PN-ABG-266

December 1985

SEASONAL CAUSES OF HOUSEHOLD FOOD INSECURITY, POLICY IMPLICATIONS AND RESEARCH NEEDS

Tentative Workshop Agenda

December 10, 1985

	Chairman: Dunstan Spencer
8:20 - 9:00	Welcome and Overview of IFPRI Research - Per Pinstrup-Andersen/Paul Lunven
9:00 - 9:30	A Conceptual Framework for Examining the Seasonal Aspects of Household Food Insecurity - David E. Sahn
9:30 - 9:45	Discussion
9:45 - 10:15	Public Health and Functional Consequences of Seasonal Hunger and Malnutrition - Philip Payne
10:15 - 10:30	Commentary - Paul Lunven
10:30 - 11:00	Discussion
11:00 - 11:20	Break
11:20 - 11:40	Seasonal Patterns of Activity and its Nutritional Consequences in the Gambia - Mark Lawrence, F. Lawrence, T.J. Cole, W.A. Coward J. Singh, and R.G. Whitehead
11:40 - 12:00	The Effect of Seasonality on Intra-Household Food Distribution and Nutrition in Bangladesh - Mohammad Abdullah
12:00 - 12:15	Commentary - Igor de Garine
12:15 - 12:45	Discussion
12:45 - 2:00	Lunch
	Chairman: Natalie D. Hahn
2:00 - 2:20	Seasonal Demands for Nutrient Intakes and Health Status in Rural South India - Jere R. Behrman and Anil B. Deolalikar

2:20 - 2:35	Commentary - Per Pinstrup-Andersen
2:35 - 3:05	Discussion
3:05 - 3:35	Seasonality in Food Systems: An Anthropological Perspective on Household Food Security - Ellen Messer
3:35 - 3:50	Commentary - Jane Guyer
3:50 - 4:15	Break
4:15 - 4:45	Discussion
4:45 - 5:05	Seasonal Cycles of Nutrition and Resource Procurement in Lesotho - Rebecca Huss-Ashmore
5:05 - 5:20	Commentary - Judy McGuire
5:20 - 5:50	Discussion

December 11, 1985

	Chairman: Jane Guyer
8:30 - 9:00	How Transitory Patterns of Employment and Income Translate into Seasonal Household Food Insecurity - Harold Alderman and David Sahn
9:00 - 9:15	Commentary - Jere Behrman
9:15 - 9:45	Discussion
9:45 - 10:05	PATTERN OF CALORIE INTAKE Seasonal Consumption Issues in Burkina Faso: Rural Versus Urban - Thomas Reardon, Christopher Delgado, and Peter Matlon
10:05 - 10:25	Seasonal Patterns of Activity and Their Relation to Household Food Security in the Ivory Coast - Paul Lunven
10:25 - 10:45	Break
10:45 - 11:05	Commentary - Dunstan Spencer

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11:05 - 11:30	Household Production and Consumption Strategies to Overcome Seasonal Labor Constraints in Zambia - Shubh Kumar
11:30 - 11:45	Commentary - Nancy Pielemeier
11:45 - 12:15	Discussion
12:15 - 1:45	Lunch
	Chairman: Michael Lipton
1:45 - 2:05	Wages and Labor Supply in Rural India: The Role of Health, Nutrition, and Seasonality - Anil B. Deolalikar and Jere R. Behrman
2:05 - 2:20	Commentary - Michael Lipton
2:20 - 2:50	Discussion
2:50 - 3:10	The Commercialization of Pastoralists: Effects of Age, Gender, and Wealth on the Seasonality of Time Allocation - Jean Ensminger
3:10 - 3:25	Commentary - Jan Hoorweg
3:25 - 3:45	Break
3:45 - 4:15	Discussion
4:15 - 6:15	Discussion in Working Groups

December 12, 1985

	Chairman: Igor de Garine
8:30 - 9:00	A Review of the Magnitude, Causes, and Implications of Seasonal Price Variability - David E. Sahn and Christopher Delgado
9:00 - 9:15	Commentary - Lauria Unnevehr
9:15 - 9:45	Discussion

9:45 - 10:15	The Interplay of Seasonal Stabilization of Rice and Corn Prices in Indonesia - C. P. Timmer and Chrisman Silitonga
10:15 - 10:30	Commentary - Robert Herdt
10:30 - 11:00	Break
11:00 - 11:30	Discussion
11:30 - 12:00	The Feasibility and Implications of Marketing Institutions to Stabilize Seasonal Prices in Burkina Faso - Kenneth Shapiro
12:00 - 12:15	Commentary - Peter Temu
12:15 - 12:45	Discussion
12:45 - 2:00	Lunch
	Chairman: Mohammad Abdullah
2:00 - 2:30	A Review of the Role of Agricultural Research, Technology and Policy in the Seasonality of Household Food Supply and Production in Sub-Saharan Africa - Brhane Gebrickidan
2:30 - 2:45	Commentary - N. D. Hahn
2:45 - 3:15	Discussion
3:15 - 3:45	The Role of Agricultural Research, Technology and Policy in Effecting Seasonal Household Food Security in Asia - Robert Herdt
3:45 - 4:00	Commentary - Harold Alderman
4:00 - 4:30	Break
4:30 - 5:00	Discussion
5:00 - 5:30	The Impact of Irrigation Schemes in Thailand and the Philippines on Seasonal Food Availability, Labor Demand and Earnings - Dow Mongkolsmai and Mark Rosegrant

5:30 - 5:45	Commentary - Mulumba Kamuanga
5:45 - 6:15	Discussion

December 13, 1985

	Chairman: Peter Temu
8:30 - 8:50	The Impact of Technological Change on Seasonal Food Insecurity in the Semi-Arid Area of North Arcot, India - Per Pinstrup-Andersen
8:50 - 9:05	Commentary - Dow Mongkolsmai
9:05 - 9:35	Discussion
9:35 - 9:55	The Household-Compound Farm in Tropical Africa - Natalie D. Hahn
9:55 - 10:10	Commentary - Shubh Kumar
10:10 - 10:40	Discussion
10:40 - 11:00	Break
11:00 - 12:15	Discussion in Working Groups
12:15 - 1:30	Lunch
	Chairman: David Sahn
1:30 - 1:50	Indigenous versus Introduced Solutions to Seasonal Food Stress - John Moris
1:50 - 2:05	Commentary - Richard Longhurst
2:05 - 2:30	Discussion
2:30 - 3:00	The Role of Agricultural Research and Secondary Food Crops in Reducing Seasonal Food Insecurity - Michael Lipton and Richard Longhurst
3:00 - 3:15	Commentary - Anil Deolalikar

3:15 - 3:30	Break
3:30 - 4:00	Discussion
4:00 - 5:00	Reports of Discussion Group Chairmen
5:00 - 5:30	Synopsis and Future Research Needs - Per Pinstrup-Andersen

WORKING GROUP ASSIGNMENTS

AFRICA - (Duke of Gloucester Room)

Natalie Hahn
Kenneth Shapiro
Jon Moris
Rebecca Huss-Ashmore
Jan Hoorweg
Brhane Gebrekidan
Chris Delgado
Shubh Kumar
Jane Guyer
Tom Reardon
Nancy Pielemeier
Dunstan Spencer
Richard Longhurst
Igor de Garine
Jean Ensminger
Mark Lawrence
Mulumba Kamuanga
David Sahn

ASIA (Room 217)

Chrisman Silitonga
Harold Alderman
Mohammad Abdullah
Laurian Unnevehr
Philip Payne
Dow Mongkolsmai
Mark Rosegrant
Michael Lipton
Per Pinstrup-Andersen
Anil Deolalikar
Ellen Messer
Judy McGuire
Jere Behrman
Paul Lunven
Peter Temu

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

Preliminary Draft
For Discussion Only

A CONCEPTUAL FRAMEWORK FOR EXAMINING THE SEASONAL ASPECTS OF HOUSEHOLD FOOD INSECURITY

by

David E. Sahn

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

Maryland Inn
Annapolis, Maryland
December 10-13, 1985

INTRODUCTION

The purpose of this workshop is to examine seasonal aspects of household food insecurity. This involves examining patterns of seasonal variations, its causes and consequences. In addition, we are interested in whether seasonal patterns are stable and predictable from year to year, and whether and why seasonal patterns are changing concurrent with agricultural and economic development.

A number of excellent and insightful papers have been prepared for this workshop. Our ultimate challenge is to synthesize salient evidence from the diverse presentations which follow into a systematic examination of the seasonal dimensions of household food insecurity. In order to facilitate this task, this paper has the modest objectives of presenting a conceptual framework to guide our deliberations.

CONCEPT OF HOUSEHOLD FOOD INSECURITY

The focus of our interest is the analysis of food security at the household and individual level, as juxtaposed with national or global level. Examining national data obscures the fact that despite achieving national security, as measured by commanding adequate and relatively stable levels of food resources, there may be great regional disparities and inequities in the distribution of income and wealth. Within a given town or village only a segment of the population may encounter a seasonal shortage of food or display major fluctuations in their levels of consumption. Similarly, not accounting for the fact

that the allocation of food within the household may be biased against one or more members may obscure the fact that some individuals, most likely women or children, are indeed insecure about the regularity and adequacy of food consumption while other family members are not. While the global and national dimensions of food insecurity condition the plight of the household and individual, this workshop will concentrate on the extent and policy implications of seasonally determined inadequate levels of consumption for the household and individual.

The concept of food security revolves around achieving target levels of consumption. The major factors which condition the ability to consume an adequate target level are the availability of food, coupled with having command over resources and the desire to acquire that food.[1] However, the definition of "target levels" represents a potentially ambiguous concept. Siamwalla and Valdes[2] adopt a definition in which the trend level of consumption is the target. They perceive food insecurity to constitute a problem of short-term variability whereby consumption falls a certain percentage below trend levels. The more frequent consumption is below trend levels, the more insecure is the household. They argue that persistent poverty and chronic

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[1] Per Pinstrup-Andersen, "The Nutrition Effects of Export Crop Production: Current Evidence and Policy Implications," in Nutrition and Development, edited by M. Biswas and Per Pinstrup-Andersen (London: Oxford University Press, 1982).

[2] Ammar Siamwalla and Alberto Valdes, "Food Insecurity in Developing Countries," Food Policy, Vol. 5, No. 4, November 1980.

malnutrition represent a long-term problem which is outside the purview of food security.

Framing food security solely in terms of a problem of short-term variability, while appealing, is considered too restrictive for the purpose of this workshop. Rather, a food-insecure household or individual may be defined by their inability to consume a diet that is sufficient to meet the physiological needs for basal metabolism, growth and desired levels of physical activity.

There are a variety of reasons for adopting this broader perspective, given that the focus is on household, not national, food security. It is difficult to define a trend level of consumption for households. Such an approach may be feasible on a national level using aggregate statistics of yearly consumption. However, it is simply not realistic to extrapolate the household level of consumption from national data. Furthermore, the types of longitudinal household studies that generate such trends are extremely rare, largely due to their prohibitive expense. But most important is that the idea of defining household food security solely in terms of the extent of deviation from the average, while compelling, neglects the fact that some households have levels of intake which fall markedly below requirements despite smooth levels of consumption. In our discussion of seasonality, it is precisely those households on which we want to concentrate attention, and understand whether and how seasonal patterns contribute to their plight.

To amplify, some households and individuals are in a perpetual state of impoverishment whereby they virtually never achieve an adequate level of food consumption. For other households and individuals, the converse is the case -- they virtually never feel insecure about being hungry, although there may be considerable deviation above and below their trend level of consumption. A third group are those individuals and households which intermittently confront circumstances whereby either fluctuations in the command of resources to purchase and grow food, or availability of food, bring about circumstances that result in their not consuming a diet which supplies needed nutrients for growth and activity. The concern of this workshop is equally with the first and third groups of households -- those which are chronically undernourished due to inadequate consumption and those which share that plight intermittently.

In the case of the chronically food-insecure household, there are certainly seasonal and annual fluctuations in their level of deprivation. But more important, the question arises as to what extent does the seasonal nature of the rural economy predispose or precipitate chronic food insecurity and undernutrition. Therefore, in considering seasonal dimensions of the food system, it is necessary to determine whether and why certain periods of the year portend heightened vulnerability as well as how seasonal patterns in agriculture contribute to an overall state of chronic impoverishment and food insecurity.

In sum, this conference focuses on seasonal dimensions of food security and the extent, causes, and implications of variability during

the course of a year. This involves formulating policies for reducing seasonal hunger in the larger context of chronic undernutrition, and identifying areas for further research.

A CONCEPTUAL FRAMEWORK OF THE DETERMINANTS OF SEASONAL FOOD INSECURITY

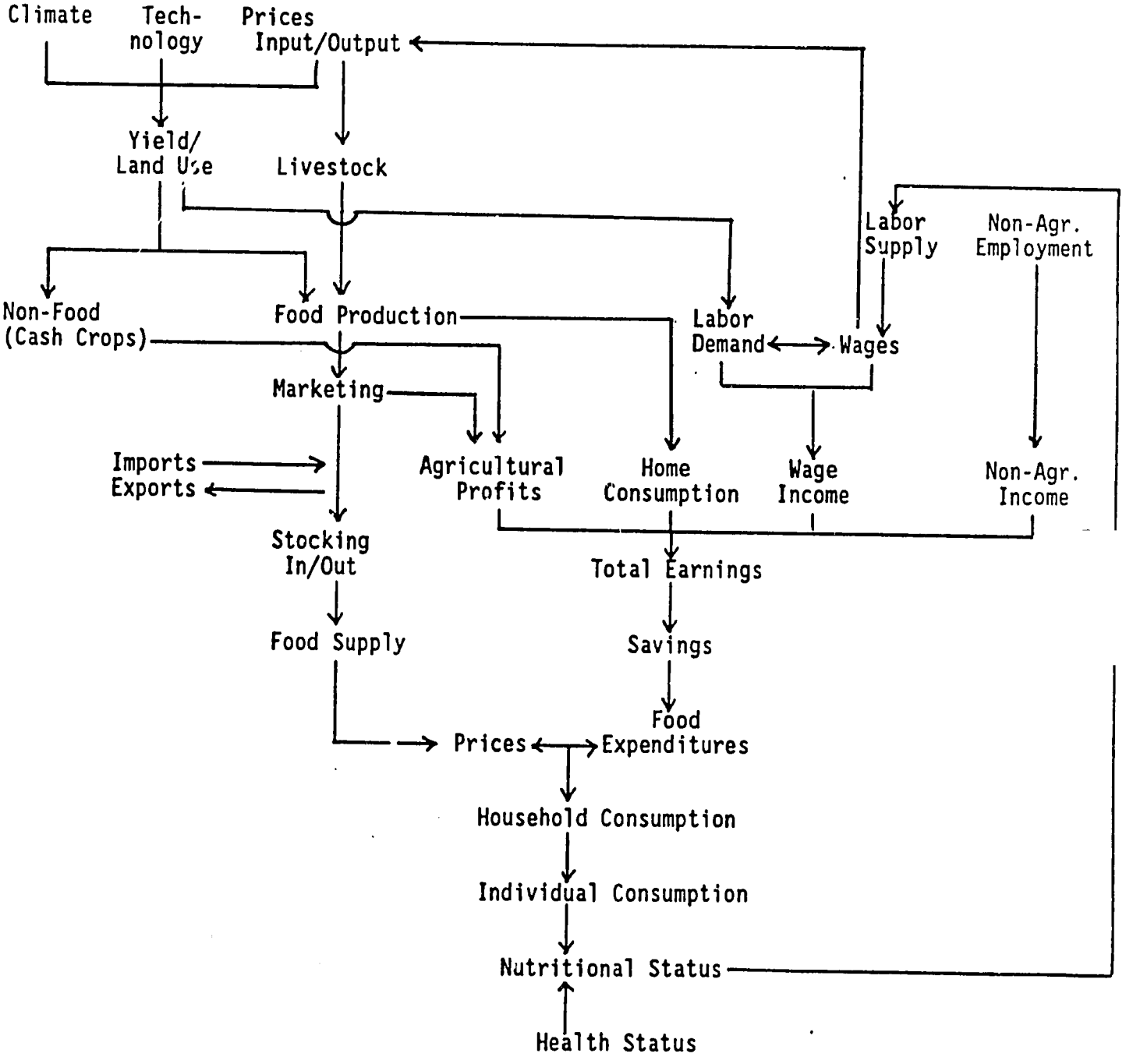
Seasonal fluctuations in household food security and nutritional status are the end point of a series of events and processes. In order to begin to understand them, a schematic diagram is presented in Figure 1. The most important factors which contribute to the causation of malnutrition are depicted. Each of these in turn is conditioned by a large number of variables, all of which have a seasonal dimension.

These pathways are discussed briefly below, identifying salient points relevant to seasonal aspects of household food security. Those factors highlighted below should thereafter serve as organizing themes for considering and discussing the papers which are presented during the workshop.

Food Availability

The availability of food during any given season is determined primarily by three factors: (1) the timing of what is produced; (2) the timing of what is put into, or removed from stocks; and (3) the timing of trade between communities, regions, and across national borders.

Figure 1 -- The Determinants of Nutritional Status



Farm Production

Farming activities revolve around the climate, a seasonal phenomenon over which we exert a little control. While weather events (e.g., levels of solar radiation, precipitation) are given exogenously, the interaction of the natural ecology with technology and markets determines the seasonal pattern of food production. While some periodicity in food production is inevitable, there are a number of policy and research issues that demand our attention. Most important are questions regarding how farmers can control and/or respond to climatic events through adjusting production techniques and management practices.

A related issue is that not only does technology affect seasonality, but that the scarcity of factors at various periods in the production cycle (e.g., labor bottlenecks at harvesting) determine the nature of technical change, as well as the annual aggregates of factor scarcities. The implication is that not only does the choice of technology in production affect seasonality of production and earnings but seasonal constraints in production guide the nature of technological change. Consequently, when new technology is developed which does not consider seasonal bottlenecks in the production process, its adoption will be impeded.

The bi-directional interface between seasonality and technology suggest a simultaneous model of how one affects the other. Understanding the seasonal constraints to adoption, coupled with how adoption impacts on seasonal demand for factors of production, and the subse-

quent response of factor markets (e.g., labor markets) represent an important theme of this meeting.

Storage

The second important factor which determines the seasonality of food availability is the effectiveness of storage operations. Regardless of when crops are harvested, the ability to store inter-temporarily represents a mechanism to smooth out seasonal food availability. This suggests that the availability of storage infrastructure, stocking behavior, and the functioning of markets -- i.e., efficiency and competitiveness of inter-period arbitrage -- represent essential ingredients to reducing seasonal fluctuations in food availability.

In addition, on-farm storage technology and practices represent important factors in determining the availability of food between harvest periods. Consideration of the extent of these losses is also paramount in order to assess the potential for intervening in this area. It is also important to assess the tradeoffs between on-farm storage versus more centralized storage facilities.

Related to the storage question is the issue of processing of foodgrain and other agricultural products. Examining techniques to preserve foods and reduce their perishability, both through development of germplasm which yields hearty grains and post-harvest processing, also represent areas for our discussion.

A further dimension of the storage issue concerns the role of institutions in promoting temporal arbitrage. The need for, and proper

role of government -- state and parastatal marketing boards -- remains a controversial subject. The arguments for such institutions arise primarily out of the assertion of uncompetitive markets and exploitative traders. We must assess the extent to which these concerns are valid, and if so, identify the appropriate response for government in the domain of grain marketing.

Trade

Just as stocking operations allow a country or region to stabilize food availability, so too can trade operations be timed so imports arrive during the lean season. To the extent that a country is geographically diverse, the potential arises for inter-regional trade to smooth out seasonal variability. Market infrastructure and integration represent the vital ingredients to promoting trade of foodgrains from one region of the country to another. Engaging in international trade to reduce seasonality is a more difficult endeavor. Not only is the timing of imports/exports to correspond to the lean period difficult, but there may be other considerations such as seasonal fluctuations in international commodity prices which represent an equally strong influence over when grains are purchased and when they arrive at the port.

Tradeoffs in Reducing Seasonality in Food Availability

The options for smoothing seasonal food availability through production strategies, storage operations, and trade draws into question how to deal with tradeoffs between them. For example,

production strategies designed to maximize the aggregate level of annual output may conflict with investments, technology, and management practices that promote intra-year stability in food availability. These tradeoffs can in turn be evaluated from an economic perspective of valuing any foregone production against the lower levels of output and/or increased costs which accompanies production techniques that emphasize smoothing out streams of seasonal food production. In turn, the economic costs of employing storage and/or trade activities versus production practices to reduce seasonality in food availability should be explored. Thus, there is the need to consider the interface between decisions regarding policies designed to influence seasonality in agricultural production and the functioning of commodity markets, both in terms of the role of domestic storage activities and international trade.

Ability to Obtain Food

Aggregate food availability by season is indeed a first indicator of the seasonal nature of farming and the efficiency of market operations. However, it gives virtually no indication of how food is distributed between households within a given season nor the capacity and desire of the family to obtain an adequate diet on a seasonal basis.

The ability to obtain food is determined by a combination of the level of food production and its concomitant effect of agricultural earnings and food available for home consumption, coupled with the

amount of income in cash and in-kind from other sources. In turn, levels of expenditures, which may reflect a combination of transient and permanent components of income, condition the ability to obtain food. The different sources of income, both money and non-money, as well as expenditures all have important seasonal dimensions which affect the availability of food at the household level.

Home Consumption vs. Marketing

Agricultural households have the option of consuming their own production or selling it if a market exists. The potential and wisdom of consuming at home or selling in the marketplace is determined primarily by farmgate prices relative to retail prices, the access to and cost of capital, and the efficiency of storing on-farm versus in central warehouses, as determined by the extent of post-harvest losses and economies of scale in storing foodgrains.

The prices received by the farmer relative to the cost of buying back food on the retail markets is largely a function of the efficiency and competitiveness of inter-period arbitrage as manifested in retail price patterns. If post-harvest prices are kept low relative to pre-harvest prices through exploitative practices of oligopolistic traders, this should clearly encourage home consumption. Of course, this option only arises if on-farm storage is available and the farmer's need for low-cost capital can be met through accessible financial institutions.

The ability to time home consumption to periods of seasonal food stress is, however, not an alternative for the landless laborer or

urban worker. They cannot circumvent participation in the marketplace. As such, one of the mechanisms to cope with the prospect of seasonal food insecurity is not available.

Other Money Income and Expenditure Patterns

The seasonality of earnings is conditioned by the pattern of income from a variety of sources, including agricultural sales, wages, business profits, remittances, and transfer payments. It is likely that the pattern of agricultural income from field crops, a function of the timing of market arrivals and prevailing prices, will be markedly seasonal. Livestock operations or cash crops may, however, balance or exacerbate the seasonality of agriculture-related activities.

Likewise, the wage income from agriculture-related activities is a consequence of the pattern of labor demand (i.e., hours worked) and reservation and market wages, all of which will have a seasonal element. Thus, understanding the nature of labor markets and wage formation is necessary to explain observed variability in agricultural income. Examining seasonality of rural income also requires considering the ability of farmers and laborers to smooth out their stream of earnings through changing farming techniques and management practices (e.g., crop choice, water control, seed varieties) and finding non-agricultural income to compensate for the seasonal cycles in farming.

But most important is the relationship between commodity prices and income patterns. If they are counter-cyclical, purchasing power

remains the same from one season to the next. If not, savings and dissavings are required to smooth out real expenditure. Thus, it is the covariance of prices and income, not the extent of seasonality in the individual variables, which should be the focus of our attention. In this regard, one must recognize the difference between producers and consumers.

In the case of non-agricultural workers, the situation is relatively simple. Their food security is affected directly and primarily through seasonal food prices. Of course, to the extent that seasonality in agriculture affects employment and wage cycles in the non-food sector, as mediated by the demand for goods and services, the earning of non-agricultural workers may also be affected.

The situation for the farmer and agricultural workers, however, is considerably more complex. A farmer's real income is determined not only by the price changes he confronts as a consumer but also farmgate prices which determine the price he receives for his surplus. Thus, in theory, if a government takes upon itself to stabilize seasonal prices, although it will likely smooth out the purchasing power of those who are not producers, the result may be quite to the contrary for the farmer. Similarly, the extent to which the seasonal variability in the farmer's income translates into the same for landless laborers is a complex and unresolved empirical question. The functioning of labor and wage markets must be studied. In sum, smoothing out the real income of those in the rural sector is complex, and must take into

account the movement of farmgate and market prices, the timing of sales, as well as wage and labor demand fluctuations.

Regardless of the pattern of earnings and purchasing power, as determined by the movement of prices relative to income, the ability of the household to save and dissave provides the opportunity to smooth out expenditures. The implication is that no matter what the stream of earning looks like, financial intermediaries provide the means to control and adjust expenditure patterns to eliminate any potentially deleterious nutritional consequences of lumpy income. As such, the performance of capital markets is a major issue in the realm of seasonality which should be the focus of our attention.

Prices

The formation of prices over the seasons represents an important theoretical and empirical question. Neoclassical economic theory suggests that prices are formed by the intersection of supply and demand curves. The question, however, of changing seasonal patterns of marketed supply and effective demand proves rather more complex and unpredictable than expected on the basis of the simple supply/demand framework. Rather, seasonal prices are a function of the accuracy of expectations concerning supply and demand conditions in the future, and the extent to which changes in anticipations bring about adjustments in the quantity of food marketed by producers, and traders and the demand of consumers. Further insight is needed into how expectations are formed, and what role government can assume to improve the

accuracy of those expectations. This coupled with exploring the functioning of commodity and futures markets is needed to both examine and explain the extent and regularity of seasonal price movements.

The major policy questions that are of interest revolve around the appropriateness of, and mechanisms for, reducing seasonality in prices. This suggests the need for further inquiry into the magnitude of seasonal pricing, the covariances of price movements among staple commodities and from one market to another, the buffering mechanisms used by households to address these price variations, and how government can best achieve stability. The latter issue should include consideration of who gains and who loses from stabilization, what are the explicit and implicit costs of government intervention, and what have been the experiences of such interventions to date.

Desire to Obtain Food

In different seasons of the year, the roles and time allocation of household members change. This affects both the value of leisure and income control. In addition, the physiological requirements for nutrients shift in accordance with changing patterns of morbidity, work, and weather. These factors coupled with the shifting pattern of seasonal prices and incomes which alter the budget constraint can be expected to exert influence over the household's food acquisition behavior, thereby resulting in seasonal variation.

To amplify, at different seasons of the year, the value of women's time may vary. This in turn is translated into a combination

of their earnings being seasonal, as well as the nature of their activities varying by season. In regard to the earnings, there is a need to determine both how differential control of income affects consumption outcomes and how household members with divergent preference ordering reconcile their differences through some sort of bargaining process.

Concerning the seasonality of activities, there may be different levels of energy expenditures in accordance with changes in seasonal patterns of labor/leisure. Work output per unit time as well as hours worked may change dramatically from one season to the next. The question of whether levels of calories and nutrient intake adjust commensurate with the undulations in requirements remains a subject for further empirical study.

Besides the consideration of to whom income accrues, a related issue which may affect the desire to obtain food is the changing composition of income by season. The hypothesis has been presented that income in the form of own production and food stamps may contribute relatively more to food consumption than wages and salaries. This and the related issue of to whom income accrues clearly represent important areas for further research.

Another related aspect of the desire to obtain food revolves around the seasonal patterns of celebrations and ceremonies. Whether it be observance of religious holidays or other festivals, there may indeed be regular periods where either food consumption increases or

changes in composition occur, which are attributable to traditional beliefs and culturally determined food habits.

Intra-Household Food Distribution

The consumption of food by the individual is functionally related to both the level of household calorie intake and the choices regarding intra-household food distribution. Despite the expectation that household food availability and consumption will determine the level of intake of individuals, there is an unresolved question of whether and to what extent patterns of intra-household allocation vary systematically by season. One can consider a variety of hypothetical reasons for predictable changes in the pattern of intra-household distribution by season. For example, households may, or may not, adjust intra-household distribution in accordance with the variability in energy expenditures which results from seasonal patterns of labor demand. Similarly, it may be that in periods of seasonal stress, as measured by household food availability, certain individuals are more likely to be systematically discriminated against.

A further consideration which might influence seasonal patterns of food consumption for individuals is that income controlled by different household members may be allocated differently. The same may apply to income which takes different forms (e.g., agricultural versus cash income). To the extent that the form and source of income is seasonal, it will in turn influence intra-household distribution of resources. Thus, we must explore the extent that there are systematic

changes in allocative behavior in accordance with different seasons, who benefits and loses, and what are its causes.

Nutritional Status, Energy Balance, and Health

Our ultimate concern is the nutritional status of the individual. This is fundamentally determined by the energy balance of the individual and their health status. Concerning the former, energy balance is determined by the extent to which calorie consumption is in equilibrium with the energy requirements, including those for adequate growth and activity. This balance is seasonally determined by variability in work, basal metabolic rate (e.g., the higher level during the cold months), genetically determined seasonal patterns of growth, and, of course, dietary intake. Each of these factors have a seasonal dimension. The relationship among them will determine seasonal patterns of energy balance.

The long established synergistic relationship between nutrition and infection interjects a health component to seasonal patterns of malnutrition. Major causes of infection, such as malaria and diarrheal diseases, follow regular patterns just as upper respiratory disease is linked with other climatic changes. These seasonal patterns in morbidity portend heightened nutritional risk.

Related to the issue of changing patterns of morbidity by season are issues regarding how access to health services, or decisions whether to seek such services are variable according to the different periods of the year. In the case of primary health care services

which are delivered by volunteers or auxiliary medical personnel with other jobs, there may be periods of the year when the opportunity cost of delivering health services is so high as to preclude doing so. Similarly, work in the fields during times of high labor demand may discourage households from seeking health care. The proper care of children and other at-risk groups in the population will also affect health status, and thereby nutrition. To the extent that women's time is allocated differently according to seasonal labor requirements, child care practices may change with a consequent impact on morbidity and nutrition. These questions of time allocation thus need to be the subject of further consideration, both to design programs and policies which relieve bottlenecks, and are responsive to the shifts in constraints to adequate child care and health practices.

Finally, there remain some compelling questions which condition the importance of our work for the next four days. Specifically, we will begin this meeting by trying to address the following questions to better identify the magnitude, causes, and consequences of seasonal food insecurity: How does one define seasonal <u>hunger</u> and <u>malnutrition</u>? Does it represent a syndrome or phenomenon which has particular traits other than those that we traditionally use to describe chronic or acute malnutrition? Thereafter, we need to identify specific characteristics of seasonal hunger and malnutrition. But most important is addressing the short- and long-term consequences of seasonal hunger and malnutrition. This involves considering the adaptive processes (e.g., physiologically, metabolically) that mitigate the consequences of seasonal

variability in food consumption. Knowledge of the coping mechanisms which can protect the health and nutritional welfare of the poor is a prerequisite to designing cost-effective strategies to reduce the deleterious effects of seasonal fluctuations.

The Effect of Seasonality in Nutritional Status on Labor Supply and Productivity

One of the most complex elements of the relationship between seasonality and household food security concerns the effect of poor nutritional and health status in one period of the year on worker productivity and nutrition. There is a growing literature on the impact of nutritional status on the ability to perform work. To the extent that there is a period of seasonal stress, which weakens the laborer so that his ability to sow his grain or weed his fields is compromised, this could in turn compound the problem of food insecurity in the seasons and years which follow. The potential for a downward spiral arises as a result of a period of seasonal stress.

Like many of the issues connected with seasonality, the linking hypotheses between a season of stress and the consequent deterioration in living standards are many, and most remain untested empirically. First, we must consider the ability for physiological and behavioral adaptation to adversity. Second, there is a need to critically evaluate the evidence that hunger proves a constraint to the household's earning potential. Third, even if the former two are substantiated, the question of whether poor nutrition and low productivity are primarily a seasonal phenomenon remains to be shown. This would be

contingent on facts such as that peak labor requirements coincide with periods of food shortage, and the household does not employ buffering mechanisms to deal with this coincidence. Thus, our concern with seasonality leads us to consideration of existing evidence, and the need for further research on the relationships between food intake, physical activity, work capacity, and performance; their seasonal variations throughout the agricultural calendar; and social and biological adaptive behavior.

COVARIATION IN THE ELEMENTS OF THE CONCEPTUAL FRAMEWORK

In the above discussion of the conceptual framework, an underlying theme is that the implications on household food security of seasonal fluctuations in a given variable, other than the end point of the system -- nutritional status -- are difficult to infer. This problem emanates from the fact that it is the covariances in the cyclical movement of variables which bring about or mitigate potentially harmful consequences of seasonal fluctuations. Important in this regard is whether the fluctuations, for example, in wages and hours worked, production and imports, or energy intake and energy expenditures are pro- or counter-cyclical. Similarly, we are extremely interested in whether income and prices covary, and if so, the sign and strength of that covariation.

The problem which we face is that much of the data presented on seasonality, including some papers prepared for this workshop, concentrate on seasonal variations in one or two of the variables

in the conceptual framework. For example, data may be presented on the seasonal prices of one staple commodity without looking at the pattern of substitutes; or the seasonal price index of foodstuffs is given without determining the pattern of earnings; or seasonal energy intake is available without looking at data on the variability in labor requirement and activity levels. The result of these limited data may be that erroneous inferences are drawn concerning the effect of these variations on seasonal food insecurity. This admonishes that we must critically examine seasonal data and be cognizant of the complex interactions among a number of factors which contribute to seasonal malnutrition.

