Nutrition Intervention in Developing Countries

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Study V
CONSUMER FOOD PRICE SUBSIDIES

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Study VI
AGRICULTURAL PRODUCTION, TECHNICAL CHANGE, AND NUTRITIONAL GOALS

Prepared by the Harvard Institute for International Development

Prepared for
Office of Nutrition
Development Support Bureau
U.S. Agency for International
Development

Nutrition Intervention in
Developing Countries

Study V
CONSUMER FOOD PRICE SUBSIDIES

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FOREWORD

How do nutrition projects begin? How are specific interventions selected? Who makes the decisions and what is the rationale behind them?

Since such decisions relate to health or food policies of countries and have important implications for budgets, personnel and other resource allocations, it would be prudent that they be made only after careful study and analysis. Regrettably, this is not usually the case. More often than not, the choice is a subjective one.

Some interventions are undertaken because they seem "obvious." Since many others are doing it, it seems like the right thing to do, and there is unquestioned faith that it works. An approach may be fashionable at a given time period. A particular activity may be promoted by an external agency. There may be very attractive offers, such as free food or technical assistance, or a start-up grant.

To the degree that costs are considered, there is usually concern only with what funds are needed to cover immediate and direct costs. The indirect or hidden costs, which may be much greater, are overlooked. Project staff time may be charged to other budgets. The implications for an increased demand on energy or scarce materials may not be considered. There is a tendency to forget overhead costs such as those for the use of buildings or for heating, cooling, and lighting.

Social costs are even more often ignored. Some projects accelerate a change away from traditional practices such as breast-feeding or using natural foods or cultivating home gardens. A project may encourage a welfare mentality, reduce incentives to work, or create lasting demands for convenience foods where packaging and processing may forever raise the price of a food. Obsessed with political needs, decision makers may not be concerned with long-term consequences, such as the problem of terminating a popular service when it is no longer needed.

Too often these kinds of questions are not addressed, resulting in only marginal effectiveness for many projects. An apparently "good project," (that is, one which is scientifically sound, well organized, etc.), will bring disappointing results if it is aimed at a problem it is not designed to deal with. This in turn can lead to a dilemma of whether to continue a project while lacking confidence in it or to terminate it and admit failure. More often, projects go on and on without bringing results but without any objective evaluation or analysis.

Avoiding these problems requires accurate identification of problems, insightful analysis of causation, and a good understanding of interventions in terms of how they work, what they cost, what they achieve, what other consequences they bring, and what pre-conditions should be present before a particular intervention is selected.

To help deal with the question of intervention selection the U.S. Agency For International Development commissioned Harvard University to prepare this series of Special Studies dealing with supplementary feeding, nutrition education, formulated foods, food fortification, consumer price subsidies, agricultural production, and integrated programs. Together the separate pieces comprise a manual intended to provide guidance on selecting from alternative approaches to reach the pre-school child. We hope this effort contributes to improving the process of intervention selection, and thereby, to more effective prevention of malnutrition.

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Development
Washington, D.C. 20523

PREFACE

This study on consumer food price subsidies is part of a series of seven studies examining the major types of nutrition programs operating in developing countries. The companion volume on Agricultural Production and Nutritional Goals is closely linked to consumer subsidies and the reader is urged to review it in conjunction with this one. The remaining studies cover supplementary feeding, nutrition education, formulated foods, fortification, and integrated nutrition and primary health care programs.

The purpose of this series is to provide guidance to planners in developing countries and international development agencies on the nature and design of these major types of nutrition interventions. The lack of knowledge about intervention design, costs, and effectiveness was cited by the National Academy of Sciences in its 1976 World Food and Nutrition Study as a major impediment to efforts to reduce the malnutrition problem. Our series, which was prepared for the Office of Nutrition of the U.S. Agency for International Development, is an attempt to help close that knowledge gap.

We have tried to assess the "state of the art" of nutrition interventions through a review of published and unpublished literature, a mail survey of 200 nutrition projects in 64 developing countries, interviews with professionals from many disciplines and institutions involved in nutrition programming, and direct field analyses of selected nutrition programs. From these multiple sources and voluminous data, we have attempted to present a representative picture of each nutrition intervention. A commonly cited difficulty for planners, especially in developing countries, is ascertaining what is going on elsewhere and obtaining factual information on the many facets of designing a nutrition program. We have attempted to alleviate that problem by providing fairly complete, although not exhaustive, documentation and supporting references. Such attention to detail is needed when one is actually going through the intervention design process. However, not all readers will need to immerse themselves in this detail. To facilitate their use of the series, we have preceded each subsection with a set of Key Questions that are addressed therein. At the end of each subsection we have presented a short Summary of the major points covered. Both the Questions and Summary sections are blocked off to facilitate the reader's scanning the document and identifying those parts that are of most interest.

Despite our efforts for completeness and our intense desire to provide useful guidance, the relative paucity of reliable evaluative data on nutrition programs and the limitation of this work leave us far short of the ideal. It has not been possible to ascertain the quality of the data and research designs of most of the literature we have reviewed. Our analyses and suggestions should be viewed as tentative, subject to further verification. It is hoped that these documents will facilitate such future evaluative efforts and that this study and the others in the series will at least provide a reasonable base upon which others can build.

This study has benefited from the collaboration of many individuals. We appreciate the valuable comments of the Expert Review Panel used by the AID Office of Nutrition. The case study on the Pakistan ration shops was based on a survey carried out by the Nutrition Cell, Planning Division, Government of Pakistan, with assistance from AID/Washington. The case study on the Mexican subsidized milk distribution program was made possible through the collaboration of the Mexican National Institute of Nutrition and the government's milk company LICONSA.

Special thanks are owed to the efforts of Dr. Adolfo Chavez and his excellent staff who carried out the field study under the coordination of Catherine Overholt.

The document was enhanced by the administrative assistance of Sara Hazel, Melanie Mahin, and many other members of the HIID staff. The financial and technical support of the AID Office of Nutrition was also essential, as was the original vision of Dr. Martin Forman whose guidance and support was critical to the realization of this study.

On behalf of my colleagues and co-authors, I express our deep appreciation for the efforts of all the individuals and institutions who gave so generously to this undertaking. It is our fervent hope that this collective effort will assist others in addressing more effectively the pressing problems of global malnutrition.

James E. Austin
Project Director
Cambridge, Massachusetts

CHAPTER ONE

OVERVIEW*

I. INTRODUCTION

Purchasing power is well recognized to be one of the major determinants of nutritional status. A current objective of many governments is to reduce real prices faced by consumers in order to increase consumption of food. This increase in consumption is often of nutritional benefit, whether or not nutritional improvement is an avowed purpose of the price reduction.

Price interventions may take a number of forms. These include three kinds of direct subsidies paid by the government. Food producers, sellers, or consumers can be paid subsidies to make up the difference between a lower retail price and a higher wholesale or producer's price. The subsidy may be on the cost of distribution or on the cost of the food itself. In many countries subsidized foods are rationed as well, both to prevent demand from exceeding supply and to separate the subsidized from the open market.

Of course, rationing alone will lower the price of a scarce good from what it would be in an unrestricted market. Rationing without direct subsidy is one of a number of closely related policies which influence food prices either indirectly through supply, by regulating imports and exports and production incentives, or directly by imposing price ceilings or fixed marketing margins. These related policies may be considered implicit subsidies, in which the source of the subsidy is income forgone by the farmer or food entrepreneur.

This volume is primarily a consideration of food price subsidies and pricing policy. It is a discussion of key elements which should be considered in the design of such policies rather than a manual of how to implement them. Diversity of conditions such as balance of payments, income, income distribution, infrastructure, food tastes, availability of voluntary support organizations, managerial capacity, and experience with subsidies means that few generalizations can be made. Further, little technical or quantitative assessment of price subsidies has been conducted.

Government price policy has microeconomic consequences which affect the purchasing power of households. Price policy is also very closely bound up with macroeconomic policies regarding foreign trade, investment, intersectoral relationships, and aggregate demand. The macro- and micro-economic aspects of price policy are equally important to

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*This and the following two chapters were written by Beatrice Rogers. The chapters in this volume were reviewed by all the monograph collaborators; from their joint work each chapter has benefited.

the design of an effective program of subsidies. This volume discusses primarily the the household-level effects of food prices. Assessment of the influence of macroeconomic development policies on income and nutritional status are considered briefly in an appendix. Agricultural policies are discussed in a separate volume.

II. ROLE OF CONSUMER FOOD SUBSIDIES

A. KEY QUESTIONS

- What are consumer price subsidies?
- What is the rationale for using them and what can they be expected to accomplish?

B. Definition

Consumer food price interventions for nutritional purposes are those that attempt to improve the nutritional status of the population or of particular target groups by lowering the real prices of specific foods or of food in general, so that consumption levels, and therefore nutritional status, may be raised. Broadly defined, any government intervention in the market that affects food prices to the consumer can be seen as a nutrition intervention. Indeed, all national policies affecting any food prices should be (but are not) evaluated in terms of their probable nutritional impact on the population. In this discussion, however, we confine ourselves to those interventions which alter the consumer price of foods forming part of the everyday diet of the population and which operate on the market or through quasi-market systems such as ration shops. Thus, subsidies placed on specialized weaning foods and operating through the health care system are excluded from consideration, but food stamps, as well as food distribution systems operating in or parallel to the market are considered.

Price subsidies may be implicit, explicit, or a combination of the two. When a subsidy is implicit, the price of a food is lower than it would be in the absence of government intervention, but the difference is not paid by the government; rather, it is absorbed by the producer or seller of the food who would get a higher price in a free market than he can if the market is restricted. An example of an implicit subsidy is rationing, which artifically limits the quantity demanded, thus lowering the price at which an equilibrium between supply and demand is reached. Export restrictions have a similar effect. They increase the supply of a food on the domestic market relative to demand, and so lower the price at which the market clears. Subsidizing imports, or distributing on the market food imported on concessional terms (food aid) will similarly increase the supply and lower the equilibrium price of the food. Obviously, these implicit subsidies have effects other than reducing consumer prices. They also may reduce the incentive of farmers to produce the low-priced foods. Such

policies may, therefore, under some circumstances have the detrimental effect of reducing national food self-sufficiency and domestic farm income and of increasing reliance on foreign suppliers, contributing to a negative balance of trade. Another form of implicit subsidy is a price ceiling, a government imposed limit on the price which may even be below the cost of producing and distributing it. While price ceilings hold down prices, they may have the unintended result of driving the controlled goods off the market or of creating a black market for them if an adequate return cannot be made at the official price.

In the case of explicit subsidies, the price to the consumer is fixed below the free market price, but the price paid to the producer (or middleman) is established separately at a level high enough to encourage production and distribution of the subsidized good. The government pays the difference either to the producer or middleman so that he may charge less, or to the consumer so that he may pay more. For example, in the Pakistan ration system, the government pays a (high) support price to farmers for their wheat and sells it at a lower price to ration shop owners, absorbing the loss. In the case of the U.S. Food Stamp Program, the price difference is paid to the consumer. Explicit subsidies avoid many of the negative side effects of market distortions which result from implicit subsidies, but they do require considerable government expenditure.

While food price policies may have the effect of improving the economic well-being and nutritional status of the poor, it is recognized that they may be adopted for a variety of economic and political reasons not directly related to nutrition.

These economic and political considerations are often given more weight in the government planning process than are nutritional concerns. Thus, the role of the nutrition planner in many cases is to propose marginal changes in food pricing policy which will improve its nutritional effectiveness without jeopardizing the other objectives which it serves. This, of course, leads to different recommendations from those which would result from a purely nutritional orientation. A thorough understanding of the ways in which price policy can affect food consumption and hence nutrition is essential to the formulation of useful recommendations within these constraints.

If price policy is to be compared with another intervention in terms of its cost and effects, the appropriate comparison is with income policy, since both are directed at increasing purchasing power. Indirect means of influencing food consumption through changes in overall income levels or income distribution are not really part of price policy as we have defined it. Nonetheless, the effects are similar. (See Study VI on Agricultural Production.) A decreased price of a commodity through the subsidy has a direct consumption effect on that food (price elasticity of demand), an effect on the consumption of other foods and nonfood goods because of the changes in their price in relation to the subsidized food (cross-price elasticity of demand), and an income effect because of the increased purchasing power due to the subsidy and different expenditure patterns of different income levels (income elasticity of demand).

C. Rationale

From the point of view of the nutrition planner, the rationale for using consumer food price strategies is simple: to the extent that malnutrition is due to insufficient income, it can be alleviated by increasing the purchasing power of the consumer.

Price strategies have several disadvantages over income strategies. First, income subsidies or other efforts at income redistribution, while they may be more desirable from a market efficiency standpoint, are less feasible politically. This is in part due to the unpopularity among elites of income transfers in general. In-kind transfers, particularly those with a humanitarian objective like feeding the hungry, are generally more acceptable. Countries which are unwilling to transfer incomes to the poor are often willing to transfer large sums to subsidize staple foods (IBRD 1979).

Second, food price strategies bear a more direct relation to consumption of foods in general (or particular foods if effectively targeted). Income subsidies can be argued for on the grounds that they confer greater increases in overall welfare among the recipients, because they do not constrain the choice of consumption goods. Price subsidies, however, may direct increases in consumption specifically to subsidized foods.

Two caveats should be introduced regarding this category of interventions. One is that they will only be effective if the group of people suffering from malnutrition in a particular country or region purchases a sufficient proportion of their food supplies in the market, and if the quantities purchased are price-responsive, that is, that as the price goes down, consumers purchase greater quantities of the food. The relationship between a change in consumption and a given change in price is measured by the elasticity of demand. Those rural poor who produce most of the food they consume might be unreachable through this type of intervention. Second, it should be remembered that food is not only a vehicle for adequate nutrition. It is also a major consumption good and a commodity that occupies a large proportion of the wholesale and retail markets in any country. Therefore, food price manipulations have great political and economic significance, and these considerations, from the point of view of policymakers, may overshadow those related strictly to nutrition and health.

Price-altering measures may be adopted in response to a variety of circumstances. It may be the case that certain groups in the population simply cannot obtain an adequate diet at market prices given their income. The government may act to reduce wide seasonal or year-to-year price fluctuations without intentionally altering some presumed "natural" average market price. Of course, there is difficulty identifying, in a world fraught with taxes and tariffs, import and export restrictions, and other nonmarket forces, just what the natural price ought to be. Also, it is difficult on a short-term basis to distinguish temporary flunctuations from long-term, secular changes in price levels (Mellor 1966). In some cases, the justification for price intervention is that a low-income country feels

it cannot ask its citizens to compete for food at world market prices, and so actions are taken to insulate the domestic from the international food market.

The objective of these interventions may be nutritional: to increase the food consumption of a particular group. It may be to ensure equitable distribution of foods in short supply and to prevent profiteering on the part of producers or distributors of scarce commodities. In addition, such programs may be seen in part as income-transfer devices.

What can consumer price interventions be expected to accomplish? They can increase the consumption of foods in income classes where demand is price-elastic. They cannot be expected to influence consumption among rural populations who do not participate in the cash economy, though it should be pointed out that these are increasingly rare. These groups have to be reached by some other program such as supplementary feeding. Subsidies can specifically increase food consumption of low income groups, provided that the subsidy can effectively reach the target population. They may alter the relative quantities of various foods consumed by altering relative prices, as well as increasing the total absolute quantity consumed. They cannot change the distribution of food consumption within the family, unless specific foods which are only or mainly consumed by particular individuals, such as children or pregnant women, can be identified and subsidized.

Price policies affect directly all those groups who purchase the subsidized food. For nutritional purposes, subsidies should be directed toward the lower income groups who cannot afford to purchase an adequate diet. Unfortunately, many subsidy systems have been directed more toward urban than rural consumers, even though rural consumers are also needy and also participate in the cash market for food. In many countries, subsidy programs have been implemented to benefit government employees or the military. Such programs are obviously not designed to reach the poorest consumers.

These limitations mean that food price interventions are likely to be most useful in the case where income is the limiting factor on food consumption, and where the nutritition problem is caused by an insufficient quantity of food being available to the household. Malnutrition specific to a subgroup such as weanlings or pregnant women is usually caused by maladaptive dietary practices and beliefs, and therefore is less amenable to intervention through the pricing system. A particularly vulnerable family member benefits from food price subsidies only to the extent that he or she participates in the increased food consumption of the household. Price interventions are most effective if a nutritious food can be identified which is consumed largely by the malnourished population.

A key economic concept for understanding the potential impact of consumer price subsidies is that a change in relative prices induces a change in quantities consumed. The total effect of the quantity of a good demanded in response to a change in prices can be decomposed into an income and a sub-stitution effect, as Slutsky was the first to demonstrate in the Slutsky Equation. (For a more complete explanation of the Slutsky Equation, see Barmol [1977].)

A price change implies a change in real income of the consumer. If the price of a good increases (or decreases), the purchasing power of the consumer is reduced (or increased), and the consumer will adjust demand for the good accordingly. The income effect, then, is the variation in quantity demanded that is due to the change in real income implied by a price change. The income effect for most goods is likely to be small because consumer expenditure on any one item is usually a relatively small proportion of the total consumer budget. Therefore, a decrease in price of that item alone will not increase real income significantly.

The substitution effect is that part of the variation in quantity demanded that results from changes in relative prices (if the income effect is ignored). As the price of a good changes, its relative price also changes. The result is that less will be consumed of the good whose relative price has increased and more will be consumed of the goods which are substitutes for it. For example, a fall in the price of rice makes rice a better buy relative to bread than it was before. This by itself would always induce consumers to increase purchases of rice, substituting them for purchases of bread because rice is now relatively more price attractive.

To summarize, a change in the price of a good will affect a consumer's demand for that good, and the effect can be divided into two parts: the substitution effect and the income effect. Both effects are the result of the same price change, and their sum is equal to the observed variation in quantity demanded.

We have discussed some limitations on the potential nutritional effectiveness of food price subsidies. There are a number of non-nutritional concerns which also must be addressed in an assessment of price interventions. A primary one is expense. Most government subsidy programs are extremely costly, accounting for between 0.1% and 30% of current budget expenditure (Davis 1977). This may not be more than a comparable income transfer program would cost, but it can be a heavy financial burden nonetheless. There are ways of reducing program costs, some of which are discussed in this volume, but a substantial outlay is probably unavoidable.

The relationship between the price facing consumers of a food and that paid to producers is another area of concern. Many governments have been tempted to reduce their own expenditure on consumption subsidies by enforcing artifically low prices to the producer or middleman, so the amount of subsidy required will be less. The obvious result is that farmers then prefer to produce other commodities whose price is not regulated, and the domestic supply of the subsidized food decreases. If the government is determined to meet the demand for the food anyway, it has to turn to imports, which may have a detrimental effect on the balance of trade. It is important that the issue of agricultural incentives be considered at the same time that consumer price subsidies are being implemented. Consumer subsidies do not have to be associated with agricultural disincentives, but they have been in many cases.

Trade policy is another area which is closely related to food prices. Government policies to restrict or to encourage imports or exports of food by means of taxes, tariffs, or licensing directly affect the supply of food in the country and therefore its price. Food imported on concessional

terms at low prices (food aid) has been an important part of many subsidy programs. Clearly, food trade policy must be coordinated with subsidized consumption programs. Given a decrease in the price of a good, the substitution effect will always increase the demand for the good, and the income effect will increase the demand for the good unless it is an inferior good.

If a household does not increase its consumption of a subsidized food, and if its increased purchasing power is devoted to non-nutritional goods, the nutritional benefit of a subsidy will be nil, even though the household's perceived welfare will have increased. To the extent that consumption of the subsidized food increases with a fall in price (without a corresponding decline in the consumption of other foods), and to the extent that additional nutritious foods are purchased with the incremental income, a subsidy will produce positive nutritional results.

Of course, the substitution and income effects of a price change will vary with different subsidized commodities and with different patterns of consumer preference. These effects can be predicted by measuring direct and cross-price elasticities of demand for various goods and population groups. Subsidy programs cannot be evaluated on a generalized basis, since both the cost and the nutritional effectiveness of each program will depend on the consumption patterns and demand elasticities of the subsidized food.

Many of the food subsidy programs presently operating serve the urban population primarily or exclusively, and many of them seem to benefit the middle or lower-middle class as much as the poor. There are political reasons for this, of course. Few countries have attempted to target their subsidy programs to the nutritionally needy, so that little experience is available to indicate the feasibility of such targeting.

Another consideration relevant to these programs (which may be a drawback or an advantage depending on whether or not the subsidy is genuinely beneficial)is that they are highly visible, and therefore tend to create vocal political constituencies. Therefore, it is difficult to cut back subsidies when the financial situation of a country worsens (IBRD 1979).

D. SUMMARY:

ROLE OF CONSUMER FOOD PRICE SUBSIDIES

Consumer food price subsidies can be used to increase food consumption, and thus improve nutritional status, although it is difficult to direct them to specific target groups within the household. They can be very expensive. Historically they have been implemented primarily for political rather than nutritional purposes, and therefore have not been designed to reach the poor. The feasibility of effective targeting has, therefore, not been tested.

III. COMMON FORMS AND USAGE

A. KEY QUESTIONS

- What forms do subsidies usually take?
- How have subsidies been used throughout the world?

B. Common Forms

Price interventions may take the form of (a) price controls (fixed prices for specific foods); (b) fixed margins (a specified percentage markup is allowed at each processing stage from producer to consumer); (c) direct government subsidies on particular foods (the government sells the food at less than cost or less than the market price); or (d) government-issued stamps or chits that give a discount to target group families on some food or group of foods (the discount being made up by the goverment).

Within these basic categories, there is wide variation in the design of individual countries' programs. These variations in design have a profound effect on both the cost and the effectiveness of food price subsidies.

For example, a government-imposed price may apply to all of the food sold so that government exercises monopoly control. Alternatively, the price may be fixed only for a portion of the food on the market, the rest being sold at an uncontrolled price (parallel free market). Clearly, a government subsidy on a fraction of the food purchased in a country will cost less than a subsidy on the whole amount. If only some of a given food is subsidized, however, a means must be devised to separate the subsidized from the free market. Some means which have been used are the establishment of separate retail outlets (such as ration shops or cooperative stores), subsidizing only one variety or grade of a food, and packaging the subsidized food differently from the full-priced food.

Another variation in design is the imposition of rationing. Some countries limit the quantity of a subsidized food which may be purchased, while others do not. As we have mentioned, rationing alone reduces the cost of a subsidy program, other things being equal.

Targeting is another area in which national price subsidy policies differ. In some countries, a particular target group (such as low-income households) is identified, and only members of the group are eligible to purchase subsidized foods. Targeting may be administered bureaucratically by means of an application procedure, or it may be achieved by indirect means. For example, distribution of the subsidized food may be confined to a particular geographic area, or the food chosen for subsidy may be consumed only (or primarily) by a particular subpopulation. In some countries, the subsidy is not targeted but is available equally to all.

The specific food chosen for subsidy is also a significant factor in program design. Even within the area of basic staples, a wide range of choices exists from the preferred high-prestige food of the country to foods recognized as relatively undesirable, such as the coarse grains. A program will have very different effects depending on the food which is subsidized.

A final element of administrative and financial concern is the management of food stocks. The government may have to carry a sizable inventory. The infrastructure investment and working capital costs can impose a sizable financial burden. Similarly, the administrative demands placed on the bureaucracy to manage the logistics of procurement, storage, and distribution can be high.

Virtually all governments exercise some influence over the price structure in domestic markets. The more complete the government control of markets, the more difficult it becomes to identify particular subsidies. In the People's Republic of China, for example, all prices of staple foods are centrally determined, and there is rationing in cities. It is not possible to identify an individual price subsidy, since the entire economy is insulated from the world market and domestic prices are largely determined by fiat. This is not to imply that such price determinations are arbitrary. They are clearly the result of careful and knowledgeable analysis and planning with social objectives.

We have already made the distinction between explicit subsidy programs, in which the government spends money to make up the difference between a higher wholesale price and lower price to the consumer, programs of implicit subsidy or price reduction, in which government controls reduce the price from what it would be in an unrestricted market without direct government expenditure.

C. Global Usage

The use of one or another means for affecting food prices is extremely widespread. Table 1 presents some information on various price-altering programs throughout the world. The list is not exhaustive, and the information is not complete; it does indicate the considerable extent to which such programs are used. The column on Targeting gives some idea of who the beneficiaries of these programs are. It refers only to programs which are intentionally targeted by the government to a particular group. The table does not, however, indicate which of the programs were undertaken primarily or even partly for nutritional purposes.

A few brief program descriptions provide some idea of the variety of forms these interventions can take, and give substance to the program parameters discussed later. It should be noted that each subsidy program described is not necessarily the only one of its type operating within the country.

TABLE 1

PRICE ALTERING PROGRAMS

Country	Commodity	Implicit Subsidy	Explicit Subsidy	Rationing	Targeting	Free Market	Special Outlets
ASIA:							
Bangladesh (Davis 1977)	rice wheat sugar veg. oil salt	?	yes	yes	low-income pop.; govt. servants, military; institutions	yes[a]	yes
Burma (Davis 1977)	rice	?	yes	yes	low-income government employees	yes	yes(?)
India (Davis 1977; Swaminathan and Devadas 1975)	wheat rice coarse grains	Export ban; restrict inter-zonal trade; some govt. monopoly	yes	some states	some states low-income population	retail only	yes
Indonesia (Davis 1977; Soemardjan (1975)	rice wheat sugar	yes	yes	no	no	no	no
Korea (Davis 1977)	mixed rice and barley	yes	?	no	no	yes	?
Nepal (Davis 1977)	rice	?	?	no	?	?	?

[a]No free market in five major cities.

TABLE 1 (continued)

Country	Commodity	Implicit Subsidy	Explicit Subsidy	Rationing	Targeting	Free Market	Special Outlets
ASIA (cont.):							
Pakistan (Davis 1977; Rogers and Levinson 1976; Rogers 1976)	wheat	yes	yes	yes	no	yes	yes; mostly urban
	sugar	Export ban; govt. monopoly	no	yes	no	no	yes
	edible oil	yes	?	no	no	no	no
	rice	govt. monop. on wholesale purchase and export	no	no	no	yes	no
Philippines (Andrews 1978)	grain	fixed prices	no	no	no	no	no
Sri Lanka (Isenman 1978; Gwatkin 1978)	rice wheat sugar	yes	yes	yes	yes (since 1977)	yes	yes
Thailand (Davis 1977)	rice	Export ban	no	no	no	yes	no
	foods(?)	?	food stamps	yes	low-income population	yes	no
AFRICA:							
Chad (Center for Research on Economic Development 1977)	millet (until 1970) rice sugar oil consumer goods	?	yes, on imports	?	?	?	yes, few, mostly urban
Egypt (Chan 1976; Taylor 1976)	wheat sugar beans	fixed margins	yes	no	no	no	no
	rice tea	yes	yes	yes	?	yes	yes

TABLE 1 (continued)

Country	Commodity	Implicit Subsidy	Explicit Subsidy	Rationing	Targeting	Free Market	Special Outlets
AFRICA (cont.)							
Gambia (Center for Research on Economic Development 1977)	rice	fixed price margins; govt. monopoly on imports	on imports	?	?	?	?
	consumer goods	fixed prices; margins	?	?	?	?	?
Ghana (Simmons 1978)	?	?	?	?	?	?	?
Kenya (General Accounting Office 1975; Braun 1977)	maize wheat beef (until 1975)	fixed prices, margins; international trade restrictions	yes	?	?	?	yes (?)
Mali (Center for Research on Economic Development 1977, Intech 1977; Pinckney 1975)	millet sorghum rice groundnut oil	govt. monopoly (ineffective)	yes; govt. stores operate at loss	yes	no	yes; black	yes; urban
Mauritania (Center for Research on Economic Development 1977)	rice sorghum millet	? yes	yes yes	? yes	? free to distribute; subsidized to low-wage earners	? ?	? yes
Morocco (Davis 1977)	sugar edible oil flour products	?	?	no	no	?	no
Niger (Center for Research on Economic Development 1977)	grain	govt. monopoly (ineffective)	yes; govt. stores operate at loss	no	no; inferior quality	yes; black	yes

TABLE 1 (continued)

Country	Commodity	Implicit Subsidy	Explicit Subsidy	Rationing	Targeting	Free Market	Special Outlets
AFRICA (cont.):							
Nigeria (Simmons 1978)	milk sugar flour	price controls on imports	on imports(?)	?	?	?	?
Senegal (Center for Research on Economic Development 1977)	grain	govt. monopoly (not enforced)	yes; govt. stores operate at loss	no	?	yes; black	yes; mostly urban
Somalia (Parfrey 1978)	all foods	fixed prices (managed economy)	?	?	?	?	?
Tanzania (Davis 1977)	?	?	?	?	deficit areas	?	?
Tunisia (Austin 1977)	cereal milk meat some other foods	fixed prices, margins	yes(?)	?	?	?	?
Upper Volta (Center for Research on Economic Development 1977)	grain	govt. monopoly (ineffective fixed prices and margins)	yes	?	?	?	yes; urban
Zambia (Davis 1977)	wheat	govt. monopoly	yes, on imports	no	no	?	?
	maize edible oil some other local crops	govt. monopoly	?	no	no	?	?

TABLE 1 (continued)

Country	Commodity	Implicit Subsidy	Explicit Subsidy	Rationing	Targeting	Free Market	Special Outlets
LATIN AMERICA:							
Bolivia (Sampere 1978)	beef	price ceiling	?	?	?	?	?
Brazil (Moran 1975)	grain(?)	govt. competes with free mkt.	?	?	?	yes	yes
Caribbean Area (McIntosh 1975)	?	price controls, fixed margins	?	no	no	yes	no
Colombia (Moran 1975; McIntosh 1975)	grain	fixed prices; govt. monopoly on imports	yes	?	?	yes	yes
Costa Rica (Moran 1975)	?	fixed prices; govt. competes with free mkt.	?	?	?	yes	yes
El Salvador (Moran 1975)	grain(?)	fixed prices	?	?	?	yes	no
Guatemala (Moran 1975)	grain(?)	fixed prices	?	?	?	yes	no
Guyana (Moran 1975; Sampere 1978)	grain(?)	fixed prices	no	?	?	?	yes
Honduras (Moran 1975)	grain(?)	fixed prices	?	?	?	?	yes
Jamaica (Moran 1975)	grain(?)	fixed prices	?	?	?	?	yes
Mexico (Austin and Cassus 1975)	maize wheat beans sorghum edible oil other basic food and nonfood items	yes; govt. stores compete with free mkt.	yes; stores operate at loss	no	no	yes	yes

TABLE 1 (continued)

Country	Commodity	Implicit Subsidy	Explicit Subsidy	Rationing	Targeting	Free Market	Special Outlets
LATIN AMERICA (cont.):							
Nicaragua (Moran 1975)	?	fixed prices	?	?	?	yes	no
Peru (Moran 1975; Farren 1975; Sosnick 1975)	wheat maize soy oil rice lard beef potatoes onions other foods	ceiling prices	yes; on imports	no	no	yes; price controls not enforced	Lima only
EUROPE AND NORTH AMERICA:							
United Kingdom (Davis 1977)	milk butter cheese flour bread tea	?	yes	no	no	yes	no
United States (Sexauer 1977)	all American-produced and some imported foods	no[b]	food stamps	yes; sliding scale income supplement	yes; low-income population	yes	no

[b] Subsidies eliminated, fall of 1978.

(1) In Mexico, CONASUPO, a government agency, operates a vertically integrated wholesale-retail system to supply basic commodities, including some nonfood items, in areas where it is felt that the private-sector retail system is either deficient or exploitive. It competes with the private sector both in purchasing its supplies and in selling them. CONASUPO runs its own stores, including supermarkets, smaller shops, consumer cooperatives, and mobile units (stores operating out of vans). Anyone may use CONASUPO stores -- the program reaches about half the population of Mexico -- and there is no limit on the quantities that may be purchased.

The system was originally intended to keep prices below market levels by means of greater efficiency; however, as a whole the stores operate at a loss which is made up by the government. The original intent was also to increase the purchasing power of low-income families, but because it operates mainly in urban areas, the benefits to the rural poor are limited.

(2) In Egypt, all prebaked bread made of wheat flour is sold at heavily subsidized prices. A government agency purchases a percentage quota of domestic wheat at prices well below those paid for the wheat on the open market. The supply is augmented by substantial imports, both commercial and concessional. The subsidized bread, sold in ordinary bakeries at a fixed markup, is not rationed, and there are no conditions of eligibility for purchase.

The program serves mainly urban areas, since in rural areas bread is baked at home and a higher proportion of maize is consumed. The price of a loaf of bread has been found to have changed very little between 1952 and 1975, in spite of considerable inflation and increases in the cost of living. Demand for the commodity is consequently high, making the program costly, particularly in terms of foreign exchange.

(3) Pakistan operates an explicit subsidy program for wheat flour and a rationing program involving an implicit subsidy on sugar. The government spends money to make up the difference between the high wheat price to the producer and the low one to the consumer, while sugar prices are kept low by means of rationing and price control without direct government expenditure. Wheat is procured domestically at support prices and is also procured from commercial and aid imports. It is milled under government auspices and distributed at a lower cost through special ration depots, which are privately operated under government license. Wheat is distributed in urban areas and in rural areas only where food grains are in deficit. The quantity available is limited and obtainable at the subsidized price on presentation of a ration book in which purchases are recorded. Allotment is based on family size and age, with no limitation on eligibility for the program. However, the flour is generally considered inferior in quality, and this has the effect of targeting the program somewhat toward the low-income urban consumer. A free market in wheat and flour coexists with the ration system. (See Chapter Four for a complete description.)

By contrast, there is no legal free market in refined sugar, although there is an active black market. Sugar is purchased by the government from growers on a quota basis. Private exports are not permitted, nor is unauthorized private milling. The sugar is refined in private mills under government supervision, and distributed in rationed quantities at a price which just covers processing and distribution costs through the same system and under the same conditions as wheat. Sugar, though, is available in all rural as well as urban areas.

(4) Sri Lanka's food-consumption subsidy is part of the government's overall commitment to the policy of maintaining a social welfare state. Like other South Asian food-subsidy programs, Sri Lanka's used to be a ration system. Rice, wheat, and sugar were distributed in quantities deter-mined by the number of household members. A given quantity of rice was distributed free, with an additional fixed quantity available at a subsidized price. Wheat was distributed at a subsidized price, with no ration imposed. Sugar was sold on a ration basis, with additional quantities available at higher prices. Subsidized milk food was sold to families with infants or expectant mothers.

The ration program has played a major role in the politics of the country. The program is costly, absorbing as much as one-quarter of the annual budget (Davis 1977), and governments have been voted in and out of power based on promises alternately to maintain the ration or to balance the budget. In 1978, the government attempted to cut the costs of the program by restricting eligibility to the bottom 50% of the income-distribution scale. Subsequently, a food stamp program was implemented to take the place of the ration system. The impact of these measures on the nutritional status of the population has not yet been directly evaluated.

(5) The United States of America subsidizes food prices by means of food stamps, which can be used as money for the purchase of food in most ordinary retail stores. The stamps are good for most foods on the market; the few existing restrictions are based on supporting American food producers rather than on nutritional value considerations.

Eligibility for food stamps is restricted to low-income households. A complex application procedure is required before a household may participate in the program. This administrative determination of eligibility depends on the availability of both adequate income records and skilled bureaucratic personnel. The amount of the price subsidy is based on family size and income level. Originally, households were required to pay a variable proportion of the value of the stamps they received, the rest being paid by the government. Now there is no purchase requirement, and households receive free stamps only in the amount of the subsidy.

While the program has always benefited the poor, it was initiated as a means of expanding the demand for American food products. It is now quite explicitly a nutrition program and has been greatly expanded, with considerable income redistribuiton effects.

These are a few of the many kinds of food price subsidy programs. in use today. In the following section we discuss individual program parameters and the factors influencing decisions about specific program designs.

D. SUMMARY:

COMMON FORMS OF CONSUMER PRICE INTERVENTIONS

Consumer food price interventions exist in a wide variety of forms. They may be considered explicit subsidies if the government pays money to make up the difference between a low consumer price and a higher producer or wholesale price. They are implicit subsidies if the government restricts the market in such a way as to lower food prices but does not pay money directly to subsidize the food. A subsidy is still involved, but it is paid as income forgone by those who would be able to charge higher prices in an unrestricted market.

There is a wide variety of forms of subsidy programs in effect in the world today. Some important variations in program design are: choice of a food to subsidize; whether to subsidize all or only part of the supply of that food; whether to limit the quantity available at the subsidized price (rationing); whether to limit the number of people who may purchase the subsidized food (targeting). These design factors are important in determining both the cost and effectiveness of the food subsidy program.

CHAPTER ONE FOOTNOTE

[1]On-site and take-home supplementary feeding, whether given free or in exchange for work, can also be considered as a subsidy. These programs are not discussed here (see Study I, Supplementary Feeding).

CHAPTER TWO

INTERVENTION DESIGN

I. INTRODUCTION

The design of a consumer price program will be discussed in terms of the likely impact on nutritional status in the country. It should be borne in mind that these programs frequently have multiple objectives, of which nutritional benefit may not be the most important. Nutritional implications of program decisions should nonetheless be understood in order to derive the maximum possible benefit from any price intervention that is undertaken.

Price policies are market interventions and are likely to have an effect on production incentives and on the economy at a national level. These effects are of great importance, but they are not treated here. One must be aware, however, that a price intervention program cannot be effective unless it can survive. This means different things in different countries, but it certainly means that political demands, foreign-exchange needs, inventory, infrastructure needs and management skill requirements, budgetary limitations, and resource availability all legitimately enter into the process of decision-making.

II. INTERVENTION DESIGN

A. KEY QUESTIONS

- How can programs be targeted to the nutritionally needy?
- What commodity(ies) should be subsidized?
- Should rationing be used?
- What pricing policy should be pursued?
- What distribution system should be used?

B. Program Targeting

Cost effectiveness of subsidy programs is determined, in part, by how well the subsidy is directed at chosen target groups. Although subsidizing the population in an unrestricted fashion may be desirable politically, adherence to nutrition objectives implies that targeting should be employed in order to minimize costly leakages to nontarget group members. Low income and participation in the cash market for food should be two primary characteristics of target groups. The lowest-income groups are, in general, the most nutritionally needy. If, however, these groups do not participate in the cash market for food, their consumption cannot be influenced by price alterations, although they may be drawn into the market by lowered food prices. This is not necesarily a justification for confining the program to urban areas, since even in food-producing regions, large segments of the population purchase some or all of their food, and these are likely to be the lower-income, non-landowning groups. It is difficult with this kind of program to reach specific age and sex groups within the population, although a food with a very strong image as a "baby's food" or a "woman's food" might be consumed only by the one group. It may be desirable to direct the program toward one particular geographic area where food is in short supply or incomes are particularly low. Targeting may also be employed on a seasonal basis, providing subsidies just before the end of the growing season when supplies are low and prices high. Targeting through the selection of commodities with appropriate economic characteristics is discussed later. This may be the most acceptable and efficient way of restricting (by voluntary self-selection) the benefits of the program.

The feasibility of targeting for nutritional objectives is largely unexplored. Explicit poverty-oriented programs have historically been uncommon. Food subsidies of any kind have been most often employed to reduce the urban cost of living and minimize political unrest (IBRD 1979). The planner is faced with the difficult task of balancing political and nutritional concerns.

All targeting puts administrative demands on the government. These demands are lightest when targeting by commodity selection is used, and heaviest when income is used as the criterion of eligibility.

Administratively, targeting by income may be an effective way to channel program benefits in a country where household incomes and other determinants of eligibility are relatively well documented, where the completion of written application forms is not an excessively intimidating task, and where reliable bureaucratic personnel are readily available. The Mexican government's subsidized milk distribution program uses such a system. In places where skilled administrators are scarce, literacy is low, and income and other resources can easily be miscalculated (deliberately or by mistake), such methods are likely to be ineffective. If the commodities in the program are desirable, it is not difficult in such cases for ineligible people to bribe administrators or to falsify their income statements for admission. If the community is heavily involved in the program, it may be able to police such abuses. Still, the uneducated poor

might be unable to understand how to comply with requirements. Furthermore, application procedures presumably require some degree of centralization, which may create problems of accessibility.

One suggestion to reduce the likelihood of exorbitant costs and large political constituencies is that programs be limited in scope initially to the most needy groups. They could be made larger gradually, as resources allow. Another option which is likely to be much less popular is to cut back existing programs. Complete elimination of subsidy programs has been tried recently in both Egypt and Peru, and in both countries severe popular protest has been the result. In Egypt, the program has been reinstated. The government of Sri Lanka has recently initiated a means test whereby eligibility for subsidy is determined on the basis of income. Only families earning less than 300 rupees per month (which is less than the amount designated by the government as needed for a minimum diet) are eligible. This has resulted in a reduction in the number of eligibles from 13 million down to 7 million. This restriction was enacted in response to the unsustainable cost of the program, and was feasible because of political commitment to improving economic growth.

Geographic targeting may be feasible by restricting shipment and distribution of subsidized commodities exclusively to the deficient regions of a country, as, for example, by setting up outlets only in target regions or neighborhoods. If food is scarce throughout the country, or if subsidized prices are substantially lower than those in neighboring regions or countries, however, an incentive for smuggling is created. This necessitates enforcement of restrictions on the movement of foods. The feasibility and cost of such enforcement must be considered as part of the subsidy plan. Singh (1973) discusses the difficulty of enforcing the interzonal restrictions on movement of food grains in India, and concludes that such restrictions are virtually unenforceable. (See also Uma Lele 1975.) In Mexico, however, distribution of liquid milk in low-income neighborhoods of Mexico City appears to be effective in restricting benefits to residents of those neighborhoods. One reason for the difference is that milk is difficult to store and resell, and another is the Mexican program's coupon system (Sanchez et al. 1978).

