing one did not); the impact of policy on job creation can be negative if the displaced system is more labor intensive than the existing one.

Food Price Stability

Most governments in developing countries would like to control the intra-year and inter-year movements in the domestic prices of their principal food staples, but only a few successfully stabilize these prices. From an economic viewpoint, successful price stabilization can reduce price risks in agricultural production, guarantee stable markets throughout the system, and obviate the need for costly and unnecessary adjustments by both producers and consumers to fluctuating prices and profits. Politically, food price stabilization permits governments to maintain control of a critical parameter affecting the production decisions of farmers, the real incomes of powerful

urban consumers, and the nutritional status of the poorest people. Success has been limited due to the shortage of managerial talent, infrastructure, analytical capability, and budgetary resources to finance capital assets and annual storage costs of stabilization agencies.

Indicators of success in stabilizing domestic food prices are sometimes available within the PAM framework, but only if the PAM data have been collected for a number of consecutive years. The purpose of stabilization is to hold the domestic price within some desired range irrespective of movements in the comparable world price. Some countries attempt to follow an expected trend for the world price, but to reduce domestic price variation around both sides of that trend. Successful stabilization requires holding the domestic price within the targeted range by supporting the floor price to producers through purchases of food crops and holding the ceiling price to consumers through injections of food stocks. Performance can be gauged by contrasting movements in actual intra-year prices with the targeted range. Over time, the impact of the stabilization program can be found by comparing the variation of domestic prices with that of world prices and with the rate of domestic inflation. Stabilizing effects of domestic stock policy can be identified if the variation of real (inflation-adjusted) domestic food prices is less than that of real international prices.

Food Security

Food security is an elusive objective in both definition and realization. Security in food supplies implies that consumers

have ample food available to them throughout the year at prices they can afford to pay. In the long run, therefore, food security becomes synonymous with eradication of hunger and poverty, which are admirable, but difficult objectives to attain. In that sense, food security is complete only when people are well enough off to be able to afford a nutritionally sound diet on a sustaining basis. Some combination of calorie intake, disposable income, and nutritional status of the lowest income group (e.g. the bottom quintile) would provide quantitative evidence of adequate long-run food security. (To paraphrase Keynes, the hope is that "In the long run, we are all fed.")

Short-run food security is more problematic. Because poverty cannot be quickly reduced in many countries, short-run indicators of food security might ideally focus on the level and distribution of food calorie consumption. However, data on consumption of foodstuffs are notoriously weak in most poor countries, especially for the poorest people. One substitute indicator of the degree of short-run food security is the domestic food price. If the government food agency is not successful in holding the ceiling price to consumers, because of unanticipated domestic production shortfalls or lack of foreign exchange to purchase imports of food, the country's food security is vulnerable.

Some countries wish to avoid being dependent on world markets for regular imported supplies of food--because they fear politically-induced threats of embargoes by food exporting countries or they dislike facing unstable world prices and are unable to set up a successful buffer stock program to insulate

and to stabilize domestic prices. Avoidance of dependence on world markets is a legitimate political goal, but a reduction in food imports does not necessarily connote increased food security. In the absence of a successful price stabilization agency, a country's food security depends on the variability of its domestic food prices and production relative to fluctuations in the prices and availabilities of imports. Even if the food agency cannot carry out a consistent program of buffering domestic prices from world price variations, an indication of the degree of food security can be obtained by monitoring the adequacy of the level and locations of pipeline stocks held by the public food agency, especially before and during the country's "hungry season" (the period immediately preceding the harvest of its main food staples).

SECTION C

POLICY CHOICE MODEL

The Model

The discussion in the earlier section of this report indicates that the gains from trade, and the consequent losses from not making full use of trading opportunities, are measurable within the framework of a simple model. For purposes of illustration, this section develops such an empirical model and then tests it with Indonesian data. This is not intended to answer fully--or even partially--the whole range of questions surrounding Indonesian food and agricultural policy. Instead, it is a way of exploring, with actual data, the way in which a model of this kind might be used in an actual policy situation.

The calculation of the gains from trade is based on the estimation of the costs (to society) of producing a particular commodity compared with the cost of acquiring the commodity from abroad or the revenue from selling it abroad. If the value of the commodity exceeds its costs, then production yields a social profit. The emphasis on the model introduced in this section is thus the social profit (or rent) generated by producing agricultural commodities. For completeness, the consumer benefits from trade are also included; a more detailed model of consumer behavior could easily be constructed and linked with the production model discussed below.

No attempt has been made to quantify the value associated with "non-efficiency" objectives--though these may prove very important in practice. Economic analysis identifies the cost of

achieving such objectives in terms of reduced levels of social profits.

The calculation of social profits associated with any particular strategy for food production and imports requires detailed knowledge of the farming systems that are involved in domestic production. Such knowledge is not often readily available. An empirical analysis of social costs requires research activity by people knowledgeable about the farming systems. An alternative approach, based on inferences from market-level data, is often quicker to implement but might hide important facets of the production process. As a consequence, both approaches are illustrated here. For convenience, these can be labeled the "market data" and "budget data" approaches. The correspondence between these was demonstrated in a previous section. This is reinforced here by the parallel use of the two methods of calculating social costs.

The "Market Data" Approach

The essence of this method of measuring the gains and losses from particular strategies is to determine the social cost of production from an estimated or assumed relationship between cost and output. A market supply curve, corrected for input cost policies, is the usual starting point. In addition, the market data approach can handle gains and losses in consumption as a result of social and private prices--usually by means of a market demand curve. To derive the gains and losses over time assumptions must be made on developments due to technology, income and other factors.

The steps involved are shown in Figure 5. Starting from price and market balance data, projections are derived of production, consumption, and trade for differing levels of policy price. This projected market balance, along with the historical data, can be used to estimate the following values:

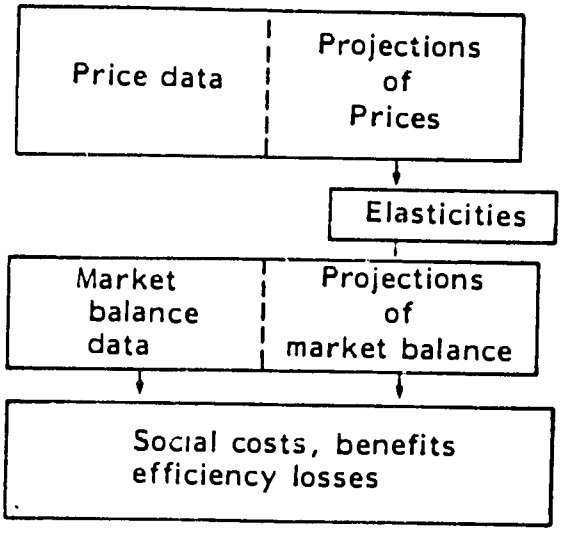
- social value of consumption
- social value of production
- social cost of consumption
- social cost of production

The net social benefit on production and consumption, and on both, can thus be obtained by subtraction of costs from benefits. The social value of consumption requires an assumption about the demand curve and any divergence between private and social valuation. The social value of production is given by the value of output at prices which reflect, at an equilibrium exchange rate, the value of similar goods at the border. The social cost of consumption is generally also given by world prices, at corrected exchange rates, and that of production is assumed to be given by the supply curve, adjusted for input subsidies and taxes.

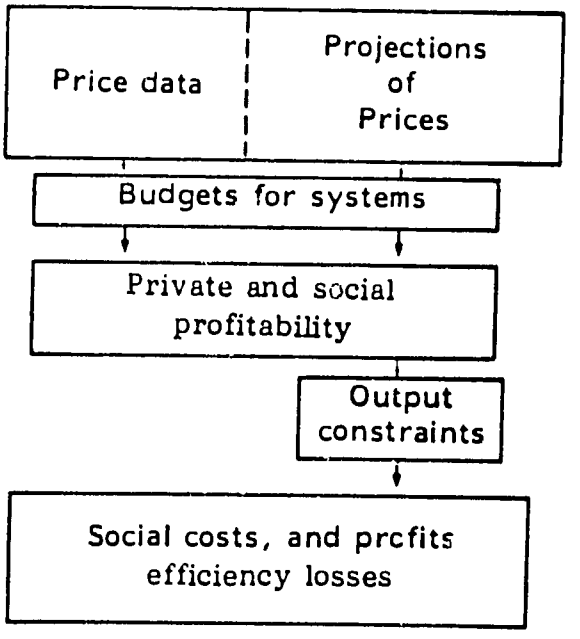
One major drawback with this method is its sensitivity to the assumed shapes and elasticities of supply and demand curves. The behavior of such curves at prices much below or above normal levels is rarely known, and yet that behavior markedly affects the value of the measures of social benefit. For this reason, little cordons should be put on the absolute size of benefits and costs estimated in this way. Relative costs and benefits among

Figure 5

a) Market data approach



b) Budget data approach



strategies can be presumed to be much more reliable in that they are all likely to be subject to the same absolute errors. In general, of course, the estimates are only as good as the parameter assumptions employed.

The "Budget Data" Approach

This approach is also outlined in the figure. The starting point is again a set of price observations and projections for agricultural inputs, outputs, and factors for exchange rates and general inflation. These data are then applied to typical budgets of agricultural systems, which relate factors, inputs, and outputs together on a per hectare basis. Straightforward accounting gives private profits, and assumptions on the efficiency (social) cost of inputs and factors and value of outputs gives the profit in social terms. In a previous section it was shown how these relationships can also be used to account for the effects of policy on system profits.

To find the aggregate (rather than the per hectare) social profit, the system level results need to be weighted by the importance of each system. Applying constraints in terms of the hectares that are available to a particular system gives the total possible output. By eliminating those systems for which private profits are consistently negative, the likely actual output level can be calculated. The hectarage thus used multiplied by the social profits gives the total social profit, net of the excess costs in systems where social value is more than social cost. The hectare constraints act to give a step-wise supply curve, as discussed above.

The choice between the two approaches is largely a matter of data availability. For illustration it is assumed below that data on farm budgets are better for rice than for corn and not readily available for cassava. For rice a step-wise supply function based on 12 difficult rice systems was employed; for cassava a single system represented all output; and for corn three different systems were selected. In addition, the market data approach was used for all three commodities.

To use these models to illustrate policy choice, the three alternative strategies discussed in Section A need to be translated into distinct policies and policy attitudes. These distinct policies can be evaluated and compared using the results of the model. Figure 6 summarizes policy components of the three distinct strategies. More detail on the three different strategies in the Indonesian context is given below.

The self-sufficiency strategy (SSS) takes as its key the relationship between domestic production and consumption, whether in the short-run or the long-run. As a consequence, this policy can be assumed to be manifest by steady increases in the domestic price for import goods and possibly a reduction in the price of exports. Input subsidies and investment schemes would tend to be targeted toward the import-competitive sector. By contrast a self-reliant strategy takes as its starting point the relationship between the price of goods on the world market and the domestic cost of production. That gap is narrowed over time regardless of whether imports or exports occur. Self-reliance in trade is assumed to go along with a policy of reducing input

Figure 6

	Imports	Exports
Self-Sufficiency	- increase producer price - input subsidies - investment	- discourages production - increase consumption
Self-Reliance	- producer price toward world price - no input subsidies - neutral exchange rate	- producer price toward world price - no input subsidies - neutral exchange rate
Trade-Dependency	- reduce producer price - subsidize consumption - tax inputs	- expand export sectors

taxes and subsidies that would otherwise distort the countries' competitive position. Above all, self-reliance implies an exchange rate policy that does not tax imports or tax exports.

Trade dependency occurs when exports have been stimulated beyond the point at which their cost is covered by foreign exchange earnings or where imports are encouraged even though domestic production would be cheaper. Translated into policy terms, this would imply reductions in price levels for importables, together with taxes on inputs and consumption subsidies, combined with an expansion of exportable products.

Illustration: Food and Agricultural Policy in Indonesia

The policy choice model is designed to permit measurement of the efficiency and non-efficiency impacts of three alternative food and agricultural strategies--self-sufficiency (SSS), self-reliance (SRS), and trade-dependence (TDS). In an analysis of recent past events, the model results show which of the three strategies was in fact followed, during various time periods. The net impact of commodity-specific, macroeconomic, and investment policies on agricultural systems, within a given period, will have been either anti-trade biased (SSS), trade neutral (SRS), or pro-trade biased (TDS). Alternatively, in a forward-looking analysis of potential future effects of policies, the model provides measures of the production, consumption, trade, and welfare effects of each of the three strategies. Given the underlying efficiency of a country's diverse agricultural systems to produce staple foods, each strategy creates differing levels of incentives or disincentives to produce by altering market prices of output and inputs.

