Resource Allocation Decisions of Low Income Rural Households:

Nutritional Implications for Agricultural
and Rural Development Projects

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Presentation

This report is in part an extract of a companion report entitled, "Resource Allocation by Low Income Households," by David L. Franklin and Marielouise W. Harrell. That report presents an empirical test of the economic theory of household production and its relevance towards food and nutrition policies and projects for low income rural areas. This report is intended to present guidelines for rural and agricultural development practitioners towards the incorporation of nutritional goals, objectives and components into development assistance activities. While this report pretends to accomplish this latter end, it is primarily a tract to colleagues in the fields of nutrition, economics, agricultural and rural development, food policy and agricultural research. With them it seeks to share insights and impressions from research such as that cited above, from a rather extensive review of the literature, and from over fifteen years of research and field experience with efforts directed at improving the diets, health and incomes of low income persons in many settings in Africa, Latin America and the United States.

The underlying philosophy of this report is unabashedly that of an economist. This economist comes by his economics honestly; having discovered economics after years of frustration in attempting to develop, design and deliver food and nutrition services (including agricultural research results) only to find time and again that the intended beneficiaries valued the "benefits" less than these were valued by the benefactors. Doing good is very difficult!

The views presented here began to coalesce a decade ago after a reading of a borrowed copy of <u>Transforming Traditional Agriculture</u> by Professor T. W. Schultz, whose other writings and personal communications are reflected, shamelessly, without citation, throughout the report. Many colleagues and former collaborators may also find themselves at the core of the ideas presented here--to Tucker, Wymore, Weldon, Cock, Jennings, Scobie, Valdes, Pinstrup-Andersen, Vial, Mora and Parillon, you are hereby absolved of any responsibility.

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1.0 Nutrition Issues in Agricultural and Rural Development

Most of the people of the world spend more than half of their resources in the acquisition of food. The rest spend about a third of their resources on food; even in relatively rich countries, food expenditures absorb a fourth of personal income. Human activities directed at acquiring food would therefore appear to be the single most important use of human time.

Until only recently, the word "nutrition" has evoked a notion of the delivery of food and services to passive recipients. While such a notion may be valid in specific cases such as famine relief during disasters, the evolving view is that the achievement of nutritional states by humans is the consequence of rational and efficient behavior. When the level of achieved nutritional well-being is judged to be unacceptable by biological or social norms, the modern view towards nutrition intervention is to provide resources and incentives whereby the poor might develop self-sustaining solutions to their nutritional problems.

Such an approach towards self-reliance and self-sustaining solutions to nutritional problems is based on insight into the allocative decisions of the poor regarding the acquisition of food and other goods and services. The basic concept is that the nutritional well-being of a society is both a consequence and cause of the developmental processes within that society. Nutritional outcomes and the nurturing behavior of individuals must therefore be given explicit consideration in the formulation of developmental assistance policies and in the design of developmental programs and interventions.

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This report is directed at providing guidelines towards achieving nutritional objectives in developmental assistance programs. The emphasis is on agricultural and rural development activities because these represent the bulk of the developmental assistance which is given to developing countries. The principal conceptual framework is formed by the policy papers on Nutrition and on Food and Agricultural Development issued by the United States Agency for International Development in May of 1982. The AID paper on Nutrition Policy states that the Agency seeks to ameliorate the problems of undernutrition and inadequate utilization of ingested nutrients by seeking to maximize the nutritional impact of economic assistance. The suggested approach is that sectoral programs and direct interventions be designed with explicit nutritional goals and with explicit recognition of the resources used by the intended beneficiaries as they seek to achieve their nutritional well-being. The Nutrition Policy paper recommends two specific areas where high nutritional pay-off is expected: agricultural programs and health programs. The recommendations regarding agriculture emphasize attention to the consumption effects of crop and technology selection as well as the effects of agricultural policy. In the area of health, the emphasis is on incorporating nutritional considerations into primary health care through growth monitoring for young children, nutritional assistance in maternal and child health activities, the promotion of appropriate infant feeding practices and through increasing the access to potable water and sanitary environments.

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The policy paper on Food and Agricultural Development is directed at developing self-sustaining food and agricultural systems in developing countries with consideration to both increased production <u>and</u> increased effective demand. The objectives of AID's food and agricultural development policy are said to include the following:

o improved consumption in rural areas through expanded productive employment and income for men and women who lack purchasing power to obtain food,

o sound nutritional principles in the design of agricultural production and marketing policies, including improved access and utilization of food by those at nutritional risk, and

o effective direct distribution of food to those facing severe malnutrition.

The instruments which are recommended for achieving these objectives are improved policies and productive incentives including promotion of increased employment and the provision of complementary public sector investments in health, in rural infrastructure and in agricultural research and extension systems.

Both papers emphasize that food aid, other than for famine relief, should be used to promote self-sustaining nutritional well-being. In agriculture, food aid is to be used to support rather than discourage domestic food production. Direct feeding programs are to support human resource development and employability through, for example, the promotion of improved

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health practices. Ultimately, food aid at the national or community level should be replaced with local programs that increase productivity and income. At the core, the two policy papers recognize that food aid is not a permanent solution to the nutritional problems of low income persons, households, communities and countries.

Implicitly, if not explicitly, the AID policy papers also recognize that the normal activities in developmental processes are insufficient to solve the nutritional problems of the poor unless explicit nutritional goals and activities are incorporated into development assistance activities. Other than through direct delivery of nutritional services or food aid, however, there is little generalizable experience as to how the AID policy directives can be implemented at the program and project level in specific settings.

1.1 Integrating Nutrition into Agriculture and Rural Development

Many rural development efforts and self-help nutrition and health interventions are based on the mobilization of the beneficiaries' resources, particularly their labor time towards the creation of socially beneficial capital (physical and human). The opportunity cost of the time of beneficiaries is usually viewed to be low by development planners. This view is the result of focusing on market valuations of human time, i.e. the rural wage rate. The presence of rural underemployment (and unemployment) at low wages is cited as evidence that human time is plentiful in low income settings. The alternate view which is

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emerging from the research and literature on the economics of time in poverty contexts is that human time is scarce, because subsistence production and nurturing tasks are time intensive, and in these settings, time is of very low productivity. In fact, it can be said that the poor are poor because their time has low productivity, and thus the poor must allocate the bulk of their time to achieving what, frequently, are substandard levels of satisfaction of basic needs.

Interventions which seek to incorporate the poor into the development process must find means for releasing human time from activities related to basic needs acquisition so that the poor can allocate time to human capital building activities and to directly productive activities. Nutrition and health interventions have the potential to contribute to this end, if they are designed as an integral part of developmental interventions which seek to promote production of surpluses for the market. For example, appropriately designed nutrition interventions could release human time from food acquisition and preparation or health related tasks to allow household members to participate in agricultural extension programs or community development activities.