While targeting can never be perfect, one must balance the cost of leakages against the probable cost of an elaborate bureaucratic system to administer eligibility restrictions. Attempting to eliminate all ineligible people is likely also to exclude some of the eligible group.

C. Choice of Commodity

Selection of a commodity or group of commodities to subsidize must take into consideration the existing consumption patterns of the target group. The food ideally should be one that is already consumed by this group. Choosing a food which is the dominant staple of the whole population may be much more costly, however, than selecting alternative foods which have equivalent nutritional qualities and are considered less desirable by nontarget group members (IBRD 1979). In groups where lack of

income causes malnutrition, it is usually protein-calorie malnutrition caused by an insufficient quantity of food that is the nutritional problem. Specific micronutrient deficiencies may also result from lack of income to purchase sufficient nutritious foods. It is this condition which food price subsidies are best suited to correct, since they affect the quantity of food consumed. They may not correct imbalance in the compositon of the diet due to inadequate knowlege, but they make possible the purchase of a more balanced diet by freeing income formerly diverted to grain or other staples.

For the purpose of targeting, there is little reason to subsidize relatively costly staple grains such as wheat and rice, when alternatives such as corn, millet, and sorghum, which are less expensive and have more desirable economic characteristics (i.e., they are not generally preferred by the well-to-do) can also alleviate protein-calorie deficits. In recent years, calorie rather than protein deficiency has become the focus of nutritional concern. In places where protein intake is adequate, or would be if the the protein food did not have to be used for energy, (for example, in cereal staple countries such as India) subsidy of a low-protein, calorie-dense food might be able to alleviate the nutritional problem at lower cost than even the coarse grains. In countries where the diet lacks protein (in the African countries where cassava is a staple, for instance), obviously this would not be the case.

In many countries the staple diet, while nutritionally adequate for adults, is not nutritient-dense enough for babies and small children whose stomach capacity is limited. To supplement children's diets, high protein foods (animal protein or the vegetable-protein milk substitutes) are needed. Food price subsidies of such foods are not likely to be as cost-effective as other methods of supplementation, since these foods are very desirable, and if they were subsidized, leakage to nontarget groups would be substantial. To the extent that the income freed by a subsidy on a dietary staple were spent on special foods for children, a subsidy would benefit this particular vulnerable group.

The argument for subsidizing a food which is already part of the diet of a country is that other foods will be unacceptable, so that even at low prices they will not be consumed. There are, however, several documented cases of changes in dietary patterns among the poor in response to price shifts. Isenman (1978) reports the shift in dietary staple from rice to wheat among Indian Tamil tea estate workers in Sri Lanka, and attributes it to the widespread availability of imported wheat at low (subsidized) prices. In Bangladesh, Majid and Levinson (1976) report that when sorghum was made available through the ration system, many of the poorest households chose sorghum over the usually preferred wheat, because they could get a larger quantity for the same price.

When a scarce luxury product is subsidized or rationed, as is sugar in Pakistan, the program may serve political, economic, and to some extent income-redistribution aims but is not ideal as a nutrition intervention.

In economic terms, it is important to select a food that has a high price elasticity of demand among the target group. This means that the quantity purchased is very responsive to changes in price. Thus, the change in price caused by the program would be expected to increase consumption in this gorup. The larger the role this food can attain in the diet of the target group, the greater the potential nutritional impact. It is also important to analyze cross-price elasticity of demand, that is, the tendency for people to reduce their consumption of other foods as they increase consumption of the food whose price is reduced. The subsidized commodity should not have a high positive cross-price elasticity of demand with other elements of the diet. If it does, substitution takes place. Thus, demand is shifted toward the subsidized product, consumption of other nutritionally important elements of the diet is reduced, and nutritional benefits of the subsidy are neutralized. Optimally, cross-price elasticities should be very low or negative.

Further, elasticities of demand among nontarget groups should be considered. The food should have a decreasing price elasticity of demand with increased income and a lower or negative income elasticity of demand in the income groups above the target level, so that these groups do not choose to take take advantage of the subsidy. In other words, the food selected for subsidy should be a low-status food: one that is widely consumed by the poor but is not preferred by the relatively wealthy If several qualities or grades of a food are available, the low quality should be selected for subsidy.

Another consideration in selecting a food for subsidy is the availability of supplies. The objective of such programs is to expand the quantity of the commodity demanded but not to increase dependence on foreign supplies or act as a disincentive to domestic production (see Study VI, Agricultural Production, Technical Change and Nutritional Goals).

A comment should be made about the U.S. food stamp program, which is neutral with respect to the specific foods that are subsidized. This program is comparable to an income transfer in that the nutritional impact depends in each case on the household's marginal propensity to consume food and particular foods. That is, it will depend on how likely a household is to devote increases in income to food. Such a program is of greater nutritional benefit in countries or among groups in which increased income is likely to be devoted to increased food intake and to nutritious foods. From a nutrition standpoint therefore, this type of program may be less desirable than a subsidy that can target the proposed consumption toward nutritious foods. The Columbia food-coupon program is tied to specific foods, including the nutrient-dense weaning food Bienestarina. The special Supplemental Feeding Program for Women, Infants, and Children (WIC) in the U.S. also has coupons linked to certain nutritous foods.

D. Rationing

Rationing controls the cost of a subsidy program by limiting the amount of food which may be purchased at the subsidized price and thus the total subsidy paid by the government. Rationing may also forestall the need to turn to foreign markets for additional quantities of the subsidized

food. If the quantity that may be purchased is not rationed, and the price is held below the "natural" price at which quanity supplied would equal quantity demanded, it is simple economics that demand will exceed supply. In this case, the government has to procure additional supplies, possibly from the international market. Since prices on the international market are not ordinarily subject to the manipulation of a single purchaser (in contrast to the domestic market, where the government may exercise its power to exact quotas from producers), the government may spend a great deal of foreign exchange maintaining its subsidy program. An example is the Egyptian wheat subsidy, which demanded enormous expenditures during 1972-1974 when international wheat prices soared.

Rationing entails a certain amount of bookkeeping and bureaucratic expense. Ration cards or books must be issued and maintained. The expense of rationing must be balanced aginst the likely cost of a program in which quantities are unlimited. (Once again, quality and the volume of demand for the particular food affects this balance consideration.)

A further question if rationing is instituted is whether entitlements should be legally transferable. If they are, the incentives for a black market, with its consequent windfall gains to entrepreneurs, are reduced. However, the ration allotment then becomes more or less equivalent to money, and the effect of directing the consumption increase from the subsidy to a particular food is weakened. If the object of the program is simply to give everyone in the country equal access to food, then allowing the sale of the allotment clearly makes sense. If nutritional objectives are to be served by encouraging increased conumption of a particular food, then perhaps it does not. If the food is not in demand by the nontarget group (and if eligibility is not restricted), then it does seem logical to allow the unclaimed food to be distributed to the needy. This appears to occur on an informal basis in Parkistan, where some ration shop owners report selling wheat above the quota to those who want it, since other customers registered at their shop do not use their entire allotment.

The institution of rationing alters the effectiveness of a food price subsidy. Changes in the relative prices of goods affect consumer behavior only at the margin -- that is, when the consumer is deciding whether to purchase an additional unit of one item or another. If the ration limits purchases of the subsidized good to quantities below what would be purchased in the absence of the subsidy, then the effect of the subsidy is simply that of an income transer (Selowsky 1979). This increment is equal to the amount the consumer saves by buying the food which he would have bought anyway at a lower price. As a result of the subsidy, a consumer may purchase more of the subsidized food (if it is available at a higher price), but no more than he would as a result of an increase in income. One advantage of price over income subsidies, the encouragement of the consumption of particular foods, is lost if the ration quantity is inframarginal. Of course, another advantage of price subsidies over income transfers - that they are politically more acceptable and therefore easier to implement - remains regardless of the size of the ration.

The question then arises, how large should the ration be? The need to control the cost of the subsidy must be balanced against the desired consumption effect. Again, the selection of an appropriate low-prestige food for subsidy is important. Then the demand curves for the needy target group and the nonneedy population will be different. The curve for the nonneedy will be steep, while that for the target group will be flatter. If price elasticities of demand are available, so that demand curves can be plotted, it is possible to calculate the amount by which a given price decrease will increase consumption. The ration should then be set at a level slightly higher than that needed to alleviate existing nutritional deficiencies, to allow a margin of safety, and the price set at the appropriate level to encourage this level of consumption. This ration exceeds the margin for the nontarget group as well, but demand for the food is so price inelastic, and is at such a low level in this group, that their increased consumption is negligible, and their net income increment is also small. From a nutritional cost-effectiveness point of view, it is preferable to select this kind of food, and set a ration which is outside the margin for the target group than to set a smaller, infra-marginal quota for a food demanded more or less equally by all groups.

In order to set the ration this way, some estimate of the nature and magnitude of the nutritional deficiency must be available, as well as estimates of demand elasticities by various foods in target and nontarget groups. These estimates cannot and need not be perfectly accurate, of course. Many countries have some information on food demand which could be used in these determinations.

The forgoing analysis assumes that the income received in the form of a food subsidy is treated by the household just as any other income. There is some evidence that this is not the case. Kumar (1979) found that income increments from subsidized food in Kerala were disproportionately devoted to food purchases, compared with income from other sources. If food subsidy income tends to be spent on increased food purchases, then the probable nutritional effect of such programs is greater than classical economic analysis would imply.

In many cases, the size of the ration is constrained by availability. An example is India (Swaminathan and Devadas 1975). If the target group of the program is not the entire household, in order to achieve the nutrition objective, it is necessary to set a ration in excess of the nutritional needs of that group to allow for unavoidable leakages within the family. The intrafamilial leakages in subsidized systems are also present in free, take-home feeding programs (see Study I, Supplementary Feeding).

E. Setting Prices

1. Variable Subsidies

Setting prices for subsidized foods raises a number of issues related to program costs as well as nutritional benefits. Ideally, in order to keep costs low, a price subsidy would just allow the consumer to obtain an adequate diet while spending the same amount he or she spends without the subsidy. This should reduce substitution, that is, the likelihood that people will use the subsidy to free up money for nonfood consumption rather than increasing their consumption of the subsidized food. Normative

judgment would be required here to determine how much a household "should" spend on food, and what other budget items are "necessary." The price would vary according to the needs and financial resources of the consumer, so that the size of the subsidy would be precisely what was required to achieve the desired food consumption objective, no less and no more. In theory, this is what is achieved by the U.S. Food Stamp Program's sliding scale. Similarly in Mexico and Colombia, variable subsidies are achieved by giving more food coupons to families with more children, on the assumption that their need is greater. Such systems are quite complex to administer, and for most countries it is probably preferable to fix a price suitable for those at the lower-income end of the target group and live with the fact that the subsidy is greater than strictly necessary among the higher-income segments of the needy population.

2. Fixed Prices

Depending on the extent to which the government already determines the price structure, price controls on specific foods imposed without subsidy may create a variety of problems. Where considerable widespread effective control is not exercised, the imposition of price controls is likely to be very difficult to enforce, and may result in an active black market (in which prices will be even higher than they would have been in the absence of any intervention) or in supplies disappearing from the market (if suppliers find their costs cannot be met at the controlled price). Without some form of rationing, price controls may result in shortages, since demand may exceed the quantity available.

A caveat should be introduced here. If the government establishes a fixed price for a commodity, there will be considerable political resistance to having that price raised, even if inflation and a general increase in incomes would justify it. (Of course, this applies even more strongly to a free ration such as used to exist in Sri Lanka). The degree of resistance will depend on the expectations that have been raised by the program, specifically, on how long the price has remained at a given level. For this reason, it may be wise to keep the price flexible and review it on a regular (e.g., yearly) basis.

It should be remembered that a program to benefit the needy must incur costs. It is probably better to err on the side of lower prices and higher costs than to risk providing inadequate support to the poorest in the population. In the Egyptian case, Taylor's (1976) estimates support the proposition that, in spite of substantial cost, price subsidies for staples should be maintained; their reduction would have a significant negative impact on calorie intake, especially of the poor.

3. Fixed Margins

One way to avoid the trap of fixed prices is to allow prices to vary with costs by fixing percentage margins at each stage in the marketing process. One problem with fixing margins is that there is then no incentive to try to bargain or shop around for the best possible wholesale price. There is also the possibility of collusion between buyer and seller, with the wholesaler inflating his price so that the retailer may charge more.

Furthermore, fixed margins might not serve the original purpose of protecting the low-income consumer from large price fluctuations and increases, unless the margins are based on some supply price established by the government, in which case all the considerations involved in setting the retail price again apply. In a market in which several break-bulk operations are required before food reaches some remote areas of a country (that is, where the food passes through several wholesalers), a system of fixed margins may not allow for a price increase sufficient to cover the real costs of bringing food to those markets. This will result either in disobedience to the regulations or a lack of supply in those regions. Fixed margins may also favor the larger scale farmers and processors who may have lower costs per unit due to economies of scale. Finally, margin maintenance is administratively difficult to enforce.

F. Choice of Distribution System

Coverage of the population by a subsidy program depnds in part on the number and accessibility of outlets for the subsidized food. The question therefore arises whether it is better to make use of existing food marketing outlets, to allow a parallel privately run system of special outlets for the subsidized foods, or to establish government-run distribution centers.

If the subsidy program is set up specifically to remedy a deficiency in the existing marketing system (as was CONASUPO in Mexico), then clearly the first option should not be taken. Where the private marketing system is effective and universally available, its use is likely to save government expenditure and to maximize coverage. A frequently cited advantage of food stamps in the U.S., compared with the earlier commodities distribution, is that with the food stamps the consumer can conveniently shop at a local store instead of having to travel to a separate, possibly inconvenient location. In less developed nations as well, use of subsidized commodities is likely to be greater if established patterns of obtaining food do not have to be varied too much.

The need for rationing, special accounting, or other control procedures may be a disincentive to private food retailers to undertake distribution of subsidized foods. Some margin must be allowed to the retailer to provide a motive for participating in the program.

In some countries, subsidized food is distributed through privately owned shops operated under license from the government. An example of this is Pakistan's ration-shop system. Because there is a small margin on each sale, the profit motive induces shop owners to maximize coverage and convenience to their customers. (This is less true in rural areas where the shops distribute only sugar, a commodity in high demand by all income groups, and have a virtual monopoly on its sale). Transport and stocking arrangements are made by the individual shop owner, which allows maximum flexibility within the system. Such special outlets are probably best suited to areas in which the existing food-retail establishments are insufficient.

The difficulty with establishing government-owned and operated outlets is that this entails substantial cost, and it is unlikely that as many can be set up throughout a country as there would be if the individual shops were privately run with government supervision and control. A purely government-operated system also requires centralized organization of supply, transport, inventories, and accounting for all the stores, which places a considerable demand on administrative capacity. Once again, the degree to which the government already has the capacity to operate an integrated retail system is an important factor in the decision about what types of outlets to use. Maximizing coverage and convenience to the consumer and maintaining sufficient and reliable supplies are the primary considerations. Egypt's subsidized bread is sold through ordinary bakeries (though other subsidized foods are sold through consumer cooperatives), whereas Mexico's system uses government-operated facilities. Planners and administrators should investigate the possibility of using local voluntary groups to run, or to assist in running outlets for subsidized food.

G. Monopoly Control or Parallel Free Market

Should the government attempt to subsidize or control the price of all the food on the market, or should a parallel free market for the food be allowed to exist? A key issue here is that of market differentiation (see FAO 1979). If it is possible to divide the market and subsidize one distinguishable grade or type of the food, then a legal parallel market can perform several useful functions. It can eliminate or reduce the incentive for diverting the subsidized food to the black market. If a better grade is already available on the open market, there is less reason to pay black-market prices for the subsidized grade. It allows producers and middlemen to make up the loss from selling to the government at fixed prices (where this is done) through the price charged for the remainder (Narain 1975). In Peru, the government was at one time able to make up the whole cost of the subsidy on lower-grade rice by charging a higher price for premium domestic and imported rice (Shepherd et al. 1967). Even if two qualities of food cannot be distinguished, a parallel market can still serve these functions, but more careful government control is needed to prevent diversion of the subsidized supply to the more lucrative free market. In many countries, a fixed ration at a subsidized price can be supplemented by the consumer at higher prices.

The degree to which monopoly control of a commodity's sale by the government is feasible and enforceable, given the economic and cultural traditions of a country, must be an important consideration in making this decision. Assessment of administrative capacity and of available distribution systems should precede initiation of any subsidy program.

H. Form of the Price Intervention

Price interventions may take the form of imposed price controls, subsidies, market injections (subsidized imports distributed through the existing market system), other market interventions (export laws, rationing,

interzonal restrictions), or food stamps. One might include income transfers in the category as well.

Most of the considerations determining the choice of one form or another are political, or deal with macroeconomic policy rather than with nutrition. The form chosen probably affects the nutritional impact of the program, however.

Food stamps have a number of appealing features: they can be used at existing retail outlets, and thus minimize inconvenience to the consumer; they distort the market less than other forms of price intervention, since the stamps are spent like money; and they can be issued on a sliding scale, so that the size of the subsidy matches the need of the individual.

There are several important considerations that might also argue against food stamps, however. The capital and resource cost of printing and distributing the scrip to be used in the program can be substantial. Not only paper and printing, but also transport costs are involved. Administration is likely to be complex, since the very nature of the program requires eligibility determination. Since the stamps can be used like money (unless tied to special foods), there is no possibility of using the quality differential to make the task of targeting easier.

Food stamps that are not restricted to specific foods have the disadvantage that unless the consumer uses the subsidy to buy more of the foods needed in the diet, they may have limited nutritional impact. Consumer choice cannot be influenced by this method. An analysis of income elasticities of demand for different specific foods in the target population would indicate whether the benefits of the food stamp program were likely to include improved nutritional status. This is by no means a simple task, nor is it likely to be conclusive. If the food stamps are "tied," as mentioned earlier, then greater control can be exercised over changes in the diet.

Whether prices are lowered by dumping low-cost food on the market, by restricting food shipments within the country, by subsidies to producers or retailers, by monopoly purchase, or by some combination of these, the impact of the lowered price on the food consumption of different groups should be the same, subject to the considerations discussed in the previous sections. All these market interventions are likely to have an effect on production incentives and on the economy at the national level. These effects are of great importance. They are not treated here, but they must be considered in planning or modifying a price subsidy program.

I. Other Issues

Though subsidy programs are often not primarily a nutritional policy instrument, their nutritional impact may be maximized by coordinating their use with nutrition interventions such as supplementary feeding and with efforts to improve water supplies, immunize against common infections, and educate the public on how to make the best use of the subsidized food.

(See other volumes in this series for discussion of these policies.) Economists who will probably be designing subsidy programs should consider the efforts of nutritionists and health professionals, who are likely to be carrying out feeding and nutrition education programs, and should coordinate with them whenever possible.

SUMMARY:

INTERVENTION DESIGN

The cost-effectiveness of subsidy programs can be improved by targeting the program to the nutritionally needy and controlling leakages outside the target group. Where administrative capability and adequate records exist, this may be achieved by bureaucratic determination of eligibility. An alternative more suitable to many developing countries is to subsidize a food which forms a large part of the diet of the needy, but which is not desired by the well-off population. Coarse grains or poor-grade grain staples are examples of such foods. If these are subsidized, the nonneedy will voluntarily exclude themselves from the program.

Rationing the quantity of food available at the subsidized price will reduce the cost of the program and may prevent increased dependence on foreign supplies. In the absence of rationing, at below-market prices, demand will exceed supply, and imports may be necessary.

If a free market in the subsidized food is allowed to coexist with the subsidy, then rationing is easier to enforce, the incentive for black-marketeering is reduced, and some of the disincentives to domestic production can be counteracted.

Subsidies may be direct, with government expenditure making up the difference between consumer and producer prices, or they may take the form of imposed price controls, fixed margins, or food stamps. Direct subsidies are costly but prevent production disincentives. Fixed prices or margins may result in black markets or in shortages of the commodity. Food stamps have the advantage of adjusting the size of the subsidy to the need, but their management is complex.

Distribution of subsidized food through existing market channels will be less costly and result in wider coverage of the target group than establishment of special government outlets. Private traders may be unwilling to accept

the subsidized food if it presents an administrative burden unless they are compensated. But if market incentives are allowed to operate and if decentralized administration of outlets is permitted, convenience and accessibility will be maximized.

The nutritional impact of food subsidies will be increased if subsidies are part of an integrated program which provides for other basic needs.

CHAPTER THREE

INTERVENTION EVALUATION

I. INTRODUCTION

Subsidy programs should ideally be designed with particular objectives in mind. Levels of costs and effectiveness should be considered a priori and used as measuring sticks against which programs should be assessed on a continuing basis. Although measurement of costs and effectiveness is difficult, ongoing evaluation efforts are one important element in ensuring that subsidy programs are implemented in accordance with their stated objectives. Evaluation efforts also maintain awareness of the program's costs.

II. COSTS

A. KEY QUESTIONS

- What determines the cost of a subsidy?
- What is known of the cost of subsidies?

It is nearly impossible to discuss the costs of price interventions in any general way, since the scope and form of the different programs vary so widely. In countries where the programs are national in coverage, the cost can be considerable: from 0.1% of the total government expenditure in the United States, for example, to as much as 22% of the expenditure of the government in Egypt (Table 2). For Pakistan, the comparable figure for 1974-1975 is estimated at 10.8% (Rogers and Levinson 1976). The CONASUPO milk distribution program in Mexico, which is not a national program, has an estimated subsidy cost of around U.S. $5 million per year on annual sales of about 170 million liters. This subsidy is offset in part by higher revenues on sales of other LICONSA (a subsidiary of CONASUPO) products to other consumers. Of course, the quality of data and methods of accounting are variable enough to make these figures mainly suggestive. There is no question that this type of program is expensive. The fact that it is so extensively used throughout the world indicates that it can serve a wide variety of purposes considered important by an equally wide variety of national governments.

TABLE 2

SELECTED COUNTRIES: BUDGETARY COST OF FOOD SUBSIDIES
(in percent of total expenditure)

Country	1972	1973	1974	1975
Bangladesh	--	13	11	8
Burma	--	--	8	5
Egypt	4	10	22	21
Indonesia	--	1	13	7
Korea	4	10	14	19
Morocco	1	1	9	12
Pakistan	1	8	13	11
Sri Lanka	13	14	17	16

Source: Davis 1977.

Costs can be affected by a number of the program parameters discussed in the previous section: 1) careful selection of the commodity, 2) rationing of quantities, 3) targeting, and 4) the setting of a realistic price. Targeting should be employed only up to the point where costs outweigh savings resulting from reduction of leakages. Administrative costs may be reduced by making use of existing distribution systems, by trying to subsidize commodities which are self-targeting, and by other means. But ultimately, it must be realized that programs of nutritional improvement (as well as price stabilization, production incentives, and others) involve an expenditure for a payoff that may never be quantifiable in national accounting terms. (See Selowsky and Taylor 1973, for one attempt to quantify the economic benefits of nutrition programs.)

Direct costs of subsidy programs primarily include food purchase, administration, start-up, storage, packaging, processing, and transporting, net of income from sales. Indirect costs are more elusive and may pervade a country's economy, depending on the scope of the subsidy program. Balances of payments, inflation rates, and levels of aggregate demand, savings, and government revenues may all be affected. Subsidies thus can play a major role in national economic policy. One of the more important variables influencing this role is the percent which imports make up of domestic staple food needs. The source of financing a subsidy is also obviously of great significance.

The total program costs should be related to the number of target-group program recipients. In this regard, costs can be quite high due to leakages to nonneedy groups. Of course, the cost-benefit calculation is directly affected by the definition of the target group. Reutlinger and Selowsky have made some calculations of the presumed cost of such leakages, and have pointed out the economic importance of targeting (1976). Their illustrative, "but not unrepresentative," example estimates that, with a general food-price subsidy on a food consumed equally by all income groups, it would cost $12.00 to get $1.00 worth of food to the target group. This assumes a program which involves no targeting whatsoever. A perfectly targeted food stamp program would cost about $1.33 to provide $1.00 worth of food. These figures have not been verified empirically in actual program settings. Additional leakages occur even with targeted programs (see Study I, Supplementary Feeding), and the actual costs per child under 3 or pregnant or lactating women are likely to be even higher than those calculated for the needy population as a whole. Furthermore, many subsidy programs are somewhat targeted to the needy, even though targeting may be imperfect. Further field research is needed.

Choice of what levels of cost are reasonable is determined largely by political factors, by the country's domestic and international economic status, and by the availability of foreign assistance. The extent to which a focus on nutritional objectives can be achieved in subsidies may depend on existing levels of financial commitment to explicit nutrition and health programs. The nutrition planner may be faced with the task of presenting sound arguments for the design of subsidies as an integral part of a basic needs strategy, rather than as a political tool.

B. SUMMARY:

COSTS

Subsidy programs are recognized to be quite costly. Direct government expenditure on subsidies has consumed from 0.1% to as much as 22% of some national budgets in some years. Indirect costs of some programs has included disincentives to domestic agricultural production and dependence on foreign suppliers. Direct costs can be controlled by means of effective targeting, rationing, careful selection of subsidized commodities, and the use of existing marketing and distribution systems. Indirect costs can be minimized by rationing, separating the consumer from the producer price, and minimizing market distortion.

The high cost of subsidy programs is balanced by the fact that they can serve multiple government objectives other than only nutritional ones. This partly explains their widespread use in spite of their high cost.

III. EFFECTIVENESS

A. KEY QUESTIONS

- What influence can subsidy programs have on food consumption and nutritional status?
- What measures of effectiveness should planners use in evaluating subsidy programs on a nutritional basis?

The ability of a price intervention scheme to affect nutritional problems depends, as mentioned, on the extent to which income is the limiting factor in dietary intake and on whether the demand for food (or for the subsidized foods) is price elastic. The foods subsidized should also contain the deficient nutrients (usually calories and protein) or should be negatively cross-elastic with foods which do. Price interventions can affect only that part of the population that purchases its food. Subsistence farmers and those who are paid in kind are not affected, although the extent to which price changes affect the size of in-kind payments would be a useful area to investigate. Therefore, the nutritional usefulness of price changes depends on the specific nature both of the nutrition problem and of the way in which consumers obtain their food.

The nutritional impact of food subsidies depends on the relationship between increased food consumption and improved nutritional status. We mentioned in Chapter One that the health of vulnerable individuals within the household will improve as a result of subsidies only if their own food consumption rises. If these persons are malnourished because of poor dietary practices (such as food restrictions) or other causes not related to purchasing power, then food price subsidies will not help them. If nutritional status is low because of parasite infestation or morbidity, then obviously these are the causes which must be addressed. Food subsidies can only affect malnutrition caused by limited purchasing power relative to the price of food.

The few attempts to quantify the impact of price subsidies on food intake indicate that it can be substantial. One estimate of the effect of Pakistan's ration system has calculated that increments equal to 8.6% of caloric requirements and 24% of protein requirements were obtained by the second lowest income class (Rogers and Levinson 1976). A study of the U.S. food stamp program has estimated that each dollar of stamps increased food consumption by 35 to 60 cents. This measure does not indicate whether absolute quantity of food increased, or whether more expensive foods were purchased, and so does not necessarily reflect nutritional impact. These increases in family food intake also do not necessarily document the net gain to the preschoolers and pregnant and lactating women within families. A larger portion of the increased family intake due to the subsidy might go to older siblings or older adults, rather than to those in the target groups. Such diversion obviously would decrease nutritional impact on the target group, but might be of benefit if the improved consumption resulted in increased work capacity or school performance of older members. Here is an area where nutrition education might be effectively coordinated with food subsidies. Education can provide the motivation to change intrafamily distribution patterns, while subsidies can make it possible to do without reducing present consumption levels of any family members.

In their study of the CONASUPO program in Mexico, Sanchez and co-workers (1978) found the percentage contribution of milk to both calorie and protein adequacy among preschoolers receiving subsidized milk is larger than the family percentage and larger than that of the control group of preschool children. This indicates that the families receiving milk may favor the child in the distribution of CONASUPO milk, and that they are thereby able to improve the adequacy of preschool food consumption. Ration programs in Sri Lanka in 1970 were found to have provided about 20% of total caloric intake and 14% of income for the lowest income group (Isenman 1978). Only 5% of the population was found to be consuming less than 1900 calories per day.

Since many countries already have well entrenched food price subsidy programs, it is important to ask what would be the nutritional effect of reducing or eliminating these programs. The indications are that food consumption, particularly that of the poor, would be substantially reduced if subsidies were eliminated and prices rose (Taylor 1976; Rogers 1978). Taylor has calculated that the elimination of food subsidies in Egypt would have a powerful negative, contractionary effect on the economy as a whole.

Food price interventions might be made more cost effective from the nutritional standpoint by incorporating some of the design considerations discussed above. Individual programs might be improved by expanding the number of commodities subsidized (or by changing those now subsidized) to include more nutritious foods and those for which demand is greater among the poor, by increasing the availability of distribution outlets, by adjusting quantities available or prices charged, and possibly by expanding outreach and including more target households in the program.

Ongoing evaluation should ideally incorporate indicators of cost, coverage of the target group, and leakages outside the target group as well as measures of influence on food and nutrient consumption and nutritional status. Studies mentioned above have measure increases in calorie consumption due to subsidies (Rogers 1978; Taylor 1976; Isenman 1978). These increases, however, usually refer to the amount of calories distributed per person, rather than actual changes in the quantity of food eaten. Surveys of individual food consumption and nutritional status might be preferable measures of nutritional effectiveness of subsidies as well as of other nutrition interventions. But since nutritional status is strongly influenced by other factors, its use may not be an unequivocal indicator of the effectiveness of subsidies in delivering food to target households.

To recap, the effectiveness of food subsidy programs can be measured by the following:

(1) percentage of total family calories and proteins represented by the consumption of the subsidized foods (importance of subsidy in diet);

(2) increase in family intake of calories and proteins after participating in program (longitudinal, assesses net nutrient gain taking account of substitution effect, that is, displacement of previously consumed foods by subsidized foods);

(3) increase in family intake relative to a control group (isolates effect of subsidy from other external changes);

(4) increase in intake of at-risk family members relative to average family intake (assesses intra-familial sharing);

(5) improvement in anthropometric measurements of at-risk groups relative to control groups (assesses one aspect of biological impact).

Subsidies may in part influence equity. To the extent that the subsidies result in a real income transfer to the poor and thereby reduce income disparities, subsidies to maintain low prices may be justified in part by equity considerations. Additionally, where income limits food intake in a nutritionally marginal population, a target-oriented price system can provide an effective, efficient, and impartial way of improving food consumption, and through that, nutritional status and health.

B. SUMMARY:

EFFECTIVENESS

Some price subsidies have been shown to increase caloric intake, though their relationship to nutritional status and nutrition-related health problems is indirect. Ongoing evaluation should consider costs, coverage of the target group, leakages outside the group, and changes in food consumption, as well as changes in nutritional status. Where food price subsidies are already in effect, planners should consider the implications for food consumption and nutrition if subsidy programs were cut back.

Effectiveness measurements include (1) percentage of total family intake subsidized, (2) increase in family nutrient intake after participation, (3) family intake increase relative to control group, (4) intake increase of at-risk group relative to family, and (5) improved anthropometry relative to control.

CHAPTER FOUR

CASE STUDY: PAKISTAN'S RATION SHOPS*

I. INTRODUCTION

Pakistan, like all the countries of the South Asian subcontinent, has a long-standing program of retail food distribution at subsidized prices. In Pakistan, the program operates through a nationwide system of government-licensed, privately owned ration shops which sell limited quantities of whole wheat flour and sugar. An examination of Pakistan's ration shop system illustrates some of the design considerations discussed in the previous chapters.

This chapter will first describe the Pakistan ration system. It will then discuss the apparent present and potential effectiveness of the program in reaching various income and geographic groups on the basis of its coverage of the population and its rate of use, with specific references to the system's individual design characteristics.[1] An estimate of the program's costs will then be presented, along with a discussion of the factors which influence the level of cost of the program, those which are subject to administrative control, and those which are not. We will then attempt to estimate the magnitude of the program's nutritional and economic benefits to various population groups, including urban and rural populations at various income levels in the four provinces.

In light of the information presented in the first four sections of the chapter, we will then discuss possible modifications in the existing system which might affect one side or the other of the cost-benefit equation. The consequences of eliminating the program altogether will also be considered. This will be done in part to make the point that a program which is already in place and operating must be looked at differently from a proposed program not yet implemented. In the first case, the costs, political and otherwise, of eliminating the program will form part of an evaluation, whereas in the second, the considerable fiscal, administrative, and political start-up costs of the program will be weighed against its potential benefits.[2] The fact that Pakistan's ration system is well entrenched and highly visible will be seen to be an important contributor to its effectiveness.

This study is offered as one example of a food subsidy program. It is not intended to show an ideal system, nor is it presented as a typical case. Many of the principles of program design and administration derived from the Pakistan experience are certainly applicable in other situations, but the political, social, and cultural context of a program are as important as the design of the program itself in determining whether or not it will achieve its goals. Thus, to apply the findings regarding the Pakistan ration system to other countries, one must first give consideration to the effect of those environments' specific characteristics.

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*This case study was prepared by Beatrice Rogers.

II. PAKISTAN'S RATION SHOPS: DESCRIPTION

Two commodities, wheat flour and refined sugar, are distributed through the ration shops. The contrast between them in terms of their handling by the ration system permits a testing of our assertions in Chapter Two about the role of quality in targeting a subsidized food and about the administrative advantages of allowing a parallel free market to exist in a subsidized food.

A. Consumption Patterns

The flour (called atta) distributed through the ration system in urban areas is 100% whole-wheat flour, milled under government supervision in large roller mills. Wheat, consumed mainly in the form of unleavened bread called chapatis, made from atta, is the dietary staple of Pakistan. It is a major contributor of protein and calories to the diets of the poor. At a household income level of 100 rupees ($1.00 = Rs 9.90) per month (a level representing approximately the lowest 5% of the population), wheat contributes an average 51% of the caloric intake and 66% of the protein intake of families, and absorbs 36% of household income (Hammer 1977). At the national median income level of 600 rupees per month, wheat still contributes 41% of calorie and 56% of protein consumption of the household, and accounts for 15% of household income. As is characteristic of food staples, the income share devoted to wheat declines as income rises, while the absolute quantity consumed by a household rises with income at a decelerating rate. This relationship of expenditure to income is known to economists as Engel's Law. Price and income elasticity of demand for wheat are, however, relatively high in the lower income groups. The price and income elasticities of income share devoted to wheat are shown in Table 3.[3] The fact that absolute quantities consumed increase sharply at higher income levels is partly accounted for by the fact that household size is strongly correlated with household income, so that wealthier households not only are able to purchase more, but also have greater demand for food.

Because it is an important contributor of calories and protein, and because the price elasticity of demand is more strongly negative among the poor, wheat is likely to be an effective carrier of a food price subsidy aimed at reducing protein-calorie malnutrition. The fact that it is widely consumed by all income groups, however, means that a nontargeted price subsidy is likely to entail large leakages outside the target group and to be extremely costly. It is therefore fortunate (although not intentional in the program) that the wheat distributed in the ration shops is perceived to be of a lower quality than that available from other sources. Consequently, higher-income consumers tend to prefer nonration wheat.

There are several reasons for this perception. Historically, people in Pakistan have preferred to obtain whole wheat kernels, called gundum, and to have them ground privately at a small mill, so they may be sure that no adulterants have been added. There is a suspicion that any preground flour may be adulterated (Micas Associates 1974), and the suspicion is stronger regarding ration wheat, possibly because consumers

TABLE 3

PRICE AND INCOME ELASTICITIES OF INCOME SHARE DEVOTED TO WHEAT*

Household Income (rs/mo)	Income Elasticity	Price Elasticity	Household Consumption (seers/mo)
100	-.676	-.758	29.18
300	.497	-.624	56.37
600	-.228	-.422	73.43
900	-.125	-.159	75.65

* Calculated for the whole country according to the following equation:

$$\frac{PQ}{Y} = a + \eta_y \log Y + \eta_p \log P \quad \text{where}$$

Y = household income per seer
P = price of wheat (in rupees)
Q = quantity consumed (in seers)
η_y = the income elasticity of demand for wheat
η_p = the price elasticity of demand for wheat

**Rs. 9.90 = U.S. $1.00.

***1 Seer = .932 kg.

Source: Hammer 1977.

know that the shop owner's profit margin is fixed so that he can increase his profit only by diluting the product. Urban consumers are becoming more accustomed to purchasing packaged foods, however, so the bias against buying flour already ground is diminishing. Another reason for the low quality image of ration atta is that in the past a considerable proportion of it has been made from imported wheat, obtained from commercial and food aid imports. Imported wheat is usually of a variety higher in protein than the locally grown type, but it is also darker in color and produces, according to consumers, a rubbery chapati. Open market wheat and atta are usually of the domestic variety, which is preferred. Although wheat imports have fallen off sharply since 1975-76 so that less imported wheat is used in ration atta, the negative perception of ration atta has persisted.

Two points should be made regarding the issue of low quality ration atta. One is that it has never been part of the government's intention to provide an inferior product through the ration system. Considerable publicity is in fact given to government efforts to upgrade and monitor the quality and purity of the atta. The second point is that much of the fear of adulteration of the atta may be a matter of consumer perception rather than fact. Personal observation by the author in ration shops throughout the country and at different times of year has not revealed ration atta which has been excessively moist, or spoiled, or apparently adulterated. While such atta probably does reach the market occasionally, this may indeed be the exception rather than the rule.

Regardless of its validity, the negative image of ration atta causes its consumption to fall off more rapidly than that of free market atta or whole wheat, as income rises. The expenditure elasticity of quantity consumed is negative for above-median income households in both rural and urban areas, as is characteristic of an inferior good (Rogers 1978). Average per capita consumption of ration atta in urban areas is 6.5 kilos per month in below-median households, and 5.3 kilos in those above the median, a substantially smaller amount.

In order to measure the equity of distribution of a good in a population, the concept of intensity of consumption has been developed. It is used to determine whether a subgroup in the population consumed a disproportionate share of the available supply of a good. It is calculated as the ratio of two proportions: the proportion of total supply of a good consumed by the particular subgroup, and the proportion of that subgroup in the population. For example, say that the city of Karachi represents 5% of Pakistan's population, and that 20% of all automobiles in Pakistan are bought and used in Karachi. Then the intensity of consumption of automobiles by Karachi is .20/.05 or 4.00. If the ratio is greater than 1.00, the group consumes more than it would under strictly equitable distribution. If it is less than 1.00, the group is consuming less than its "fair share".

The intensity of consumption of wheat by the below-median income population is .95 which indicates that the poor consume somewhat less than their share of the total wheat supply in the country. By contrast, the intensity of consumption of ration atta by this group in urban areas is

1.11, which indicates that the poor consume a larger share of this commodity. (Since ration atta is not ordinarily available in rural areas, a comparable figure for the rural poor cannot be computed.)

In marked contrast to ration atta, the sugar distributed by the ration system is far from being perceived as an inferior good. In fact, refined sugar is strongly demanded by all income groups. The expenditure elasticity of demand for ration sugar is significantly positive in urban areas and rural above-median groups, and per capita ration sugar consumption is slightly higher in the above-median than in the below-median groups in both urban and rural areas.

Sugar does not have the nutritional significance of wheat in the Pakistani diet. It contributes about 6% of average caloric intake. (This value is almost the same at household income levels of 100, 600, and 900 rupees per month. Of course, the same percentage contribution of calories represents a considerably larger absolute quantity consumed at higher incomes, since total caloric intake is much higher.)

Nonetheless, consumers apparently consider sugar to be virtually an essential commodity, at least in some quantity. At an income level of 100 rupees per month, households devote an average of 12.8% of their income, a substantial proportion, to the purchase of refined sugar. Since imports of sugar are restricted and available supply is therefore limited, one function of the ration system is to regulate demand in order to prevent upper-income households from bidding up the price, and to ensure access to supply even by low-income groups. The system does serve to make the consumption of sugar more egalitarian: intensity of consumption of ration sugar by below-median income households is .93, whereas that for all refined sugar (ration and black-market) is only 1.78.

B. Market Control by Ration Systems

Sugar is subject to statutory rationing. This means that the entire supply of refined sugar is controlled by the government. No trade in this commodity may legally take place except under government auspices, and at the retail level it may take place only in the ration shops. In contrast, atta is subject to provisioning. This means that all consumers are guaranteed access to a limited quantity at a fixed low price from the ration shops, but additional supplies of atta and other forms of wheat are freely available at uncontrolled prices on the open market. In the case of sugar, the government exercises monopoly control over its supply and distribution. In the case of wheat, the government enters the wholesale market competitively with other suppliers and exercises no control over retail sales except through the ration system.

C. Distribution of Ration Commodities

The ration system operates throughout the country in the four provinces (Baluchistan, Northwest Frontier Province or NWFP, Punjab, and Sind), and in the federally administered territories of Azad Kashmir and the Northern Areas. Shops are established in both urban and rural areas,

but wheat is distributed only in urban areas and in wheat-deficit regions. Urban areas are defined as towns with a polulation of 10,000 or more and with more than 50% of the population deriving its income principally from nonagricultural sources. Wheat deficit regions are those regions which are net importers of wheat. These are mainly in the provinces of NWFP and Baluchistan, and include Azad Kashmir and the Northern Areas.