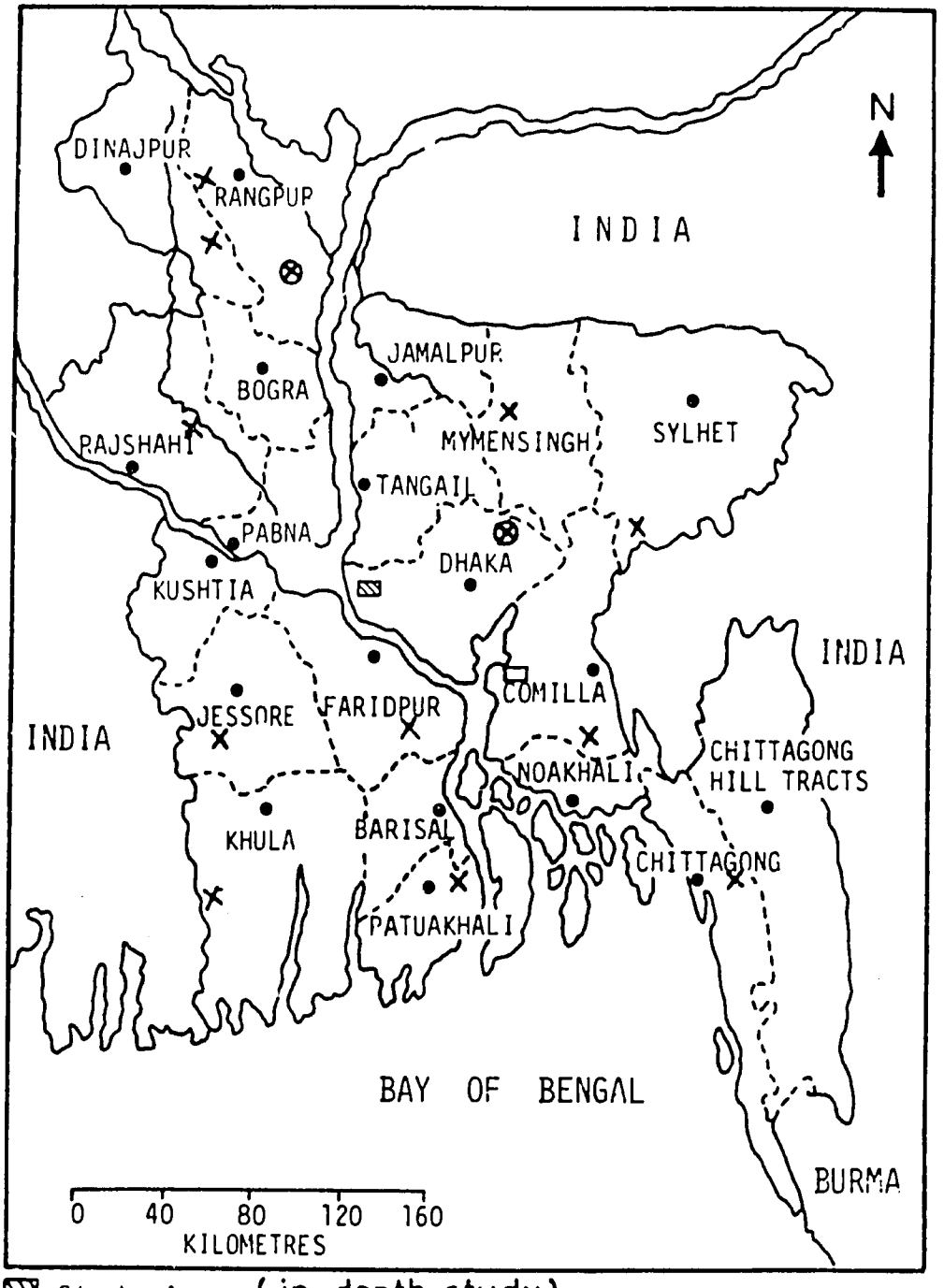
CONSIDERING SEASONALITY IN THE BROADER CONTEXT

This introductory paper, like the workshop, concentrates on seasonal dimensions of household food insecurity. However, an underlying current in many of the papers which follow is that instability in agriculture, food availability, earnings, and consumption is not simply a seasonal phenomenon, but also occurs from one year to the next. The larger domain of the concern over instability, therefore, encompasses both inter-year and intra-year instability. There are some issues that need to be addressed concerning the interaction of inter- and intra-year variability, despite that we will limit our purview to seasonality.

It can be argued that seasonal, unlike inter-year, fluctuations are predictable events -- that is, for a given data element, whether it

Figure : 1

MAP OF BANGLADESH



Study Area (in-depth study)

× National survey locations

⊗ Seasonal survey locations of national survey

□ Matlab study Area

Figure 2: Harvest periods of different foods grown in Bangladesh

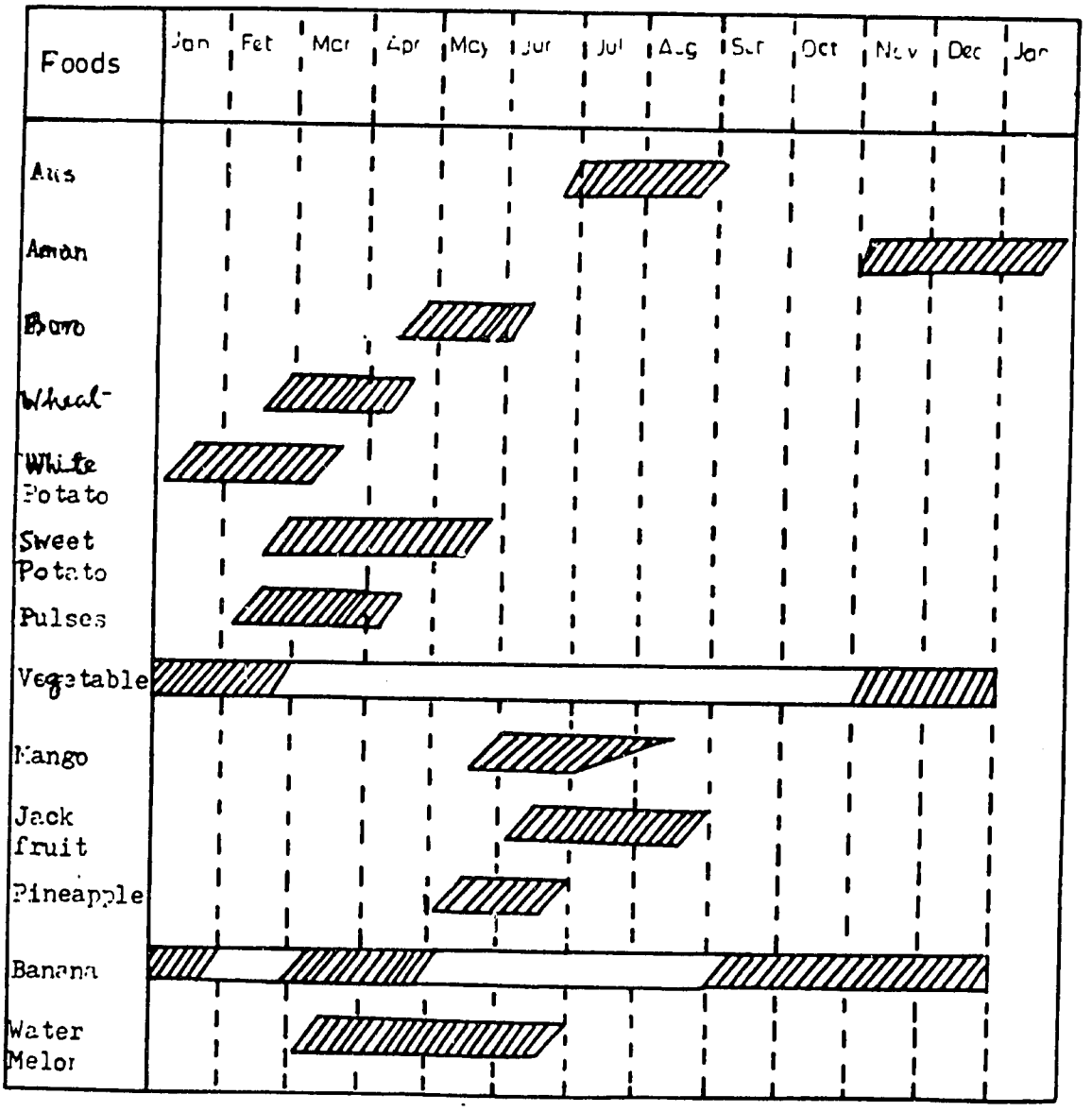
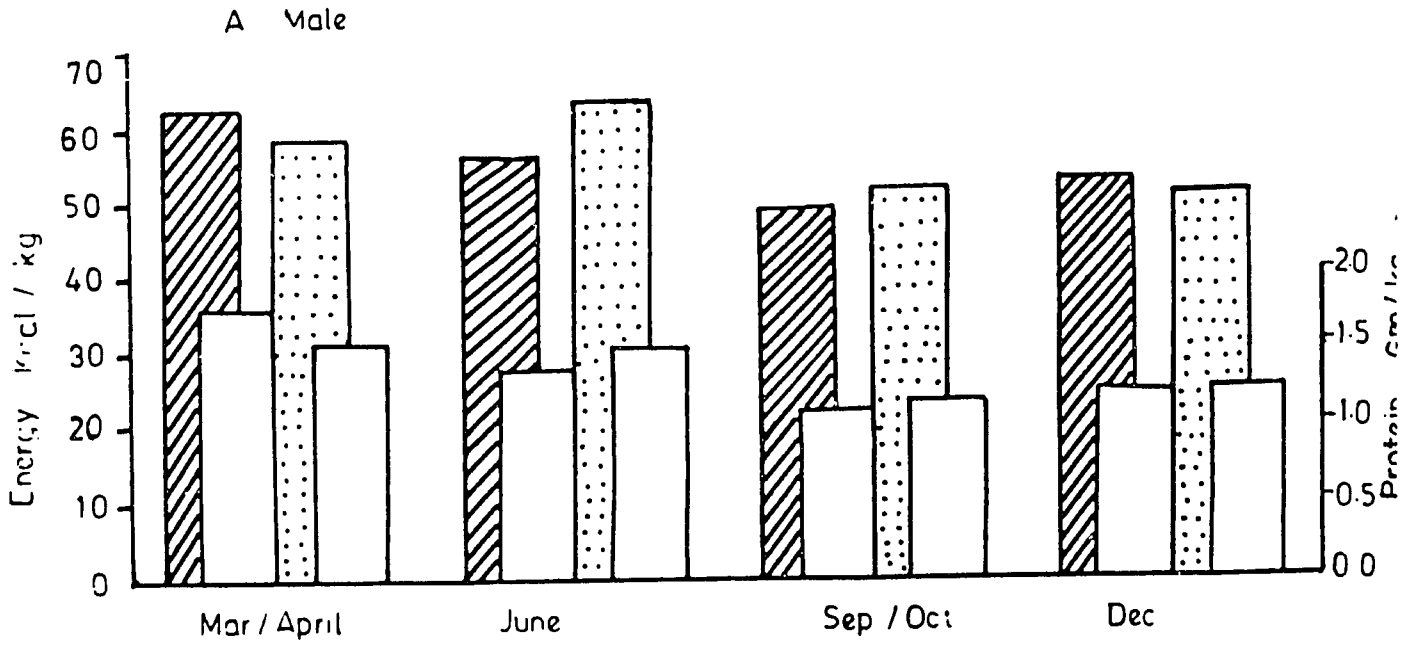
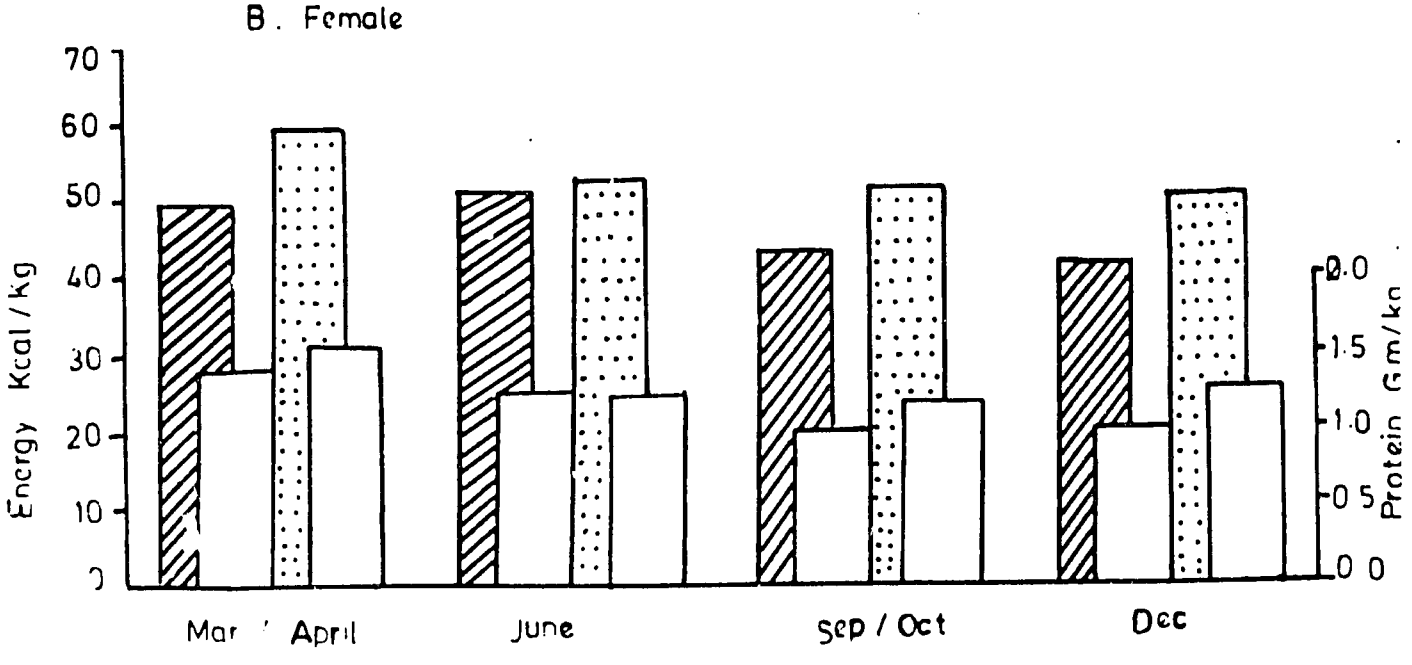


Figure 3

Mean Energy and protein intakes of adults (15 - 44 y) by sex socio economic group and season.





Poor

Better off

Protein

Figure 4

Mean Energy and Protein intakes of children by sex and season.

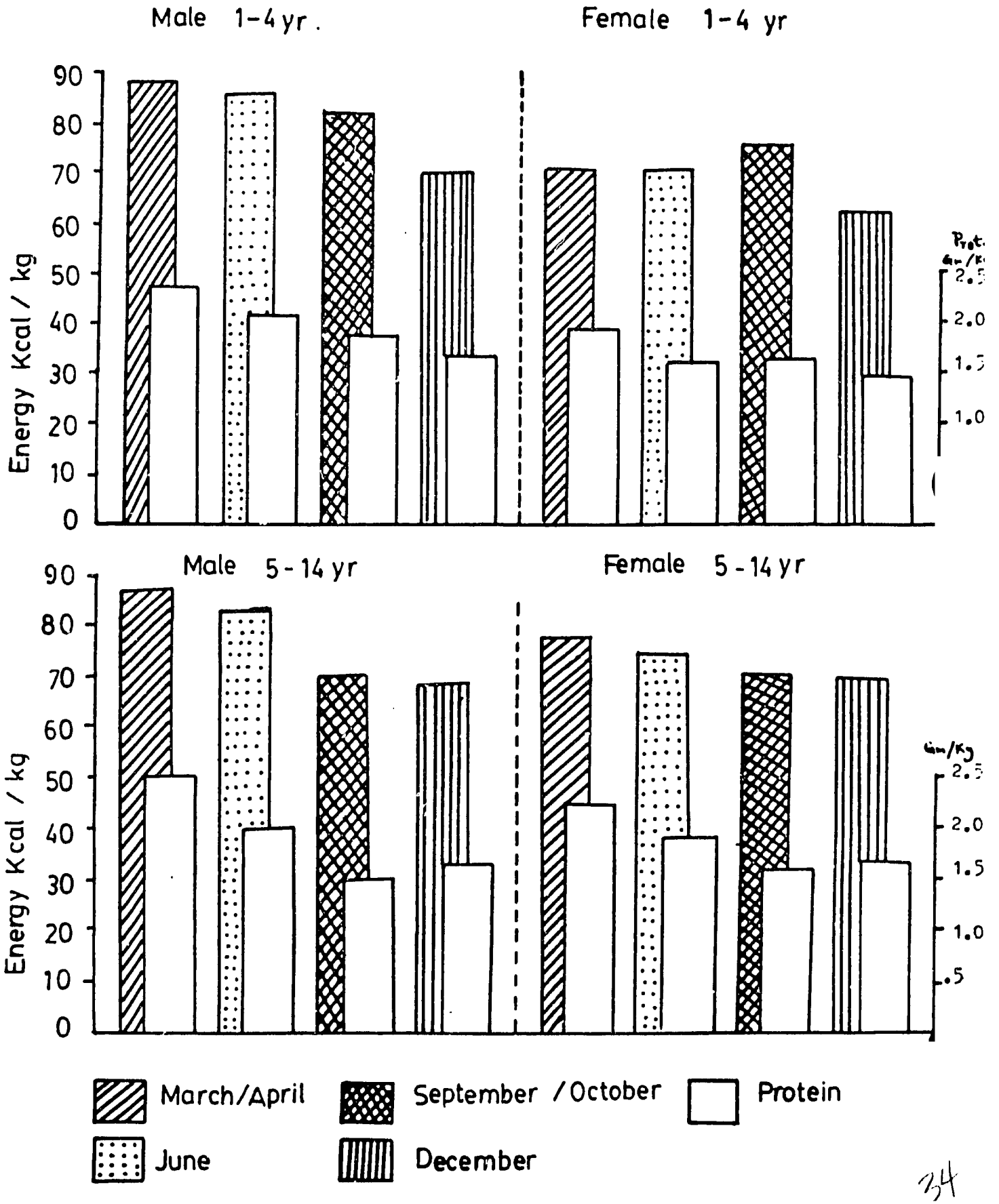


Fig. 5 : Energy Intake as % of Household Heads Intake

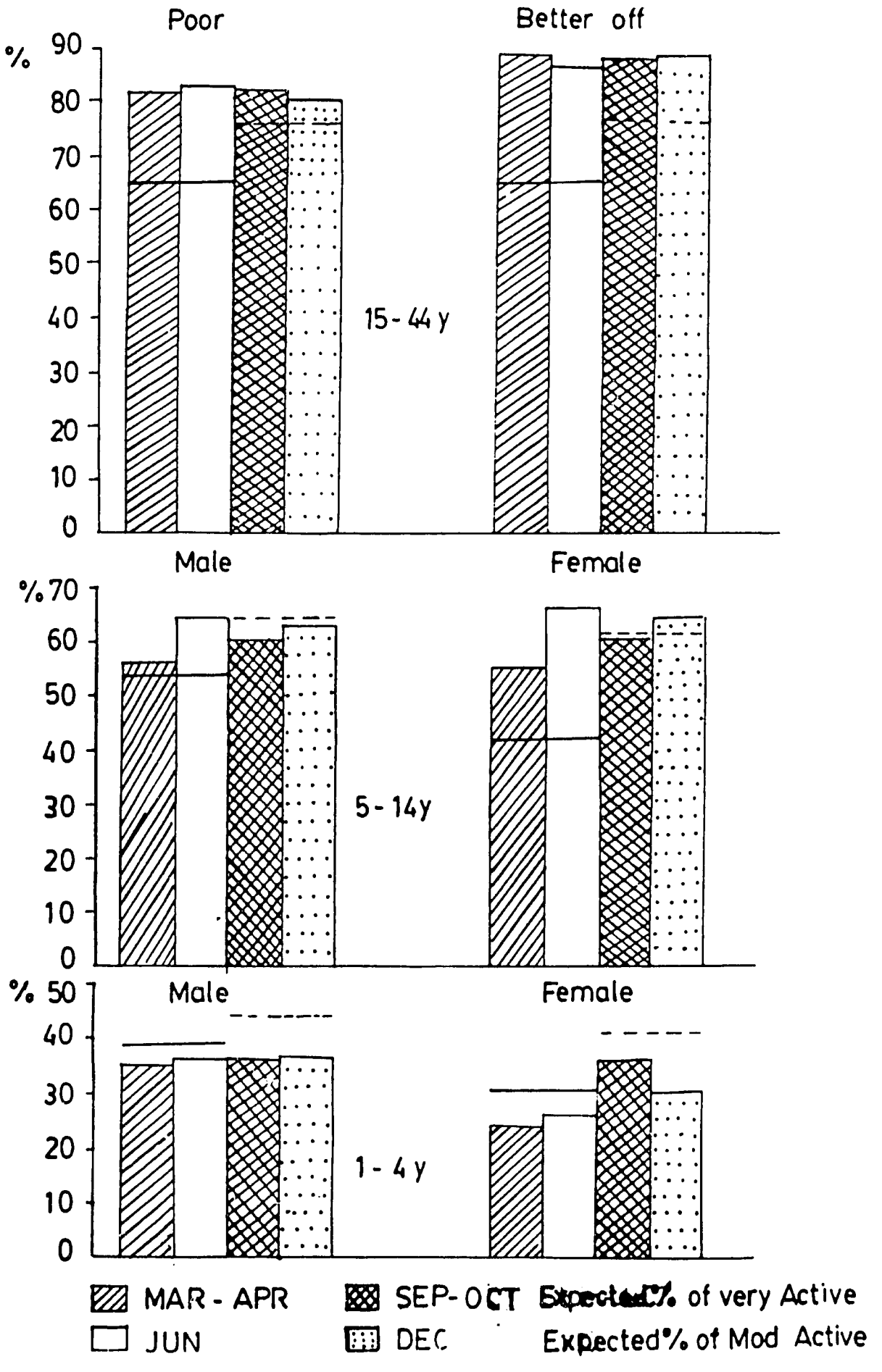
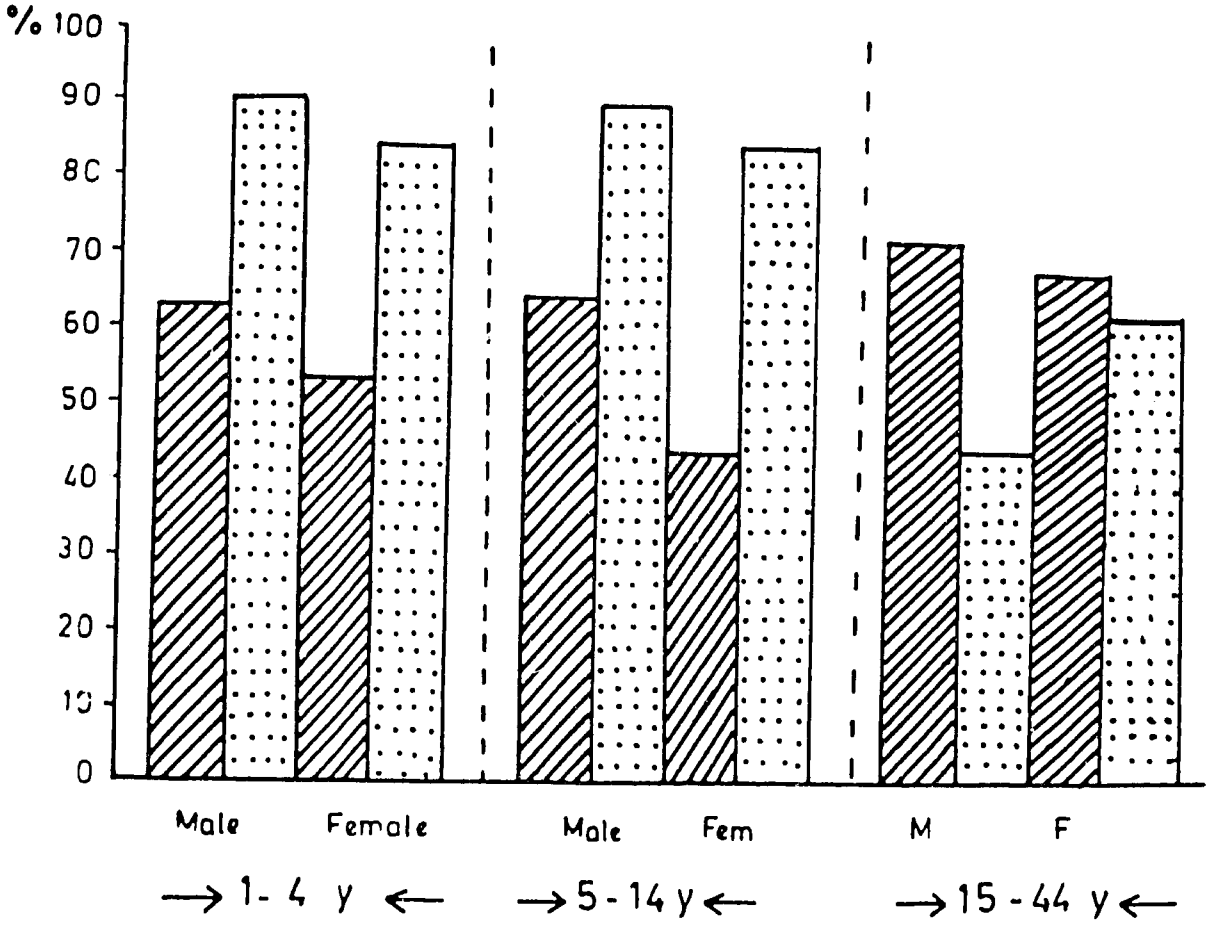


Fig .6 : Between season loss and gain in weight

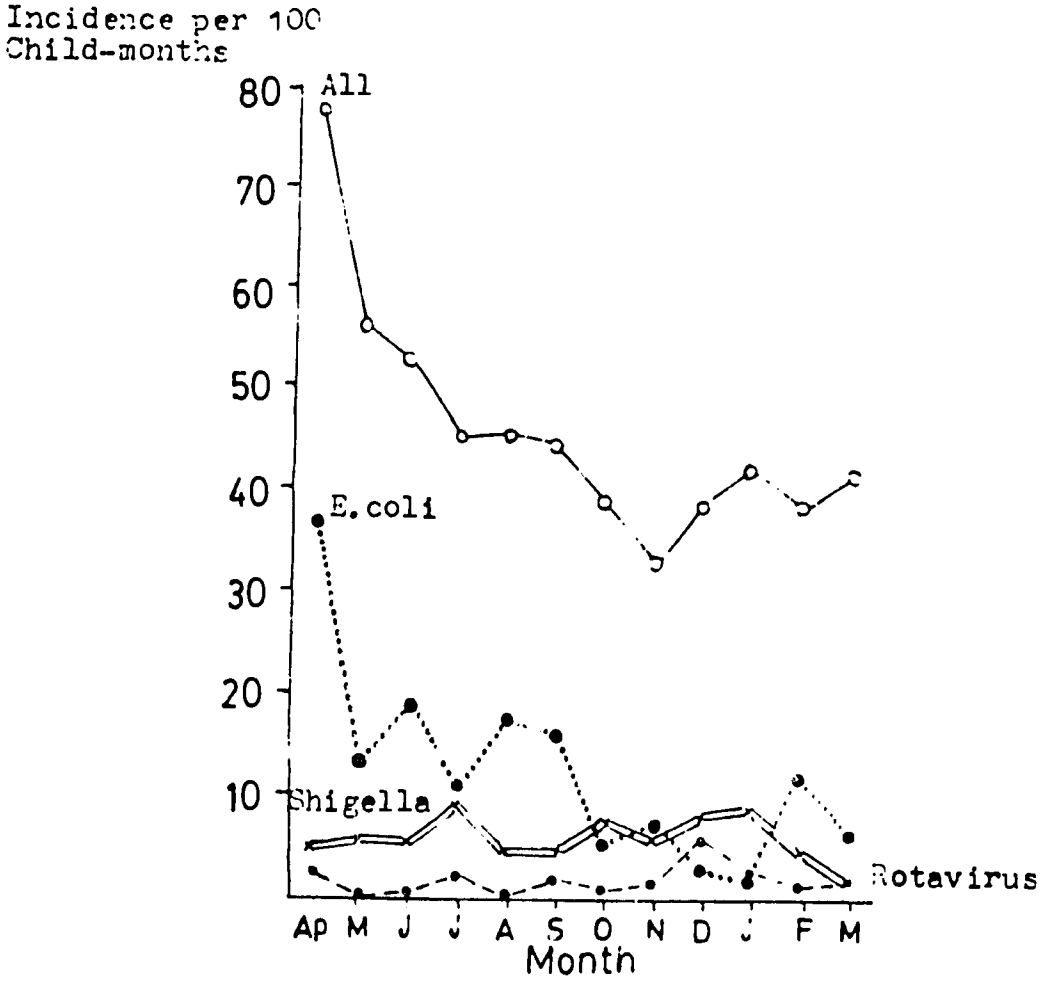


%Losing wt between June and September

% Gaining wt between September and December

Figure 7 : Seasonal Prevalence of Diarrhea

a. By enteropathogen and calendar month in a cohort of 197 rural Bangladeshi children aged 2-60 months.



b. Percent prevalence of diarrhea in childer under 5 years (National Nutrition Survey : 1962-64)

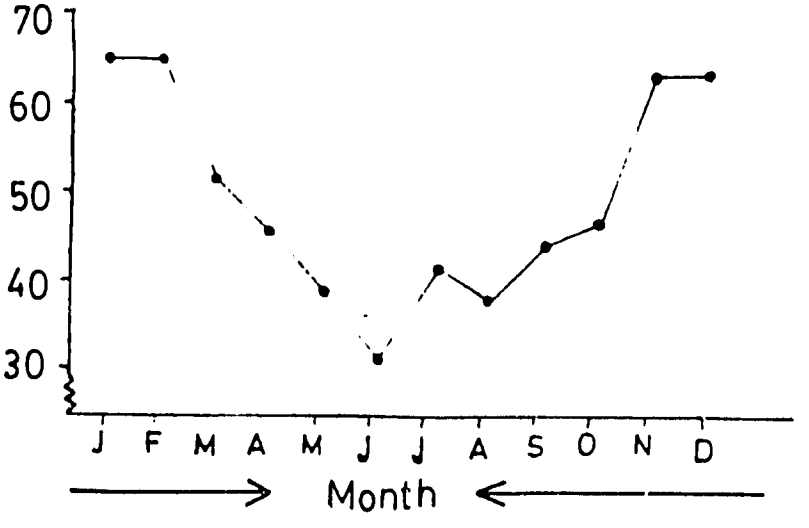


Table 1 : Energy intake (kcal/p/d) by age groups and sex of different surveys in Bangladesh compared.

Age	Cross-sectional (1) 1975- 76		Cross-sectional (2) 1981- 82		Cross-sectional(3) Matlab		Season 2 of this study (4)	
	M	F	M	F	M	F	M	F
0- 4 Y	-	-	-	-	809	694	-	-
1- 3 Y	630		659		-	-	-	-
1-4 Y	-	-	-	-	-	-	908	712
4- 9 Y	1345		1389		-	-	-	-
5-14 Y	-	-	-	-	1590	1430	1483	1413
10-15 Y	2050	1839	2089	1835	-	-	-	-
15-44 Y	-	-	-	-	2700	2099	2828	2109
16-59 Y	2921	2304	3038	2205	-	-	-	-
45 Y	-	-	-	-	2630	1634	2530	1817
60 Y	2585	1872	2819	2037	-	-	-	-

1. Nutrition Survey of Rural Bangladesh : 1975- 76 (Ref: 10)
2. Nutrition Survey of Rural Bangladesh : 1981- 82 (Ref: 11)
3. Chen et al (1981) : (Ref: 7)
4. Abdullah (1983) (Ref: 1)

Table 2: Mean weight by age, sex and seasons in two traditional subsistence village of Bangladesh : 1975- 76.

Village 1: Dhaka.

Age	July		August		November		April	
	Male	Female	Male	Female	Male	Female	Male	Female
1- 3 Y	8.8(18)	8.3 (9)	8.2(17)	8.0(11)	8.5(14)	8.4(9)	8.9(17)	8.3(12)
4- 9 Y	15.1(29)	14.5 (18)	15.4(26)	13.5(18)	15.8(24)	14.9(19)	17.0(24)	13.2(18)
10-15 Y	24.8(11)	28.5(14)	23.9(19)	26.0(14)	23.5(20)	26.0(18)	25.6(19)	27.0(20)
16-59 Y	43.2(40)	37.8(42)	42.2(41)	36.8(46)	43.3(35)	35.8(41)	42.0(53)	36.6(47)

Village 2: Rangpur.

Age	May		August		October		March	
	Male	Female	Male	Female	Male	Female	Male	Female
1- 3 Y	12.3(13)	8.9 (12)	8.7(11)	7.6 (15)	9.3(12)	8.6 (10)	9.6 (13)	8.7(13)
4-9 Y	16.9(38)	17.9 (29)	15.4(27)	15.4 (26)	15.4 (32)	15.1 (19)	16.0 (58)	17.8(39)
10-15 Y	25.0(20)	32.4 (20)	25.8(28)	29.7 (23)	25.9 (21)	28.1 (26)	26.6 (26)	28.7(27)
16-59 Y	45.4(32)	40.2 (40)	45.4(53)	38.7 (53)	44.3 (41)	38.0 (32)	44.6 (51)	38.5(55)

Figures in parentheses are numbers.

Table 3: Prevalence of wasting (1) among the under 6 children in 2 Bangladeshi villages by age group, sex and month of measurement.

Months	0 - 5 months.				6 - 11 months.				1 - 6 years.			
	M		F		M		F		M		F	
	n	%	n	%	n	%	n	%	n	%	n	%
January	17	47.1	10	70.0	17	94.1	12	58.3	207	72.0	209	77.0
February	10	40.0	8	50.0	13	76.9	13	69.2	217	75.1	213	80.8
March	27	33.3	12	66.7	24	79.2	12	66.7	211	86.7	232	89.7
April	22	59.1	13	46.2	26	76.9	14	57.1	238	85.3	252	90.1
May	18	55.7	12	41.7	32	81.3	16	87.5	243	84.0	250	87.6
June	13	84.6	6	66.7	28	92.9	16	87.5	246	84.6	260	89.6
July	12	75.0	6	33.3	32	96.9	21	66.7	263	80.2	261	83.9
August	5	60.0	6	50.0	37	83.8	20	80.0	248	83.1	246	85.8
September	3	33.3	5	20.0	21	85.7	10	70.0	177	85.3	145	
October	5	40.0	11	18.2	27	81.5	11	81.8	176	91.5	202	88.1
November	5	80.0	9	44.4	17	76.5	8	75.0	198	86.9	209	87.1
December	4	75.0	5	40.0	18	77.8	11	45.5	191	76.4	188	78.7

(1) Wasting has been defined as - 2 SD and below of NCHS standard.

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INSTITUTE

1776 Massachusetts Avenue, N W
Washington, D C 20036 U S A
(202) 862-5600
Telex 440054
Cable IFPRI

Preliminary Draft
For Discussion Only

PUBLIC HEALTH AND FUNCTIONAL CONSEQUENCES OF SEASONAL HUNGER AND MALNUTRITION

by

Philip Payne

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

Maryland Inn
Annapolis, Maryland
December 10-13, 1985

4'

be prices, food production, weight gain, and so forth, there is a combination of trends, cycles, as well as a stochastic element. Seasonality can be considered to be the cyclical component, while inter-year instability the stochastic element. To the extent that this is an accurate portrayal, there is a compelling argument that the consequences of seasonality can be easily dealt with by consumers, producers, and traders because of its predictability. Of course, this is predicated on commodity, capital and labor markets functioning according to neoclassical prescriptions. Thus the seasonal variability is juxtaposed with the random nature of inter-year fluctuations which pose a more difficult set of problems to consumers, producers, traders, as well as market because of the introduction of the elements of uncertainty and risk.

There are some specific points to consider in this regard. First is the need to examine the empirical question of whether seasonal fluctuations are indeed predictable. We must address if this is the case, and if not, why in certain circumstances for some variables the pattern of seasonal variability is indeed difficult to predict. The problems of finding empirical evidence on this question is manifest. It emanates from the obvious difficulty and expense of collecting monthly or bimonthly data over a series of years. Caution is therefore advised in that for the remainder of the workshop, we will be examining seasonal patterns of variability often based on a single year's data. Unless there is some reasonable certainty that these cycles are

representative and regular year after year, we are admonished to be careful in the conclusions we draw.