The state-of-the-art on the incorporation of nutritional objectives into agricultural and rural development activities is given by some recent publications of FAO and the World Bank. Beghin et al. (1980) prepared a report for FAO which purports to be a guide for selection of nutrition components for agricultural and rural development projects. The report is a compendium of

the usual list of specific nutrition interventions such as supplementary feeding, nutrition education, surveillance, food fortification, etc. That report does not indicate how the interventions can strengthen the agricultural or productive objectives of such projects, nor does it consider the possibility that participation in nutrition interventions might actually withdraw resources from the directly productive activities of a project. No consideration is given to the private costs involved in participating in nutrition interventions. The report is strong in its recognition that participation decisions and self-reliance are important issues regarding the interaction of nutritional activities with productive activities. Education programs, surveillance systems, food production programs and village-level storage are seen as interventions that are supportive of other project objectives and thus likely to become self-sustaining. Beghin's report illustrates the difficulty in achieving successful interventions; even food production activities which are principally directed at nutritional goals are recognized to be frequently non-economic and susceptible to abandonment by the intended beneficiaries.

One of the principal proponents for the incorporation of nutritional objectives into rural development activities is Alan Berg of the World Bank. In a recent report Berg (1981) states that the nutrition problem in most countries is not likely to be resolved by increasing incomes and agricultural production. He recommends that nutrition be inserted as an explicit objective in

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agricultural and rural development projects; furthermore, he suggests that agricultural policies and projects should be routinely examined for their nutritional effects. For example, Berg has argued for food policies that promote the production of low cost foods that only the poor eat. To this end, recommendations would be made that agricultural technology be targetted at the production of crops such as cassava, taro root, sorghums, millets, and other low income elasticity foods with the expectation that shifts in the supply of these foods would lead to increased food availability to low income producers likely to be suffering from malnutrition. This recommendation is in the spirit of the recommendations in the award-winning article by Pinstrup-Andersen, et al. (1976). It is possible, however, that such policies could have deleterious effects on low income producers of these foods. The induced supply shifts generally would lead to large drops in the prices of these less preferred foods, and therefore drops in the income of the producers of less preferred foods. There would be no guarantee that the resulting increase in food availability at the household level in the producer's household would be absorbed, or even sufficient to compensate the shift in the demand for other foods which would ensue with the drop in the producer's income. To offset these possible outcomes, Berg and others offer other proposals for nutrition-based food policies which involve government intervention in marketing and storage of food, including consumer and producer subsidies. The purpose of these would be to lower the cost of marketing, and to stabilize price fluctuations.

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particularly of foods consumed primarily by the poor. There is
no clear evidence that such efforts can have nutritionally bene-
ficial outcomes and to the extent that parastatal intervention in
food markets usually leads to serious distortions in the
structure of incentives, deleterious effects on nutritional
status could occur, and frequently these outcomes turn out to be
regressive in terms of their income distribution impacts, e.g.
Tanzania, Peru, the Dominican Republic, etc.

Pines (1979) has proposed a "nutritional review" within
agricultural and economic planning. He recommends that
agricultural development plans and policies be reviewed for their
specific impact on the incomes and consumption of malnourished
families, and calls for a pro-nutrition bias in the formulation
of plans and policies. Schuh (1978) and others have argued that
such a biased orientation towards basic needs or equity can
distort economic signals to the point that the poor (intended
beneficiaries) become worse off.

How, then, are the nutritional problems of the poor to be
addressed? The central thesis of the approach presented here is
that household decisions regarding the fulfillment of basic needs
are strongly determined by decisions on the allocation of time to
household production activities and that these decisions are in
turn affected by and affect decisions regarding the allocation of
material and human resources to production for the market.
Consequently, policies and programs that seek to increase
production for the market must be designed with a better

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understanding of the interactions between intra-household resource allocations and participation in productive processes in product and factor markets.

1.2 The Household Economics Approach

Until recently, the general view was that malnutrition was fundamentally a food supply problem and that the main solution was to grow more food. It is now widely recognized that it is very difficult to improve the nutrition of the poor simply by increasing food supplies.

More recently, it has been emphasized that low effective demand among the poor requires income transfers or targetted food programs to achieve appreciable improvements in food intake by persons in poor households (Reutlinger and Selowsky, 1976; Reutlinger, 1979; Pinstrup-Andersen, et al., 1976, 1977; and Selowsky, 1980). Furthermore, it is also now widely accepted that even targetted food programs that transfer food resources in substantial quantities to specific members of households achieve very little nutritional impact because of the problems of leakages (Beaton and Ghassemi, 1979; Mora et al., 1974; Beartl et al., 1970; and Guzman et al., 1968). While further evidence is being developed to reinforce the notion that food transfer schemes such as ration shops, food stamps, and price subsidies are at best high cost means for improving nutritional well-being of poor persons (Perrin and Scobie, 1981), and in fact that "cheap food policies" can have serious sectoral and economy-wide deleterious effects (Keeler et al., 1982; Schuh, 1978; and Clay et al., 1981), interventions in the market for food continue to

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be the principal approach towards ameliorating the human and social problems concomitant with malnutrition.

A different approach is emerging from some recent research on nurturing behavior in low income households; this research has been based on the new economic theory of household production (Franklin and Vial de Valdes, 1979; and Chernichovsky, 1978). This research is developing information and evidence that poor households spend a very large portion of their material and human resources (time) securing food supplies and other basic goods and services. The levels of satisfaction of basic needs thus achieved are frequently below any acceptable norms. The households in these conditions seem to be caught in a vicious cycle of substandard consumption that leaves little time and few material resources with which to invest in the productive potentials being developed and promoted by agricultural research and extension services, rural development projects, etc. As such, these households contribute little to measured economic development and to the extent that resources are being directed at transferring income, food and other goods and services to them, these households are often viewed as a drag on the development process.

This dilemma is frequently referred to as an equity versus efficiency trade-off, or as the debate between "trickle up" or "trickle down" approaches to development. The use of such labels for the problems in development policy and approaches has obscured some fundamental facts regarding poverty. Among these

is the fact that the main resources for development under
conditions of poverty are the knowledge and abilities of poor
people as embodied in their use of time. With this view of
poverty as a backdrop, development and economic policies and
programs would need to be enhanced to increase the supply and
demand for skilled human time by removing the distortions to
market signals that create disincentives for the poor to invest
in themselves and inhibit their participation in the productive
processes of their society.

The emphasis from this view is on an <u>enhancement</u> of existing
initiatives that seek to incorporate the poor into the productive
processes, not on a reformulation of development approaches. The
suggested enhancement is that development actions give explicit
recognition to the role of human time in determining the resource
allocation decisions by poor persons. The core of the new view
is that policies and programs that seek to enhance the
productivity of human time in poor settings would not only enable
poor people to better meet their basic needs but would create
incentives for greater supplies of marketed goods and services to
the economy as a whole.