It is important for our subsequent discussion to note that the ration atta is sold only in urban ration shops. In the federal territories, in rural areas where wheat is sold, and in much of Baluchistan, ration shops distribute the more highly prized whole wheat kernels, called gundum. This seems to be done primarily for reasons of logistical convenience. Therefore, we would not expect to observe self-targeting of wheat towards low-income households in these areas.

Sugar is, by law, distributed in all ration shops, both urban and rural, although the size of the sugar ration is smaller in rural areas. Of course we would not expect to observe self-targeting of sugar at all, since sugar is not an inferior good like atta.

III. ADMINISTRATION AND MANAGEMENT OF THE RATION SYSTEM

The ration system is administered mainly at the provincial government level, subject to national policy determined by the central government. Day-to-day management of individual ration shops is the responsibility of the shop owners.

A. Central Government

The central government determines the size of the ration and the price structure for the rationed foods. It sets the procurement prices, intended as a production-incentive support price, for domestically produced wheat, and the price at which this wheat is issued to the provincial governments. Central government funds make up the difference in these prices. The prices at which atta may be issued to shop owners and sold to consumers are also centrally determined. The central government has sole responsibility for importing wheat, and pays for its transportation to provincial storage depots. It also pays for the difference between the import price and the issue price. However, imports are being reduced due to rising local production; the government has no plans to import wheat after 1978. This means the ration system will be supplied entirely by domestic wheat, which will be less expensive for the government. If increases in domestic supply continue, then wheat prices on the open market may fall to the level of the ration price. If this happens, the ration shops will simply sell wheat (atta or gundum) without restriction at the market price. This has happened before in Pakistan's experience.

The central government purchases all the output from sugar refineries at fixed prices. The price is intended to encourage modernization of refining facilities, primarily by affording a premium to the largest, newest mills. Sugar producers within a fixed distance from each

refinery are required to sell their entire crop to the refinery, also at centrally determined prices. There have been no imports of sugar since 1973. The price structure for the procurement and distribution of sugar has been set with the intention of controlling the price, but not providing a subsidy. Sugar distribution is supposed to be at cost. In the past two years, due to an increasing volume of sugar from the newer mills, a slight subsidy on sugar has evolved; this is absorbed by the provinces.

The federal government also pays for the bags in which wheat and sugar are distributed. This is important because resale of these bags is the main source of profit to shop owners. Since the costs of the ration system are paid out of general government revenues, it is difficult to identify the exact source of the funds which are used to pay for the wheat and the bags.

B. Provincial Governments

Provincial governments are responsible for domestic procurement of wheat, for purchase of imported wheat from the central government, and for the transportation, milling, and storage of ration wheat and sugar. They establish regulations for the operation of the ration shops, which therefore may vary from one province to another. For example, these shops in NWFP and Punjab may sell only ration foods, whereas in Sind they may sell other commodities as well. District and local offices of the provincial Food Departments issue licenses to operate ration shops, supervise shopowners through regular inspection of their stock and records, and provide stocks to the shopowners from provincial warehouses. The offices also issue ration books to consuming households. Although ration system personnel are authorized to visit applicants at home, in order to ensure that household size has not been overstated, such checking is apparently not done very often.

C. Shop Owner

Each ration shop is privately owned, although subject to licensing and supervision by the provincial government. The shopowner pays rent on his shop and wages to any staff he may hire. He orders sugar and atta according to his needs up to the maximum quota for the number of recipients registered at his shop, and he arranges and pays for transportation of commodities between the warehouse and his shop. He keeps records of the amounts sold and to whom, and records his sales in customers' ration books as well to ensure that the quota is not exceeded.

The margin of profit between the wholesale price and the selling price of sugar and atta is quite small: about one paisa (one one-hundredth of a rupee) per kilo of atta, and only three paisa per 100-kilo bag of sugar. These margins are more than taken up by the operating costs of the shop. The profit to the shopowners is in the sale of the bags in which atta and sugar are delivered. These sell for Rs 4.00 (U.S. 40¢) to Rs 8.00 (U.S. 80¢) apiece.

Of course additional profit may be made by selling sugar on the black market or wheat at open-market prices. This may be done by diverting legitimately obtained supplies, either by refusing to sell to ration card holders or by selling any unclaimed surplus. Another way to obtain extra supplies is by padding the number of registered recipients, either through false applications for cards or by failure to remove recipients from the rolls when they die or move away. It is not known exactly how widespread these practices are. (Some indications are discussed in Section III.) However, it is known that Karachi, which had a census population of about 3.5 million people in 1972, had 5.1 million people registered as ration recipients in 1974-75. Similarly in Lahore, it has been found that the 1975 ration population of 4.2 million exceeded the census population of 2.1 million (Rogers and Levinson 1976). (Of course, there are incentives for avoiding being counted in the census, so the discrepancy should not be entirely attributed to inaccurate ration-shop records.) Most program officials believe such practices are aimed at obtaining extra sugar for sale through the black market, rather than atta.

D. Ration Shop Operation

1. Number and Distribution of Shops

It is central government policy that there should be one shop licensed for every 3,000 to 6,000 individuals. If a shop's registered population goes above 6,000, a second shop is to be licensed in the same neighborhood and the customers divided between the two. On the basis of population estimates, the number of shops far exceeds, on the average, that necessary to maintain this ratio. Average availability ranges from one shop for 1326 people in urban NWFP, to one for 1878 people in rural Sind. In the remote desert areas of Baluchistan and in the mountainous parts of the federal areas, however, much of the population is probably unable to reach a shop regardless of average availability. These areas account for less than 8% of the population.

As mentioned above, it is not unlikely that the registered population of the shops exceeds that actually served. In addition to the shopowner's misreporting, households may overstate their number of members. It is not uncommon for a household head working in a city to register his whole family there, even though they live (and may even receive their ration) in a rural village, in order to obtain the higher urban quotas.

2. Hours of Operation

Urban ration shops are open all day, five days a week, all year. In rural areas, the schedule is more variable. Shops open for a few days a month, when supplies are available. Apparently, they may not always be open at the same time each month. Clearly, this means that in rural areas consumers who are unable to afford their whole quota at one time cannot purchase the rest of it later in the month, because the shop is then closed. Also, there is sometimes difficulty in getting information about when the shop is going to be open.

3. Size of the Quota

The urban quota of ration atta is one seer (932 grams) per "unit" per week. Adults (over age 12) represent two units, whereas children and infants represent one unit each. The adult quota is therefore 7.5 kilos per month, and the child's is half that. The adult quota of wheat, if it is all consumed, represents an average daily intake of 825 calories and 26 grams of protein (USDHEW 1972). This amount constitutes roughly one-third of the average caloric intake requirement for adults, and more than half the protein requirement (although in the amounts consumed, the wheat protein is incomplete without a suitable pulse or animal protein complement [WHO 1974]). In recent years, since there has been no shortage of wheat, children have been receiving the adult quota in most places.

The rural quota is the same, when it is given. In many areas, wheat is given only at certain times of the year (e.g., before harvest), and, since many people take only their sugar ration, more than enough wheat is available to give as much as is wanted to those who do use it. This is because at present (in 1978) supplies of wheat are plentiful. In conditions of scarcity, this would not be the case.

In Azad Kashmir and possibly in the other federal territories, the quota is lower: 2.33 kilos per person per month, regardless of age (Levinson 1976). The sale price is also slightly lower. The size of the quota may be constrained by availability. In Tarbela Township, a city growing very rapidly in 1976 due to migration from villages flooded by the new dam, people have reported receiving half-quotas of wheat. In Azad Kashmir, the quota is sometimes as low as .82 kilos per person per month. where supplies have not arrived. The wheat quota is not varied according to whether it is distributed as atta or gundum.

The quota of sugar is the same for adults and children. In urban areas and in Sind and Punjab, it is 940 grams per person per month; 1400 grams in NWFP, and 700 grams in Baluchistan. Rural quotas are less. They range from 235 grams in Punjab and NWFP, to 470 grams in Baluchistan. In Punjab and Sind, there is an official "town" quota of sugar, which is between the rural and the urban one. However, the definition of these "towns" has not been available.

The quota size of both sugar and atta determined by the central government appears to be based on availability and cost to the program, rather than on some concept of nutritional need. Program officials have been unwilling or unable to explain the basis on which the provincial quotas are determined. Undoubtedly this is a highly sensitive political question. Apparently one objective of the program is to satisfy politically active segments of the population, such as workers in large urban centers and some tribal areas, including parts of NWFP and the federally administered territories. Thus presumably, a political motive enters into the determination of quota size.

4. Price of Ration Foods and Size of the Subsidy

Table 4 gives the range of prices observed in the country over a four-month period (September - December 1976). On the average, ration atta is about two-thirds the price of market atta, and ration sugar is about half the price of sugar on the black market. Note that gundum is less expensive than open-market atta. This is because the processing cost of gundum is incurred by the consumer after purchase and so is not included in the market price. The effective subsidy to the consumer varies with the cost of open-market substitutes for the subsidized food. Gundum is a high quality substitute for ration atta, whereas gur, or unrefined brown sugar, is a low quality substitute for refined sugar. It should be noted also that substitutes are not always available in the market.

Gur is sometimes not found in urban markets, and atta or gundum or both may be unavailable in various regions and seasons. The Micronutrient Survey has found whole wheat for sale in only 40% of urban Punjab markets, and atta for sale in only 25% of rural markets, for example. Therefore in some cases, the relevant price differential is not between ration and market atta, but between ration atta and its closest available substitute.

The size of the subsidy paid by the government, which is the difference between its agricultural support price for wheat and the price at which it is issued for sale, does not vary regionally or seasonally. The effect of the subsidy, though, is greatest when and where other foods are relatively more expensive.

5. Ration Consumer Eligibility

There is no limitation on eligibility to receive rationed foods. Any resident of Pakistan, citizen or foreigner, may obtain a ration book. The application procedure exists only to determine the number of household members and to assign households to a shop. Temporary cards are available for people who will be resident in an area only for a limited period of time.

According to program officials, the application procedure takes only a few hours. It is not known the extent to which the application procedure deters people from obtaining ration cards, but the Micronutrient Survey found that the overwhelming majority of the population participates in the ration system. Since the application requires a household to list its residence, there is the possibility that the small percentage of homeless individuals in Pakistan, who are certainly in the poorest segment of the population, may not be able to obtain ration food. Many of these people have no cooking facilities either. They might not be able to use the commodities, except to sell or barter.

TABLE 4

PRICE RANGES FOR RATION COMMODITIES AND THEIR SUBSTITUTES
(Rupees per seer)

Food	Mean	High	Low	(N)
Urban				
Gundum	1.21	1.55	0.55	145
Ration Atta	0.92	1.13	0.87	265
Market Atta	1.32	2.25	1.00	249
Gur	2.92	6.00	2.00	270
Ration Sugar	4.27	5.00	4.00	176
Market Sugar	9.13	10.00	5.50	20
Rural				
Gundum	1.08	1.50	0.87	500
Ration Atta	0.95	1.13	0.80	255
Market Atta	1.29	1.75	1.00	413
Gur	2.53	5.00	1.25	777
Ration Sugar	4.16	5.00	3.00	358
Market Sugar	7.35	10.00	5.50	183

E. History of the Ration System

The ration system was established by the British in 1942, to deal with shortages of goods caused by the war. At that time the shops handled a variety of essential commodities including, in addition to wheat and sugar, tea, matches, kerosene, yarn, and cotton cloth. The system was continued after Partition in 1947, to control hoarding and profiteering on items which were still scarce.

Wheat was subject to statutory rationing, and there was a government monopoly on its trade until the early 1960s, when supplies became adequate, rationing was abolished, and free trade in grain was allowed as an incentive to production. The ration shops continued to sell atta, which the government obtained through its guaranteed-purchase price-support scheme for farmers, but with no limitation on quantity. Bad weather and disruption due to the war with India rendered supplies scarce again in the mid-sixties. Provisioning (the supply of a limited quantity at a subsidized price, with more available at higher prices), but not the government monopoly, was reinstituted then, and has continued to the present.

Distribution of sugar through the ration shops was started during the Korean War, when high demand for textile fibers shifted domestic production away from sugar. Statutory rationing was introduced in 1972, in order to limit the demand which was causing a drain on foreign exchange due to imports. As mentioned earlier, the importing of sugar was ended in 1973.

In 1972 and 1973, there was a severe shortage of vegetable oil, and the ration shops were used to control the price and ensure equitable distribution of this commodity. The oil became available once again in unlimited quantities on the open market after 1974, though the price was - and still is - controlled.

During the history of the ration system, the product mix, and the price and size of the ration, have varied. Prices have been raised in response to inflation and to fluctuations in the international market. Ration size has varied somewhat with availability. This flexibility, which has been part of the program from its inception, has allowed its costs to be kept under control and has contributed to its viability.

The ration system is a long-standing and highly visible program. It serves an important political purpose as an apparent demonstration of the government's concern for the common people, and an economic one as a buffer against fluctuations in the price of the basic food staple. For this reason, any attempt to limit or eliminate the system would undoubtedly be extremely unpopular and politically unwise. Furthermore, the system, as it now operates, represents a lengthy period of development and a considerable amount of experience. Shops are widespread and accepted throughout the country, and supply procedures and logistics are well established. These factors, too, constitute an argument in favor of maintaining and working with the system as a means of reaching much of the Pakistan population.

IV. RATION SYSTEM EFFECTIVENESS: COVERAGE AND USAGE RATE

In this section, we discuss the specific design features of the ration system which influence (1) its accessibility to the popultation; (2) the rate of use of its commodities and the extent of targeting of these commodities toward low income groups; and (3) the availability and reliability of supplies. The relevant design features are, in the first instance, the use of private entrepreneurs and the incentive of profit; in the second instance, the choice of commodities with certain quality characteristics and consumption patterns; and in the third instance, the quality factor and the existence of a legal, parallel free market in the subsidized food. In the next section, the task of estimating the nutritional and economic impact of the ration program is undertaken.

A. Ration Shop Accessibility[4]

Providing services of any kind to the whole population of Pakistan presents a problem, because there are large areas in which adequate, year-round roads are not available; transportation is often unreliable; and in some regions population density is quite low. Baluchistan, which contains only 4% of the population of Pakistan but is its geographically largest province, presents the most serious obstacles to service delivery, but there are mountainous parts of NWFP and desert regions of Sind which are similarly remote and inaccessible.

Reaching the small proportion of the population in these remote areas with social programs may be many times as costly as reaching the bulk of the people who live closer to roads and transportation. However, almost any area which supports a market of any kind can be reached by a ration shop, since the mechanisms of the shop are, in fact, those of the market. The incentives to establish a ration shop are much the same as those for establishing any other small business, and the obstacles are not significantly greater, particularly in underserved areas where there would be no competition for obtaining a license. Government resources and administrative capacity are not severely taxed in setting up additional ration shops, since, after licensing, other arrangements are the responsibility of the individual entrepreneur. This is undoubtedly one reason why they are so widely available.

In urban areas, about 95% of all households have a ration shop within half an hour's walking distance. More than 99% have a shop less than an hour away. The urban population not covered by the ration system is virtually negligible.

In rural areas, coverage is high compared with other services, but it is not universal and there are significant interprovincial differences in ration shop availability. In Baluchistan, with its very low population density, only 32.5% of rural households have a shop within an hour's distance, and 67.5% of households have no access to a ration shop. In the other three provinces, 75 to 80% of households can reach a ration

shop within an hour. In Punjab, the most agriculturally productive province, 19% of rural households do not have a shop, possibly because local production of wheat and sugar is high enough to obviate the need for one. In the other provinces, shops are available at more than two hours' distance to 15% to 20% of rural households. Not surprisingly, distance is significantly related (inversely) to use of the shop. Nonetheless, 40% of the rural households which must travel more than two hours to a ration shop do purchase sugar there, and half of these households which have ration wheat available purchase it as well.

The high coverage by the ration system is in striking contrast to other government delivery systems. For example, only 56% of urban households by their own report have access to any government health serives. In rural areas, this figure drops to 40%. Furthermore, coverage is extremely uneven, with notably superior coverage in Punjab and fewer available services in Sind. This is in marked contrast to the ration shops, which are approximately evenly distributed through the country, except in Baluchistan.

. Usage Rate of Ration Shops

About 90% of the households which have a ration shop available to them purchase sugar there. In urban areas, the figure is 95%, and there are no significant differences among provinces. In rural areas, the rate of use for the purchase of sugar ranges from 88% in NWFP to 51% in Sind. The relatively low rate of use in Sind is attributed by respondents to the fact that the shop, apparaently unlike those in other areas, frequently runs out of supplies of sugar. The high rate of use of the shops for sugar nationwide indicates the lack of obstacles to participation in the ration program. (Except, of course, in areas where no shop is available). Since shops are located in the bazaar where households do their ordinary marketing, no major alteration in behavior is required to take advantage of the ration system. Since sugar is not legally available elsewhere (and is twice as expensive on the black market), motivation to use the shops is high.

The rate at which households purchase wheat at the shops is somewhat lower, since not every family chooses to make use of its allotment. In urban areas, the percentage of households purchasing ration wheat ranges from 72% in Sind and Punjab to 94% in NWFP and Baluchistan. In rural areas, the use of ration wheat, in areas where it is available, ranges from 80% in NWFP to zero in Sind. In rural Baluchistan, all households which can purchase ration wheat do so. It is evident that, in urban areas, a higher percentage of households make use of their atta ration than could probably be considered truly needy. Nonetheless, there is some degree of targeting toward the poor, which is evident in the consumption pattern of ration atta in urban areas described previously. Average per capita consumption of ration atta in urban households of below-median expenditure is 6.92 kilos per month, about one kilo per month below the quota. This figure is 29% higher than the average of 5.36 kilos in above-median households. Average total wheat consumption (all forms of wheat) is about nine kilos per month in both groups.

Table 5

Mean Per Capita Consumption of All Wheat and Ration Wheat by Income Group
(kilos/month)

	Rural		Urban	
Total Expenditure	All Wheat	Ration Wheat	All Wheat	Ration Wheat
Below Median	13.62	4.25	9.35	6.52
Above Median	15.70	4.49	9.21	5.36

In low-income groups, 69% of this amount is provided by the ration shop. On average, low-income households purchase only 88% of their allotment, but this is because in some areas wheat is not always available at the shop. Both high and low-income groups purchase about the same percentage of their wheat in the form of atta (about 82%), but in the high income group a small proportion of this is obtained from the ration shop, presumably because of the perceived quality difference. In fact, poor quality is the most common reason given in urban areas for not purchasing available ration atta. And among higher-income respondents not purchasing ration atta, poor quality is given as the reason more frequently than among low-income respondents.

Expenditure elasticities of quantity of ration atta consumed[5] confirm that this product is considered inferior among the upper-income urban population. The elasticity is 0.910 for below-median households, and falls to -.601 for the above-median group. These elasticities are computed for quantity consumed rather than income share. This means that the numerator in the ratio, which determines the elasticity (the percentage change in consumption divided by the percentage change in household expenditure), is the quantity of atta consumed, rather than the share of total household expenditure taken up by ration atta. Thus, as household expenditure rises above the median, less ration atta is purchased, as it is presumably displaced by superior quality wheat as well as other foods. By contrast, the comparable elasticity for gundum (whole wheat) is zero in the below-median population and 1.05 above the median.[6]

In rural areas, where gundum is sold through the ration shops, it is not surprising to find that there is no clear evidence of targeting toward the poor, since gundum is not a low-prestige product. In areas where ration wheat is sold throughout the year (only a small and atypical proportion of rural areas), there is no difference in per capita ration wheat consumption between upper- and lower-income households. The figure is slightly over four kilos per month for both groups. Expenditure elasticity of demand for the ration wheat does shift from positive to slightly negative, as income moves above the median, but this is true of all wheat. In the higher-income group, households are shifting in their consumption patterns away from wheat and atta and toward foods of higher perceived quality, such as rice, milk, beef and mutton, and chicken.

These findings indicate that the relatively low perceived quality of the ration atta distributed in urban areas has an influence in targeting the atta toward lower income groups. Although the leakages to the non-needy (above-median) population are substantial, it is likely that a stronger quality differential would result in a more narrowly targeted program. (It should be noted that any concept of leakage is based on the idea of targeting the subsidy to the needy. The Pakistan government does not consider distribution of subsidized wheat to the wealthy a leakage.)

A comparison of these results with those relating to the consumption of sugar demonstrates the difference in distribution pattern when a high quality, luxury product is sold. In both urban and rural areas, per capita consumption of ration sugar is higher in the upper-income groups. In the cities, monthly consumption is .91 kilos, compared with .83 kilos below the median. In rural areas, the figures are .21 kilos and .18 kilos, not significantly different from each other. Expenditure elasticity of demand for ration sugar remains positive at all income levels; in rural areas, the elasticity is higher in the upper income group. Clearly, no targeting of the subsidy is evident in the case of sugar. On the other hand, the ration system definitely serves the function of equalizing the distribution of sugar by limiting the quantity available to upper-income consumers and by guaranteeing access to the supply by those low-income consumers who are able or willing to pay the price. And of course, the price is considerably below what it would be without government control; witness the black market price of up to Rs 10.00 per seer, compared with the ration price of Rs 4.50. The intensity of consumption of ration sugar by below-median-expenditure households is .93, indicating that they consume slightly less than an equal share of the total supply. But the comparable figure for all refined sugar (ration as well as black market) is .78, showing the markedly less egalitarian distribution. Of course, if ration sugar were eliminated from the calculation, the distribution of the black-market sugar would be much more biased towards upper-income consumers.

Evidently, most consumers would purchase more sugar if they were able to. No one ever suggests that ration sugar might be of inferior quality. There are households which have a ration shop available to them but do not purchase sugar. The reasons given for this pertain mainly to problems in supply: the shop runs out too frequently or does not sell sugar. Interestingly, 17% of the rural households failing to purchase sugar have given as their reason that "the shop is for richer people." Since this has virtually never been mentioned as a reason for not purchasing atta, it is one more indication of the high quality image which ration sugar possesses.

C. Reliability of Supply

The majority of ration shops seldom if ever run out of supplies of atta or sugar. Table 6 shows the frequency with which households have reported that their shop runs out. It is clear, however, that shops are

TABLE 6

FREQUENCY OF SHOP RUNNING OUT OF RATION COMMODITIES
(percent of households reporting)

Frequency of Running out	Atta		Sugar	
	Rural	Urban	Rural	Urban
Never	78.6	90.1	69.1	92.1
Less Than One in Four Visits	13.5	7.9	2.1	4.9
One or Two in Four Visits	1.3	1.8	3.4	2.3
Three or Four in Four Visits	0.0	0.2	19.7	0.4
Always	6.6	0.0	5.7	0.3
N	67	186	452	247

more likely to run out of sugar than of atta. Rural shops are more likely than urban ones to run out of either commodity, and they run out of sugar significantly more frequently. Fully 25% of rural households have reported that their shop usually or always is out of sugar. This is reflected in the fact that, of the 28% of rural dwellers who do not purchase ration sugar, 86% have said this is because the shop runs out too often or does not sell sugar at all. Since all ration shops are by law supposed to sell sugar, this is a further indication of problems in supply.

These respondents frequently have accused the ration shop owner of selling sugar on the black market or of saving it for his friends or for influential people in the village. Clearly, there are considerable incentives to divert the supply of sugar away from the ration shop, and this is reflected in the lower level of supply reliability. In fairness, since sugar is to be distributed in more locations than wheat, legitimate problems in supply may also be greater for this commodity. Nonetheless, the non-producing rural regions where wheat is sold also tend to be in the remoter areas, mountains and deserts, and yet supply is relatively reliable.

When shops do run out of atta, most consumers (62%) say they buy it in the bazaar. Twenty-one percent come back to the ration shop later for their quota. When shops run out of sugar, most consumers (72%) say they buy an alternative (probably gur) in the bazaar. Only 6% say they return to the shop. Thus, there is a lower expectation with sugar that supplies once exhausted will subsequently become available.

Having a shop run out of sugar does not appear to be related to the income level of the purchaser. There are interprovincial differences, however. Shops in rural Sind run out of sugar more frequently than elsewhere. Sind contains large areas of desert, and transport is unavailable in these places. However, similar difficulties exist in Baluchistan and in mountainous NWFP, so it is not clear why the problems should be greater in this one province.

V. QUANTIFYING THE NUTRITIONAL AND ECONOMIC BENEFITS OF SUBSIDIZED FOOD DISTRIBUTION

In the case of a subsidy which has no restrictions on quantity, the effect on consumption may be measured by the price elasticity of demand for the subsidized food and the cross-elasticities of demand for other contributors to the diet. The changes in consumption of various foods expected to result from a change in the price of the subsidized food can be converted into nutrients to predict a net change in nutrient intake. Of course, an increase in nutrient intake can be considered of nutritional benefit only if the consumer were eating too little before the subsidy was implemented.

When a subsidy is combined with rationing, the measure of its effect on consumption depends on whether or not the ration limit is less than the quantity consumers would choose to buy in the absence of the quota.

Three possibilities for ration size relative to demand can be considered. The ration may be greater than the quantity consumers choose to purchase, even at the subsidized price. In this case, the ration represents no real constraint on consumption, so the effects of the subsidy may be measured by direct and cross price elasticities, just as in an unrestricted subsidy. The consumer increases his consumption of the subsidized food somewhat but still falls short of the limit.

If the quota is fixed at a point less than the desired consumption, the effect of the subsidy will be measurable by a combination of price and income elasticities. The consumer will increase his consumption of the subsidized food up to the quota limit, and will alter his consumption of other foods according to their changed relative prices. However, he cannot buy as much as he wants at that price; having reached the limit, he still has an increment in real income to spend on unsubsidized good, including unsubsidized quantities of the subsidized food.

If the quota is less than the amount that would be consumed at the prevailing market price, the consumer would purchase at least the rationed quantity of the subsidized food even if it were not subsidized. In this case, the price subsidy functions simply as an income transfer. Since the quantity which may be bought at the subsidized price is inframarginal, relative prices of goods at the margin are not altered, so price elasticity of demand is not the relevant concept. The consumption effects of a subsidy combined with this kind of quota may be predicted by looking at income elasticities of demand and at the size of the income increment due to the price subsidy.

A subsidy unrestricted in quantity has several advantages, from the point of view of benefits, over a subsidy with ration. Of course, if there is no restriction on the amount of a subsidized food which may be purchased, those who want the good can obtain a larger income increment than they can in a restricted program. (This is a disadvantage from the point of view of controlling costs.) Since price elasticities tend to be of greater magnitude than income elasticities, an unrestricted subsidy will cause a greater increase in consumption of the subsidized food than an inframarginal subsidy which gives the same real income increment. Thus, consumption increases can be somewhat directed to particular foods with an unrestricted subsidy, and not with an inframarginally restricted one.

Low income groups tend to have more strongly negative price elasticities than the wealthy. They are, therefore, likely to benefit disproportionately from unrestricted subsidy, since they alter their demand more sharply in response to a change in price. If a subsidized food is rationed and the limit is inframarginal for both the wealthy and the poor, then the magnitude of the benefit is equal for both groups; the targeting effect is lost.

We have already seen that the wheat subsidy in Pakistan is weakly targeted toward the needy because of the presumed poor quality of ration atta: those with income above the median buy slightly less per person than

below-median households. However, the Pakistan ration system is generally of the inframarginal type. Close to 90% of the population consumes more wheat than its ration allotment, and only 3.6% of those who use ration wheat buy less than their quota. (ABout 30% of the urban and 73% of the rural population buys no ration wheat at all. It is not meaningful to classify these people as unrestricted by the ration, since they derive no benefit from the ration in any case - whether measured by price or income.) The ration for sugar restricts virtually everyone. Only 0.3% of the population voluntarily buys less than the quota. Those who do not use ration sugar at all (6% of urban and 28% of rural dwellers) say this is due to outside circumstances, not to their choice.

Since both the sugar and atta rations are inframarginal, their effect on food consumption can be measured by income elasticities of demand for the major food in the diet and the size of the income increment represented by the subsidies. The effect on nutrient intake can be roughly calculated by multiplying the expected change in a food's consumption by the nutrient content of the food. This change affects nutritional status only when the household's members are nutritionally deficient.

In this section we attempt to quantify the nutritional benefits of Pakistan's ration system. This is done by calculating the average income increment represented by consumption of subsidized foods and using income elasticities of demand to estimate expected changes in consumption. There are several conceptual difficulties with this approach. First, it should be noted that the ration system has been in place for 40 years, so the idea of a "change" in consumption is misleading. Pakistani consumers have established demand patterns based on availability of the ration and subsidy system. In quantifying the benefit of this system we are assuming that a rise in prices to free market levels with its consequent lowering of real income would have the reverse effect of lowering prices, although it is known that demand elasticities are not symmetrical (Hogarty and McKay 1975). Also, the elasticities used here are based on cross-sectional data from the Micronutrient Survey, and are being used to estimate changes in demand over time, although such estimation is inaccurate (Sinha 1966).

A more serious difficulty is that of estimating the difference between subsidized prices and those of the free market. In this analysis, we have used prevailing free market prices as a proxy for what prices would be in the absence of a subsidy. This ignores the substitution effect which would occur if the subsidy were withdrawn and prices (for the rationed quantities) rose. Probably the true free market price for atta is slightly lower. The present "free market" price for sugar is a black market price. However, this would probably not fall substantially if the ration were lifted, assuming import restrictions remained in force. Continued scarcity would probably keep the price high. These prices are the most reasonable available estimates for the hypothetical free market prices.

The income increment for each household attributable to the ration system was calculated by multiplying the quantity of each ration commodity consumed by the local price difference between the ration and the

free market price. This was divided by household income to obtain a percentage income increase. Since average benefit for the whole country was sought, nonusers of ration foods are included in the calculation, with an income increment of zero. This means that the potential influence of the system is considerably understated, especially in rural areas where only 15% of households have ration shops which sell atta, and only half of these households use it. The mean income increment from ration sugar and wheat purchases was calculated separately for above- and below-median income households in urban and rural areas.

Income elasticities of demand for 12 major foods were then calculated for these four groups. The mean income increments are shown in Table 7:

Table 7

Mean Income Increment Due to Consumption of Ration Wheat and Rural Households Above and Below Median Expenditure
(Percent of Household Income)

	Rural		Urban	
	Below	Above	Below	Above
Wheat	.1993	.1191	3.4641	1.3819
(N)	(229)	(250)	(95)	(118)
Sugar	.9809	.4761	7.4079	2.9971
(N)	(343)	(353)	(128)	(134)

the income elasticities of demand are presented in Table 8. Income elasticity was computed using a double log equation controlling for household size and province. Province was an important variable since consumption patterns for different foods vary by geographic area irrespective of household income.

For each population group, the income increment due to ration purchases was multiplied by the demand elasticity which was then multiplied by the mean quantity of the food consumed by the household to obtain the mean expected household increase (or, in a few cases, decrease) in consumption of that food. This quantity was multiplied by the calorie and protein content of the food (obtained from the FAO Food Composition Tables for Use in East Asia) and these were summed to obtain the net increase in calorie and protein consumption per household per month. Dividing by the average number of household members in each group, and by the number of days in a month, yields the figures in Table 9, mean daily per capita increase in calorie and protein intake as a result of ration distribution.

TABLE 8

EXPENDITURE ELASTICITIES OF DEMAND FOR FOODS BY INCOME GROUP AND URBAN/RURAL LOCATION[a,b]

	Rural		Urban	
Food	Below Median	Above Median	Below Median	Above Median
Wheat	.3975	.5406	.5313	.2343
Rice	1.0923	.5008	.3805	.6340
Maize	-.1161 (ns)	.1186 ns	.1116 (ns)	.1124 (ns)
Other Cereals	-.1218 (ns)	-.0339 ns	.0339 (ns)	.0582
Pulses	.4226	.6470	.4022	.1497 (ns)
Meat	.8128	.6221	.5326	.7470
Milk	1.7352	.9721	.8688	.8849
Eggs	.9016	1.5245	.9297	1.8000
Vegetables	.8066	.7866	.7166	.6500
Veg. Ghee	.2967	.0457 (ns)	.5255	.1950 (ns)
Sugar	.4630	.6808	.3775	.2720
Gur	.5097	.8942	.1973	.0016 (ns)

a. Computed according to the following equation:

$$\log \text{consumption} = a + B_1 \log \text{Expenditure} + B_2 \log HH + B_3 \text{Bal} + B_4 \text{Sind} + B_5 \text{NWFP}$$

Where Consumption = household monthly consumption
Expenditure = household total monthly expenditure
HH = household size (number of resident members)
Bal = dummy variable for Baluchistan
Sind = dummy variable for Sind
NWFP = dummy variable for Northwest Frontier Province

b. All elasticities (regression coefficients) are significant by F-test at .05 or better except where marked "n.s."

Table 9

Average Per Capita Daily Increase in Calorie and Protein Consumption Due to Ration Distribution

	Rural		Urban	
	Below Median	Above Median	Below Median	Above Median
Calories/ person/day	16.1	11.2	113.8	36.7
Protein (gms) person/day	.59	.39	3.84	1.34

These figures are quite low, except for the urban below-median income population. For this group, which has been estimated to consume about 80% to 90% of its calorie and protein needs, this represents a 6% increment in calorie intake, and about an 8% increment in protein consumption. These increments, of course, would be higher among the lower income, more deficient households. The rural figures are low because in rural areas so few ration shops sell wheat, and the size of the sugar ration is smaller than in urban areas.

The rationale for not distributing wheat in wheat-producing areas is that sufficient wheat is available at low prices, and that such a system would result in farmers buying their ration at the subsidized price and reselling it through the procurement process at the support price.[7] However, even in rural wheat-producing regions of the country, most households depend on the market for at least part of what they consume. In rural areas where ration wheat is never sold, households obtain an average of 39% of their wheat consumption from home production, leaving 61% to be supplied by the market. Furthermore, consumption of home-produced wheat is very strongly positively correlated with income, so that lower-income families are more dependent on the market for their supply of wheat than are wealthier households. And, since prices are subject to wide seasonal variations, even wheat producing areas do not have low-priced supplies available throughout the year.

Clearly then, if we consider the target group to be all malnourished families, a significant portion is missed by the ration program. If the government wanted to reach the needy with a nutrition program, it should probably consider extending some form of subsidy program to the rural areas (preferably targeted through quality as the present rural program is not), or implementing other programs to control price fluctuations of staple foods.

One further consideration relating to the probable nutritional importance of the ration program should be introduced. The food consumption data obtained by the survey is all for an "average" month, based on estimates of yearly consumption. Fluctuations in consumption over time have not been recorded. For a population which is just at the margin of nutritional adequacy, however, these fluctuations, due to short-term variations in income or prices, may be of major significance. Such a population has no savings to draw on, and its health and nutritional conditions are often precarious, so that a slight or brief reduction in food intake may be sufficient to precipitate more severe malnutrition or

disease. Under these circumstances, the ration system may provide a "floor" for consumption, a low-cost source of food that families can turn to when need arises. Obviously, the nutritional impact of the program in such cases would be much greater than that implied by average consumption levels.

VI. RATION SYSTEM COSTS AND BENEFITS

A. Program Costs

The budgetary costs of the wheat subsidy and ration program are made up of the following components: the cost of the wheat itself, net of the price paid for it by the consumers; the costs of procurement, transportation, and storage of the wheat in warehouses, as well as the relatively minor administrative costs of maintaining offices and staff to oversee program operation; and the cost of the bags in which the wheat and sugar are delivered to the ration shops. Milling charges for wheat are included in the price paid by the consumer, and the costs of transport from the warehouse and distribution at the retail level are covered by the shop owners. In the case of sugar, the government pays for procurement, processing, and storage, but these costs are supposed to be fully covered in the retail price, so that the entire subsidy consists of the cost of the bags.8

Obviously, some of the costs of the program are relatively more subject to government control than others. The international price of wheat is an exogenous factor to the Pakistan government as is to a great extent the amount of wheat donated through international food aid. Cost fluctuations due to world market price shifts can only be controlled by limiting the amount of wheat imported and reducing the quantity available, a strategy which is not feasible because of political factors. Although the domestic procurement price is fixed by the government, given the structure of the program (in which wheat sales to the government are voluntary), the price must still be kept at a competitive level in order to procure adequate supplies. And since the program also functions as a price support for farmers, it would probably be politically impossible to lower the price, once raised to meet the demands of a tight market, if supplies once again became plentiful. Logistics and administrative costs are relatively fixed, as is the cost of the bags. (The expense of the ration system increased after the separation of Bangladesh, because jute bags could no longer be obtained internally and had to be purchased on the international market.)

The principal means of limiting the costs of the program are limiting the size of the ration, raising the cost to be paid by consumers, and varying to the extent possible the mix of domestic and imported wheat. The size of the ration is already fixed; the consumer price along with the procurement price has been raised a number of times in the history of the program in response to inflation, most recently in 1975. In recent years, the quantity of wheat available on a donated or concessional basis has fallen off considerably, largely due to cutbacks in United States PL-480 distribution. Commercial imports have also been falling due to increasing domestic production. Wheat imports have fallen from a total of 1.34 million

metric tons in 1974-1975 to 1.17 million tons in 1975-76, and to only 350,000 tons in 1976-77. The cost has fallen even more precipitously, since prices have dropped from their extremely high levels of 1974. The government of Pakistan is optimistic about the continued improvements in domestic production. They anticipate no wheat imports after 1977-78, a situation which should reduce wheat subsidy costs by 45% (Fifth Plan 1978-83).

1. Cost Breakdown and Estimated Direct Costs, 1976-779

Procurement price of domestic wheat is presently set at Rs 37.00 per maund (U.S. $99 per metric ton). This wheat is issued to the provinces at Rs 32.00 per maund (U.S. $86 per metric ton), for a net federal subsidy of Rs 5.00 per maund (U.S. $13.4 per metric ton or 13¢ per kilo). The provincial government issues the wheat to ration shop owners at Rs 34.80 per maund (U.S. $93 per metric ton); the 2.80 rupees is taken up in milling charges, paid by the provinces. In addition, the cost of storage, transportation, and the bags amounts to between 6 and 10 rupees per seer (Ministry of Food 1977). So the subsidy on domestic wheat is Rs 5.00 maund or U.S. $13.40 per metric ton, paid by the central government, plus approximately Rs 8.00 per maund, or Rs 214.40 (U.S. $21.44) per metric ton, paid by the province.

In 1976-77, the federal government purchased wheat on the international market at an average price of $148 per ton, or about Rs $55.00 per maund. This wheat was issued to the provinces at Rs 31.50, a price difference of Rs 23.5 per maund (U.S. $63 per metric ton). In addition, the federal government paid the cost of transportation from Keamari Harbor in Karachi to provincial warehouses, so that the total federal subsidy on imported wheat was Rs 28.50 per maund or U.S. $76 per metric ton (Ministry of Food figures). The provincial subsidy of Rs 8.00 per maund was the same for domestic and imported wheat. Table 10 shows the purchase and issue prices for domestic and imported wheat.

Table 10

Purchase and Issue Prices for Domestic and Imported Wheat, 1976-77
(Rupees per Maund)*

	Purchase Price	Issue Price to Province	Issue Price to Shops
Domestic	37.0	31.5	34.8
Imported	55.0	32.0	34.8

*U.S. $1.00 = Rs 9.90
1 maund = 40 seers = 37.3 kilograms.

In order to estimate total costs for the year, we must first determine the total quantity of wheat distributed through the system, how much was imported, and how much was domestically procured. Since there is a variable lag-time between procurement and distribution, possibly different prices should be assigned to different proportions of the imported wheat, but since we have no way of determining how this should be done, we will simply use the 1976-77 price.

It should be noted that not all the subsidized wheat in Pakistan is distributed through the retail ration system. Subsidized wheat is used in public institutions (schools, hospitals, government hostels) and in feeding the military. Some private institutions use it, and there is provision for open-market sales of wheat at subsidized prices as a means of increasing supply and bringing down prices on the open market. (For example, in 1976-77 wheat was released on the market at Rs 42.00 (U.S. $4.20) per maund as an inflation-control measure.)

In 1976-77, about 80% of total government wheat offtake was distributed through the ration shops: 27% of this in rural areas and 73% in urban areas. Total subsidized distribution was projected at 2.8 million tons, of which 2.4 million were allocated to ration shops. Actual figures for 7 months of Calendar 1976 indicated that distribution might in fact fall below these figures. Based on average monthly figures in April through October 1976, offtake would be 2.2 million tons, 1.7 million of which would go to the ration shops. Projections from the Ministry of Agriculture were that about 34% of these stocks would be made up of imports and the remainder from domestically procured wheat.

Thus for the ration system alone (using the larger of the two figures above) about 816,000 tons of imported wheat would have been sold, and 1.58 million tons of domestic wheat. At an estimated net subsidy cost of Rs 28.50 (U.S. $2.85) per maund on imported and Rs 5.00 (U.S. 50¢) per maund on domestic wheat, there would have been a net federal subsidy cost of Rs 623 million on imported and Rs 211.7 million on domestic wheat. At an estimated Rs 8.00 per maund provincial subsidy, the total spent on ration distribution by the provinces would have been Rs 514.5 million. Total expenditure would have been Rs 1,349 million or $135 million.

Given that we are working with projected figures and estimated costs, these figures are not too far off from the government's own figures for subsidy costs in 1976-77, shown in Table 11, taken from the Fifth Plan.