In considering the issue of the predictability of seasonality, a fundamental question is what causes these intra-year patterns in variables like prices, income, and expenditures to be unstable from year to the next. The answer lies in examining the two other components of a data series, trends, and stochastic elements. Concerning the former, it is inevitable that a change in general trend levels of variables, such as food production, income, and consumption, will be accompanied by shifts in the seasonal patterns. The question arises as to whether the seasonality of the various factors in the framework is increasing and/or changing, and if so, why and under what circumstances this is the case. For example, an increasing trend in production will likely be predicated on technological change which will alter the timing of output, concurrent with increasing the surplus which will affect marketing efficiency and competition. Similarly, the changes in labor requirements which accompany production increases may alter the nature of wage formation or implicit labor contracts, affecting not only the level of income but its seasonal flow. Likewise, as incomes rise, access to and use of capital markets may increase. This is all to suggest that we must consider whether, why and how trends in various elements of the conceptual framework increase or decrease seasonal variations, and the stability and predictability of seasonal patterns.

Another important explanation for seasonal undulations being unstable and unpredictable is inter-year fluctuations. The stochastic

element of production and food availability, coupled with policy and behavioral changes from one year to the next, contribute to unstable and unpredictable seasonal patterns. To the extent that the farmer, trader, or consumer faces uncertainties and changing circumstances in terms of levels of production, prices, earnings, and other factors from year to year, this will be reflected in differing seasonal patterns. This implores us to consider whether in fact reducing inter-year instability should be the focus of our attention, given our aim to reduce the deleterious consequences of seasonality. Consequently, the following types of questions need to be addressed: Is it only during years of low levels of production that households are at heightened risk during the lean season? If inter-year instability in production and imports could be reduced, would the pattern of seasonal prices more closely reflect the economic costs of storage? If the uncertainty involved in yields or prices were reduced, would the farmer be less likely to be exploited in terms of low post-harvest prices followed by precipitous increases, or by money lenders during the lean season when agricultural inputs must be purchased?

Finally, the contention that seasonal undulations are predictable, and therefore amenable to adaptation without serious consequence, is based on the efficient functioning of price, capital, and wage markets. There is, however, evidence that poor countries are often characterized by market inefficiencies, such as rationing of capital, great divergence between the returns to savings and cost of borrowing, poorly functioning or non-existent future markets, and oligopsonist traders.

If this be the case, it suggests that the deleterious consequences of seasonality could be overcome through improving market performance. Whether this is the case and whether or not our attention should be focused on addressing seasonal food insecurity through indirect measures to improve the functioning of commodity, capital, and labor markets, rather than direct intervention programs, is a matter for further consideration in assessing policy measures during this workshop.

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1776 Massachusetts Avenue, N.W
Washington, D.C. 20036 U.S.A.
(202) 862-5600
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THE EFFECT OF SEASONALITY ON INTRA-HOUSEHOLD FOOD DISTRIBUTION AND NUTRITION IN BANGLADESH

by

Mohammad Abdullah

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

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Annapolis, Maryland
December 10-13, 1985

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Seasonal Pattern of Activity and its Nutritional consequences in The Gambia

Lawrence M*, Lawrence F, Cole TJ, Coward WA,
Singh J, Whitehead RG.

Medical Research Council Dunn Nutrition Unit, Keneba, The Gambia
and Cambridge, U.K.

* present address:
Institute of Physiology,
The University,
Glasgow G12 8QQ,
U.K.

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Introduction

The Gambia is a small country in the extreme west of Africa, consisting of a 30 mile wide strip of territory on the north and south banks of the river Gambia. The three villages that formed the subject of this study, Keneba, Kantonkunda and Manduar lie in the western half of the country, in an area somewhat isolated by brackish river and saltmarsh. The majority of Gambians are subsistence farmers growing millet, sorghum and rice for food, and growing groundnuts for consumption at home and for sale as a cashcrop. These crops are grown during a relatively short monomodal rainy season from July to October. The problems of a short growing season have been compounded recently by several years of low rainfall. In Keneba, rainfall since 1980 has varied between 500 and 700 mm/year, whereas in the late seventies there was between 600 and 1100 mm of rainfall annually. Although total crop failure has not yet occured in The Gambia, partial crop failure is, to a greater or lesser extent, an annual event, and this results in regular food shortages prior to each harvest at a time known locally as the "hungry season".

Study design and analysis

We have recently completed in Keneba the Gambian component of a multi-national study of energy balance during pregnancy and lactation. This involved longitudinal measurements, over a period of up to three years, of changes in maternal adipose tissue stores, changes in various aspects of total energy expenditure and changes in total food intake. These data have been analysed using within-subject

multiple linear regression to investigate the influences of a) stage of pregnancy or lactation and b) season. Of these two factors, only the effect of season will be discussed in this paper.

A further aspect of the study has been to assess the impact of a maternal dietary supplementation programme. The supplement consists of an energy-dense groundnut biscuit and vitamin-enriched tea drink prepared from locally available ingredients and aid foods. Between 1978 and 1982 all lactating women resident in Keneba received the supplement as part of a study to assess its impact on lactational performance. Since 1980 the supplement has also been distributed to pregnant women in order to assess the impact on birth outcome. Consumption of the supplement takes place on six days a week throughout the year in a supervised and purpose-built centre. In pregnant women uptake varies between about 600 kcals/day post-harvest and 800 kcals/day at the peak of the annual "hungry season" in August (1); in lactating women uptake varies between 700 kcals/day post-harvest and 950 kcals/day in August (2).

For the purposes of the present study women recruited in Keneba received the supplement from before conception and throughout pregnancy and lactation. For comparison with this supplemented group, women from the two nearby villages of Kantonkunda and Manduar were recruited; they were offered similar medical care to those from Keneba, but did not receive the supplement. A brief subject profile is given in table 1.

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Seasonality of agricultural work and its impact on energy expenditure in rural Gambian women

Women throughout The Gambia have an important role in agriculture, and in Keneba they cultivate both rice and groundnuts. Agricultural work is not restricted to the rainy season (July to October) but extends into several months before and after (fig 1). Work begins in April with the preparation of vegetable gardens. In early June the fields are cleared, and in late June, as the first rains soften the hard ground, the fields are dug and seeds are planted. This work continues throughout July. In August and September the main task is weeding. In October the rice harvest starts, and this is followed in November and December by the groundnut harvest. All these tasks are carried out by hand, using cutlasses, hoes and a variety of other hand-held implements.

Seasonal variation in activity pattern related to agricultural work could exert an influence on maternal nutritional status via an effect on total energy expenditure. The magnitude of any change in total energy expenditure will vary according to the amount of time devoted to agriculture, the level of energy expenditure during agricultural work, and equally importantly, the energy cost of the activities that the agricultural work replaces.

In order to investigate seasonal variation in activity pattern we have used observers keeping activity diaries; recording every 2.5 minutes throughout the day the activity the subject was performing. An analysis of over 1100 days of activity diary is presented in figure 2. Results from unsupplemented and supplemented

women have been combined as there were no major seasonal differences in activity pattern between them. The values shown represent the time spent actually performing a particular task; the walking and resting components of an activity have been included in the walking and resting categories respectively. In January, when almost no agricultural work was performed, the 14.4 hour observed day was divided between lying, sitting and standing, i.e. resting or chatting and so on (7.4 hours or 52% of the day), food preparation activities (1.8 hours or 13% of the day), household activities, i.e. drawing water, washing clothes etc. (2.1 hours or 15% of the day) and walking (2.3 hours or 16% of the day). The remaining 4% of the observed day was divided between miscellaneous activities, child-care and any agricultural work left from December.

Between April and July agricultural work accounted for an increasing proportion of the observed day (fig 2), until by July 3.5 hours/day were actually spent at work (largely digging) in the fields. A further 50 minutes a day were spent walking to and from the fields. This massive increase in agricultural work was achieved by a reduction in the time spent performing other activities; an hour less food preparation, an hour less household work, 1.5 hours less resting and a slight reduction in the time spent walking in the village. Finally, the length of the observed day increased by about half an hour a day at this time of year. In August and September slightly less time was spent in the fields than in July, and thereafter the burden of agricultural work declined considerably, to about an hour a day in the harvest months of October, November and December.

A lot of time is devoted to agriculture in some months of

the year, but do these tasks demand a high level of energy expenditure? Table 2 presents estimates of the energy costs of individual field activities, measured by open-circuit indirect calorimetry, and listed in order of the month in which they were performed. Full details of this study are given elsewhere (3). The most strenuous activities we measured were clearing the fields and digging in June/July, which required 3.5 - 4.5 kcal/min. This level of energy expenditure would not however be classified as heavy, but only as moderate, according to the widely accepted classification of Durnin & Passmore (4). To a casual observer this would come as a surprise since outwardly these tasks are quite hard work. One possible mechanism for coping with energy shortage is of course to maximise the efficiency with which any particular task is performed, and to some extent this may be happening here. Certainly these women work with considerable economy of effort, i.e. there are few superfluous energy-wasting movements. Only one other task, digging groundnuts in November, required even a moderate level of energy expenditure (about 4 kcal/min) and many other activities, e.g. weeding and harvesting rice (August-November) required really quite low rates of energy expenditure (about 2 kcal/min).

In figure 3 the day has been divided according to the number of hours spent at 5 levels of energy expenditure (<1.2, 1.2-1.7, 1.8-2.5, 2.6-3.5 and >3.5 kcal/min). For this analysis the unobserved part of the day was assumed to have been spent sleeping at expenditure level 1 (<1.2 kcal/min). In January, over 19 hours or 80% of the day was spent at level 1, 2 or 3 (2.5 kcal/min or less), 4.4 hours (18%) was spent at expenditure level 4 (which includes walking) and only about 15 minutes or 1% of the day was spent at expenditure level 5

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(>3.5 kcal/min). The major changes in this pattern with season were a) an increase of 1.5 - 2 hours/day in the time spent at expenditure level 5 in June/July and b) a similar increase in time spent at expenditure level 3 (1.8-2.5 kcal/min) in August/September. These increases were due to digging the fields and weeding rice respectively, and were compensated by reductions in the time spent at expenditure levels 1 and 2, i.e. <1.7 kcal/min. These results suggest quite a substantial effect of season on total energy expenditure, and in figure 4 we have estimated this effect by integrating the results from figure 3, assuming the following average rates of expenditure for levels 1 - 5 respectively, 0.95, 1.4, 2, 3 and 4 kcal/min. The lowest level of daily energy expenditure was apparently achieved in March (2250 kcal/day), with expenditure rising to a peak of 2650 kcal/day in July before falling once again to about 2350 kcal/day between August and December. Some caution must be exercised in interpreting these figures however, as a number of fairly crude assumptions have been made; for example that metabolic rate during the night averaged 0.95 kcal/min and that the average cost of each level of expenditure remained constant throughout the year. Neither of these assumptions is likely to be entirely correct. Furthermore, it is evident that these figures for expenditure are substantially higher than the food intakes previously measured in this population. Some seasonal discrepancies might be expected but the overall average expenditure for the year (about 2350 kcal/day) should approximate to average energy intake. In pregnancy however, average food intake in Keneba was 1470 kcal/day rising to 1900 kcal/day after supplementation (1), whilst in lactating women the corresponding figures are 1570 and 2290 kcal/day (2). Although the estimates of energy expenditure in figure 4 represent a combined value for unsupplemented and supplemented women in the

non-pregnant non-lactating state, neither of these two factors provides a satisfactory explanation for the discrepancy.

The recent development of a method for measuring total energy expenditure over periods of up to 2 weeks using stable isotopes, the doubly-labelled water technique (5), provides a promising new approach to this problem. The method is currently being used in Keneba.

Seasonal energy imbalance in pregnant Gambian women

A further component of the study has been to estimate, in pregnant women, seasonal changes in body weight and body water (TBW), and thus body fat (calculated as weight - TBW/0.73). TBW was measured using a deuterium oxide dilution technique. After adjusting for stage of pregnancy, the impact of season on body weight and body fat in unsupplemented women was highly significant ($p<0.001$), with over 4 kg of fat being lost between March and November (fig 5), by which time mobilisation of body fat was providing over 10% of daily energy requirements or about 250 kcal/day. The rate of fat loss was greatest from the end of June onwards, i.e. sometime before food shortages began to bite in August and September, and this indicates that the initial stimulus to body fat mobilisation was the seasonal increase in activity documented above rather than any decline in food intake.

Although there was also an effect of season on body fat in supplemented women, supplementation appears to have diminished the magnitude of seasonal energy imbalances. In the supplemented group no

individual monthly increment in fat was significantly different from Dec/Jan, whilst in unsupplemented women both the Feb/Mar and Oct/Nov increments were significantly different, and in addition, the overall significance of the seasonal effect was greatly reduced, to $p<0.02$ in the supplemented group compared with $p<0.001$ in unsupplemented women.

Seasonal variations in resting metabolic rate

The large seasonal imbalance between energy intake and output has other effects besides that on body weight. Figure 6 illustrates seasonal variation in resting metabolic rate (RMR), after adjustment for stage of pregnancy or lactation. In unsupplemented women RMR was significantly lower between August and November than it was in Feb/Mar by about 50 kcal/day. (N.B. the calculated expenditures in figure 4 take no account of this.) This drop occured at the time of year when the lowest body weights and lowest food intakes were also recorded.

One possible cause of a drop in RMR could be the loss of lean tissue that normally accompanies the depletion of adipose tissue reserves. However, in this study we found no significant seasonal variation in TBW, an index of lean body mass. Moreover, we used multiple regression analysis to investigate the effect of body weight change on RMR and found that the effect of season was still significant even after adjustment for body weight. Alternatively the RMR per kg lean tissue may have been reduced, as has been observed in studies of semi-starvation (6).

As with body fat, supplementation appears to have diminished the effect of season on RMR change. The drop observed in supplemented women during Aug/Sept (fig 6) did not by itself reach significance, and the overall effect of season was less significant in supplemented than unsupplemented women ($p<0.05$ compared with $p<0.01$).

The effect of season on pregnancy outcome and lactational performance

Previous work in Keneba carried out by Dr A.M.Prentice and others has provided considerable information on the effects of season and supplementation on both pregnancy outcome and lactational performance. The initial study was to investigate the effect of supplementation on breast-milk output, measured by test-weighing over a 12 hour period. Whilst there was evidence of a marked decline in breast-milk output during the rainy season in women in the 2nd to 6th month of lactation (7), this effect was much less in evidence in older children measured subsequently (2). However, the results of the supplementation trial were unequivocal, with no improvement in breast-milk output being observed (2).

In contrast to this was the marked effect of supplementation during pregnancy on birthweight. Prior to the introduction of the supplementation programme in Keneba average birthweight, adjusted for gestational age, sex and parity, was 2.74 ± 0.05 kg during the rains (defined here as July to January) and 2.97 ± 0.05 kg during the dry season. This seasonal decline in birthweight was eliminated by supplementation, with weights of infants born July to January improved by an average 224 g (1). There was also a marked reduction in the

incidence of low birthweight (<2.5 kg) at this time of year, from 28% to 5% of births. The supplement was without effect on birthweight during the dry season.

Conclusions and summary

It was intended that this section of the workshop should address the causes, implications and control of seasonal hunger. In this paper we have concentrated on the seasonal demands of agricultural work and its effect on the nutritional status of pregnant and lactating rural Gambian women.

June/July is the period of most intensive agricultural work as fields are cleared, dug and planted at the beginning of the rains. More than 4 hours/day are spent in tasks directly related to agriculture, and for about half this time women work at a rate in excess of 3.5 kcal/min. We estimate that total energy expenditure rises by more than 300 kcals/day at this time, with most of this extra requirement having to be met from adipose tissue energy reserves. Total expenditure is somewhat reduced in Aug/Sept, the peak of the annual "hungry season", but fat mobilisation continues at a high rate because of the reduction in food intake. These large seasonal imbalances of energy intake and expenditure cause serious depletion of the relatively small maternal adipose tissue reserve, and also result in reductions in resting metabolic rate, the consequences of which are not at present clear. Perhaps the most important effect of seasonal food shortage is however the reduction in average birthweight which occurs at this time of year.

Seasonal food shortages occur because both stored food supplies and the cash derived from the sale of groundnuts in December are exhausted before the next harvest comes in. This situation has been exacerbated by several years of low rainfall and poor harvests, and perhaps also by a change in agricultural and dietary practices. Over the last 10 years an increasing amount of land has been used to grow groundnuts for sale rather than to grow millet and sorghum, the traditional staple foods. This has increased dependance on the purchase of imported rice during the dry season, supplies of which have, since 1983, often been irregular. This has caused local and sometimes acute food shortages from time to time.

One possible means of alleviating seasonal food shortage is to supplement "at risk" groups such as pregnant or lactating women. The Dunn Nutrition Unit has developed a low-cost energy-dense biscuit supplement which can be baked locally and which makes constructive use of aid foods such as dried skimmed milk which may otherwise go to waste. The supplement is effective in preventing seasonal reductions in birthweight (1), and may also reduce seasonal fluctuations in body weight, total body fat and resting metabolic rate.

It may be less desirable to supplement lactating women however, not only because supplementation failed to improve milk output, but also because of its effect in reducing the duration of post-partum lactational amenorrhea (8). Supplementation thus speeds the return to fertility and may potentially increase birthrate, a clearly undesirable change. Probably any supplementation programme should be allied to a simultaneous programme of birth control.

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Table 1. Subject profile

	mean ± SD
age (years)	25.9 ± 4.4
height (mm)	1576 ± 65
weight (kg)	51.0 ± 6.7
parity (live plus stillbirths)	3.8 ± 1.7
length of gestation (weeks)	39.2 ± 1.3
pregnancy weight gain (kg)	8.3 ± 3.2
birthweight (kg)	2.98 ± 0.32

details of the 50 women studied longitudinally during pregnancy and lactation are given, unsupplemented and supplemented subjects combined.

TABLE 2. The energy cost of "field" activities in rural Gambian women.

month	activity	kcal/min mean ± SEM	n	cal/kg/min mean ± SEM	n
April	washing salt at the salt flats	2.38 ± 0.20	4	41.6 ± 3.6	4
April/May	walking and bending cutting fencing sticks	3.00 ± 0.30	5	59.4 ± 5.7	5
April/May	sitting digging holes for fencing	3.36 ± 0.27	7	64.7 ± 3.9	7
April/May	standing tying fencing together	2.27 ± 0.12	7	43.5 ± 1.9	6
June	walking and bending clearing fields	3.74 ± 0.13	15	66.7 ± 3.6	12
June/July	bending digging with a short-handled hoe	3.73 ± 0.11	46	68.9 ± 2.4	42
June/July	standing digging with a long-handled hoe	4.63 ± 0.11	46	85.9 ± 2.1	46
June/July	standing covering rice seed after sowing	3.92 ± 0.21	14	68.7 ± 4.1	13
June/July	bending covering rice seeds after sowing	2.95 ± 0.17	12	56.1 ± 3.0	11
July/Aug	bending planting groundnut seeds	3.43 ± 0.44	4	68.6 ± 7.5	4
Aug/Sept	sitting or bending weeding rice	1.94 ± 0.03	89	36.3 ± 0.6	77
Aug/Sept	bending weeding groundnuts with a short hoe	2.77 ± 0.08	45	51.3 ± 1.5	40
Oct/Nov	bending harvesting rice with a knife	2.05 ± 0.05	27	39.1 ± 1.1	24
Nov	bending harvesting groundnuts with a spade	3.95 ± 0.13	26	76.4 ± 2.5	26
Nov	walking and bending gathering groundnut plants	3.45 ± 0.15	9	66.7 ± 3.0	8
Nov/Dec	bending harvesting vegetables	1.89 ± 0.13	6	37.2 ± 1.8	6
Dec	standing beating groundnuts	3.13 ± 0.07	25	59.8 ± 1.5	24
Dec	sitting sorting groundnuts after beating	1.60 ± 0.03	28	30.9 ± 0.8	28
Dec	walking and bending gleaning groundnut fields	2.40 ± 0.16	9	45.4 ± 2.2	9

Figure 1. The agricultural year

Activity	month(s)
fencing gardens	April/May
clearing	June
digging and planting	June/July
weeding	Aug/Sept
harvesting	Oct/Nov/Dec

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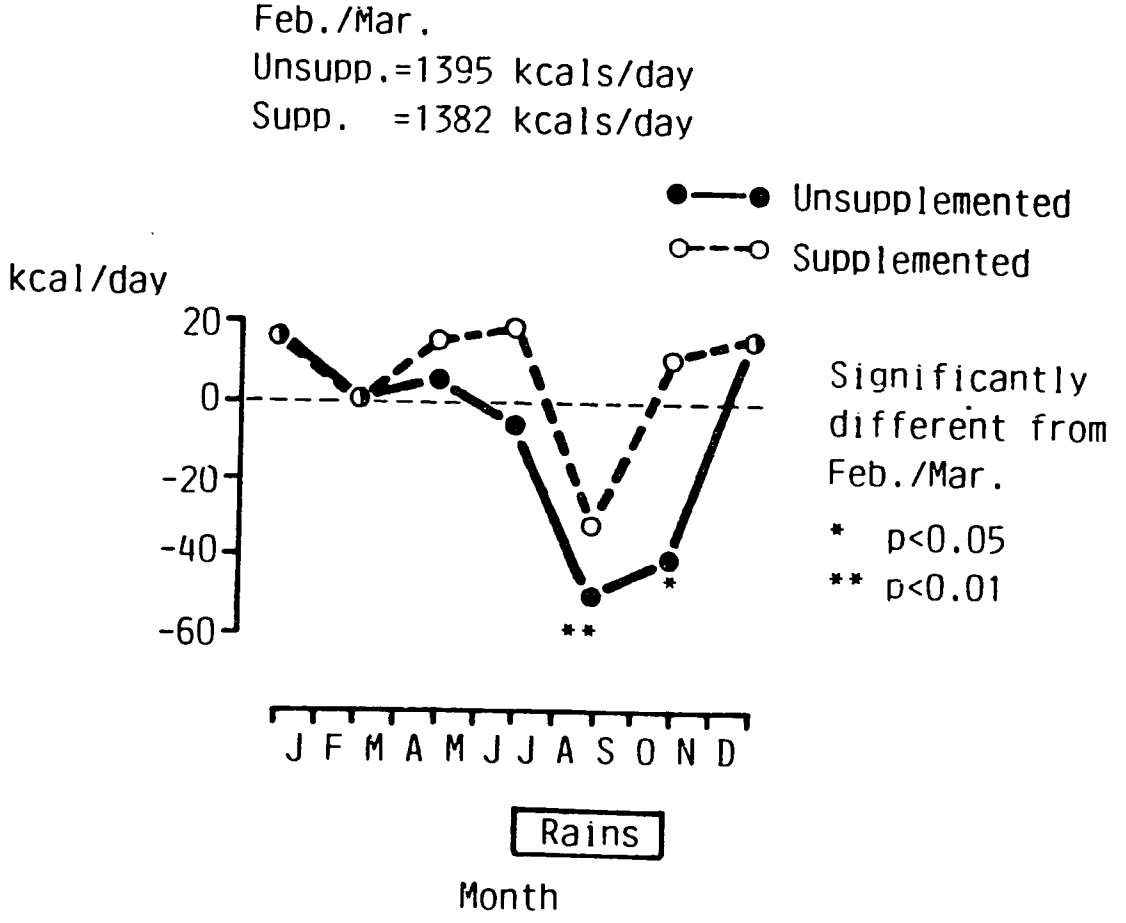
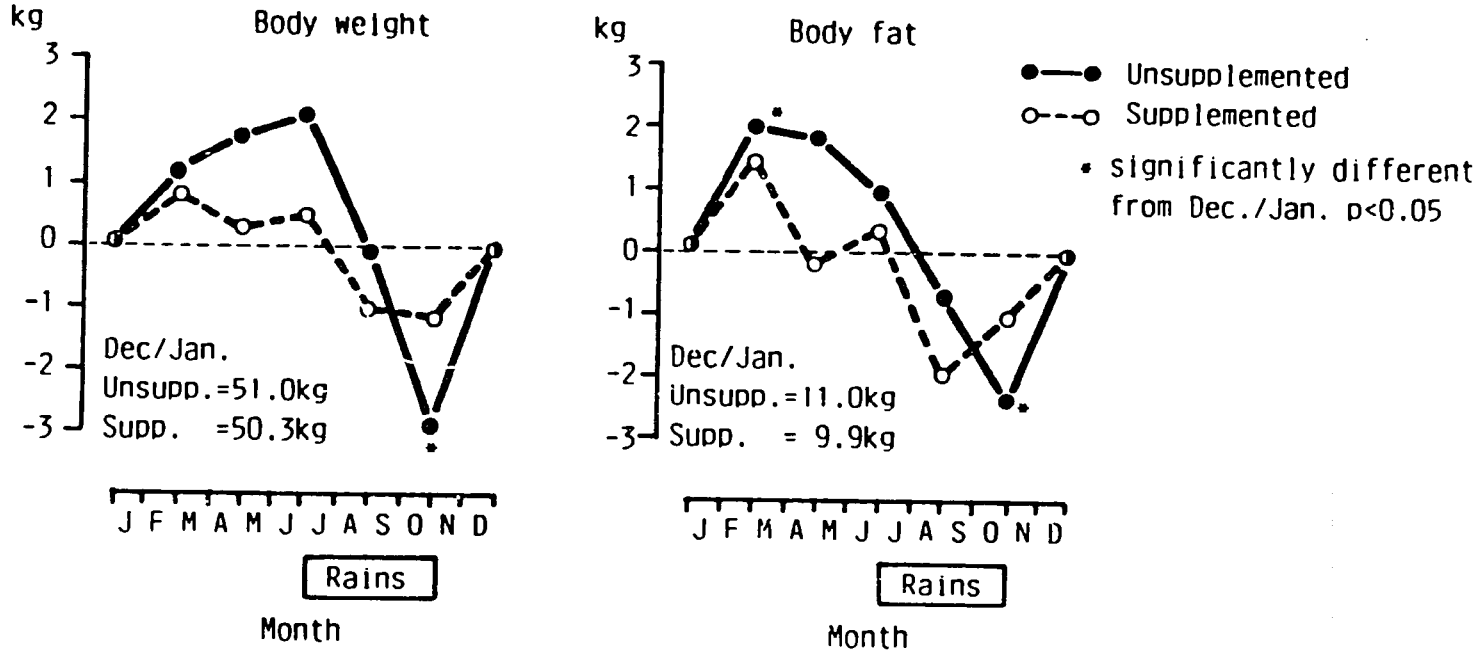
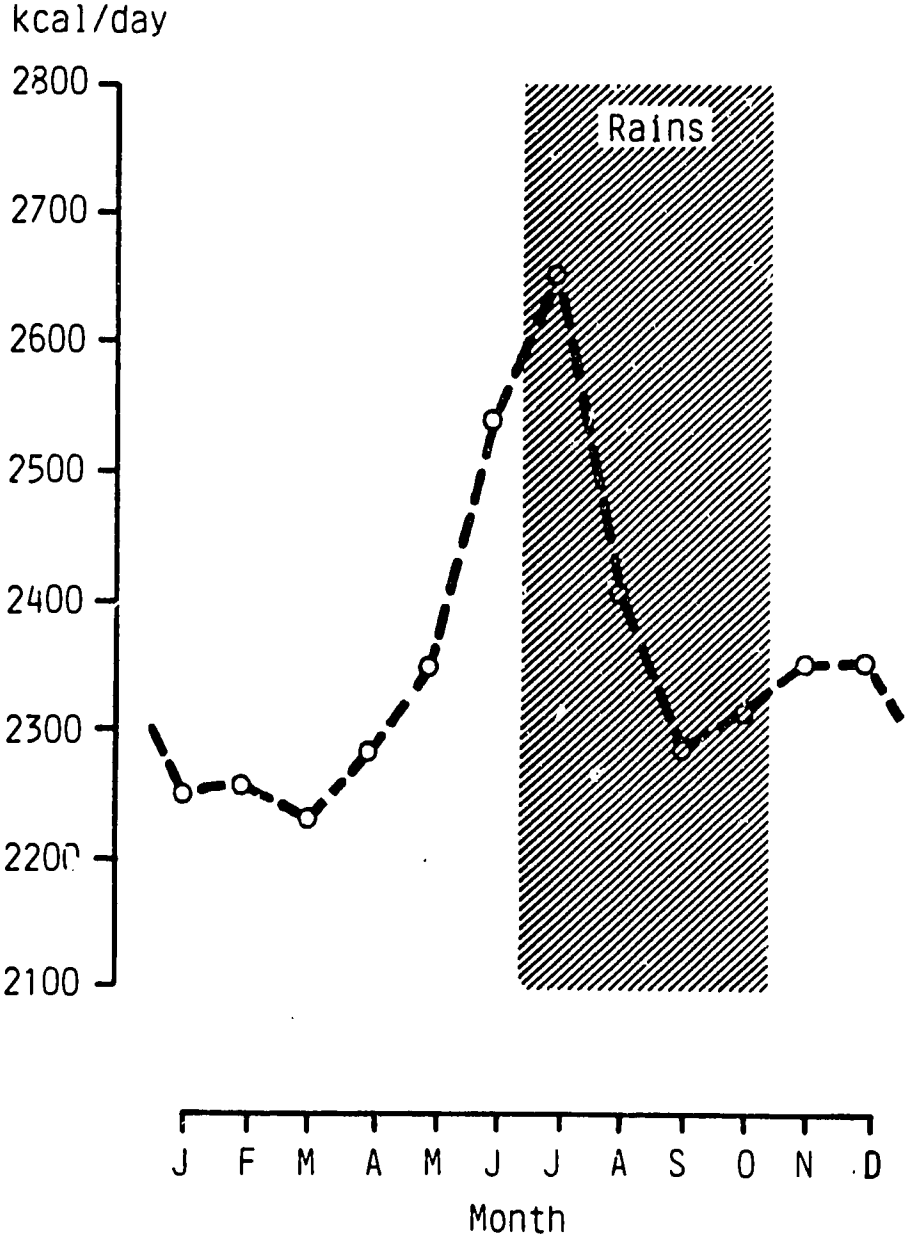
Seasonal variation in resting metabolic rate of rural Gambian women (adjusted for stage of pregnancy or lactation).



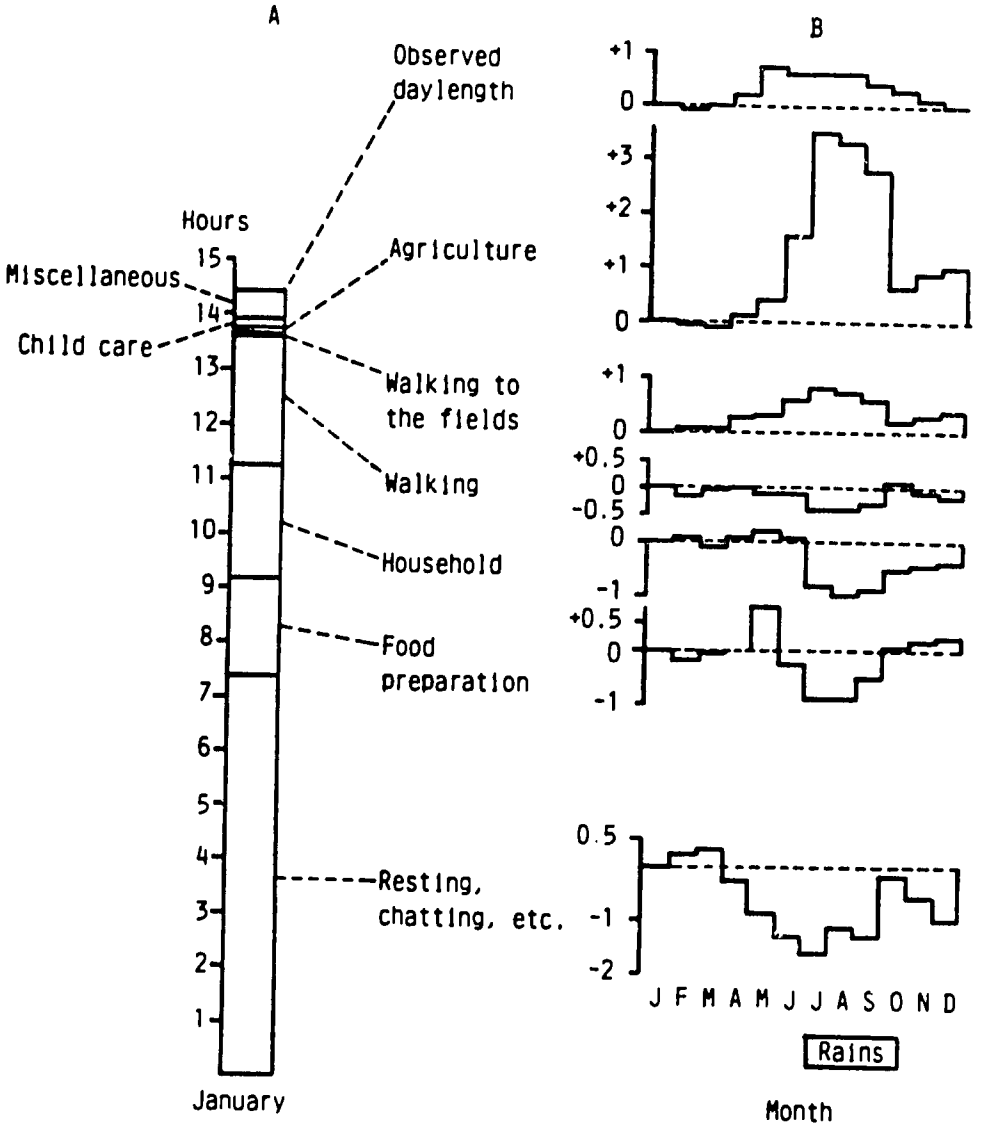
Seasonal variation in body weight and body fat content of rural Gambian women (adjusted for stage of pregnancy/lactation).



Seasonal variation in total energy expenditure of rural Gambian women (adjusted for stage of pregnancy or lactation).



Seasonal variation in the activity pattern of rural Gambian women (adjusted for stage of pregnancy or lactation). A - division of the day between various tasks in January and B - changes relative to January in months Feb-Dec.