Recent work at the World Bank illustrates the additional
insight which can be developed with this broader view of the
rural household. Singh and Squire (1977) have applied the
household production approach to nutrition policies for rural
areas. They conclude that, "the theory of the farm household is
of considerable importance when examining the likely impact of
exogenous changes in input and output prices, prices of non-farm

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goods and technology, and hence of nutritional policies in rural areas designed to impact through these instruments." In their study, a model based on the theory of household production is used to empirically explain why agricultural households in the Muda River Valley in Malaysia increase the consumption of their own produced rice when market prices increased. This occurred because the income effect of the price rise more than offsets the negative substitution effect of higher prices. They also suggest a possible explanation for decreased food consumption when rural wages increased; in this case the household's costs of production (its own labor costs) increase causing a shift backwards in the internal (household) supply of foodstuffs. Similar results were obtained for Korean farm households by Choong, Singh and Squire (1981).

More recently, Strauss (1981) has applied the concepts of household production to data from rural Sierra Leone. The essence of his findings is that consideration of the farm household as a joint production-consumption unit produces additional insight than that derived solely from application of conventional approaches. In his results, market prices and income significantly affect the caloric levels of household diets. His results also indicate the need for specific consumption oriented programs and policies; normal development would require 22 years to close the apparent calorie gaps. A major recommendation which arises from his research is that technical change in rice production would benefit the lower

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income households more than higher-income households even if the increased output led to significantly lower prices for rice in the market. The reason for this is that household demand for their own produced rice is price responsive and the gains in consumption would offset the losses in market (cash) income. Furthermore, his results indicate that a general orientation to production for the market, e.g. export crops and an increasing reliance on market purchases for the fulfillment of food needs does not necessarily lead to deleterious nutritional outcomes.

The recent research of Singh, Squire, Strauss and others has concentrated fundamentally on the marketable surplus question which arises when a producing household also consumes part of its product. These efforts help clarify much of the debate on the issue which so dominated the literature on price responsiveness by low income farmers (Bardhan, 1970; Bharagava and Rustogi, 1972; Dandekar, 1964; Desai, 1961; Khan and Chowdhury, 1962; Mathur and Ezekiel, 1961; Sharma and Gupta, 1970; Krishna, 1963; and Behrman, 1968). The contributions of the new theory are important. For example, they lead to the recommendation that the promotion of technical change which makes household labor more productive will enhance nutrition more than would a price support system for the products of the low income rural households (Barnum and Squire, 1979).

1.3 The Theory of Household Production

The theory of household production has its foundations in the works of Lancaster (1966) and Muth (1966), but is is more commonly attributed to Becker (1965) for his work on the

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allocation of time. The human capital school at the University of Chicago (Schultz, 1973) applied the theory to issues of women's labor force participation and fertility decisions on a large number of settings in developed and developing countries. The present approach to the theory is frequently referred to as the Becker-Lewis (1973) approach. Franklin (1979) extended a model of the demand for child traits [developed by DeTray (1973)] to analyze the demand for nutritional well-being and the derived demand for food as a factor of production in the production of human capital in households with malnourished children. Evenson (1978b) presents a summary of the basic concepts underlying the "Chicago School" approach to the new theory and methods. His colleagues in the Philippines have continued on the application of the theory to fertility and labor force participation decisions and began the exploratory efforts to apply the theory to the production of nutrients (Ybanez-Gonzalo and Evanson, 1978) and to explain the determinants of nutritional status of young children (Battad, 1978).

The underlying foundations of all of the efforts are the same; these are synthesized as follows:

o   Analyzing household behavior in terms of preference patterns of the services which flow from goods and from people permits a better assessment of attributes of the goods and their role in satisfying human wants or needs.

o   The theory acknowledges that not all dimensions of

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consumer satisfaction are derived from goods and services purchased in the market place. Consumers also obtain utility from goods and, especially, from services which they produce at home. In fact, the household is now viewed as a production-consuming unit where members are involved in using various combinations of inputs, both purchased external to the household and provided by the members themselves, to produce a combination of outputs which are in their most basic form the sources of satisfaction of wants for the household members.

o   One of the major inputs used in the household production model is the time of household members. In order to assess the value of member's time, time prices are usually estimated from salary/wage data or other proxy variables which serve as indications of society's evaluation of the value of people's time. These estimations usually under-value the worth of people's time to the extent that not all human production activities enter the market place. In addition, the individual's evaluation of the worth of his/her time may be different (higher or lower) than society's evaluation.

o   An additional component of the evaluation of household time is recognition of the different levels of education, technical training and general experience of people which adds to their human capital. The concept

of human capital is essentially an adaptation of the traditional concept of capital, which is that it is an input in the production processes which is also an output of some previous production process. In the case of human capital, the inputs used to increase the size or stock of human capital are education (formal and informal), health care, diet and exercise, and whatever other general experience which increases the individual's ability to produce and consume more efficiently.

o   The combination of monetary income and household production introduces the concept of full income. This concept basically recognizes that the real income available to members of a household is usually greater than the money measures of income earned in market places. The value of full income is determined by the value of the time contributed by the combined individuals in the household to the household production process and to market effort.

o   Finally, the theory includes concepts of market prices of goods and services and factor prices, as well as internal or shadow prices of resources within the household. In this fashion, the theory is used to analyze the allocation of household resources in terms of their marginal contribution to household satisfaction, as well as within the external pricing

system of the market place.

2.0 A Case Study from Rural Panama

In a companion report by Franklin and Harrell (1983) a Household Production Model was derived and empirically tested with data from Veraguas Province in Panama. Data was collected in 1981 from 30 communities which were participating in some form of nutrition oriented rural development activity, including community food production projects, supplementary feeding and maternal and child health projects. The province of Veraguas was selected for the study because it had extensive coverage of the three types of interventions, as well as the broader coverage of water and sanitation programs.

The prevalence of malnutrition in the selected communities in Veraguas was 29.9 percent for both acute and chronic malnutrition. There was almost no acute malnutrition as defined by low weight-for-height indicators (prevalence of 1.6 percent across all the selected communities). This compared with a provincial prevalence of 8.4 percent for acute malnutrition and 26.4 percent for chronic malnutrition in the Veraguas Province of the 1980 National Nutrition Survey (Parillon et al., 1981).

The economic optimization model which was derived and tested represents the behavior of rural households that may (1) produce food for their own consumption, (2) sell agricultural products to the market and (3) sell labor services to the market as well as buy labor services from the labor market. The model used is of the Becker-Lewis type that centers on time allocations and on human capital concepts. This class of models has been applied to

women's labor force participation questions by Gronau (1973), to fertility issues by Willis (1973), to child quality questions by DeTray (1973), to child mortality by Anderson (1977), to food demand by Franklin (1979), to nutrition evaluation by Franklin and Harrell (1983), to marketed surplus issues by Renkow, Leonard and Franklin (1983), and to the costs and determinants of breast-feeding by Franklin and Harrell (1983).