Since we are concerned in this chapter with the cost of the general consumer subsidy through the ration shops, we are using as the total cost estimate our derived figure of Rs 1,349 million. This is quite close to 80% of the official government figure, which is Rs 1,305 million. This cost represents 5.9% of total government revenues, estimated at Rs 22,894 million in the Fifth Plan, or just about 1.2% of estimated Gross National Product for that year. It is a somewhat lowr cost estimate than that derived for 1974-75 (Rogers and Levinson 1976), especially in view of the substantial inflation since then. But as we have mentioned, various factors, including a lower world market price for wheat and growth in domestic production, have operated to lower the cost. If wheat production continues to improve, costs will be still lower in 1977-78.

2. Indirect Costs

There is considerable discussion in the literature about the potential agricultural disincentive effect of food price subsidies. There

TABLE 11

GOVERNMENT EXPENDITURE ON SUBSIDIES - FISCAL YEAR 1976-1977

Federal	Rupees (millions)
Imported wheat	891
Indigenous wheat	285
Other subsidies	73
Sub-total	1,249
Provincial	
Wheat subsidy	456
Total	1,632

Source: Government of Pakistan 1975.

are several mechanisms by which such disincentives may be felt. The government may procure the food to be subsidized by means of enforced sales by farmers at below-market prices, or it may simply set a limit on the price which farmers may charge for the food. Alternatively, the open market price of the food may be reduced by increasing domestic supply through export restrictions or low-priced imports. Market prices are also reduced if demand is artifically limited through rationing.

In Pakistan, an effort has been made to avoid any disincentive effects on domestic production of wheat. The price paid to farmers is competitive with that paid by other buyers; it must be, since sales to the government are voluntary. The ration and subsidy system should, in fact, promote wheat production, since the guaranteed-purchase provision reduces farmers' uncertainty of finding a market for his crop.

Other aspects of the program are consistent with the hypothesis of a disincentive effect. Until 1978, imported concessional supplies of wheat were sold at heavily subsidized prices, and exports of wheat are still restricted. Demand for wheat is not limited by rationing (since amounts above the subsidized quota are freely available), but the availability of the low-priced ration reduces demand for the remainder of the domestic supply. The prevailing price for wheat in Pakistan is below that on the international market.

It is worth noting that government policy aims to promote wheat production by maintaining a support price for wheat as well as by other means. The success of this policy, aided by good weather, is evident in the increasing production and yield of wheat and in the country's reduced level of imports. Whether production increases might have been faster in the absence of the subsidy program is a matter only for speculation. Apparently some trade-off of production against the nutritional well being of the population (and against political stability) was considered worthwhile.

The case with sugar is somewhat different. Enforced sales to the government at fixed prices, an absolute ban on exports, and a somewhat effective government monopoly all act to lower the price which farmers can get for sugar, and should act as a substantial disincentive to production. The government has attempted to set the price at a level high enough so that a major shift into other crops has not taken place. Nonetheless, one may assume that there is some disincentive to investment in sugar production as a result of the ration system.

These agricultural disincentives represent one possible hidden cost of the ration system in Pakistan. To measure the extent of the disincentive effects would require an extensive study of its own, a study beyond the scope of this report. Given that the domestic and international grain markets are fraught with distortions of all kinds - taxes, tariffs, and various kinds of subsidies, it would be difficult to identify those costs which are attributable to the ration system alone.

3. Leakages

For the sake of this discussion, let us suppose that households below the median in income constitute the needy, and are the appropriate target group for a subsidy program. Remember that this is our definition of a target group, not that of the Government of Pakistan. This bottom 50% of households represents 39% of the population due to the smaller size of low-income households. Since one estimate holds that 38% of the population of Pakistan suffers from some degree of malnutrition, this is probably a reasonable target group.

We already know that leakages to the nontarget population are substantial. Increases in the quantity of food consumed by the wealthy cannot be considered a nutritional benefit, since we assume that their food consumption even without the subsidy is more than adequate for health.

However, to the extent that they consume ration wheat and sugar they are benefiting economically from the subsidy. Since the intensity of consumption of ration wheat by the urban poor is 1.11, and the poor are 39% of the population, this means that the poor consume about 44% of total ration supplies, while 56% goes to the nonneedy. In rural areas, where no targeting to the poor takes place, the intensity of consumption of ration atta by the poor is only .95. Thus only 37% of ration wheat supplies reaches the needy there, and 63% goes outside the putative target group. Furthermore, we have already seen that large portions of the rural population are not reached at all by the wheat ration system. But this is a question of coverage rather than of leakage. Similarly for sugar, the consumption intensity for the below-median population is .93, which means that only 36% of ration sugar reaches the group we have defined as the appropriate target.

These leakages figures are extremely high. They represent a total of 1.39 million tons of subsidized wheat alone reaching the nontarget population. Clearly, any means of reducing this leakage, if it did not at the same time reduce participation by the needy, would improve the cost-effectiveness picture by making possible a greater nutritional impact for the same level of expenditure. Narrower targeting might be achieved by creating a more marked difference in quality between market and ration wheat. It might also be done by administrative means (setting a cut-off on eligibility), if a simple way of determining eligibility status could be devised. Of course, the larger the quality differential, the less the incentive to nonneedy households to have themselves falsely declared eligible. Extreme caution would have to be exercised not to create an application procedure which by its complexity, invasion of privacy, or frequency of repetition would deter from applying the very people who need the program most.

Another important consideration is that one of the political strengths of the program is the fact that it is open to all. Administrative targeting to one portion of the population might reduce its political support. Also, the political repercussions of cutting a large and powerful group out of the ration system might be severe. With quality as a targeting mechanism, the decision not to participate appears voluntary on the part of the consumer,

and such targeting is therefore politically more acceptable. An experiment under way in Bangladesh, distributing the inferior grain sorghum in the ration system, should shed some light on the effect of a really large quality difference on ration food consumption patterns (Karim et al. 1979).

B. Costs and Effectiveness

Earlier we presented a very approximate calculation of average calorie and protein increment which can be attributed to the ration and subsidy programs. In urban areas, the increment to the below-median income group was estimated to be 114 calories and 4 grams of protein per person per day.

Using these figures, we can estimate the cost of delivering this increment to the target group. Since urban dwellers constitute about 25% of Pakistan's population of 73 million people (1972 census projection for 1976-77), about 18 million of its people live in cities. The urban target group, that is, the bottom 39%, is thus about 7 million individuals. Seventy-three percent of ration food is distriubted in urban areas, so we have estimated the cost of the urban distribution program to be 73% of the government's total subsidy cost of the ration-shop system, amounting to 984 million rupees or more than 98 million dollars. This is probably a slight overestimate, since transportation costs are greater to rural areas. Thus, the cost of delivering to the lower 40% urban income stratum an average incremental 114 calories and 4 grams of protein per day through the ration system is found to be Rs 140 per person per year, or 0.38 rupees or 3.8 U.S. cents per day.

In rural areas, the average per capita daily increment in calorie and protein intake, based on income elasticities of demand, is a negligible 16 calories and less than one gram of protein. However, the rural ration program reaches a very small proportion of the rural population. Let us consider only those ration shops which sell wheat all year round. These serve 33% of the population of rural Baluchistan, 66% of the population of rural NWFP, and only 6% and 7% of rural Punjab and Sind, respectively. Although clearly a larger proportion of people are reached in the neediest areas, the number of rural dwellers reached by the program is only 9% of the rural population, a total of about five million individuals. Of these, only 39% or 1.95 million constitute the target group of persons in households with below-median incomes.

If the rural expenditure on the ration program is divided by the number of target recipients, a per capita yearly cost of delivering the nutrients of Rs 170 (U.S. $17.00) is obtained. The figure is somewhat misleading on several counts. First, it assumes full participation in the ration program by the target group, and this is not the case. In Sind, for example, almost no one buys ration atta even in the few locations where it is offered. Also, this figure cannot be applied to the cost of extending the program throughout the rural areas, since costs might well increase as more and more inaccessible areas are brought into the system. On the other hand, however, it should be noted that these calculations underestimate the potential effectiveness of the program as well as its cost by ignoring the shops where wheat distribution is seasonal. In these areas, the role of the ration in providing a floor on household wheat consumption may be critical.

These calculations define, as the target population of the wheat subsidy, all those in households with incomes under the median (calculated separately for rural and urban areas). Individuals in these households benefit from increased consumption only to the extent that they are recipients of the food. A price subsidy on a food staple, such as that on wheat in Pakistan, is not specifically aimed at reaching the traditional vulnerable groups, that is, pregnant and lactating women and children under age three, which are frequently targeted in programs expressly concerned with affecting nutritional status.

In the following paragraphs, the cost of the program will be calculated as if only pregnant and lactating women and children under three were the target group. This is done only for the sake of comparability with other interventions. It does not make sense to do this for a program which affects consumption only at the household level. Given the lack of information on intrafamilial distribution, we will assume that the benefits of subsidized wheat distribution are equally distributed within the household regardless of age or sex, although this assumption is undoubtedly false. It will thus be possible to compute the total number of target group members in the population and to calculate the cost of delivering a calorie and protein increment to this population, considering benefits to other household members as leakage or waste.

The total number of women and children under age three in the Pakistan population was calculated by applying percentages derived from the 1962 census of West Pakistan (published in 1966) to the estimated total 1977 population of 73 million. This was done because the more recent census breakdowns by age and sex were not yet available in the United States. The number of pregnant and lactating women was calculated by applying percentages derived from the Pakistan Fertility Survey published in 1976, which had a nationally representative sample. Clearly, the resulting figures were approximate.

On the basis of these calculations, there were 5.4 million pregnant or lactating women in Pakistan in 1977: 4.1 million in rural areas and 1.3 million in cities and towns. There were 6.8 million children under three years of age, of whom 5.2 million lived in the country side and 1.6 million in urban areas. The total number of vulnerable group members in urban areas was thus 2.9 million, of which we may estimate that 40% fell in the below-median income class. Hence, there was a "vulnerable" target population of 1.2 million, or 17% of the low-income target group previously discussed.

Since the total cost of the program does not change along with our definition of the target population, the cost for the increment of 114 calories and 4 grams of protein per target group member per day must be increased in inverse proportion to the size of the target group with respect to the previously defined target population. This calculation results in a daily cost figure of Rs 2.25 (U.S. 22¢), or Rs 813 (U.S. $81.30) per year. A similar exercise could be performed for rural areas. The cost of the rural program calculated on the basis of target-group pregnant and lactating women and children under three is Rs 2.74 (27 ¢)

per day or Rs 985 (U.S. $98.50) per person per year. The low level of benefits for this cost is hardly worth considering. However, the benefits of the program in rural areas could easily be increased disproportionately to the costs by using the available distribution system to distribute more, and more easily targeted foods.

These computations have been made to illustrate the steps one would go through to estimate costs relative to nutritional objectives. However, the nutritional objectives tested ought to be those appropriate to the intervention being evaluated. The accuracy of the results is highly conditional on the validity of estimates and assumptions noted earlier.

Such figures are not very informative or practically useful. The Pakistan wheat ration is quite clearly not designed to reach only the vulnerable groups in the population. For a price subsidy to achieve that goal, quite different foods would be subsidized: not the major grain staple, but foods with a particular appeal to pregnant and lactating women and children. Subsidy programs in other countries (notably Colombia's food stamp program and the WIC program in the United States) are directed at commodities such as milk, eggs, and specially fortified cereal foods. Such programs may be combined with advertising or education to promote consumption of these foods by the vulnerable groups. Although such a strategy for price subsidization is feasible, it is not a part of the existing ration and subsidy system in Pakistan.

The reason for looking at Pakistan's system of subsidies is to show that a [illegible] price program developed for other reasons has the potential for making nutritional improvements as well. The cost estimates developed in this section have been weighed against the presumed nutritional gains from the program. However, the program would exist regardless of its specifically nutrition-related effects. Its political and economic benefits should also enter into the cost and benefit equation. Its nutritional benefits might even be considered a "free" bonus. Only in the last few years has nutritional improvement been mentioned as a ration program goal. This new focus may open the door to program modifications designed to improve the nutritional cost-benefit equation. The cost of these modifications might justly be weighed only against their nutritional consequences, but the cost of the program itself must be balanced against the whole range of political, economic, and social welfare benefits which it is intended to achieve.

C. Nutritional Impact

For a subsidy program to have a nutritional impact, it must result in an increase in the consumption of deficit nutrients by the deficient population. A look at some of the relationships among ration wheat consumption, staple grain consumption, income (measured in terms of expenditure), and nutritional status may provide a fuller understanding of the ration system's nutritional significance. The only available measure of nutritional status has been anthropometry. In this discussion, the measure is the degree of malnutrition of the most seriously affected

child under age five in each household. Children have been classified according to the McLaren and Read (1972) and the Waterlow (1973) methods, in which low numbers indicate more serious levels of growth retardation. Households without children have been excluded from these calculations. A series of regressions was run using as a dependent variable the dichotomous variable "presence of a malnourished child in the household." This variable was determined separately using the McLaren and the Waterlow standards.

In urban areas, it was found that neither the total quantity of ration atta consumed by the household, nor the percent of total grain consumption which was in the form of ration atta showed a significant relation to the presence of a malnourished child, when income and number of household members were entered first in the regression equations. Per capita consumption of grain showed a small but statistically significant negative relation to the percent of ration atta consumed. Per capita grain consumption was most strongly positively related to income, and negatively to the number of household members.

These findings do not indicate that the ration system has no effect on grain consumption or nutritional status. On the average, ration atta represents 45.5% of total grain consumption of urban households; this percentage is higher in low-income groups. Total grain consumption is negatively related to the percent of ration atta, because those who can afford to consume more grain rely less heavily on the ration system. It appears that the ration system in urban areas provides a minimum level of consumption, above which the relatively better off population purchase additional quantities. The effect of ration food consumption is not seen in superior growth levels of children, because the per person monthly income increment from the ration is not large enough to increase calorie and protein consumption sufficiently to meet nutritional requirements. Intrafamilial food distribution patterns may also reduce the actual incremental nutrients going to the preschoolers, and thereby reduce nutritional impact. One cannot compare equivalent low-income families who do and do not consume ration atta, because consumption of ration atta is almost universal among the urban poor. Nevertheless, it is likely that, in the absence of the wheat subsidy, food consumption by poor families would decline.

In rural areas, a relatively small number of ration shops sell subsidized wheat. Considering only those areas where wheat is sold, we have found that when income and provincial variation were controlled, there was a slight positive relationship between percent of ration atta consumed and nutritional status as measured by the McLaren method. This may indicate that the availability of ration atta enabled the household to consume more food than would otherwise have been possible. Income is more strongly positively related to household and per capita grain consumption levels in rural than in urban areas. The consumption of ration atta there shows a stronger inverse relation to income. Even with income controlled the availability of home-produced wheat in rural areas shows a significant inverse relation to the use of ration wheat. This means that

the ration is used by the relatively needy and by those who do not or cannot produce their own grain. In regions where ration wheat is available, it constitutes 27% of total grain consumption on the average. Once again, these findings seem to indicate that the subsidy plays a positive role in maintaining existing levels of consumption.

D. Improving Dietary Benefits of the Ration System

The dietary benefits of the ration system are determined by several factors. These include the choice of commodity to be subsidized, the size of the ration, the price (both relative and absolute) of the subsidized food, and the coverage of the population by the system. Changes in any of these factors would affect the magnitude of the dietary benefits of the program, but at different costs and with different consequences for leakages. Also, of course, some changes are politically more feasible than others.

There are a number of ways in which the mix of subsidized commodities might be changed. One way would be to shift to a relatively less desirable grain, such as sorghum, as was tried experimentally in Bangladesh (Karim et al. 1979). This, as we have discussed, would probably result in a much narrower targeting of the program toward the needy. It would undoubtedly reduce the dietary benefit of the program, since fewer people would take advantage of it. Even at very low-income levels, people devote some money to improving the perceived quality of their diets, at the expense of quantity (McCarthy 1975), although this apparently takes place after a minimal level of nutritional adequacy has been reached (Poynor 1976). Considerable political resistance would certainly meet any attempt to substitute coarse grains for wheat in the ration system, but this could be mitigated by allowing consumers a choice of less wheat or more of the inferior grain for the same cost. This might result in the neediest consumers choosing quantity in preference to quality, which might increase the program's nutritional benefit to that group.

Another way to improve the benefit of the program might be to subsidize a low-prestige pulse, such as gram, along with wheat. This would promote consumption of the complementary proteins to those in wheat, thus improving both the overall nutritional benefit and that derived from the wheat alone. The logistics of including pulses in the subsidy program would be different from those for wheat, since processing is not centralized, and government procurement does not take place at present. However, this would not be an insurmountable problem. Expansion of the number of commodities subsidized would be politically popular. It might also be quite expensive, if many people chose to purchase the newly subsidized foods. A possibility for minimizing the additional cost would be to select a low-prestige food and to tie its sale to the purchase of the less desirable grain.

Increasing the size of the atta (or, in rural areas, gundum) ration would be expected to increase consumption and therefore to have positive dietary impact, although this could be very costly to the government. It would probably be less costly, and entail less leakage, than lowering the price, however. The reason is that the needy are more likely

than others to buy all of their quota at the shop, so only the needy would be likely to take advantage of an increased allotment. If the price were lowered, all ration atta consumers would benefit, even those who are not economically needy. Furthermore, if the price of the ration were lowered, the dietary impact would only be that measured by the increased real income of the consumer. If the size of the quota were increased, consumers could only take advantage of the change by purchasing more wheat, so substitution might be less. As we have mentioned, increasing the quality differential between ration and free market grain would also control leakage.

We have shown that coverage in urban areas is virtually 100%. Availability of subsidized wheat in rural areas is quite limited, however. It is likely that increasing the availbilit of subsidized wheat in these areas would greatly increase the dietary impact of the program, since we have found that rural consumers do depend on the market for much of their grain consumption. As we have discussed, it would be important for the sake of cost control to target the program in rural areas by subsidizing a less desirable product such as atta or a mix of atta with another grain flour, or by some other means.

A decision among these various methods for increasing the dietary impact of the ration system would have to be based on estimates of cost and political acceptability, and on the analysis of the nature of existing nutritional problems. It would be important to know whether undernutrition is common in the rural areas not now served by the program, for example.

The point should perhaps be made once again that if the kind of undernutrition is prevalent which is caused by maladaptive dietary practices such as denying food to vulnerable group members or cooking in a way which loses nutrients, then subsidized food distribution, in the absence of other interventions, will not be able to alleviate the problem.

E. Consequences of Eliminating the Wheat Subsidy

In view of the popularity and visibility of the wheat subsidy program, the political consequences of attempting to eliminate it are likely to be disastrous. The experiences of Egypt and of Sri Lanka in attempting to reduce or eliminate a food staple subsidy bear this out. Since the Pakistani program involves limitations on quantity and a flexible price structure, and is rapidly reducing its dependence on imports (at least for the present), it is unlikely that the cost of the program would become so prohibitive that the whole system would have to be disbanded. If the food situation should ever deteriorate temporarily so as to require a return to imports, this is likely to be precisely the time when domestic supplies would be scarce and prices high, and the consumer protection afforded by the ration shop with its excellent coverage would be most needed.

It is sometimes asserted that food subsidies are a wasteful, consumption-oriented expenditure, and that they are contrary to the dictates of fiscal responsibility, which would argue for expenditure on productive investment. Of course, much has been written about the role

of nutrition programs as an investment in productive human capital, and this would argue in favor of subsidies which in fact improved the nutritional status of the poor. A concern for equity and for improving the lot of the poor would also argue in favor of such programs.

Another approach to this issue is to look at the macroeconomic effect of the food subsidy on the economy as a whole. McCarthy and Taylor (1977) have done this for Pakistan, and have developed another persuasive argument against the elimination of an existing food subsidy. They point out that demand for staple foods is relatively price and income elastic. Elimination of the subsidy would of course drive the price of wheat up, and thus raise the cost of living for all, but disproportionately among the poor. Due to the inelasticity in demand, the percentage decrease in quantity purchased would be less than the percentage increase in price. The population as a whole would thus devote a higher proportion of its income to food and consequently a smaller amount of income would be used for the purchase of other goods. This would have a negative, contractionary effect on the economy as a whole.

Through manipulating a macroeconomic model of Pakistan's economy, McCarthy and Taylor estimate that a doubling in the market price of wheat (probably an overestimate of the effect of eliminating the subsidy) would result in a drop of 2.6% in real GNP. They also conclude that caloric intake would be reduced among the poor in both urban and rural areas. Interestingly, they find also that increased government expenditure in the amount saved by eliminating the subsidy would not restore the calorie consumption of the poor to its subsidized level.

Although precise figures are subject to question, the general dynamic by which reduction of the subsidy would result in an economic contraction appears to be reasonable.

VII. CONCLUSIONS AND RECOMMENDATIONS

The findings of the ration-shop study support a number of assertions about the influence of various design factors on the effectiveness of a price subsidy program. They suggest that quality can in fact be used as a mechanism for targeting a food subsidy. Although the targeting effect observed in the study is not very strong, neither is the quality differentiation. This consideration could be applied to the selection of other foods to subsidize. Gram, for example, as well as being an excellent source of protein, exhibits a consumption pattern quite strongly biased toward low-income consumers. Limiting the quantity of wheat available at the subsidized price has contributed to the viability of the program by controlling its total cost, although it also limits the benefit of the program. We have seen that the low quality of ration wheat and its availability on the free market reduce incentives for diversion of ration supplies; shops almost never run out of atta. Running out of sugar is more common, since sugar is in great demand and is not legally available elsewhere. Hence, the incentives for

black-marketeering in sugar are strong. Due to the use of a quasi-market distribution system, which is decentralized and depends on private entrepreneurial initiative, the number of shops and the coverage of the population is very high: the system reaches 90% of the population.

Although the study shows that leakages in the ration system, that is, sales to nonneedy households, have been considerable - more than 50% - it still has found that in terms of cost for nutrients delivered, the program has been relatively cost effective in urban areas. Estimated nutrient increments of 114 calories and 4 grams of protein daily per capita cost about Rs 140 per member of the urban target group family per year. In rural areas, the increments are considerably lower and the cost somewhat higher: Rs 170 per person per year for very little consumption benefit.

Obviously, if one only considers the particularly nutritionally vulnerable and pregnant and lactating women as the target group, then the annual per capita costs would be much higher (Rs 813 urban and Rs 1000 rural). However, the program is not designed specifically to reach these groups, but rather serves as an income transfer mechanism for the whole family.

Wheat distribution in rural areas is extremely limited: less than 10% of the rural population has access to subsidized wheat. The study has found that even in rural areas most people purchase wheat from the market, and that the lower income population is least likely to have access to home-grown wheat. Therefore, a market price intervention might in fact be nutritionally effective in rural areas.

The ration-shop program enjoys strong public support, and eliminating it would probably not be politically feasible. Even if it were, doing so would be fiscally unwise. In addition to the fact that the subsidy improves nutrient consumption in the low-income population, it also stimulates total economic consumption. If the price of all wheat rose to unsubsidized levels, all groups, but particularly the poor, would be forced to spend more on food, since demand for food is relatively inelastic. They would therefore have less income available to spend on nonfood items; this reduction in nonfood expenditure would be likely to have a substantial contractionary effect on the economy as a whole.

These findings are to some extent unique to the Pakistan system. However, the principles derived can be applied to a variety of other settings, if appropriate caution and common sense are used.

CHAPTER FOUR FOOTNOTES

[1]The data on which this chapter is based were collected as part of the Pakistan Micronutrient Survey of 1976, a national-level nutrition survey undertaken by the Nutrition Cell, Planning Division, Government of Pakistan, using funds from the Planning Division and from the U.S. Agency for International Development. A complete description of the sample, the survey method, and copies of the survey instruments may be found in Rogers (1978).

[2]An important corollary to this is that a program may have significant nutritional consequences, even though it was initiated and is maintained for other purposes. In such a case, evaluation is concerned with the primary objectives of the program, although a nutritional consideration may strengthen the case for maintaining, eliminating, or modifying it.

[3]Elasticities of demand are a measure of how responsive demand for a good is to changes in price or income. The price elasticity of demand is the percent by which demand changes in response to a 1% change in price. Price elasticities are usually negative, since, when prices go up, demand usually goes down. Similarly, income elasticity of demand is the percent by which the quantity demanded changes in response to a 1% change in income. For most goods, income elasticities are positive, because, when incomes go up, people can and do buy more. Income elasticities are negative, however, for inferior goods, because, as soon as people can afford to, they stop buying the inferior goods and start buy higher quality substitutes.

The concept of elasticity of demand is usually applied to aggregate demand figures, not household demand. In this case we are concerned with the effect of price and income changes on the diet and we can derive more useful information from a household-level analysis. Elasticity is a relative, not an absolute measure. If very little of an item is consumed, then even if income elasticity is very high and the quantity demanded doubles, the absolute amount consumed may still be very small.

[4]The data reported here were all based on the Micronutrient Survey, which collected information about both the ration system and health care delivery. The sample studied in the survey was randomly chosen to represent the whole population of Pakistan, excluding the northern and tribal areas. These areas account for no more than 5% of the population (1972 census).

[5]These were calculated by regressing the log of per capita consumption on the log of total household expenditure for above- and below-median expenditure groups, separately for urban and rural areas.

[6]One reason for this is that consumption of home-produced wheat, which is of course obtained in whole-wheat form, is very strongly positively related to income.

[7]Stronger arguments are the considerable expense of distributing wheat in these more expensive rural areas and the relatively lower political volatility of rural dwellers compared with city workers.

[8]We are concerned here with budgetary outlay for the ration program. Obviously, there is considerable revenue forgone to the government and to sugar producers, because of the decision to restrict completely any international trade in sugar. Before 1973, the government expended substantial foreign exchange due to high levels of sugar imports since demand was so high. Statutory rationing of sugar after December 1972 was instituted, in order to conserve foreign exchange and still make sugar available in a politically acceptable way.

[9]A cost estimate for 1974-1975 may be found in Rogers and Levinson (1976).

CHAPTER FIVE

CASE STUDY: SUBSIDIZED MILK DISTRIBUTION IN MEXICO*

I. INTRODUCTION

This chapter examines the Mexican government's subsidized milk distribution system operating in Mexico City. The program is based on reconstituted, commercially imported, powdered milk. Thus, it represents a nationally funded food program drawing on the international commodity markets. The case was selected to provide a contrast to the Pakistan ration system discussed in the previous chapter: the Mexican system operates only in the capital area, involves only one product, and utilizes computer-based ration card procedures. Of particular interest are the elements of community participation and its efficient administrative system.

The paper will first present a brief overview of the program and then examine specific program design characteristics. Finally, the costs and nutritional aspects of the program will be discussed.

II. PROGRAM OVERVIEW

The milk program serves Mexico City, whose 12 million inhabitants make it among the biggest cities in the world. There were over a quarter million recipients in 1977. The program has undergone many changes over the years. Beginning as part of a larger food distribution program, it was subsequently separately organized into independent centers. Although the original rationing system employed had many administrative problems including long lines and reselling of milk by recipients, the current system is very expeditious and efficient.

CONASUPO, the government's food marketing agency, imports the powdered milk, and its subsidiary, LICONSA, reconstitutes it (see Table 12). Official statistics show that the program expanded 44% between 1971 and 1976, to reach an annual production volume of 274 million liters (see Table 13). LICONSA's production represents a 23.3% share of the milk market in Mexico City and a 4.0% share nationally. It is estimated that domestic production will fall short of demand by 373 million liters.[1] LICONSA sells the milk at a U.S. $.03 loss per liter. The subsidized price is less than half the price of milk sold on the free market.

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*The primary authors for this case study are Catherine Overholt, Eileen Kennedy, Federico Sanchez, Adolfo Chavez, and James Austin.

TABLE 12

PURCHASES OF MILK POWDER OF LICONSA FROM CONASUPO[1] FOR THE PERIOD 1971 TO 1976

Year	Milk purchases (metric tons)	Average price of milk powder (US$ per kg)
1971	16,306	0.42
1972	15,530	0.61
1973	17,307	0.60
1974	23,453	0.81
1975	18,837	0.89
1976	15,223 2/	0.94

1/ CONASUPO is the only entity, public or private, which is empowered in Mexico to purchase milk in the international market; hence LICONSA and other organizations are secondary purchasers.

2/ Purchases for the period January 1 to August 31, 1976.

Source: LICONSA 1976.

TABLE 13

LICONSA REHYDRATED MILK PRODUCTS, 1971-1976
(thousands of liters)

Year	Production Volume	Production Index	Daily Average	Installed Daily Capacity 1/
1971	190,416	100.0	635	720
1972	176,153	92.5	587	720
1973	196,766	103.3	656	1,000
1974	231,143	121.4	770	1,000
1975	256,631	134.8	855	1,000
1976 2/	274,512	144.2	915	1,000

1/ On the basis of three 8-hour shifts.

2/ Production figures for 1976 are estimates based on real data for the period January 1 to August 31, 1976; linear extrapolation has been used.

Source: LICONSA 1976.

III. PROGRAM DESIGN

The key program characteristics which will be examined in this section are the following: recipient selection procedures, participant profile, ration card issuance, ration redemption, milk delivery, and product composition and use.

A. Recipient Selection

1. Eligibility Criteria

Eligibility for the LICONSA milk distribution program (MDP) is based primarily, but not exclusively, on the presence of children (health need) in the family and on the income of the head of the household. Program eligibility is established, in general, by the Social Work Department (SWD) of LICONSA on the basis of a brief socioeconomic study. In addition, a person will be admitted to the program if they show medical certification of need, regardless of sex or age.

a. Family Composition and Size

Children under 12 years of age are eligible, as well as pregnant and lactating mothers. The elderly and "habitual milk consumers"[2] are also eligible for the program. The number of children and other eligible members in the family determines the amount of milk the family receives each week.

b. Income

This is not a strict criterion for eligibility. Families in which the head of the household earns $10,000 pesos (U.S. $442.47) per month and in which there is not a large number of children (more than 6) are not normally considered eligible. This income level is not a rigid cut-off point, and a milk allowance may be made to a family that is defined as needy by the head of the Social Work Department. (In Mexico City the minimum legal salary is 3,100 pesos per month or about U.S. $140.) Milk distribution centers were originally set up in low-income neighborhoods to reach the poorer segments of the population.

c. Age of the Children

Twelve years of age is considered the upper limit for eligibility (school age in Mexico), but this is not a rigid criterion, and in some cases children in their early teens may be included in the program. Thus, there is not a strong orientation toward targeting the program to the more nutritionally at-risk preschoolers, although a radio and poster promotion program has emphasized the need to give priority to children when milk is scarce.

2. Mechanisms for the Application of the Eligibility Criteria

The nomination of candidates to the milk distribution program is done by a Consumer Committee consisting of community volunteers who bring the family to the attention of the social worker (SW). The SW then collects the socioeconomic information of the family to ascertain its eligibility. If the family is eligible, the SW places that family's name on the waiting list.

The information for the socioeconomic study is usually obtained from the mother at the milk distribution center or in the offices of the Social Work Department. In a small number of cases, the information is verified by the SW through a household inspection. Because the SWs are often overworked, it is unlikely that the household visits are carried out in more than 5% of all cases. The socioeconomic study contains the following information: name, address, occupation, and salary of the head of the household, name of the employer, and family composition (names, relationship, age and sex of the other family members).

The existence of the Consumer Committee does provide an indirect opportunity for verification of information. Since there is always a waiting list, this suggests that there is pressure from the population to participate in the program, and that those outside the program may point out to the SW that there are families in the program that are undeserving. In our field survey, we have attempted to determine whether the members of the program felt that there were substantial numbers of people receiving milk who should not be in the program. Their answers have indicated that there may be a small number of such nonneedy families.

The Consumer Committee represents an interesting attempt to elicit local participation. These committees are supposed to provide community outreach (identifying the needy), as well as assist in the milk-distribution centers. A survey of 1,058 LICONSA participants in 1976 has revealed that these committees have functioned fairly well.[3] About 82% of the respondents have had no complaints about the Consumer Committees, and have felt that they have improved the orderliness of the distribution, helped resolve disputes, and kept the distribution centers cleaner. Still, only 38% have thought that all is well and no changes are needed. The degree of community involvement in and representativeness of the Consumer Committee is questionable, given that 76% had not known how it was formed and 40% had not known any of its members.

3. Duration of Eligibility

Duration of eligibility is practically indefinite, but a new ration card must be obtained every six months. This process is almost automatic, but in theory it results in an opportunity for screening that may result in the removal of some families from the program. Whenever a family desires a modification in its status (i.e., change in time, location, or frequency of purchase), this creates the opportunity for very

close scrutiny of that family by the SW and to some extent by the Consumer Committee, again with possible removal of the family from the program. In practice, it is probably not easy to remove a family from the program. Attrition is more often the result of a decision on the part of the family, either because it has moved to a different location, or because it has forfeited its right to the program by continued tardiness, or unexplained absences, or loss of card.

4. Promotional Aspects of the Milk Distribution Program

Aside from a biweekly newsletter and some radio advertisements, there is little direct promotion of the program. On the other hand, indirect advertising methods are in constant operation. The presence of the LICONSA milk tank trucks and of the CONASUPO transportation fleet are the most visible reminders of the program. The large number of milk distribution centers, distributed strategically in Mexico City, and the significant number of milk consumers, together with the long-standing of the program serve as its main promotional features.

B. Participant Profile

LICONSA has no systematic data on either the socioeconomic or the nutritional status of the participating population.

To obtain this information, an initial field study of 4822 participants was undertaken in mid-1977 in collaboration with the LICONSA Social Work Department (SWD), the National Institute of Nutrition (NIN), and the third semester students of the School of Social Work of the National University of Mexico. The surveyed population was drawn from a random sample of 40 of the more than 500 milk distribution centers. Almost three-fourths of the heads of households had less than six years of formal education (see Table 14). About half of the participants were nonskilled, nonsalaried, or unemployed and half-skilled or white-collar workers (see Table 15). About one-third of the families had incomes below the minimum wage (see Table 16). The type of housing is shown in Table 17 and water and drainage availability is shown in Tables 18 and 19.

In summary, the program beneficiaries appear to be in the lower- and lower-middle-income strata. Not all LICONSA milk goes through the milk distribution centers, however. Table 20 shows the other groups of recipients.

C. Ration Card Issuance

1. Volume of Milk Allowed Per Family

This is determined as the product of the number of deserving members (women of reproductive age, elderly persons, and children) times the standard milk quota of 0.5 liters per person per day. There is a maximum of 4 liters per family per day.

TABLE 14

FORMAL EDUCATION OF THE HEADS OF HOUSEHOLDS OF LICONSA PROGRAM PARTICIPANTS

Number of years of formal education	% of total (N=4599)
Less than 4 years	32.9
4 to 6 years	40.9
More than 6 years	26.2
No answer	-

TABLE 15

OCCUPATION OF THE HEADS OF HOUSEHOLDS IN LICONSA PROGRAMS

Type of Occupation	% of total (N=4747)
Unemployed	4.4
Non-salaried worker	14.9
Non-skilled worker	29.9
Skilled worker	29.3
White-collar worker	21.5
No answer	-

TABLE 16

WEEKLY INCOME OF THE HEADS OF HOUSEHOLDS IN LICONSA PROGRAMS

Level of weekly income of the head of the household 1/ (Figures in $ Mex.) 2/	% of total (N=4765)
Without income	1.6
Less than $325	5.5
$326 to $610	20.3
$611 to $814	44.1
$815 to $1,433	23.6
More than $1,433	4.9

1/ Weekly minimum legal wage in Mexico City is $742 (Mex. Cy.)

2/ Rate of Exchange: $1.00 U.S. = $22.60 Mex. pesos

TABLE 17

TYPE OF CONSTRUCTION MATERIAL IN THE HOUSES OF LINCONSA PROGRAM PARTICIPANTS

Type of construction material of the house	% of total (N=4788)
Tin or cardboard	10.9
Wood	1.6
Adobe	6.5
Brick	48.0
Plastered brick	33.0
No answer	-

TABLE 18

WATER AVAILABILITY IN THE HOUSEHOLDS OF LICONSA PROGRAM PARTICIPANTS

Type of municipal service available	% of total (N=4803)
Public	6.3
Outside the house	30.7
Inside the house	63.0
No answer	-

TABLE 19

DRAINAGE AVAILABILITY IN THE HOUSEHOLDS OF LICONSA PROGRAM PARTIGIPANTS

Type of municipal service available	% of total (N=4784)
Open air fecalism	2.8
Latrine/Septic tank	17.2
Municipal drainage	80.0
No answer	-

TABLE 20

LINCONSA CUSTOMERS[1]

Points of Sale[2/]	Free-flowing milk (liters)	Two-liter milk bags (liters)
1. LICONSA concessionaires (MDCs)	492,800	241,400
2. LICONSA-operated MDCs		9,200
3. IMPI[3] nutrition centers	42,700	7,500
4. CONASUPO employees		15,400
5. LICONSA employees	2,500	
6. Labor unions (government)		47,700
7. Cooperative societies		22,200
8. Schools, boarding schools, and day care centers		7,500
9. Hospitals and sanitariums		2,800
10. Ministry of Health and Welfare[4]		14,500
11. Detention centers		4,300
12. LICONSA and CONASUPO courtesies[5]		600
13. Other deliveries		8,900
Subtotals	538,000	382,000
TOTAL	920,000	

1/ Typical day, Spring 1977

2/ Milk is sold by LICONSA to its concessionaires at M$ 1.22 per liter in the case of both free-flowing milk and 2-liter bags. Milk is sold by LICONSA to labor unions, cooperative societies, schools, etc. at prices that vary between M$ 2.22 and M$ 3.00. Courtesies are gratis.

3/ Government agency which, among other activities, distributes free milk and other foodstuffs.

4/ Distributed as part of their social programs.

5/ Milk given as gifts

SOURCE: LICONSA 1976.

Once eligibility of a family has been established, income plays no part in determining milk volume allowances, except in the case where the family chooses to receive a lesser volume (i.e., a lower frequency of purchase) than it is entitled to. This option is exercised primarily by those too poor to buy milk every day, even at the subsidized price of M$1.25/liter (1977 prices).

2. Physical Distribution of the ID Card

This is the responsibility of the Social Work Department. The ration card is generated by the Department with the aid of a computer. The SW in charge of a milk distribution center distributes the new ration card and retrieves the old ones every six months.

A black market in ration cards is of course possible, but it does not seem likely. The ration card material, security paper with computer-printed information and a mica-coating, is difficult to duplicate by any but an organized criminal enterprise. Furthermore, the Consumer Committee knows the consumers well, since they are members of the community. No audits are practiced to police the system. The opportunity for fraud does exist, since the ration cards do not have a photograph, and they are interchangeable among the members of the family. Thus, they may be lent or rented.

3. Physical Characteristics of the Ration Card

The ration card is a rectangle of 10 x 15 cm of security paper, sealed with plastic. The seal not only protects the card but it prevents it from being modified.

When errors in ration card processing take place, new cards are made with a typewriter in the Social Work Department and then covered with mica. This does create the potential for fraud, since the type of the typewriter is different from that of the computer.

The ration card contains the following information:

a. The name of the beneficiary.

b. His or her address.

c. The address of the milk distribution center where it can be redeemed.

d. The time of day when redemption is possible.

e. Days of the week when milk purchase is possible.

(The color of the card codes for the frequency of milk purchase authorized.)

4. Function of the Ration Card

The ration card has had a long evolution, and has been developed as a response to the problems involved in control of the program. The ration card has rationalized the flow of goods and consumers through the system. The long lines and waits at the distribution points have been eliminated by replacing the "first come, first serve" rule with the programmed pick-up times. In this sense, the ration card works well, and it is the single most important feature of the distribution system. The major disadvantage of the ration card is the large amount of time of the Social Work Department spent in its generation and distribution.

D. Ration Card Redemption

1. The Redemption Process

Milk consumers arrive at the milk distribution centers between 5:30 and 8:30 a.m. The specific time of arrival is preprogrammed and specified on the ration card. Consumers must arrive on time, but there is a 15-minute tolerance before a tardiness is marked. The ration card is examined at the door, while it is being punched by hand by a member of the Consumer Committee. After the card is punched, the consumer waits briefly in line inside the buiding, and, when an automatic milk dispensing machine is freed, he/she places his/her own container in the machine, presses a button, and obtains 4 liters of milk, automatically dispensed into the container. In the larger distribution centers after receiving the milk but before paying for it, the consumer walks out of the establishment through an area that has other CONASUPO line products on display for sale, such as bread, texturized soybean protein, chocolate, and sugar.

When the milk consumer is late, the card is punched with a coded perforation to indicate this fact. Absences result in lack of perforation Three consecutive, unexplained tardiness marks add up to one absence. In turn, four unexplained absences are grounds for loss of membership in the program.

The ration card is issued to a family. Hence, any member of the family may present the card and purchase milk. This creates the potential for card transference, but, since members of the Consumer Committee punch the card every day, they eventually learn to recognize many of the customers, and thus can prevent nonmembers from profiting from the system. Exploitation of the system by the Consumer Committee is limited also, because its members are accountable to the people they represent. When a member of the Committee or the entire Consumer Committee is a source of conflict, that member or committee may be removed. Likewise, when a SW does not live up to the expectations of the milk consumers, a complaint may be registered against the SW with upper management, with adverse consequences for the Social Work Department. It appears that the program has a system of checks and balances that may be responsible for its administrative success. Some of these controls may be used to further refine the system.