In the remainder of the paper, data from Indonesia are used to illustrate how the policy choice approach and model can be applied in a developing country. Indonesia was selected as the case study country on two principal grounds: it is a large, important developing country that has had considerable success with its food and agricultural policies; and much empirical analysis has been undertaken to help explain this success (including recent work by two of this paper's authors and their colleagues). As with the choice of any country for a case study, the selection of Indonesia entails historical and institutional developments and resource and technological constraints that are particular to that country. In the following summary of Indonesia's recent food and agricultural strategy, an effort will be made to distinguish between elements that are peculiarly Indonesian in nature and phenomena that might be generalized to other developing countries, especially larger ones.

The selection of Indonesia also implies a choice of agricultural systems that produce the country's principal food staples. Table 1 presents data from Indonesia's food balance sheet for 1980. For the average Indonesian consumer, about half of total calories and of total protein are supplied from rice alone. In addition, the various forms of corn and of cassava each contribute another tenth or so of total food calories, and corn is responsible for an eighth of total protein intake. The three principal starchy staples--rice, corn, and cassava--thus together supply about 70 percent of food calories and two-thirds of protein in the average Indonesian diet. The illustration

Table 1

Per Capita Consumption of Calories and Protein, by Commodity, 1980

Commodity	Calories	Share of Total Calories (percent)	Protein (grams)	Share of Total Protein (percent)
Rice	1310	51.0	22.92	47.3
Coconuts	230	8.9	2.30	4.7
Corn (Dry forms)	225	8.8	5.87	12.1
Cassava	191	7.4	1.36	2.8
Refined Sugar	111	4.3	--	—
Copra Oil	87	3.4	--	--
Wheat Flour	69	2.7	2.22	4.6
Soybeans	51	2.0	4.50	9.3
Groundnuts	45	1.8	1.94	4.0
Palm Oil	44	1.7	--	--
Other Sugar	42	1.6	0.12	0.2
Sweet Potatoes	33	1.3	0.31	0.6
Bananas	21	0.8	0.27	0.6
Marine Fish	14	0.5	2.43	5.0
Sago Flour	9	0.4	0.03	0.1
Fresh Corn	8	0.3	0.25	0.5
Pork	7	0.3	0.17	0.3
Imported Milk	7	0.3	0.38	0.8
Tapioca	7	0.3	0.02	—
Beef	6	0.2	0.38	0.8
Chicken	5	0.2	0.27	0.6
Eggs	7	0.2	0.53	1.1
Inland Fish	4	0.2	0.76	1.2
Other Fruits	14	0.5	0.18	0.4
Other Vegetables	13	0.5	0.65	1.3
Other Meat	7	0.3	0.55	1.1
Other Fats	2	0.1	--	—
Cow Milk	1	0.0	0.04	—
TOTAL	2570	100.0	48.45	100.0

Source: Central Bureau of Statistics, Food Balance Sheet for 1980.

therefore focuses entirely on these three principal food commodities and, especially, on rice because of its dominance in Indonesia's food system.

As described in the previous sub-section, the policy choice model is constructed to cover an 11-year time span--5 years of complete, observed data, 1 year of some observed and some projected data (the most recent full calendar year for which much information is not yet available), and 5 years of projections (normally starting with the current calendar year). Accordingly, for the Indonesian case study, the data in the model pertain to 1980-84, 1985 is year of mixed observations and extrapolations, and 1986-90 is the period for the projected analysis. Discussion of the results from the model in the following sub-section will thus center on the observed and projected performance of rice, corn, and cassava systems during the 1980s. But these results can be understood fully only in the context of the longer-run evolution of the Indonesian food economy. The purpose of this sub-section is thus to provide that recent historical context, in particular by reviewing the policy components of Indonesia's food strategy.

Background

In the mid-1960s, Indonesia's economy was the "sick man of Asia," following several years of macroeconomic mismanagement, wasteful subsidies to inefficient industry, and neglect of agriculture. When the Sukarno Government was overthrown in 1965, inflation was raging at an annual rate exceeding 800 percent, the political stability of the country was threatened, and growth in the economy was at a standstill. Within only three years, the

New Order Government, led by President Suharto, regained control of macro policy and controlled inflation, ushered in a period of more than two decades of political stability, and began a 15-year period (1969-83) of sustained, rapid economic growth.

Data describing these results are presented in Table 2. Following stagnation and high inflation during the last eight years of Sukarno's Government (1958-65), the Indonesian economy underwent a wrenching macroeconomic adjustment in 1966-68. Sustained rapid growth in real (inflation-adjusted) national income began with the introduction of the first five-year development plan (Repelita I, 1969-73) in 1969. Fueled in part by the oil price rises of 1973-74 and 1979-80 and the subsequent increase in the real price of Indonesia's leading export commodity, the annual growth rate of real income averaged about 7 percent between 1969 and 1983. Some of this growth in income was offset by population growth, but during this period real income per capita grew at the impressive rate of approximately 4.7 percent per annum, and thus real national income doubled in 15 years.

The agricultural sector, including the three staple food crops, played a critical role in contributing to this strong aggregate economic performance, especially during the most recent period (1979-83). Table 3 gives some indicators of the changing structure of agriculture's share of Indonesian income. Although output of rice and corn doubled between the beginning and end of the 15-year period, the agricultural sector's income grew more slowly than the national average. Consequently, agriculture's

Table 2

Major Macro-economic Variables

	1958-65	1966-68	1969-73	1974-78	1979-83
Average population (millions)	96.5	110.6	122.6	135.5	149.1
Average real GDP (billion 1980 Rps)	15,100[a]	17,100	23,100	33,000	47,700
Average real GDP growth (percent)	0.9[a]	5.2	7.7	7.2	6.1
Average real GDP per capita ('000 1980 Rps)	157[a]	154	188	244	309
Inflation					
Period average[b] (percent)	79.0[a]	323.0	16.7	18.9	18.5
Start of period	9.1[a]	1,202.4	21.1	47.3	32.5
End of period rate of inflation (percent)	232.4[a]	121.4	37.7	10.9	14.6

[a]Real GDP, calculated using GDP deflator for 1959-65 and NDP at factor cost deflator for 1957 and 1958.

[b]As measured by changes in GDP deflator.

Source: IMF, International Financial Statistics Yearbook, various years and United Nations, Economic Survey of Asia and the Far East 1960.

Table 3

Changing Structure of the Agricultural Economy
1968-1983

(Percentage Shares)

	1968	1975	1980	1983
Agriculture in GDP at current market prices	51.0	31.7	24.8	26.4
Food crops in Agriculture	67.9	63.8	56.3	66.0
Rice in food crops (gabah production floor price ÷ food GDP)	54.4	51.2	49.0	41.3
Rice in Agriculture	37.0	32.7	27.6	27.3
Rice in GDP	18.8	10.3	6.8	7.2

Source: Central Bureau of Statistics

share in national income decreased from over half in 1968 to about one-fourth in 1983. Within the agricultural sector, the share of food crops in total income did not change much, but the contribution of rice to agricultural income declined from 37 percent in 1968 to 27 percent in 1983. Since the share of agriculture in national income and the share of rice in agricultural income both declined, the contribution of rice production to national income fell from 19 to 7 percent over the period.

These figures might create the misleading impression that Indonesia's rice sector was stagnating or in decline during the period. In a relative sense, this result occurred because of extremely high rates of income growth outside agriculture. The rapid income growth in a still low-income country (per capita income of less than $500 in 1984) created increasing demands for food and especially for rice, the preferred food staple for most Indonesians. Hence, Indonesian food planners found themselves "shooting at a moving target" because domestic demand for rice (and other foods) was expanding with the growth of income and population.

In 1970-71, for example, many analysts thought self-sufficiency in rice was just around the corner. Subsequent crop shortfalls complemented the rising trend of demand to open large import gaps. By the latter half of the 1970s, Indonesia was importing 1.8 million metric tons (MMT) of rice (1976-80 average), about one of every five or six tons that traded on the world market for rice at that time. The country had become the world's largest importer of rice, and it was in the unhappy

position of being the most important buyer in a very thin and unstable world market (the world price of rice in 1974, for example, was nearly six times as high as it had been in 1971).

Nevertheless, Indonesia's food crop production was anything but stagnant in the 1970s and early 1980s. Summary data on harvested area, yields, production, and trade for rice, corn, and cassava are contained in Table 4. Between 1966-70 (average) and 1984, rice production more than doubled to 25.8 MMT. Much of this increase was due to higher yields, which rose 85 percent in the period; area harvested was expanded by only 19 percent. In the same time span, corn output nearly doubled, rising to 5.5 MMT, despite almost no change in area harvested (which first declined and subsequently recovered). Average corn yields almost doubled to account for the expansion of output, and most of this yield and production increase for corn came in the early 1980s. For cassava, the pattern is less pronounced. Output in 1984 was 30 percent higher than in 1966-70. This expansion is explained by a yield increase of 43 percent that more than offset the decline in cassava area harvested of 10 percent. These unequal growth rates in food crop output were largely the result of differing agricultural price and technology policies for each of the three crops, which in turn caused macroeconomic policy to affect the crops differently.

Rice

To a very large extent, the recent history of food policy in Indonesia is a story of rice policy. In light of the preponderant position of rice in both food production and

Table 4

Indonesian Food Crops

Food Crop	Area Harvested (mn hectares)	Yield (tns/hectare)	Production (mn tons)	Trade ('000 tons)
Rice (milled)				
1966-70 (average)	7.87	1.48	11.64	-570
1971-75 (average)	8.33	1.73	14.38	-926
1976-80 (average)	8.69	2.01	17.45	-1,808
1981-83 (average)	9.18	2.51	23.07	-672
1984	9.40	2.75	25.82	na
Corn				
1966-70 (average)	2.98	0.96	2.87	148
1971-75 (average)	2.67	1.08	2.88	116
1976-80 (average)	2.60	1.33	3.47	-27
1981-83 (average)	2.68	1.60	4.28	-76
1984	3.03	1.81	5.47	na
Cassava				
1966-70 (average)	1.48	7.4	11.0	559
1971-75 (average)	1.45	7.9	11.5	797
1976-80 (average)	1.39	9.5	13.0	875
1981-83 (average)	1.32	9.7	12.8	701
1984	1.34	10.6	14.3	na

Source: Indonesia, Central Bureau of Statistics and BULOG.

consumption, until the 1970s, little policy attention was paid to the non-rice food crops (palawija). Hence, the trends in production and consumption of corn and cassava have been much less affected by policy than have those for rice supply and demand. Indonesian food strategies have revolved around rice, and thus disproportionate attention is also given to rice here and in the model illustration.

Perhaps the main lesson to be drawn from a review of Indonesia's recent rice policy is that even successful policy can eventually have unexpected costs when fundamental circumstances change. Since independence in 1945, Indonesian policymakers have called for self-sufficiency in rice production. Former President Sukarno temporarily--and disastrously for consumers--once achieved self-sufficiency by banning imports of rice. Self-sufficiency at demand levels reflecting long-run world prices became a goal of the New Order governments, and that goal is stated in all three of the five-year development plans--Repelita I (1969-73), Repelita II (1974-78), and Repelita III (1979-83)--under discussion here.

Although the policy elements of the rice strategy were clearly to expand production more rapidly than consumption was growing in order to reduce imports, the model results (in the next sub-section) show that most rice systems were efficient (i.e., socially profitable) and hence did not need or receive excessive net policy transfers. Instead, unwanted production disincentives from some types of policy were explicitly offset by incentives from other instruments. This intended self-reliant strategy--replacing imports efficiently and using import markets

as necessary to meet consumption objectives--worked very effectively, and in 1984 Indonesia became self-sufficient in rice. In 1985 the country exported half a million tons of rice, but by then the world price of rice had fallen to half its 1981 level and Indonesia was forced to subsidize its exports at per unit subsidy levels about equal to the world price for its quality of rice (25 percent broken) (both were in the range of $150-200 per MMT). Both the causes and subsequent problems of Indonesia's expansion of rice production need to be explained.

Table 5 contains rice data for 1968 through 1985 (estimated). The technology package underlying the increases in paddy yields included a research and extension program (BIMAS or "Mass Guidance") of seeds of high yielding varieties (HYVs), input recommendations, subsidized credit (to less than one-third of the commercial interest rate), and subsidized fertilizer and pesticides (to less than half of the comparable world prices). HYVs from the International Rice Research Institute (IRRI) in the Philippines were borrowed and adapted to local conditions. These investments in agricultural technology were complemented by infrastructural investments in improving and expanding irrigation (since the HYVs were for irrigated systems only) and transportation (roads and ports), especially on Java. Econometric estimates indicate that about half of the expansion of rice output can be attributed to investments in technology and infrastructure.