The household is assumed to attempt to satisfy two wants--"basic needs" and other consumption, including leisure. The model centers on the trade-off between the household's willingness to substitute and the household's ability to substitute between basic needs and other consumption. That is, with tastes taken as given, the household's consumption, particularly the satisfaction of "basic" needs, is determined by the conditions and costs of production within the household. With this type of model, the household allocation decisions are explained in terms of resource constraints, conditions of production within the household (including internal costs) and market prices. The household's costs or internal prices are determined by the value of the physical and household time inputs that enter into each consumption good produced by the household. Production within the household involves goods purchased in the market and the services of household human capital (time). Nutrition and health are in turn produced with physical goods (usually) purchased in the market and the use of household human capital. Nutrition is produced with food, human services, and

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health is produced with health services external to the household and household time and skills.

From this perspective, human nutrition can be viewed as being produced within the household by women and other household members. Women's time and the time of other household members and their abilities are combined with "factors of production" such as food, utensils, fuel, medical services, housing and sanitation conditions in process for "producing" nutrition in two ways--knowing what and how to use the factors that produce nutritional well-being and allocating the time required to use these production factors.

In this production process, time and abilities enter in knowing what foods to acquire, where to acquire them and how to prepare them into meals. The services of household human capital enter in the preparation and storage of foods, the prevention, diagnosis and mangement of diseases, as well as adjustments to the diet that may be accomplished as part of disease treatment. Time is also required in procuring medical services and in maintaining sanitary housing conditions. In many settings, much time is required to obtain such basics as water and fuel.

In the model for the Panama study, the household is postulated to use food from three sources: its own production, purch·ses in the market, and food gifts. This latter would symbolize a transfer from a feeding program or from relatives or friends. The household is assumed to produce food using purchased inputs and household human capital; it can also buy or

sell labor in wage markets. The household is assumed to sell a proportion of its production to the market and to consume the rest. The novelty of this model is that the purely subsistence household and the cash crop producing household are represented.

The household is also open to the product and factor markets since it can sell its produce or labor services and buy goods, food and labor in the market. The modelling assumes that the household achieves internal equilibrium in response to external markets which are also assumed to be in equilibrium. No labor market segmentation is assumed so that wage differentials among persons are accounted for by differences in skill levels. The model is solved by applying the neoclassical conditions of equilibrium to yield a set of derived demand equations.

For the Veraguas data, the specific variable realizations were as follows:

o   Household produced nutrition is indexed by the weight-
      for-age indicator of the youngest child in each
      household, expressed in normal scores as deviations
      from the WHO standard.

o   The household's food consumption is indexed by the
      household's total daily calorie consumption obtained
      through the 24-hour recall method.

o   The household agricultural production is indexed by the
      monetized value of all agricultural production, i.e.
      quantities of different commodities are aggregated by
      weighting each with their market value (unit price).

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o The household's non-food consumption is taken as an exogenous variable in this realization and is given by the difference between the value of all sources of money income and the money value of food consumption.

o The household's use of health services is also exogenous in this model and is indexed by the household's use of vaccinations for any preschool-aged child.

o The household's total labor supply to the labor market is indexed by the proportion of the household members' hours spent in off-farm employment for wages in an "average" day.

o The household's purchase of food in the market is indexed by the money value of purchased food.

o Time allocated to nurturing is indexed by the proportion of time allocated to child care, to food preparation, and in health-related activities.

o The time spent in agricultural production is indexed by the proportion of all household members' time in agricultural production on the household's own farm in an "average" day.

o The rental rate on homogeneous human capital, the market wage, is imputed from proxies related to the schooling and age of the head of household and spouse, since earlier work with data from throughout Panama showed that these human capital variables were the principal determinants of wages throughout the country

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in both rural and urban settings.

o   The monetized value of donated foods received from feeding programs (Maternal-Child Health and Food Production).

o   The household's access to potable water and sanitation is said to lower the cost (price) of producing health.

o   The price of food is indexed by the price of rice prevailing in the local retail market in each community; price variance exists because many communities are remote.

o   The price of purchased inputs in this model is proxied by the household's participation in a food production program since an important part of that program's services was the provision of free or subsidized inputs.

This model can be used to test the nutritional, food consumption, food production, food purchase, and labor supply effects from policies related to human capital and labor market issues, feeding programs, health and sanitation services, food prices and agricultural services.

As a theory of household behavior, the model generates a series of testable hypotheses. Key among these hypotheses are those that relate to the value of time and the implications for the nutritional well-being of the household's members. The first hypothesis is that as the value of time increases as a result of increases in productivity within the household or increased

opportunity in the labor market, the implied output and income effects would tend to increase the household's output and demand for nutritional well-being. Within the model, a rising opportunity cost of time would reduce nutritional well-being only if the household's preferences were highly skewed towards leisure and away from basic needs. The model's structure permits empirical tests of complementarities between food and health in producing nutritional well-being as well as for complementarities between household time (specifically women's time) and food in producing their children's nutritional status.

The theoretical predictions of the model also include an unambiguous positive "income effect" on nutritional well-being from the income value of a food gift and an unambiguous negative nutritional effect of higher food prices through their effect on the household's cost to produce nutrition. The model also implies that households with a preference for nutritional well-being would also forego the consumption of non-nurturing goods and services to attempt to preserve food consumption at the levels necessary to produce nutritional well-being.

Regarding the supply of agricultural products to the market, the effect of higher prices for food crops that the household produces cannot be predicted in theory because positive income effects increase the household's own demand for food, but the effects of higher prices reduce the household's desired level of food consumption from its own production. The model predicts a positive supply response if the share of income derived from the crop is greater than the share which the crop represents in the

"expenditures" of the household. A "cash" crop producing household would have a positive supply schedule while a food producing household may have a backward bending supply schedule if food represents a high share of its consumption and agricultural sales represent a low share of its market income. Such might be the case of a household that derives most of its income from the labor market and a small share of its food from from its own production and yet has a high expenditure share for food. Such a household would not really be a farming enterprise but rather a rural laboring household with a garden. The theoretical model also predicts a negative agricultural supply effect from higher wages or from a higher value gift of food.

The model does not provide clear predictions on the allocation of time in response to higher market wages, because income and substitution effects would tend to offset each other. To be plausible, the empirical results should yield a tendency of higher wages to extract resources from the household. It is the identification of these effects which were the core of the empirical analysis.