2. Number of Centers

In 1970 there were 518 milk distribution centers in Mexico City under the administrative control of LICONSA, the retail food subsidiary of CONASUPO. At that time, the program was afflicted with numerous operations problems, particularly, long and embarrassing lines beginning in the early morning hours, because the system was on a first come-first served basis.

Presently the speed of milk delivery is 75 persons per 15 minutes, and each family's daily quota is 4 liters. Overall quota size is adjusted by frequency. Larger families have the right to come to the center more often during the week.

In 1974, the jurisdiction over the distribution centers was transferred to LICONSA. The centers were consolidated so that 356 centers remained in operation.

No expansion of the distribution net is contemplated at this time. The centers are operated primarily on a concession basis to private enterpreneurs who earn a small fee per liter sold.

The location of centers was initially based on proximity to traditional CONASUPO stores, since the milk distribution program was an integral part of the food distribution program. Later evolution of the City resulted in some cases of incongruency between the location of a center and the need of the population it was meant to serve. In some cases these centers were closed, in other cases they were merged with other centers which now came to serve a larger clientele.

All automated centers are provided with either one or two automatic milk dispensing units. Each unit has a capacity of 2,000 liters.

Personnel needs of the centers are minimal because they are largely operated by the consumers themselves through the Consumer Committees. Service in the Committee is voluntary. The concessionaire is in charge of the collection of the funds and reimbursing LICONSA.

E. Delivery of the Milk to the MDCs

1. Milk Delivery to the Centers

Milk is transported from the rehydration plant in Tlalnepantla, State of Mexico, to the distribution centers by refrigerated tank-trucks of 10,000 liter capacity. Each center receives either 2,000 or 4,000 liters per day depending on whether the center has one or two automatic milk-dispensing units. A tank-truck serves approximately 15 centers per day in preprogrammed deliveries scheduled throughout the day.

2. Hygiene, Operational Control, and Maintenance of the Centers

After each tank-truck is emptied, it returns to the plant where it is cleaned, outside and inside, before it is refilled. Control of milk deliveries is carried out by the Department of Operational Control.

Maintenance of the distribution center is the responsibility of the concessionaire, who also is responsible for the upkeep of the milk-dispensing unit.

Civil maintenance of the buildings and mechanical overview of the milk dispensing equipment is the responsibility of LICONSA. Distribution centers are served by crews provided with radio-controlled, emergency service vehicles. Equipment breakdowns can be rapidly attended to so as to minimize delays in dispensing the milk.

3. Schedules

The development and modification of schedules is the responsibility of the Distribution Department.

F. The Product and Its Use

Defatted milk powder is purchased by CONASUPO in the international market. Main suppliers are Canada and to a lesser extent the U.S. Shipments from New Zealand have been discontinued due to high losses in the transoceanic shipments. Losses by rail are less, so that Canada and the U.S. have an advantage as suppliers.

LICONSA has its main rehydration plant in the vicinity of Mexico City, in Tlalnepantla, State of Mexico. This plant has a capacity of one million liters per day. At present the plant is operating very near capacity with crews round the clock.

The milk is rehydrated with purified water from the artesian well adjacent to the plant. Coconut fat and vitamins are added before pasteurization. (Table 21 presents its nutrient content.) Once pasteurized, the milk is held at 4°C until it is pumped into the tank-trucks.

LICONSA operates chemical and microbiological quality control laboratories that certify the quality of the raw materials and the final products.

With regard to use of the milk by the family, of particular concern is the extent to which preschoolers receive it. The milk distribution schedule has interesting nutritional and sociological implications which should be recognized. Since the milk is available to the family before 7 a.m., it is possible for fathers and other adult members of the household, as well as for school-age children, to compete for the milk with the preschool children therein. Some school-age children are reached by school breakfast programs later in the day. Our 1977 survey has revealed that teenagers and adults have also been consuming the LICONSA milk (see Table 22).

TABLE 21

COMPOSITION OF LICONSA MILK

Ingredient	Amount (gms/liter)
Skim milk powder	79.69
Milk whey powder	5.31
Coconut oil (hydrogenated and deodorized)	32.00
Water	883.00
Vitamin A	3,300 I.U.
Vitamin D_2	330 I.U.

LICONSA milk has the following nutrient profile (grams of nutrient per liter; amounts are approximate): Energy (in kilocalories) 618, protein 27.5, fat 32.6, lactose 46.7, calcium 1.3, phosphorus 1.0, vitamin A 3,300 I.U., vitamin D_2 330 I.U., riboflavin 0.002, ascorbic acid 0.001, and niacin 0.001.

Source: LICONSA 1976.

TABLE 22

INTRAFAMILY MILK DISTRIBUTION IN THE LICONSA PROGRAM

Do you give milk to . . .	% Yes	% No
The child under 2 years of age?	96.0	3.2
The child from 2 to 5 years?	100.0	0.0
The child from 6 to 12 years?	100.0	0.0
The adolescent from 13 to 18 years?	70.0	30.0
The adult from 19 to 60 years?	82.7	17.0
The elderly?	12.7	87.3

Most of the time the milk given to preschoolers is boiled (see Table 23). LICONSA milk is pasteurized, and therefore does not need boiling. However, 71% of the people do not refrigerate their milk and 59% do not consume it all on the same day (see Table 24). Thus, the risk of contamination is high, so that boiling is advisable.

IV. PROGRAM COSTS

A. Materials and Production Costs

In the international market, CONASUPO purchases milk which it resells to LICONSA. The cost of skim milk to LICONSA is M$11.00 per kilogram, fob.

The production cost of the rehydrated, fortified, full-fat milk is M$1.49 per liter (based on 1977 volume). This figure includes the cost of raw materials, maintenance of plant, labor, processing costs, and depreciation. The added cost of packaging the milk in 2-liter, polyethylene bags is M$0.19 per liter.

B. Distribution Costs

The cost of delivery of the free-flowing milk on April 30, 1977 was estimated to be M$0.11 per liter, and M$0.21 for the packaged milk. Milk is transported in bulk in refrigerated tank-trucks of 13,000-liter capacity owned by LICONSA. Packaged milk is transported in flat-bed trucks of 9,000-liter capacity. Each polyethylene bag contains two liters of milk. Milk bags are handled in plastic baskets which carry 10 two-liter bags.

C. Sales Costs

The cost of sales figures, per liter, on the 30th of April, 1977, were M$0.27 (bulk) and M$0.13 (pack). Cost of sales included a M$0.03 per liter commission to the concessionaire for either bulk or packaged milk. Other costs included were rent of the building, power and water, civil maintenance of the building, and maintenance of the milk-dispensing equipment.

D. Eligibility Certification Costs

This item is included as part of the cost of the Social Work Department. It is M$545,058 per month or M$.024 per liter.

E. Promotional Costs

There is no formal promotion program. Therefore, the cost of this activity is nil.

TABLE 23

FORM OF FEEDING OF MILK TO THE PRESCHOOL CHILD IN THE LICONSA PROGRAM FAMILIES

Form of administration	Number of families that use this mode of administration	% of total (N=3729)
Fresh	853	22.9
Boiled	2,473	66.3
Blended	1,481	39.7
With box cereals	558	14.9
In gruel or soups	2,482	66.6
No answer	1,093	

TABLE 24

MILK HANDLING PROCEDURES BY LICONSA PROGRAM FAMILIES

Questions:	% Yes	% No
Do you boil the milk?	61.8	38.2
Do you refrigerate the milk?	28.6	71.4
Do you consume all your milk on the same day?	40.6	59.4
Do you give away or exchange some milk?	1.0	99.0
Does the milk spoil frequently?	3.0	87.0

F. Administrative and Information Control Costs

Cost of administration on the 30th of April, 1977, was M$0.096 per bulk liter and M$0.104 per packed liter. This was equivalent to 5% of sales.

The computerized information system is used to control payroll, concessionaires, shipments, accounting, ration cards, and warehousing. The Information Department controls all uses of the computer. The cost of this department is M$686,800 per month. The computer is used 60 hours per week, with 70% of its time devoted to the milk program and the rest to the other LICONSA products. Computer time allocated to the milk program is divided as follows: 60% to control of concessionaires, 30% to distribution, and 10% to milk consumers. Cost per liter is estimated at $.021.

G. Investments

Total investment: M$120 million.

Investments	Production	Distribution	Sales	Administration
Milk*	23.4%	5.1%	19.8%	23.8%
Nutrimpi**	17.5	-	-	2.6
Conlac***	5.2	-	-	2.6

*Depreciated by 30%.
**Depreciated by 10%; Nutrimpi are nutrient dense wafers.
***Depreciated by 80%; Conlac is an infant formula food.

Dispensing units represent an investment of M$22.5 million. The cost of each automatic milk-dispensing unit is M$310 to $350 thousand.

Gross capital investment	M$180 million
Depreciation (cumulative)	80 million
Fixed capital investment	100 million

H. Total Costs

Table 25 presents production cost and gross revenue figures for the 1971-1976 period. The estimated per liter costs, revenues, and subsidy level as of 1977 are shown in Table 26. The subsidy is about M$0.76 or U.S. $0.03 per liter, or around U.S. $6 million per year on annual sales of about 200 million liters. This subsidy is offset in part by higher revenues on sales of other LICONSA products and on sales to other customers.

TABLE 25

LICONSA MILK SALES AND PRODUCTION COSTS

Year	Production volume	Cost of production	Sale price at the MDCs	Gross revenues from milk sales
	(Thousands of liters)	(M$/liter)	(M$/liter)	(Thousands of M$)[1/] [2/]
1971	190,416	0.74	0.80	137,559
1972	176,153	0.96	0.80	134,266
1973	196,766	1.02	1.25	217,594
1974	231,143	1.28	1.25	287,632
1975	256,631	1.38	1.25	329,874
1976[3/]	274,512	1.51	1.25	367,518

1/ Not all of the milk produced by LICONSA is sold at the MDCs. The milk sold to labor unions and cooperative societies commands a higher price, while some milk is distributed gratis.

2/ In 1975 rehydrated milk sales represented 62.5% of sales revenues for LICONSA. Other significant sources of revenues that year were: evaporated milk sales 28.2%, infant formula (CONLAC) sales 6.0%; and the sale at the MDCs of nondairy CONASUPO line products 2.4%.

3/ Production and revenue figures for 1976 are estimates based on data for the period January 1 to August 31, 1976; linear extrapolation was used.

Source: LICONSA 1976.

TABLE 26

LICONSA MILK PRODUCTION COST ANALYSIS - 1977

Cost Item[1/]	M$/liter	%
Production	1.49	74.1
Distribution	.11	5.5
Sales	.27	13.4
Eligibility Certification	.02	1.0
Administration	.10	5.0
Computer Control System	.02	1.0
Total	2.01	
Sales Price	1.25	
Subsidy	.76	

1/ Excludes depreciation.

V. NUTRITIONAL ASPECTS

During May 1978 a second field study of 400 families was undertaken with the collaboration of the Nutrition Division of the National Nutrition Institute. The objective was to assess the nutritional impact of the milk program. The 200 milk-program recipients surveyed were randomly selected from those participants interviewed in the 1977 survey that had reported a child under the age of six living in the household. The nearest neighbor who had a preschool-age child and was not in the milk program was used as a control.

A. Socioeconomic Profile of Surveyed Population

1. Income

Accurate income data were difficult to obtain. Household income in this survey was collected by asking which family members had a wage income, how frequently they earned it, and what income was earned from other sources. Family income adjusted for family size was then calculated for each group (milk group N = 179; control group N = 172). For the control group the average weekly per capita income was M$179.42 (SD = 110.87), whereas for the milk group it was M$147.27 (SD = 90.31), or U.S. $7.97 and 6.54, respectively.

It should be recognized that there may be a tendency in the milk group to underreport income due to fear of removal from the program if income appears too high. In addition, there is a tendency for underreporting of income in both groups for two other reasons. First, some female heads of households interviewed are ignorant of the actual income of male household members. In these cases, the amount of money given to the women by the male household members for household expenditures has been recorded as a proxy for income. Second, it has been difficult to ascertain other sources of family income. They are included only to the best of our ability to obtain them.

The families studied have an average monthly income which is representative of the lower income groups in the metropolitan area of Mexico City, but probably do not include full representation of the lowest income groups. A survey of income levels and distribution in this area shows the following pattern (BIMSA 1978):[4]

Average Monthly Family Income	Percent of Population
> M$35,200	1.8%
from M$22,401 to M$35,200	3.5
from M$ 9,601 to M$22,400	15.9
from M$ 3,201 to M$ 9,600	40.9
< M$ 3,200	37.9

The average monthly family income of the milk group is approximately M$4,221 and that of the control group is M$3,912. Thus, on the average, they fall into the next to lowest income category. A direct comparison with the BIMSA data is not possible because different income categories have been used.

2. Family Characteristics

Average family size of the milk group was 6.9 members, and mean family age was 19 years. In the control group, average family size was 5.2 members, and mean family age was 23 years.

Formal educational levels for the two groups were similar, although occupations of heads of households differed: fathers of the milk program households had an average of 7 years of formal education; mothers had an average of 6 years. The control group fathers also had an average of 7 years of formal education; however, mothers had an average of only 4 years. Five percent of the milk-program head of households were unemployed, 37% were nonskilled or nonsalaried workers, 31% were semi-skilled, and 27% were white-collar workers. Of the control group, 2% were unemployed, 38% were nonskilled or nonsalaried, 20% were semi-skilled, and 40% were white-collar workers.

3. Environmental and Other Characteristics

The quality of housing is illustrated by both type of floor and number of rooms in the house. A majority of families have a cement floor - 69% of the milk program families and 62% of the control group. Twenty-six percent of the milk group and 33% of the control group families have mosaic tile, which is considered to be a better quality floor. Average number of rooms is nearly the same for both groups, 2.8 rooms for the milk group and 2.7 for the control.

The hygienic quality of the environment can be illustrated by water supply and sewage disposal. Eighty-two percent of the milk group have tap water available in the house and 86% have municipal drainage. In the control group, 80% have tap water and 85% have municipal drainage.

An overwhelming number of families have a TV as well as a radio. Ninety-three percent of the milk group have a radio and 86% have a TV. It is worth noting that, in the previously mentioned income distribution survey of metropolitan Mexico City, the families in the lowest income category almost never have television sets, although radio ownership is common. Thus, these poorest consumers are probably underrepresented in our analysis. Fifty-three percent of the milk group and 50% of the control group also have a refrigerator.

Since breast-feeding and weaning habits can strongly influence nutritional status of preschoolers, information on these customs was also collected. Twenty-three percent of the milk group mothers and 31% of the controls reported that they had not breast-fed their infants. Among those women who did breast-feed their infants, mean age for cessation of breast-feeding was 5.7 months for the milk group and 6.8 months for the control. Weaning foods, considered here to be foods other than infant formula or other categories of milk, were introduced as early as one month of age in both groups. The foods most commonly introduced first were fruit juices, commercially produced baby foods, eggs, vegetable purees, and cereal porridges. By seven months of age all families had introduced at least one of these foods.

Table 27 summarizes the foregoing descriptive parameters of the control and recipient groups.

B. Nutritional Impact

Descriptive results of the family dietary survey are presented in Table 28. (The 24-hour recall method was used.) Results for the preschool children are presented in Table 29. Mean adequacy is within the normal range for all nutrients except niacin and retinol for family, and niacin, ascorbic acid, and iron for children. The higher percent mean adequacy of retinol for the preschoolers in the milk group when contrasted with family intakes reflects, in part, the contribution of milk to increased vitamin A intake. The survey data indicate that niacin intakes in all groups are extremely low. However, the statistics probably do not reflect a true deficiency; the staple grain, corn, contributes substantially to the available niacin as well as the niacin available from milk. In addition, since protein adequacy in all groups is greater than 100%, part of the tryptophan can be converted to niacin. It should be noted that for all nutrients except niacin the standard deviations are large.

Table 30 presents the contribution of milk to overall calorie and protein adequacy for both family and preschool child consumption in both the milk and control groups. The mean percentage contribution of milk is significantly higher ($p = .01$) for milk-program participants than for the control group with regard to family protein and calorie requirements and to child calorie requirements. The mean percentage contribution of milk to child protein requirements, although higher than that of the nonmilk-program children, is less statistically significant ($p = .10$). In addition, the mean percentage contribution of milk to child protein and calorie requirements is higher than that to the family. This would indicate that more milk tends to be distributed to the preschool child than to the other members of the family.

Regression analysis techniques were used to provide further descriptive information. The role of milk in the consumption patterns of both milk-program participants and members of the control group was examined. Calories and protein consumed from milk by each group at both the family and child level were analyzed using per capita income, family size, mother's education, and a weighted average of source of water, sewage disposal, and quality of housing as independent variables. Both arithmetic and double log forms were used.

The regression analysis has revealed a systematic relationship between family size and family consumption of calories and protein from milk that is both positive and significant ($p = .01$). That is, as family size increases, the calories and protein consumed from milk also increase. This is as one would expect since a criterion for participation in the program is the presence of preschool children and elderly in the family, and milk quota is determined in part by the number of the individuals. The regressions for family consumption of calories and protein from milk by the control group yield no strong relationships among any of the variables.

TABLE 27
DESCRIPTIVE PARAMETERS FOR CONTROL AND RECIPIENT GROUPS
(means)

	Recipients	Control
Income		
Monthly earnings	M$4, 21	M$3,912
Family Data		
Family Size	6.9	5.2
Family Age	19 years	23 years
Education		
Father's Formal Education	7 years	7 years
Mother's Formal Education	6 years	4 years
Employment - Head of Household		
Unemployed	5%	2%
Nonsalaries Workers	37%	38%
Semi-skilled	31%	20%
White Collar	27%	40%
Environment		
Cement floor	69%	62%
Mosaic Tile	26%	33%
No. of Rooms	2.8	2.7
Tap Water	82%	80%
Municipal Drainage	86%	85%
Radio	93%	91%
TV	86%	81%
No Breastfeeding	23%	31%
Cessation age	5.7 months	6.8 months

TABLE 28

AVERAGE FAMILY DIETARY ADEQUACY*
(in percentage of requirement - SD in parentheses)

	Calories	Protein	Calcium	Iron	Thiamin	Riboflavin	Niacin	Ascorbic Acid	Retinol
Milk group (N = 199)	96.4(34.7)	114.1(40.0)	167.7(68.4)	133.3(53.6)	139.3(53.6)	99.3(66.3)	12.1(8.0)	89.3(117.3)	59.3(40.7)
Nonmilk group (N = 201)	120.0(83.5)	141.3(92.8)	192.9(142.0)	153.1(102.0)	162.5(78.3)	106.2(60.5)	13.1(8.0)	100.5(134.9)	72.4(66.0)

TABLE 29

AVERAGE PRESCHOOL CHILD DIETARY ADEQUACY*

	Calories	Protein	Calcium	Iron	Thiamin	Riboflavin	Niacin	Ascorbic Acid	Retinol
Milk group (N = 192)	86.1(52.2)	127.1(76.0)	134.2(87.1)	73.2(53.2)	113.5(67.2)	121.5(108.8)	9.1(15.2)	70.7(88.8)	154.7(265.4)
Nonmilk group (N = 182)	92.2(64.6)	137.3(89.4)	129.4(91.2)	63.2(45.8)	115.5(90.4)	134.7(123.5)	9.3(10.9)	66.4(105.5)	148.1(235.3)

*Based on Bourges, Chavez, and Arrayo 1970; Hernandez, Chavez, and Bourges 1977.

TABLE 30

AVERAGE PERCENTAGE CONTRIBUTION OF MILK TO PROTEIN AND CALORIE REQUIREMENT

	Mean Calorie Adequacy	% Contribution of Milk	Mean Protein Adequacy	% Contribution of Milk
Milk program families	96.4(34.7)*	12.3(6.9)**	114.1(40.0)	20.8(11.0)
Nonmilk program families	120.0(83.5)	9.1(10.4)	141.3(92.8)	14.0(14.3)
Milk program preschoolers	86.1(52.3)	24.0(18.0)	127.1(76.0)	35.9(22.8)
Nonmilk program preschoolers	92.2(64.6)	19.3(23.9)	137.3(89.4)	25.5(28.5)

*SD in parentheses.
**It is believed that virtually all of the milk consumed by the program families came through the programs.

When examining the consumption of calories and protein from milk by the group as a whole, one sees that membership in the milk program is positive and significant ($p = .01$). That is, milk program families consume more calories and protein from milk than do nonmilk-program families. However, in the case of total calorie and protein consumption of the family, with group membership as a dummy variable in addition to the same aforementioned independent variables, group membership is no longer significant. Family size is the only significant ($p = .01$) variable. This would indicate that, although calorie and protein consumption increases as family size increases, the milk program does not increase overall protein and calorie consumption. Instead, it would seem to allow participants a wider range of choices for consumption and families a readjustment of their food expenditures, substituting milk for other previously purchased foodstuffs. However, as mentioned earlier, the milk group does appear to allocate more of the milk to the young child. Thus, the program may be affecting intrafamilial distribution.

The regression analyses for preschool consumption do not reveal any significant relationships. These data are inherently weak as their collection requires a mother to remember what her child has eaten. This is difficult to do with any precision, especially for children who are ambulatory and may fend for themselves for food. Therefore, it is not surprising that these analyses yield no conclusive results.

C. Growth Impact

The anthropometric data that have been collected for the preschoolers in this study (weight for age, length for age, and weight for length measurements) have been analyzed to provide a broader understanding of the effect of the milk program. A Z-score has been computed on the basis of the National Center for Health Statistics (1976) 50th percentile standard for weight, height, and weight for length. The formula used is:

$$Z = \frac{\text{Actual anthropometric measurement} - 50\% \text{ standard}}{\text{Standard deviation for } 50\% \text{ standard}}$$

Analysis of variance has been used to compare the Z scores for weight, length, and weight for length in the milk and nonmilk group. The results are shown in Tables 31, 32, and 33. In order to determine if participation in the milk program contributed significantly to the anthropometric measurements, the Z score for weight for age, length for age, and weight for length has been regressed on per capita income, family size, mother's education, a sanitation variable, and the preschoolers' protein and calorie adequacy. Participation in the milk program has been added as a dummy variable. The results indicate that while holding the socioeconomic and dietary variables constant, participation in the milk program is not significantly associated with any of the anthropometric scores. The trend toward higher scores in the milk group is due to differences in per capita income and family size.

TABLE 31

ANALYSIS OF VARIANCE OF Z SCORES FOR WEIGHT/LENGTH FOR MILK AND NONMILK GROUPS

	Sum	Mean	Std Dev	Sum of Sq	N
Milk	5.7816	0.0301	0.2654	13.4509	(192)
Nonmilk	0.1853	0.0010	0.0385	0.2682	(182)
Within groups total	5.9669	0.0160	0.1920	13.7191	(374)

Source	Sum of Sq	D.F.	Mean Square	F	Sig.
Between groups	0.079	1	0.079	2.145	0.1439
Within groups	13.719	372	0.037		

ETA = 0.0757 ETA Squared = 0.057

TABLE 32

ANALYSIS OF VARIANCE OF Z SCORES FOR WEIGHT/AGE FOR MILK AND NONMILK GROUPS

	Sum	Mean	Std Dev	Sum of Sq	N
Milk	-44.7096	-0.2329	1.1121	236.2362	(192)
Nonmilk	-24.8248	-0.1364	0.7090	90.9960	(182)
Within groups total	-69.5344	-0.1859	0.9379	327.2323	(374)

Source	Sum of Sq	D.F.	Mean Square	F	Sig.
Between groups	0.869	1	0.869	0.988	0.3208
Within groups	327.232	372	0.880		

ETA = 0.0515 ETA Squared = 0.0026

TABLE 33

ANALYSIS OF VARIANCE OF Z SCORES FOR LENGTH/AGE FOR MILK AND NONMILK GROUPS

	Sum	Mean	Std Dev	Sum of Sq	N
Milk	-144.8385	-0.7544	1.9682	739.9148	(192)
Nonmilk	-108.8953	-0.5983	1.8001	586.4947	(182)
Within groups total	-253.7338	-0.6784	1.8883	1326.4095	(374)

Source	Sum of Sq	D.F.	Mean Square	F	Sig.
Between groups	2.275	1	2.275	0.638	0.4249
Within groups	1326.410	372	3.566		

ETA = 0.0414 ETA Squared = 0.0017

IV. CONCLUSION

The government's subsidized milk distribution program plays a major role in Mexico City's milk system by providing almost one-fourth of the total milk supply.

From the planning standpoint, the program illustrates that a commodity-specific, subsidized food intervention in a developing country can be operated with considerable administrative sophistication and competency. It also shows that community participation in the management of a program is possible. The improved administrative and control system plus the community involvement have increased the ease with which beneficiaries can participate and has reduced the likelihood of program abuse.

Our surveys reveal that the program is reaching low-income consumers, however, not the poorest segments. The dietary analyses reveal that most milk and control families and preschoolers are consuming adequate diets. Milk provides an important contribution to calorie and protein intake of both groups but is more significant for the milk group, especially for the preschoolers. This could logically be assumed to be the result of the subsidized milk program. However, the fact that total protein and calorie consumption between the milk and control groups for both family or preschool does not differ significantly suggests that the program is not having any effect on total protein-calorie consumption patterns. The anthropometric measures also fail to show any impact due to program participation. However, there exists the possibility that the control group is different from the milk group. If they, in reality are nutritionally better off to begin with, this would suggest that the milk program was having a positive effect. A longitudinal study, rather than a cross-sectional one, perhaps, would be able to ascertain effects on preschoolers of long-term participation or participation at very young ages. Nonetheless, it does appear that the program may be influencing intrafamilial distribution patterns in favor of the preschoolers; shifts of higher quality foods such as milk to this group could contribute to improved growth and nutritional status. A different research design might be able to test this hypothesis.

What is clear is that the milk program is providing an economic benefit to large numbers of low-income families (a subsidy of approximately M$4 per liter relative to the free market price). It may also be providing nutritional benefits, but these are unclear. If more of the lowest income group could be drawn into the program, the chances for nutritional effects might rise. More active outreach efforts to reach the poorest groups, relocation of milk centers in poorer areas, and more promotion would appear desirable. In any case, it would be desirable to document longitudinally the nutritional effects of the program and to ascertain how participant characteristics, participation rates, and ration size influence program impact. Such information would be very useful in any future efforts aimed at adjusting the program so as to increase its nutritional impact.

CHAPTER FIVE FOOTNOTES

[1]Gonzalo Urquiza, "La Industria Lechera Nacional," Instituto Panamericano de Alta Direccion de Empresas (P) DAEN (Mexico City, August 1977).

[2]These are members of the MDP who, for historic reasons, are eligible although they do not have young children.

[3]Central de Communicacion SA/CV, May 19, 1976.

[4]Ruro de Investigacion de Mercados SA, "Mapa Mercadologico del Area Metropolitana de la Ciudad de Mexico" (Mexico City, 1978).

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Nutrition Intervention in
Developing Countries

Study VI
AGRICULTURAL PRODUCTION, TECHNICAL CHANGE, AND NUTRITIONAL GOALS

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Prepared for
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FOREWORD

How do nutrition projects begin? How are specific interventions selected? Who makes the decisions and what is the rationale behind them?

Since such decisions relate to health or food policies of countries and have important implications for budgets, personnel and other resource allocations, it would be prudent that they be made only after careful study and analysis. Regrettably, this is not usually the case. More often than not, the choice is a subjective one.

Some interventions are undertaken because they seem "obvious." Since many others are doing it, it seems like the right thing to do, and there is unquestioned faith that it works. An approach may be fashionable at a given time period. A particular activity may be promoted by an external agency. There may be very attractive offers, such as free food or technical assistance, or a start-up grant.

To the degree that costs are considered, there is usually concern only with what funds are needed to cover immediate and direct costs. The indirect or hidden costs, which may be much greater, are overlooked. Project staff time may be charged to other budgets. The implications for an increased demand on energy or scarce materials may not be considered. There is a tendency to forget overhead costs such as those for the use of buildings or for heating, cooling, and lighting.

Social costs are even more often ignored. Some projects accelerate a change away from traditional practices such as breast-feeding or using natural foods or cultivating home gardens. A project may encourage a welfare mentality, reduce incentives to work, or create lasting demands for convenience foods where packaging and processing may forever raise the price of a food. Obsessed with political needs, decision makers may not be concerned with long-term consequences, such as the problem of terminating a popular service when it is no longer needed.

Too often these kinds of questions are not addressed, resulting in only marginal effectiveness for many projects. An apparently "good project" (that is, one which is scientifically sound, well organized, etc.), will bring disappointing results if it is aimed at a problem it is not designed to deal with. This in turn can lead to a dilemma of whether to continue a project while lacking confidence in it or to terminate it and admit failure. More often, projects go on and on without bringing results but without any objective evaluation or analysis.

Avoiding these problems requires accurate identification of problems, insightful analysis of causation, and a good understanding of interventions in terms of how they work, what they cost, what they achieve, what other consequences they bring, and what preconditions should be present before a particular intervention is selected.

To help deal with the question of intervention selection, the U.S. Agency for International Development commissioned Harvard University to prepare a series of Special Studies dealing with supplementary feeding, nutrition education, formulated foods, food fortification, consumer price subsidies, agricultural production, and integrated programs. Together the separate pieces comprise a manual intended to provide guidance on selecting from alternative approaches to reach the preschool child. We hope this effort contributes to improving the process of intervention selection, and thereby, to more effective prevention of malnutrition.

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Washington, D.C. 20523

PREFACE

This study on agricultural production and technical change is part of a seven-study series examining the major types of nutrition programs operating in developing countries. In one sense agricultural production is the oldest and most basic nutrition intervention. Nonetheless, agricultural production policies and programs have seldom been formulated with explicit nutrition objectives in mind. Thus, this study will take a more conceptual focus than the others by examining the processes through which agricultural productivity interventions can affect nutritional well-being. The other types of nutrition programs (supplementary feeding, nutrition education, formulated foods, fortification, consumer price subsidies, and integrated programs) have clearer nutrition goals and program experience; their analyses, therefore, focus more on specific operational intervention design aspects.

The purpose of this series is to provide guidance to planners in developing countries and international development agencies on the nature and design of these major types of nutrition interventions. The lack of knowledge about intervention design, costs, and effectiveness, was cited by the National Academy of Sciences in its 1976 World Food and Nutrition Study as a major impediment to efforts to reduce the malnutrition problem. Our work, which was carried out for the Office of Nutrition of the U.S. Agency for International Development, is an attempt to help close that knowledge gap.

We have tried to make a partial assessment of the "state of the art" of nutrition interventions through a review of published and unpublished literature, a mail survey of 200 nutrition projects in 64 developing countries, interviews with professionals from many disciplines and institutions involved in nutrition programming, and direct field analyses of selected nutrition programs. From these multiple sources and voluminous data, we have attempted to present a representative picture of each nutrition intervention. A commonly cited difficulty for planners, especially in developing countries, is ascertaining what is going on elsewhere and obtaining factual information on the many facets of designing a nutrition program. We have attempted to alleviate that problem by providing fairly complete, although not exhaustive, documentation and supporting references. Such attention to detail is needed when one is actually going through the intervention design process. However, not all readers will need to immerse themselves in this detail. To facilitate their use of the studies, we have preceded each subsection with a set of Key Questions that are addressed therein. At the end of each subsection we have presented a short Summary of the major points observed. Both the Questions and Summary sections are blocked off to facilitate the reader's scanning and document and identifying those parts which are of most interest to them.

Despite our efforts for completeness and our intense desire to provide useful guidance, the relative paucity of reliable evaluative data on nutrition programs and the limitations of this work leave us far short of the ideal. It has not been possible to verify the quality of the data or research designs presented in most of the literature we reviewed. Our

analyses and suggestions should be viewed as tentative, subject to further verification. It is hoped that these documents will facilitate such future evaluative efforts and that this study and the others in the series will at least provide a firmer foundation upon which others can build.

This study on nutritional aspects of agricultural production has benefited from the cooperation of many individuals and institutions. The USAID Office of Nutrition provided the essential financial support and encouragement. The former Director of the Office of Nutrition, Dr. Martin Forman, supplied the initial vision essential to shaping the entire project and with Jim Levinson pinpointed the need for focusing of the nutritional aspects of agriculture. Dr. Peter Timmer of the Harvard School of Public Health and Dr. Donald Snodgrass of HIID kindly reviewed early drafts. We also appreciate the helpful commented provided by AID's Expert Review Panel. Christopher Corkery applied editorial skills. Melanie Mahin patiently typed the many drafts and other HIID staff members also cheerfully gave administrative assistance.

The case study - Chapter Four - was made possible through the collaboration of the Instituto Colombiano Agropecuario. Those ICA officials who have provided invaluable institutional support, technical advice, and direct assistance in data collection are Dr. Jaime Isaza, Submanager of Rural Development; Dr. Humberto Colmenares, Research Director; Dr. German Escobar, Economist; Srta. Lelia Cruz, Nutritionist; and Dr. Carlos Terrazona, ICA Director in Caquez. Dr. Sergio Sepulveda also has given vital assistance in mounting the field survey of the farmers. CARE Colombia and its Assistant Director, Dr. Rudy von Bernuth, generously supplied logistical and administrative support for the field studies. Dr. Jose Obdulio Mora and Lic. Judith de Clavijo of the Instituto Colombiano de Bienestar Familiar, provided essential help in designing the nutrition survey and in processing the dietary data. A very special thanks goes to the 16 interviewers who worked tirelessly and competently while walking miles in carrying out the production and nutritional surveys. An equal expression of appreciation goes to the families who gave generously of their time and hospitality in permitting the interviews.

On behalf of the authors of this study - Richard Goldman and Catherine Overholt - and myself, we extend our deepest gratitude to these individuals and institutions. It is our hope that this document does justice to their generosity.

James E. Austin
Project Director
Cambridge, Massachusetts

CHAPTER ONE

OVERVIEW:

I. PURPOSE AND ORGANIZATION

When nutritional goals become important in national development policy, what are the implications for policies which influence resource allocation in the agricultural sector? This monograph focuses on linkages between agricultural growth and food consumption in the context of that question. The set of issues examined here is confined to the interface between changes in agricultural production and the distribution of food to families whose members are underfed. In addition the issues are chosen to reflect resource allocation questions and implications which should be of particular concern to those who analyze and advise on food policies at the national and regional revel. Agricultural production in developing countries takes place in an extremely complex biological, economic, social and political environment. No attempt is made here to deal with the subject in its entirety. While the efficient solution to many questions relating to agriculture should not be affected by the presence or absense of nutritional goals in development policy, there is a group of agricultural issues whose resolution may depend greatly on the importance of nutritional goals in overall policy. Those concerned with food policy should be aware of these issues and the possibilities they may contain for both positive and negative nutritional impact on poor consumers.

Unlike the impact of the other nutrition interventions examined in the companion volumes of this series, the nutritional impact of changes in agricultural output and technology has received little systematic attention from academics or practitioners. Consequently, data that allow empirical study is only beginning to be collected. This monograph is written largely from the perspective of economics; principles and empirical observations from economics are applied to the analysis of agriculture's impact on policy target groups. In this volume of the series, "target groups" refers to low income family units which have nutritionally deficient members.

In the first chapter we describe the distinctive role of agriculture in addressing the malnutrition problem. Chapter Two considers the key variables through which agricultural policies generate effects. This analysis provides the basis for intervention design. The third chapter presents considerations relevant to evaluating the cost and nutritional effects of agricultural programs. The final chapter is a case study of an agricultural program in Colombia and serves to illustrate that portion of the methodology discussed in the previous chapters which relates to the nutritional impact of agricultural technology on farm families.

II. ROLE OF AGRICULTURAL PRODUCTION AND TECHNICAL CHANGE

A. KEY QUESTIONS

- In what fundamental respects do increases in agricultural production and changes in agricultural technology differ from other nutritional interventions?
- What are the implications of these differences for agriculture's role in nutrition policy?

An increase in agricultural output is achieved either through an increase in land area cropped or an increase in yield (output per hectare). The contribution of each of these factors to crop output in various LDC regions in recent years is shown in Table 1. With the exception of maize in Asia and Africa, yield changes have become increasingly important as a source of increased production of wheat, maize and rice in developing countries. In part, this is because the human population growth is approaching the limits of accessible arable land in many regions. In the future, increases in area planted to crops will probably be dominated by costly new investments in drainage and irrigation which allow colonization of new land or increases in frequency of cropping on previously cultivated land. The increasing importance of rising yields also reflects the dramatic influence of new biological and chemical technology - the popularly labeled "Green Revolution" technology - in many developing countries (see Hayami and Ruttan 1971, Johnston and Kilby 1975). Decisions related to development of agricultural technology have important implications for nutrition policy since the transfer of technology is frequently the basic resource of agricultural policy instruments.

Two broad issues related to agricultural growth are of principal concern to nutrition planners. The first concerns the selection of crops on which to focus output increasing policy instruments. The issue of which crops to emphasize in the context of nutrition policy is strategic in terms of its potential impact on both consumer prices and the generation of wage income (see Chapter II parts 3 and 4). It has particularly important implications for the allocation of public funds to agricultural research and for policy related to irrigation and other types of infrastructure.

The second issue concerns the impact of agricultural production technology on the generation of income and labor use (see Chapter II, part 4). To an extent this issue overlaps the first; however, there is an important class of agricultural techology which is not directly output increasing but which can substitute for labor in the production process. In addition the farm size pattern of technology adoption can have important implications for improving the nutritional status of farm families.

TABLE 1

RELATIVE IMPORTANCE OF AREA AND YIELD AS CONTRIBUTORS TO OUTPUT GROWTH - RICE, MAIZE, WHEAT
(% contribution to growth)

Rice:		All LDC's	South Asia	S.E. Asia
1955/65	Area	55	55	52
	Yield	45	45	48
1965/73	Area	34	31	29
	Yield	66	69	71

Maize:		Asia	Latin America	Africa
1950/60	Area	55	77	33
	Yield	45	23	67
1960/70	Area	59	55	56
	Yield	41	45	44

Wheat:		Asia	Latin America	Africa
1950/60	Area	80	81	100
	Yield	20	19	0
1960/70	Area	39	20	31
	Yield	61	80	69

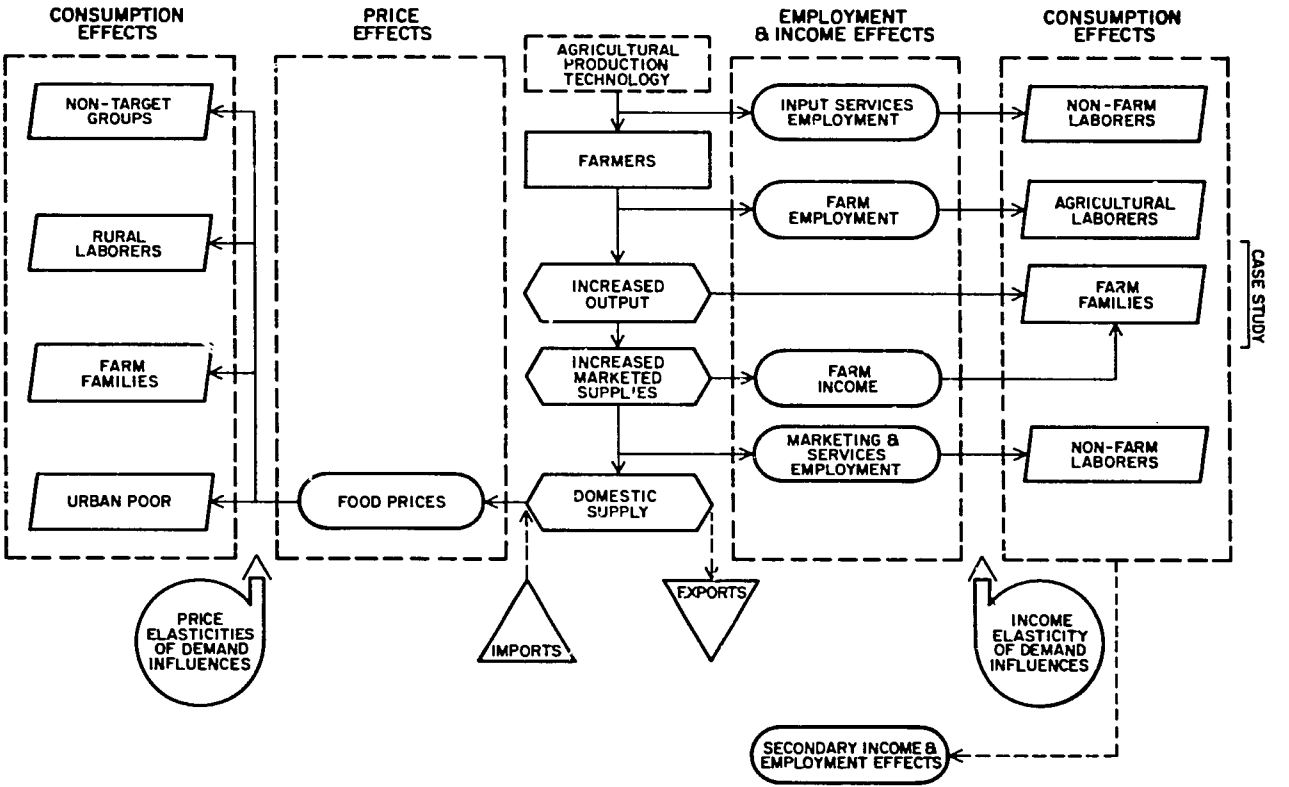
In the context of nutrition policy, increases in agricultural production and changes in production techniques differ in three fundamental respects from other nutritional interventions. Policies which influence the development and adoption of agricultural technology or public investment in output increasing infrastructure usually do not result in direct resource transfers to the target group. This is depicted in Figure 1. The impact of increased agricultural production on target group food consumption results from intervening price and income linkages. The intermediate nature of increases in agricultural production make it unlike interventions such as feeding programs or nutrition education. For those interventions, there can be a direct administrative link between the program resources and the target group so long as proper identification takes place. In theory, many nutritional activities can be designed so that target group members have exclusive access to program resources. This, of course, is not true of agriculture. Food is frequently produced on farms which are not owned or operated by target group members. Therefore the target group's relationship to the production technology is through an indirect linkage, such as income earned in a labor market or expenditures made in a consumer market. This characteristic implies that the effectiveness of an agricultural strategy which is aimed at nutritional goals depends largely on a sensitive analysis of, and design consistent with, the behavior of these linkages.