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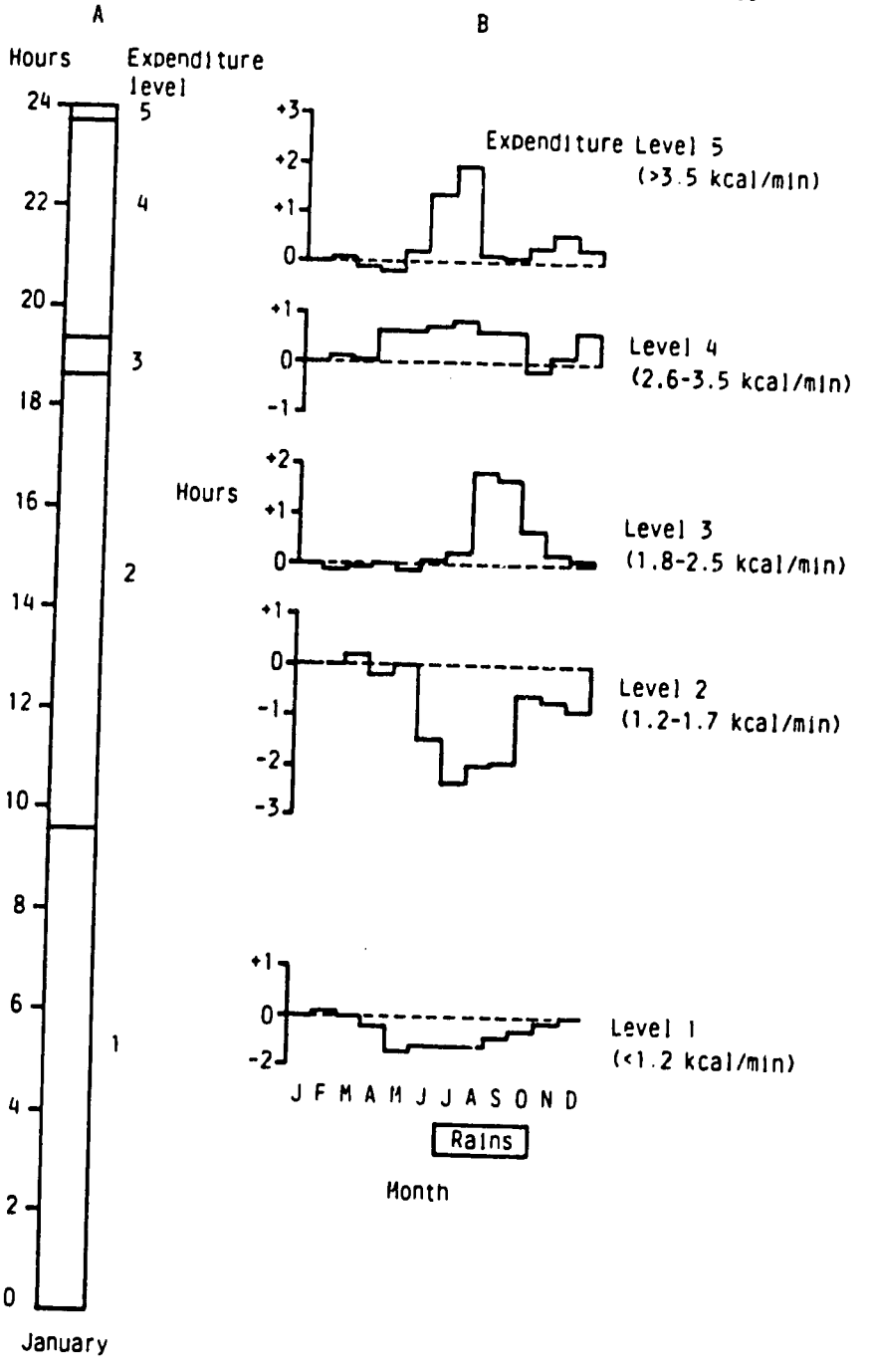
Seasonal variation in the activity pattern of rural Gambian women (adjusted for stage of pregnancy or lactation). A - division of the day between various levels of energy expenditure in January and B - changes relative to January in the months Feb. - Dec.



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Introduction:

In Bangladesh Seasonal differences in the availability and intake of food and the effect of seasonality in the nutritional status of people are now well recognised. Conclusive evidence is available on the seasonal variations in the intake of food and in the nutritional status of people in Bangladesh (US-DHEW, 1966; INFS, 1977 and 1983 Chen et al, 1981, Chowdhury et al, 1981, Brown, et al, 1982 and 1985, Abdullah and Wheeler, 1985) Intra-household distribution of food generally favours the productive adult male members of the household (INFS, 1977 and 1983) but little evidence is available as to whether the pattern of intra-household distribution of food varies with seasonal fluctuations in the availability of food at household level. It has been suggested elsewhere that intra-household distribution of food discriminates against women and young children and that in most developing countries this discrimination increases at times of shortage (Schofield, 1974 and Safilios Rothschilde, 1980).

This paper examines the seasonal variations in the availability and intake of food; in nutritional status in general, and in particular, in the intrahousehold distribution of food, in Bangladesh.

Sessons in Bangladesh:

Bangladesh is a small country of 144 thousand sq. Km and lies within the delta of three of Asia's largest rivers. Nine-tenths of the country is low-lying and delta plain. Although very small and homogeneous, there are considerable variations in the climate of the country. The summer months from April to June are followed by heavy monsoon rains from late June to September. The annual rainfall varies from 1500 mm in the west to 3000 mm in the north-east and south-east. The period from November to March is relatively cool and dry. Figure 1 presents a map of Bangladesh.

Food availability and the pattern and incidence of various infections diseases also vary according to seasons and they have differential effect on the intritional status of people.

Seasonal pattern of food availability:

There are distinct seasons of different crops grown in Bangladesh and relative abundance and shortage of food occur cyclically in relation to post-harvest and pre-harvest periods respectively of food crops particularly the rice. Figure 2 shows the harvest periods of the principal foods grown in Bangladesh.

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There are slight inter-regional variations in the harvest pattern.

Food in Bangladesh traditionally means cereals, especially rice, the availability of which is highly seasonal. The principal rice crop harvested in November-Mid-January is aman, which constitutes 60% of total rice production. Aus rice, harvested in July-August accounts for 26% and boro rice harvested in Mid-March-May provides 14% of the total rice production. The availability of rice peaks after the principal rice (aman)harvest and reaches to its lowest level in late September-Early November. This period is traditionally known as the "hungry" season in Bangladesh. Wheat is harvested in March-April.

Pulses are harvested from February through March and are more available early in the year. White and sweet pototoes are harvested from January through May. Fruits are almost entirely seasonal, the peak production occurs in May/June. Vegetables are available throughout the year although the availability diminishes in September-November when fish supply increases as the monsoon floods recede.

Seasonal variations in the availability of foods other than rice plays an important role in the dietary variety but contributes very little to the aggregate intake of macro-nutrients.

Materials and Methods:

Materials for this indepth analysis of seasonal variations in the intra-household distribution of food were generated in a longitudinal study (Abdullah, 1983) of individual food intake and nutritional status, conducted in a typical Bangladeshi central-west village during 1981-82 (Data from this study were published in the Amer. J.Clin. Nutr. 41:1985). The purpose of the study was to examine the differential allocation of food in relation to estimated requirements and also to examine whether the differential allocation puts women and/or young children at extra-risks at times of shortage.

Food intake was measured for three consecutive days in four different seasons of the year. All foods that went into the household cooking pots were measured and then each individual's portion of cooked food was weighed at each meal. The intake of snack foods was estimated at the end of each day by questioning.

A total of 53 households, each having at least one child under 5 years of age, were studied. Of the 53 households 31 were classified as 'poor' and 17 as 'better off'. Five households were relatively wealthy and were omitted from the analysis.

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Energy intake has been expressed per Kg of body weight. Analysis of variance showed significant difference ($P < .001$) in the energy intake of 'poor' and 'better off' women in the age group of 15-44 years but no socioeconomic difference in the intake of children under 15 years. The intake of children in the age groups of 1-4 years and 5-14 years have, therefore, been pooled and that of adults in the age group of 15-44 years have been analysed by socio-economic group i.e. 'poor' and 'better off'.

Two national level nutrition surveys of rural Bangladesh conducted at the Institute of Nutrition and Food Science (INFS, 1977 and 1983) have been drawn on for aggregated cross-sectional data on intra-household distribution of food and for weight data by seasons. Unpublished weight data collected in an ongoing longitudinal study being conducted at the Institute of Nutrition and Food Science (INFS, 1985) have also been analysed by month of measurement.

Other studies conducted in Bangladesh have also been cited to examine the seasonality of nutritional status.

RESULTS:

Seasonal variations in food intake (energy and protein)

For a general overview of the pattern of intra-household distribution of food, energy intakes by age groups and sex, as assessed in various studies conducted in Bangladesh, are presented in Table 1. Because of different age/ sex groupings in different studies,precise comparison is not possible.

Energy intakes by seasons and by age groups and sex have been plotted in Figures 3 and 4 to show the pattern of seasonality in food intake. Figure 3 clearly demonstrates the seasonal variations in the energy intake of adults (15-44 yrs). Analysis of variance showed that there is a highly statistically significant difference in the energy intak of both male and female adults (15-44 years) between the first and the second part of the year: the intake being higher in March/April and June than in September/October and December ($P < .001$). The difference between male and female is also statistically significant ($P < .001$). The intake of 'better off' women is also significantly higher than the 'poor' women. Except in June the 'better' off women and a 15-18% higher intake. There is no difference however, between the intake of 'poor' and 'better'offl male adults (15-44 years).

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Figure 4 shows a similar pattern of seasonality in the intake of children i,e, intakes are higher in season 1 and 2 than in seasons 3 and 4 except 1-4 year old girls who had highest intake in season 3. Analysis of variance did not however show any seasonal difference in the intake of children in any age group. As between sex there is no difference among the 5-14 year olds, but in the 1-4 year age group boys' intake was barely significantly higher than girls' ($.05 < P < .1$).

Superimposed on Figures 3 and 4 are protein intakes per Kg body weight. It is evident that the pattern of protein intake is almost the same as that of energy per Kg.

Figure 5 shows the energy intakes of adult women and children as a proportion of the male household heads'. The expected values of this proportion calculated from actual average body weights and FAO recommended intakes are also shown. Figure 5 demonstrates that relative to household heads the energy intake of women is remarkably constant throughout the year (Poor: 80-92.8% and better off: 86,2-88.7% of male heads). 'Better off' women had a slightly higher proportional intake than 'poor' women. In all the seasons women's proportional intake was above the expected range. The proportional intake of children between 5 and 14 years are within the expected range and no seasonal trend is noticed. Relatively lower proportional intake in season 1 (March/April) is expected in view of the fact that adult males had their highest intake during that period coincident with increased energy expenditure in agricultural activities and 'Food for Work' program. The proportional intake of both male and female children in 1-4 year age group is below the expected range, girls' intake being lower than boys'. No seasonal difference is seen in the intake of boys, but girls' proportional intake increased significantly in season 3 (September/October). In season 4 (December) also the proportional intake of girls (1-4) years) was higher than in seasons 1 and 2. Most interesting to note is the highest proportional intake of young girls in season 3 (the pre-harvest 'hungry' season).

Male-female differential in the energy intake of adults can be accounted for in terms of different requirements as assumed in FAO recommedndations. The intake of children in the age group of 5-14 years followed a more or less similar pattern as that of adults. Slightly lower intake in the second half of the year is not statistically significant. It is in the 1-4 year age group that the intake, compared to FAO recommended levels, was low in absolute terms as well as relative to household heads. Also in this age

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group girls received less than boys in all seasons, but their proportional intake significantly improved in the pre-harvent 'hungry' season (Season 3).

Seasonal variations in the nutritional status(weight fluctuations)

During the 1975-76 a . nutrition survey of rural Bangladesh (INFS,1977) anthropometric measurements were conducted in two subsistence farming villages of Bangladesh: one in the central-west (village 1) and the other in the North (village 2), at four different seasons. Weight data collected in this survey (unpublished) are presented in Table 2 by age groups, sex and months of measurement. Seasonal fluctuations in mean weights are evident. It appears from Table 2 that in village 1 the mean adult weight is slightly lower in July and November. Both these months are characterised by relative shortage in the availability of flood in the village. Harvesting of aus begins in July and that of aman in November involving extra-energy expenditure by working adults. While the intake is low (characteristic of the season) extra-energy cost of harvesting is likely to result in a reduction of weight in the adult (working). On the other hand adult women not doing any farm activity and not still being involved in post-harvest processing of rice are unlikely to lose weight unless severely underfed. Mean weight of adult women (NPNL) during pre-harvest hungry season does not suggest that they are discriminated against in the allocation of family food.

In village 2 mean weight of both adult men and women are higher in March and May. March is the post-harvest period in relation the major rice crop aman when intake was high and May is the pre-harvest period with regard to aus rice. The impact of low intake was to follow as in evidenced from the mean weight in early August when intake was high but the mean weight was lowest of the year. It is interesting to note that compared to August the mean adult weight was slightly higher in pre-harvest 'hungry' season in October when food intake was found to be the lowest of the year. This might possibly be due to diminished energy expenditure characteristic of the season.

Mean weights of children are higher in the pre-harvest 'hungry' season and during dry months (post aman harvest period). Lower mean weights in the rainy season can be attributed to higher incidence of infections characteristic of the season. Mean weights of children in the pre-harvest hungry season does not suggest that they are discriminated against the intrahousehold distribution of food.

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Weight of 0-6 year old children was measured in a longitudinal study being conducted by the INFS in a cluster of villages in the central-west of Bangladesh. Table 3 shows the percentage prevalence of wasting among the children weighed, by month of measurement. Wasting has been defined as- 2 S.D. and below of NCHS standard. Seasonal fluctuations in the prevalence of wasting is clearly seen. Among the 1-6 year olds the prevalence of wasting is low early in the year which then rises from March and persists through October and then declines. Lower prevalence of wasting during the period from November-February is evident.

In the 1-6 year age group, wasting is slightly higher among the female children throughout the year except in October (hungry season). In October 3.4% more boys than girls were wasted. The evidence lends support to the finding that young female children's intake improve during the period of shortage when they are preferentially treated in the intra-household distribution of food (Figure 5).

Seasonal fluctuations in the prevalence of wasting among the exclussively breast-fed infants and in the 6-11 month olds are quite marked but the pattern is inconsistent. On the whole the prevalence is high during the rains and low in early months of the year as well as during the pre-harvest lean season. Lower prevalence of wasting during early months of the year is supported by evidence in Matlab (Brown et at. 1982). Better performance in the pre-harvest hungry season may perhaps be attributed to better care of the children during this period when mothers have more free time. It is interesting to note that more boys than girls under 1 year are wasted which reverese by the time they are one year old. Sex-biased health-related behaviour, as suggested by Chen and his colleagues (1981) might possibly play some role in reversing the situation.

Figure 6 attempts to contrast weight changes between bad and good seasons. Relative to June more adults than children were found to be in negative weight balance in September (pre-harvest 'hungry' season) which indicates that the effect of seasonal food shortage is largely absorbed by the adults. As between sexes more males than females appear to have lost weight in the bad season (rains and low stock).

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Seasonal Pattern of diseases:

Infectious diseases causing wastage of the available nutrints are important determinants of nutritional status. The pattern and incidence of various infectious diseases vary across seasons. Data on seasonal pattern of disease incidence are however extremely meagre in Bangladesh. Black and others (1982) studied seasonal pattern of diarrheal diseases in two Bangladeshi villages and found that E.coli diarrhea occurs most frequently during April-September while the incidence of shigellosis is higher in dry winter months (Figure 7.a). Cross-sectional surveys conducted during the 1962-64 national nutrition survey (US-DHEW, 1966) show that the prevalence of diarrheal diseases among the children under 5 years af age is lowest in June, just before the begining of monsoon rains which then starts rising with the rains and peaks in November and persists through February at the same level (Figure 7.b). The pattern that emerged from the cross-sectional national survey is not consistant with what Black and his colleagues found in their two-village longitudial study. On the whole, incidence of various infectious diseases are considered to be high during the rainy season.

Discussion:

Bangladesh is predominatly an agranian country and the availability of food at household level is primarily determined by the cropping pattern because most of the rural households are directly or indirectly dependent on agriculture for their food supply. Household food situation improves after rice harvests. Stocks peak after the principal aman rice harvest in MID-November-January. Household food stocks are at their lowest levels in September-October. Overall food intakes have highly significant seasonal correlations: intakes being generally higher during post-harvest periods.

Seasonal variations in food energy intake of adult men and women (15-44 years) are clearly demonstrated. Figure 3 illustrates seasonal differences in intake per unit of body weight. Intake during the first half of the year is significantly higher than in the second half (P .001). Adult intake also correlates with activity pattern. High intake in March/April and June may be partly accounted for by high energy demanding activities characteristic of the season and partly by higher availability of food. Decrease in intake during the 'hungry' season in September-October is obvious. The season is also characterised by least

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agricultural activity. Relatively low intake in the post-harvest season in December is probably due mainly to slack agricultural activities during this time. Another explanation, not however investigated in this study, that people voluntarily ration their intake to stretch out the given amount of available food to cover a longer period, thus settling to low level of intake even during somewhat better periods (Simmons, 1976, Bharati and Basu, 1982), might as well be partly true.

Male-female differential in the food energy intake of adults can be accounted for by differences in their requirements as recommended by FAO. The differential remained almost constant in all the four seasons studied. Figure 5 clearly demonstrates this. Average proportional intake of women was above the expected range. Evidence does not support that the pattern of intra-household distribution of food is affected by seasonal fluctuations in the availability of food in so far as adult men and women are concerned The same is true of older children in the age group of 5-14 years. Minor seasonal differences are not statistically significant and there is no sex differential. It is only among the younger children (1-4 years) that there is a sex differential (.05 P .1). Boys received more food than girls although there is no sex differential in the FAO recommendations. Chen and others (1981) observed similar discrimination against female children in the 0-4 year age group in a cross-sectional dietary intake study conducted in four Matlab villages. The overall intake of both boys and girls was well below the recommended level throughout the year. The pattern of within-household distribution of good shows that the proportional intake of boys remained almost constant the year round but that of girls increased during the 'hungry' season in September-October. During this period their absolute intake also was highest of the year. The seasonal difference was not however statistically significant. Overall, despite significant seasonal variations in the intake in absolute terms, the pattern of intra-household distribution of food remains more or less same across seasons except in case of young female children in the age group of 1-4 years. Young girls tend to receive a larger share of family food at times of shortage. Most of the parents interviewed in the study think that young children are unable to withstand hunger and when family food is in short supply they have to be fed first even if the parents themselves are required to go hungry. Frequently parents would say that the girls would

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eventually leave their parental homes after marriage. So, they should be given preferential treatment in the allocation of choice foods. It is tempting to speculate that this kind of parental attitude might probably have resulted in the increased allocation of family food to young girls at times of shortage.

Anthropometric data presented show marked seasonal variations in the nutritional status. When food intake is low and work load high adult men tend to be in negative weight balance. Adult women on the other hand performing only light activities do not lose weight even during the hungry season (Table-2). Both men and women in the adult group do lose weight in the rainy season which is partly due to the higher incidence of infectious disease and partly due to reduced food intake. Weight fluctuations between bad and good seasons (in terms of food availability) shows that more adults than children lose weight through the bad season (Figure-6). As between sexes females tend to fare better during periods of shortage which is in consistence with the pattern of intra-household distribution of food. Prevalence of undernutrition (wasting) among the children are high during rains and low during early months of the year. The finding is afforded support by the evidence in Matlab (Brown, et al, 1982). However, relatively lower prevalence of wasting in the 'hungry' season is in contrast of Matlab evidence. Our finding that children fare well during the pre-harvest lean period is in accord with the evidence that children are given preferential treatment in the allocation of family food during periods of shortage. Recent findings of Brown et at (1985) that in general, the intakes of weanlings (in two Bangladeshi villages) declined during the monsoon period and increased in either October-November(hungry season) or December-January lends support to the evidence that the prevalence wasting is high during rains and low during the lean period (Table-3).

Empirical data presented in this presentation show that the seasonal patterns of intake-household distribution of food, and of prevalence and incidence of undernutrition and infectious diseases are neither fully consistent nor inconsistent. Generally speaking the pattern of intra-household distribution of food does not vary according to seasons but infections and malnutrition do. The effect of seasonality in the absolute dietary intake and in the incidence of infectious diseases is reflected in the nutritional outcome.

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Unresolved questions such as why do young children not receive the share of family food which the theoretical estimates of requirements would prescribe and why young girls receive a lower share than young boys; is it due to the lack of parental perceptions about the food needs of young children; are yet to be answered. Although there is no sex discrimination in the adult, as far as energy intake is concerned, yet it remains to be explored whether qualitative discrimination puts the women at extra-risks in terms of micro-nutrient intake. Relationship between seasonal fluctuations in food intake and seasonal changes in nutritional status is yet to be established. More longitudinal studies under differing ecological and socio-cultural conditions are needed for precise quantification of the effect of seasonality on intra-household distribution of food, infectious diseases and untritional outcome so as to identify the right kind of counterseasonal measures.

Introduction: Nutrition and Seasonality

During the past few years the many ways in which the seasons of the year affect the lives of peasants have come to provide a common focal point for the attention of scientists and practitioners from a broad range of disciplinary backgrounds. For many people, including no doubt (had they been asked) the peasants themselves, it must have been almost beyond comprehension that such an intrinsic aspect of human existence as the cycle of the seasons, actually needed to be drawn to the attention of professionals concerned with the problems of food and poverty. However, with some notable exceptions, this clearly was the case. Robert Chambers (1983) has described the area as a new "professional frontier" and the phenomenon of neglect as "seasonality unseen". As Chambers suggests the reasons do lie in the barriers created by specialisation, and in the biases of perceptions (often the results of the adverse effects of the seasons themselves) conditioned by difficulties of access and contact between researchers and peasants. The position in which we now find ourselves is more serious than just blindness towards a certain kind of problem: the neglect - in nutrition certainly - has been so total and so long in duration that to some extent we even lack the theoretical and conceptual frameworks necessary for analysis. Thus, whilst we can now say that the phenomenology of seasonal effects on health and nutrition is established, indeed is beginning to show an astonishing richness and extent, we cannot do much more than sketch the outlines of the theory that will be needed to take account of these processes in framing policy: specifically to develop key indicators for detecting hunger and for quantifying seasonal malnutrition. In particular to enable us to take account of the dynamic effects of cyclic changes in physical function in assessing the performance of food production systems.

It has been traditional to assess food adequacy from the standpoint that equilibrium between energy intake and output is a normal and desirable condition, and that temporary disequilibrium can be dealt with by averaging intake measurements over some suitably extended period. The result is then to be judged by comparison of the mean value with a set of normative standards. However, the added interest which a concern for seasonality has brought, for example, to the study of the energy requirements of reproduction (Roberts et al., 1982; Lawrence et al., 1984) has shown that in Gambian women, normal strategies for dealing with the combination of seasonal food availability, and the changing requirements of pregnancy and lactation are complex, and continuously by changing over time. They include adjustments of energy expenditure on work as well as of basal metabolism. These authors conclude, very reasonably, that "FAO/WHO-recommended intakes during pregnancy and lactation are 'inappropriate' for this community". The problem of course is that the whole armamentarium of recommended intakes, and of techniques for measuring and comparison of consumption patterns with respect to these standards, is premised upon the normality not only of the levels chosen, but of a steady or quasi-steady state of equilibrium. If the 'normal' state is one of a dynamic disequilibrium, with repeated cyclic adjustments over a range of values, then we shall need more than just 'appropriate' levels of recommended energy intake in order to establish whether and when seasonal effects contribute to malnutrition. Apart from food intake, nutritionists for the most part rely on growth, or changes in body weight, as indexes of nutritional status. Billewicz and McGregor (1982) in the Gambia, and Black et al. (1982) in Bangladesh, have described the influence of seasonality on growth patterns of children, and on adult body weight. These, and many other studies, illustrate the 'normality' in rural people of dynamic seasonal changes in the measurements

which are conventionally used to assess nutritional status. In the Bangladesh studies, in particular, in addition to cyclic changes over time, the two measurements, height and weight, are shown to be affected differentially with respect to the phase of the seasons, so that even the so-called 'age-independent' ratios such as weight-for-height and weight/height^2 display regular seasonal cycles. Again, there is currently a dispute amongst nutritionists about the 'appropriateness' of international reference standards for growth. But even if local standards were to be adopted, how would we interpret those fluctuations in magnitude in time and in phase? It is perhaps only partly coincidental that just as we have reached the stage of needing to address the questions of how to define seasonal malnutrition, what, if any, are its long term consequences, and what indicators could be used as a guide for policy? We discover that a good many professionals are in a state of uncertainty about what we mean by the term 'malnutrition' anyway.

Thus it is almost universal practice to refer to anthropometry as a technique for measuring 'nutritional' status, and to equate poor growth in children with 'malnutrition'. However, although the growth of small children certainly provides a very sensitive indicator, with the passage of time it has become less clear exactly <u>what</u> it indicates. For example, Grantham-McGregor, writing in 1984, says:

> Currently there is much confusion about the diagnosis and classification of malnutrition. Terms such as kwashiorkor, marasmus, 'moderate' and 'severe' malnutrition are used indiscriminately by different researchers. Some of these terms represent quite different clinical conditions which are probably associated with different social backgrounds...
>
> A further problem is that the diagnosis of malnutrition does not reflect aetiology, and malnutrition is generally caused by a combination of inadequate food intake and infections. It is not clear exactly how important the role of infection is in the aetiology of malnutrition.

Evidently, in this quotation, the word malnutrition is used to describe <u>both</u> the general concept and the specific measurement of growth deficits in children.

In addition to these semantic problems there is a major controversy about the significance of adaptive changes in food intake and body size. One faction asserts that the consumption patterns, and growth rates achieved generally in developed countries, reflect genetically determined optimum performance, and that lower intakes consumed by smaller people in poor countries must be suboptimal and therefore constitute a nutrition problem. This leads to views like that of Gopalan (1980) who says that the fact that child mortality and morbidity are strikingly lower in the state of Kerala than they are in the Punjab is evidence of great progress in 'social' development, but that the smaller size of the surviving children in Kerala means that there is more malnutrition there (twice as much in fact) than in the Punjab. Gopalan rejects the opposing view, which is that people can adapt to different environments so as to be 'small but healthy', and that it is the general levels of risk imposed by the different environments which constitute the problem for policy makers, rather than the smallness per se. Both factions do, however, agree that there must be some degree of growth retardation which is so severe as to be beyond the limits of safe adaptation so that such individuals do suffer

increased risk of early death or permanent disability. These conflicts and contradictions have been building up for some time, and the recognition of the hitherto 'unseen seasonality' serves only to highlight the uncertainties.

For the purposes of this paper, this means that we have to begin with a discussion of current theories about nutritional status, nutritional adequacy, and malnutrition. The most critical issue which divides the theoreticians is that of individual adaptability: to what extent can the adjustments in metabolism, body size and behaviour which individuals make in accommodating to changes in their environment be regarded as cost-free, or adaptive in nature, rather than pathological? Obviously, a crucial question if we are concerned with distinguishing 'malnourished' from 'normal' individuals in populations whose situation is relatively static, even more so if those adjustments are being driven by regular seasonal changes. As we shall see, the resolution of this apparently straightforward question is by no means easy. Indeed, it raises some philosophical issues which do not perhaps permit a general solution. Thus, the notion of the 'cost' of adjustments or accommodations turns out to have two alternative meanings: in a biological sense the cost of a change would need to be measured by the extent to which it reduces inclusive fitness, i.e. the overall chances of survival of the genotype as distinct from the individual: in the sense of social valuation, however, the costs would need to be assessed either in economic terms, as the value of total output foregone, or in relation to the quality of life, in terms of individual or social values - and these will of necessity vary between different economic and cultural contexts.

Even bearing in mind that malnutrition is likely to emerge as being as much a social construct as a biological state, it is still necessary to develop a dynamic framework for analysis if the further implications of seasonality are to be included. The literature on nutrition and health and development abounds with various models describing the interactions between different environmental factors - food, disease, psychological and physical behaviour etc., and the nutrition/health status of an individual. Whilst, for the most part, the intention of these is the communication of ideas about dynamic processes and interactions, they cannot easily be extended in such a way as to increase intuitive understanding of how these will be affected by repeated cyclic changes. We shall need to develop new kinds of models to do this, and these will have to be of a kind which will allow us to test new ideas and hypotheses by simulating time changes. Although many other disciplines have a long tradition of the use of simulation models as aids to research and application, this is not so far the case with nutrition, and there is very little on which to build. What is described later is therefore to be seen as a very tentative first step in putting together a few of the concepts of nutrition, of work physiology, and of the seasonal relationships in food production. To the extent that we have some confidence in these, we can then see how they interact when we 'run' the model through a simulated time sequence. The results of doing this are so far of heuristic value only - not predictive in the sense of giving policy-relevant statements about the future of particular real production systems. They do, however, provide a new perspective from which to look at some case studies of actual situations, and hopefully to get some clues as to where to go next.

Finally, as to 'hunger' as distinct from malnutrition, there is perhaps even less which can be said usefully. Again, we find a confluence of ideas from many different directions - hunger as a euphamism for want and deprivation and hunger as an expression of appetite, and hence connected with the biological regulation

of energy balance. It is self-evident that seasonality will have implications for all of these and there is plenty of descriptive evidence that rural people know hunger at some seasons and have customs, often involving the use of drugs, to ammeliorate its sensations. Conversely, children who become ill with infectious diseases often fail to respond precisely because a lack of hunger reduces the level of stimulus and response between child and parents, and hence to a reduction in care and attention just when it is most needed.

Theories of Malnutrition

The following is a description of two 'theories' about the general nature of the processes by which biological regulation and hence the state of nutrition is maintained. If these seem to be presented in a starkly contrasting fashion, this is in order to convey more effectively the consequences of the different hypothetical assumptions which underlie the theories. This should not be interpreted as excluding the possiblity that the truth lies somewhere between the two. The two theories have been described by Payne and Cutler (1984) as the 'genetic potential' and 'adaptability' models. Firstly, the genetic potential model, which probably represents the conventional and certainly the most widely held view about malnutrition. This is the logical development of an assumption that the actual condition of an individual in respect of functional performance is the result of a conflict between the tendency of the body to revert to a 'normal' or preferred state, and the displacing effects of the environment - food supply, work stress etc.

The body is conceived as a system which is not only self-regulating, but self-optimising. For each individual there exists a preferred state characterised by a unique set of values of all of the variables which describe the system components (weight, height, blood levels etc.). This state is an optimal one in the sense that all of its functional aspects taken together are such as to maximise its fitness. If there are no constraints on diet, or continued adverse environmental influences, an individual will always tend to seek out and return to that preferred state, or in the case of children, a preferred 'road to health' or pathway of growth and development. Individuals differ from one another with respect to the values of the component variables which characterise their particular preferred state, and with respect to the levels of performance of which they are capable when at their own particular optimum states. These interindividual differences are inherent and result from differing genetic constitutions. Individuals who are prevented from returning to their preferred state, because of dietary or other constraints, are regarded as malnourished in the sense of being in a non-optimal condition. Malnourished states can be detected and graded for severity by the extent of deviation of one or more state variables from those which characterise the preferred state.

The implications of this model are:

1. Nutritional status is made consonant with the current widely held view of health as a positive condition, and not simply the absence of recognisable disease. It is important to note that the performance of a malnourished individual could be either affected currently with respect to some existing challenge, or could imply a reduced potential for dealing with some future situation such as an increased demand for work, for resisting an infection, for a psychosocial response etc. That is to say malnutrition results in both sub-optimal responses to current stresses and to increased risk of failure at some future time. Not only are children in Kerala pronounced to be malnourished

simply because they are smaller than they could be: in terms of the 'human capital' paradigm, their present condition is also a measure of future human capital foregone.

2. If, as the model proposes, individuals with no food constraints automatically assume their preferred states of nutritional health, then studying healthy populations will provide us with normative values of variables - body dimensions, growth rates, blood levels etc. - which can be used as reference levels for indicators of nutritional status. The range of interindividual variation of these in well-fed populations can be taken as valid estimates of the extent of normal variation in genetic constitution. It is implicit in most applications that these normal values and ranges can be applied to cross-population comparisons.

3. One or more of the state variables can be used to establish nutrient requirements on an experimental basis by finding the lowest levels of intake needed by a sample of individuals to maintain those chosen indicators at their preferred (i.e. optimum) levels.

4. The procedure for quantifying malnutrition in a population is then, in theory at least, straightforward. We may either count the number of people who have values of status indicators which depart so much from the normal reference values as to imply that those concerned are more likely to have made some adverse adjustment to a constrained food supply than simply to have unusually low preferred values (e.g. take as being malnourished all people who have body weights less than two standard deviations below the reference mean). Alternatively, we could measure food consumption and count as either the current, or likely future malnourished, all those people whose intakes are so low as to be more likely the result of food restriction than to their having unusually low requirements for the maintenance of their preferred states.

While this seems fairly to characterise the main features of the conventional view, it would not be correct to imply that these principles are universally explicit. The problem, however, is that with some notable exceptions (e.g. Frank, 1984; Margen, 1984; Seckler, 1982, and Sukhatme, 1977) they are frequently implicit, in the way data is analysed, and in the way research projects are formulated. Thus, the development of various 'classifications' or grades of malnutrition in terms of anthropometric measurements, implies not only that there is an underlying continuous gradation of effects, but that measurements of current states of individuals can provide information about differential causes. It is usual to express measurements of height, weight etc. as percentages of international growth standards, and there are in fact perfectly sound practical reasons for doing this, connected with grouping data from children of different ages. However, these standards are based on measurements of 'healthy' children in developed countries (usually the USA). No amount of protestation (e.g. Waterlow et al., 1977) that these are to be regarded as <u>reference</u> values rather than targets can really correct the impression that any continuing deficits below the standard are evidence not only of adjustments to adverse or sub-standard environments, but are, as Gopalan so strongly asserts, a measure of the irretrievable loss of human capital.

In research design, the very notion of seeking for evidence to show how marginal malnutrition 'causes' functional defects in terms of morbidity, cognitive development, social competence etc., neatly expresses the main features of the theory. When interactions and causal sequences are acknowledged, various

analytical strategies and models are adopted in order to attempt to distinguis the 'specific' effects of food intake, from other variables. This notion of t separability of effects of different explanatory variables on specific outcomes provides theoretical justification for the current emphasis on impact evaluation of nutrition interventions.

The adaptability theory inclines to the view that an individual's genes do not in fact uniquely determine his or her characteristics in any simple way, rather they define the range and nature of adaptive adjustments that the individual can make in response to the environment, food supply etc. A young child will respond in a relatively reversible fashion to dietary changes and may, for example, follow a period of reduced growth by a fast 'catch up'. With increasing age, this potential for fully reversible responses is reduced, and growth becomes more and more 'programmed' on to a relatively less flexible course. This means that adjustments to changes can be both short term and reversible, but also long term and relatively irreversible, and that we can expect to find groups of people who have on average different patterns of physical characteristics and capacities from those of other groups living in different environments.

Looked at in this way, plasticity, i.e. the capacity to change through interacting with the environment, is itself a characteristic of fitness. It is the way the organism responds to information about the outside world, the levels of disease, food supply etc., which are current and which are likely to be encountered in the future. The process of interaction and the plasticity of response can occur over time spans beyond one generation. Lighter and shorter parents tend to have smaller, slower growing children, and these in turn do likewise. The reverse effect can also take several generations to complete, as we know from the experience of developed countries, where even with increased social mobility it has taken about four generations to reduce body size differences between socio-economic classes. The fact that children under the age of five years, regardless of origin, show a similar range of capacity to respond to their environment by changing growth patterns with a degree of reversibility, simply means that up to this age plasticity is retained. Finally, the adaptability theory replaces the idea of 'fitness' of the individual by that of inclusive fitness in the evolutionary sense. This is achieved through sets of characteristics and functional levels which maximise the chances of genotype rather than simply individual survival and reproduction.