The other half was due to price policy. The National Food Logistics Agency (BULOG) has successfully implemented a buffer

Table 5

Indonesian Rice Data

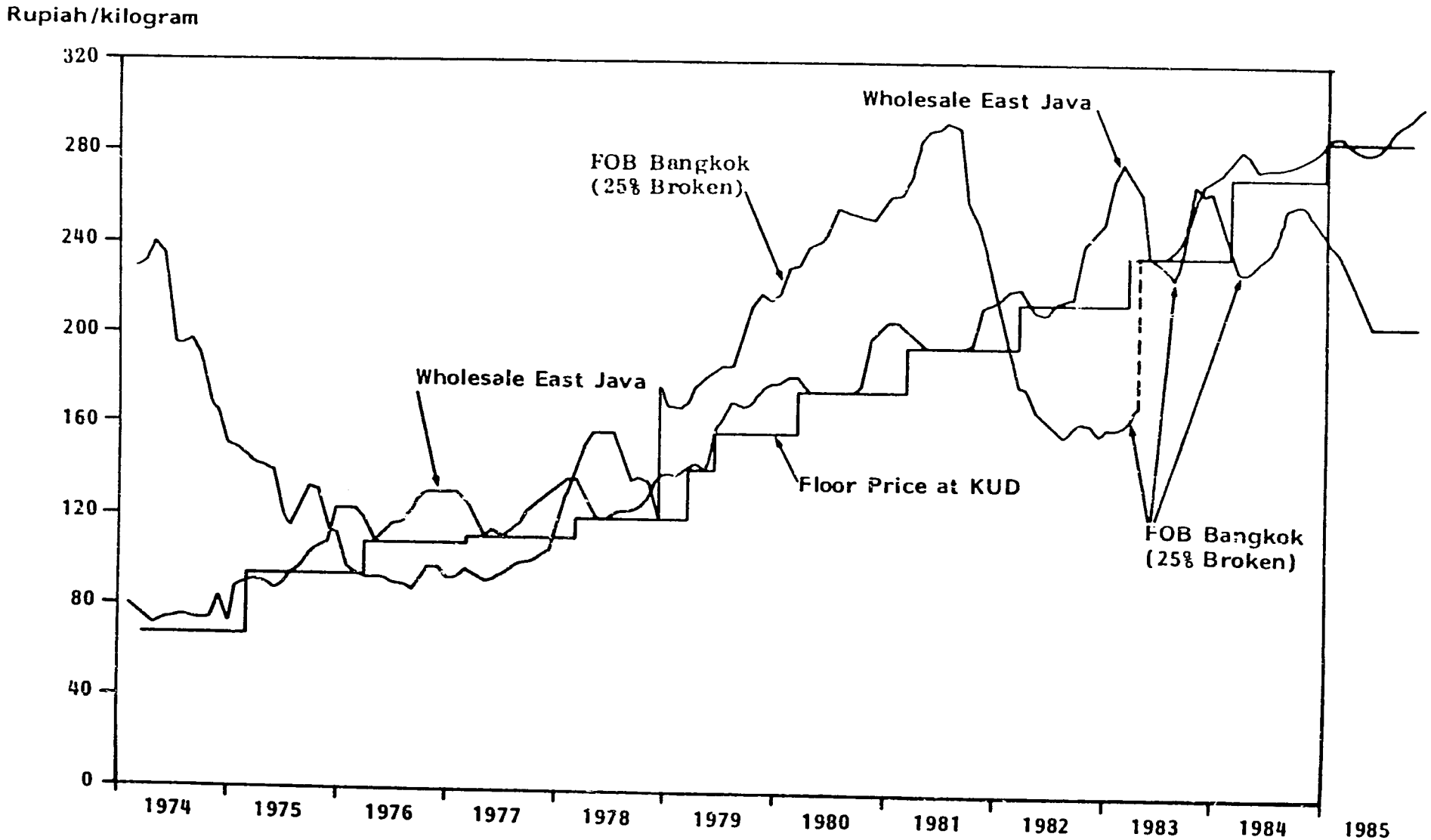
Year	Area (million ha.)	(Gabah) Paddy Production (million tons)	Rice Production (million tons)	Paddy Yield (kg/ha)	Fertilizer Use (thousand tons N,P,K)	Paddy Support Price (Rp/kg)	Urea Price (Rp/kg)	Paddy/Urea Price Ratio
1968	8.01	17.16	11.67	2.14	120	23	40	.58
1969	8.01	18.02	12.25	2.25	192	21	32	.66
1970	8.14	19.33	13.14	2.38	197	18	27	.68
1971	8.32	20.19	13.72	2.43	244	21	27	.79
1972	7.90	19.39	13.18	2.45	308	21	26	.79
1973	8.40	21.49	14.61	2.56	379	30	40	.76
1974	8.52	22.47	15.22	2.64	393	42	40	1.05
1975	8.50	22.34	15.18	2.63	423	59	60	.98
1976	8.37	33.30	15.84	2.78	416	69	80	.86
1977	8.36	22.35	15.88	2.79	557	71	70	1.01
1978	8.93	25.77	17.53	2.89	618	75	70	1.07
1979	8.80	26.28	17.87	2.99	699	85	70	1.21
1980	9.01	29.65	20.16	3.29	1,012	105	70	1.50
1981	9.38	32.77	22.29	3.49	1,241	120	70	1.71
1982	8.99	33.58	22.84	3.78	1,365	135	70	1.93
1983	9.16	35.30	24.07	3.85	1,365	145	90	1.61
1984	9.40	37.98	25.82	3.95	1,683	165	90	1.83
1985*	9.67	38.21	25.98	3.95	1,800	175	100	1.75

*Preliminary

stock policy for rice since 1974. Through good management and well designed and located warehouses, BULOG defends a paddy floor price to farmers by buying at the announced floor price and usually holds a rice ceiling price for consumers by selling rice from their stocks when the wholesale price approaches the ceiling. The success of the floor price is demonstrated in Figure 7; the wholesale price in East Java (the main production and consumption region in Indonesia) has only rarely and temporarily fallen beneath the policy-determined floor price. Financing for BULOG is provided by an essentially open line of credit at the central bank, and the marketing margins are maintained wide enough to encourage the private trade to do the bulk of the provisioning (BULOG never buys or sells more than at most 15 percent of rice supplies). Price stabilization has thus been done effectively. BULOG has held 3-4 months of stocks in its warehouses and has varied its purchases of imports to keep the pipeline at desired levels. Price policy has thus been geared to trade policy since BULOG has had an import monopoly and has varied imports to maintain domestic policy prices.

Figure 7 also shows the annual and trend levels of Indonesian and comparable world prices of rice. In setting domestic rice price levels, Indonesian policymakers have attempted for the most part to approximate the expected trend of world prices. Between 1973 and 1982, on average the trend domestic price was somewhat lower than the trend world price. This disincentive to production was countered with the technology and investment policies, summarized above, and with very substantial subsidies on fertilizer to induce adoption of the

Figure 7 -- Rice Price Trends: 1974-1985



Source: BULOG

fertilizer-intensive HYVs. Since 1977, the paddy floor rice has been increased relative to the fertilizer price; the ratio rose from 1.01 in 1977 to a peak of 1.93 in 1982 and was 1.75 in 1985, as shown in Table 5.

The comparisons between domestic (wholesale, East Java) and world (fob Bangkok, 25% broken) prices, shown in Figure 7, permit undertaking an interesting, if stylized, exercise. As argued in earlier parts of this paper, food policy strategies ideally should be evaluated according to the net policy transfer effected by the entire set of price, macroeconomic, and investment policies. For heuristic purposes, this stricture is violated here, and only the impact of output price policies affecting rice prices is considered. Inspection of Figure 7 shows that the relationship between Indonesian and world prices moved in 3-year cycles starting in 1973 (not shown in Figure 7). If one is willing to contrast the stated self-reliant strategy with the revealed strategy as defined solely by output price relatives, the following picture emerges:

Rice Strategy	Time Period	Trade Status/Rice
self-sufficiency (Pd>Pw for import; Pd<Pw for export)	1982-84	imports
self-reliance (Pd=Pw for import or export)	1976-78	imports
trade-dependence (Pd<Pw for import; Pd>Pw for export)	1973-75	imports
	1979-81	imports
	1985	exports

where Pd = Indonesian wholesale price and Pw = world price (cif, 1973-84; fob, 1985-)

Although policymakers professed a desire for a self-reliant strategy, the highly fluctuating world rice price made it difficult or impossible to define and then follow trend world prices. In the 1973-75 period, the world price of rice sky-rocketed and Indonesia realized a trade-dependent strategy. When world prices stabilized in 1976-78, a self-reliant outcome was achieved. But then world prices rose, peaked, and fell again during 1979-81, shifting Indonesia back to trade-dependence, when it was paying large subsidies to sell imported rice at domestic prices as much as $100/MT beneath world levels. The outcome altered again during 1982-84, when the combination of policy-induced increases in the domestic price coincided with much lower world prices to create a realized strategy of self-sufficiency. In 1984, rice self-sufficiency was reached, and in 1985 Indonesia became a net exporter of rice. Unhappily for Indonesia, the world price of rice fell to record low levels (in real terms), and the country therefore slipped into trade-dependence, this time as an exporter.

The recent decline of the world rice price is directly related to Indonesia's own successes in stimulating rice production and hence in shifting its international trade position from being a net importer of nearly 2 MMT to becoming a net exporter of 0.5 MMT. Rough estimates have shown that this net trade shift of 2.5 MMT by Indonesia in a world rice market of only 11-12 MMT could itself have been responsible for a decline in the world price of rice of perhaps $125/MT. This unwanted "large country" market power in the world rice market provides another piece of the puzzle in understanding why Indonesia's

success in achieving rice self-sufficiency has created largely unforeseen difficulties in managing rice policy under changed circumstances. Export surpluses that require subsidies for disposal are an undesired by-product of successful growth of rice production. Yet implementing a disincentive policy for rice is difficult when planners are concerned with rural dynamism and the growth and distribution of incomes and jobs.

Corn

Two fairly recent phenomena have thrust corn more directly into the policy limelight. Traditionally a food staple consumed largely on farm or in rural areas by poor people (who typically preferred but could not afford rice), corn has in recent years begun to be consumed increasingly in end uses other than direct human food consumption--most notably as animal feed, reflecting the growing income-driven demand for animal products (especially eggs and poultry meat). A recent estimate shows that as much as one-fourth of Indonesian corn in the mid-1980s is fed to animals.

Two policy responses have followed this change in dietary habits and corn use. First, BULOG began implementing a floor price for corn in 1978, and that price was raised substantially in the early 1980s, as shown in Figure 8. Second, BULOG has sporadically entered the corn import market to meet seasonal demands for corn exports by the Indonesian animal feed compounders. As Figure 8 indicates, Indonesian prices were close to world prices, although usually somewhat above them, so that little trade took place. Table 4 shows that Indonesia had exported regularly in the decade ending in 1975, and the country

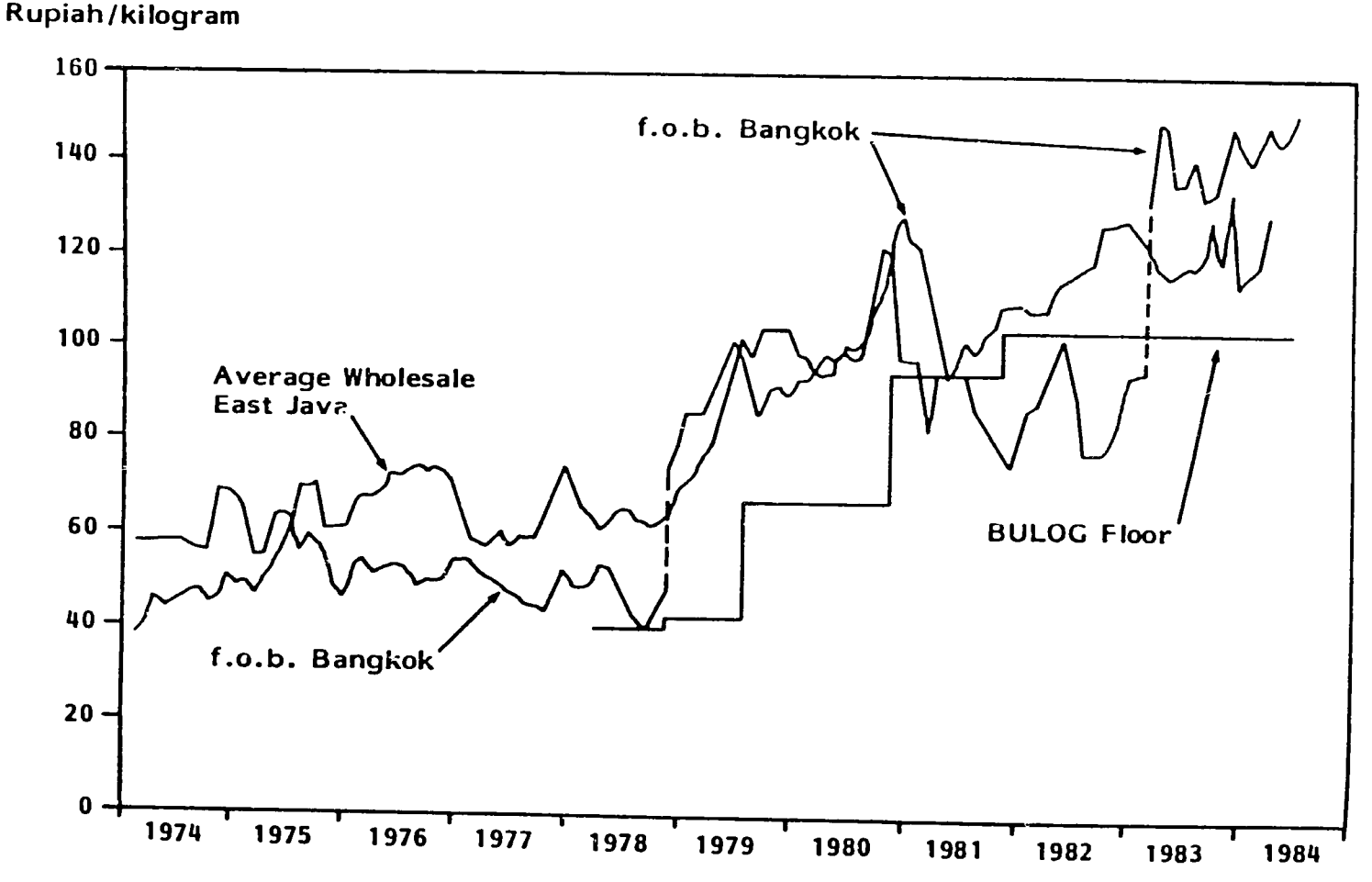
resumed its status as an exporter in 1983 when the world price recovered and after Indonesia devalued (causing the dotted line effect in Figure 8).