2.1 Summary of Empirical Results

The structure of the model consists of allocation of resources to nurturing activities and to production activities. The resources to be allocated are time and market goods and in theory these are to be allocated according to relative prices. The price of human time was proxied as a rental rate on human capital services. The price of food was represented by the price

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of the principal consumption and production staple--the price of rice. There were no other prices directly observed in the data; access to health and sanitation were used as proxies for lower costs of producing health, and participation in community food production projects was used as a proxy for lower prices for agricultural production inputs. Thus in this model, the relevant policy instruments which could affect the variables in the model are those that affect the market for human capital in terms of stocks (investments such as schooling) and flows (labor force participation), the price of rice, access to public health services and access to agricultural production inputs. Statistical estimation of a simultaneous equations model with the data from Veraguas Province in Panama yields the following overall results.

In the context of the structural model the positive "income" effects of human capital variables dominated any negative substitution effects in the nurturing activities. The human capital variables are important determinants of the supply of agricultural output, of labor market effort and of the allocation of household time between agricultural production or the labor market. The patterns of signs on the human capital variables in the model's equations suggested that human time and food (and perhaps other inputs) are complements in the nurturing activities. Human time and purchased inputs appear to be complements in the agricultural production activities, also.

The pattern of signs on the price of food variable is consistent with conventional theory, i.e. negative elasticities

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in the food and nutrition demand equations and positive in the agricultural supply equation. An important finding was that for rice-producing households, a higher price of rice leads to reduced calorie consumption at the household level and increased market purchases of other foods.

The health, water and sanitation variables seemed important in the nurturing activities and in the supply of agricultural output and wage labor equations. In the latter equations, the effect of these variables was positive. Caution should be exercised in interpreting these results to mean that these factors contribute to the supply of productive effort since these variables may simply be reflecting proximity to roads and product and labor markets.

In general, the structural equations exhibit the appropriate properties regarding the signs on the price and income effects. The coefficients on the wage variable for the labor supply and agricultural labor use equations imply that labor use in agricultural production occurs at very low productivity levels and that the conditions in these communities satisfy the general notion of a labor surplus rural economy.

Specific results are presented alongside the results published in Barnum and Squire (1979) for Malaysia. The results are then used in a policy simulation exercise to derive some generalizations about rural and agricultural development approaches to improve nutrition. As indicated in Table 1, the Panama and Malaysian model results are similar, but differ in two

Table 1. Household Response Elasticities for Selected Variables in the Household Production Models for Panama and Malaysia[1]

Household Response Variables	Price of Rice[2]	Wage Rate Males	Wage Rate Females	Technical Change in Agricultural Production[3]	Increased Food Aid
Food Consumption					
Panama (calories)	-0.60	+0.06	-0.28**	NA	NA
Malaysia	+0.38	-0.08	NA	+0.42	NA
Food Expenditures					
Panama	+1.09**	+0.05	+0.54***	NA	-0.12**
Farm Output					
Panama	+0.25	-0.02	+0.41*	+0.76***	-0.05
Malaysia	+0.61	-0.47	NA	+1.61	-NA
Marketed Surplus					
Panama	+0.35	NA	NA	NA	NA
Off-Farm Labor Supply					
Panama	-0.01	-0.09***	+0.22***	+0.11	0.00
Malaysia	-0.57	+0.11	NA	-0.65	-NA
Farm Labor Demand					
Panama	-0.08	-0.05	+0.00	+0.03	-0.00
Malaysia	+1.61	-1.47	NA	+1.61	-NA
Nutritional Status					
Panama	-0.12	+0.02	+0.44**	NA	+0.07

[1] Malaysian estimates from Barnum and Squire (1979).

[2] For Malaysia this is the price of rice and the elasticities are estimated from quarterly expenditure data with the Linear Expenditure System; for Panama the price is the price of rice in each community.

[3] For the Malaysian data, this represents a "neutral technical shift parameter"; for Panama, the variable is an index of the use of "modern" inputs in agricultural production.

*P $\leq$ 0.20

**P $\leq$ 0.10

***P $\leq$ 0.05

NA = not available in a structural equation.

important aspects. The demand for food within Panama has the expected negative elasticity with respect to the market price of rice, the principal staple in both countries, and a positive response to higher rice prices in Malaysia. The signs of the elasticities with respect to the price of rice and the wage rate for the farm labor demand equation are different for the two countries, and in the case of Panama, the response appears counter-intuitive, in that one would expect rice producers to use more labor in response to a higher price of rice and less in response to a higher opportunity cost of human time.

A possible explanation for these two results lies in the differences between the agricultural systems of the two regions. The Malaysian region is reportedly an irrigated region in which technical innovation has relaxed a land constraint. The agriculture in the communities in the Panama study is rainfed agriculture, and rice is produced under upland conditions; the soils are poor and there reportedly exists scarcity of good soils. Some communities even practice "slash and burn" techniques on the sides of the mountains. These conditions cause rice production to be directed at subsistence consumption, and most households purchase some rice in the market. Furthermore, rice production represents less than half of the value of the imputed money income for almost all of the households in the study, and rice represents more than a third of total calories in the diet. The Panamanian households tend to consist of rural wage-workers that grow rice for consumption and supplement their wage income with the sale of horticultural products, and the

Malaysian households are rice farmers.

The Panamanian wage workers are generally underemployed, since they must travel significant distances to work seasonally on larger private and public agricultural estates, or work semi-permanently in the cities. The conditions in rural Panama are similar to many of those in other settings throughout Latin America; truly subsistence agriculture is virtually non-existent except among Indian tribes. From Mexico to Peru, many low income rural households are part-time farmers and part-time laborers, as in rural Panama.

The similarities in the results are strong. Both studies revealed positive supply response to prices. Higher rice prices do lower the supply of labor to the market; higher market wages reduce farm output and reduce food consumption marginally as an apparent consequence. In both countries, farm output responds positively to technical innovation in agriculture. Apparently in Malaysia, this leads to improved nutrition. In Panama, lower prices for rice, which might result from supply increases, would also improve nutrition. In both countries, there would appear to be scope for nutritional improvement through improved agricultural productivity.

2.2 Specific Nutritional Results

In addition to those results, which are comparable to the Malaysia study, the Panama study also yielded the following insights regarding nutrition and nurturing activities. Increased human capital which increases the value of market time produces a

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significantly positive shift in the "equilibrium" level of the households' nutritional indicator. In terms of the model this suggests that full income effects dominate any negative substitution effects in consumption or production. These full income effects of increased human capital arise in two manners-- increased market wages and increased efficiency in household production (Michael, 1973).

The money value of a food gift (Title II take-home foods) yielded a positive but not statistically significant impact on child's nutritional status. This result probably also embodies the effect of participation in the maternal and child health activities of the Title II food distribution programs. The effects of the variables such as access to water and sanitation are positive as would be expected. Earlier work for rural Panama as a whole suggested that these latter were important determinants of nutritional status (Franklin and Harrell, 1983). The results also suggest complementarities between human capital and food in the production of nutritional status.