The model for adequate nutrition, which results from these concepts, contrasts with the genetic potential theory of malnutrition in the following way.

1. The body is still viewed as a homeostatic self-regulating system whose state can be measured in terms of such variables as body size, growth rates, levels of various food constituents etc. However, there are no preferred values for any of these variables, nor is there any internal reference which defines an optimum set of values to which the system will always tend to return.

2. The body can adapt to a range of different diets and environments, and the levels and sizes of the various components in any particular circumstances are a reflection of the adjustments that have taken place in order to achieve internal stability.

3. The state of nutrition (i.e. the sizes, levels etc. which characterise the adapted individual) and the amount of food needed to maintain that state, are

thus the outcome of the relationship between the individual and his or her environment. Also, since the food available will generally depend upon the pattern and level of work done on the environment by that individual, we can say that food requirements and states of nutrition are aspects of the human energy costs of production of food and other essentials. These complementary relationships are obviously modified by the health environment. Therefore if in addition the individual is part of a social group, these health relationships will themselves be modified by the extent of entitlement of the individual to a share of the social product of the group in the form of health provision, collaborative work, collective insurance against risks and hazards etc.

4. It is accepted that individuals are likely to vary one from another in some important respects. Firstly, in their capacity to adapt, i.e. in the magnitudes of the adjustments they are able to make in response to environmental stresses without risk of physiological breakdown and subsequent death or disability. Secondly, in the efficiency with which they convert food to work. Thus some people may need more or less food than others in order to take up the same production possibilities: and some may be better able to exploit the potential or more extreme environments.

The contrasts between this and the more conventional viewpoint are now clear. Firstly, the differences in body size between children (and for that matter adults) from different socio-economic environments, are to be interpreted as indicators of the overall effects of those environments since they show how much adaptive adjustment has been made by individuals living in them. To the extent that environments which result in adaptations towards small size or low food intakes frequently also carry increased chances of adverse events: infectious disease, recurrent poor harvests or other discontinuities of food supply, loss of employment, breakdown of inter-personal relationships etc., it is to be expected that people living under such conditions will often be small in stature. Thus we should expect to find a larger proportion of children in socially disadvantaged households who are small for their age. In just the same way as we should expect to find that a larger proportion of such children would perform less well in tests of psychosocial capacity and responsiveness. We should not, however, infer a causal connection between the smallness and the poor performance, and we should thus be very cautious about using smallness as a measure of deficit in functional performance.

The adaptability model evidently does not say anything directly about malnutrition. This is to be regarded as the result of failure to maintain homeostatic control, and happens when an individual is forced beyond the limits of his adaptive range.

The condition of being malnourished is thus the end point of a more or less catastrophic transition or system failure, rather than simply being in a range of sub-optimal states. An implication of this kind of catastrophic process is that it is inadvisable to draw inferences about 'first causes', or the existence of common causal sequences, by demonstrating associations between the frequency of malnourished individuals and various environmental factors. This is because the end point might be reached through any one of many different sequences of events. For example, one effect of an infectious disease is often to reduce appetite and hence depress intake of food. But if low intakes then act on the body so as to increase the severity of the effects of disease, or if the infection itself increases food requirements, what we are likely to see is a self-reinforcing process which might be triggered either by an episode of

infection or of food restriction.

Similarly, the first effect of a period either of illness or of food shortage might be to impair the capacity of an adult for physical work. If this happens at just the critical time when hard work has to be done to prepare ground for the next crop, or at just the only time in the year when scarce employment becomes available, the outcome would be the same - the initiation of a self-reinforcing process whereby the capacity to produce food or cash is reduced to the point where hunger threatens to damage the health of perhaps an entire household. The difference of course is that in this case the 'system' which breaks down includes the network of components of food entitlement of the household as well as the physiological regulation of its members.

It is important to say that to my knowledge there is no evidence so far which could be used to refute either theory. It has been suggested by Rand, Scrimshaw and Young (1979) that the validity of the adaptability model is dependent upon the existence of autocorrelation - which they claim not to find. However, autocorrelation is a necessary feature of <u>any</u> active regulatory system, i.e. of both models.

However, the following statements by two people who represent the most polarised positions are quite an impressive illustration of the divergent policy implications of the two models. The first is by Gopalan (1980):

> "We have therefore to conclude that during the last 30 years, in spite of all our advances in the agricultural, industrial and technological fields, and in spite of several 'applied nutrition programmes' and 'supplementary feeding programmes', we have not really made any significant dent on the problem of malnutrition in our children. We have reduced infant and child mortality to some extent and we have thus 'saved' many children whom, otherwise, the merciful hand of death would have removed. There is thus an increasing pool of survivors who have escaped death but who exist in a substandard state of health and nutrition with permanent impairment of functional competence and productivity. The result is a progressive erosion and deterioration of the 'quality' of our human resources."

He goes on to say that on the basis of physical size, only some 15% of children born in India are destined to become "truly healthy, physically fit, productive and intellectually capable citizens of the country". The contrasting statement is from Seckler (1982):

> "... except where people are in clear and present danger of functional impairment due to malnutrition, interventions should be targeted to poor environments and not to poor individuals. Once the environment of small people is improved, their size will take care of itself. Until their environment is improved, their size is best left to take care of itself."

For Seckler then, the size of the problem of malnutrition, considered as a public health need of a proportion of the young child population of India, is literally the complement of Gopalan's. One says that 10-15% are severely growth affected, and therefore actually malnourished. The other, that only 15% are nutritionally healthy and free of the risk of functional impairment.

Seasonal effects on growth obviously assume quite different significance depending upon which of these views is accepted. Black et al. (1982) describe their longitudinal studies of child growth as suggesting that because the repeated checks to growth imposed on a child become progressively less reversible with age, this 'ratcheting' effect is an important mechanism resulting in an accumulation of growth deficits throughout the whole of childhood. For Gopalan this might well mean that a reduction in seasonal growth checks ought to be a major objective of public health policy as a contribution towards dealing with the problem of the 85% who exist in a substandard state of health.

A further direct consequence of the neglect of the subject of seasonality is that of the huge numbers of studies of the growth of children in relatively affluent societies, very few have been analysed for possible seasonal effects. There is nevertheless strong suggestive evidence that growth is seasonal even in the absence of any reason to suspect fluctuations in food supply or general welfare. Thus, Dugdale and Eaton-Evans (1985) studied a sample of 1,000 infants born in Brisbane, and compared the 'summer' and 'winter' weight gains during the first to third month of age. They found significantly slower growth during the winter months. Brisbane is a city with a subtropical climate (latitude 27°S), and by European or North American standards, Brisbane's winters hardly qualify for the name. There are, however, shorter days and lower temperatures than in summer. Griffiths (1985) has recorded daily weights for 2 year periods of a group of pre-school and early school age children of professional parents living in London. All show signs of a marked 'staircase' effect of the season of the year on the course of weight gain. In some individuals growth virtually ceased for 3 month periods, resulting in crossing of a number of percentiles of standard NCHSS growth charts. An effect just as great as observed by Billewicz and McGregor (1981) for Gambian children. The slow growth period of the children in London was in summer, and although this might be taken as a reflection of what the British call summer, the difference from the Brisbane results serves only to underline our ignorance. This is not the place for an exhaustive review of what is known about the direct biological effects of temperature and day-length on growth and metabolism. However, it is well established that a number of animal species, for example, deer and sheep, as well as some smaller animals, show regular seasonal cycles of food intake, resting rates of energy metabolism, and growth. Thus in sheep and deer, growth over the first few years normally has a staircase pattern - rapid in summer and slow in winter. These effects are not mediated through food supply - they persist even under controlled conditions when food is constant in composition, and access is unlimited. They can, however, be shown to be set in train by changes in day length: longer summer days produce more rapid growth, higher rates of energy metabolism, and greater voluntary food consumption than short winter days. The organ responsible being the pineal gland.

The picture is thus incomplete and inconsistent with respect to timing, and therefore likely causes. Nevertheless, there remains the strong likelihood that a significant component of the seasonal growth disturbances we see in developing countries will be found to be due to factors other than lack of food or the incidence of disease.

In view of all these problems of interpretation, it is clearly not possible to make any effective commentary on the general problem of the public health aspects of child growth, as an indicator of malnutrition, let alone to contemplate the additional factor of seasonality, whilst still appearing to

remain indifferent as between the widely divergent theories about the significance of adaptive responses. I have to say at this point therefore that I am inclined towards the adaptability perspective. This is partly on the grounds of general consistency with the rest of biological theory, but also because the evidence regarding associations between growth status in children, or body dimensions in adults, and functional capacity, generally seems to point to relatively small, or often zero, functional losses accompanying a certain range of adjustments of growth or size: but very significant penalties resulting from growth deficits beyond a certain degree. In other words, the relationships are either found to be very non-linear, or else to exhibit a 'threshold' effect.

Growth, health and malnutrition

The aspects of function for which we have some evidence are: susceptibility to infectious diseases; ability to combat and recover from infectious episodes; cognitive development; physical work capacity; and in the extreme, ability to survive.

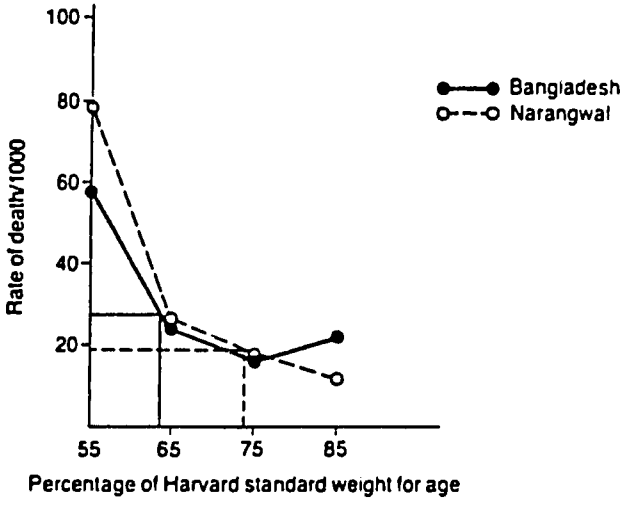
The clearest evidence we have is about the last of these - survival. Figure 1 shows the relationship between prospective risk of death, and of body weight as a percent of standard weight-for-age in young children in Bangladesh (Chen et al., 1980), and in India (Kielmann and McCord, 1978). The latter suggests a non-linear graded response, rather than a clear threshold effect. However, with the kind of data available, the analysis of risk functions is more a reflection of the prediliction of the analysts for one kind of model over another, than of any real ability to distinguish continuous from discontinuous relationships.

Tomkins (1985) has reviewed the evidence for the nature of the relationships between infectious diseases and growth. Firstly, with respect to incidence, e.g. the frequency with which children with different levels of growth performance suffer illness. For measles, diarrhoea and pneumonia, there seems to be no relationship between incidence rates and any of the anthropometric indicators, except for the possibility that growth deficits caused in the first place by measles may be subsequently followed by increased susceptibility to other infections, notably diarrhoea. There is, however, evidence for higher rates of incidence of diarrhoea in severely growth effected children.

With respect to severity and duration of illness, again the evidence seems to point to none, or only slight differences between normal and mildly growth-affected individuals, but very markedly worse effects on the severely undergrown, particularly for the important childhood diseases such as measles and diarrhoea. The one exception to this pattern seems to be that of duration of the infection, and this is with respect to diarrhoea: even moderate growth reduction is associated with prolonged symptoms (see, for example, Black, Brown and Becker, 1984a). The problem of interpretation of this, however, is the causal sequence involved: diarrhoea results in reduced absorption and, amongst many other effects, often inanition as well. Prolonged attacks are thus as likely to be the cause as the outcome. This introduces a further complication with respect to understanding the effects of seasonality. Black, Brown and Becker (1984b) describe the seasonal incidence of diarrhoea, and of corresponding checks to growth, and in addition show reduced food intakes co-incident with the peak of incidence of infection: it is, however, impossible to say which is the initiating event.

Figure 1

Relationship between body weight and prospective risk of death in Indian and Bangladeshi children



90

Tomkins' final conclusions about infection and malnutrition are that:

> "The implication is that families with malnourished children are usually the underpriviliged families with greatest difficulties in obtaining employment, food, potable water, decent housing or access to even the most basic medical care facilities. It is at this stage (i.e. analysis of nutrition in relation to outcome of infection) that the signficiance of PEM* as a risk factor for infection is seen not just as a biological influence on immune response or physiological function during an infective process, but as a marker for those who are without sufficient power to survive in the environment."
>
> If we add to this the evidence that severely growth affected children, whatever the cause, are clearly at high risk and in need of priority remedial treatment, we have a general statement which parallels and complements that of Seckler.

One thing which emerges most clearly from all of these observations and research is the highly complex nature of the interactions which define the relationship between disease, nutrition and growth. Thus, although growth may adapt so as to match food availability, at least up to a certain point this seems not to exacerbate the effects of disease. However, when infections do occur (as they inevitably will), they also affect growth. As Figure 2 shows, this may be directly through reducing absorbtion of food (or in some other way changing the metabolic efficiency with which food is used), or it may be indirectly through reducing appetite. In other words, the effects of disease can be indistinguishable in terms of its effects on growth from those of a restriction in the amount of food supplied to the individual child. Even more complex than this is that the extent to which food consumption and growth are affected by infections will depend on the level of knowledge and time available to the mother, which are in turn components of what Sen (1981) describes as the endowment and exchange entitlements of the household. Thus, to the notion that body size is a measure of the extent of adaptation to the integral effects of a number of different components of the environment, we have to add that by itself it can tell us little if anything about the relative importance of any one of those components.

The problem of distinguishing between causality and association is even more acute with respect to possible connections between body size and cognitive performance. It is undeniable that smallness, both of children and of adults, can be shown to be associated with various measures of cognition and of behavioural performance. However, there are usually rather compelling reasons for thinking that this is the outcome of some other common factors.

A food intervention trial in Guatemala provides an interesting illustration. Food supplements were made available to women during pregnancy and lactation, and subsequently to their offspring! This was done on a voluntary basis, subjects being given food on request at health centres. The outcomes were measured in terms of physical growth, morbidity, and a wide range of tests of cognitive development and of social interactive behaviour of the children, and on later follow-up, subsequent school performance. The results show that <u>on average</u> the growth and behavioural performance, measured in terms of

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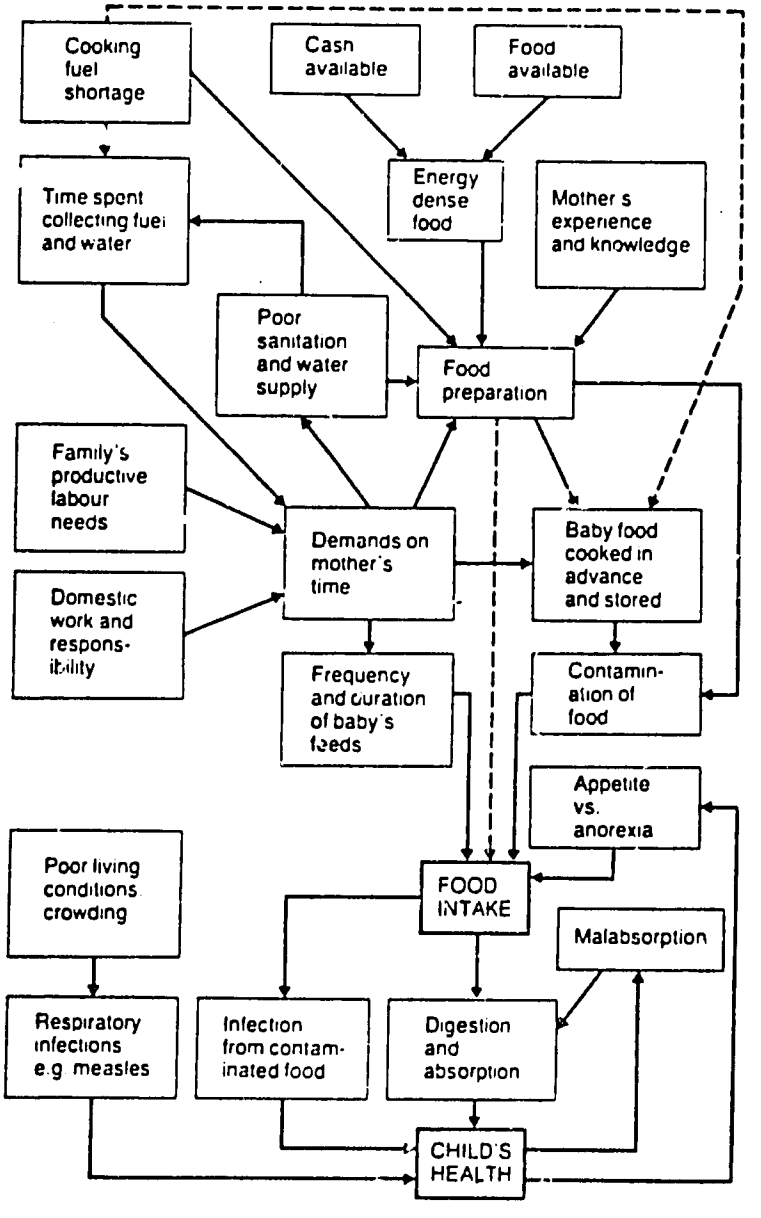
*By PEM (protein energy malnutrition), Tomkins means growth deficit.

Figure 2

Factors operating at the household level which affect the state of nutrition of children



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spontaneous exploratory levels, competitiveness, persistence etc. of the children, were poorer for the group whose uptake of supplementary food was smaller. (In fact, these differences in behaviour were seen for the most part in boys rather than girls.) (Barrett, Radke-Yarrow and Klein, 1982) At the age of 6 to 8 years, these children continued to show differences in mood, levels of play activity and degree of dependency on adults. But what are we to make of the results of a trial which shows that low voluntary intakes are associated with poor performance? It is said that there were no differences between the high and low uptake groups in terms of household socio-economic status. Is it therefore reasonable to say, as Barrett (1984) does, that nutrition is the causal agent, and that food supplementation of whole populations would greatly increase social performance and productivity? Or, would it be wiser perhaps to say that low voluntary uptake of food and smaller body size of children are telling us something about the quality of these people's physical, psychological and social environment that we are not at the moment able to measure directly?

Anthropometric indicators and seasonality

The diagram (Figure 3) shows the ways in which the main factors of the environment which influence nutrition, health and growth, interact at different levels of organisation in the total food system. It is not difficult to see that any one or all of these are likely to vary seasonally, and that this will result in the changes in body weights of adults and growth rates of children that are a common feature of rural populations. However, using growth alone, we are in no better position to distinguish between the relative strengths of the periodic components of the different factors than we are between the more constant components.

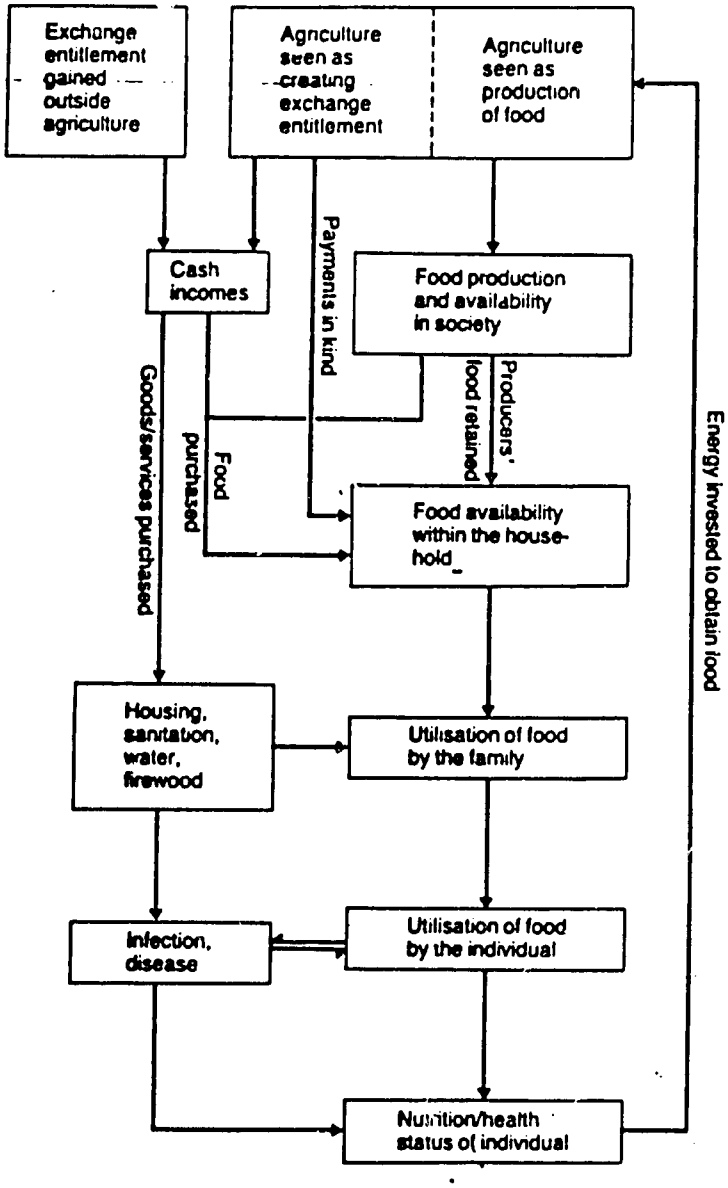
The same constraint to interpretation will apply with even greater force to the outcome of more serious levels of stress. If general environmental conditions are poor, with high levels of exposure to diseases, coupled with limited command over economic resources, then the additional effect of seasonality may be to provide the increment of stress needed to precipitate severe growth depression or loss of body weight. The interactions shown in Figure 2 will still apply, but with the probability of triggering positive feedback effects producing the progressive self-reinforcing process referred to earlier.

The best we can say then about anthropometry as an index of seasonal stress is that it can provide a general proxy for the extent of fluctuations of environmental stresses plus, in more seriously affected people, evidence of timing and extent of stresses which cross a critical threshold of risk to the individuals.

In children it seems reasonable to accept any of the conventional systems of classifying 'severe' or clinically manifest malnutrition for defining the break point at which anthropometry ceases to be a measure largely of the environment, and becomes an unequivocal index of personal risk to the individual. This would, for example, mean taking the Gomez or Wellcome classifications of weight-for-age less than 60%, or the Waterlow (1972) classification of less than 70% of standard weight-for-height, as representing that transition. For purely practical reasons, measures such as weight-for-height might turn out to be more reliable, but with the cautionary note that the seasonal checks to height and weight may not always be in phase.

Figure 3

Relationships between the various components of exchange entitlement, household food availability, and food utilisation



With respect to adults, the position is much less well defined. Over concentration upon child growth and health, as if these were the only manifestation of hunger, has led to neglect of the problem of indicators for working adults. In non-growing subjects, a measure which is independent of height has obvious attractions, and in studies of the general relationship between body build and health, the index weight ÷ height^2 (commonly called either the Quetelet (1871) index, or Body Mass Index (BMI)) is coming to be generally used.

Although there is no generally accepted figure for a lower limit to BMI which is compatible with health and the maintenance of physical work capacity, there are some prospective studies which show that mortality experience is higher for people at the low end of the range. Thus Keys (1980) analysed actuarial data to show that mortality in middle aged American males from various different occupations is higher for those with BMI's below 20. Cole (1974) studied British men in the age range 55-65, and showed that mortality rates were three times higher for the group with BMI's below 19.7 than those between 19.7 and 22.4. (They were twice as high as for those above 22.4.)

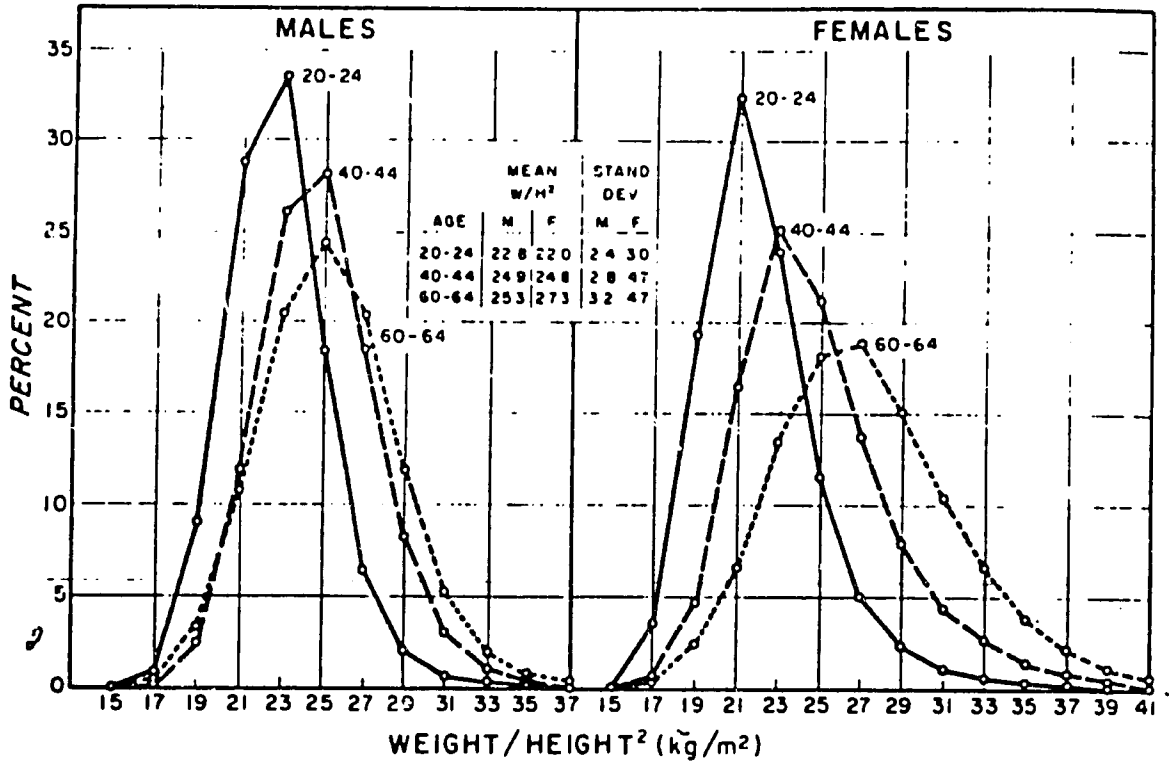
The most extensive study so far is of 1.8 million Norwegians (Waaler, 1984). Figure 4 shows the distribution of the values of BMI in the Norwegian population, and also the relative mortality risk for different age groups. (The curves are very similar for younger ages, but rise more steeply on the right hand side.) Cause specific mortality follows generally similar patterns, but for low BMI values, obstructive lung diseases exert a strong effect on the shape of the curve. The general similarity of these curves with those in Figure 1 is striking, but of course the same strictures regarding causality apply. A value of 19 for BMI in males seems to carry about 10% excess mortality risk, but the curves are markedly steeper for women, which might suggest the need for a higher threshold value.

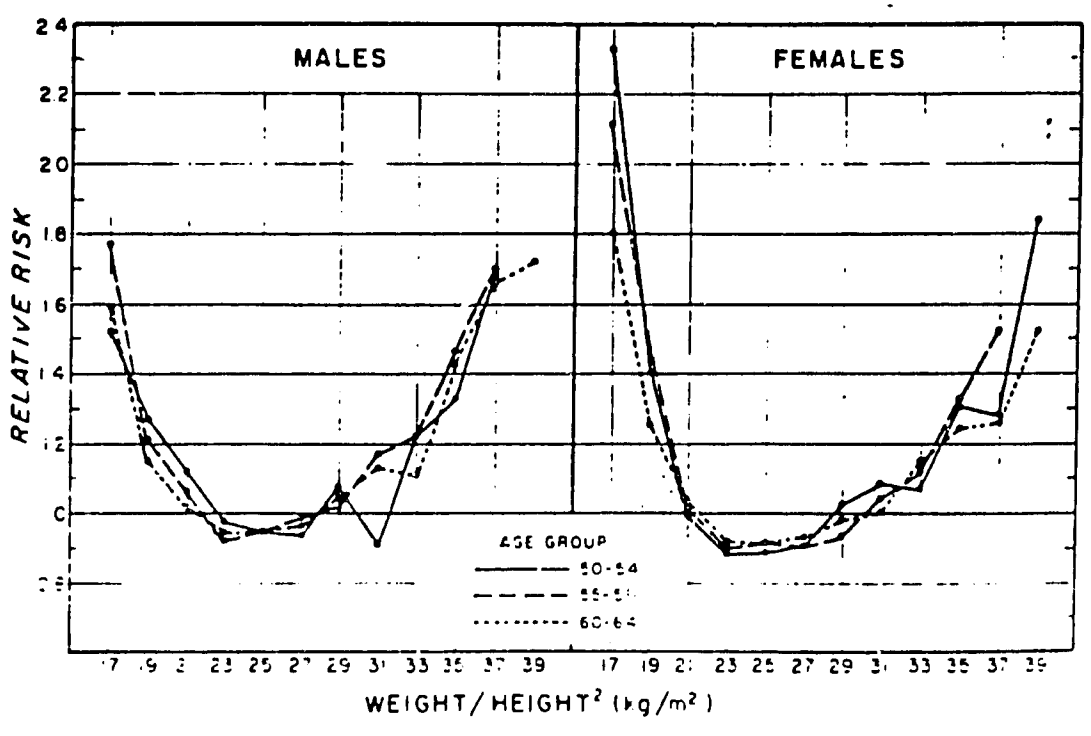
We also have estimates of mean values of BMI for a number of population groups. For example, Eveleth and Tanner (1976) quote 18.3 and 20.4 respectively for national samples of Indian and Javanese males. Shetty (1984) found 20.7 and 16.6 for two small groups of Indian subjects. Those with the low values were employed labourers who whilst showing no signs of clinical malnutrition had adapted to very reduced levels of daily energy intake and resting metabolic rate during a prolonged period of drought and underemployment. Dugdale (1985) says that a value of 19 or 20 is generally accepted as a reasonable lower limit but that data from Thailand suggests that 18 might be a better cut-off level for developing countries.

It would of course be very useful to know about the relationship between BMI and work capacity or efficiency. However, literature on body size, food supplementation and work performance, though extensive does not permit any but the rather general observation that maximum work capacity (e.g. maximum rate of oxygen uptake), and also total product (e.g. sustained daily rate of output) are functions of body size, particularly of lean body mass. We should therefore expect to find an individual's work performance to be adversely affected if body weight (and hence BMI) is reduced. From this it may also follow that for a given level of work requirement (e.g. the rate or duration of work needed to complete a particular cultivation task) there may be a required minimum body size. Thus for adults there may be in addition to a lowest value of BMI consistent with health and survival, other higher levels which have to be sustained in order to maintain the minimum work performance needed to support

Figure 4

The distribution of body mass index in the Norwegian adult population, and the relationship between BMI and prospective risk of death.





their own particular livelihood pattern.

Food supplementation studies suggest on the whole that achieving sufficient body mass may be a necessary condition for increasing work output (since, to put it simply, body size is a measure of 'horse power' rating) and that providing extra food energy to balance increases in output, whilst clearly necessary in the long term, may according to circumstances be neither sufficient or even necessary in the short term.

Food Consumption Indicators

There are methodological problems which will probably always severely limit the utility of quantitative estimation of nutrient or energy consumption, except for highly controlled research situations. Intakes can be measured on individuals, but precision is bought at the expense of invasiveness as well as in money and time: it is possible to know accurately how much food a person has eaten over a period, but only with so much observer interference as to cast doubt on the result as an estimate of normal habitual intake. This does not of course mean that measures of household food consumption, or of changes in patterns of food availability, or of critical levels of food stocks etc., are useless: simply that the widespread belief that nutritionists can 'tell what a man is by what he eats' falls sadly short of the truth. Even if we could measure intakes of individuals, the problems of constructing indices of nutritional adequacy of these are essentially the same as those of interpreting differences in growth and body size. In fact it was Sukhatme's (1961) critical attack on the conventional wisdom about interpreting household intake data, and his advocacy of an approach which takes account of adaptive responses, that largely initiate the current controversy. With respect at least to energy, the problem of interpretation is made even greater because of the very wide range of adaptive responses which are made possible through altered physical activity levels: it is of course precisely those changes which are a main feature of the effects of seasonality.

It seems unlikely that these difficulties will be resolved simply by greater precision in the prescription of requirements. The latest FAO/WHO/UNU (in press) report on protein and energy defines energy requirements as follows:

> "The energy requirement of an individual is that level of energy intake which will balance energy expenditure when the individual has a body size and composition and level of physical activity consistent with long-term good health, and which will allow for the maintenance of economically necessary and socially desirable physical activity".

This definition is based on the understanding that people can adjust to changes in energy intake in a number of ways, some physiological and some behavioural. Thus a reduction in energy intake can be compensated for by reducing expenditure either at work or during leisure time. Besides this, however, changes in body weight and/or body composition and metabolism can result in an altered requirement for maintaining the body, again offsetting a reduced intake. These different kinds of adjustments can take place either singly or in various combinations, so that in practice high or low levels of physical activity can be found associated with either large or small body size, and with marked differences in composition.

The definition of requirements does, however, imply that there are safe limits

to these adjustments. Thus there are upper and lower limits to the range of body weights which are consistent with good health. Similarly for changes in body composition or metabolic regulation. But also it is implied that the requirement should be such as to allow for some minimum necessary and desirable levels of physical activity. So, the concept of energy requirement is no longer that of a single fixed level appropriate for a given person, but rather of a set of safe limits, defined not just in terms of physical health but of an acceptable level of economic and social performance. A person who adjusts to a change in intake in such a way as to remain within those safe limits could be said to have successfully adapted to that change.

The problem of course is that even if we could establish the limits, we would be left with a very wide range. For example, there is some justification (which the new report will substantiate) for setting the barest minimum energy needed for survival at 1.2 x basal metabolic rate. This would suggest 1,460 kcals per day as the intake which for an average Indian peasant spells the division between hunger and frank starvation. If we were also able to agree on what would be a 'reasonable' level of work output on employment this might give an upper limit of 2,400 kcals/day on a year-round basis. If his actual intake was found to be anywhere within that range, we could either say that his ability to work was limited by his energy intake, or that his intake was self limited to match the amount of work available: without additional evidence of some kind it would be impossible to tell which of these alternatives was correct. As another example, girls in Kerala grow a little below the third centile of the Harvard standard. At 6 years they weigh, on average, 15.5 kg, whereas the Harvard 50th centile is 20 kg. This looks a big difference. However, 4.5 kg averaged over 6 years means a difference of 2 gms a day, and the best estimate we have of the energy cost of growth in children is 5 kilocalories per gram. Thus, if we had two girls who were the same with respect to physical activity, disease levels etc., one following the 50th and the other the 3rd centile, we would expect, other things being equal, to find a difference of 10 kcals/day in their intakes (weight growth is almost linear over this age period). The measurement would have to be made with a standard error of better than 1 per cent to detect this. In practice also, sources of variance such as day-to-day changes, and even more significantly, seasonal-to-season changes are of very much greater magnitude than the energy equivalents of differences in growth.