The second phenomenon affecting corn has been the development and dissemination of fertilizer-responsive HYVs and the consequent near doubling of corn yields. Like rice, corn has also benefited from the government's investment in transportation and from the spread of fertilizer distribution facilities throughout much of the countryside. An extension program for non-rice food crops (BIMAS Palawija) has not been widely effective, but the government's research stations for corn have introduced open-pollinated HYVs that have been higher yielding and disease resistant (especially to downy mildew). Government research on corn seeds has been complemented by privately sponsored research. Cargill, Inc., has developed a hybrid corn variety that has achieved yields of 4 to 10 times recent on-farm levels. The Cargill hybrid has been field-tested and seed began to be marketed in 1985. The prospect of increased use of both hybrid and open-pollinated HYVs is the source of much optimism about rapid increases in corn yields during the remainder of the 1980s and thereafter.

Cassava

Cassava production and prices have been only indirectly affected by government policy. The market yield increases, shown in Table 4, have resulted largely from increased application of fertilizer and not from research leading to HYVs. The government has chosen not to intervene in cassava price formation, and so BULOG does not stock or trade the commodity. Cassava has

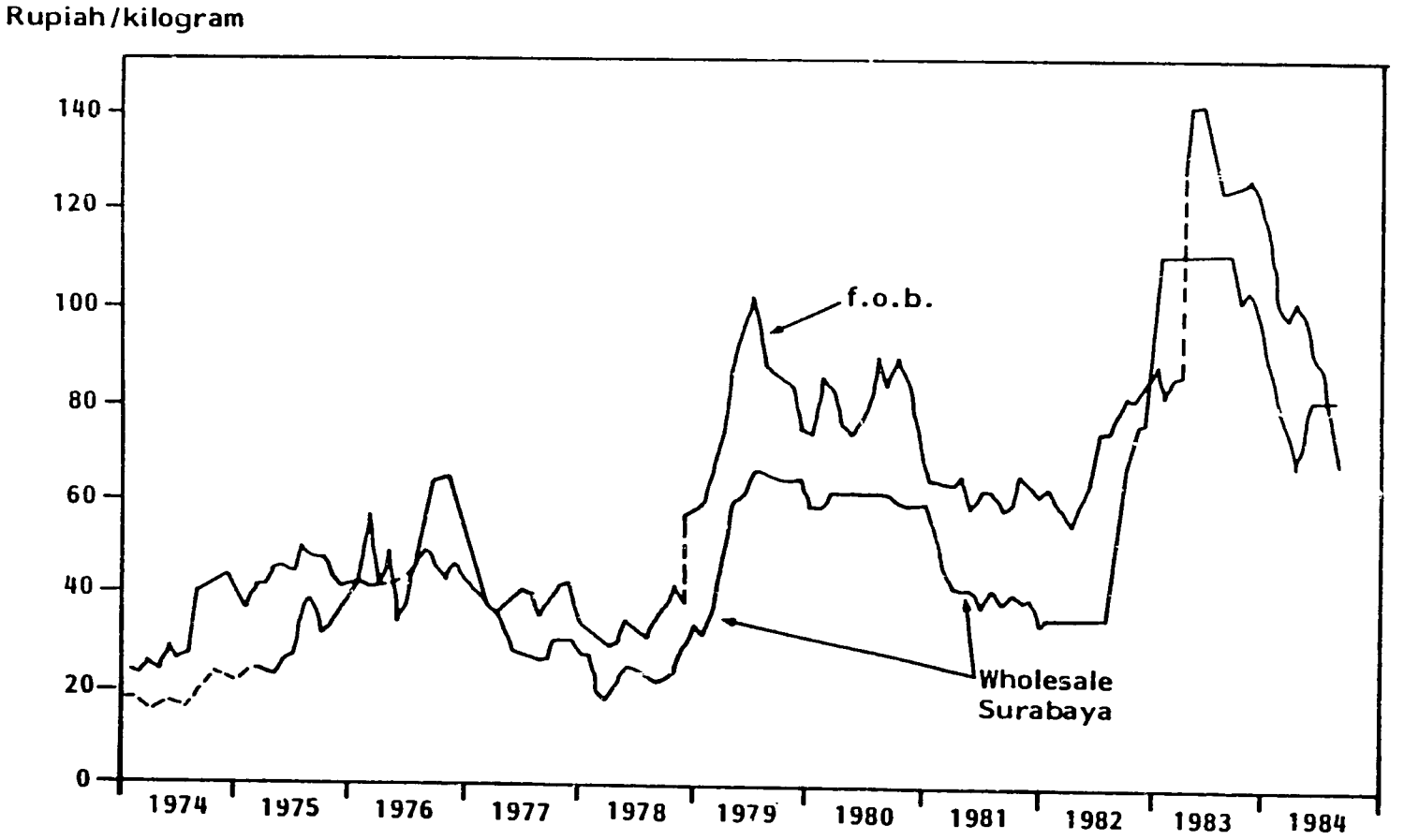
Figure 8 -- Corn Price Trends: 1974-1984



benefited indirectly from public investment in transportation infrastructure that reduced marketing costs, expanded domestic markets, and raised on-farm profits for this bulky root crop. Subsidized fertilizer creates some incentives for cassava farmers, but most cassava farmers use limited amounts of chemical fertilizer. In short, cassava production and consumption fall at the opposite end of the policy spectrum from rice, which is heavily impacted by policy.

The cassava story is well told in Figure 9. The fob export price in Surabaya (East Java's major port) is derived from the import price in Rotterdam of dried cassava (gaplek) pellets used in the European Community (EC) as an ingredient in manufacturing compound animal feeds. (Neither cassava pellets, which supply calories, nor soybean meal, which gives protein, are subject to the EC's variable import levies that limit EC imports of wheat, corn, and other coarse grains.) The domestic Indonesian prices for all cassava products are typically tied to the fob gaplek price, falling just beneath it with the difference due to a small marketing margin. Hence, in most months the domestic cassava price is set by the world price. Occasionally, however, the domestic price is pulled off the floor set by the world price, due either to a poor domestic cassava crop or shortfalls in rice and corn that cause Indonesian consumption of cassava as human food to rise. When this occurs, cassava becomes a non-tradable commodity whose price is determined at levels higher than the fob floor by domestic demand (for use as food) and by domestic supplies of cassava. On rare occasions, the domestic price has

Figure 9 -- Gaplek Price Trends: 1974-1984



gone so high that imports of cassava (in the form of starch) have occurred to release more domestic supplies for food uses.

Macroeconomic Policy

One of the key ingredients in Indonesia's successful record of income growth and agricultural performance has been its effective management of macroeconomic policy. Many of the decision-makers most heavily involved in making economic policy have served in the government for much of the past two decades. Having helped create stability from chaos in the mid-to-late 1960s, these officials managed the economy prudently during the boom years of the oil price rises. Indonesia consequently was poised to adjust fairly smoothly to the initial decline in the oil price in the early 1980s. If recent low oil price levels are perpetuated for very long, however, the Indonesian macro policy-makers will face a series of extremely difficult decisions on how to adjust government revenues and expenditures and the foreign exchange accounts.

Many of these long-time policymakers have family links to agriculture, and from the beginning of the New Order Government they have demonstrated a bias in favor of agriculture. As already noted, the government has made large and continuing budget allocations in support of agricultural development--investments in irrigation, transportation and research, BIMAS and other credit subsidies, and fertilizer subsidies. In addition, the government pays a large recurring cost to stabilize rice prices and to maintain a food security stock (at a level of 1 MMT that should avoid large import purchases in 19 of 20 years).

Fiscal, monetary, and inflation control policies have their most direct effect on agricultural systems through the foreign exchange rate. Table 6 contains data on exchange rates in Indonesia from 1953-83 and calculations of the degree of overvaluation of the Indonesian Rupiah. Overvaluation occurs if the actual exchange rate does not change so as to offset fully the difference between domestic inflation and world inflation. The Purchasing Power Parity (PPP) exchange rate is a measure, based on a given base year (1971 in Table 6), of what the actual rate would need to be to offset inflation differences. The overvaluation figure is a percentage showing how much the actual exchange rate would need to be changed to accord with the PPP rate.

The results in Table 6 show that Indonesia has achieved a mixed record on exchange rate policy. Extreme distortions existed in the 1953-66 period, but the degree of overvaluation was very small (even negative) for the first few years following the devaluation in 1971. Domestic inflation jumped in 1973-74, as ways of coping with the increased revenues from oil price rise were gradually learned and implemented. Meanwhile, the government, mistakenly, froze the exchange rate at Rp 415/$1 from August 1971 to November 1978. The result of domestic inflation running at rates much higher than world inflation (i.e., that experienced by trading partner countries) and an unchanged actual exchange rate was a 50 percent overvaluation of the Rupiah by the mid-1970s.

Despite large and growing foreign exchange reserves from oil exports, the government devalued by 50 percent in November 1978.

Table 6

Exchange Rates in Indonesia, 1953-84

Year	World Inflation[a]	Domestic Inflation[b]	PPP Exchange Rate[c]	Actual Exchange Rate[d]	Over-valuation[e]
1953	0.8	--	39.5	11.60	240.5
1954	0.4	2.0	40.1	12.52	220.3
1955	-0.2	27.1	44.9	11.07	305.6
1956	1.4	13.3	50.2	11.84	324.0
1957	3.6	9.0	53.0	17.33	205.8
1958	2.7	9.1	56.4	29.55	90.9
1959	0.9	34.0	74.5	32.21	131.3
1960	1.5	31.1	96.5	37.52	157.2
1961	1.1	14.6	109.4	40.50	170.1
1962	1.1	177.2	299.9	136.50	119.7
1963	1.3	146.2	729.3	320.55	127.5
1964	1.2	114.1	1,542.0	788.35	95.6
1965	1.7	232.4	5,040.0	2,683.00	87.9
1966	3.1	1,202.4	63.6	36.00	76.7
1967	3.1	169.5	166.2	153.67	8.2
1968	2.3	125.4	366.2	300.08	22.0
1969	6.0	15.5	405.6	326.00	24.4
1970	6.5	12.3	427.8	365.00	17.2
1971	7.9	4.6	415.0	393.40	5.5
1972	13.3	6.3	389.3	415.00	-6.2
1973	23.5	31.1	413.5	415.00	-0.4
1974	15.0	40.5	505.2	415.00	21.7

Table 6 (cont.)

Year	World Inflation[a]	Domestic Inflation[b]	PPP Exchange Rate[c]	Actual Exchange Rate[d]	Over-valuation[e]
1975	-3.5	19.1	623.3	415.00	50.2
1976	19.2	19.8	622.3	415.00	50.0
1977	14.6	11.1	607.0	415.00	46.3
1978	23.5	8.1	531.4	442.10	20.2
1979	5.1	21.9	616.2	623.10	-1.1
1980	8.1	18.5	675.9	627.00	7.8
1981	13.5	12.2	728.0	631.80	15.2
1982	-12.2	9.5	833.3	661.40	26.0
1983	3.3	11.8	901.9	909.30	-0.8
1984	1.3	10.4	982.6	1,029.30	-4.5

---

[a]1953-66 computed as percentage change in U.S.C.PI., 1967-83 computed as percentage change in weighted index of consumer price indices converted to U.S. dollars, (weights for Warr, 1984).

[b]1953-66 computed as percentage change in GDP deflator, 1967-83 computed as percentage change in Jakarta consumer prices.

[c]Purchasing power parity exchange rate using 1971-415 Rps/$ as base, calculated as 415 times the world dollar consumer price index divided by Indonesia's consumer price index in rupiahs.