The second, and related, aspect of agriculture's intermediate position further differentiates it from most other nutritional policy instruments. The impact of changes in agricultural production on target group food consumption depends crucially on the structure of other policy instruments, particularly those related to international trade and other policies that influence agricultural price formation. Thus the economic environment in which changes in agricultural production takes place must be considered thoroughly while selecting the proper analytical framework for designing agricultural policy or projecting agriculture's impact on consumers.

Finally, the intermediate nature of increases in agricultural production causes it to differ from other nutritional interventions because the initial increase can be employed as a resource for policies aimed at various goals in addition to nutritional well-being, such as the generation of employment, foreign exchange (either by earning or saving), and public revenues. This aspect of agriculture's indirect relationship to the malnourished has two important implications. First, agricultural strategies generally cannot be designed to contribute only to nutritional goals. Therefore, the full cost of agricultural investment should not be attributed to its contribution to nutritional goals when the relative efficiency of various nutritional policy instruments is evaluated. The appropriate portion of cost to attribute to nutritional impact may be impossible to determine, however. Similarly, because of this difficulty and the trade-offs among policy objectives implied by alternative investment profiles, agricultural activities frequently appear to be better uses of scarce resources when evaluated against the full set of policy objectives rather than the subset of nutritional goals. The second implication of

Figure 1

EMPLOYMENT, INCOME, PRICE AND CONSUMPTION EFFECTS OF AGRICULTURAL PRODUCTION TECHNOLOGY



agriculture's role as a generator of resources is that in some policy environments agriculture can contribute to nutritional goals as a source of public revenue to finance other consumption-oriented policy instruments. This relationship, however, highlights the important choices to be made within an overall nutrition strategy between allocation of scarce public resources to consumption subsidies, on the one hand, and investments necessary to generate resources required to finance the subsidies over time, on the other (see Chapter III, part 2).

B. SUMMARY:

ROLE OF AGRICULTURAL PRODUCTION AND PRODUCTIVITY

Decisions influencing the development of agricultural technology and the choice of crops for emphasis in agricultural policy can have important impact on the undernourished. This impact is indirect, however, and occurs through the influence of price, employment, and income effects. The type of impact will depend on the role of target group members in the agriculture production system, macro policies related to agricultural prices, and the degree to which resources generated in the agricultural sector are used to serve other national policy goals.

CHAPTER TWO

INTERVENTION DESIGN

I. INTRODUCTION

The economics of nutrition policy has been analyzed with increasing sophistication in recent years (e.g., Pinstrup-Andersen et al. 1976, Reutlinger and Selowsky 1976). There have also been many explorations of policies aimed at alleviating general poverty in developing countries. Our concern here is to summarize some of these contributions, examine their relevance for achieving nutritional objectives in the context of general economic policy, and draw out their various implications for agricultural policy.

The first section addresses the issues of how and to what extent changes in agricultural production and technology influence the consumption and nutritional status of poor consumers. Resolution of these issues is crucial for the efficient allocation of resources to agriculture in the context of nutrition policy. It entails an understanding of indirect income linkage and macro policies affecting agricultural price formation. The second and third sections examine in some detail the implications expected from price effects or income effects for allocation of resources in agricultural strategies.

II. PRICE AND INCOME EFFECTS

A. KEY QUESTIONS

- What is the importance of the location of the target group in the economic system for increasing their food consumption?
- What are the mechanisms through which agricultural production generates price and income changes and nutritional effects?
- Is an increase in domestic agricultural production (i.e. an outward shift in the supply curve) sufficient to lower domestic food prices?

The ultimate goal of agriculture in nutrition policy is to increase the food consumption of target group members, i.e., families whose members suffer from nutritional deficiency or are at risk of becoming deficient. This implies that increases in agricultural production and changes in technology must (1) increase incomes of target group members, or (2) lower the staple food prices which they face in consumer markets.

Which mechanism is feasible and efficient depends on both the socioeconomic characteristics of target group members and the larger economic environment, particularly the conditions of agricultural price formation.

In developing countries the proportion of people whose daily food consumption is at least 250 calories below recommended daily requirements is estimated by Reutlinger and Selowsky (1976) at 56%. The percentage varies substantially, by region, and between countries. Agricultural policy which takes into account nutrition objectives must depend on where these people are located in the economic system as depicted in Figure 1. If target group members own or operate farms, the introduction of cost-reducing technology on these farms can have a direct income and consumption effect. If target group members are agricultural workers, a wage increase or fuller employment could occur as a result of increased demand for their services to facilitate an increase in output. These secondary income effects could occur in industries producing agricultural inputs, in those processsing agricultural outputs, or in firms supplying marketing services to agricultural producers and to food consumers. In addition as incomes increase, consumers make expenditures in many markets thus generating further secondary income and employment (see Krishna 1974, Mellor 1976, and Figure 1). If the majority of the target group have little or no direct functional relationship to the new agricultural technology, they must depend on price effects, at least in the short run, for improvements in their nutritional well-being as a result of an increase in output.

Unfortunately, most countries have insufficient data to generate anything more than a crude description of the functional activities of people in the lower deciles of the income distribution. Clearly, the simple notion that the great mass of rural dwellers are farm operators or even that they earn the majority of their income from agricultural field work is highly suspect. Table 2, based on census data, presents a breakdown of the rural labor forces of fifteen developing countries into agricultural and nonagricultural sector workers. In these countries 12% to 49% of rural dwellers are classified as primarily nonagricultural workers. They work principally as shopkeepers or artisans, in mining activities, and in manufacturing and construction. Some difficulty in classification is due to the possibility of multiple job holding. Nevertheless, in some countries the percentage classified as rural, nonagricultural workers is impressively large.

Even those people classified as working in the agricultural sector play multiple economic roles. The relationship of the poorest of rural dwellers to field crop production may be particularly ambiguous. In 1961, 25% of India's agricultural work force operated no land. Another 38% operated less than five acres (Mellor 1976). Since the families associated with these groups are likely to comprise a large portion of India's underfed people, a realistic appraisal of agriculture's role in nutritional strategy partially depends on whether improvements can be made in agricultural activities that generate income streams to which these people have access.

TABLE 2

DISTRIBUTION OF EMPLOYED LABOR FORCE BETWEEN AGRICULTURAL AND NONAGRICULTURAL ACTIVITIES IN RURAL AREAS, SELECTED DEVELOPING COUNTRIES

Category	Country	Year	Primary employment	
			Agricultural	Nonagricultural
			- - - - - (percentage) - - - - -	
Rural Areas, excluding urbanized settlements	Kenya	1969	72	28
	Iran	1972	67	33
	Guatemala	1964	86	14
	El Salvador	1975	68	32
	Colombia	1970	77	23
	Venezuela	1971	63	27
	Chile	1970	70	30
	Brazil	1970	88	12
	Indonesia	1971	72	26
	Thailand	1972	82	18
	Philippines	1970	72	28
	West Malaysia	1970	68	32
	Korea, Republic of	1970	81	19
	Taiwan	1966	51	49
	India	1966/67	80	20
Rural areas, including rural towns	Colombia	1974	57	43
	Philippines	1970	60	40
	West Malaysia	1970	63	37
	Korea, Republic of	1970	75	25
	Taiwan	1966	49	51
	India	1966/67	76	24

Source: Anderson and Leiserson, 1978.

The situation in India is not unique. In neighboring Pakistan, the 1971 Census of Agriculture shows nonartisan, landless, nontenant families comprise 26% of the agricultural families. These families rely on very small numbers of livestock for much of their livelihood. They acquire fodder in exchange for agricultural work. Little is known about the relative importance of these and other activities in their total incomes, but the simple notion that improvements in field crop production would have important direct impacts on these people may not be warranted. The important issue of dynamic but less direct income effects on these families is addressed in section four. This indirect impact of agricultural production and technologies could be great, given the improved crop technologies now available and their economic value. However, appropriate design of nutrition policy requires a good deal more research on the functional activities of these landless, rural families who would appear to be at considerable nutritional risk and may comprise a large proportion of the malnourished in many countries.

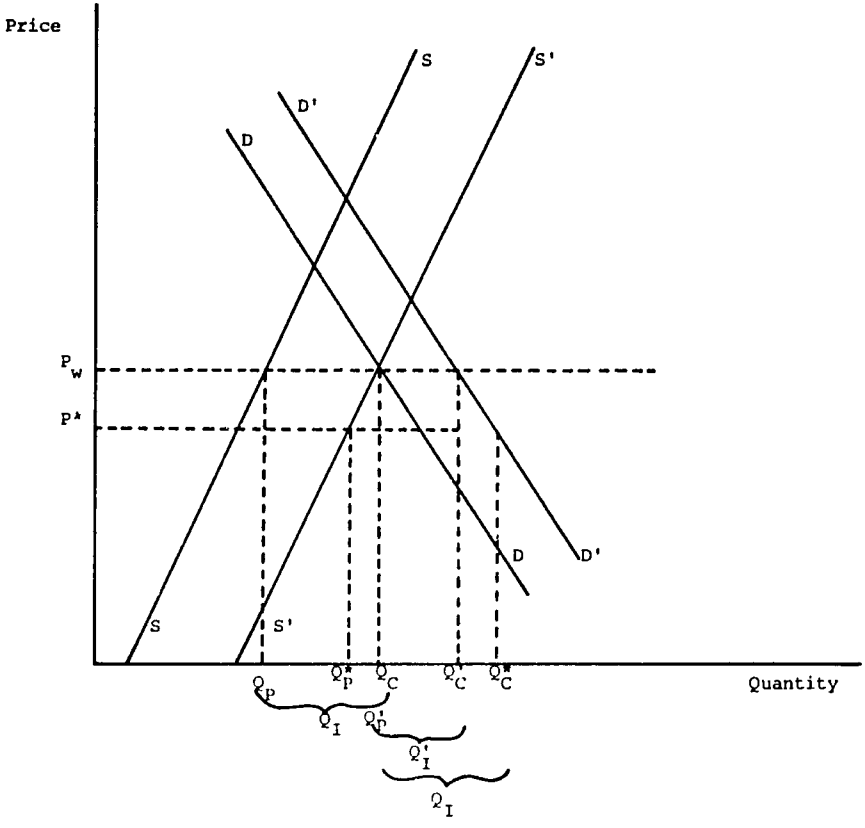
Although the employment profile of most of the families who comprise the target group of nutrition policy is uncertain, a large portion of the group relies on a market or source other than their own farm for a part of their food supplies. Agricultural policy, therefore, may have its greatest nutritional impact through food price effects. Two principle issues are involved here. First, the crops and technologies one would choose to maximize income effects on the target group may be different from those that maximize price effects. Therefore, the relative costs involved in producing the two effects influence the efficient allocation of resources within agriculture. This issue is pursued below in sections two and three. Secondly, other policy goals may compete with nutrition policy, so that tendencies for domestic agricultural expansion to influence food prices are offset.

Since the presumption frequently exists that agricultural expansion produces a reduction in food prices (i.e., supply increases relative to demand), and since some of the analytical tools available to nutrition planners are applicable only to policy instruments that produce price effects, it is important to determine the mechanisms by which production increases can affect food prices.

The difficulty encountered by many poor countries in allowing increases in agricultural output (which can come via increases in yields or in area planted) to have price effects is illustrated in Figure 2 and in the following calculations in Table 3, which show the number of years required to reach food self-sufficiency. In Figure 2, SS is the domestic supply curve of foodgrain prior to technical change, and DD is the domestic demand curve. This country produces Q_P of foodgrains and consumes Q_C. The differenc between Q_P and Q_C is made up by imports, Q_I. If the imports are subsidized, the price of foodgrain in the domestic market is P_W, the world price. After a period of time during which output increasing technical change takes place, the domestic source supply curve shifts out to S'S' (sufficient to replace the previous level of imports). However, the demand curve shifts out to D'D' over the same time due to population growth and increases in per capita income. In this example the rate of agricultural expansion is greater than that of demand expansion; therefore, at the

FIGURE 2

OUTPUT EXPANSION AND PRICE EFFECTS



D = Total demand curve before increased production

S = Supply curve from domestic sources before increase in production

Q_I = Imported quantity at world prices (P_w) before increase in production

D' = Total demand curve after increase in population and per capita income

S' = New supply curve from domestic sources following increase in production

Q_I' = Imported quantity at world prices after increases in supply and demand

TABLE 3

NUMBER OF YEARS REQUIRED TO REACH FOODGRAIN SELF-SUFFICIENCY

		Assumptions			
		1	2	3	4
Agricultural foodgrain productivity growth rates		.04	.04	.045	.045
Per capita income growth rate		.02	.02	.025	.025
Population growth rate		.025	.028	.025	.028
$\frac{Q_o}{C_o}$	E_y				
.8	.3	26	39	19	26
.8	.4	33	58	23	33
.8	.5	46	116	31	58
.8	.6	77	∞	47	117
.87	.3	16	24	12	16
.87	.4	21	36	15	21
.87	.5	29	72	19	36
.87	.6	48	∞	29	73
.95	.3	6	9	4	6
.95	.4	8	13	5	8
.95	.5	11	27	7	13
.95	.6	18	∞	11	27

$\frac{Q_o}{C_o}$ = Current rate of self-sufficiency.

E_y = Income elasticity of demand for foodgrain.

end of the period the country is less dependent on imports but is still importing nevertheless. In the absence of a consumer subsidy, the domestic price is unchanged, still equal to the world price, and imports will equal Q_I'. If, following an increase in production, imports had been maintained at Q_I (greater than Q_I'), then total supply would have been Q_C^* and the domestic price would fall to P^*. But this would require the government to directly subsidize domestic consumption, since private importers would take a loss importing grain at P_w and selling it on the domestic market at P^*. Unless government also subsidized producers at P_w, their output would fall from Q_p' to Q_p^*, the shortfall being made up by additional foreign exchange expenditures on imports.

If the country becomes a potential exporter by virtue of agricultural growth exceeding demand growth over time, the pure economics remain the same as in the importing case. In terms of a policy decision, however, this case is different, because an important and often constraining policy resource, government revenue, is not required to finance a price subsidy. If exports are restricted by policy, then an increase in domestic supply occurs forcing the consumer price below the level of world prices, P_w, which can be considered the opportunity cost of food to the economy. Unless domestic producers are directly paid the difference between P_w and the new domestic price label, the burden of subsidizing consumers will shift from the treasury to producers who will be producing at prices below the world price level.

It is instructive to calculate the amount of time required to achieve food self-sufficiency, at which point a government could rely on export restrictions, rather than on fiscal subsidies, to lower food price. Under the assumption of constant growth rates over time in agricultural productivity, Q' (i.e., the rate of shift in the supply curve) and in percapita income and population, C' (the two principal factors influencing the rate of growth in demand for food, i.e., the rate of shift in the demand curve),* the following equation relates the current rate of self-sufficiency, $\frac{Q_o}{C_o}$, to the time required, t, to reach complete self-sufficiency (i.e., $\frac{Q_t}{C_t} = 1$):

$$t = \frac{\ln \frac{Q_t}{C_t} - \ln \frac{Q_o}{C_o}}{\ln(1+Q') - \ln(1+C')}$$

The situation depicted in Table 3 shows the self-sufficiency time horizon under four different combinations of assumptions of fairly rapid sustained growth in agricultural production coming through increased yields

*C' = p' + Ey' where
p' = population growth rate
y' = per capita income growth rate
E = national aggregate income elasticity of demand.

and area (4% to 4.5% annually), moderately high population growth rates (2.5 to 2.8%), and per capita income growth at 2.0 to 2.5% (the higher rate is associated with the more rapid agricultural growth rate). The range of initial staple food self-sufficiency rates is 80 to 95%. Most of the poorer developing countries fall into this range, although quite a few are less than 80% self-sufficient. A study by the International Food Policy Research Institute of a representative sample of 28 developing countries found the following: 14% were exporters, 21% were basically self-sufficient, 46% had self-sufficiency ratios betwen 76 and 94; and 18% had self-sufficiency ratios below 76 (Valdes and Huddleston 1977). The range of income elasticities, 0.3 to 0.6, is plausible and could be interpreted as reflecting different distributions of the increment in national income over time - the more egalitarian development pattern resulting in the higher aggregate income elasticities.

Excepting the highly self-sufficient countries, even under high sustained agricultural growth, many countries will require at least 20 to 45 years to reach food self-sufficiency. Reading across the table reveals the substantial reltionship between even a small decrease in the population growth rate and the time required to attain self-sufficiency. Reading down the table shows the impact of various aggregate income elasticities of demand on food self-sufficiency. To the extent that egalitarian development strategies tend to increase the weight of higher income elasticities in the national aggregate, the length of time required to reach self-sufficiency may be lengthened considerably.

The point of this discussion is not to extol the virtues of policies leading to early food self-sufficiency. Instead, we wish to place an order of magnitude on the length of time that countries reflecting various characteristics will have to partially rely on fiscal subsidies to lower food prices even under high rates of agricultural growth. By substituting C'/Q' for Q_t/C_t in the previously cited equation, one can solve for the amount of time required for food imports to stop growing. After this time the absolute foreign exchange cost of fiscal subsidy declines (in the case where imports have been employed to maintain the domestic price below the world price).

Clearly, an increase in domestic agricultural production is not sufficient to lower domestic food prices unless supply increases exceed demand growth over time and a barrier to exporting exists. Given the preoccupation of most developing countries with foreign exchange scarcity and the lack of revenue-generating instruments, the tendency is strong to view increases in agricultural production as an instrument for import substitution rather than supply expansion. Whatever the balance of political forces on this issue, however, the following is important for those who design and evaluate agricultural strategies in terms of nutritional goals: to be aware that the price effect of domestic production increase, a crucial parameter for evaluating nutritional impact, is itself a policy variable which reflects the degree of openness of the economy to world market forces. Expedient assumptions about the price elasticity of the "domestic" demand curve can be very misleading in the absence of analysis of the policy environment influencing price formation. Econometric estimates

about the potential for price effects may lead to inappropriate resource allocations within agriculture in pursuit of nutritional goals.

An important caveat should be noted here. Output expansion in regions of developing countries which are poorly served by marketing services can lead to local price decreases, despite the fact that the country as a whole may be a net importer. As market integration increases, this potential decreases.

B. SUMMARY:

PRICE AND INCOME EFFECTS

The ultimate goal of agriculture in nutrition policy is to increase food consumption of the target group members. Target group members who own or operate farms may experience a direct income or consumption effect, whereas those who are agricultural workers may receive higher incomes as a result of an increased demand for their services. If the target group members have little functional relationship with the new technology, they must depend, in the short run, on output-induced price effects for improvement in nutritional well-being. Although information about the employment profile of those who comprise the target group is often not available, a large portion of the target group relies on a market or source other than its own farm for a part of its food supply. Therefore, agricultural policy may have its greatest nutritional impact through food price effects.

An increase in domestic agricultural production is not sufficient to lower domestic food prices except in regions poorly integrated into a national marketing system. Generally, increases in domestic production must be accompanied by price and trade policies aimed at facilitating supply expansion in order for food prices to decrease. Where foreign exchange is particularly scarce, pressure will exist to use agricultural production gains as an instrument for import substitutions rather than supply expansion.

III. AGRICULTURAL RESOURCE ALLOCATION TO ACHIEVE PRICE EFFECTS

A. KEY QUESTIONS

- What factors must be considered in selecting crops on which to focus output-increasing policy instruments (such as research or irrigation policy) in order to have the greatest impact on net nutritional intake of the target group members through price effects?
- What are the principal implications of using price effects to determine the benefits to target group members of alternative resource allocations?
- To what extent does crop substitution modify the nutritional impact from the Green Revolution?

At the national and regional level policy makers should determine the cost-effective combination of crop activities that will have the greatest impact on the net nutritional intake of target group members through price effects. The discussion in the previous section about conditions which influence food price levels suggests that an increase in agricultural production in and of itself cannot be assumed to result in lower prices. Therefore, the analysis in this section is valid under either two conditions: (1) the policy environment is such that increases in domestic production will result in supply expansion sufficient to lower food prices, or (2) nutrition planners develop information which may bear on a change in price policy to allow price effects. In the former case analysis in the context of nutrition goals will reveal which crops are more appropriate as targets for research expenditures, extension programs, or other activities designed to increase production. In the latter case analysis may reveal previously unknown opportunities for reaching the malnourished population through a combination of agricultural production and price policy.

In order to focus resources on the appropriate crops it is important to understand how prices effect the consumption levels of target and non-target group members as the supply of particular crops expands. The principles involved are competition between target and non-target group members in the marketplace, the substitution of one nutrient source for others in diets of target group members, and the cost of producing nutritional impact. A decrease in the market price of an agricultural commodity offers an incentive to both target and nontarget group members to increase their consumption of that good. The magnitude of response to a price change differs between groups and among commodities due to differences in income levels and the structure of preferences. The direct price elasticity, relating the percentage change in quantity demanded to a percentage change in price, is a measure of price responsiveness. This measure, applied to the quantity consumed per capita and the group population, shows

the initial pressure exerted in the market by that group as it competes for the supply increment following a decrease in price. The competitive strength of nutrition target group members grows relative to that of the nontarget group to the extent that they have a relatively high price elasticity of demand and a relatively large initial level of per capita consumption. The initial demand pressure exerted by all groups in response to a price decrease may exceed the actual supply increment, in which case the price begins to rise again. Pressure on the market is released by groups whose members begin to shift their expenditures to competing foods. Shifting expenditures among substitute goods as their relative prices change reflect the cross-price elasticity of consumer demand.

Two points should be emphasized from the preceding discussion. First, the portion of any supply increment actually acquired by target group members will depend on the group's propensity and ability to place expenditures in the market relative to non-target groups. These conditions will vary from commodity to commodity. Thus, the degree of "nutrient leakage" to nontarget group members due to their preferences and purchasing power is an important determinant on the cost-effective allocation of resources among crops. Second, the target group's consumption of the incremental crop production will not generally represent an equal increase in their total nutrient intake because, in part, it will be substituting for other foods previously consumed (i.e., the cross-price elasticity impact).

Pinstrup-Andersen et al. (1976) have developed a procedure for measuring these complex effects to project the actual impact on the target group resulting from supply expansion of various foods. The procedure involves the estimation of a complete matrix of direct and cross-price elasticities for a full set of foods and across target and nontarget groups. The matrix is estimated under assumptions that render it solvable for equilibrium prices and group-specific quantities, so that, following a supply curve shift, the distribution of the full supply increment as well as the impact of cross-elasticity or substitution effects can be traced to each group.*

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*The methodology is based on assumptions which define what is known in economics as a "linear expenditure system," and can be usefully employed in situations where lack of data precludes the direct estimate of relevant price and cross-price elasticities. The assumptions behind the linear expenditure system are strong and the results should be checked carefully for plausibility and used with care. See C. Peter Timmer (1979) for an alternative approach.

The usefulness of this approach can be understood from the following summary of an application to urban consumers in Colombia (see Pinstrup-Andersen, et al. 1976). The population has been divided into five income strata, the bottom two of which are on average deficient in calorie and protein intake. The solution of the elasticity matrix for the impact of supply expansion for various commodities allows calculation of the proportion of the physical supply increment actually consumed by the target group, as shown in Table 4. The relative amount of the production gain going to nontarget group consumption varies substantially by commodity, but it is generally large. The direct, indirect, and net change in per capita calorie and protein consumption following a 10% supply expansion is shown in Tables 5 and 6 respectively. Again, the net impact and degree of net leakage vary substantially by commodity.

Clearly this technique can be enormously useful for determining resource allocation. Analyzing demand patterns by income class may reveal policy options that would otherwise remain hidden by aggregate demand analysis. The objective is to identify foods for which the poor have an unusually high relative price elasticity. These foods are frequently considered "inferior" and sometimes account for a small share of expenditure even among the poor. They often account for a small share of total agricultural production as well and are neglected in agricultural development policy. Yet if supply can be expanded at reasonable cost, important marginal impact on consumer diets can be achieved, since a large proportion of the supply increment is captured by the poor. The fact that relatively little of the supply increment is acquired by non-target group members is particularly important if, as part of this strategy, budget resources are expended to provide a consumer price subsidy (see Timmer and Alderman 1979, for an example from Indonesia). Although in the Colombian example shown here the distribution of benefits to non-target groups is often quite large, in the cases of potatoes and cassava most of the supply increase is captured by the target group. This "self-targeting" characteristic may be attractive to policy makers responsible for determining the role of agriculture and price policy in nutrition strategies. (See also Study V, Consumer Food Price Subsidies). A policy decision to encourage a greater role in the food economy will probably imply additional resources allocated to the crop in agricultural research and extension.

It may be useful to note here some of the more problematic implications of using price effects on nutrition target groups to determine the benefits of alternative resource allocations within agriculture. First, if the Colombian example is at all typical, the leakage of benefits to non-target groups is quite large. This may result in biased and deflated cost effectiveness estimates unless conscientious effort is made to quantify other relevant benefit streams, such as income linkages to target group members or major contributions to other national policy goals. It may be appropriate to use the impact of net price changes as one element in a composite benefit index, so that the bias resulting from attributing the full cost of production to only one benefit stream is reduced.

TABLE 4

PERCENT OF SUPPLY EXPANSION EXPECTED TO BE CONSUMED BY CALORIE AND PROTEIN DEFICIENT STRATA

Food for Which Supply is Increased	% of Increase Consumed by Calorie Deficient Strata	% of Increase Consumed by Protein Defici Strata
Beef	12.1	28.7
Pork	11.1	29.4
Eggs	12.5	32.1
Milk	12.0	28.7
Rice	20.2	40.3
Maize	27.8	54.7
Beans	19.1	42.2
Lentils	7.9	21.9
Peas	8.0	22.1
Potatoes	27.5	58.8
Cassava	30.4	62.9
Vegetables	19.5	40.3
Tomatoes	21.1	40.6
Plantain	25.7	55.3
Oranges	12.4	29.4
Bread and pastry	25.0	50.2
Sugar	20.1	37.6
Oils and fats	17.2	39.3

Source: Pinstrup-Andersen, de Londono, and Hoover 1976.

TABLE 5

CHANGE IN DAILY PER CAPITA CALORIE INTAKES CAUSED BY A 10% INCREASE IN THE SUPPLY OF ANY ONE OF THE FOODS FOR $E_s = 0$

Foods for Which Supply Is Increased	Deficient Strata			Nondeficient Strata		
	Direct	Indirect	Net	Direct	Indirect	Net
Beef	14.56	-6.49	8.07	23.65	0.99	26.64
Milk	6.17	-3.04	3.13	10.14	0.37	10.51
Rice	36.10	6.89	42.99	31.82	-1.03	30.79
Maize	38.21	0.07	38.28	22.24	-2.22	20.02
Beans	7.77	0.29	8.06	5.27	-0.01	5.26
Peas	0.23	-0.67	-0.44	0.59	0.16	0.75
Potatos	10.86	4.21	15.07	6.38	-2.63	3.75
Cassava	17.29	5.79	23.08	10.07	-11.16	-1.09
Vegetables	2.57	-1.62	0.95	2.36	0.27	2.63

Source: Pinstrup-Andersen, de Londono, and Hoover 1976.

TABLE 6

CHANGE IN DAILY PROTEIN INTAKES (G./CAPITA) CAUSED BY A 10% INCREASE IN THE SUPPLY OF ANY ONE OF THE FOODS FOR $E_s = 0$

Foods for Which Supply Is Increased	Deficient Strata			Nondeficient Strata		
	Direct	Indirect	Net	Direct	Indirect	Net
Beef	1.41	-0.15	1.26	1.98	0.07	2.05
Milk	0.42	-0.08	0.34	0.59	0.04	0.63
Rice	0.79	0.16	0.95	0.66	-0.07	0.59
Maize	0.94	-0.02	0.92	0.44	-0.09	0.35
Beans	0.57	0.01	0.58	0.44	0.00	0.44
Peas	0.06	-0.02	0.04	0.13	0.01	0.14
Potatos	0.24	0.06	0.30	0.10	-0.10	0.00
Cassava	0.09	0.05	0.14	0.04	-0.35	-0.31
Vegetables	0.10	-0.03	0.07	0.08	0.02	0.10

Source: Pinstrup-Andersen, de Londono, and Hoover 1976.

Second, the criteria for selecting crops to be promoted rely solely on product characteristics as revealed through consumer demand behavior. Exclusive reliance on these criteria focuses resource allocation in agriculture on food crops and away from industrial crops, despite the employment or other income-generating linkages to the target group that may be associated with those crops. These criteria also exclude foreign exhange earning crops to the extent that their prices reflect world rather than domestic market forces. Used in isolation, therefore, the criteria may be most applicable to urban target groups, which have small liklihood of being able to capture direct employment and income benefits generated by crop production.

Third, in some environments the impact of supply response may be more important than in the Colombian example cited above. In the Colombian case the issue of supply response has been treated rather simplistically with the elasticity of supply for all crops estimated as zero in one solution and one in another. As expected, under conditions of relatively high supply elasticity, the overall net impact is reduced. Supply elasticities depend largely on the conditions of substitution among crops. These can change radically following the introduction of new crop technology. In addition, even under conditions of constant relative prices, technical change can produce important substitutions due to the change in relative net returns-per-acre among various crops. These effects are completely ignored in the analytical model summarized above. A more complex and sophisticated simulation would be required to capture these effects. An example of such a simulation of the production environment is provided in part IV below.

The issue of crop substitution has been raised by critics of Green Revolution technology. In India, for example, there is concern that the rapid spread of high-yielding wheat varieties has driven pulses - the major source of protein in the predominantly cereal-based diets of North India - from the cropping pattern. Of key policy concern is the net effects of these production changes on nutrient availability.

An interesting analysis of the situation was presented in a recent paper by Ryan and Asokan (1977). In the ten years prior to 1966, the year high-yielding wheats were introduced in North India, trend pulse acreage and production increased by 7.7% and 6% respectively. From 1964-1965 to 1974-1975 trend acreage and production fell by 2.8% and 4.8% respectively. Wheat acreage and production increased by 14.8% and 36% in the ten years prior to 1966 and by 55% and 136% respectively between 1964-1965 and 1974-1975. The net reduction in total pulse area during the first ten years of the high-yielding wheat program was only 22% of the increase in area sown to wheat.

Ryan and Asokan have estimated the pre-Green Revolution trend in pulse and grain crops and projected it through to 1974-1975 to obtain an estimated 1974-1975 production "without the Green Revolution." This estimation is compared to production "with the Green Revolution." The results in nutrient terms are shown in Table 7. The net positive impact of the Green Revolution on nutrient availability is substantial for all major nutrients except lysine.

TABLE 7

AVERAGE 1974-75 TOTAL PRODUCTION OF NUTRIENTS FROM WHEAT, PULSES, WINTER RICE, AND BARLEY IN THE SIX MAJOR WHEAT-GROWING STATES OF INDIA WITH AND WITHOUT THE WHEAT "GREEN REVOLUTION"

Nutrient	Unit	Average total production in 1974-75 from linear trend lines fitted through:		Percentage change in total trend production in 1974-75 had Green Revolution not occurred (%)
		Actual production from 1964-65 to 1974-75 (i.e. "With Green Revolution")	Actual production from 1954-55 to 1964-65 and then projected to 1974-75 (i.e. "Without Green Revolution")	
Total weight of six food-grains	'000 MT	39,363	34,089	-13.4
Protein	'000 MT	4,897 (5,060)[1]	4,408	-10.0 (-12.9)
Energy	10^9 Kcal	135,045	116,830	-13.5
Lysine	'000 MT	203 (207)	216	+ 6.4 (+ 4.3)
Methionine + Cystine	'000 MT	161	136	-15.5
Tryptophan	'000 MT	53	47	-11.3
Leucine	'000 MT	355	334	- 5.9
Isoleucine	'000 MT	200	196	- 2.0

1 Figures in parentheses include an allowance for the estimated additional protein percentage of the high yielding varieties.

Source: Ryan and Asokan 1977.

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An interesting analysis of the situation was presented in a recent paper by Ryan and Asokan (1977). In the ten years prior to 1966, the year high-yielding wheats were introduced in North India, trend pulse acreage and production increased by 7.7% and 6% respectively. From 1964-1965 to 1974-1975 trend acreage and production fell by 2.8% and 4.8% respectively. Wheat acreage and production increased by 14.8% and 36% in the ten years prior to 1966 and by 55% and 136% respectively between 1964-1965 and 1974-1975. The net reduction in total pulse area during the first ten years of thed high-yielding wheat program was only 22% of the increase in area sown to wheat.

Ryan and Asokan have estimated the pre-Green Revolution trend in pulse and grain crops and projected it through to 1974-1975 to obtain an estimated 1974-1975 production "without the Green Revolution." This estimation is compared to production "with the Green Revolution." The results in nutrient terms are shown in Table 7. The net positive impact of the Green Revolution on nutrient availability is substantial for all major nutrients except lysine.

TABLE 8

RELATIVE COSTS OF PROTEIN AND ENERGY FROM WHEAT AND CHICKPEA IN 1965-66 AND 1977

Crop	(Rs/100 g) Cost of protein in: 1965-66 Nominal Terms	1965-66 Real 1977 Terms	April-June 1977 Actual	(Rs/'000 Kcals) Cost of energy in: 1965-66 Nominal Terms	1965-66 Real 1977 Terms	April-June 1977 Actual
Wheat	0.633	1.398	0.919	0.216	0.477	0.313
Chickpea	0.479	1.06	0.819	0.227	0.501	0.389

TABLE 9

TREND LEVELS OF PRODUCTION PER HECTARE OF PROTEIN AND ENERGY FROM WHEAT AND CHICKPEA IN THE SIX MAJOR WHEAT-GROWING STATES OF INDIA IN 1964-65 AND 1974-75

Crop	YIELD (kg/ha)		PROTEIN (kg/ha)		ENERGY ('000 Kcal/ha)	
	1964-65	1974-75	1964-65	1974-75	1964-65	1974-75
Wheat	900	1414	106	167	3114	4892
Chickpea	615	657	105	112	2214	2365

Source: Ryan and Asokan 1977.

The cost of protein and calories from wheat and pulse sources in 1977 relative to 1965-1966 is shown in Table 8. It can be seen that over that period of time wheat protein became cheaper relative to pulse protein. The same is true for calories. In addition, after translating 1965-1966 prices into real 1977 terms to account for general inflation, one finds that both wheat and pulse proteins and calories were actually cheapter in 1977 relative to 1965-1966. These changes suggest considerable potential for a positive net nutritional impact from the Green Revolution. However, the actual impact would require an examination of dietary patterns of the target groups. Wheat as a protein source for weaning infants might be less effective because of its lesser protein concentration relative to tat of the pulses (see Volume IV, Formulated Foods, in this series).

While substitution effects may be substantial and must be considered carefully when planning agricultural strategy, the power of new agricultural technologies should not be underestimated. The impressive increases in wheat physical and nutrient yield per hectare is shown in Table 9. These yields combined with acreage expansion may have more than offset the substitution impact of declining pulse production. Of course, the impact of the Green Revolution must be examined beyond its influence on new supply balances and nutrient cost. In Section IV therefore we turn our attention to the complex issue of income linkages associated with new agricultural technologies.

B. SUMMARY:

AGRICULTURAL RESOURCE ALLOCATION TO ACHIEVE PRICE EFFECTS

The portion of a supply increment actually acquired by target group members depends on the group's propensity and ability to buy foods in the market relative to nontarget groups. The direct price elasticity is an index of price responsiveness and relates the percentage change in quantity demanded to the percentage cnange in price of a good. The group's gross increase in nutrient consumption is greater than its net increase as a result of substitution among foods. Shifting expenditures among substitute goods as their relative prices change is known as cross-price elasticity.

Measuring these complex effects to project the impact of supply expansion on the target group involves the estimation of direct and cross-price elasticities for a full set of foods and across target and non-target groups. This technique of analysis is only appropriate when supply expansion can be expected to reduce food prices or where nutrition planners are developing information with a view to influencing change in price policy.

The principle pay-off to this analysis is the discovery of foods which "self-target" to the malnourished population, thus minimizing leakages to non-target members. Used in isolation of other measures, however, this technique may bias the focus of nutrition and national planners inappropriately. For instance, leakage to non-target group consumption varies but is generally large. This may bias cost effectiveness estimates of the net impact of price changes unless other relevant benefit streams are quantified. Examining only food price effects focuses resource allocation on food crops and away from industrial crops or foreign exchange earning. This focus would fail to capture employment and income benefits generated by these crops. Also, the impact of supply response may be important. Under conditions of relatively high supply elasticity the overall net impact is reduced.

The evidence of net nutritional impact of the Green Revolution is positive. Production substitution effects may be substantial, but, in the case of India, the increased yields of wheat combined with acreage expansion have overwhelmed the substitution impact of decling pulse production.

IV. AGRICULTURAL RESOURCE ALLOCATION TO ACHIEVE INCOME EFFECTS

A. KEY QUESTIONS

- Why must a nutrition-oriented agricultural strategy consider the income- and employment-generating potential embodied in new agricultural technology?
- What considerations are important in the potential for improved technology to increase the nutritional well-being of poor families?
- What crop specific characteristics are important in addition to capacity for generating net income?
- What are the direct employment effects of technical change?
- What are employment linkages?
- What are the criteria for agricultural resource allocation implied by an employment- and income-oriented strategy?
- Are crops and technologies with strong employment and income linkages the same as those that induce substantial increases in consumption by target group members in response to lower prices?

Although price effects can have an immediate and sometimes dramatic effect on target group food consumption, a nutrition-oriented agricultural strategy must rely heavily on the income- and employment-generating potential embodied in new agricultural technology. As Figure 1 in Chapter One shows, income linkages, like price linkages, are also complex and are determined by the economic function of target group members. In the case of farm operators there is a direct link to income generated from the adoption of new agricultural technology. Agricultural workers have less direct access. The income linkage depends on the nature of new technology, the performance of agricultural labor markets, and social reltionships with farm operators. Non-agricultural workers can also benefit from the dynamic impact of increased agricultural production and productivity on the economy (Mellor 1976). But these linkages, though strategic, take a longer time to develop. The strength of each of these linkages can be influenced by policy decisions.

Perhaps the easiest case to analyze is that of the farm operator who adopts improved agricultural technology. The various studies of the impact of the Green Revolution suggest that improved technology, particularily new seed varieties, fertilizer and irrigation, has a substantial and positive impact on farm incomes, even those of tenants. It can be expected that both owner-operators and tenants earn higher returns to their own labor and management following increases in farm productivity. What is surprising is that tenants as well as owners often acquire a share of the increased returns to land as well (see for instance Goldman and Squire 1978, Kikuchi et al. 1977, Rao 1975). There now is substantial evidence that the principal constraints on adopting improved biological technology are primarily agroclimatic in nature, often related to water control, and frequently are not related systematically to farm size or wealth (see Perrin and Winkleman 1976, Herdt and Mandac 1979, Scobie 1979). In regions where new high yielding seed varieties are well adapted, the small farm class often achieves surprisingly high rates of adoption, as exemplified by Table 10 for the case of India in the early Green Revolution period. Most studies of production efficiency by farm size conclude that small farms are at least as economically efficient and frequently more so than large farms (see Bardham 1973, Cline and Berry 1979). In some economies smaller farm operators may pay higher prices for inputs and receive lower prices for outputs. The evidence on this is highly conflicting, however. In general, it seems fair to conclude that if research strategies are successful in creating improved technology suitable for an agro-climatic zone, small farmers will benefit in absolute income terms although their relative position in the income distribution may worsen (see Hanson 1979).

This conclusion is not intended as an argument against policies aimed at increasing access of small farmers to credit or removing market imperfections and developing less cash intensive technologies. It is a fact that many poor farmers are not benefiting from new agricultural technology, and there are undoubtedly many cases where institutional factors prevent small farmers from making intensive use of new technology. Evi- suggests, however, that improving the incomes of poor farmers may depend

TABLE 10

CHARACTERISTICS OF TECHNOLOGY ADOPTION, 1968-69 to 1970-71

INDIA (PUNJAB, HARTANA AND TAMIL NADU STATES)

	1968-69				1970-71			
Farm size (acres)	% of all farmers who are adopters	% of all farmers with irrigation who are adopters	Area under HYV %	HYV area as % of irr. area	% of all farmres who are adopters	% of all farmers with irrigation who are adopters	Area under HYV %	HYV area as % of irr. area
0-5	2.16	34.7	14.6	33.6	29.1	42.1	16.5	29.3
5-15	26.7	37.5	12.8	32.1	33.4	45.3	16.3	29.3
15-25	28.2	46.7	13.1	39.6	42.7	58.1	18.5	40.7
25	30.2	46.5	11.1	35.9	36.7	44.4	18.1	48.7
All	25.5	38.7	12.8	34.8	33.5	46.5	17.4	36.4

notes: Only figures for net irrigated area are available for 1968-69. Gross irrigated area figures (used for computation in cols. 5 and 9) were constructed by imputing a cropping intensity equal to that employed by the farmer in 1970-71.