Changing the unit of measurement from the individual to the household clearly adds to the problem, since we cannot aggregate the individual requirements of the family members without making assumptions about distribution in addition to those which have to be made in order to fix the requirements of each of the members.

Abdullah and Wheeler (1985) studied the household, and individual intakes of Bangladeshi villagers in order to try to assess the extent to which intra-household food allocation might account for the higher levels of malnutrition and mortality amongst girl children as compared to boys. They found that whilst the share of the total consumption allocated to small girls was somewhat lower than that given to small boys, the girls' proportional share actually increased during the winter season when food was shortest. However, for both sexes, food intakes were much lower (by 15 to 30 per cent) than the WHO/FAO recommended levels, and just when their energy intakes were lowest their nutritional status in terms of weight-for-age was tending to improve. These authors concluded that there were seasonal changes in the physical activity of small children, as well as of the adults, so that food allocation within households cannot easily be

interpreted either in terms of 'requirement' levels, or of shares relative to the total.

The question then is of what value, if any, are conventional measures of average daily food consumption at the household or at the individual level, as a part of the task of assessing the effects of seasonality on household food entitlement? Before attempting an answer we shall need to return to the point made in the introduction about the current lack of an adequate theoretical basis for analysing energy balance in dynamic situations.

A simulation model of seasonal changes in energy balance

In populations subject to seasonality of work and food supply, energy equilibrium is the exception rather than the rule. This is particularly true of regions where peasant farmers harvest one staple crop a year, which has to be stored until needed either in granaries or in the ground. Food in store inevitably suffers spoilage: the longer it is kept, the greater the loss. In addition, the work load of such farmers is variable. Immediately after harvest there is commonly a 'rest' period of several months, then the heavy physical work must be done to prepare the ground for the next crop, followed by planting, weeding and finally harvesting. The period of greatest energy expenditure is therefore several months removed from the last harvest. The farmer and his family could in theory use their stored food in a variety of different ways. If they were to eat large amounts soon after harvest they might reduce the overall storage losses but would incur greater metabolic losses because of their increased body weights. Also, with this strategy they might run the risk of having insufficient food to balance the high energy expenditures of cultivation and harvesting of the next crop, and would thus experience large losses of weight. At the other extreme they might conserve and ration food throughout the year so as always to balance current demands for energy and so maintain a constant body weight. In this case the mean storage time of food would be longer and year-round losses would be greater. In other production situations, factors such as the use of animal or other power assistance, multiple cropping or seasonal off-farm employment opportunities would of course complicate the range of choice of strategy.

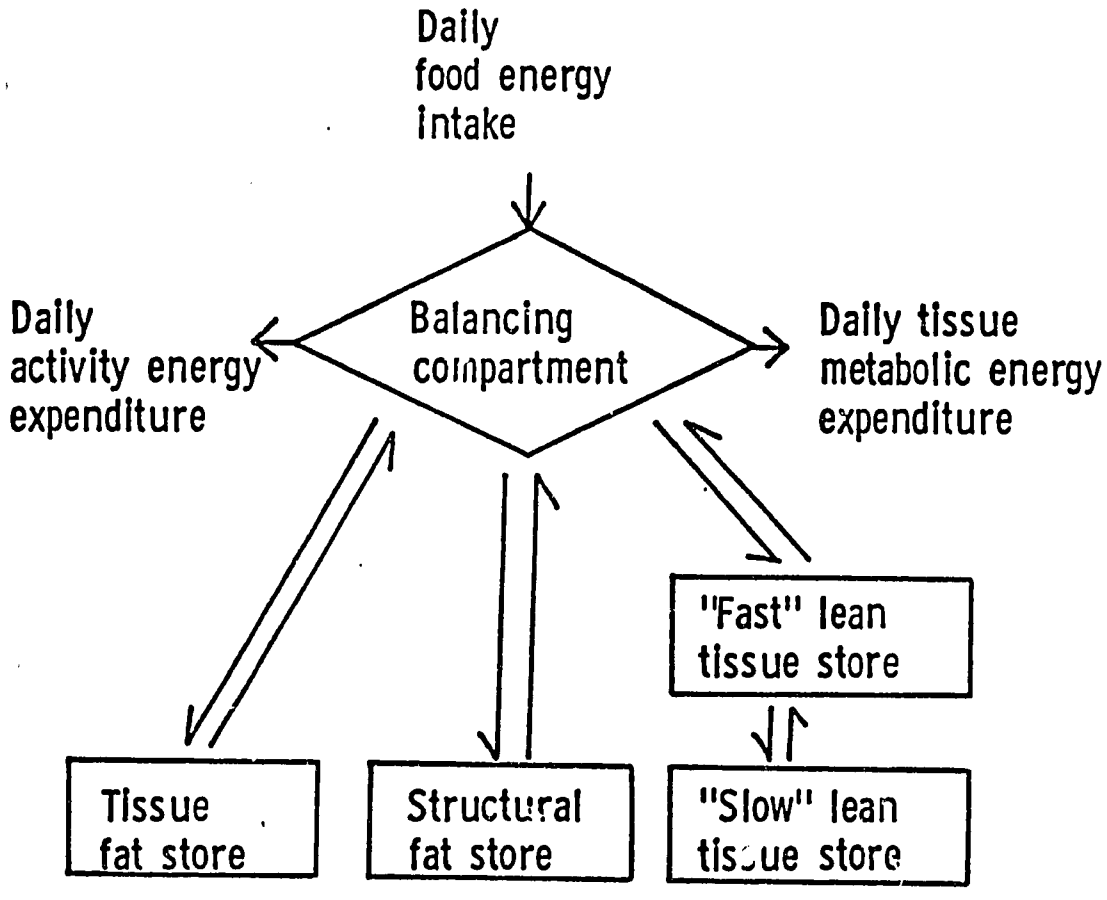
The Model Man

Payne and Dugdale (1977) have described a model which simulates the regulation of energy balance in adults. In this model, the tissues of the body are represented as four compartments linked together as shown in Figure 5.

The model is represented by a computer programme, which calculates day by day changes in body weight and composition. After specifying initial values for body size and consumption, the inputs to the computer consist of daily schedules of food energy intake and physical work output. At the end of each day, the energy needed for maintenance is calculated from the sizes of the body compartments and hence the energy balance for that day can be computed. If the balance is positive, the surplus energy is stored in the different compartments as lean tissue and fat tissue: the ratio of lean to fat stored is fixed for any particular individual. If the energy balance for the day is negative, the deficit is made up by depleting the compartments of lean and fat tissues, again in the same ratio. The model does not have any preferred value of body size bu if the average level of food intake or of work output is changed, compartment sizes and hence maintenance energy requirement will adjust upward or downward

Figure 5

The "model man" showing the tissue compartments and the balancing compartment



until equilibrium is re-established. If intake and expenditure vary over time, for example because of seasonal effects, then the output of the model will be a description of the pattern and magnitude of seasonal weight fluctuations.

The Model Farm

The model can be extended by linking the 'man' to a 'farm' with which he can grow food in exchange for making work inputs. The 'harvest' from the farm is placed in a food store from which the farmer can take the food every day over the subsequent year until the next harvest comes in.

Figure 6 shows how these components of the model farm system are linked. The box containing the farmer represents the model man described above. In what follows the 'farm' is restricted to a single crop production unit, which yields the same amount of food energy every year. The seasonal patterns of work input to the farm, and food withdrawn from store, can be specified. At harvest, the total annual crop yield is transferred to the food store, after which it becomes subject to a storage loss which can be specified in the programme as the daily fractional rate at which the food energy contents of the store are degraded by microbiological spoilage, insect or rodent attacks etc. The farmer can take food from the store each day in various ways so as, for example, to meet periods of heavy work requirements, or post-harvest feasting etc. A number of 'runs' of the model have been made using different food allocation patterns and different rates of storage loss, all of which have been designed so that the total amount of food available each year, i.e. farm production minus storage loss, is completely used up. There is never a surplus carried over from one year to the next. In this form the model is self-stabilising and after a number of simulated years (usually 10-15), settles down to an exactly repeating cycle of weight changes.

In what follows the model is used to show the effects of different patterns of food use using data reported by Fox (1953) for Gambian farmers, and Tin-May-Than and Ba-Aye (1985) for Burmese farmers. Table 1 shows a summary of the measurements of body weight and height, body mass index (weight/height^2) and the seasonal range of energy expenditures (Table 1). At the time when Fox described them, the Gambian men were growing a single annual crop of millet for which they prepared the ground by manual labour, entailing peak work expenditure rates of a little over 1000 cals per day. During the post harvest period they were described as extremely sedentary with maintenance energy expenditures barely above basal rates. The Burmese farmers are also producing a single crop (rice), and have very high daily rates of energy expenditure during the ploughing season, despite the use of draft animals. Expenditure rates are also high during the harvest period and some off-farm employment is taken when there is no farm work to be done. These differences in work pattern are reflected in very much higher annual rates of energy expenditure by the Burmese, 210% of BMR, as compared with 140% of BMR by the Gambian men. Despite this the Burmese are shorter and lighter, and have lower body mass indices than the Gambians.

Table 1: Simulation of seasonal changes of body mass index of Burmese farmers

BMI	Observed pattern	High-post harvest	Constant intake	Constant weight
Mean	19.5	19.9	19.9	20.4
Max	20.4	23.2	22.5	20.4
Min	19.0	17.9	17.8	20.4

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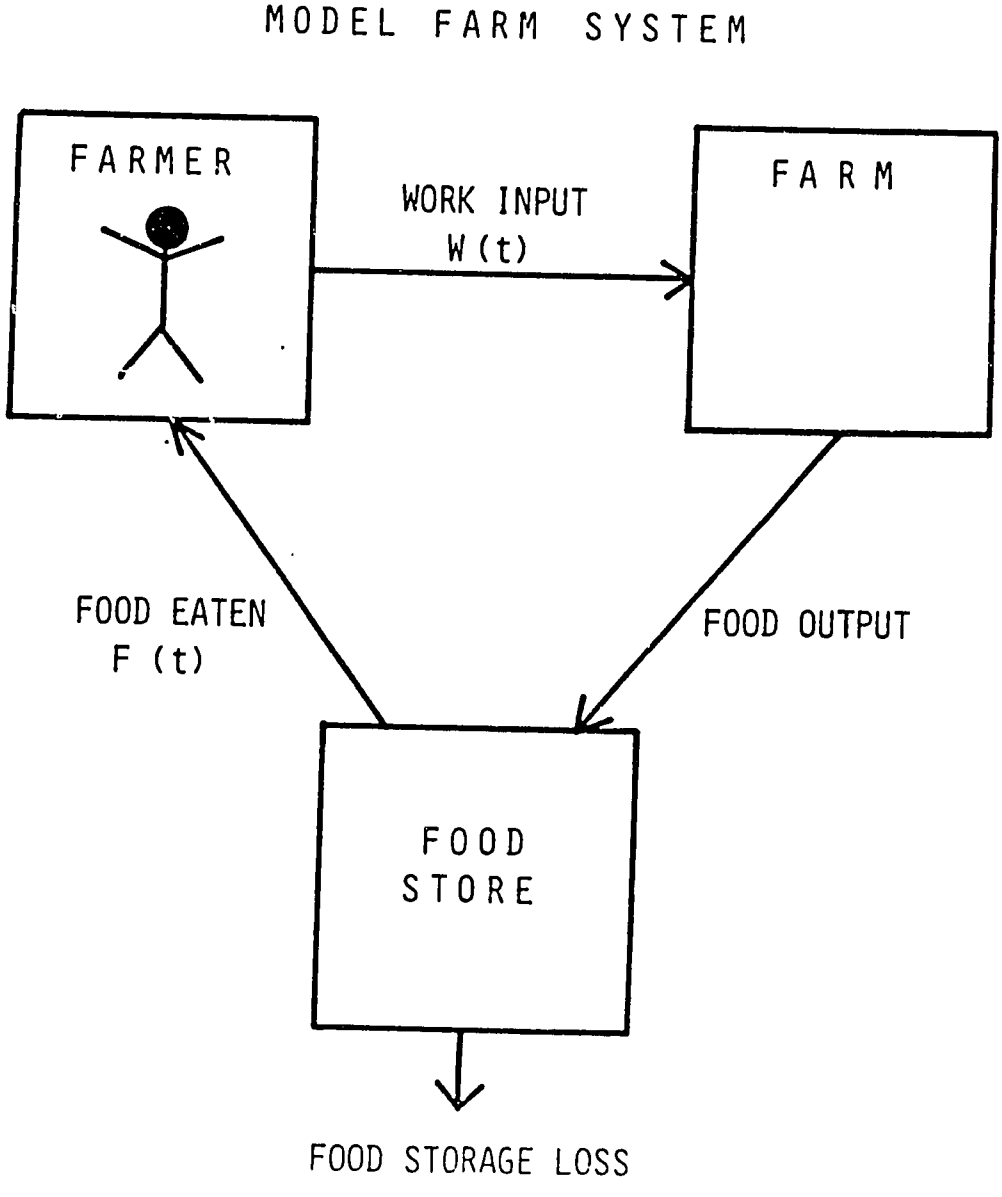
Figure 6

The model farm system

The compartments show the farmer (represented by the "model man") the farm and the food store.



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The Gambian Farmer

The Gambian farmers do not eat the largest amounts of food at the times when work on land preparation and harvesting is heaviest. Instead they eat most during the immediate post-harvest period (see Figure 7), when their work energy expenditure has fallen to a very low level. This traditional pattern of post-harvest feasting which is a not an uncommon feature of traditional peasant communities, is in part responsible for the seasonal weight fluctuations, and it is interesting to see how this chosen strategy compares with other possible ones in terms of weight changes and storage losses.

Four different strategies of food allocation have been compared.

1. The time pattern of energy intakes actually observed by Fox for the whole Gambian farming community.

2. Exaggerated post-harvest feasting, falling off rapidly to a much reduced level - this is intended to show what could be the maximum effect of early food use on post-harvest storage losses.

3. A constant daily intake over the whole year.

4. A feeding pattern adjusted so as to maintain constant body weight, i.e. intakes always balancing expenditures. The results of simulations using these four strategies are shown in Figures 7, 8 and 9.

Figure 7 shows the observed patterns of expenditure and intake and also the actual changes in mean weight of a group of Gambian men. When these observed weights are compared with those predicted by the model, the pattern of actual and simulated weights are similar (see Figure 8). The model shows larger seasonal swings but these are well within the range of individual variation for men from the same region, reported by Billewicz and McGregor (1982).

Figure 9 shows the three other allocation patterns. Table 2 shows the average year round body weights and the maximum seasonal weight changes predicted by the model and how these are affected by the rate of storage loss.

When storage losses are set at zero, the 'best strategy' for food allocation seems to be that which sustains body weight at a constant level. However, as the rate of storage loss is increased towards more realistic values, the advantages of high post-harvest consumption rates become greater, with average weights highest of all for the exaggerated post-harvest feeding schedule, and lowest for the constant weight strategy.

Average year-round body weight is probably less important than the maximum body weight which is attained at the start of the heavy work season. As Table 2 shows, the effects of different allocation patterns on maximum weight is even greater than it is on average weight. What is particularly striking is the relative disadvantage of attempting to maintain a constant body weight, which is of course the result of eating according to the conventional advice of matching intake with 'requirements'!

Figure 7

Energy intake, work output and body weight of Gambian farmers (Fox 1953)

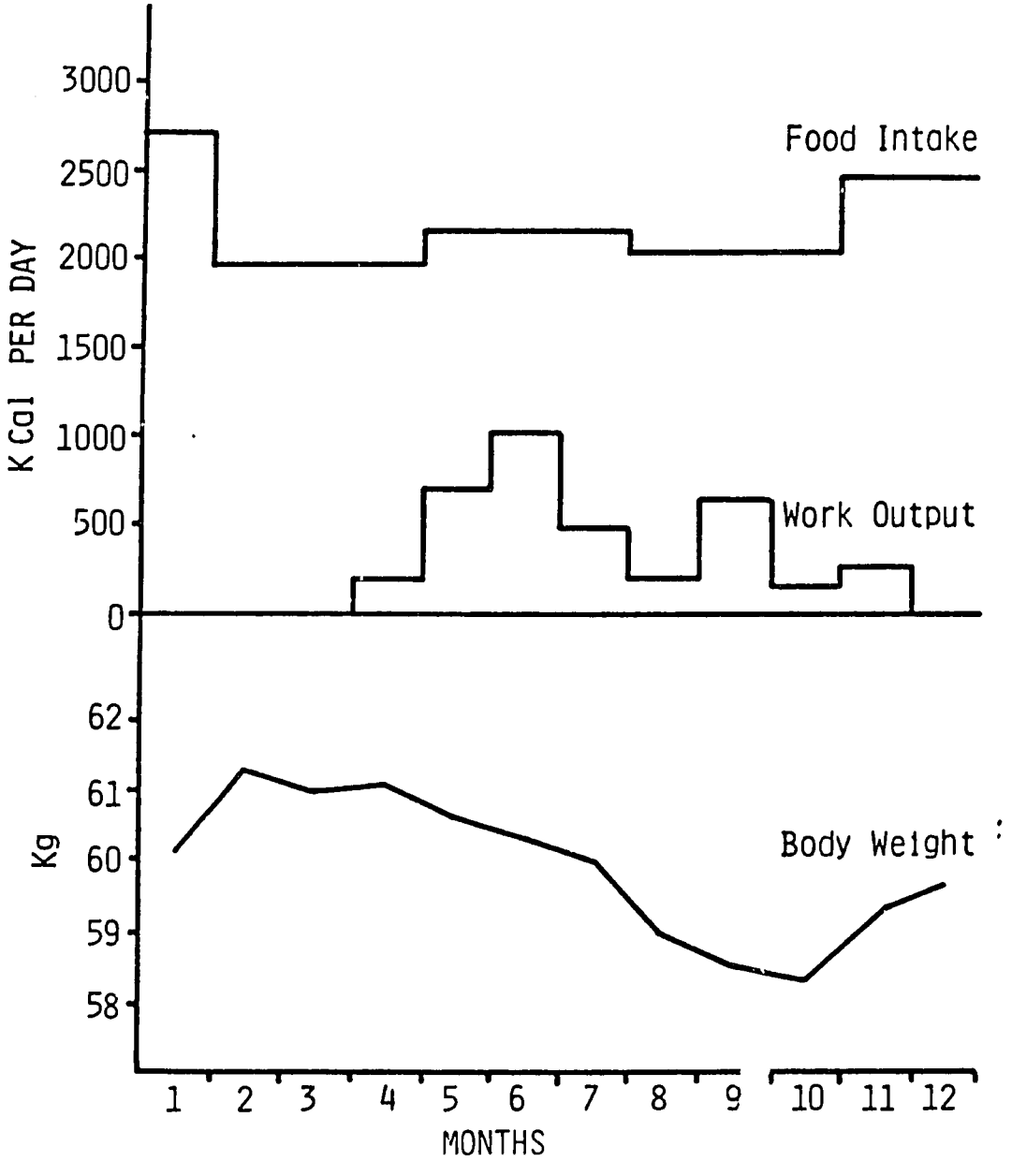

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Figure 8

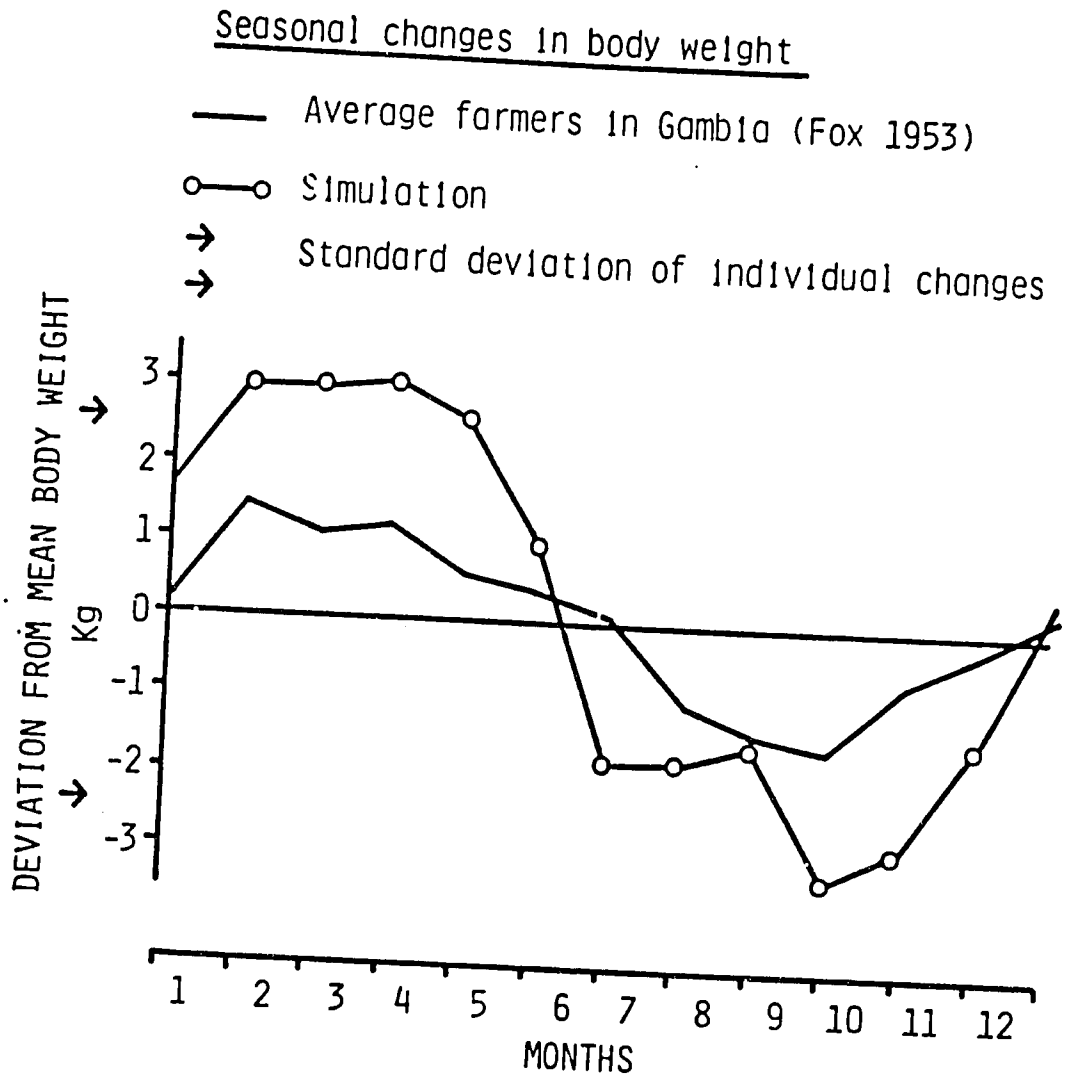
Seasonal changes in body weight
Average farmers in Gambia (Fox 1953)
Simulation
Standard deviation of individual changes
DEVIATION FROM MEAN BODY WEIGHT
Kg
3
2
1
0
-1
-2
-3
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS

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Figure 9

Four of the possible patterns of food allocation over the year; which have been tested using the model.

The lower diagram shows the actual work output of the Gambian farmers.

Four food allocation patterns

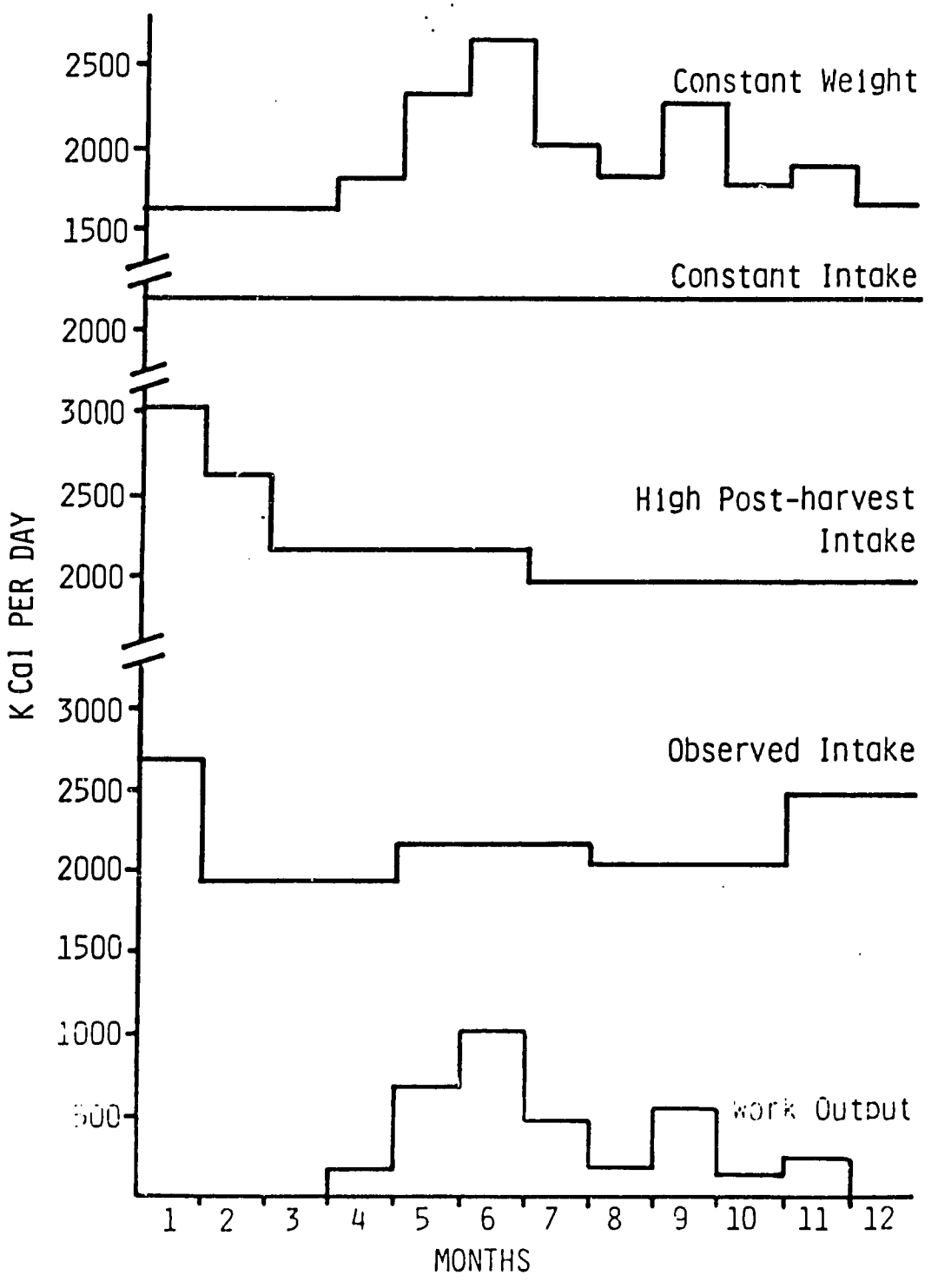

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Table 2

Seasonal weight changes of Burmese farmers, simulated using different food allocation strategies and rates of post-harvest losses

Body weights of different rates of storage loss		Food allocation strategies			
		Observed intake pattern	High post-harvest intake pattern	constant intake pattern	constant weight intake pattern
% loss/ day	Weight kg				
0	Max	59.5	66.2	62.4	65.5
	Min	57.1	54.0	53.7	65.5
	Mean (range)	58.5 (2.4)	61.6 (12.2)	59.6 (8.7)	65.5 (0)
0.03	Max	54.0	58.7	56.9	55.3
	Min	50.2	46.7	48.1	55.3
	Mean (range)	52.9 (3.8)	54.1 (12)	54.0 (8.8)	55.3 (0)
0.1	Max	43.8	47.5	47.0	43.9
	Min	40.2	35.7	38.0	43.9
	Mean	42.4 (3.6)	42.9 (11.8)	43.9 (9.0)	43.9 (0)

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The observed intake pattern shows clear advantages over both constant intake and constant weight strategies, and is indeed quite close in efficiency to the exaggerated post-harvest feasting pattern. These advantages derive partly from the fact that high body weight is sustained at just the time when this is likely to be most crucial for work output, but is then allowed to decline and thus reduce maintenance costs during the rest of the year.

But, as Table 3 shows, storage losses are significantly lower when using the high post-harvest intake strategies, and this of course results in higher overall consumption. As the table also shows, the model simulates very well the effect on annual storage losses, of withdrawals of food for consumption throughout the year. Food left uneaten in store and exposed to daily losses of 0.03% or 0.1% would be degraded to the extent of 10% or 30% per annum respectively.

The Burmese Farmer

The data given by Tin-May-Than and Ba-Aye suggest that the annual energy intake was 17% higher than the annual expenditure. An attempt at simulation using these values in the model gave initial weight gains of 11.0 kg per year, with average body weight plateauing at 100 kg over the course of 5 years. It has therefore been assumed that there is a systematic error in the reported intake data, and the total annual intake has been scaled down accordingly while maintaining the relative pattern of seasonal variation. Subject to making this adjustment, the pattern and extent of seasonal weight changes generated by the model, are in very good agreement with those observed (Figure 10).

The same range of strategies of food allocation has been studied, as with the Gambian farmers. As before, each of these strategies has been tested with various rates of storage loss. As Table 3 shows, the proportion of food lost during a year depends again primarily on the extent to which food is consumed early in the storage cycle. The difference between the Gambian and the Burmese systems, however, is that the observed pattern of food use is far from being the optimum from the point of view of food conservation.

Table 4 shows the outcomes in terms of body weight, and the magnitudes of weight changes. The contrast with the Gambian farmers is that the observed pattern of food use is not the one which would sustain the highest possible body weights, either on average or at the start of the heaviest work period. In effect, the choice seems to be much more directed towards constancy of body weight even at the expense of somewhat greater food losses.

Table 5 shows the effect of the different strategies on body mass index at different times of the year. As compared to either the exaggerated early consumption, or the constant intake strategy, the observed pattern effectively prevents the BMI from falling to values below 19.0.

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Figure 10

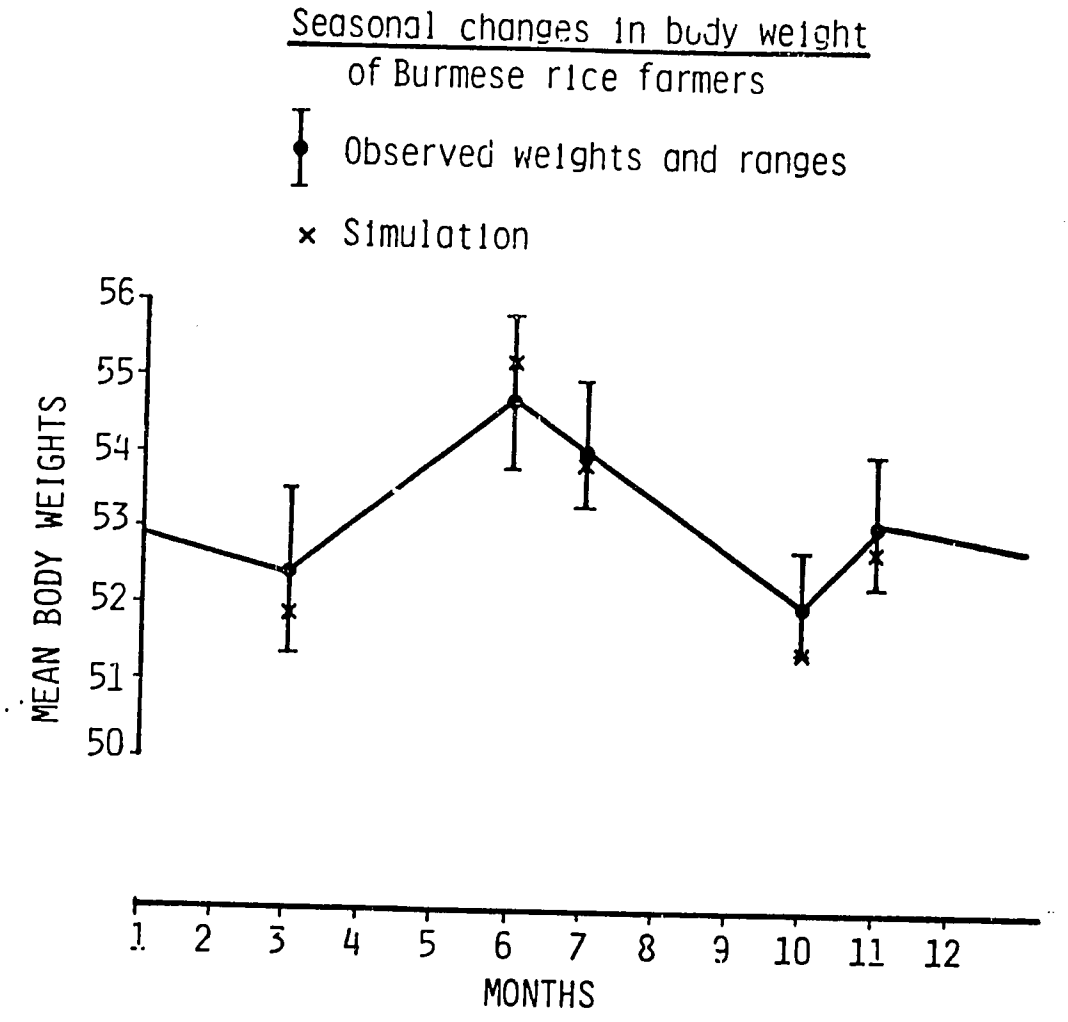
Seasonal changes in body weight
of Burmese rice farmers
Observed weights and ranges
× Simulation
MEAN BODY WEIGHTS
56
55
54
53
52
51
50
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS

Table 3

Effect of different food allocation strategies on annual storage losses

Per cent of stored food lost per day, and theoretical annual losses	Percentages of food lost during one year with different food allocation strategies			
	Observed intake pattern	High post-harvest intake pattern	constant intake pattern	constant weight intake pattern
Gambian farmers				
0.03 (= 10% per annum)	5.1	4.9	5.3	5.5
0.1 (= 30% per annum)	16.3	15.9	16.9	17.5
Burmese farmers				
0.03	5.4	5.1	5.3	5.4
0.1	17.2	16.4	16.9	17.4

40

Table 4

Seasonal weight changes of Gambian farmers, simulated using different food allocation strategies and rates of post-harvest losses

Body weights at different rates of storage loss		Food allocation strategies			
% loss/ day	Weight kg	Observed intake pattern	High post-harvest intake pattern	constant intake pattern	constant weight intake pattern
0	Max	64.2	55.1	65.1	65
	Min	57.7	57.4	59.9	65
	Mean (range)	61.5 (6.5)	60.8 (7.7)	62.2 (5.2)	65 (0)
0.03	Max	59.4	62.0	58.9	55.4
	Min	52.9	54.4	53.7	55.4
	Mean (range)	56.8 (6.5)	57.7 (7.6)	56.0 (5.2)	55.4 (0)
0.1	Max	51.8	54.1	51.3	47.2
	Min	45.4	46.7	46.0	47.2
	Mean (range)	49.1 (6.4)	49.9 (7.4)	48.3 (5.3)	47.2 (0)

Table 5

Comparisons of body size and energy expenditure rates of Gambian and Burmese farmers

		GAMBIA	BURMA
Weight kg	Mean	58.47	53.5
	Max	59.8	54.8
	Min	56.8	52.1
Height cms		168.3	164.7
Body Mass Index	Mean	20.6	19.7
	Max	21.1	20.2
	Min	20.1	19.2
Seasonal energy expenditure cal/day	Mean	2100	3003
	Max	2600	3840
	Min	1600	2230
Energy expenditure kg	Mean	35.9 kcal/kg	56.1 kcal/kg
Energy expenditure as per cent of basal metabolic rate	Mean	140	210

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The first points to emerge from this admittedly very simplistic exercise are that attempts to assess adequacy of food supply on the average, or of food stocks at a particular time, can only be made from the perspective of an understanding of the particular farm and livelihood systems concerned: there are no completely general rules. Looking first at the Gambian farmers, we have a relatively simple single crop production system which (at the time when the data was collected) was still largely one of subsistence farming. Immediately after the harvest when food was relatively plentiful, there was a period of several months with (for men at least) little agricultural work, but a fair number of traditional festive occasions. Food eaten in excess of requirements produced very rapid weight gain, so that with the advent of the rains when the heavy work of land preparation had to be done by human labour, body weight was maximal. Food stocks, however, were then at their lowest, and intakes much less than requirements, led to weight loss. At first sight the picture is one of people constantly trying to produce enough food to last them over the year so as to sustain nutritional status, or at least body weight, at a constant level - and apparently always failing. The model shows, however, that the strategy followed for rationing out food and effort was in fact a conservative one, minimising post-harvest storage losses whilst ensuring maximum body weight during the short period when peak work output was needed. The result was a livelihood system which supported people at a level of year-round energy expenditure of only 1.4 times their basal rate of metabolism - a figure very little above that considered to be the absolute minimum for survival (FAO, 1974).