[d]1953-1966, effective exchange rate for rubber exports, (Pitt, Table IV.1, p. 99), 1967-83, average market exchange rate (IMF, IFS).

[e]PPP exchange rate divided by actual exchange rate, minus one, times 100.

The purpose was to correct the overvaluation and to restore the competitiveness of non-oil tradable goods and services, including most agricultural commodities (except for rice, which was already protected from the taxing effects of overvaluation because of the quantitative restriction on rice imports). The 1978 devaluation achieved its purpose, but starting in 1981 the oil price decline and global recession together created adverse movements in Indonesia's international terms of trade. In March 1983, Indonesia devalued by 38 percent, a move that restored equilibrium in the exchange rate. Since then, the government has gradually depreciated the exchange rate on a daily basis, and by early 1986 the rate had fallen to Rp 1125/$1. Depending on oil price movements, this rate could, of course, be highly vulnerable to change in the future. Exchange rate policy, in short, had little effect on rice production incentives (since rice and fertilizer prices were otherwise set by policy), but it intermittently created disincentives for corn, cassava, and other agricultural production by causing Rupiah prices of tradable agricultural commodities (not protected by quantitative restrictions on trade) to be lower than they should have been. Although adjustments in the exchange rate were delayed--thereby taxing non-rice agriculture--macro policymakers eventually made corrections to remove these disincentives stemming from overvaluation of the exchange rate.

Several key ingredients of success in managing macro and food policies have been identified in this brief review of recent events in Indonesia's food sector. In no particular order of

priority, these ingredients include: political stability to permit making difficult short-run adjustments within the context of a consistent, long-run strategy; continuity of economic policy-makers and staffs; importance of institutional and analytical capacity; understanding of the use and limitations of economic policy and its analysis; appreciation of the limits of the appropriate substitution of public for private activity; critical nature of public investments in research for agricultural technology and infrastructures; and orientation toward the use of private sector domestic marketing and of world markets and prices in guiding domestic decisions.

Model Construction and Results

The model was run for a total of nine different scenarios: the three food strategies for each of three different external environments--relative stability, a sharply lower trend in world prices for the major agricultural products, and a situation where the real exchange rate depreciates as a result of a reduction of the price of a major non-agricultural export good--such as oil in Indonesia.

Assumptions

The variables chosen to be varied under different policy scenarios include:

- domestic commodity prices in real terms
- fertilizer price, relative to world price.

The variables that are assumed to change with external events are:

- world prices of commodities in nominal dollars

equilibrium exchange rate as influenced by the prices of major export products.

All other variables in the assumptions table are considered invariable with respect to policy scenarios.

The values of the assumptions are shown in Table 7. The three strategies are characterized by their domestic price policies on farm commodities, on fertilizer prices, and consumer prices for commodities. The three scenarios are distinguished by different world price trends and alternate exchange rate behavior. The nine combinations of internal and external variables represent a "test" of the model.

The self-sufficiency strategy is illustrated by a policy of price increases of two percent for rice--the principal staple food--irrespective of what happens to world prices and real exchange rates. The fertilizer subsidy is, however, assumed to increase with an exchange rate depreciation, so as to protect domestic farmers from the price increase. Consumer prices for rice also move independently of external conditions and maintain their same relationship with producer prices. In contrast to the rice price, the price of cassava is assumed to follow the world price, and the price of corn is assumed to fall in real terms relative to world prices, indicating a policy of reducing incentives to this export crop.

The self-reliance strategy is illustrated by a policy of moving commodity prices to the "trend" or long-run world price levels, removing subsidies on fertilizer, and allowing consumer prices to change with world and farm level prices. This strategy means that variations in world price trends influence domestic

Table 7

Assumptions Made in Three Different Alternative Strategies (A, B and C) Under Three Different Scenarios (1, 2, and 3)

Variable	A. Self-Sufficiency			B. Self-Reliance			C. Trade Dependence		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Rice price	+2	+2	+2		to		-2	-5	-2
Cassava price	0	-3	0		trend		0	-3	0
Corn price	-2	-5	-2		world price		+2	+2	+2
Fertilizer subsidy	constant	constant	+50%	remove	remove	remove	remove	remove	remove
World price									
Rice	+5	+2	+5	+5	+2	+5	+5	+2	+5
Cassava	+5	+2	+5	+5	+2	+5	+5	+2	+5
Corn	+5	+2	+5	+5	+2	+5	+5	+2	+5
Offical exchange rate = PPP rate	PPP	PPP	-50%	PPP	PPP	-50%	PPP	PPP	-50%
Consumer price									
Rice	+2	+2	+2		to		-4	-4	-4
Cassava	0	-3	0		trend		0	-3	0
Corn	-2	-5	-2		world price		+2	+2	+2

Numbers indicate percent change each year, 1986-1990

PPP = Purchasing Power Parity (i.e., constant real exchange rate)

prices, as do real exchange rate shifts. Some minor subsidies on pesticide use are assumed to remain.

The trade-dependence strategy involves decreases in the producer price of rice, following the world price. The consumer price is assumed to decrease at a somewhat faster rate--to benefit urban consumers--but not to vary with world prices. In nominal terms, the consumer rice price rises one percent per year. Corn prices are assumed to increase relative to world prices--reflecting an attempt to stimulate exports and also to be unresponsive to world price and exchange rate changes. The strategy is, in other words, committed to stable and favorable prices for cash-crop producers and staple-crop consumers. As with the self-sufficiency strategy, cassava policy is assumed to be neutral.

These policies are assumed to diverge from 1986 to the end of the decade. The historical period is identical in all nine cases. By 1990 the rice price to producers varies from 164 Rp per kg (in 1982 prices) under a trade dependence strategy with falling world prices to 350 Rp per kg under self-reliance and a sharp fall in the exchange rate. The internal fertilizer price ranges from 95 Rp per kg (in 1982 prices) under the self-sufficiency strategy to 164 Rp under the assumption of falling exchange rates. Consumer rice prices are highest under self-reliance and the depreciation of the rupiah and lowest under the urban-oriented trade dependence strategy.

Market Balance

The assumptions described above are fed into both the individual system budgets and the "elasticity" model. This model calculates a new market balance (production, consumption, stocks, and trade) for the three commodities for each of the projection years. The elasticities used are simple own-price and cross-price parameters assumed to take effect in one year. In addition, an income elasticity on the demand side and a technology shifter on the supply side represent changes in market balance that would occur at constant real prices. These assumptions are given in Table 8.

In addition to calculating the market balance, the "elasticity" model also analyzes welfare changes along the lines of the discussion in Section A. The market balance approach was discussed at the beginning of the present section. To carry out this approach one needs an algorithm for calculating the social costs and benefits on the basis of the market balance estimates and the elasticities. A linear approximation method was used here, which involved estimating the area under the demand and supply curves as if they were made up of two linear segments--from the actual quantity produced or consumed along the supply or demand curves until a point where it is assumed that production or consumption ceases, and then from that point to the price axis. This is illustrated in Figure 10. The artifact of a "maximum price" above which consumption ceases and a "minimum price" below which production ceases has the desired effect of putting a bound on consumer benefits, which might otherwise appear disproportionately large with a low elasticity of demand,

Table 8

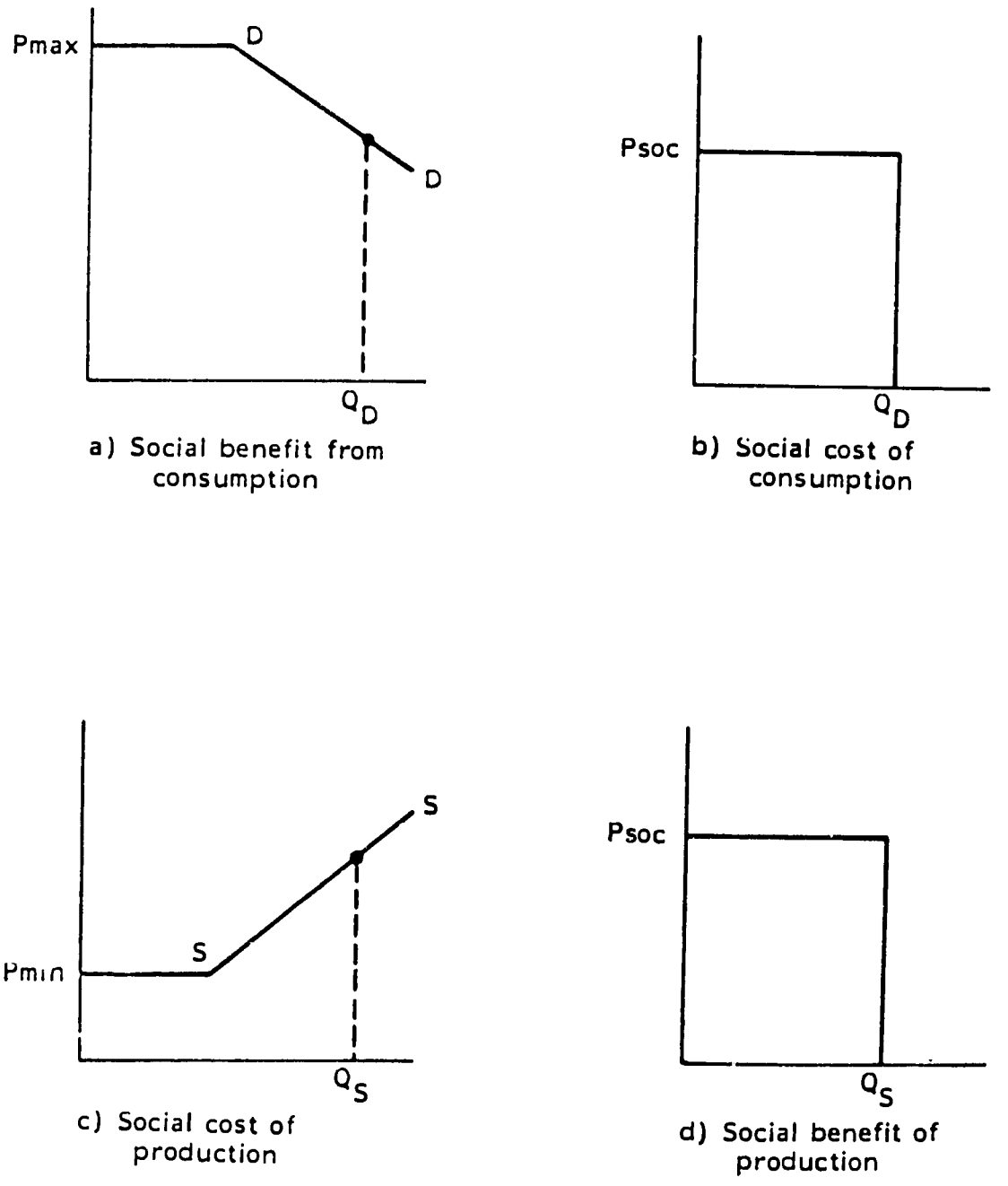
Elasticity Assumptions Used in
Market Balance Model

	Demand Elasticity with Respect to:				
Demand for:	Rice Price	Cassava Price	Corn Price	Other Prices	Income
Rice	-0.35	0.05	0.10	0.00	0.20
Cassava	0.05	-0.30	0.10	0.20	-0.05
Corn	0.10	0.10	-0.25	0.15	-0.10

	Supply Elasticity with Respect to:			
Supply of:	Rice Price	Cassava Price	Corn Price	Technol
Rice	0.25	0.00	-0.05	0.50
Cassava	0.00	0.10	0.00	0.50
Corn	-0.05	0.00	0.20	0.50

FIGURE 10

Illustration of Method of Calculating Social Values and Costs of Production and Consumption



and of avoiding the problem of implausibly low initial costs apparently implied by an inelastic supply curve. The linear approximation of the underlying marginal social benefit and marginal social cost curves serves to give a rough indication of relative welfare effects, but should not be taken as an exact measure.

Budget Data for Agricultural Systems

Two criteria dictate the choice of Indonesian agricultural systems to be used to illustrate the "budget data" model. One criterion is the availability of detailed budget information on the costs of production, processing, and marketing and on the prices of paddy (unmilled or "rough" rice) and of rice (milled rice) throughout the system (cif or fob, wholesale, ex-mill, and farmgate). The Central Bureau of Statistics (BPS) gathers data on farm level costs through sample surveys throughout Indonesia; these data are aggregated according to province and technology. The most recent survey, covering crop year 1982, is reported in Cost Structure of Farms, Paddy and Palawija, 1982. In addition, the Food Research Institute, Stanford University, recently carried out in-depth field research in Indonesia on cassava (1979-81) and on corn (1983-85), and the results included detailed information on farming and marketing costs and technologies. These data are reported in Walter P. Falcon, William O. Jones, Scott R. Pearson and others, The Cassava Economy of Java, Stanford University Press, 1984 and in C. Peter Timmer (ed.), The Corn Economy of Indonesia, Cornell University Press, forthcoming.