The estimated model for Panama indicates that the total calorie supply at the household level is not increased when additional children are born into the household until these children attain school age. After that, each additional person adds only one-half of a recommended daily calorie intake to the total household calorie intake. Thus, additional children tend to lower the family's per capita calorie adequacy. In particular, it would appear that no efforts are made to increase family consumption to compensate for preschool children. This

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effect may be the result of a high incidence of breast-feeding in these rural households (85%) and a prolonged duration of breast-feeding. As such, it suggests inappropriate infant feeding practices.

Furthermore, the results suggest that the households were experiencing increasing difficulty in achieving nutritional adequacy with additional food alone. This implies that even though food intakes were inadequate, other household production factors in the nutrition production function were more limiting. To improve the child's nutrition score by 10%, the household's total calorie intake would have to be increased by 40%. In other words, food must be complemented with additional factors in order to produce any further substantial improvement in the nutritional status of the preschool-aged children. The nutrition and calorie demand equations indicate that food and women's time are complementary in producing nutritional well-being. Such a strong complementarity would suggest the need to take explicit account of time allocations in the design of nutrition and feeding programs.

In general, households that receive donated foods reduce their levels of food expenditures in the market. Donated foods tend to reduce the supply of market effort and the demand for farm labor. Households that achieve higher levels of total family calorie intakes achieve these in part from additional purchases in the market; households with higher levels of agricultural output exhibit lower levels of expenditures on pur-

chased foods; and households that face higher prices for rice obtain more of their food from the market. It appears that higher prices for rice reduce the household's own consumption of rice and generate higher levels of sales of rice; the resulting income is then used to buy other foods. All of these effects are consistent with the notion that conditions in the market for food, particularly prices, do affect household consumption and production behavior, and that food aid, while nutritionally beneficial, does reduce the allocation of time to "productive" activities.

The elasticities presented in Table 1 are "all other things equal" responses to changes in the policy or exogenous variables. Table 2 presents the results of using the model estimates to evaluate the potential effect of some policy and program instruments while allowing all the variables to vary in accordance with the structure of the model. Nine scenarios were evaluated with respect to their impact on nutritional status, calorie consumption, food purchases, agricultural output and labor supply. Scenario 1 evaluates the effect of high support prices, scenario 2 evaluates the effect of technical change in rice production in the presence of high support prices and scenario 3 evaluates the impact of technical change that results in lower food prices. Other scenarios evaluate human capital investments, "integrated rural development" and food aid in various combinations. In each scenario, the policy or program variables are assumed to change by 100 percent, so that the computed results represent the (mutatis mutandis) elasticities

Table 2. Results of Simulated Policy or Program Instruments
on Selected Variables in the Panama Structural Model

Policy or Program Instruments	Output Elasticities				
	Nutritional Status	Calorie Consumption	Food Purchases	Agricultural Output	Labor Supply
High Support Prices for Rice Alone	-0.26	-0.56	+0.70	+0.16	+0.01
Support Prices and Technical Innovation	-0.26	-0.06	+0.92	+0.94	+0.12
Low Prices for Rice Resulting from Innovation	+0.26	+1.06	-0.4?	+0.62	+0.10
Investments in Human Capital for Women	+0.43	+0.07	+0.54	+0.30	+0.22
Human Capital and Technology Investments	+0.03	+0.56	+0.30	+0.81	+0.02
Integrated Rural Development	+0.20	+0.07	+1.55	+1.27	+0.25
Food Aid Alone	+0.07	-0.01	-0.13	-0.05	-0.01
Food Aid and Integrated Rural Development	+0.27	+0.06	+1.42	+1.22	+0.25
Food Aid and Women's Human Capital	+0.51	+0.06	+0.42	+0.25	+0.22

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after allowing all the variables to vary in accordance with the model.

High prices and technology yield increases in agricultural supply but reduce nutritional levels and calorie consumption because food acquisition becomes costlier. These are results like those predicted by Pinstrup-Andersen (1983) regarding the increasing commercialization of subsistence agriculture. The integrated rural development scenarios imply high prices, enhanced human capital for all household members and technical innovation; these scenarios produce positive nutritional and productive outcomes. Investments in women's human capital yield substantial nutritional improvement and modest increases in productive output. Food aid alone produces little nutritional impact and negative (disincentive) effects on productive effort. Food aid enhances the productive and nutritional impacts of integrated rural development efforts and of human capital investments.

The results of the policy simulation are similar to the results reported for Sierra Leone by Strauss (1983). They are also in general agreement with some of the explicit recommendations made by Berg of the World Bank, and appear to verify some of the expressions of concern given by Pinstrup-Andersen (1983) regarding the possible deleterious effects on nutrition arising from increased commercialization of subsistence agriculture. Since increasing market orientation and increasing innovation are fundamental to the development process, the importance of these results is to suggest the form in which

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nutrition and productive output can be enhanced. High support prices alone will improve output, but would appear to reduce nutritional status. One mechanism would appear to be the shift in the household's food consumption from its own produce to market foods. This shift increases food expenditures but appears to decrease caloric intake. On the other hand, technical innovations that cause supply shifts have been criticized for their impact on producers' incomes. These results and those of Strauss (1983) suggest that the household benefits from lower prices which arise from increased food supplies. Technology generation with investments in human capital appear to be the approaches that would best meet productive and nutritional goals. Price policies and food aid do not appear to be desirable as stand-alone instruments, but would be useful as means for creating incentives for the adoption of technology and for investment in human capital formation activities.

3.0 Conclusions and Generalizations

The empirical results of this study are generally consistent with the predictions of the neoclassical economic model of household resource allocation behavior. The joint determination of time allocations and production and consumption decisions of low income rural households was treated explicitly in the theoretical formulation of the economic model of choice and in the derivation of empirically estimable relationships. The point of departure in the analysis that follows is the major conclusion that time allocations and market price conditions matter in the determination of nutritional well-being in low income rural households and, importantly, that nurturing decisions significantly affect product and factor market behavior of these households. This means that agricultural programs and policies can determine nutritional well-being and households' behavior in seeking to achieve nutritional well-being can significantly affect the outcomes of agricultural and other developmental activities among the rural poor in settings like Panama.

3.1 The Importance of Time and Timing

The achievement of improved nutrition policies and programs requires that policy makers and program designers and implementors make explicit recognition of the value of human time and the timing of nutrition-related activities. Most developmental efforts which have been directed at helping low income households have underestimated the value of human time. For example, the design of appropriate technology has usually

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been synonymous with labor-using or labor-intensive technology.
Some popular development theories are based on the stylized
notion of the marginal value product of labor being driven to a
subsistence wage by an inexorable malthusian treadmill. Human
time is, thus, usually viewed as an underutilized and low value
resource which is plentiful and must be used more extensively.
Many developmental efforts, including most food and nutrition
programs and policies which have been implicitly or explicitly
based on the assumption that human time is plentiful, have failed
to achieve their desired impacts. For example, it could be
argued that the scarcity of human's time could, in part, explain
the general lack of impact of most supplemental feeding programs
found by Beaton and Ghassemi (1979).