The Burmese farmers rely on rice as a main source of food energy and grow this for a restricted period of the year, but are more engaged in the market. They produce a surplus and take off-farm employment and there is no time of the year spent in total inactivity. Although their daily rates of energy expenditure are very high during the whole of the four months of the ploughing season, the character of the work is likely to be different since, they use draft animal power. They are able to accomplish this with smaller body weights than the Gambian men, even allowing for their smaller height. Fairly high rates of daily work output are sustained for much of the rest of the year, and the overall production system is maintained by year-round energy expenditures of 2.1 times their basal metabolic rate. The simulations show that although there might be advantages of reduced storage loss and of higher maximum body weights as a result of concentrating consumption of food early in the storage cycle, these would be offset by much greater seasonal swings of body weight. Their higher level of overall production and ability to exchange cash for food, probably means they are less sensitive to the relatively small changes in food entitlement that these reduced storage losses represent. However, the very high rate of energy turnover is combined with the low maintenance requirements that go with small body size and hence small body reserves of energy. Consequently the factor which is likely to be critical for them is that of maintaining weight or BMI above some minimum value below which their capacity for long sustained (as opposed to peak intensity) of work output might be threatened. The model simulations show that compared to the other strategies, the observed pattern of eating ensures that body mass index does not in fact fall below 19.

The simulations therefore point to the potential importance of adult anthropometry as seasonality indices, but again to the necessity of placing these within the context of the farm/livelihood system.

Multiple and Composite Indicators

Used on their own, the nutrition indicators that are currently available are clearly of limited value for any but the most general comparisons between population groups, or for observing longer term trends. This is particularly the case with child anthropometry, largely because of the complexity of the environmental causes of poor growth. Until about the mid 1970s it was commonly accepted, more because of vigorous advocacy than on the basis of any objective evidence, that small size in children was prima-facia evidence of current deprivation and distress of those individuals. Moreover, the need for improved food availability was stressed as being the major policy implication. To the extent that disease was acknowledged to be an element in the cause, it was asserted that this would also be countered by improved nutrition so that there were many who argued that combatting 'marginal' and 'moderate' malnutrition through incrementing food consumption would be a sufficient strategy for improving child health - albeit one to be assisted and accelerated wherever possible by improving immunisation and basic health provisions. I believe the evidence now is that infectious disease, or rather the lack of means to combat it, needs to be treated as a primary deprivation in its own right, and not one which can be dealt with to any useful degree through fungibility of the benefits of improved food consumption with those of disease control. Indeed, if anything, the evidence points in the reverse direction: in many cases the impact of disease is such as not only to overlay but to extensively distort the effects that variations in food availability would otherwise have. The implications of this for understanding seasonality are that fluctuations and changes in growth and body size must only be interpreted along with an assessment of the pattern and character of the infectious diseases to which the particular population is exposed. Comparison of the weights or heights of children in different locations or at different times without reference to the level of exposure to malaria, measles or diarrhoea, can tell us little if anything about the extent to which their size is conditioned by the food available to them as individuals, even less about the food entitlement of the households to which they belong.

With respect to the health status of adults, the situation is probably very similar but much less well studied. Seasonal infections are probably an important cause of loss of work time, or of reduced work capacity. A study by Maxwell Stutley and Bojanic (1982) of six Bolivian farmers showed that only one was not ill during the study year, four lost between 3 and 20 days, and one lost more time sick (128 days) than he spent on farm work. Most of this was during the main agricultural season, and there were additional days lost because of illness of wives and children. One of the main effects of seasonality on hunger may well be mediated by the influence of disease on production, and we might even speculate that in some circumstances, reduced growth of children in a household could as well be seen as a measure of the general level of disease risk to which all of the members are exposed, and hence of the cause rather than the outcome of impaired household food entitlement.

There is one way, however, through which the utility of nutritional indicators could be enhanced. This is by extending the unit of measurement from the individual to the household. Dugdale (1985) has suggested that by measuring all the members it should be possible to distinguish patterns which characterise different types of problems and causes.

Table 6 shows some of the many possible patterns that would be found. In order to do this, it will of course be necessary to have agreed anthropometric indicators of risk for adults as well as for children. However, as we have seen this is now becoming possible.

As in the case of individuals, the need to interpret seasonal effects will bring greater complexity to the use of household anthropometry: but it may also bring benefits. By imposing regular and predictable stresses upon the household, seasonal changes can help to identify and locate critical processes and events for which the risk of breakdown is high. But, as has already been stressed, this will always have to be done within the context of an understanding of the pattern of livelihood processes within which the nutritional measurements are made.

Table 6: Some patterns of undernutrition in families

Pattern	Present nutritional status of: Father	Mother	Infant	Preschool child 1	Preschool child 2	School child 1	School child 2	School child 3
A	+	+	+	+	-	+	+	-
B	+	+	+	0	0	+	+	-
C	+	+	0	0	-	+	-	-
D	+	0	0	0	-	+	+	-
E	0	0	0	0	0	0	-	-
F	+	+	+	+	-	+	0	+

+ means weight-for-height satisfactory, 0 means weight-for-height below critical level

- means no family member

Pattern A shows that the current nutrition of all family members is adequate. The parents and older children may be small in stature, reflecting undernutrition in early childhood, but their present nutritional status is satisfactory.

In **pattern B** the adults, infant, and older children are all adequately nourished, but the pre-school children show evidence of present undernutrition. This is a very common pattern in poor communities, where infants are generally protected for the first few months of life by breastfeeding, but from the later months of infancy to about four years of age the children are undernourished with resulting decrease in height-for-age, weight-for-age, and weight-for-height. By the time these children reach school age they can cope adequately with their environment. From then on their current nutrition, as indicatred by weight-for-height, approaches normal but they are left with a deficit in height-for-age and weight-for-age. This pattern of malnutrition does not reflect an absolute deficiency of food in the family home, rather it suggests either a lack of satisfactory foods for young children or else other deficiencies in their care. These are common causes of malnutrition in developing countries where young children are expected to eat the same foods as adults and where both parents may spend their days in the fields, leaving the care of young children to older siblings.

Pattern C suggests poor practices of infant and child care, perhaps with a working mother who cannot feed and care for her infant and younger children during the day.

In **pattern D**, poor nutrition or disease in the mother is almost certainly the primary factor leading to secondary effects in the younger children. The school-age children can fend for themselves.

Pattern E indicates an absolute lack of food in the family.

Pattern F with isolated 'malnutrition' of a school-age child is much more likely to result from disease than malnutrition.

Many other family patterns are possible and each could be interpreted as a result of specific family problems.

Malnutrition and disease tend to cluster in problem families. When such families are identified and the pattern of their needs determined, intervention can be targeted more accurately and efficiently. Anthropometry has its limitations and cannot detect all diseases, but it will increase the efficiency in the use of field data for action programmes.

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INSTITUTE

1776 Massachusetts Avenue, N W
Washington D C 20036 U S A
(202) 862-5600
Telex 440054
Cable IFPRI

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SEASONAL PATTERN OF ACTIVITY AND ITS NUTRITIONAL CONSEQUENCES IN THE GAMBIA

by

M. Lawrence, F. Lawrence, T.J. Cole,
W.A. Coward, J. Singh and R.G. Whitehead

IFPRI/FAO/AID Workshop on Seasonal Causes of
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1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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SEASONAL DEMANDS FOR NUTRIENT INTAKES AND HEALTH STATUS IN RURAL SOUTH INDIA

by

Jere R. Behrman and Anil B. Deolalikar

IFPRI/FAO/AID Workshop on Seasonal Causes of
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Seasonal variations are substantial in many rural areas of developing countries. Seasonal fluctuations often are great in environmental conditions, food availability, food prices, and labor demands. Chambers, Longhurst and Payne, Schofield, and others have suggested that such variations may have substantial impact on nutrition and health status.

However, even if seasonal variations in environmental conditions, income and prices are substantial, seasonal savings and dissavings patterns may preclude there being much impact on nutrient intakes. Moreover, even if there are seasonal patterns in nutrient intakes, adjustments in energy expenditure may mitigate the effect on indicators of even fairly short-run health status.

Whether seasonal variations in such variables as prices affect nutrition and health status substantially, thus, is an empirical question. Our contribution is this paper is to explore such impacts for a rural south Indian sample by investigating questions such as the following: Do nutrient intakes and health status vary seasonally? Do demands for nutrient intakes differ significantly across seasons? Do price and asset elasticities differ seasonally? Are these seasonal effects different for nutrient intakes of men versus women versus boys versus girls? Likewise, does health status differ significantly across seasons and among demographic groups? Do comparisons of the nutrient and health status results indicate similar or differential responses to prices and assets? Do parental preferences regarding the equity-productivity tradeoff and favoring children by birth order or gender in the intrahousehold allocation of nutrients vary across seasons?

We organize our investigation of these questions by first discussing briefly alternative farm-household models of demand for nutrient intakes and health status, then presenting and summarizing our data, and finally presenting and discussing our empirical estimates.

1. Farm-Household Models of Demands for Nutrient Intakes and Health Status

The determination of the allocation of nutrients to individuals and of individual health status occurs substantially within households, given the prices that the household faces and the assets that it controls. In order to decide how to specify our empirical relations, we therefore briefly consider the implications of two major strains in the existing household literature for our specifications.

Constrained maximization of and unified household preference function: In the standard neoclassical models of the household, it is assumed that the household acts "as if" there is an unified household-level preference function that depends, inter alia, on the health status of the individual members of the household. Individual health status is of direct interest because of concern about the health per se of the members of the household, in addition to any indirect effects that health may have on the income of the household through increasing productivity.[1] These preferences are maximized subject to relevant production functions, the assets that the household owns (including time as well as physical assets), and the market prices that the household faces. Among the relevant production functions are those which determine individual health status as a function of individual nutrient intakes, other direct health-related purchased or produced inputs, environmental conditions, genetic endowments and other relevant factors. The maximization process leads to reduced-form demand relations for individual nutrient intakes and health status dependent upon the exogenous (to the household) prices and predetermined assets broadly-defined.

If product and labor markets are incomplete and/or if labor productivity is associated with nutrient and health status, it is not possible to separate empirically the household income/production decisions from the demands for individual nutrient intakes, other health-related inputs, and health status. That is, in such demand relations, income should not be treated as a predetermined variable as in standard demand analysis, but recognized as a simultaneously-determined outcome.

In recognition of this possibility, so-called "farm-household" models have been proposed and utilized by Lau, Lin and Yotopoulos (1978), Barnum and Squire (1979) and others. These models view the farm production and household demand processes as inseparable. For the empirical case of relevance for this study, markets appear to be incomplete and there are studies which indicate an empirically-significant labor productivity-nutrition intake/health link (e.g., Deolalikar 1984, Kyan and Ghodake 1984, Ryan 1982). Therefore the farm-household approach appears to be appropriate for this study. This means that among the relevant production functions in the constrained maximization are the farm product production functions and the labor market wage production functions, both of which may depend on individual nutrient intakes and/or health status. As a result, the reduced-form demand relations for individual nutrient intakes and health status depend not only on consumption goods prices (including those for nutrients and other-health related inputs) and household assets, but also on prices of agricultural products and inputs and on agricultural assets. If a farm household produces and consumes a particular good, an increase in the price of that good has a positive income impact on the demand for that good that works in the opposite direction from the standard negative effect on consumption of the price rise; if the household produces sufficiently large quantities of the good, the former income effect

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may dominate so that consumption increases as the price rises.[2] On the other hand, neither wages nor income are predetermined; therefore they do not appear in such reduced-form relations.

Bargaining models of intrahousehold allocation: A common alternative view is that the assumption of an "as if" unified preference function for the household is fundamentally misleading. Instead, intrahousehold allocations reflect the outcomes of ongoing bargaining processes, with the strength of each bargainer depending on his or her assets (including human capital) and his or her power (e.g., Engle 1984, Folbre 1986 and the references therein). Bargaining strength in part reflects market options (e.g., with women having greater bargaining strength if their labor market options are better) and cultural factors (perhaps working through markets and other institutions). Within this framework, of course, incomplete markets and/or labor productivity-nutrient/health status links may require a household-farm demand cum production approach rather than a narrower consumption demand-only focus. The resulting reduced forms relate the individual nutrient and health status outcomes to all consumption and production-related prices, all individual assets and whatever else determines individual bargaining power. For goods that are produced and consumed, once again, the total impact of price changes depends on opposing income/production and price/consumption effects, with possible additional complications if the bargaining strengths of particular household members are affected by the price change.

To us it seems plausible that bargaining among household members is an important part of what determines intrahousehold allocations of nutrients and individual health status. Yet, for the purpose of most of this and many similar studies, we can remain agnostic about which of these two strains of literature on household models is more relevant. This is the case because the

reduced-form demand equations that come out of the two approaches are identical with regard to the inclusion of typically-observed variables. To distinguish between the approaches on the bases of the reduced-form estimates would require observations on some assets controlled by certain types of individuals (e.g., women) that plausibly affect bargaining power, but not income nor (shadow or market) prices.[3] Within most data sets, including the one that we use, it is extremely difficult to identify such variables.[4]

But for most of our purposes in this study (except for Section 5), it is not critical to do so. We primarily are interested in the reduced-form determinants of individual nutrient and health status outcomes and whether the reduced-form elasticities change across seasons. Therefore the important implications of both strands of the farm-household literature is that the reduced-form demands for individual nutrients and health status depend upon both consumption and production prices and assets and that the income effect of production prices opposes the demand effect of consumption prices for goods that are both produced and consumed by farm-household units. We do not need to be able to look into the "black box" mechanisms of intrahousehold decision-making to test empirically whether the coefficients in the particular (log-linear) approximation of these relations that we use are or are not different across seasons.

2. Data from Rural South India

We use the ICRISAT VLS (International Crops Research Institute for the Semi-Arid Tropics Village Level Studies) data set to estimate reduced-form individual nutrient intake and health status relations. The ICRISAT VLS data are panel data that have been collected at regular intervals since 1975 on production, expenditure, time allocation, prices, wages, and socioeconomic

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characteristics for 240 households in six carefully selected "typical" villages in three different agroclimatic zones in SAT India. Within each village 10 households are randomly selected representatives of agricultural labor and nonland holding households and another 30 are a stratified (by size of land holdings) random sample of cultivating households. For the 1976/7 and 1977/8 crop years, four nutrition surveys were taken in which were recorded individual nutrient intakes in the past 24 hours and anthropometric measures of health status. These surveys were timed to obtain observations from each village on both the "surplus" season -- during which food is relatively available -- and the "lean" season during which food is relatively scarce. We use these seasonal definitions for our analysis below. We utilize the average value for each season for each individual as an observation, which gives us a total of 1786 individual/season observations.[5,6]

The basic dependent variables of interest for this study are measures of individual nutrient intakes and of individual health status. We focus on individuals because of the increasing evidence that substantial variation occurs in standard nutrient intakes among members of households (e.g., Behrman 1985, Behrman and Deolalikar 1985b, Horton 1984, Pinstrup-Anderson and Garcia 1984, Pitt and Rosenzweig 1984 and 1985, Rosenzweig and Schultz 1982, and Schofield 1974). For nutrient intakes we concentrate on calories and proteins.[7] For short-run health status we use weight-for-height, an anthropometric measure that is widely assumed to pertain to short-run health status.[8,9] Each of the nutrient variables was standardized for age and sex by using Indian Recommended Daily Allowances in Gopalan, Sastry and Balasubramanian (1971). Weight-for-height was standardized by modified Harvard standards (see Ryan, Bidinger, Rao and Pushpamma 1984, p. 14). The use of Indian or modified international standards instead of using standards

from more-developed, healthy populations should help to avoid the possible mistatements of nutritional and health status through using inappropriate reference groups that have been emphasized increasingly recently by Sukhatme (1982), Seckler (1980), Srinivasan (1981) and others.

Table 1 gives the means, standard deviations, the standard errors of the means, and the coefficients of variation by seasons for these nutrient intake and health status variables for all individuals and for men, women, boys and girls (with individuals over 15 years of age classified as adults). The means for all individuals taken together and for each of the four groups are significantly below the standards.[10] For calories, the overall lean-season mean is 46.7 and that for the surplus season is 48.5 percent of the standard, with women significantly higher than men and men significantly higher than children with regard to satisfaction of the standards for both seasons. For the overall sample and for each individual group, the means for calories are significantly greater in the surplus than in the lean season. For proteins, the overall lean-season mean is 68.6 percent and the surplus-season mean is 69.4 percent of the standards, with boys significantly higher than girls and girls significantly higher than adults with regard to satisfaction of these standards for both seasons. The mean protein intakes, however, do not differ significantly between the seasons for any demographic group. For weight-for-height, the overall lean-season mean is 84.5 and the surplus-season mean is 83.9 percent of the standards, with children significantly higher than women and women significantly higher than men with regard to satisfaction of these standards. For none of the demographic groups is the seasonal difference for weight-for-height significant at the five percent level, though that for women is significantly higher in the lean season at the 10 percent level.

Thus, with respect to the dependent variables, most members of our sample

Table 1. Characteristics of se distributions for calorie and protein intakes and fo ,ht-for-height for all individuals and for men, women, boys and girls in rural south India, 1976-1978[a]

	Lean Season				Surplus Season			
	Mean	Standard deviation	Standard error of Mean	Coefficient of Variation	Mean	Standard deviation	Standard error of mean	Coefficient of Variation
All Individuals								
Calories	46.7	17.5	0.4	37.5	48.5	16.0	.35	33.0
Protein	68.6	32.0	0.7	46.6	69.4	26.1	0.6	38.4
Weight-for-height	84.5	9.8	0.2	11.7	83.9	10.0	0.2	11.9
Men								
Calories	46.6	16.3	0.7	35.0	48.7	14.3	0.6	29.8
Protein	67.7	26.8	1.6	43.0	67.1	22.9	0.9	34.1
Weight-for-height	80.2	9.8	0.4	12.2	79.8	9.5	0.4	11.9
Women								
Calories	50.5	18.9	0.8	37.4	52.5	16.7	0.7	31.8
Protein	67.4	30.2	1.3	44.8	68.4	25.1	1.0	36.6
Weight-for-height	84.0	10.0	0.5	11.9	82.7	10.0	0.5	12.0
Boys								
Calories	44.2	16.7	0.8	37.4	46.7	16.7	0.8	35.7
Protein	76.1	35.2	1.3	49.5	73.7	31.1	1.5	42.9
Weight-for-height	88.3	7.7	0.4	8.7	87.8	8.7	0.5	9.9
Girls								
Calories	44.2	17.4	0.9	39.4	45.1	15.7	0.8	34.8
Protein	70.4	35.4	1.7	50.2	70.0	28.5	1.4	40.7
Weight-for-height	88.8	8.5	0.5	9.6	88.8	8.6	0.5	9.7

[a]All variables are relative to standards of 100. See Section 2 for the data sources.

are significantly below the standards — especially for calorie intakes — with some variance among the four demographic groups. For calories — but not for proteins nor for weight-for-height — there are significant differences in the means between the seasons. Of course whether or not there are significant differences in the means does not indicate whether or not the reduced-from relations differ seasonally. For the nutrients, finally, there are substantial interpersonal variations around its means which tend to be larger systematically in the lean season than in the surplus season.

The independent variables of primary interest for this study pertain to consumption and production prices and assets. Because of limited price variation in our sample (due to limited variation in observations both over time and across space), multicollinearity precludes including a large number of prices. We focus on five key prices for: rice, milk, sorghum, pulses, and bullock hours. Though individual households vary, the average household both produces and consumes all of these items. We do not include nonfood prices that are directly related to health status because we do not have observations on such prices.[11] We used monthly prices to calculate seasonal prices for each of these five items for each village. With regard to assets we focus on the size of operational land holdings since the primary form of physical wealth in these communities is land.[12]

3. Estimates of Reduced-Form Demand Relations for Nutrient Intakes and Health Status for All Individuals

Table 2 presents the basic reduced-form log-linear estimates of the demands for the two individual nutrient intakes and the weight-for-height indicator of health status for all 1786 individual/season observations. In

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Table 2. Reduced-form seasonal log-linear demand relations for standardized calories, proteins and wieght-for-height for individuals in rural south India, 1976-1978[a]

Right-side variables	Calories	Proteins	Weight-for-height
Price of milk	5.6 (10.9)	7.9 (13.9)	0.3 (2.0)
Price of milk x season	-6.5 (11.3)	-7.9 (12.4)	-0.3 (1.5)
Price of sorghum	-1.3 (6.7)	-1.2 (5.4)	0.1 (2.2)
Price of sorghum x season	1.2 (5.1)	0.9 (3.6)	-0.1 (0.1)
Price of rice	-7.5 (11.0)	-9.4 (12.4)	-0.1 (0.6)
Price of rice x season	7.8 (11.0)	9.8 (12.4)	0.2 (0.9)
Price of pulses	-4.7 (11.2)	-6.3 (13.5)	-0.1 (0.8)
Price of pulses x season	5.2 (12.0)	6.4 (13.3)	0.1 (0.8)
Price of bullock power	-1.7 (9.9)	-2.2 (11.1)	-0.1 (1.2)
Price of bullock power x season	2.0 (9.9)	2.4 (10.8)	0.1 (1.9)
Size of holding	0.0 (3.1)	0.0 (3.3)	0.0 (0.5)
Size of holding x season	0.0 (0.6)	0.0 (0.7)	0.0 (0.4)
Age	0.1 (5.0)	0.0 (2.3)	-0.1 (11.2)
Age x season	0.0 (0.3)	0.0 (0.2)	0.0 (1.1)
Male	0.0 (1.2)	0.0 (1.8)	-0.0 (2.5)
Male x season	0.0 (0.1)	0.0 (0.4)	0.0 (0.3)
Intercept	17.1 (16.2)	20.9 (17.7)	4.8 (13.3)
Season dichotomous variable	-13.7 (12.8)	-16.9 (14.1)	-0.4 (1.2)
R-square	0.17	0.23	0.17
F-ratio	21.7	31.7	21.4

[a]The data are described in Section 2 and the specifications are discussed in Section 3. The season dichotomous variable has a value of zero in the lean season and a value of one in the surplus season. The male dichotomous variable has a value of one for males and zero for females. Beneath the point estimates are the absolute values of t statistics.

addition to the five prices and land holdings, we also include age and gender of the individual of relevance for each observation among the right-side variables since there seems to be some differences among demographic groups in the nutrient and weight-for-height distributions summarized in Table 1. Because of the log-linear specification, each of the coefficients of the right-side variables is an elasticity, giving the percentage change in the dependent variable for that column relative to a given percentage change of the designated right-side variable. Each coefficient for each right-side variable, moreover, is allowed to vary by seasons: the elasticity in the lean season is just the coefficient of the variable itself, but to obtain the elasticity in the surplus season to that value must be added the coefficient immediately below of the variable times the seasonal variable (e.g., the lean season elasticity of calories with respect to the price of milk is 5.6 and that for the surplus season is -1.1). We discuss first the nutrient determinants and then those for health status.

Reduced-form individual nutrient demand relations: Significant price effects are pervasive for both calories and proteins, as are significant differences between the price elasticities for the lean versus the surplus seasons. The sign patterns of the price elasticities for the lean-season and for the adjustment for the surplus season are the same for both calories and proteins, though both the absolute magnitudes of the lean season elasticities and of the adjustments for the surplus season — if significantly different — are larger for proteins than for calories.[13] Thus there is a systematic tendency for proteins to be treated as "luxuries" relative to calories in the senses that intake is adjusted more in response to price movements in the lean season and that the price responses change more between seasons. Note that

this pattern occurs even though the seasonal differences in the means for proteins in Table 1 are not significant, but those for calories are.

What is the nature of the seasonal patterns in the nutrient price elasticities? For all of the prices, the lean-season price elasticities are fairly large in absolute magnitude, implying considerable price responsiveness when food is relatively scarce. For all but milk, the signs are negative. As prices of any of the other three farm production-household consumption goods (i.e., sorghum, rice and pulses) and the one agricultural input increase during the lean season, intakes of both nutrients decline more than proportionately. For milk, in contrast, the positive elasticity suggests that these households are substantial net suppliers of milk even in the lean season and the positive impact on nutritional intakes of the income gained from milk sales outweighs negative price effects when the price rises.

For the surplus season, in contrast, all of the nutrient price elasticity estimates are significantly closer to zero. That is, except for milk, they are algebraically more positive — presumably because the income effects are relatively more important in these cases during the surplus season when these households are selling their marketed surplus. Thus the seasonal changes in the price elasticities seem generally consistent with the seasonal patterns of production and market involvement.

What about the impact of household assets and individual characteristics? Among these, only the size of operational holdings and age have significant coefficients. In both cases the elasticities are quite small — 0.1 or less. For the land asset variable this result is consistent with the growing evidence of there being a very limited impact of income on nutrient intakes apparently because at the margin other food characteristics (e.g., status value, tastes, appearance, processing) are valued much more

highly than nutrients even by these relatively poor people.[14] For age, there apparently is a small systematic improvement in nutrient intakes relative to standards over the life cycle. Gender has no significant effect at the five percent level, though for proteins there is a small effect that is significant at the ten percent level. But there is not evidence of a seasonal effect of land assets, nor of age nor gender of the individual.

Reduced-form individual health status relations: Price effects are less pervasive and less substantial for the indicator of health status than of nutrient intakes. At the five percent level only the lean-season prices of milk and of sorghum have significantly nonzero coefficient estimates (though that for bullock power in the surplus season is significant at the ten percent level), and the largest of these elasticities is only 0.3 Thus, despite significant and substantial price responses in nutrient intake relations that differ between the seasons, there is not much evidence of important price responses and even less evidence of seasonal differences in the determinants of this indicator of health status. Apparently nutrient requirements adjust seasonally[15], energy expenditures adjust seasonally to compensate for changed nutrient intakes, and/or the impact on health status of seasonal nutrient changes in response to prices is not captured well by anthropometric measures such as weight-for-height.

What about the impact of household assets and individual characteristics? The land asset coefficients in the health determination relation are not significantly nonzero at the five percent level. For age and being male, in contrast, the impacts are negative and significant, though once again without seasonal effects.

Thus, there appears to be virtually no evidence of significant seasonal effects in the reduced-form relation for health status, as contrasted with the

substantial seasonal effects in the reduced-form relations for nutrients.

4. Estimates of Reduced-Form Demand Relations for Nutrient Intakes and Health Status for Men, Women, Boys and Girls

The estimates in the previous section indicate some possible effect of age and sex on nutrient intakes and health status relative to standards, but with no difference across seasons in any such effects. However these estimates restrict the differences by sex and age to be additive. Given the considerable emphasis on differential treatment of different types of individuals within households (e.g., Engle 1984, Folbre 1984, 1986 and the references therein) and some statistical evidence that such differential treatment occurs in rural Indian households (e.g., Behrman and Deolalikar 1985b, Rosenzweig and Schultz 1982 and the references therein), it is of interest to explore whether the nutrient and health relations differ in other than additive ways across types of individuals.

Table 3 gives estimates of the three relations for the four groups of individuals: men, women, boys and girls. The general patterns are the same as in the overall estimates of Table 2: price responses are pervasive for nutrient determinants, though larger in absolute value for the lean than for the surplus season and tending to be larger for proteins than for calories; price effects are very limited for weight-for-height; and land asset effects generally are fairly limited.

But what is of interest for our present purpose is not the general picture, but the details. Do the estimates differ significantly among the four types of individuals?

Strictly speaking, the answer to this question is: not in many cases.

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Table 3. Reduced-form seaso -linear demand relations for standardized calories and proteins and weight-for-h or men, women, boys and girls in rural south India[a]

	Calories				Protein				Weight-for-height			
	Men	Women	Boys	Girls	Men	Women	Boys	Girls	Men	Women	Boys	Girls
Price of milk	5.2	5.6	4.9	6.6	7.9	8.7	6.6	7.9	0.3	-0.1	0.6	0.8
	(6.4)	(5.6)	(4.3)	(5.0)	(8.8)	(7.7)	(5.0)	(5.5)	(0.9)	(0.3)	(1.9)	(2.2)
Price of milk x season	-6.3	-6.6	-6.0	-6.9	-8.0	-8.5	-7.1	-7.3	-0.5	0.3	-0.6	-0.5
	(6.9)	(5.8)	(4.7)	(4.6)	(8.0)	(6.7)	(4.8)	(4.6)	(1.4)	(0.8)	(1.7)	(1.3)
Price of sorghum	-1.6	-1.9	-1.0	-0.5	-1.6	-1.8	-1.1	0.0	0.1	0.4	0.0	-0.1
	(4.9)	(5.0)	(2.3)	(0.9)	(4.4)	(7.3)	(2.1)	(0.0)	(0.9)	(2.8)	(0.2)	(0.8)
Price of Sorghum x season	1.4	1.6	1.0	0.3	1.3	1.3	1.0	-0.3	0.1	-0.4	0.0	0.0
	(3.8)	(3.6)	(1.9)	(0.4)	(3.1)	(2.6)	(1.7)	(0.4)	(0.7)	(2.1)	(0.3)	(0.1)
Price of rice	-7.1	-8.0	-6.3	-8.7	-9.5	-10.7	-7.7	-9.1	-0.2	0.7	-5.2	-0.8
	(6.6)	(5.9)	(4.3)	(4.9)	(8.1)	(7.1)	(4.5)	(4.8)	(0.6)	(1.4)	(1.2)	(1.8)
Price of rice x season	7.7	8.1	6.8	8.7	10.2	10.7	8.5	9.0	0.6	-0.8	0.6	0.7
	(6.9)	(5.7)	(4.4)	(4.7)	(8.3)	(6.8)	(4.7)	(4.6)	(1.2)	(1.4)	(1.4)	(1.4)
Price of pulses	-4.5	-5.1	-4.0	-5.2	-6.5	-7.2	-5.3	-5.9	-0.2	0.4	-0.4	-0.6
	(6.8)	(6.1)	(4.4)	(4.7)	(8.8)	(7.8)	(5.0)	(5.1)	(0.6)	(1.2)	(1.4)	(1.9)
Price of pulses x season	5.2	5.5	4.4	5.8	6.7	7.1	5.5	6.0	0.3	-0.6	0.4	0.5
	(7.5)	(6.3)	(4.7)	(5.1)	(8.8)	(7.4)	(5.0)	(5.0)	(1.2)	(1.7)	(1.4)	(1.8)
Price of bullock power	-1.8	-1.6	-1.6	-2.0	-2.3	-2.2	-1.9	-2.0	0.0	0.0	-0.2	-0.1
	(6.4)	(4.6)	(4.0)	(4.3)	(7.5)	(5.9)	(4.0)	(4.1)	(0.3)	(0.3)	(1.7)	(1.2)
Price of bullock power x season	1.8	2.0	1.9	2.0	2.4	2.5	2.1	2.1	0.0	0.2	0.2	0.2
	(5.8)	(5.3)	(4.3)	(3.8)	(6.8)	(6.1)	(4.1)	(3.8)	(0.5)	(1.4)	(1.7)	(1.6)
Size of holding	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	(1.0)	(2.8)	(0.9)	(1.5)	(1.9)	(2.6)	(1.2)	(1.5)	(0.7)	(0.4)	(1.0)	(1.2)
Size of holding x season	-0.0	-0.0	0.0	0.0	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(0.2)	(1.1)	(0.8)	(0.5)	(0.7)	(0.7)	(0.2)	(0.5)	(0.5)	(0.3)	(0.2)	(0.7)
Intercept	17.3	17.9	15.5	18.5	21.6	22.6	18.3	19.4	4.5	3.4	5.4	5.7
	(10.1)	(8.7)	(6.6)	6.7)	(11.6)	(9.9)	(2.7)	(6.6)	(6.7)	(4.4)	(8.2)	(7.9)
Season dichotomous variable	-13.5	-14.4	-12.2	-14.7	-17.7	-18.5	-14.5	-15.3	-0.4	0.7	-1.1	-1.4
	(7.9)	(6.9)	(5.1)	(5.3)	(9.4)	(8.0)	(5.3)	(5.1)	(0.6)	(0.9)	(1.7)	(2.0)
R-square	0.19	0.18	0.12	0.15	0.30	0.26	0.19	0.20	0.05	0.08	0.04	0.11
F-ratio	10.0	7.9	4.4	4.5	18.6	12.3	7.1	6.2	2.5	3.1	1.2	3.1

[a]There are 573 observations for men, 465 for women, 386 for boys and 324 for girls. For other details, see note to Table 2.