The second criterion for system choice concerns the purpose of the analysis. If, for example, the purpose were to carry out a complete study of Indonesia's food economy, one would hope to include systems that represent all principal agro-climatic zones and technologies of production. In this paper, the purpose is much less ambitious: to illustrate both the elasticity and the budget data approaches to measuring the effects of alternative food strategies in the context of recent and projected policy circumstances in Indonesia.

To this end, different coverage is given to the three food staples--rice, corn, and cassava. For all three commodities, aggregate analysis is carried out using the elasticity approach. For cassava, only one aggregate agricultural system is analyzed in this paper; in light of the paucity of government policy impacts on cassava production, relatively little is gained by complementing the elasticity approach with the disaggregated budget data approach. For corn, only three agricultural systems are defined to demonstrate the often-confronted situation of limited data. Finally, for rice, twelve separate systems are included in the model to approximate the situation of more complete data--and to reflect the greater importance of rice in the Indonesian food economy. In sum, the selection of systems is done to illustrate three situations--an elasticity approach with only one budget (cassava), a mixed elasticity and budget data approach with limitations on system coverage (corn), and a full budget data approach with sufficient information to permit a high degree of disaggregation (rice).

Twelve rice systems are included in the analysis. These systems are stratified according to location (four geographic regions--East Java, Central Java, West Java, and Sumatra) and technology (three technologies--high yielding variety package, irrigated (HYV), traditional variety package, irrigated (TYV), and traditional variety package, non-irrigated (upland)). Together, these 12 systems accounted for 75 percent of Indonesian rice hectarage harvested and an even larger share of the country's total rice production in the 1982 crop year (March 1982-February 1983). The three corn systems are: high productivity, multiple corn crop, non-irrigated (East Java); low productivity, multiple corn crop, non-irrigated (South Sulawesi); and high productivity, multiple corn crop, irrigated (East Java). Together they represented about two-thirds of area planted to corn in 1982 and a somewhat larger share of corn output in that year.

The budget data for all 16 systems are reported in Tables 9 and 10. The tables contain information based on farm and post-farm surveys for 1982, the base year of the analysis. The principal data requirements for the budget-based analysis are farm level data on input quantities and prices, imputed land rent, output yields and prices, and post-farm level data on marketing margins. All of these data inputs are included in the budget tables. The information on rice systems was collected by Indonesia's Central Bureau of Statistics and that on corn and cassava by Stanford's Food Research Institute. Details n sources of data are contained in Annex 3. For the rice systems,

Table 9

Budgets for Indonesian Rice Systems 1982

	Rice 1	Rice 2	Rice 3	Rice 4	Rice 5	Rice 6	Rice 7	Rice 8	Rice 9	Rice 10	Rice 11	Rice 12
Input quantities												
Labor, days	196	138	131	49	118	115	64	17	91	61	56	11
Bullock, pr. days	4	3.3	4.7	1	4	0.5	1	0.7	1	0.7	1.7	0.2
Tractor, days	0.1	0.02	0.02	0.3	0.003	0	0	0.01	0.01	0.001	0	0.01
Fertilizer, kg	297	317	345	252	8	41	54	11	100	121	172	21
Seed, kg	35	39	41	41	38	42	38	37	39	39	38	36
Pesticide, kg	3	3	2	3	0.2	0.7	0.1	0.8	0.6	0.5	0.7	0.5
Domestic input prices												
Labor, Rp/day	800	800	800	800	800	800	800	800	800	800	800	800
Bullock, Rp/day	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Tractor, Rp/day	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
Fertilizer, Rp/kg	80	80	80	80	80	80	80	80	80	80	80	80
Seed, Rp/kg	525	275	292	271	215	165	246	209	211	201	209	206
Pesticide, Rp/kg	848	848	848	848	848	848	848	848	848	848	848	848
Total cost, Rp/ha	271,098	222,292	266,188	142,799	158,601	158,466	155,099	51,702	118,599	101,011	97,178	34,883
Domestic factor												
1) Labor	156,800	110,400	104,800	39,200	94,400	92,080	51,200	13,600	74,400	50,400	43,200	8,800
2) Bullock	9,400	7,755	11,045	2,350	9,400	1,175	2,350	1,645	2,350	1,645	3,995	470
3) Tractor	11,000	2,200	2,200	33,000	110	0	0	1,100	1,100	110	0	1,100
Tradable inputs												
1) Fertilizer	23,760	25,360	27,600	20,160	640	3,440	4,320	800	8,000	9,680	13,760	5,680
2) Seed	18,375	8,775	12,556	11,653	8,930	6,930	9,348	7,733	8,307	7,839	7,942	7,415
3) Pesticide	2,544	2,544	1,696	2,544	170	594	85	678	509	424	594	424
Interest on working capital	9,219	6,525	6,644	4,525	4,731	4,327	2,796	1,065	3,933	2,913	2,887	993
Imputed land rent	40,000	58,734	99,847	29,367	40,000	50,000	85,000	25,000	20,000	30,000	25,000	10,000
Total output value (Rp/ha)	409,838	434,304	602,140	368,928	411,656	322,876	318,636	309,308	195,570	183,744	191,040	161,184
Output price paddy (Rp/kg)	95	96	96	96	106	106	106	106	106	96	96	96
Yields, kg/ha	4,299	4,524	4,965	3,843	3,031	3,046	3,006	2,918	1,845	1,914	1,990	1,679
Profit (Rp/ha)	138,740	212,012	335,752	226,129	253,055	164,410	163,537	257,606	76,971	80,733	93,662	126,301
Marketing Margins												
Labor	71	70	70	70	55	55	55	55	55	70	70	70
Capital	32	32	32	32	25	25	25	25	25	32	32	32
Fertilizer, Rp/kg	39	39	39	39	30	30	30	30	30	39	39	39
Seed, Rp/kg	10	10	10	10	10	10	10	10	10	10	10	10
Pesticide, Rp/kg	10	10	10	10	10	10	10	10	10	10	10	10
	10	10	10	10	10	10	10	10	10	10	10	10

Rice system 1: HYV Java Barat, 1 crop per year.
Rice system 2: HYV Java Tengah, 1 crop per year.
Rice system 3: HYV Java Timur, 1 crop per year.
Rice system 4: HYV Sumatra, 1 crop per year
Rice system 5: LYV Java Barat, 1 crop per year
Rice system 6: LYV Java Tengah, 1 crop per year
Rice system 7: LYV Java Timur, 1 crop per year
Rice system 8: LYV Sumatra, 1 crop per year
Rice system 9: Dryland Java Barat, 1 crop per year
Rice system 10: Dryland Java Tengah, 1 crop per year
Rice system 11: Dryland Java Timur, 1 crop per year
Rice system 12: Dryland Sumatra, 1 crop per year

Table 10

Budgets for Indonesian Corn and Cassava Systems, 1982

(Annual per hectare vales, seasons aggregated)

	Corn 1	Corn 2	Corn 3	Cassava
Input quantities				
Labor, days	162	223	147	35
Bullock, pr. days	46	43	5	0.3
Fertilizer, kg.	950	1,124	110	27
Seed, kg.	67	200	25	22
Pesticide, kg.	1.35	2	0	0.05
Domestic input prices (farmgate)				
Labor, Rp/day	800	700	1,000	660
Bullock, Rp/day	1,920	2,720	2,000	2,475
Fertilizer, Rp/kg	80	80	80	80
Seed, Rp/kg	120	120	80	130
Pesticide, Rp/kg	848	848	848	848
Total Cost, Rp/ha	415,546	487,052	210,012	70,106
Domestic factors				
1) Labor	129,600	156,100	147,000	23,100
2) Bullock	88,320	116,960	10,000	743
Tradable inputs				
1) Fertilizer	76,000	89,920	8,800	2,160
2) Seed	8,040	24,000	2,000	2,860
3) Pesticide	1,145	1,696		42
Working capital	12,594	16,149	6,972	1,201
Imputed land rent	99,847	82,227	35,240	40,000
Total output value (Rp/ha)	395,178	550,830	177,830	97,544
Output price at farm (Rp/kg)	105	105	105	10
Yields, kg/ha	3,764	5,246	1,694	9,837
Profit (Rp/ha)	-20,368	63,778	-32,182	27,438
Marketing margins				
Corn 1	23	23	23	32
Labor	10	9	9	9
Capital	13	14	14	14
Fertilizer	10	10	10	10
Seed	10	10	10	10
Pesticide	10	10	10	10

Corn system 1: High productivity irrigated sawah. (Kediri, monoculture, 2 crops pa).

Corn system 2: High productivity tegalan system. (Malang, monoculture, 3 crops pa).

Corn system 3: Low productivity tegala system. (Bone, monoculture, 2 crops pa).

the critical technical relationships between input levels and yields need further verification through disaggregated field tests before they can form the basis for convincing policy analysis. But the data reported are sufficient to permit illustration of the budget-based analytical approach.

Policy Analysis Matrices for Agricultural Systems

As described in Section B, the budget data for each agricultural system and year are then used as inputs into the construction of policy analysis matrices (PAMs). The PAMs for all 16 systems, based on the assumptions of a self-reliant strategy and a stable international environment, are reported in Annex 4. The PAMs for the first rice system (Rice 1, HYV, West Java) are shown in Table 11. The budget data in the first column of Table 9 are carried over to the top part of Table 11 and reported as the receipts, costs, and profits for 1982 in private (actual market) prices at the farmgate.

The three remaining parts of Table 11 (and of all the PAM tables) together constitute the PAMs at the system level, that is, including costs of farming, processing, and transportation to the wholesale market and returns in that market. The entries are exactly as explained in Section B, except that they are arrayed in columns rather than laid out in matrix format. For example, the column for 1982 in the second part of Table 11, entitled Private Prices (system), is the top row in the PAM matrix for system Rice 1 in 1982; private profits for that year were Rp 180,789 per hectare. The results presented directly beneath in the third part of Table 11, labeled Social Prices (system) are the second row in the PAM for Rice 1 in 1982; social prices for

Table 11
Policy Analyses Matrices for One Indonesian Rice Strategy Under a Self-Reliant Strategy and a Stable International Environment, 1980-1990
(Rp/ha)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRIVATE PRICES (farmgate)											
Receipts	370397	401348	409838	469114	452422	429988	504499	514589	524880	535378	546086
Costs	227901	236602	231098	233363	237061	252454	249484	249484	249484	249484	249484
DF											
Labor	156800	156800	156800	156800	156800	156800	156800	156800	156800	156800	156800
Capital	22690	32639	29619	27789	30869	35250	32280	32280	32280	32280	32280
TI											
Fert	27324	25839	23760	27027	27621	35528	35528	35528	35528	35528	35528
Seed	18375	18375	18375	18375	18375	18375	18375	18375	18375	18375	18375
Pest	2712	2949	2544	3372	3396	6501	6501	6501	6501	6501	6501
Profits	142496	164746	178740	235751	215361	177534	255014	265104	275396	285894	296601
(Land)	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000
PRIVATE PRICES (system)											
Receipts	568654	603768	616391	680054	667449	649158	728382	742950	757809	772965	788424
Costs	424306	437015	435602	441957	449826	469475	470845	475273	479788	484394	489093
DF											
Labor	245182	246986	248827	250667	252544	254459	256412	258405	260437	262510	264624
Capital	130713	142866	142096	142516	147890	154612	154029	156464	158947	161481	164065
TI											
Fert	27324	25839	23760	27027	27621	35528	35528	35528	35528	35528	35528
Seed	18375	18375	18375	18375	18375	18375	18375	18375	18375	18375	18375
Pest	2712	2949	2544	3372	3396	6501	6501	6501	6501	6501	6501
Profits	144348	166752	180789	238097	217623	179683	257537	267677	278021	288571	299332
(Land)	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000
SOCIAL PRICES (system)											
Receipts	933430	998551	636047	615718	607255	608074	728382	742950	757809	772965	788424
Costs	448947	479486	462669	456297	455290	466787	470815	475243	479758	484364	489063
DF											
Labor	245182	246986	248827	250667	252544	254459	256412	258405	260437	262510	264624
Capital	130713	142866	142096	142516	147890	154612	154029	156464	158947	161481	164065
TI											
Fert	49421	65258	47875	39224	30884	33280	35528	35528	35528	35528	35528
Seed	18375	18375	18375	18375	18375	18375	18375	18375	18375	18375	18375
Pest	5257	6001	5497	5515	5598	6061	6471	6471	6471	6471	6471
Profits	484482	519065	173378	159420	151965	141287	257567	267707	278051	288601	299362
EFFECTS OF POLICY (system)											
Output policy transfer	-364776	-394784	-19657	64336	60194	41085	0	0	0	0	0
Factor policy transfer											
Labor trans.	0	0	0	0	0	0	0	0	0	0	0
Capital trans.	0	0	0	0	0	0	0	0	0	0	0
Tradable input policy transfer											
Fert. trans	-22097	-39419	-24115	-12197	-3263	2249	0	0	0	0	0
Seed trans	0	0	0	0	0	0	0	0	0	0	0
Pest. trans	-2545	-3052	-2953	-2143	-2202	440	30	30	30	30	30
Net policy transfer	-340134	-352313	7411	78676	65658	38396	-30	-30	-30	-30	-30

that year were Rp 176,952 per hectare. The bottom row of the PAM for Rice 1 in 1982 is given in the fourth part of Table 11, called Effects of Policy (system); the net policy transfer--the difference between private and social profits--was Rp 3,837 per hectare, because subsidies on purchased inputs (fertilizer and pesticides) more than offset the taxing effect of setting the domestic rice price below the comparable world price. Since any PAM applies to a single system in a given year, the tables for each system contain 11 PAMs, pertaining to the years 1980 through 1990. The results are presented in columns rather than matrices in order to save space.