Source: Berry and Cline 1979.

more on research and development strategies aimed at creating technology suitable to the difficult agro-climatic and management conditions of low productivity farms than on policies aimed at eliminating institutional biases in the agricultural sector.

The relationship between new agricultural technology and the nutritional status of family farm members stems from the income generating capacity of the improved technology. In general, the analysis of consumer food expenditures focuses on the importance of income but ignores the relative influence of various sources of income. Many believe, however, that nutrition policy aimed at poor farmers and their families should consider certain crop-specific issues in addition to the potential for generating new income. There are at least four reasons for this.

In agricultural regions with important market imperfections or where roads and other transport facilities are lacking, there is frequently a large differential between the farmgate and retail price of food commodities. In this situation, the income generated per dollar of investment in cash crop technology relative to that of staple food crop technology must be larger than in the case where the farmgate-retail price spread is small, in order to have an equal impact on food consumption in poor farm families. This is so because expenditures generated out of cash-crop income trade for food at the higher retail price. However, consumption out of staple-food income trades at the opportunity cost, which is the lower farmgate price. Massell has tested for this relationship in the expenditure patterns of rural families in Kenya and Uganda and found it to be present for some commodities (Massel 1969). In the context of selecting crops on which to focus output increasing policies, the presence of this phenomenon represents an argument for assigning an additional weight to staple food crops above their general potential for producing net income.

Differentiating among crops for reasons other than those relating to net income may also be important where social structure assigns ownership of specific crops within families according to the sex of family members. This characteristic is particularly widespread in Africa south of the Sahara, where polygamous marriages are prevalent and wives customarily receive little income support from their husbands. They must support themselves and their children. There is usually a clear cultural distinction between particular crops owned by wives and those owned by husbands (see Boserup 1970 and Johnston 1958). A production increasing strategy which emphasizes crops and income streams not owned by women may have a detrimental effect on the nutritional status of women and children.

Another dimension of crop production which is particularly important to the poorest families is income instability. Some associate this characteristic particularly with export oriented tropical tree crops due to the normally long gestation period between planting and harvesting and price instability in the world market. The relative importance of this characteristic is not clear. There are certainly numerous examples from countries such as Malaysia, Kenya and Nigeria of the positive impact tropical tree crops can have on the well-being of small farm families. There may be cases where adoption of tropical tree crops on small farms displaces staple food crops and reduces crop system flexibility, making more

difficult the adjustments required to maintain nutritional status in years of poor harvest or low prices.

The impact of instability on the resource allocation behavior of farmers is not easy to measure. However, studies suggest and most observers agree that instability is an important factor which tends to increase the amount of staple food crop acreage in crop patterns and to reduce the amount of cash inputs applied in production (see Norman 1975, Herdt and Wickham 1974). In addition, there is a growing body of evidence supporting the notion of a vicious circle of impoverishment, malnourishment and sickness engendered by seasonal production instability (see Chambers 1979). Policies oriented toward reducing agricultural instability may result in substantial improvement in the nutritional and health status of poor farmers. Such policies include improving crop resistance to pest infestation and drought, increasing cropping intensities through investments in irrigation and the development of quick maturing varieties.

A final reason for considering factors other than the net income generating potential of output increasing technology concerns tenancy displacement. Output increasing technology frequently worsens the income distribution in rural areas while raising the real incomes of both small and large farmers. In some regions, however, substantial improvements in cash crop technology may provide an incentive for landlords to take over land previously cultivated by tenants (Ladejinksy 1977). The potential for this to occur may be substantially increased in regions where price and other policies encourage mechanization, where land reform legislation is threatened, and where custom or political pressure discourage the adjustment of rental terms to reflect the impact of the new technology without adequately protecting tenant security. The many instances of successful technical change which did not involve these severe dislocations suggest that technology per se is not the cause. However, any strategry aimed at improving rural diets through output increasing production technology must give careful consideration to the implications of rural power structure and to policies which ultimately work to the disadvantage of tenants in the process of technical change.

In many rural areas poor farm families may not comprise a large portion of the malnourished rural population. The direct access to land, even small amounts, may ensure nutritional adequacy in terms of calories and proteins for many farm families. Agricultural workers and landless families are more likely to be malnourished than members of small farm families. The relatively small nonagricultural sector of developing economies, even under conditions of high growth, cannot for many years absorb into employment the population growth increments with which it is confronted. As a corollary, however, the dominant role of agriculture in both national income and employment imply the potential for great leverage under conditions of technical change and increasing agricultural productivity. Although projects and specific investment activities must ultimately be the vehicles for exploiting this potential, it is essential for nutrition planners to understand the issues within the context of agricultural strategy. Despite the urgency of the nutrition problem, ad hoc approaches to agricultural resource allocation which emphasize immediate gains may be unreal-

istic. A more effective policy must exploit agriculture's potential for producing a complex of employment and income-generating linkages to target group members.

As an example, labor's share in the value of grain output prior to technical change is frequently on the order of 30%. The subshare of hired labor is sometimes less than half of this amount. Under technical change the relative share of labor may fall despite a rise in the absolute incomes of workers. In some sense the value increment going to nontarget group members can be viewed as a leakage, and investment design must be sensitive to this. Unlike leakages defined in the analysis of price effects, however, these leakages are income. A large portion of this income will be spent directly or indirectly on agricultural goods, the producton of which may involve target group members. These dynamic linkages, if properly understood and exploited within agricultural strategy, may offer more benefits to target group members than the more immediate and identifiable direct employment effects.

In order to understand some of the interrelationships involved, it may be useful to follow an example developed by Raj Krishna (1974). Crop production may be decomposed into a series of labor-using activities that are either "area-based" or "output based." The changes in amount of labor employed in land preparation or weeding, for instance, are much more closely associated with changes in the amount of land under cultivation than with changes in crop yield per acre. The reverse is true in the case of harvesting and threshing labor. Moreover, these relationships vary from crop to crop. In addition, area-based activities may have "output effects," inducing labor use indirectly. The result is that for the same crop some aggregate cultivation technologies are more labor-intensive than others; and, given current technologies in use, some crops are more labor-intensive than others. Projections of change in labor use for the agricultural sector can be broken down into changes in the relative importance of particular area and output-based activities in the production of a single crop and in the relative importance of various crops in production over time.

Krishna identifies ten different area and output-based wheat and rice production activities in the Indian Punjab. On the basis of official projections of changes over time in the relative importance of new seed varieties, irrigation, and mechanical ploughing and threshing, the employment effects are calculated as shown for wheat in Table 11. In this case the total effect of the projected innovations is quite negative, a net decline of 92 manhours per hectare. The advantage of this technique is its ability to identify the effect of discrete activities that, if undesirable, may be amenable to policy action. In this example the negative employment impact of mechanical threshing is outstanding. When one examines the combined effect of projections for both crops, wheat and rice, plus estimates of increases in crop intensity (i.e., the number of cropped acres per cultivated acre), the net negative employment effect is less proncounced, as shown in Table 12. Rice is a more labor-intensive crop than wheat, and the increase in its acreage share produces a "crop-mix" effect on employment. Increases in crop intensity, facilitated largely by the introduction

TABLE 11

DECOMPOSITION OF THE CHANGE IN THE TOTAL LABOR INPUT PER HECTARE IN WHEAT PUNJAB, 1968-69 TO 1973-74

Effect	Manhours/hectare
1. Irrigation effect	+16.28
2. Variety effect	+17.35
3. Tractor-ploughing effect	- 5.26
4. Irrigation technology effect	-34.59
5. Threshing effect	-70.58
6. Interaction effect of irrigation and varietal improvement	+ 2.08
7. Negative interaction effects	-16.89
Total	-91.61

Source: Krishna 1974.

TABLE 12

SEPARATION OF TECHNOLOGY, CROP MIX AND INTENSITY EFFECTS ON LABOR PER HECTARE (NET) IN WHEAT AND RICE (COMBINED), PUNJAB, 1968-69 TO 1973-74

Effect	Manhours/hectare
Technology	-74.51
Crop Mix	+17.04
Intensity	+27.67
Interactions	- 0.34
Total	-30.14

Source: Krisha 1974.

of tube wells, have important labor-using effects as well. The introduction of policies that discourage mechanical threshing would probably result in substantial, positive net employment effects.

The utility of this approach depends critically on valid projections of investment profiles and on the resulting crop-mix and crop-intensity effects. Krishna's example has relied on rather crude projections. New technologies such as seed varieties and irrigation change the relative net returns per acre of crops in the cropping pattern and facilitate the production of new crops or more of the same crops. Governments can rarely dictate the response to this new technology, which depends on the independent decisions of many farmers and farmer groups. This behavior must be modelled accurately to result in useful projections. Linear programming provides an appropriate, although by no means foolproof, method for generating complex projections. An example of the complex crop mix and intensity effects under technical change projected by a linear programming model of farm behavior in the Pakistan Punjab is shown in Table 13. The labor implications of various technologies can be estimated from these projections with a procedure very similar to that used in the Krishna example above.

Whatever the direct employment effects of technical change are, the income streams thus generated result in consumption expenditures. These expenditures also produce employment effects. Using input-output analysis, Krishna completes his example by showing the total farm employment effect of a 5% growth in farm output (Table 14). The negative direct labor displacement effect is more than offset by the multiplier of demand linkages stimulated by the initial income-generating impact of agricultural growth. The subsequent final consumption demand for farm products has a particularly large impact on employment. Investments in crop research, extension, and marketing organization should anticipate the indirect demands generated by initial agricultural growth. A strategy that places an initial emphasis on staple grains must diversify to other crops for which there is a high income elasticity of demand if employment linkages are to be fully exploited.

The potential of new agricultural technology for generating income and employment can be analyzed in two stages. The first relates to the character of the technology itself and the second relates to price policy. In the first instance agricultural technology can be defined in terms of its output increasing and labor substituting characteristics. Mechanical threshers and tractors, for instance, do little to enhance the production of the crop to which they are applied, and they are direct substitutes for labor. New seed varieties, fertilizer and irrigation all contribute directly to increased production and the potential demand for labor, particularly in harvesting and threshing. Herbicides substitute for labor but may contribute to a larger harvest hence, indirectly, to the demand for labor. Mechanical technology, because it can perform work faster than human and animal labor, is justified by some in terms of its contribution to increasing crop intensity, a potentially high labor-using factor. In a comprehensive survey of Indian experience, Binswanger (1978) finds little evidence supporting this view, however. In the context of nutrition policy, strongly labor-substituting technologies should be discouraged.

TABLE 13

OPTIMAL CROPPING PATTERNS AND CROPPING INTENSITIES IN THE CENTRAL PUNJAB WHEAT-COTTON AREA UNDER ALTERNATIVE TECHNOLOGICAL ASSUMPTIONS[1]

(Percent except as otherwise indicated)

Crops	Traditional technology		Improved wheat technology		Improved rice technology		Improved wheat and rice technology	
	Without tube well	With tube well	Without tube well	With tube well	Without tube well	With tube well	Without tube well	With tube well
Winter crops								
Wheat	43.5	8.8	45.1	42.2	42.7	31.0	44.3	34.3
Barley								
Oilseeds	2.6		2.7					
Gram								
Fodder	14.0	12.0	6.8	11.9	11.1	10.5	6.9	5.0
Sugarcane		6.9		6.9	4.8	6.1	3.7	5.6
Vegetables	1.1	1.4	1.7	1.4	1.6	1.2	1.7	1.1
Orchards		2.1		2.1		1.8		
Subtotal	61.2	31.2	56.3	64.4	60.2	50.6	56.6	46.0

Summer crops								
Rice	2.3		5.2		8.5	24.0	7..	37.7
Cotton	25.5	50.8	27.1	16.8	15.8	9.0	20.1	
Maize								
Fodder	10.2	9.2	10.6	9.2	9.9	8.2	10.4	7.5
Sugarcane		6.9		6.9	4.8	6.1	3.7	5.6
Vegetables	0.8	0.6	0.8	0.7	0.8	0.6	0.8	0.5
Orchards		2.1		2.1		1.8		
Subtotal	38.8	69.6	43.7	35.7	39.8	49.7	42.7	51.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total cropped acreage	11.8	14.5	11.8	14.6	12.2	16.4	11.5	17.7
Cropping intensities	94.0	116.0	95.0	117.0	98.0	131.0	92.0	142.0
New revenue (rupees)	2,034	3,192	2,358	3,649	2,197	3,382	2,475	4,131

[1] Based on 12.5 acre farm.

Source: Gotsch and Falcon 1975.

TABLE 14

DECOMPOSITION OF TOTAL EMPLOYMENT GROWTH DUE TO 5% FARM OUTPUT GROWTH WITH TECHNICAL CHANGE, INDIA (BASE 1964-65)

Effect	Manyears	Percent
Pure labor displacement effect	-2,737,670	-148.9
Farm input demand effect	784,490	42.7
Farm final demand effect	2,434,180	132.4
Nonfarm final demand effect	764,390	41.6
Nonfarm input demand effect	592,580	32.2
Total	1,837,970	100.0

Source: Krishna 1974.

Price policy has important implications for impact of new technology for two reasons. First, price policies frequently encourage and subsidize the use of mechanical technology on the mistaken assumption that it is essential to modern agriculture in devleoping countries. Low interest loans for tractor and thresher purchase and overvalued exchange rates which make imported capital goods artificially cheap are principle examples of price policies which work to lower employment in agriculture.

The second important aspect of price policy concerns the aggregate responsiveness of domestic output prices to increases in crop production induced by new technology or other output-increasing investments. As shown above, this response is determined by the degree of openness of the agricultural economy to the world market. If production increments substitute for imports or are exported, then little or no impact on price is expected, and increases in production result in substantial increases in income and labor demand in the agricultural sector. However if domestic supply expansion occurs (in per capita terms), then price will fall, somewhat offsetting the potential income generating impact of the supply expanson. As prices decline, the incentive to increase production also decreases, leading to lower demand for labor than in the case where price is unresponsive. It is important to note that lower staple food prices have a positive impact on real income and stimulate demand for labor intensively produced consumer goods. It is also important to recognize that the potential for new technology to increase output and the direct demand for labor in agricultural production is greater in environments where output expansion does not result in a substantial fall in price.

The selection criteria for a nutrition strategy which relies on the generation of employment and income for impact is unlike a strategy which relies on price effects. The criteria for agricultural resource allocation implied by an employment and income-oriented nutrition plan rests on the technical input requirements of various crops, the relative labor intensities of cultivation activities, and the demand characteristics of crops, particularly those associated with income rather than price response. Implementation of these criteria may result in very different resource allocations from those chosen under a price-oriented strategy. For instance, crops that result in export expansion or import substitution, such as cotton and sugarcane, both of which may be relatively labor-intensive crops (Mellor 1976), receive no emphasis in a price-oriented strategy but may play an important role in an income-employment oriented program.

Commodities with high income elasticities and important employment linkages are emphasized in an income-employment strategy but perhaps not if price effects dominate selection criteria. This may be so, because either income-generated linkages are ignored under price effect criteria or because some commodities which are subject to high income elasticities are also subject to high price elasticities from both target and nontarget groups. Dairy products may fall into this category. They are generally subject to high income elasticities across a wide range of income groups. The configuration of target and nontarget group price elasticities, however, may cause a price decrease to result in direct leakages into nontar-

get group consumption or indirect leakages due to consumption substitution by target group members. Since the production of dairy products is in some countries particularly prevalent among small farmers and landless families, the failure to exploit this potential linkage would be unfortunate.

A final observation concerns technical change and its impact on institution elements in rural labor markets. Social structural features represented by reciprocal obligations between landless and landowning classes frequently work to guarantee socially acceptable levels of employment to landless people and result in payments to workers that may be higher than would result from competitive wage determination in a market economy. The introduction of new agricultural technology and consequent increase in monetization may erode thse relationships, so that more labor dislocation would result than would be predicted were social structural issues not considered at the planning stage. For example, there is strong evidence that in parts of Indonesia traditional arrangements which guarantee landless people access to harvest employment are breaking down where new rice varieties are introduced (Collier et al. 1974). The extent of this breakdown and its relationship to the new technology is unclear and controversial, however (Hayami and Hafed 1978). The breakdown of traditional systems of employment has received attention in recent years, although analysis of the factors involved requires considerably more research (see Gotsch 1971, Rao 1975, Scott 1976, Sisler and Colman 1979, and Swenson 1976).

B. SUMMARY:

AGRICULTURAL RESOURCE ALLOCATION TO ACHIEVE INCOME EFFECTS

Price effects can have an immediate influence on target group food consumption, but an effective longterm nutrition oriented agricultural strategy must rely on producing employment- and income-generating linkages to the target group. The small nonagricultural sector of developing economies cannot absorb expected population increments into employment. Technical change and increasing productivity in agriculture imply direct employment effects that may be either positive or negative - which kind depends on the labor intensity of the crop technology and the crop mix.

Direct employment effects generate income streams that result in consumption expenditures which also produce employment effects. Dynamic linkages generated by agricultural growth may offer more benefits to target group members than more immediate direct employment effects.

Price policy can play an important role in determining the type of new technology used by farmers. Many countries discriminate against labor-using technologies by offering price subsidies on mechanized inputs. Policy related to output prices can influence the flow of income and strength of labor demand generated by output increasing technical change.

Criteria for agricultural resource allocation implied by a strategy oriented to generation of employment and income rest on the technical input requirements of crops, the relative labor intensities of cultivation activities, and the demand characteristic of crops. Different resource allocations may result under this strategy than those chosen under a price-oriented strategy.

CHAPTER THREE

EVALUATION

I. KEY QUESTIONS

- Would the full cost of agricultural investments be attributed to their contribution to nutrition goals?
- What is agriculture's major contribution to nutrition goals?
- What is the conflict between agricultural growth and consumer subsidy programs?

II. INTRODUCTION: DETERMINING COSTS AND BENEFITS

As for any intervention, a list of all program inputs is required to determine the costs for an agricultural intervention. The market values of program inputs generally are identified from accounting records or imputed from market prices. Goods or services whose market costs differ from social opportunity costs should be shadow priced. Shadow pricing represents the value to society of the input in its next most productive use. Frequently the national planning agency or development bank has already calculated such shadow prices. A more detailed discussion of appropriate methodology is given in Gittinger (1972). Measuring the domestic resource costs (DRC) of alternative production activities is a variation of the benefit-cost approach. This method allows the comparison of projects in terms of the project specific domestic resource costs of earning or saving a unit of foreign exchange. The Food Research Institute at Stanford University has employed this technique in two studies investigating the political economy of rice in Asia and West Africa (See Food Research Institute Studies 1975, for a report of the Asia study; the West African study will be published by Stanford University Press in 1980-1981).

Nutrition benefits can be more difficult to identify. If the target group members own or operate farms on which increases in productivity take place, the nutritional benefits to the family may be measured directly. Chapter Four illustrates a methodology for doing this. Target group members who have no relationship to the new technology may accrue nutritional benefits primarily through price effects. The measurement of these benefits can be accomplished with methodology similar to that of Pinstrup-Andersen or Timmer and Alderman above and with careful consideration of the macro policies affecting price formation. Nutritional benefits which accrue to agricultural workers whose wages rise or who are more fully employed because of an increased demand for their services are more difficult to identify and measure. Employment linkages may be difficult

to measure due to the complexity of projecting such things as crop substitution effects. Furthermore, as previously indicated, agricultural labor markets in developing countries are frequently characterized by social structural aspects whose dynamics in the face of a changing economic environment are difficult to predict.

In theory most nutritional activities can be designed so that target group members have preferential or exclusive access to program resources. This is not true for agriculture, because the target group's relationship to the program resources, i.e., the production technology or public investment in infrastructure, may be through an indirect linkage such as a labor or consumer market. Agriculture further differs from other nutritional policy instruments in that there is an intermediate generation of potential value prior to its consumption by malnourished individuals. Increases in agricultural production, therefore, can serve as a policy resource for a number of different goals, some of which may conflict with nutritional goals. If agriculture is not designed to contribute only to nutrition goals, the full cost of agricultural investments should not be attributed to their contribution to nutrition goals. It may be impossible to determine the appropriate portion of cost to attribute to improvement in nutritional well-being. Because of this difficulty and because of trade-offs among policy objectives implied by other investment opportunities, agricultural activities are better evaluated against the full set of policy objectives rather than the subset of nutritional goals. In this context research into the specific impact of various agricultural activitier on the malnourished should provide more insight into the weights to attach to agricultural policy options in relation to nutrition goals.

III. THE FISCAL IMPACT OF AGRICULTURAL PROGRAMS

In many countries the fiscal role of agriculture in nutrition strategy may be critical. Many analysts lay heavy emphasis on the need for direct subsidy programs to achieve nutritional targets (see Reutlinger and Selowsky 1976). In addition, we have shown here that, for the foreseeable future in most countries, general price effects can be achieved only through consumer subsidies at direct cost to the treasury. These subsidy instruments cannot be viewed as complete policies, because their cost tends to grow rapidly, and, in the absence of a broader, more consistent set of policy instruments, they frequently cannot be sustained. The agricultural sector can make an important contribution to nutritional goals as a source of public revenue to finance consumption oriented policies. A growing agricultural sector is virtually a prerequisite for a successful program of consumer subsidies. Agricultural growth can provide additional income and employment, so that the size of the target group which requires subsidy is reduced. In addition, it can provide a growing source of revenue and foreign exchange with which to finance consumer subsidies. This fundamental complementarity belies an equally fundamental resource conflict, however.

Agricultural growth itself, though potentially a net generator of resources, requires a large volume of initial investment. In order for the

developing countries as a group to achieve a compound food grain growth rate of 2.6% over the period 1974 to 1985, an estimated investment of $25 billion would be required in the first five years (Burke and Goering 1977). If demand trends continue, the developing countries would still be short of food grains by about 33 million tons. They would (at constant prices) be dependent on external sources for 15.5% of total food grain consumption. If we add to this the additional 25 million tons of grain required for calorie sufficiency (estimated by Reutlinger and Selowsky), the dependency level is 27%. Closing this gap with domestic production would require an additional domestic investment of $32.2 billion, or a total investment more than double the projected figure based on current policies, revenue sources, and expenditure patterns.

Obviously, this investment is not going to be made, and complete self-sufficiency cannot be achieved in so short a time. The figures show, however, that even to establish a more modest agricultural growth rate of 3 to 3.5%, a very substantial additional investment in such things as irrigation facilities and market roads is required. Most of this investment must come from public revenues in the form of capital development expenditures. This is where the conflict between agricultural growth and consumer subsidy programs emerges.

The budgetary cost of food subsidies in various developing countries is shown in Table 15. (For further information, refer to Study V in this series.) When viewed as a proportion of total public expenditures, these subsidies are large. However, the direct competition between food subsidies and the investment requirements for agricultural growth is captured best by subsidy costs measured as a percentage of public capital expenditure. The average for the countries reported here is 43%.

Clearly, an effective nutrition plan must come to grips with important fiscal issues. Unless the fiscal requirements of agricultural growth, on the one hand, and consumer subsidies, on the other, are properly phased over time in an overall nutrition strategy, currently effective subsidy programs may become untenable as the population of target group clients grows and fiscal support fails to keep up. In addition to this basic strategy consideration, increasing attention must be given to the search for cost-effective subsidy instruments (see Reutlinger and Selowsky 1976) and to policies regarding the taxation of agricultural productivity. The issue of whether or not to allow increases in agricultural productivity to have domestic price effects emerges once again here. As domestic product prices fall in response to agricultural production, the ability of land-based revenue systems to appropriate the value of the technical change dividend diminishes.

IV. CONCLUDING NOTE ON AGRICULTURAL EFFECTS

Any sustained attack on nutritional problems must recognize the strategic role of agricultural productivity in nutrition policy, regardless

TABLE 15

BUDGETARY COST OF FOOD SUBSIDIES, 1974

	Percent of Total Public Expenditure	Percent of Public Capital Expenditure
Bangladesh	11	24
Burma	8	—
Egypt	22	67
Indonesia	13	34
Korea	14	49
Morocco	9	34
Pakistan	13	28
Sri Lanka	17	67

Source: Davis 1977.

of whether the ultimate effects are through general changes in food price levels, income-generating linkages, or direct subsidy programs such as food stamps. The expected means of impact, however, influence the appropriate allocation of resources within agriculture. The criteria for selecting agricultural activities that impact through price effects are substantially different from those which are associated with income and revenue linkages. The designers of effective agricultural strategy within the context of nutrition policy must pay careful attention to the larger economic environment through which agricultural productivity influences consumer well-being. It is particularly important for a stretegy to be consistent with other policies influencing domestic price formation. A realistic appraisal of the availability of revenue-generating instruments and access of rural target group members to income streams generated by new technology is also critical.

Although agricultural growth, in and of itself, cannot eliminate poverty, a strong committment to agricultural growth combined with an appropriate allocation of resources within agriculture is essential to alleviation of the worst nutritional problems. A projection of the size of undernourished populations between 1975 and 1990 under conditions of constant income distribution but various rates of agricultural and per capita income growth is shown in Table 16 reproduced from the work of Reutlinger and Selowsky. They interpret this table to show that agricultural and economic growth alone cannot eliminate undernutrition. Although this interpretation is undoubtedly correct, a striking aspect of the table is the dramatic reduction in the proportion of the population which is undernourished that can be achieved with sustained agricultural growth. Under scenario A (the "realistic" growth projection), the population of those who suffer deficits in excess of 250 calories below requirements is reduced from 48% of total population in developing countries in 1975 to 19% in 1990.

In a recent paper using data from Columbia, Pinstrup-Andersen and Caicedo (1978) show that, under constant price conditions, a 1% increase in consumer income distributed proportionally among consumer groups will increase consumption by the nutritionally deficient group 13.2 calories and 0.41 grams of protein per day. Thus, sizable percentage increases in porportional income growth could significantly contribute to the reduction of intake deficits relative to recommended dietary allowances.

In order to achieve this result, difficult decisions must be made regarding allocation of public revenues to investment in agricultural infrastructure. Moreover, the constant income distribution assumption can only be fulfilled through an allocation of resources that exploits potential income linkages. Additional leverage in this regard results from social policies designed to redistribute access to agricultural factors of production, such as land reform or the development of socialist organizations such as those that have appeared in China (see Timme 1976). Failure to maintain or improve the income distribution may limit substantially the impact of agricultural growth on nutritional goals. Such failure may result in worsening nutritional status for target groups under conditions

TABLE 16

SIZE OF UNDERNOURISHED POPULATION, 1975 AND 1990
WITH ALTERNATIVE PROJECTIONS[1]

gion	Undernourished Population: With calorie deficits below requirements			in excess of 250 calories below requirements		
	A	B	C	A	B	C
	- - - (million people and fraction of total population) - - -					
	1975					
atin America	112(.36)	112(.36)	112(.36)	71(.23)	71(.23)	21(.07)
sia & Far East	924(.82)	924(.82)	707(.63)	707(.63)	707(.63)	221(.20)
ear East	94(.51)	61(.33)	61(.33)	61(.33)	24(.13)	24(.13)
frica	243(.77)	193(.61)	193(.61)	93(.61)	93(.61)	93(.61)
Total	1373(.71)	1290(.66)	1073(.55)	932(.48)	815(.42)	359(.19)
	1990					
atin America	102(.23)	102(.23)	30(.07)	30(.07)	30(.07)	30(.07)
sia & Far East	1299(.82)	994(.63)	994(.63)	311(.20)	311(.20)	311(.20)
ear East	89(.34)	35(.13)	--	35(.13)	--	--
frica	280(.62)	280(.62)	135(.30)	135(.30)	135(.30)	--
Total	1770(.64)	1411(.51)	1159(.42)	511(.19)	479(.17)	341(.12)

cenarios A to C bracket the realistic range of agricultural and per capita ncome growth rates C resulting only from extraordinary commitment and anagement.

urce: Reutlinger and Selowsky 1976.

where economic growth and expanding demand at the aggregate consumer level outpace the growth in food supplies (from domestic and foreign sources) and force a rise in relative food prices (Pinstrup-Andersen and Caicedo 1978). Failure to maintain or improve the income distribution may limit substantially the impact of agricultural growth on nutritional goals. Such failure may result in worsening nutritional status for target groups under conditions where economic growth and expanding demand at the aggregate consumer level outpace the growth in food supplies (from domestic and foreign sources) and force a rise in relative food prices (Pinstrup-Anderson and Caicedo 1978). Finally, the development of an effective mechanism for taxing the agricultural growth underlying Table 14 can provide the resources necessary to subsidize many of those who remain undernourished. Without an effective agricultural growth strategy, it is difficult to imagine how a successful nutrition policy can be achieved.

V. SUMMARY

Costs are determined as for any investment. The full set of agricultural investments should not be attributed to their contribution to nutrition goals, since agriculture contributes to a variety of goals in addition to nutritional ones.

The agricultural sector can contribute to nutrition goals as a source of public revenue to finance consumption-oriented policies. However, agriculture requires a large volume of initial investment, and costs of food subsidies may well compete with investment requirements. Agricultural growth and consumer subsidies must be properly phased over time in an overall nutrition strategy.

CHAPTER FOUR

CASE STUDY: NUTRITION IMPACT OF AGRICULTURAL TECHNOLOGY ON FARM FAMILIES

I. INTRODUCTION

The preceding chapters presented a framework for understanding how and to what extent agricultural production and new agricultural technology can influence nutritional well-being. Reference to Figure 3 shows many of the complex linkages which relate changes in agricultural production to the various target groups of nutrition policy. It is not easy to find examples where these relationships and linkages can be observed directly. As emphasized earlier, there has been little effort to identify undernourished people in terms of their functional relationship to the various linkages portrayed in the figure. This is particularly true for nonfarm operating rural families. In addition, there are no cases of documentary evidence tracing over time the nutritional impact of agricultural growth policy in any particular country.

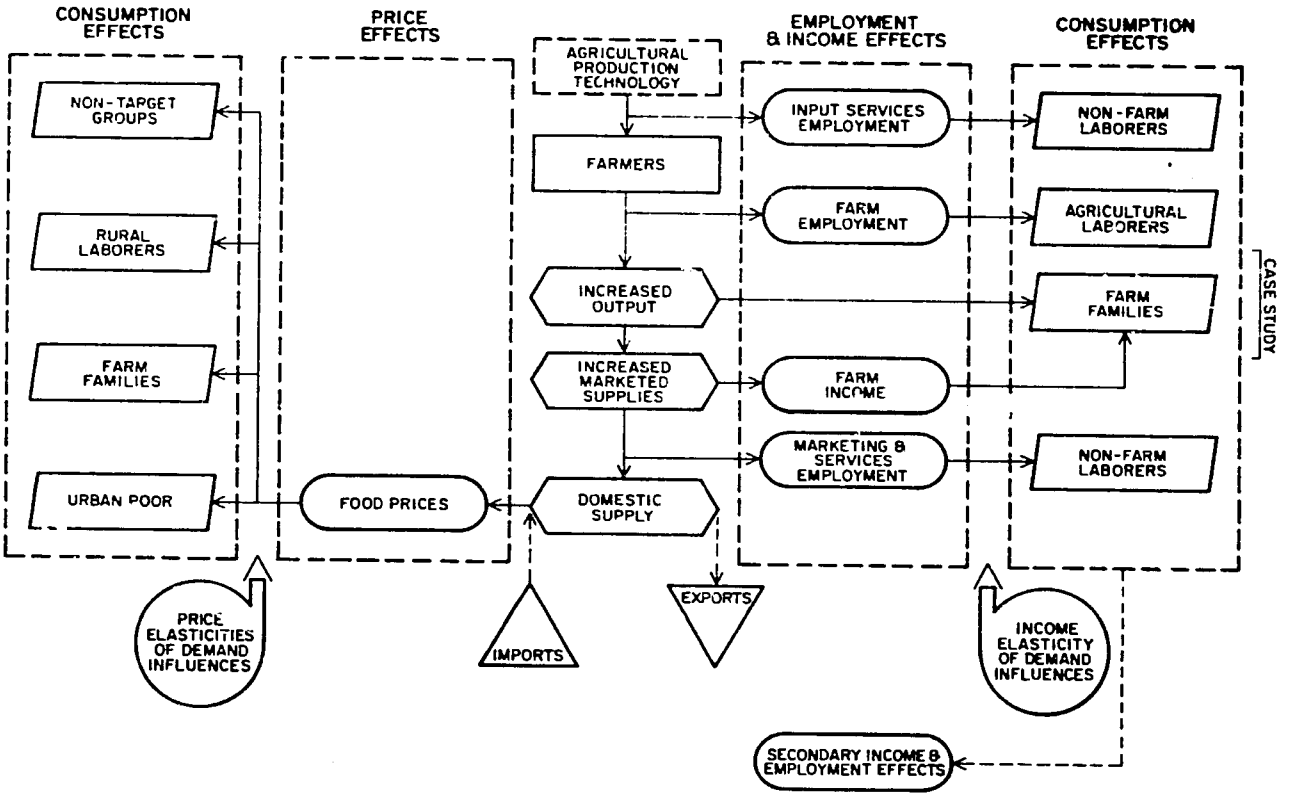
The lack of data as well as time and resource constraints face this project. Therefore, the case study presented here will focus on one of the most direct relationships depicted in Figure 3, that involving increased agricultural production generated by new agricultural technology on very small farms. As discussed in Chapter Two, output-increasing technology has had substantial impact in recent years on small farms in many parts of the developing world. There is virtually no evidence, however, showing the impact of this technology on the nutritional well-being of farm families.

Farm families derive income primarily from their control of labor, land and management resources. We can expect therefore that improved agricultural technology will result in important income gains to small farm families who can adopt the technology. This income gain may result in substantial improvement in diets.

Although sources of income are not usually distinguished in an economic analysis of consumption behavior, many believe that the crop composition of agricultural growth can have an independent impact on nutritional welfare of farm families. There are at least four reasons why this might be so. The first involves the influence of rural power structure. Improvements in cash crop technology may provide an incentive to landlords to evict tenants and take over land for direct cultivation. This may be more likely in enviornments where price policy is also encouraging mechanization. Alternatively, landlords may hold a sufficient monopoly position in the land market to force tenants to increase the share of land to cash cropping without allowing changes in rental terms which could offset the decrease in subsistence crop area. A second source of concern relates to the long gestation periods between planting and harvesting and unstable market conditions associated with many tropical tree crops. Small farmers

Figure 3

EMPLOYMENT, INCOME, PRICE AND CONSUMPTION EFFECTS OF AGRICULTURAL PRODUCTION TECHNOLOGY



may be induced during periods of high prices to reallocate acreage away from food crops to tree crops. As the economic return from these crops fluctuates (it is actually zero for a period of years) farmers may not be able to adjust other income sources in order to maintain nutrution at adequate levels. A third source of concern about crop composition and its impact on nutrition may arise in regions where social structure differentiates by sex within families the ownership of incomes from various sources. If agricultural technology is improving productivity of crops whose incomes are owned by family members not directly responsible for child rearing, this could have deleterious results on child nutrition. This may be a particular problem in parts of Africa. Finally, as discussed in Chapter Two, market imperfections may result in such a wide differential between farmgate and retail prices that achieving the same nutritional impact may require larger increases in cash crop productivity relative to that for subsistence crops. It is important to note that while these crop composition effects have been speculated on by many, there is very little evidence on the subject. In this case study only the last of the four issues raised above is explored. The others are discussed in somewhat more detail in Chapter Two above.

The Caqueza Project in Colombia was selected as the subject of this case study because (1) it was a government project aimed at providing improved technology to "small farmers"; (2) the farmers participating in the program were achieving increases in yield of staple food crops; and (3) documented evidence of malnutrition existed for the region. The government of Colombia saw the Caqueza pilot project as important to its agricultural policy because it would provide insights into methodological aspects of rural development. Our examination of the Caqueza situation attempts to illustrate some of the issues that need to be investigated in the process of designing and evaluating small farmer production programs aimed at nutritional impact on that group. The range of issues and methodologies explored here are limited somewhat by the characteristics of the project itself and the short period of time available to us for observation.

As described below, the Caqueza project is a very small pilot project and has not had a substantial impact on total food supply in the region. Regional income and employment effects, therefore, are probably minimal. The project focused on attempts to increase maize and potato production, so that the issues of farm structure and income instability related to cash crops which require long gestations (e.g., perennial tree crops) are also not raised here. Measuring nutritional intakes, particularly that of children, is very difficult and ideally observations over time should be made in order to offset seasonal effects and errors in observation as well as to follow a set of families or individuals through a process of change. Our study was constrained to dietary surveys during only one period. Thus it was impossible to capture any seasonal patterns. Despite these limitations, the results of this study contain some important considerations for those who design small farmer production assistance programs as part of a nutritional improvement strategy.

The case study will not examine the technology generation aspects of the Caqueza Project. Readers interested in this dimension are referred to the detailed description of the project by Zandstra, Swanberg, Zulberti, and Nestel (1979).

The case study is organized in the following manner. The next section describes the Caqueza region and the rural development pilot project underway there. It also contains a description of the sample survey procedure and the data we collected. This section is followed by two others that employ the survey data in a descriptive profile of family characteristics, consumption patterns, farm productivity, and income sources in Caqueza. Section Five describes a simple model of the structure of demand for nutrients and discusses various hypotheses about the role of income and agriculture in determining nutrient consumption. It is followed by a statistical analysis of hypotheses and a section of conclusions.

II. AGRICULTURAL PROGRAM CHARACTERISTICS AND SURVEY METHODOLOGY

In 1966, the Colombian government began to focus attention in its national planning efforts on the rural sector. Particular emphasis was placed on increasing the incomes of traditional farmers with small-size farms. One result of the attention given to small farmers at the national level was the initiation of six experimental rural development projects in 1971 under the direction of the Instituto Colombiano Agropecuario (ICA). These experimental programs had the responsibility to develop and transfer technology that would increase productivity of traditional crops on small farms. The increases in productivity in combination with other social and economic activities (e.g., road construction, rural electrification, education, health services) were intended to increase the real incomes of small farmer participants.

A. The Caqueza Project

The Rural Development Project of East Cundinamarca was one of the six projects. It was established in four of the municipalities of the eastern Cundinamarca region and became known as the Caqueza Project. The region is characterized by mountain-side farms and contains two distinct ecological zones, one below 2,200 meters and the other above. Farm sizes in the area vary, but most are small; 65% are less than 5 hectares (12.5 acres). The low altitude zone is one of small farms on which maize is the principal crop, while in the higher altitude zones, farms are larger and potatoes are the principal agricultural product. Seventy percent of the farmers of the region own their own land, 12% both rent and own land, and 18% are renters only but with reasonable security that their tenancy will continue in future crop cycles. The average annual income in 1972 was estimated at U.S.$645 per farm family or U.S.$86 per capita (Zandstra et al. 1976).

Nine hundred seventy-six farm families - 42% with farms of less than 3 hectares, none with farms larger than 3 hectares - were considered to be potential project participants. Malnutritional considerations were not included in the original design of the Caqueza Project. The objectives

were to develop and transfer technology to these small farmers in order to increase productivity of their traditional crops. Thus, the project began with experiments in the area to adjust existing technologies in corn and potato production to specific regional conditions. During the first year of experimentation the project identified new agronomic technology (i.e., seed type, fertilizer, pesticide use, and planting density), which, under experimental conditions on small farmer plots, is reported to have increased maize production 202%. Potato yield is reported to have increased by 51% (Zulberti et al. 1975).

Potato farmers quickly adopted the new technology which was primarily a change in cultivation technique rather than a use of new cash inputs. Adoption of the new recommendations in the maize growing area was slow, however. ICA policy makers, recognizing the cash intensity of the maize recommendations, focused on credit availability and risk as principal constraints to adoption. In response to these constraints, an experimental output-sharing program was initiated in the maize zone in 1974 and became known as the Maize Plan.

Twenty-seven farmers agreed to participate in the Caqueza Maize Plan in 1974, and it operated through a local producers cooperative in the following way:

1. A requirement for participation in the program was that farms be no larger than 3 hectares. Most farmers who participated had farms less than 2 hectares.

2. Participating producers paid an inscription fee equivalent to U.S.$10/hectare. These farmers were asked to plant maize using the recommended methods of plant density, fertilizer, pesticides, and weeding. Farmers were encouraged to use the project's hybrid variety maize seed but were allowed to choose their own traditional variety.

3. The cooperative supplied the producers with all cash inputs - seeds, fertilizers, pesticides - according to project recommendations.

4. Technical supervision/assistance was provided by ICA.

5. At harvest, production equal to or less than 800 kg/hectare remained with the producer. Up to this point, the producer did not have to return the value of the inputs to the cooperative. Eight hundred kilos/hectare was the average yield expected under traditional methods. Production in excess of 800 kg was divided equally between farmer and cooperative.

In this year, on land using the new technology, the plan is reported to have generated a 95% average increase in maize yield (Zandstra et al. 1976).

This increase was substantially below that reported on the experimental plots in previous years, but there are several reasons why this phenomenon might occur. First, ICA reports that farmers tended to assign their poorest quality land to the Maize Plan. In addition, presumably for reasons of taste preference and risk averseness, many farmers used their traditional maize variety rather than the unfamiliar hybrid variety. The traditional varieties are mildly fertilizer responsive relative to the impressive response of the new hybrids. Regardless of variety, farmers reportedly used a good deal less fertilizer than recommended. Finally, although the risk-sharing plan effectively hedged the farmer against a cash loss or loan default, the 50-50 sharing also reduced the incentive for intensive input use. These factors, singly or in combination, probably contributed greatly to the lower yields relative to those achieved by the ICA experiments.