The timing of human activities and the embodiment of human
capital in the use of time are important determinants of success
in developmental efforts, particularly those regarding nutrition.
Human capital includes all innate and acquired abilities of all
people. The use of time is required to obtain the services of
human capital. The higher the value of the stock of human
capital, the higher the value of a unit of human time. The value
of human time is enhanced by private and public investments in
health, schooling, feeding, shelter, work experience, etc., and
reduced by disease, malnutrition, accidents, etc. The choices
that affect the formation and depletion of human capital are
primarily choices of household decision makers in behalf of the
members of the household and always involve choices on the

allocation of human time.

In addition, in the rural environment, agricultural output is limited by the availability of time (human labor) at critical stages in crop production--land preparation, planting, weeding, harvesting and marketing. In settings where rainfall is erratic or rainy periods are short, the timing of these activities becomes even more crucial. In urban settings, timing is important because market work and the opportunity to obtain goods and services is constrained by the operating hours of the work places, shops and other services.

Even within the household itself, timing is very important. For example, a mother cannot choose the time at which a baby will become hungry; even if a feeding pattern is developed, it takes time and effort to develop it, and then the pattern must be followed. In rural and other settings, household production activities are generally limited to the daylight hours. These usually require the coordination of schedules with other humans. In absolute subsistence situations, household and production tasks must be carefully coordinated throughout the work day and the seasons.

Programs and policies that seek nutritional improvement should be determined with explicit recognition of the value of time and the importance of timing in the decisions of the poor. In particular, the importance of women's time tends to be overlooked because women's time is usually not directly valued in the market. Adult women in rural Veraguas spend approximately ten hours per day in cooking, food preparation, household tasks and

child care. It is surprising that a few of them find time to participate in wage work, agricultural production, and even schooling. The time of adult males is also scarce; those who are not working on the farm are working at wage labor. Quite a few find time to help with food preparation and household chores and a small number even help with child care. There is a clear division of labor among household members according to age and sex and these households are fully occupied. Their poverty is not founded on lack of effort, but rather that their time is of low productivity.

In formulating development strategies, including those related to nutrition, one should seek to enhance the scope of choices for the poor, to tilt the scales of value in favor of the goods and services produced by the poor, and to enhance the stocks of full wealth (human and material) of the poor (Schultz, 1979). Since the poor have little material capital and their human capital embodies predominantly their ability to perform unskilled tasks, little additional wealth can be generated by labor-using technologies because this use of human time will rapidly face the binding constraint of twenty-four hour days, critical periods in agricultural seasons and finite lifetimes. What is needed is new capital that is complementary with human skills. Specifically, innovations should be demanders of skilled human time, and development efforts should seek to enhance the supply of skilled human time. That is, concomitant with the generation of new forms of material capital (household devices,

roads, wells, new seeds, new foods, etc.) developmental efforts should be directed at human capital formation and thus at expanding the supply of skilled human time for market and non-market activities. The consequences of the development of such efforts transcend the individual household and affect the economy and society as a whole, for as Schultz (1977) states:

> "Households in low income countries perform, in fact, a substantially larger economic role than they do in high income countries. The value of home production is not only large relative to the total family income, but it is also produced predominantly by family labour and only in small part by purchased inputs because of their high price relative to the market value of the time of members of the households."

3.2 Policy and Program Implications

The issues and principles discussed above are of direct consequence to specific policies and programs that are aimed at improving human nutrition. The following examples are presented as a non-exhaustive attempt to illustrate how the recognition of the importance of time may lead to different types of policies and program designs.

3.2.1 Food and Feeding Issues

Application of the theory of household production to the issue of the role of time in food acquisition indicates the following conclusions from the empirical analysis:

o   Food and household time, particularly the time of women, are complements in the production of nutritional well-being. An increasing opportunity cost of time produces a higher level of food expenditures and may cause changes in the caloric content of the diet

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sufficient to reduce total calorie intake.

o   The higher the productivity of time in food production
and nurturing activities, the higher the demand for
food.

o   An increase in the value of market time and labor force
participation will reduce the demand for food when
there are few substitutes or augmenters for women's
time in nurturing activities within the household.

Since there is little reasons to believe that nurturing
activities are not of high importance to low income households,
the results imply unambiguously that increasing the value of time
through time saving or productivity increasing technologies or
opportunities will increase the demand (and in subsistence cases,
the production) of food for household use. Since it is now
widely known that even in direct feeding programs the use of food
gifts or subsidized food programs produce disappointingly low
increases in food use (Beaton and Ghassemi, 1979), the consistent
implication of the theoretical and empirical perspective is that
the time costs of participating in food transfer programs must be
high relative to the alternative uses for that time.
Furthermore, a mechanism by which increasing market activities
could reduce food consumption level is through the extraction of
women's time from food production and preparation activities.

This leads to the following recommendations for food
policies and food program designs.

o   Food programs that are queue rationed have high real
costs for the intended beneficiaries which may negate

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the intended food and income transfer effects of the "cheap food".

o   Food-for-work programs may be of high relative costs to low income households, particularly if the food-for-work activities compete with other food production activities such as weeding and harvesting.

o   Weed control techniques and other farming systems technologies that increase labor productivity may produce substantial positive nutritional impacts. In settings such as tropical Africa, these may be greater than the impact from land saving technologies, i.e. yield increasing technologies which focus on land rather than time as the critical resource.

o   Food aid can lead to long run sustainable improvement when used as a compensation for the time of a participant such as in maternal and child health programs. Other areas where food could be used as an incentive are farmer training programs or other skill creating activities. In these efforts the ration size and composition should be of high economic value in order to compensate the whole household for the time of one of its members.

o   Technical change in food production, even if it leads to lower received prices, can have significant nutritional impact through two mechanisms, lower costs for the households own food and higher resource

productivity, particularly labor incomes. Artificially high prices in the absence of innovations could be perversely deleterious if they raise the price of food and cause resource misallocations. Food price stability near market clearing prices would seem a more appropriate use of food price policies than either high or low food price supports or controls.

o   Agricultural policies and programs that encourage the transition from subsistence food production to cash crop production should be designed with recognition of the positive and usually rising opportunity cost of human time. This process will frequently imply higher real food costs to the formerly subsistence households through two non-independent mechanisms. One is that local supplies of food may shift back and the other that the higher value alternative uses for time will make even home produced food costlier in real terms. Accordingly, the development of market mechanisms to supply food to cash crop producing regions should be encouraged.

o   There may exist substantial nutritional benefits from developing low cost technologies for food preparation or from encouraging the development of indigenous food processing capabilities such as grist mills, blending plants, commercial manufacturing of breads, cakes, tortillas, kisra, chapati and the like. In this regard, private commercial marketing activities should

be encouraged since market services may save the time of both food producing and consuming households.