As pointed out in Section B, the PAMs provide three kinds of results--measures of competitiveness at actual market prices (private profitability), efficiency or comparative advantage at world prices (social profitability), and the taxing or subsidizing effects of policies affecting output or input prices (net policy transfer). The results in the PAM tables show that Indonesia has a strong comparative advantage in producing rice in diverse agro-climatic zones and with differing technologies. Rice production is highly profitable, in both social and private valuations, for the eight irrigated systems, especially for those using Green Revolution technology (the first four, labeled HYV), and much less so, but still positive, for the four rainfed systems (the last four, labeled dryland). At the farm level the private profits of all rice systems far exceed the levels of imputed land rents, indicating that rice is substantially more profitable than alternative crops.

For cassava, an aggregated system that is meant to approximate a nation-wide average, both private and social profits are also very large. The three corn systems differ in profitability. The two East Java systems show positive private profits that are projected to grow with the increasing dissemination of improved seeds, but the low productivity system in South Sulawesi has negative private profits in 1983 and 1984 and is projected to cover its imputed land rent only by the end of the decade. All three corn systems are seen to overcome a mixed pattern of results on social profits in the early 1980s and to exhibit future comparative advantage--under the assumption of stable world prices and exchange rates.

A main advantage of the PAM approach is its demonstration of the effects of commodity and macro policies on agricultural systems. For Indonesian rice systems, in the first half of the 1980s the rapidly falling world price of rice combined with policy decisions to raise floor prices to producers to create a large switch in output policy transfer. In 1980 and 1981, the domestic rice price to farmers was much less than the then very high world price of rice, causing a large tax on rice production (for example, Rp 364,776 per hectare for Rice 1 in 1980, as shown in Table 11). But by 1984, the world price had dropped a great deal and the domestic floor price had been raised causing the Indonesian rice price to exceed the world price (for example, leading to a tax of Rp 60,194 per hectare for Rice 1 in Table 11). This huge shift caused the net policy transfer to change in tandem, because price policy on rice output created much larger

transfers than did the subsidies on fertilizers and pesticides. For the cassava and corn systems the effects of policy are much less marked because of a lesser degree of policy intervention and more stable world prices then occurred with rice. The projected effects of policy are close to zero for all three commodities because the PAM tables reported here are those for the self-reliant strategy.

Model Results

The model generates intermediate results in a number of forms, including the policy effects calculations for each system and the market balance estimates of the elasticity model. These include useful detail that can guide the analyst to policy problems and interpret more aggregated results. For the model to measure the performance of alternative strategies one needs to condense the considerable quantity of information generated into a form that can be easily assimilated. Simplification in this section occurs in two stages: first, a summary of the results over time for each commodity sub-model (including the elasticity model); and, second, a comparison for three individual years of the three different strategies. The reader is referred to Annex 5 for the more extensive summary tables that lie behind these abbreviated versions.

The system results in the Annex include private and social profits per hectare from the budget analysis. By making assumptions of available hectares for each system, it is possible to estimate the areas that would stay in production under various price regimes. The convention used here is that only systems that are privately profitable stay in production. The hectares

used therefore include the hectares available from all the privately profitable systems. Multiplying the hectares used by the social profit per hectare for each system gives the social profit generated from production of that commodity. This profit can be added across commodities. The results of this calculation are shown in Table 12 for each of the nine cases--three strategies under three scenarios.

The other main output from the budget analysis is the net policy transfers, the difference between private profit and social profit. A positive transfer implies a subsidy from the aggregate effects of output, input or factor prices, and a negative transfer represents a net tax. If world prices rise sharply but domestic prices are kept down, for example, a tax--or negative transfer--results. Private profit will be less than social profit. Multiplying the per-hectare net policy transfer from the budgets by the "hectares used," as discussed above, given the net policy transfer for a commodity. This can also be aggregated across commodities. Table 12 also includes this measure for each of the nine cases.

It has been emphasized that the budget approach and the market balance (or elasticity) approach are complementary to each other. The summary table (Table 12) also includes the "bottom line" results from the elasticity model. The net social benefit from production corresponds to the surplus of social benefit over social cost at the projected output. It corresponds to the social profit from the budget approach. The net social benefit from consumption is the surplus of benefit over cost at projected

Table 12

Summary of Social Profits and Transfers Under Alternative Strategies and External Environments, Various Years, '000 Billion Rps, 1983

	SELF-SUFFICIENCY			SELF-RELIANCE			TRADE-DEPENDENCE		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
				Social Profit from Production					
1986	2.34	2.14	4.84	2.75	2.59	5.58	2.75	2.59	5.58
1988	2.43	1.94	5.01	2.87	2.38	5.79	2.87	2.38	5.79
1990	2.53	1.74	5.18	3.00	2.16	6.01	3.00	2.16	6.01
				Total Policy Transfers to Producers					
1986	0.32	0.44	-2.18	-0.01	-0.01	-0.01	-0.36	-0.50	-3.31
1988	0.49	0.84	-2.08	-0.01	-0.01	-0.01	-0.50	-0.58	-3.54
1990	0.68	1.26	-1.97	-0.01	-0.01	-0.01	-0.64	-0.64	-3.78
				Net Social Benefit from Production					
1986	3.18	2.99	6.62	3.72	3.52	7.64	3.70	3.51	7.38
1988	3.27	2.68	6.85	3.83	3.21	7.87	3.80	3.18	7.56
1990	3.37	2.36	7.08	3.95	2.91	8.10	3.90	2.85	7.75
				Net Social Benefit from Consumption					
1986	7.72	7.84	4.68	7.28	7.45	4.28	7.36	7.53	3.91
1988	7.77	8.17	4.74	7.36	7.87	4.33	7.45	8.00	3.87
1990	7.82	8.47	4.79	7.43	8.30	4.37	7.53	8.47	3.83
				Net Social Benefit, Total					
1986	10.90	10.83	11.30	11.00	10.97	11.92	11.06	11.04	11.29
1988	11.04	10.85	11.58	11.19	11.09	12.19	11.25	11.17	11.44
1990	11.18	10.83	11.87	11.38	11.21	12.47	11.43	11.32	11.58

(1) = stable external environment
(2) = lower world commodity prices
(3) = fall in terms of trade

demand levels. There is no analogy in the budget approach, although conceptually one could collect household budgets and estimate "profits" from the consumption activity for different household situations. Net social benefit from consumption and production combines the producer and consumer effects and hence is useful when comparing strategies.

The comparison across strategies is shown in Table 12 for the years 1986, 1988 and 1990. The differences among the strategies show up clearly in the "net transfers" involved in price policy. Net transfers to agriculture under the self-sufficiency strategy with stable world prices become large when matched against falling world prices. The benefits from these transfers, relative to a self-reliance strategy where prices follow world market trends, are elusive. Social profit from production is considerably less because of over-employment of domestic resources and the lower world prices associated with the export of rice. This same effect makes social benefits greater; consumers potentially benefit from the lower social prices, but less than enough to offset the loss on production. Trade-dependence and self-reliance come out somewhat alike under stable world prices because rice production remained profitable in all systems even with lower domestic prices. Differences in welfare effects under the elasticity approach between these two systems were too small to measure.

The differences among the strategies begin to show up more significantly in the case where the exchange rate depreciates because of an assumed fall in the terms of trade. Under these circumstances the self-reliant strategy generates considerably

more social benefits than either of the other two--despite the greater consumer benefits from lower rice prices in the self-sufficiency case. As would be expected, self-reliance prevents the costly misalignment of prices which is the main drawback of both the self-sufficiency and trade-dependence strategies.

ANNEX 1

SOURCES OF DATA

1. Budget data on the three corn technologies

   Input quantities

   Input prices

   Yields

   The Corn Economy of Indonesia, Chapter 2, "Corn Production," by Stephen Link, published June, 1985.

2. Budget data on the 12 rice technologies

   Input quantities

   Input prices

   Yields

   BPS, 1982 data

3. Aggregate consumption

   Buku Saku, Statistik Indonesia 1984 (Statistical Pocketbook of Indonesia), published by Biro Pusat Statistik, Jakarta, Indonesia.

4. Aggregate production

   Same source as No. 3 (Statistical Pocketbook of Indonesia).

5. Inflation

   Unpublished thesis by Paul Dorosh. Submitted November 1985, Food Research Institute, Stanford University, Stanford, California.

   Notes: Elasticity estimates: (a) demand elasticities based on Susenas Data, (b) supply elasticities based on Paul Dorosh's time series estimates.

6. Exchange rates (nominal and real)

   See Source No. 5

7. Elasticities

   See source No. 5

8. International prices for corn, rice, cassava

Taken from Food and Agricultural Organization Yearbook, Volume 37, 1983 and adapted to the Indonesian quality and fob or cif status.

9. International price for fertilizer

Food Outlook, published by Food and Agricultural Organization (various issues).

10. Stocks (rice, corn)

Leon Mears, "Food/Rice Price Stabilization in Indonesia"

11. Floor prices (rice, corn)

(wholesale prices)

Same as source No. 10

12. Population , current and projected

"The Outlook for Indonesian Rice Consumption, 1985-1990" by C. Peter Timmer.

13. Real income, current and projected

Same as source No. 12

14. Land values

Figures adapted from those in The Cassava Economy of Java, by W.P. Falcon, W.O. Jones, S.R. Pearson and others, Stanford University Press, 1984.

15. Marketing (wholesale to farmgate)

Same source as No. 14

ANNEX 2

SOFTWARE DOCUMENTATION*

The program that calculates the costs and benefits of alternative strategies is a set of spreadsheet titles created on Lotus 1-2-3 (version 1A). It will run on an IBM-PC or XT, or any compatible machine with 256 RAM. A hard disk is preferable to speed up interchange of data among files. The program is contained on three disks with the following twelve files:

ASCOT11.WKS

ASCOT12.WKS

ASCOT13.WKS

ELAST1.WKS

CORN1.WKS

CASS1.WKS

RICEHYV.WKS

RICELYV.WKS

RICEDRY.WKS

ASCOT21.WKS

ASCOT22.WKS

ASCOT23.WKS

In addition a temporary file, ASCOT1, is created and used in any run of the program, but does not need to be stored.

---

*Software is available with the Bureau for Program and Policy Coordination, Office of Policy Development & Program Review, U.S. Agency for International Development, Washington, DC 20523

Figure A.1 shows the relationship among these files and illustrates the steps in running the program. Files ASCOT11, 12, and 13 contain the assumptions--one file for each scenario--as follows:

ASCOT11 - stable external environment

ASCOT12 - lower world commodity prices

ASCOT13 - fall in terms of trade

Each file contains the three strategies. The assumptions are read into the commodity files by invoking a macro when in the appropriate file. The commodity files can only contain the data for one strategy and one scenario at a time. The "process," the assumptions and yield summary tables. If more detail is needed than is contained in the summary tables, then it can be retrieved from these commodity tables directly, after reading in the appropriate assumptions with the macro.