In 1975 the Maize Plan had 38 participants. The output-sharing scheme was modified in the following way. The base yield above which a farmer had to commence repayment to the cooperative remained the same - 800 kilos/hectare. ICA officials expected a minimum maize harvest of 1,700 kilos/hectare. Repayment requirements were based on this expectation and maximum repayment was set at 900 kilos/hectare. Farmers were required to repay the complete yield increment above 800 kgs/hectare up to 1,700 kgs/hectare. Any yield above 1,700 kgs/hectare could be retained completely by the farmer, giving him the full value of the marginal product above 1,700 kgs/hectare. The 1976 Maize Plan had 46 participants and also followed the same output sharing modification. Some of the implications of this program design are discussed further below.

B. Nutritional Implications of the Caqueza Project

Nutritional considerations were not included in the original design or implementation of the Caqueza Project and no official identification or measurement of nutritional benefits accruing to the project participants was attempted. There was, however, reason to believe that the Caqueza Maize Plan might be having a positive nutritional effect on plan participant families.

Nutritional studies in Colombia have demonstrated that the majority of the Colombian population consumes diets deficient in all of the required nutrients with the exception of iron and vitamin C. Swanberg and Shipley (1975) reported that 49% of the preschool population they sampled in the Caqueza maize zone showed evidence of malnutrition on height-weight measurements.

The evidence of malnutrition in Caqueza in conjunction with the initiation of an agricultural project with an objective of increasing productivity on low-income small farms stimulated an interest in identifying and measuring any direct nutritional benefits to project participants. Analysis of the nutritional implications of the Caqueza Maize Plan was of interest to both the Harvard Institute for International Development (HIID) and ICA. Therefore a collaborative research effort was begun in early 1976. Since the farms in the maize zone generally have lower incomes and

lower level of per capita food consumption than in the potato zone (see Swanberg and Shipley 1975), this case study was carried out in the maize zone in order to maximize the possibility of demonstrating nutritional effects of the program.

C. Survey Population

A survey of farm families by a previous research project had delineated three groups of farmers. The first was defined as the experimental group and included 1976 participants in the Maize Plan as well as participants from the previous two years. The second group was a random selection of farmers who were not Maize Plan participants but who had obtained credit for production activities from either the Caja Agraria or local banks. The third group was a random selection of farmers who were neither Maize Plan participants nor credit recipients. The sampling procedure employed here is similar but somewhat modified. The experimental group includes all present (1976) and most previous Maize Plan participants. The size of the credit and control groups was expanded by randomly selecting a larger number of farmers for each group.

One hundred sixty-six farm families were interviewed; 48 Maize Plan farmers, 58 farmers with credit, and 60 farmers who neither had credit nor had participated in the Maize Plan. Some of these respondents had to be eliminated due to errors in the interview procedure. Forty-eight Maize Plan farmers, 54 families with credit, and 58 families without any credit were used ultimately in the analysis.

D. Survey Questionnaire

The required information was collected in the Caqueza area through the use of two distinct questionnaires: one, a production-income survey directed to the male head-of-household, and the other, a dietary recall-household characteristics survey directed to the female head-of-household. The production-income questionnaire was developed jointly by the HIID field team, the ICA field team, and Dr. Sergio Sepulveda, who had already conducted surveys in the Caquez area. The dietary recall-household characteristics questionnaire was developed by the HIID field team with technical assistance from CARE-Colombia, Dr. J. Obdulio Mora of Instituto Colombiano de Bienestar Familiar (ICBF), and the ICA home economist resident in Caqueza. (For more detailed information on dietary recall see Pardo-Tellez et al. 1968; Balough et al. 1971; Hegsted 1975; Pike 1975.) All interviews took place on the farms of the interviewees.

Interviewing was conducted during a three-week period in late January and early February. While the timing was optimal for obtaining accurate production information as it was just post-harvest, the consumption information might be biased by a greater propensity to consume in the immediate post-harvest period.

The questionnaire for dietary recall household characteristics was carried out by one ICA and seven CARE-Colombia nutritionists who interviewed female heads-of-households. All of the nutritionists were university trained and experienced in this type of field work. Their interviews were supervised by an experienced senior nutritionist who observed each nutritionist conduct an interview at least once and reviewed all completed questionnaires for accuracy.

Basic information on the amount of food consumed was determined by a 24-hour dietary recall: (1) for the family as a whole; (2) for each of the individual children under six years of age in that family; and (3) for each pregnant and/or lactating woman in that family. The recall period was considered to be the 24 hours just prior to the arrival of the nutritionist in the household. Whenever possible, the quantities of foods equivalent to those stated to have been consumed were weighed (to the nearest half-gram) on a portable food scale. Individual household measures also were converted to net weight in grams. Values of amount of food consumed were converted by hand to net weight in grams of edible portions, and nutritional content was calculated by computer according to the Colombian Table for Composition of Foods (see INN 1967). The recommended dietary intake per household was also calculated by computer on the basis of Colombian standards. Adjustments were made for family size, age, sex, presence of a pregnant or lactating woman, presence or absence of a family member and/or guest, and annual mean temperature. Nutritional adequacy for family and the individual was calculated as a ratio of actual nutrient consumption to recommended intake. A second 24-hour recall interview was conducted on a subset of 50 families (22 children) on the same day one week later, in order to assess the representativeness of a single day's diet in actual family and child consumption.

In addition to food consumption, information on height, weight, and age of children under six years of age residing in the household were recorded and analyzed according to the WHO classification for malnutrition. Breast-feeding practices of the female head-of-household and years of formal education completed by both male and female heads-of-households were determined.

The production-income questionnaire was carried out by interviewing male head-of-household since males made most of the farming decisions. The interviews were either ICA technical advisers resident in the area or university students with previous interviewing experience in Caqueza. Total farm size as well as amount of acreage devoted to each crop was recorded. The use and amounts of inputs of seeds, fertilizers and pesticides were recorded by crop. Use and amounts of labor were recorded by activity as well as by crop. Output also was reported by crop. Standard weights in kilos were developed for local measures. Current household production of cow's milk was determined by asking both the husband and wife how many standard size bottles of milk were produced daily by each cow in the previous seven-day period. The wife's responses were the ones ultimately used in the analysis since she was the one responsible for care and milking of the animals. Information concerning other animal husbandry activities or income-producing farm activities was recorded. Families were also asked to report other sources of family income such as wages earned and transfer payments received.

These interviews were supervised in the field by HIID and by a specialist from the ICA Research Division. All interviewers were observed in the field at least once, and completed questionnaires were reviewed for accuracy.

III. FAMILY CHARACTERISTICS AND CONSUMPTION PATTERNS OF CAQUEZA FARM FAMILIES

A. Family Characteristics

Average family size for the three surveyed groups was 7.4 for Maize Plan families, 6.9 for families with those receiving credit, and 7.1 for families who received no credit. Average farm size for the three groups was 2.35, 2.15, and 1.47 hectares respectively. This results in .32 hectares per capita for Maize Plan families, .31 hectares per capita for families with credit, and .21 hectares for families without credit.

Formal schooling for mothers and fathers of all three groups also was similar. Maize Plan mothers averaged 2.1 years of formal schooling, credit mothers 2.5 years and control mothers 2.0 years. Fathers had had 2.3 years, 2.1 years, and 2.0 for Maize Plan, credit and control groups respectively.

Breast-feeding and weaning practices appear to be different among the groups. Average age of the infant at the time of cessation of breast-feeding was 15 months for the Maize Plan and credit groups, but 16 months for the control. Introduction of weaning foods was taking place at a fairly early age for Maize Plan and credit groups: 4.8 and 5.2 months. The control group, however, did not introduce weaning foods to the infant until 7.3 months of age (significantly different from the other two groups at $P = .01$).

The anthropometric data collected on the children who had not yet completed six years of age indicated a fairly well-nourished population. Six of the 38 children in the Maize Plan group were classified as moderately malnourished according to the WHO classification scheme (falling between 60% and 80% of the standard weight for age). No children were severely malnourished (below 60% of the standard weight for age). Ten of the 35 credit group children were moderately malnourished and one was severely malnourished. In the control group six of the 34 children were moderately malnourished and one was severely malnourished. Therefore, a total of 23% of the children in this population are classified as malnourished. This figure is somehwat lower than that reported by Swanberg and Shipley. Forty percent of the children in their surveyed population were classified as moderately or severely malnourished. However, the methods used for assessing nutritional status were different and thus the percentages are not strictly comparable.

B. Consumption Patterns

The consumption patterns revealed by dietary surveys must be interpreted with caution. Hegsted (1975) notes that appropriate methods for evaluating dietary data and the conclusions which may be legitimately drawn from such data have not been clearly specified.

Average intake estimated from dietary surveys and presumed to be representative of habitual or usual intakes is subject to two forms of errors. The first results from day-to-day and week-to-week variability in nutrient intake and irregular consumption patterns. The shorter the observation the greater the variability. The second source of error is technical and is caused by inaccurate evaluation of the true nutrient intake.

In order to explore the representativeness of the single dietary interview in our study, correlation coefficients between the first and second 24-hour recall interviews have been computed. For family consumption the correlation coefficients are low: .67 for calories and .57 for protein. Correlations between the first and second 24-hour recall interviews for the child are even lower. With regard to the entire group of children (22), the correlation for calories is .21, while for protein it is .10. However, when one looks only at younger children (11-35 months), there is an improvement in the correlations: .56 for calories, .28 for protein. This may reflect the mother's ability to recall more precisely what small children ate, because they are more dependent on her for food acquisition than older children.

Average family nutrient intakes as a percent of total family requirements (and standard deviations for calories and protein) are presented for each of the three groups in Table 17. On the average, family nutrient consumption is above the requirement in all but vitamin A for the credit group and in protein and vitamin A for the control group. Yet, even these intakes are so close to the requirement level as to be considered adequate. If only those families with preschool children are considered, nutrient intakes are adequate for all groups with the possible exception of protein in the control group (see Table 18). Average nutrient intake for preschool children was also above the requirement and reflected no tendency of a discrimination against children in family food distribution (see Table 19). The children, on the average, are doing as well as the family and, in the case of some nutrients, are slightly better off than the family as a whole.

A different picture is presented, however, when one looks at the frequencies for families consuming less than adequate diets. In 1974 the United States Interdepartmental Nutrition Committee for National Defense regarded 86% of Colombian dietary standard as acceptable. The proportions of families falling below that level are presented in Table 20. Evidence suggests a particularly high proportion of malnourished among control group families.

The total number of pregnant and/or lactating women in our sample were small (N = 28), but average adequacy of nutrient intake was estimated and results are presented in Table 21. Although it would be difficult to make generalizations from such a small population, the data nevertheless are of interest because they suggest a group within this population that is not well-fed. The family as a whole and the young children seem to be able, on the average, to meet the daily nutrient requirements. However, it would seem that the pregnant and/or lactating woman in the family is

AVERAGE FAMILY NUTRIENT CONSUMPTION*

(as percent of total family requirement)

	calories	(S.D.)	protein	(S.D.)	calcium	iron	vit. A.	thiamine	riboflavin	niacin	ascorbic acid
Plan (N=48)	115.9	(45.40)	110.3	(54.06)	123.9	158.3	137.2	179.8	120.7	103.9	310.9
Credit (N=56)	116.7	(49.47)	116.8	(60.72)	126.9	151.5	98.2	176.9	122.1	113.0	332.0
Control (N=59)	100.9	(43.52)	93.6	(45.77)	102.5	137.5	95.5	155.2	99.1	105.9	329.9

TABLE 18

AVERAGE FAMILY NUTRIENT CONSUMPTION--FAMILIES OF PRESCHOOLERS ONLY

(as percent of total family requirement

	calories	(S.D.)	protein	(S.D.)	calcium	iron	vit. A.	thiamine	riboflavin	niacin	ascorbic acid
Plan (N=26)	108.8	(37.56)	100.9	(42.32)	104.2	133.0	112.5	168.7	108.4	95.12	273.4
Credit (N=21)	121.3	(44.36)	134.7	(65.0)	155.6	153.6	165.9	174.5	142.0	119.8	272.8
Control (N=26)	95.3	(31.57)	85.9	(20.67)	95.0	117.0	99.9	144.3	96.2	102.2	277.2

*Standard requirements used were Recommendacion de Ingesta Diaria de Nutrientes, ICBF, (Bogota, Colombia 1975).

TABLE 19

AVERAGE CHILD NUTRIENT CONSUMPTION

(as percent of child requirement)

	calories	(S.D.)	protein	(S.D.)	calcium	iron	vit. A.	thiamine	riboflavin	niacin	ascorbic acid
Plan (N=36)	107.9	(49.50)	103.1	(62.66)	104.6	122.9	129.6	146.1	131.4	87.3	300.3
Credit (N=29)	106.9	(52.86)	122.7	(67.79	120.6	126.6	104.5	138.6	145.9	97.4	212.2
Control (N=34)	106.8	(42.04)	103.2	(42.86)	93.5	128.4	149.5	151.9	122.9	109.8	271.2

TABLE 20

FREQUENCY OF BELOW ADEQUATE FAMILY DIETS

	DEFICIENT (51% - 85% of standard requirement)				VERY DEFICIENT (Below 50% of standard requirement)			
	Calories		Protein		Calories		Protein	
	N	%	N	%	N	%	N	%
Maize Plan	8	16%	14	29%	1	2%	4	8%
Credit Group	17	29	15	25	0	-	5	8
Control	27	45	21	36	2	3	7	12

TABLE 21

AVERAGE NUTRIENT CONSUMPTION OF PREGNANT AND/OR LACTATING WOMEN

(as percent of total requirement)

	calories	(S.D.)	protein	(S.D.)	calcium	iron	vit. A.	thiamine	riboflavin	niacin	ascorbic acid
Plan (N=10)	83.3	(33.35)	77.1	(39.20)	52.8	82.7	108.5	143.6	75.2	70.9	271.2
Credit (N=10)	83.1	(2815)	91.1	(46.30)	72.5	77.6	33.9	122.5	89.5	88.7	202.9
Concrol (N=8)	68.5	(17.74)	69.1	(20.99)	62.7	64.5	91.3	121.6	65.9	70.6	208.6

unable to meet the increased nutrient requirements of her physical state. Average intake is below the requirement, and in some cases, considerably below in every nutrient category except ascorbic acid. The control group is notably the most deficient.

IV. FARM AND INCOME CHARACTERISTICS OF CAQUEZA FARM FAMILIES

A. Farm Characteristics

The average size of farms sampled from the maize zone is 1.96 hectares. We have divided these farms into four subgroups: those planting no maize; those planting only traditional maize varieties; those planting only the improved ICA hybrid; and those planting both traditional and improved maize. Each of these four groups has been subdivided according to individuals participating in the Maize Plan, those receiving some form of credit (usually from the Agrarian Bank), and a control group of farmers not receiving institutional credit. The farm characteristics related to maize production for each of these groups are shown in Table 22. Although the average farm size in each group is small excluding the two groups with only one observation), the control group among traditional maize growers clearly has the smallest farms. The Maize Plan group farmers growing only improved maize tend also to operate smaller farms. The groups are strikingly similar in the proportion of farm area devoted to maize (50%-60%).

The outstanding differences among the farm groups are yield performance of the hybrid maize relative to that of the traditional varieties and the levels of fertilizer application associated with the two varieties. The grain yield of the new varieties is more than double that of traditional maize. Within the group of exclusively traditional maize growers, those with access to institutional credit use about 80% more fertilizer per hectare than those in the control group.[1] Those planting only improved maize apply three times more fertilizer than those in the traditional maize group. Those planting both varieties have noticeably larger farms and apply four times more fertilizer per hectare to their improved maize than those planting only traditional varieties and less than half the level of the purely traditional farmers to their own traditional varieties.

Although the difference in physical maize yield is more than 100% between the two varieties, the difference in net returns per hectare valued at local market prices is somewhat less. On a per hectare basis, the high-yielding maize produces about 40% more net value than traditional varieties. The difference in the physical and net value return is largely accounted for by the larger fertilizer input on the new maize and a two peso (25%) price discount in the local market due to eating quality.

The in-field performance of the new maize, even in value terms, is impressive and causes one to wonder why so few farmers in Caqueza have the new varieties. Of the 700 maize farmers advised by ICA extension workers in 1976, 600 had not adopted the new production technology. (ICA defines an adopter as one who uses <u>any</u> of their recommendations regarding seed variety, fertilizer, insecticide, and plant spacing.)

TABLE 22

FARM CHARACTERISTICS

Cultivation Group	Plan Group	N	Farm Size (ha.)	Proportion of Farm Area: Traditional Maize	Proportion of Farm Area: Improved Maize	Yield (Kgs./ha.): Traditional Maize	Yield (Kgs./ha.): Improved Maize	Value of Chemical Fertilizer per ha.: Traditional Maize	Value of Chemical Fertilizer per ha.: Improved Maize
No Maize	all	8	1.23	0	0	0	0	0	0
	plan	0	--	--	--	--	--	0	0
	credit	5	.95	0	0	0	0	0	0
	control	3	1.68	0	0	0	0	0	0
Traditional Maize Only	all	122	1.88	.58	0	1168	0	444	0
	plan	20	2.26	.60	0	1195	0	578	0
	credit	48	2.21	.52	0	1194	0	53[illegible]	0
	control	54	1.45	.62	0	1133	0	312	0
Improved Maize Only	all	13	1.81	0	.61	0	2344	0	1452
	plan	11	1.48	0	.61	0	2346	0	1573
	credit	1	5.00	0	.60	0	2100	0	200
	control	1	2.28	0	.56	0	2561	0	1377
Traditional and Improved Maize	all	17	3.03	.41	.16	1029	2541	163	2113
	plan	17	3.03	.41	.16	1029	2541	163	2113
	credit	0	--	--	--	--	--	--	--
	control	0	--	--	--	--	--	--	--

Despite the establishment of the Maize Plan for three years, a total of 95 farmers had joined by 1976, and only 16 people remained in the plan for more than one year. Even among those who do use high-yielding maize, many plant only a fraction of their total maize area with new seeds (see Table 22).

Analysts from ICA believe that the critical problems are credit availability and risk-averse behavior. The Maize Plan itself, because of its risk and cost-sharing arrangements, is designed to respond to both problems However, the cooperative credit underlying the plan is in very scarce supply, and each year the cooperative can enroll only 40 to 50 farmers.

According to ICA records of farmer performance, 78% and 87% of farmers in the plan in 1974 and 1975 respectively achieved maize yields in excess of 1,500 kgs per pectare. None experienced yields of less than 1,000 kgs per hectare. Despite this, if our survey results are representative, many of those who leave the plan and obtain credit from the Agrarian Bank drop the new varieties from their crop plan. This may be due to the Agrarian Bank not offering the risk- and cost-sharing feature along with their credit. Farmers may therefore, be unwilling to borrow large sums for fertilizer. They purchase a small amount of fertilizer and apply it to traditional maize, which at low levels of fertilizer, yields more than the new hybrid seed.[2]

More than half of the improved maize users in our sample planted only a part of their maize area to new seeds. This may be due to a credit constraint also. Most plan members, however, also planted either none or a small fraction of their maize land to improved seeds. Clearly, there is a strong local eating preference for the traditional soft maize, as contrasted with the hard Dent hybrid variety. Nineteen percent of those growing traditional maize sold these varieties in the market as contrasted with 40% of growers selling the hybrid varieties. Among those selling maize, only 37% of their traditional maize production was sold, contrasted with 62% of hybrid production.

B. Income Characteristics

Income refers to the actual and imputed market value of marketed or subsistence production, sale of labor, income from trading, and transfer payments. The income profiles of the various groups analyzed here are shown in Table 23. On the average, control group members have substantially less income per family than do members of the plan and credit groups. This is primarily the result of smaller farm sizes. For maize growers as a whole, maize (traditional and improved combined) accounts for about 50% of total income. Disaggregating, plan and credit group members who do not plant new maize earn a larger proportion of income from other crops, particularly tomatoes, onions, and potatoes, than do farmers growing new varieties. Nonfarm income sources account for 10% to 20% income for those growing no maize and those growing only traditional maize varieties. This figure drops to 5% for those planting improving varieties.

TABLE 23

INCOME CHARACTERISTICS

Proportion of Income from Various Sources*

Cultivation Group	Plan Group	N	Total Income per Family	Traditional Maize	Improved Maize	Beans	Other Crops	Non-Farm Sources**
No Maize	all	8	19205	0	0	08	67	11
	plan	0	--	--	--	--	--	--
	credit	5	21277	0	0	0	97	01
	control	3	15752	0	0	21	18	26
Traditional Maize Only	all	122	21300	47	0	13	19	14
	plan	20	26473	48	0	11	30	09
	credit	48	25228	45	0	11	24	13
	control	54	15892	48	9	16	11	18
Improved Maize Only	all	13	25353		50	12	13	05
	plan	11	21309		42	13	16	06
	credit	1	70112		88	11	01	0
	control	1	25078		92	0	0	0
Improved and Traditional Maize	all	17	24170	35	23	13	14	05
	plan	17	24170	35	23	13	14	05
	credit	0	--	--	--	--	--	--
	control	0	--	--	--	--	--	--

*The difference between the proportions shown here and 100 is explained largely by income from dairy and eggs.

**Including wages earned in agricultural and non-agricultural employment and transfers from relatives.

V. A MODEL OF CONSUMPTION BEHAVIOR

Obviously, many factors influence decisions about food consumption. We focus here on the role of income and agricultural production. Generally, we wish to investigate the following model of consumption behavior:

$$C = f(Y; S; F; A) \qquad (1)$$

where

C = family-level consumption of either calories or protein;

Y = total family net income (from both farm and nonfarm sources) - total income less cash and kind expenditure on agricultural inputs;

S = cash/subsistence composition of income;

F = family size as represented by the age-weighted recommended daily allowance of either calories or protein;

A = a variable representing those families who have adopted new agricultural technology for maize production, i.e., those in the Maize Plan or those receiving credit from Agrarian Bank.

A. Income

The relationship between income and the value of food consumption has a firm footing in economic theory. Empirical research has repeatedly confirmed this general relationship and also revealed the structure of consumption in terms of particular foods as it relates to changing levels of income. The economic value of a food, however, may have little to do with its nutrient content. Nevertheless, it is generally presumed, and empirical analysis frequently confirms, that for low-income groups there is a propensity to spend additional amounts of income (as income grows) on calories and protein. It is this relationship which determines a critical aspect of the importance of investments aimed at employment generation and spreading agricultural technology in the context of nutrition policy.

B. Cash/Subsistence Ratio

Economic theory generally has little to say about specific commodity or factor sources of income and their distinctive impact on consumption patterns. In rural regions of developing countries there is frequently a wide spread between the price at which farmers can sell their home-produced goods and the price for the same commodity at the retail market. This is due to market imperfections and lack of infrastructure for marketing. In this situation, because farm families face different (higher) prices for expenditures made from cash income on the one hand and income represented by staple food crops on the other, we expect income

source to have an impact on consumption which is independent of the level of total income. We have tried to capture this in two ways. First, following Massell (1969), we have specified a model containing a general cash/subsistence income ratio variable. Alternatively, we have also tested the independent impact of home milk production and maize production on nutrient consumption. Our survey has revealed a large population of milk cows in the Caqueza region. Milk products are obviously a principal source of nutrients in addition to maize and beans.

C. Family Size

It is reasonable that at a given level of family income, larger families will spend more on food than smaller families. Measuring family size is somewhat arbitrary. We have chosen to represent this by the age-weighted recommended dietary allowances for calories and for protein for the families in our sample. The notion here is that the family level decision to allocate expenditures to nutrients is related to a perceived physical need for calories and proteins.

D. Technology Adoption

This is a dummy variable distinguishing those who are in the Maize Plan or receiving credit from the Agrarian Bank from those who are not. The former group is comprised of those who are using more fertilizers and insecticide and of some who have adopted hybrid seed. The hypothesis is that those who are first to adopt new technology may also exhibit other characteristics of modernization such as an interest in better nutritional practices.

The mean and standard deviations of some of these variables are shown in Table 24.

VI. STATISTICAL ANALYSIS

The hypotheses discussed above are tested here using ordinary least squares regression analysis. In order to carry out these tests, we must make some assumptions about the functional form of the relationship between the dependent and independent variables. The principal behavioral characteristic (known as Engel's Law) underlying the relationship between income and food expenditure is a positive association diminishing in strength as income rises. It is also reasonable to expect that as income increases the elasticity of demand for food will decrease, particularly for staple foods. It is plausible, also, to expect the demand for calories and protein to reflect these relationships, as illustrated in Figure 4.

A semi-logarithmic functional form captures both of these characteristics. The models whose estimated coefficients are shown in Table 24 are modifications of Equation 1:

TABLE 24

MEAN AND STANDARD DEVIATION OF

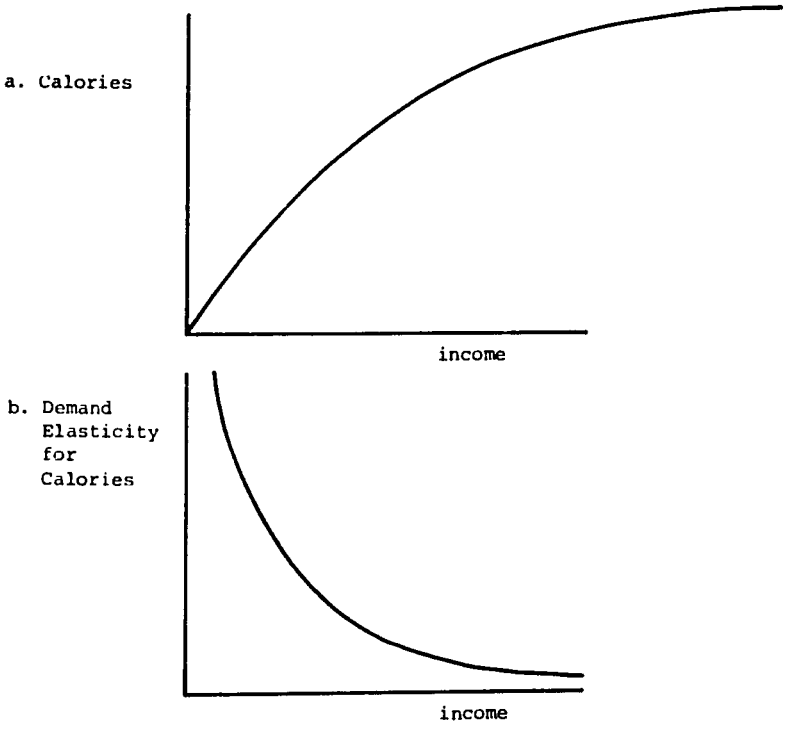
IMPORTANT VARIABLES

(138 cases)

	Mean	Standard Deviation
Family calorie consumption	13595	6660
Family protein consumption	335	169
Number of 750 cc bottles of milk produced daily	2.8	3.05
Family annual net income (pesos)	19626	14578
Number of family members	5.97	5.36

FIGURE 4

INCOME RELATIONSHIPS WITH CALORIC CONSUMPTION



$$FAMCON = CONSTANT + b_1 LNNETY/FAM + b_2 FAMSIZE + b_3 MILKPROD + b_4 MAIZPROD + b_5 ADOPT$$

where

FAMCON = family daily consumption of either calories or protein;

LNNETY/FAM = logarithm of family annual net income per weighted consumer unit

FAMSIZE = the age-weighted family RDA of either calories or protein;

MILKPROD = daily volume of milk produced on farm during week of enumeration;

MAIZPROD = total household maize production;

ADOPT = a dummy variable

1 = participants in Maize Plan and clients of Agrarian Bank;

0 = all others.

This model is semi-logarithmic in nutrient consumption and income. We have experimented with a double log and an arithmetrically linear functional form. All functional forms produced virtually the same statistical results. We present the semi-logarithmic form here because it is a priori more plausible. Our research is focused on a sample of small farm families whose incomes represent a rather narrow range in the context of Colombia's overall income distribution. This may explain the insensitivity of the estimates to various functional forms.

Each column in Table 25 reports coefficients resulting from estimating the complete form of Equation 1 (columns 3 and 6), as well as estimates with some variables omitted (columns 1 and 2, 4 and 5).

A. The Role of Income

The estimates in Table 25 show clearly that the demand for calories is influenced by the level of per capita income, but the relationship is not strong. The income elasticity of demand for calories of .1 suggests that a 10% increase in income would increase calorie consumption by 1%. The demand elasticity for calories estimated in Table 25 is very insensitive to income level; it increases only marginally as income falls. Although the estimated elasticities appear low for a low-income rural area, they are reasonably close to that estimated for Latin America by Reutlinger and Selowsky (1976). These researchers have estimated a mean calorie elasticity of .17, ranging from .28 at a per capita income of U.S.$25 to .12 at a per

TABLE 25

ESTIMATED COEFFICIENTS OF CONSUMPTION MODEL

(t values in parentheses)

	Family Calorie Consumption			Family Protein Consumption		
	1	2	3	4	5	6
Ln Net Income : Family Member	1385*	1260*	1180*	28.3*	17.8	19.1
	(2.75)	(2.48)	(1.95)	(1.9)	(1.3)	(1.1)
Family RDA (calories or protein)	.92*	.88*	.86*	.81*	.71*	.71*
	(13.2)	(11.9)	(11.2)	(10.1)	(8.9)	(8.9)
Milk Production (50 cc units)	--	1980*	1950*	--	81*	81*
		(3.13)	(3.03)		(4.7)	(4.6)
Maize Production	--	--	.10	--	--	.0017
			(.22)			(.17)
Technology Adoption (dummy variable)	--	519	515	--	32.1**	32.3**
		(.65)	(.64)		(1.5)	(1.5)
R^2	.55	.59	.59	.43	.53	.53
Income Elasticity at Mean	.10	.10	.09	.09	.05	.06

Significance Levels:

* = .01

** = .15

capita income of U.S.$3,000. The per capita income in the Caqueza region is somewhat over U.S.$100. Our dietary survey shows that while most families in our sample were reasonably well fed, despite the low-income levels, there was a large subset of families whose nutritional intake was below recommended levels. Under these circumstances it is somewhat puzzling to measure such a weak income elasticity.

The estimates of income elasticity of demand for protein are also low. In the case of the fuller models, the net income coefficient drops and becomes statistically insignificant. Why this occurs is not clear. There is no evidence of strong collinearity between income and other independent variables. It is possible that, as explained below, the technology adoption variable is picking up some of the influence of income in the more complete model.

Frequently, studies of consumption behavior show high income elasticities of demand for foods of animal protein sources, particularly meat. This does not necessarily suggest, however, that the elasticity of demand for total protein is high. Although the families in this sample are poor, and many appear to consume inadequate protein, their response to an increase in income may involve a substitution in the diet of foods of vegetable protein source (e.g., maize) for different foods but also of vegetable protein sources (e.g., pulses), so that the aggregate relationship between income and protein consumption is dampened. In addition, our results suggest that protein consumption is influenced largely by changes in output from home-produced sources, particularly milk cows.

B. Family Size

Family size as measured by dietary requirement has a substantial influence on both calorie and protein consumption which is independent of the level of per capita income. This is not unexpected. However, the estimated coefficient, which is substantially less than one, suggests that as family size increases, expenditure on calories and protein does not keep pace with the age-weighted increase in dietary requirements. For families whose average consumption is close to or below nutritional requirements this relationship suggests that increasing family size may result in poorer nutritional status even if per capita income remains unchanged.

C. Milk Production

Our hypothesis that on-farm milk production may be a key determinant of nutritional well-being is borne out by the estimates shown in Table 25. The availability of butterfat has a strong influence on the level of household calorie and protein consumption. The value of the estimated relationship is, in fact, too strong since a one-unit increase in milk production is shown to increase calorie and protein consumption by more than the quantity of those nutrients contained in a 150 cc unit of milk. One explanation for this is that milk production may correlate highly with another, unspecified, influence on nutrient consumption. It is also possible that the addition of water to milk results in more milk

reported at the consumption level than at the production level. This discrepancy notwithstanding, the role of the milk-producing sector in the diets of Caqueza small farm families appears to be substantial.

Although a market for milk exists in Caqueza, we have little information about its structure. Evidently home production is a greater determinant of milk consumption than income. This also implies an important element of seasonality in diets. Our interviews with the ICA veterinary staff revealed that milk cows are poorly nourished and subject to extended dry periods between lactations.

D. Maize Production

Maize production appears to have no influence on nutrient consumption other than through its impact on household income. The simple correlation between maize production and net income in our sample is .49, so multicollinearity may be contributing to large standard errors on the maize production variable. Nevertheless the results for maize are in striking contrast to those for milk production.

E. Cash/Subsistence Income Ratio

Following the rationale discussed in Section V, we attempted to test the statistical significance of a general cash/subsistence income variable, in addition to examining two specific commodities, milk and maize. Regardless of the particular specification employed, the variable was either highly correlated with income, hence producing unreliable estimates, or statistically not significant. We decided to discard it, therefore, in the final specification of the consumption model. The milk production variable represents an aspect of this behavior and has been found to be an important element influencing the consumption of both nutrients.

To the best of our knowledge Massell is the only researcher to have employed a cash/subsistence income variable in the past. His estimates, although somewhat more successful than ours, were also troubled by problems of high correlation with other independent variables.

F. Technology Adoption

This variable is also insignificant in the case of calories. For protein, however, there is a marginally significant relationship suggesting that those families who are adopting new maize production technology also tend to consume about 32 grams of protein per family more than other families with similar income, family size, and milk production. This is probably a behavioral characteristic unrelated to the direct consumption effect of increased maize productivity since the relationship does not appear in calorie consumption. The group of "adopters," however, has substantially larger farms and more income from cash crops and nonfarm sources than the "control" group (see Tables 22 and 23). When the technology adoption variable is eliminated from the regression, the size and significance of the net income variable increases. The significance of the adoption variable may also reflect a tendency for those individuals who adopt to also be those who are more apt to have more healthy nutritional practices.[3]

VII. NUTRITIONAL IMPACT

Although this study focuses principally on the relationship between changes in income and agricultural production and changes in family calorie and protein consumption, it would be desirable to also estimate the effects of the changes on the growth patterns of small children. The most appropriate way to investigate this relationship would be to collect longitudinal data on the children within families that have adopted the new technology recommendations. Unfortunately, the limitations of this study do not permit such data collection. An investigation of our cross-sectional data was attempted, however.

A model similar to the consumption model was used. The dependent variable, nutritional status, was defined as the percent of standard weight for age (Harvard Standards in Jelliffe 1966). The independent variables tested here were net per capita income, home milk production, mother's education, family calorie adequacy, number of preschool children in the family, and three different specifications of a modernization variable (credit use; use of fertilizer recommendations; use of improved maize seed).

Our investigation yielded no statistically significant results. The children in our sample were for the most part reasonably well fed. It is plausible therefore that within the range of observation here family level income bears no strong relationship to child nutritional adequacy. Unfortunately, our sample of underfed children was too small for in-depth analysis. These children, however, appeared to be scattered randomly across families classified both by family per capita income and by family nutritional adequacy. The malnutrition that does exist in our sample of children is more likely attributable to such factors as illness, adverse environmental influences or detrimental feeding practices. Under these circumstances, nutrition education, formulated foods, or other integrated interventions (see Studies II, III, and VII in this series) might be more likely to affect nutritional status than would an agricultural intervention. Simply increasing the supply of staples or incomes of these particular "small farmer" families is probably an insufficient intervention for the subset of malnourished children.

VIII. CONCLUSIONS

This case study explored the behavioral structure of food consumption in the Caqueza region of Colombia in order to gain insight into the impact that improvements in agricultural production might have on consumer diets. The Caqueza Project was selected because of the large numbers of small maize farms in the area, an active government credit and extension program involving locally high-productivity maize technology aimed at "small farmers" and a previous nutritional survey of the area which revealed a pattern of deficient diets and a high prevalence of preschool malnutrition.

Despite the poor mountainous land, the small farm sizes, and the revious evidence of malnutrition in the area, our study indicated that the amilies are on the average consuming nutritionally adequate diets. In ddition, even though one third of the families reported diets deficient n calories and protein, evidence of moderate or severe malnutrition in the reschool population was lower than would be expected. This finding highlights a critical aspect of designing agricultural programs for nutritional mpact: namely, the importance of carefully identifying the nutritional rofile and needs of the target group. The assumption that families operating small farms are in general nutritionally equally needy is a precarious one. The nutritional problems of small farm families may fall cross a wider spectrum of severity and causality than might casually be resumed. Small farm families are a heterogenous group. This diversity eans that careful nutritional assessment of the farm families should roceed the mounting of the technology program. This will allow one to arget the production technology to the more nutritionally needy small arm families whose low incomes and food supplies represented the primary auses of the malnutrition.

In fact, the largest and most severe incidence of rural malnutrition may in some areas not be found among the families of small farm operators but rather among the landless. In a population approaching nutritional dequacy, such as the one we examined in Caqueza, the impact of income on arginal nutrient consumption is likely to diminish rapidly. Although the arket value of food consumption continues to increase with income beyond he threshold of nutritional adequacy, the substitution of higher cost referred foods begins to dominate the expenditure pattern and the net ncome-nutrient relationship may diminish rapidly.

In Caqueza, therefore, our finding of a low-income elasticity or nutrients among the general population of poor farm families is not ery surprising, although the extremely low-valued income relationship, articularly for protein, is unusual.

Despite the finding of a low-income elasticity, it is nevertheless possible that particular income sources play a more active role in etermining incremental nutrient consumption. This is an important issue n the design of agricultural production programs with nutritional goals. ur analysis showed that in Caqueza, maize production, the principal aple food, had no additional effect on nutrient consumption after controlling for the general level of aggregate income. There was a moderately igh correlation between maize production and aggregate income, however, hich may have confounded our attempt to measure statistically the independent influence of maize. On the other hand, household milk production as shown to have a strong independent influence on both calorie and protein consumption.

The policy implications of this set of findings may be important. The current moderate incidence of malnutrition in Caqueza may not e easily remedied by programs aimed at improving maize production or gricultural productivity generally. Over time, however, an expanding ncome base is necessary in order to maintain the present nutritional

status in the face of a growing population. This raises the issue of which are the most efficient farm income generating activities to develop in the context of nutritional goals. Our study was unable to support the notion that in the selection of particular activities, maize production should receive preferential consideration if it fails to justify itself on the normal economic criteria of being relatively more efficient in generating net income per unit of investment. If the expansion of cash crops, such as vegetables or industrial crops for instance, should show greater economic promise than maize, their development and promotion should be considered seriously. It should be emphasized, however, that this is not a conclusion or policy recommendation of this study. Although farm families appear not to differentiate maize income from general income, any development strategy which results in more dependence on the market for staple foods must consider seriously issues related to supply availability, price and market structure.

The case study did reveal a very strong independent impact of household milk production on nutrient consumption. This suggests that investments in improving milk production capacity may produce an unusually large nutritional dividend. In Caqueza, however, development planners and agricultural researchers have largely neglected this activity. Virtually nothing is known about the local market for dairy products or the seasonal implications of households relying heavily on domestic milk production. Nor is there a program aimed at improving productivity of milk animals.

Although rural populations and production environments vary widely, this case study has explored some of the critical issues and relationships associated with the nutritional impact of small farm development programs. The issues addressed here are not exhaustive. They are important, however, in the design of nutrition-oriented agriculture production programs across a variety of small farm environments.

In order to test this notion on a specific farm commodity, we chose milk production. Our analysis shows a very strong relationship between milk produced on farm and family consumption of both calories and proteins. This suggests that investments that improve the quality of milk-producing animals, the availability of fodder or concentrates, or the ability of families to acquire a milch animal will result in a nutritional dividend larger than investments which produce general income. A similar test with respect to maize production showed no significant commodity effect.

Holding total income and family size constant, we also examined whether adopters of new maize production technology also consumed more calories or proteins. Although there was no significant relationship in the case of calories, our analysis revealed a relationship between adoption and protein consumption. This reflected a strong propensity to spend incremental cash income on protein sources. The "adopter" families had larger farms and earned more cash income generally. In addition, the presence of the "adopter" variable reduced the strength of the relationship between general income and protein consumption.

In summary, our sample population has not revealed a strong tendency to consume calories out of incremental income. There is a striking association, however, between milk production and calorie and protein consumption. In addition, there is some evidence that additional income from cash crop and wage sources would have a positive impact on protein consumption. In terms of agricultural instruments to support nutrition policy, a high priority should be given to exploring ways to increase on-farm milk production. Further efforts are also required to understand the slow adoption of new maize technology and to expand accessibility to the cost-sharing credit facility.

CHAPTER FOUR FOOTNOTES

[1]This larger fertilizer application appears to result in only marginally greater yields. This relationship between fertilizer application and yield measured here, however, since seed rate is not controlled. ICA's on-farm research program shows that traditional maize varieties display a substantial fertilizer response. Research has also shown that denser planting also contributes a great deal to yield.

[2]This description of farmer behavior is supported by our data but must be considered conjecture at this stage. More focused research is required.

[3]Although it must be considered conjecture at this stage, the tendency for adopter families to follow better nutritional practices is supported by our data. For example, Maize Plan families introduce weaning foods to infants a full 2.5 months earlier than do control families.

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