If made available with the complementary inputs of safe water and information, weaning foods may produce direct nutritional benefits to the infants of working mothers and income-mediated nutritional benefits to the working woman herself and other members of her household.

3.2.2 Other Nurturing Behavior

Since nutritional well-being is also a result of household behavior regarding health services and practices, the use of time in health programs and other nutrition-oriented programs is also important. Program services may not be used because of the high burden imposed on the household in terms of time and transportation costs. In some cases, preventive medical care programs, especially nutrition education programs, may have a low demand by households because their usefulness is often not recognized by the family decision makers, or they may compete with traditional practices perceived as a substitute by the household.

In order to guarantee the success of any intervention program, it is not enough to generate a greater supply of goods and services. It is also important to fit the program to the effective demand from the target population. This is not independent of the resources and constraints of the household unit. This view of effective demand being determined in part by

time constraints and available information leads to the following recommendations:

o   Preventive health programs which seek to modify behavioral patterns should attempt to measure time constraints and assess the participant's perception of need.

o   Geographical and economic accessibility should be an important consideration for health/nutritional programs in order to assure adequate participation.

Health investments are likely to have high payoffs in low income settings since the poor are less able than those not poor to shift the time incidence of sickness away from their productive times. For example, in farming households, those that are not as poor may be able to hire farm labor to substitute for the time of sick persons within the family. Sickness for the poor semi-subsistence household could imply totally foregoing productive activities or producing at much lower levels. Prevention and curative interventions that reduce the amount of "sick time" could have large private and social payoffs in these very low income settings. The time released from "sickness" can be used directly in production or in acquiring skills and information regarding improved production technologies, e.g. participating in agricultural extension activities.

3.2.3 Family Structure and Role Allocation

In Panama, lack of employment opportunities in rural areas, and low levels of cash income are determinants of male out-migration. These results of fast out-migration from rural areas

have seen the emergence of an increasing number of households in which women have become the primary, if not the sole supporters of the household. Households in which women are heads of households are among the poorest in the population. When the woman has the dual role of mother and market participant, inevitably she is faced with difficult economic and emotional trade-offs in her time allocation between her child caring, other household responsibilities, and income-generating activities.

There is some evidence that in poor households there tends to be a negative relationship between the mother's participation in the labor force and health and nutritional status of the young child (Franklin, 1979; Popkin, 1980). This relationship results primarily because feeding and caring for young children is time intensive and the process that has led to higher labor force participation by women in low income settings has yet to evolve adequate substitutes for her time within the household. Based on the empirical results of rural Panama, the joint effect of positive wage elasticities for food expenditures, negative calorie effects from higher opportunity cost of time, and positive effects on nutritional status from higher valued time of mothers imply that significant nutritional benefits may be derived from increased labor market or product market participation by women if this process is encouraged by the promotion of information, skill development and technologies which increase the productivity of household time allocated to nurturing tasks. This insight leads to the following policy

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recommendations:

o   Identify which skills women need to develop that would

        increase their productivity at home and in the market

        place. These include training in farm production in

        rural areas.

o   Good health for children which prevents mortality will

        reduce the need for "extra pregnancies," and thus

        should provide more time for women's market production.

3.3   The Role for Technical Innovations in Agricultural Production

Concern for urban poverty has generated calls for low prices
for food, and concern for incomes of farmers and agricultural
workers has generated castigations of the innovations resulting
from agricultural research. The literature on the impact of
innovation in agriculture is incomplete; however, one pervasive
notion is that innovation has been labor-saving and has driven
people off the farms and into poverty. This phenomenon calls for
the development of "appropriate technology" to thus stem the
rural to urban flow of people. Much of the confusion arises in
the literature because human capital and the value of human time
is ignored when the effects of technical innovations are
evaluated.

The seed-based innovations of the Green Revolution have been
said to be biased in favor of large farmers because they are
labor saving and capital (fertilizer, irrigation, machinery,
etc.) using. Consequently, the small, poor rural farmers are
said to lose due to differential access to credit and lack of
machinery, fertilizers and irrigation. A closer look at the form

of such innovations yields other insight.

Most crops have their centers of origin in the tropics where the crops themselves and their adversaries (pests, diseases, etc.) have evolved to a biological equilibrium. The success stories in tropical agriculture are almost restricted to cases where the crops have been taken out of their center of origin. For example, rice has more than doubled in yield in Colombia, but remains near its pre-Green Revolution average yield in Asia. Additionally, in order to increase plant yields, botanists have manipulated certain genetically determined physiological characteristics of the crops. These efforts have led to a reduction in the plant's vegetative vigor and thus in the crops' ability to compete with pests, diseases, weeds, drought, flooding, poor soils and other natural enemies. Thus, in order to obtain high yields with these plants, farmers must protect the plant with more weeding, insect and pest control, fertilization, and water control.

Innovation yields an increased demand for crop protection. The demand for crop protection can also be a demand for human time and skills. In addition, the changes in the cropping tasks, implied by technical innovation, also suggest that these technical innovations create opportunities for human skill augmentation. Technical innovation need not displace humans; in fact, it could create higher income opportunities through the demand for skilled human time. This is not to deny that those with larger endowments of human capital and with easier (less

costly) access to markets for factors of production will be able to capture the benefits from these innovations more rapidly than those without the larger initial stocks.

The essential point is that technical change in agriculture need not impoverish low income farmers; it is necessary, however, to be explicit about the information and skills required from the potential adopters of new technology. Most importantly, it is important to take explicit account of the "raw" time requirements of the new technology. Even in labor surplus areas, critical periods during the vegetative cycle may generate periods of labor scarcity. Crops and cropping techniques to be promoted as part of an agricultural development effort should be selected with a knowledge of labor availabilities within the farm and with knowledge of the role of the importance of off-farm labor supply in the incomes of rural households. These are issues of timing, rather than total labor time.

The choice of crops should also includes consideration of the household's production of its own food; if new crops or even new varieties of a food staple are to be introduced, there should be assurances of adequate supplies of the traditional and preferred staples. In this regard, marketing infrastructure, e.g. information and roads, can facilitate economic development through specialization of production. Marketing and consumption information must also be considered because with increasing real incomes, even the poor will shift their consumption to preferred foods. Deleterious nutritional results could ensue if the market place fails to respond to these new demands. Thus, market system

development must be an important component of any effort that
seeks to transform subsistence agriculture into a greater
commercial orientation through innovation or promotion.

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