The commodity files are as follows:

ELAST1 - market balance approach, all three commodities

CORN1 - three corn systems

CASS1 - one cassava system

RICEHYV - four high-yielding rice systems

RICELYV - four low-yielding rice systems

RICEDRY - four dryland rice systems

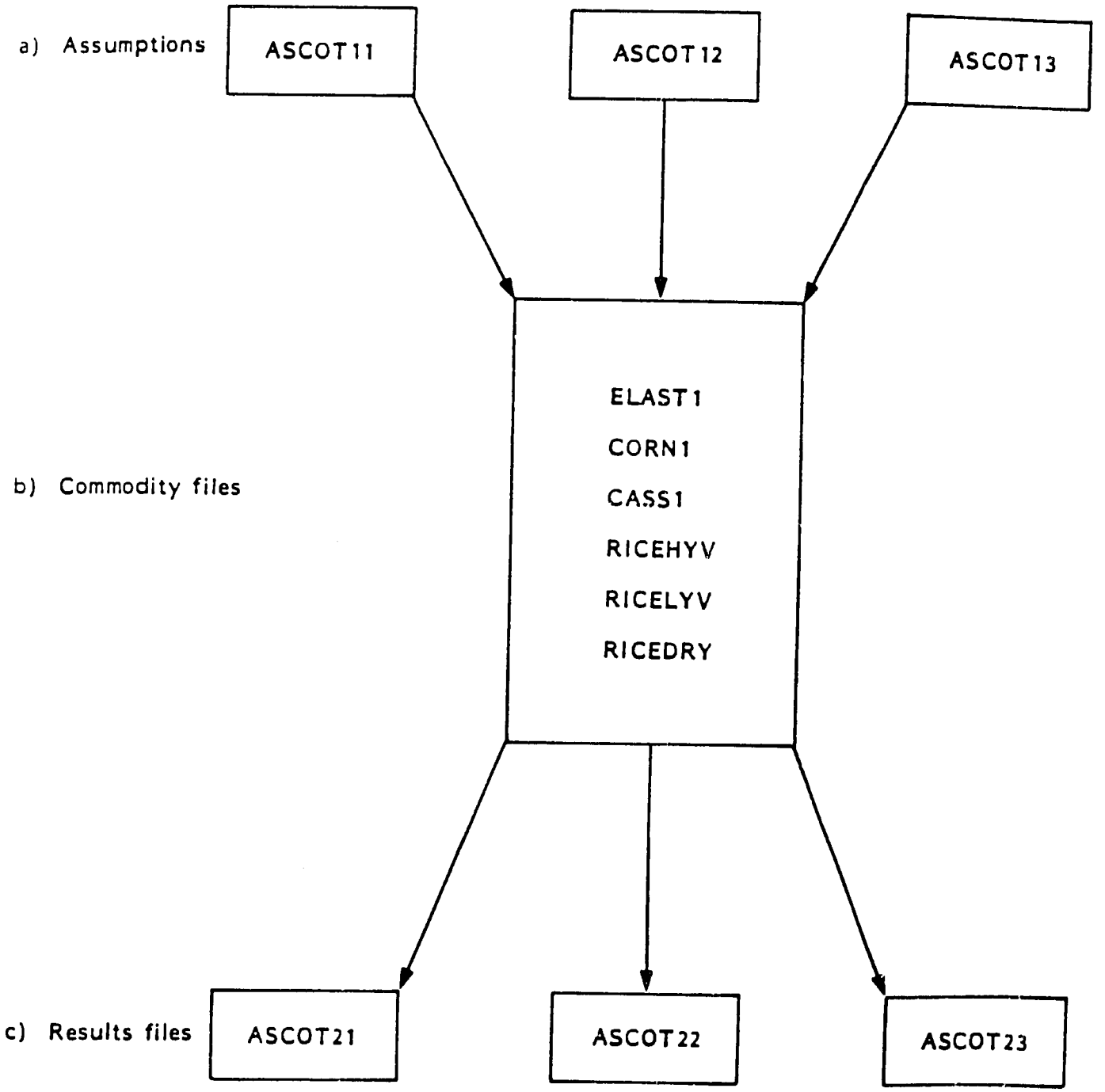
For each scenario there is also a summary file, ASCOT21, 22, and 23, corresponding to the three sets of assumptions.

ASCOT21 - stable external environment

ASCOT22 - lower world commodity prices

ASCOT23 - fall in terms of trade

Figure A.1 Schema for Spreadsheet Model, Showing Relationship Among Files



These files read, by invoking macros, the summary tables from the commodity files, and in turn prepare a "summary of summaries" and a "comparison across strategies." All files contain macros to print out appropriate files.

As each commodity file contains only one combination of strategy and scenario at a time--in order to keep the size manageable--to construct a summary file corresponding to a particular assumption set requires an iterative process as follows:

- enter assumption set in ASCOT file - ASCOT11, 12, or 13.
- save as ASCOT1 (since this is the file name recognized by the macros in the other files)
- retrieve LLAST1 file and invoke macro A, B, or C, depending upon the strategy, and save
- retrieve CORN1 file and invoke macro A, B, Or C, and save
- retrieve CASS1 file and invoke macro A, B, or C, and save
- retrieve RICEHYV file and invoke macro A, B, or C and save
- retrieve RICELYV file and invoke macro A, B, or C and save
- retrieve RICEDRY file and invoke macro, A, B, or C and save
- retrieve summary file, ASCOT21, 22, or 23, depending upon the assumptions file chosen, and invoke macro A, B, or C depending upon strategy
- print summary tables with macros P, Q, or R, depending upon strategy, macro X for summary of summaries, and macro Y for comparison tables.

More detail of the construction of the files is given in the figures A.2.A to A.2.D. This figure shows the areas within each spreadsheet that contain data, budgets, analysis and summary

Description of Files and Ranges

Figure A.2.A. Assumption File

ASCOT11	Strategy One	Strategy Two	Strategy Three
	Macro econ		
	Domestic prices		
	World prices		
	Yields		

ASCOT12 similar to ASCOT11 but with falling world prices for commodities

ASCOT13 similar to ASCOT11 but with deteriorating terms of trade.

Figure A.2.B. Market Balance Approach

ELAST1

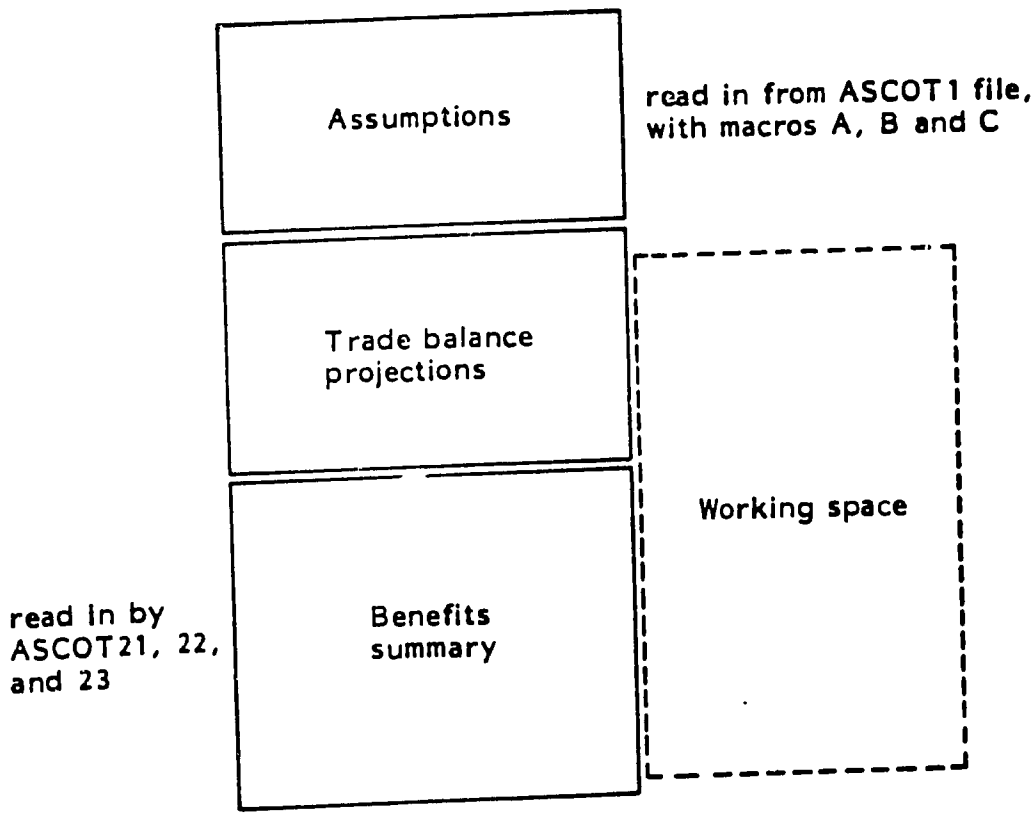


Figure A.2.C. Budget Data Approach

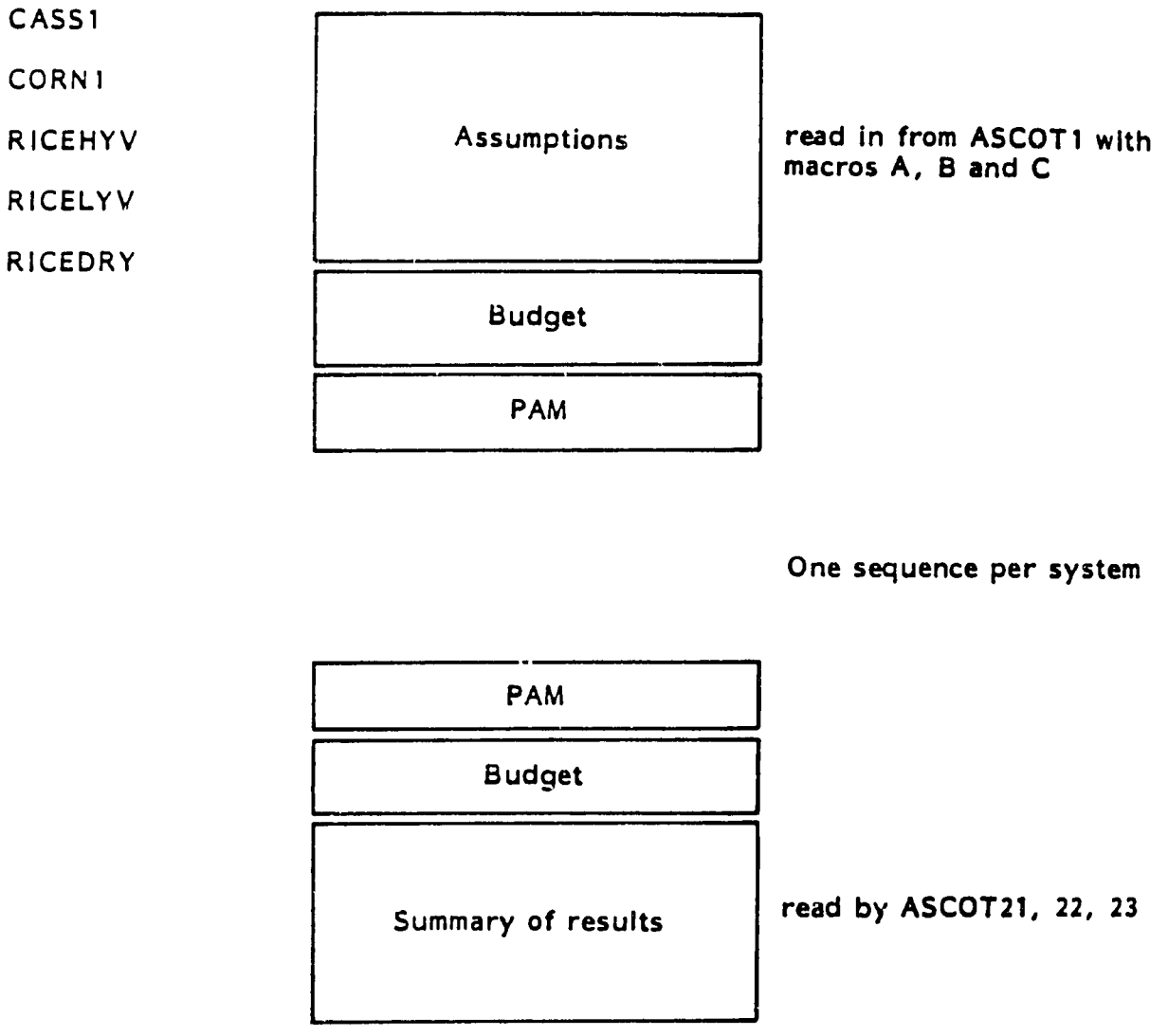


Figure A.2.D. Summary and Comparison

ONE	TWO	THREE	
Summary ELAST			read in from ELAST1
CASS			read in from CASS1
CORN			read in from CORN1
RICEHYV			read in from RICEHYV
RICELYV			read in from RICELYV
RICEDRY			read in from RICEDRY
Summary of summaries			
Comparison 1986	1988	1990	

ASCOT22 - as ASCOT21 but using results initiated by ASCOT12

ASCOT23 - as ASCOT21 but using results initiated by ASCOT13

tables: it also shows the linkage among spreadsheets and the range names created for various sections. A user who wished to print other tables or make modifications to the program can do so by exploring the spreadsheets with the aid of this range name list. More details can be obtained from the authors. A listing of formulae for key parts of the spreadsheets is also available.

The total printed output from all nine combinations of strategy and scenario--including budgets--runs to about 500 pages. To keep to manageable proportions users are recommended to print initially only the following tables for each "run."

Table	File	#Pages	Macro
Assumptions	ASCOT11, 12, or 13	2	Alt P
Yield assumptions	ASCOT11, 12, or 13	1	Alt H
Trade Quant.	ELAST1	1	Alt T
Elasticities assumptions	ELAST1	1	Alt E
Budgets	CORN, RICEHYV, etc.	1	Alt P
PAMs	CORN, RICEHYV, etc.	1	Alt P
Summaries	ASCOT21, 22, or 23	6	Alt P,Q,Or R
Summary of summaries	ASCOT21, 22, or 23	1	Alt X
Comparison	ASCOT21, 22, or 23	1	Alt Y