Pairwise t-tests for differences in the coefficients are significant at the five percent level only when comparing the impact of the price of sorghum on nutrient intakes for women versus girls in the lean season. This comparison is weakly reminescent of the relatively great price responses for nutrient intakes for women and relatively small ones for girls reported for annual estimates in Behrman and Deolalikar (1985b). In addition there are several cases in which the coefficient for at least one group is significantly nonzero, but that for at least one other group is not, though the difference is not significant since the standard error is so large for the latter. Examples of this pattern include the lean-season positive impact of size of operational land holdings on women's caloric intakes (and to a lesser extent, their protein intakes), the lean-season positive (sic) impact of the sorghum price on women's weight-for-height and the significant adjustment in this case across seasons, the lean-season positive impact of the price of milk on girl's weight-for-height (and, at the ten percent level, for boys) and the lack of a significant difference across seasons for the sorghum price impact on nutrients for girls (and for boys only at the ten percent level). Finally, though the estimates generally do not differ significantly for women from those for other groups (except for the effect of lean-season sorghum prices for women versus girls noted above), it is striking that for 19 of the 20 price or seasonal price difference coefficients, that for women is largest in absolute value (and is second largest in the other case — the lean-season price of milk for calories). Such a pattern is quite unlikely to occur by chance. Therefore it seems that women's nutrient consumption is a relative luxury in the senses that the lean-season price responses and the cross-season price elasticity adjustments are greatest for it.

Thus, there does seem to be some weak evidence of differential responses

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across the four groups. The size of land holdings may be more positively associated with nutrient intakes of women in the lean season than for others. Women's nutrient intakes are treated as relative luxuries and those for girls, at least in the important case of the price of the basic staple of sorghum, are treated as least adjustable. But on the whole the differences in the reduced-form nutrient intake and health status relations among these four groups are not very substantial nor often significant.

5. Seasonal Differences in Parental Preferences Parameters

To this point we have concentrated on reduced-form relations for nutrients and health status which, as we discuss in Section 2, are consistent with the leading alternative stories about the nature of intrahousehold allocation mechanisms. However now we explore some important dimensions of intrahousehold allocation conditional on this allocation being determined "as if" an unified preference function is being maximized. Subject to further assumptions about function forms for these preferences and for the health production function, we obtain seasonal estimates of two critical characteristics of these "as if" preferences: (1) the extent of parental inequality aversion that indicates the tradeoff in parental concern about the productivity of their nutrient investments in their children and the equity of the distribution of such investments among their children and (2) the extent of parental unequal concern in the sense that parents weigh equal health outcomes differently for different children depending on their relative birth order and gender.

The basic framework for this analysis is the Behrman, Pollak and Taubman, (1982, 1986) preference model for parental allocation of investments among

their children.[16] We now sketch out this model and refer the interested reader to the above references for more details.

We assume that the "as if" unified parental preference function is separable between the distribution of expected health outcomes for the children in the household and other outcomes of interest. Representative preference curves for the part of the parental welfare function defined over the expected health of the individual children are given in Figures 1A-D.

The first characteristic of these preferences mentioned above, the equity-productivity tradeoff, refers to the curvature of the preference curve. If the preference curve is linear as in Figure 1A, parents follow a pure investment strategy, allocating nutrients so as to maximize the aggregate expected health of their children, independent of the distribution of that health among their children. Any differential predetermined characteristics of the children, such as differential genetic make ups that mean that some are inherently more healthy than are others, are reinforced by the allocations of nutrients so that such nutrient investments have their highest possible returns since the returns from such investments are greater for children who inherently are more robust. If the preference curve is squared-cornered as in Figure 1B, parents follow a Rawlsian investment strategy, with concern only about the expected health of the worst-off child. This strategy implies compensating investment behavior as parents invest more in the child with the worst inherent healthiness. Between the two extremes there are curves such as in Figure 1C with productivity-equity tradeoffs. The less (more) the curvature, the more the parents reinforce (compensate for) inherent health differences among their children. There is one curve along any ray from the origin with a curvature in between the extremes for which parents neither compensate nor reinforce inherent differences among their children, but follow a neutral

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Figure 1: Behrman-Pollak-Taubman model of intrahousehold allocation of nutrients among children to produce a distribution of expected health among the children

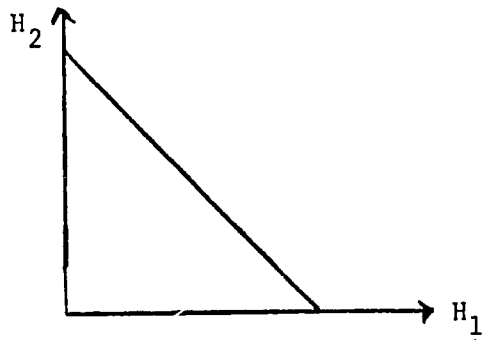

Figure 1A. Linear parental preferences (pure investment or no inequality aversion case) with equal concern.

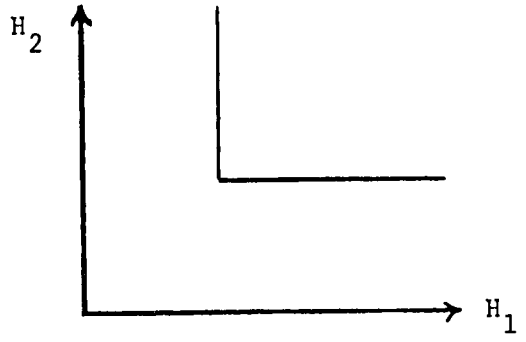

Figure 1B. Square-cornered parental preferences (Rawlsian or infinite inequality aversion case) with equal concern.

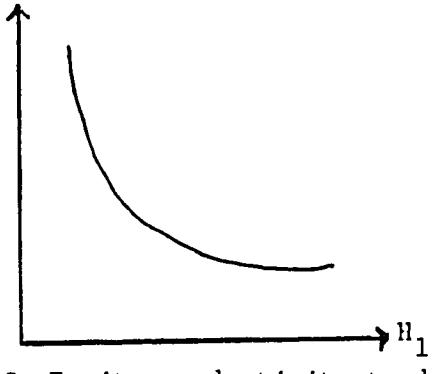

Figure 1C. Equity-productivity tradeoff in parental preferences with equal concern.

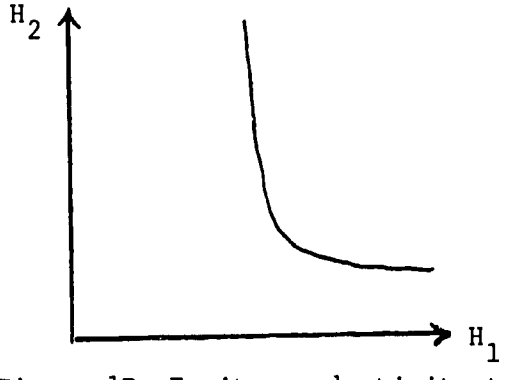

Figure 1D. Equity-productivity tradeoff in parental preferences with unequal concern favoring child one.

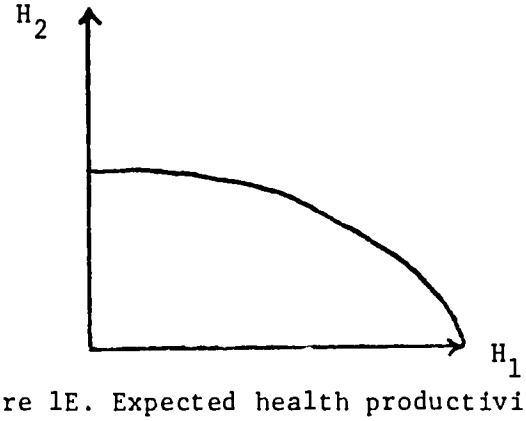

Figure 1E. Expected health productivity possibility frontier with child one having ter endowments.

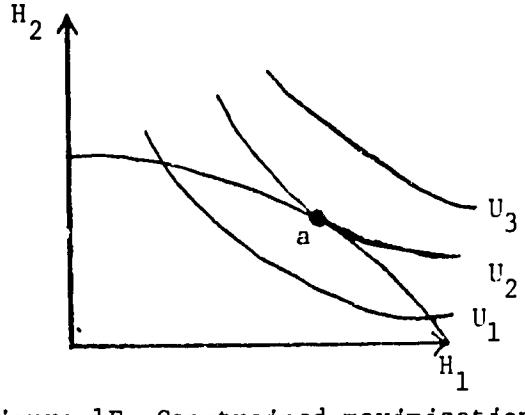

Figure 1F. Constrained maximization of parental preferences at point a.

strategy.[17]

The second characteristics of these preferences mentioned above, the extent of parental unequal concern, refers to the asymmetry of the preference curves around a 45° degree ray from the origin. If the preference curves are symmetrical around the 45° ray as in Figures 1A-1C, parents weigh equal outcomes for different children equally. If the parents weigh equal outcomes differently for different children, the curves are not symmetrical around the 45° ray. Figure 1D gives an example in which parents weigh equal outcomes more heavily for child one than for child two — or have unequal concern favoring child one over child two.

For our empirical estimates we assume that the parental preference function for the distribution of expected health outcomes among their children is of constant elasticity of substitution (CES) form:

$$U_H = \sum_{i=1}^{n} a_i H_i^c \tag{1}$$

where U_H is the separable parental utility derived from the expected health of their n children;

H_i is the expected health of the ith child;

a_i is the parental weight on expected health outcomes for child i; and

c relates to parental inequality aversion.

Parental inequality aversion is associated with the parameter c. At one extreme $c \to 1$ is the pure investment or zero inequality aversion case in which parents are concerned only about the total expected health of their children, not the distributed of expected health among their children. At the other extreme $c \to -\infty$ is the Rawlsian or infinite inequality aversion case in which

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parents only value improved health for the worst-off child. Among the infinite values in between is $c = 0$, which is the neutral case in which parents neither reinforce nor compensate for predetermined inequalities in the health of their children. The a_i refer to the extent of unequal concern, with $a_1 > a_2$ implying that the parents favor child one over child two.

These preferences are maximized subject to two sets of constraints. The first is a budget constraint for total investments in all n children. The second is a set of production function constraints for the health of each individual child, as dependent on the nutrients and other investments in that child and on that child's predetermined healthiness (or endowments). For our empirical work we use a quasi-Cobb-Douglas health production function:[18]

$$H_i = N_i^h f(X_i, E_i) \tag{2}$$

where H_i is the expected health of the ith individual,

N_i is the nutrient intake of the ith individual,

X_i is other purchased health-related inputs for the ith individual;

E_i is the predetermined health endowment of the ith individual;

h is the elasticity of the expected health outcome with respect to nutrient intakes; and

f is any function with properties so that the expected health production function has the standard desirable characteristics.

These constraints define an expected health-production frontier, as is

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illustrated in Figure 1E. In general this frontier is not symmetrical around the 45° ray since one child is better endowed than the other. Figure 1E is drawn as if child one is better endowed than is child two.

Preferences are maximized subject to the expected health-production frontier. Given standard assumptions about the preferences and health production technology so that an interior solution occurs, the maximum is at a tangency of the preference curve with the expected-health production frontier as in Figure 1F at point a. At this point parental utility is greater than for other obtainable preference curves which are not tangent to the expected health production possibility frontier, such as U_1 (and still higher preference levels than U_2, such as U_3, are not obtainable since they are every where outside of the expected health production-possibility frontier). Since the expected health-production frontier differs across pairs of children because relative endowments differ across pairs of children, the tangencies are at differ parts of the preference curve for different pairs of children. Therefore we can estimate the curvature (and thus the equity-productivity tradeoff) and the location (and thus asymmetry or unequal concern) of the preference curve by observations on a number of tangencies for different pairs of children.

To estimate the parameters of the preference function, we utilize the first-order conditions associated with such tangencies. The ratio of these first-order conditions gives:[19,20]

$$(3) \qquad \left(\frac{a_i}{a_j}\right) \left(\frac{H_i}{H_j}\right)^c e^u = \frac{N_j}{N_i}$$

To investigate the possibility of unequal concern reflecting relative birth order or gender of the children, we posit that:

$$(4) \qquad \left(\frac{a_i}{a_j}\right) = e^{\alpha D_B + \beta D_G}$$

where D_B is a dichotomous variable with a value of one if child i is older and a value of zero of child j is older; and

D_G is a trichotomous variable with a value of one if child i is male and child j is female, a value of minus one if the opposite is the case, and a value of zero if both are of the same gender.

Substitution of (4) into (3) and taking logarithms leads to:

$$(5) \qquad \ln (N_j/N_i) = \alpha D_B + \beta D_G + c \ln (H_i/H_j) + u$$

One advantage of this expression is that it is linear in the parameters. A second advantage is that unobserved endowments do not enter directly into the expression. On the other hand, since nutrient intakes and health status are determined simultaneously, the parameter estimates may be biased.[21] In fact, it can be shown that the simultaneity bias results in an upward bias in the estimate of c (see Behrman 1985 or Behrman and Taubman 1986).

We have estimated relation (5) with the parameters constrained to be identical for calories and for proteins, in both cases with weight-for-height as the health indicator, for 269 pairs of children from our sample for both the surplus and the lean seasons. Table 4 presents these estimates.

These estimates suggest that for the surplus season, parental inequality aversion is not significantly different from zero, nor significantly different from values estimated for the allocation of schooling investments among

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Table 4. Seasonal estimates of parental inequality aversion and unequal concern in Behrman-Pollak-Taubman model of intrahousehold nutrient allocation for rural south India, 1976-1978[a]

	c Inequality Aversion or Equity-Productivity Tradeoff	Unequal Concern α Relative Birth-Order	 β Gender	$\bar{R}^2$	
Surplus Season	.23 (1.4)	.06 (3.1)	.08 (3.0)	.04	7.3
Lean Season	.57 (4.2)	.02 (1.6)	.05 (2.3)	.05	8.9

[a]Section 2 describes the data. Section 5 describes the model. Beneath the point estimates in parentheses are absolute t statistics.

children in two generations for the United States (Behrman, Pollak and Taubman 1982 and 1986, Behrman and Taubman 1986). However for the lean season, inequality aversion is significantly larger than for the surplus season or for the United States.[22] Thus, when food is scarcest, parents in these rural south Indian households apparently act as if they adopt much more of a pure investment strategy then when food is relatively available,[23] which may leave the children who are poorly endowed quite vulnerable.

What about the extent of unequal concern? The estimates suggest that parental preferences weigh equal health outcomes about 1.05 to 1.08 as much for boys as for girls in both seasons, without a significant difference between the seasons. Parents also weigh equal equal health outcomes about 1.02 to 1.06 as much for older as for younger children, again without any significant difference between the seasons, though the estimate for the lean season does not indicate a significant effect of birth order.[24]

6. Concluding Remarks

For this sample from rural south India, on the average there are seasonal differences in mean standardized intakes of calories, but not for proteins nor for the weight-for-height short-run indicator of health status. However such averages do not in themselves tell whether there are significant seasonal differences in the determinants of nutrient intakes and short-run health status — that is, in the responsiveness to prices and assets. We use a farm-household model to estimate, for the first time to our knowledge, seasonal reduced-form demand relations for individual nutrient intakes and health status.

Our estimates indicate that there are significant and substantial seasonal differences in these relations for nutrients. There is a systematic

pattern of price responses being relatively large in absolute magnitude in the lean season when food is relatively scarce. They change substantially for the surplus season, with the adjustment in an algebraically positive direction for most of the price responses, which is consistent with the implications of the farm-household framework since there is a large positive income effect in the surplus season when these farm households sell their products. With respect to the composition of nutrients, intakes are adjusted systematically more for proteins than for calories in response to price changes, suggesting that calories are treated as relative necessities and proteins are treated as relative luxuries even though average levels of protein intakes do not differ between seasons. The greater flexibility in protein than in calorie intakes may not be surprising given that on the average individuals in this sample satisfy a significantly higher percentage of protein than of calorie standard requirements. Among different types of individuals identified by gender and age, these are significant differences in the mean satisfaction of standard requirements for both seasons for both nutrients (with women doing relatively well and children poorly for calories and with boys doing relatively well and adults poorly for proteins). However these differences do not seem to reflect substantial differences in the price responses in different seasons for different types of individuals, though there is some suggestion that nutrient intakes for women are treated as relative luxuries in the sense of adjusting most when prices change. Finally, we find very little evidence of a response to the size of land holdings, and almost no difference in any such response across seasons.

For the determinants of short-run health status as represented by weight-for-height, in contrast to the determinants of nutrients intakes, we find little evidence of significant responses to prices or to land holding or of

significant differences across seasons in the relations.

Investigation of the magnitude of critical parameters in the "as if" parental preference function regarding the allocation of nutrient investments among their children leads to no evidence of significant seasonal differences in the extent of parental favoring of boys over girls and of older children over younger children. However, there are significant seasonal differences in the apparent parental tradeoff between productivity and equity, with the parents acting as if they are followig much more of a pure investment strategy in the lean than in the surplus season.

There are several important implications of these results for analysis and policy. First, the analysis of seasonal nutrient and health patterns is enriched by analysis of seasonal differences in reduced-form determinants and in underlying structural relations. There may be important seasonal differences in the responses to such determinants even though there are not significant seasonal differences in means, as for proteins in this sample. In order to analyze the effects of market changes or of proposed policies, it is necessary to understand the extent of responsiveness in the underlying relations, and to what extent there are seasonal variations in such responses. Second, for nutrient intakes the price responses dominate, with little evidence of important asset responses. Therefore analysis of nutrient determinants and of related policies need to be very sensitive to market environments and changes in these environments, including seasonal changes. Third, in contrast, at least over the range of nutrient and health variations experienced by this sample, there is not much evidence of significant price nor asset responses for health status in either season. Though substantial adjustments apparently occur in the determinants of nutrient intakes, we do not find evidence of related adjustments in the health relations. If indeed

weight-for-height is a good indicator of short-run health status, this result may reflect the pattern of seasonal intrapersonal adjustments in metabolism and energy expenditures. Fourth, if one is interested in nutrient intakes, then attention to the lean season seems to be important for this sample. The combination of the relatively great price responsiveness and the behavior as if there is an adoption of closer to a pure investment strategy by parents in the lean season means that the more vulnerable are likely to be particularly exposed to malnutrition risk when food is scarcest.

Notes

[1]If there were no concern about health status per se, but only indirect effects of health status on productivity, the reduced-form demand relations discussed below still would be of the same general form.

[2]In rare cases a good that is produced and consumed may be a inferior good for which the income elasticity is negative. In such a case if the household is a net supplier, the income effect would reinforce the standard price effect.

[3]Human resources such as schooling or market wages cannot be used to discriminate between the two models since they plausibly affect both the shadow price of time and bargaining power.

[4]For more on this topic see Rosenzweig (1984) and Rosenzweig and Schultz (1984).

[5]For further details concerning the ICRISAT VLS data, see Binswanger and Jodha (1978) and Ryan, Bidinger, Rao and Pushpama (1984).

[6]The same individual may be included in the original data set up to four times. We have not attempted to control for fixed effects within seasons because for five of the six villages there is only one observation on one or the other of the seasons (i.e., only one observation during the lean season in three cases and only one during the surplus season in two cases), so such controls within seasons are not possible in many cases. Also we have found for nutrient estimates across the crop years that controlling for fixed

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effects does not make much difference (Behrman and Deolalikar 1985a).

[7]We also have considered the seven other nutrients for which data are available in the ICRISAT VLS surveys: β-carotine, riboflavin, vitamin C, calcium, iron, thiamine and niacine. However the general results do not differ substantially from those for calories and proteins presented below, so we focus on these two often-emphasized nutrients to preclude the presentation of an avalanche of estimates.

[8]We refer to this anthropometric measure as an indicator of health status, which is produced by nutrient intakes and other factors. Often such measures are refered to as indicators of nutritional status, but since nutrients are but one of the inputs in the production of health status, the labeling of the output as if it reflects only one or only some of the inputs may be misleading. For references and further discussion, see Behrman and Deolalikar (1986).

[9]For evidence that weight-for-height is significantly associated with intrahousehold allocation of nutrients and with labor productivity, see Behrman (1985) and Deolalikar (1984) respectively. We also have considered the other short-run anthropometric indicators available in the data set: weight, triceps skinfold fatness, and arm circumference. Since the general results do not vary substantially from those discussed below, we only present the estimates for weight-for-height to limit the possibility of not seeing the forest for the trees.

[10]Unless otherwise qualified, we use "significant" to refer to the standard

five percent level for a t-test throughout this paper.

[11]Pitt and Rosenzweig (1985) report that such prices in the form of the availability of community health care do have significant impacts. If the unobserved prices are correlated across the ICRISAT villages with our five included prices or with land holdings, our estimates of the coefficients of our observed variables may be biased.

[12]The data set includes information on schooling, but schooling levels are quite low and do not seem to be significantly associated with nutrient intakes and health status (e.g., Behrman and Deolalikar 1985b and Ryan, Bidinger, Rao and Pushpamma 1984). Therefore, in the interests of a parsimonious specification, we have not included schooling in the estimates presented below. We also do not include other assets and endowments, many of which are unobserved. If such unobserved variables are correlated with our included variables, our coefficient estimates may be biased.

[13]For the lean season the point estimates differ significantly between calories and proteins for the prices of milk, rice and pulses with the absolute values larger in each case for proteins. The difference between the lean- and surplus-season elasticities are significant between calories and proteins for milk, rice and pulses, with the absolute magnitude of the adjustment larger in each case for proteins.

[14]See Behrman and Deolalikar 1985a and Ryan, Bidinger, Rao and Pushpamma (1984).

[15]Srinivasan (1981) and Sukhatme (1982), for instance, have emphasized the existence of substantial intraperson variations in nutrient requirements.

[16]Behrman (1985) presents an extension to the multi-input, multi-output case, but that extension is not relevant here since we are focusing on one output measure for health.

[17]In the special case of a constant-elasticity-of-substitution preference function, the same curve has this property for all rays from the origin. Equation (1) below is of this form.

[18]For simplicity we write this expression with only one nutrient intake. In general, however, N_i could be a vector of such intakes.

[19]An addition assumption is that parents face the same prices for child investments for all of the children in the household. That is, the price of a calorie obtained, say, from sorghum is the same independent of which child eats the sorghum.

[20]Note that the expected health production function parameters do not appear explicitly in this ratio form.

[21]Furthermore, if child endowments are not observed and if the parents face the same prices for investments in all children, there are not instruments that could be used to control for the simultaneity.

[22]All of these estimates may be biased upwards, as noted above, but there is

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no reason to expect that the lean-season estimates are biased any more than are the others, so the relative comparisons still are informative even if there is an upward bias.

[23]Though still with some concern about inequality. Similar results are obtained with a multiple-indicator representation of health in Behrman (1985).

[24]These estimates do not indicate why there are greater weights placed on health outcomes for boys and older children. Rosenzweig and Schultz (1982) suggest that the reason, at least in regard to the gender distinction, is due to higher labor market returns to boy's than to girl's health.

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INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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SEASONALITY IN FOOD SYSTEMS
AN ANTHROPOLOGICAL PERSPECTIVE
ON HOUSEHOLD FOOD SECURITY

by

Ellen Messer

IFPRI/FAO/AID Workshop on "Seasonal Causes of
Household Food Insecurity: Policy Implications
and Research Needs

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Seasonality in Food Systems:An Anthropological Perspective On Household Food Security

Ellen Messer
Dept. Anthropology
Wheaton College
Norton, MA 02766

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INTRODUCTION

Why seasons matter (Chambers 1982) has been explored continually by anthropologists. A review of their efforts indicates "seasonality" is an important factor in human subsistence and social life but involves multiple dimensions: a)nutrients, b)foods (intake and consumption patterns), c)illness, d)economic activities, such as trade, market, work activities (wage labor). No particular household structure or social organization provides a recipe for limiting seasonal risks, as conditions of natural resources, climate, population, and access to markets vary from area to area. The common sociocultural "coping" mechanisms involve a)alternative sources of food, b)alternative food intake patterns, including social mechanisms such as movement to other households), c)rationing, d)occupational diversification to secure alternative cash sources of income to buy food, e)alternative activity patterns--there is more resting.

Anthropologists studying food systems--production, cultural classifications, rules for social distribution, and nutritional patterns of consumption--and their evolution, have found seasonality in climate and available food resources, ordinary and ritual activities, and behaviors and emotions affect social cooperation, cultural identity, nutrition, and health. For archaeologists, seasonality and scheduling of foraging and cultivation activities among different plant and animal food species have been central to the elucidation of the evolution of diet and human social organization in both the Old and the New World (Flannery 1973). How people adapt to the seasonal resources in different ecological zones, move or trade among those zones, and develop domestication and husbandry strategies for overcoming seasonal limitations through cultivation, storage and trade have been major

topics in prehistoric through contemporary investigations. For sociocultural anthropologists, seasonality in the food quest has been essential to the study of social organization and cultural activities which center around food. American ethnographers of the 1930s and 1940s, following standard descriptive formats, considered seasonality in plants, animals, agricultural and foraging strategies, and also in crafts and alternative occupations such as marketing. Regarding seasonal hunger in Africa, British Social Anthropologists since the 1930s have reported how food supplies in many African societies dwindle from one harvest to the next, and have described, and in many instances, judged the rationality of native cultivation, preservation, storage, and food distribution or rationing strategies (e.g., Fortes 1936; Richards 1939; Sharman 1970). That hunger exists, in both objective physiological as well as subjective psychological terms has been documented (e.g., Richards 1939; Ogbu 1973), along with analyses of whether adequate food production and consumption are within or beyond the control of the local population.

The eco-logic vs. socio-logic of seasonal settlement and subsistence strategies, has been a primary concern of those studying predominantly foraging and pastoral societies (Evans-Pritchard 1940; Mauss 1979) as well as those examining relationships between diet and domestic life in all levels of social organization (Sharman, Theophano, Curtis, and Messer). (I.e., the seasonal round of the environment explains the periodicity and duration of social cycles; it does not explain either the form of sociality which prevails in each phase or the institutional forms which express it.) Cross-cultural studies have explored the linkages of seasonality with the sexual division of labor in agriculture and child care arrangements (White

et al. 1981; Burton and White 1984). Ecological studies have considered seasonality in resources and activities from both objective and native points of view. Native understandings of seasonality in food supplies, the nutrient contents of foods, and hunger, which inform their decisionmaking in the food quest have been compared and contrasted with objective (scientific biological, energy, and nutritional) assessments of available foods and diets over the seasons (e.g., Jochim 1981; Winterhalder and Smith 1981). "Strategies for survival" have formed the subject of specialized inquiries, as anthropologists seek to understand responses to seasonal food shortages in ordinary years, and also to disaster (e.g., Raymond Firth 1959; Laughlin and Brady 1978; Colson 1979; Dirks 1981).

Economic studies have also described seasonal diversifications and restrictions in occupational activities and diet at the household level (e.g. Rosemary Firth 1949) and the role of exchange--particularly rates of exchange--in seasonal and permanent production specialization, such as that between pastoralists and agriculturalists (Bates and Lees 1977). Nutritional anthropological studies have examined seasonal adjustments in household composition in relation to food supply and sources of income (Sharman, Theophano, Curtis, and Messer n.d.), including the impact of seasonal income by sex, seasonal illness, and seasonal migrant labor on the nutrition and care of children.

Biophysical anthropologists directly address the topic of seasonality in their descriptions of energy expenditure, nutrition, health and disease, and also as they examine sociocultural health and nutritional strategies in harsh physical and political environments (Huss-Ashmore and Johnston 1985).

Key issues which emerge from such studies are that strategies to overcome seasonality and achieve food security undergo continual alteration as political, sociocultural, economic, and biological environment change simultaneously. There appears to be relatively little information on seasonal work, income, and consumption patterns in home or industrial manufacturing occupations. Most figures are still annual "averages" and not disaggregated by season. Additionally, the literature on seasonal food procurement strategies varies greatly from one geographical area to the next. For Africa, much of the literature examines crop and other income production strategies. There is also a growing historical literature on cropping and migratory work patterns, changing household and community structure, as influenced by colonial and national policies. However, there is relatively little literature on internal stratification of communities engaged in the cash economy, or on their dietary decisionmaking and intakes once they are dependent on market food purchases. For South and Southeast Asia, there appears to be abundant literature on food habits, social stratification, and the negative impact of agricultural development policies, particularly given the differences in access to land and wealth within communities. There is also good information on intrahousehold food distribution, particularly as it affects the nutrition and health of women and children. However, there appears to be less on seasonal income in non-agricultural occupations. For Latin America and the Caribbean, food system studies seem to focus on the nutritional differences within communities, stratified by income and ethnicity. For Mexico, there has developed a growing literature on how people choose foods when allowed market purchases, and the nutritional consequences of such decisions (dietary diversification)

compared with consumption of home-produced diet. There is less systematic information, however, on how people cope with seasonal shortfalls in home produced food supplies, although there is historical information on the topic (Warman 1981). Such disparities reflect both the differing interests of anthropologists who have worked in the different regions, but perhaps the complexity of food flows, nationally, regionall, communally, and within communities and households.

In sum, seasons are complex, involving several different types of seasonality, which must be seen as interrelated in the resource strategies of individuals, households, and communities. This paper will selectively examine the African literature on food system seasonality, paying particular attention to household food security strategies. It will then emphasize which types of models and data from the wider anthropological literature mig. ; be most useful for constructing a better understanding of seasonal hunger and its possible antidotes more generally.

Anthropological Studies of Africa

British social anthropologists working in pre-World War II colonial Africa provided some our earliest and most complete studies of the interrelationships among food supply, social organization, and nutrition over the seasons. Their studies indicated seasonal shortfalls in cultivated foods, extensive seasonal reliance on gathered foods, limited food purchases, and considerable reliance on social distributions when food was plentiful. Richards (1939), in her classic study of the Bemba of Northern Rhodesia, concluded that the reason natives did not work harder (a primary concern for British mining and other economic interests) was not a question of sloth, but of undernutrition. In this society, men had been drawn away

from their roles in local gardening production to the mines, and women found it difficult to perform the heavy clearing tasks traditionally assumed by males, and their own cultivation and gathering roles. Analyzing the activities throughout the year and the social relations surrounding food, Richards found that during the period of the year when women most needed food energy to sustain clearing and planting of fields, food was in shortest supply. Thus, they were enmeshed in an ongoing cycle of underproduction and undernutrition.

As part of her study, Richards recorded in detail the timing of seasonal rains, associated flora and fauna which could be seasonally foraged, the timing and nutritional value of different crops, and storage, preparation, and preservation methods for both wild and cultivated species. She analyzed the emotional qualities assigned to different foods: their desirability in terms of taste and digestibility, their importance in native ceremonial life--for instance, the importance of grains used in beer-brewing immediately after the harvest, and people's perceptions of the nutritional qualities and physiological effects of different staple grains and relishes eaten with them. People recognized seasonal hunger, when the staple grain was in short supply, and people had to fall back on bush foraging. They consciously restricted activity when food intake was low, although the season of peak labor demand was also the period before food supplies were replenished. She also described the social dimensions of food production, preparation, distribution, and consumption, noting how all kinship relations were marked by prescribed rules of sharing, as well as how these obligations would break down in times of dearth. She concluded that seasonal shortages were the result of insufficient labor rather than insufficient land. Marketed foods

at the time do not seem to have made significant inroads, although in times of dietary monotony, traders could command high prices for good, such as salted fish, which would break this monotony.

Fortes and Fortes (1936), working among the Tallensi of West Africa during the same period, described how natural and ritual seasonal cycles, social organization, and social relations were interrelated in terms of the food supply. They found among the Tallensi the same productive bottleneck as Richards had found among the Bemba--that during the planting time, the season of greatest energy needs, the food supply was exhausted. In this case, they concluded that this was in part a problem of underproduction, but also one of allocation of resources, since the Tallensi spent grain liberally in the season immediately following the harvest on beer-brewing and began rationing only later in the season. Like Richards, the Forteses described in detail the minimal, unpalatable diet of the hungry season, but attributed the shortfall in food crops to poor cultivation practices, excessive beer drinking and festivities when grain was plentiful (rationing did not begin immediately) and th lack of storage. In a much later study, Sharman (1970), noting seasonal shortages among some households in a Ugandan study, suggested one key to understanding who suffered seasonal hunger and which children were seasonally or permanently malnourished was how grain reserves were managed by women. Her study, then, indicated that it was not food supply, but the care and skill with which women rationed or distributed it which determined nutritional differences among households.

Ogbu (1973), by contrast, documenting seasonal hunger among the Onicha Ibo of Nigeria and the Chakaka Poka of Malawi, judged food supplies to be inadequate, due to underproduction and/or failure of storage. People

adapted by reducing the number of meals per day and the quantity of food per meal, by shifting from preferred to less preferred foods, and by reduction in activities of both adults and children, and ultimately, weight loss. Seasonal hunger was predictable, and in both cases people attempted to prepare for it, though unsuccessful in most instances. In Onicha, seasonal food shortages were due to shortage of farmland, low yields of farms, and high storage losses of staples. Even though the people worked very hard, and manured their fields with animal dung, household garbage and compost, after three years land was completely exhausted and had to be rested; in the interim, yields were low. Moreover, they suffered substantial post-harvest losses as root crops rotted in the ground. Among the Chakaka Poka, farmland was not a problem, but farms, widely separated in space, suffered losses to all manner of predators. They also lacked sufficient labor to expand holdings, since many men were away on labour migration. Ogbu suggested that they were also somewhat careless cultivators; they preferred to work communally after consuming beer, and then were sloppy in tilling and ridging. Cash cropping was also implicated in food shortfalls, as people tended to devote insufficient time to food crops. Here, too, they lacked adequate means of food preservation and storage.

Huss-Ashmore (1984a,b), reporting on village nutrition in Lesotho, found seasonal hunger to be related to the seasonal demands on women's labor, particularly food cultivation and fuel-gathering processes, rather than insufficient agricultural output. Women showed weight loss immediately following the period of greatest energy investment--the main harvest, when they had to walk up to two hours to reach fields, where they then labored up to eight hours a day. Not having time to cook, they lost

weight, while their children suffered additional health detriment, as time available for child care and household hygiene also was in short supply. In this case, too, men had largely left agriculture for wage labor in the mines--a nutritional "strategy" to provide cash to buy food in bad years, though perhaps not nutritionally satisfactory in either the short or the long run.

Among the Ntumba and Ngoni of Central Malawi, by contrast, Nurse found the hunger season to be a shortage of vegetable foods. Meat was in good supply and almost became a staple at the time. Labor migration was said not to influence production, since men did not work in local subsistence agriculture (although they will work for cash in agriculture elsewhere). And, cash available in the hungry season was said to attract grain supplies from other areas. Inadequate storage facilities--wicker granaries which allowed a large proportion to rot during the rainy season, and rats and mice to prey during the dry were known to further limit food supply, so that people tended to sell their crop, and then buy back, rather than suffer storage losses.

In sum, these seasonal hunger studies indicated that "hunger" had diverse causes and interpretations: in only some cases insufficient production, in most cases inadequate storage, and apparently few reliable sources of cash income. Other than reduction in household size (through labor migration), they paid little attention to social mechanisms of food redistribution although Nurse speculated that spending grain on beer for work party to repair one's house was probably a good health strategy. They also indicated a substantial reliance on foraging to get through the hungry season, even if one lost weight.

Diverse diet, particularly seasonal reliance on foraged foods, has been emphasized as the main route to food security for those populations which are not food short. Grivetti (1978), for example, credits Sahelian populations which have weathered the drought as surviving by seasonal diversification toward various plant and animal resources in their surroundings. Brokensha and Riley (1980) and others (see Brokensha et al.; Fleuret 1979) have also counted the nutritional significance of uncultivated vegetable species which are harvested seasonally in good years, and year round in bad.

Other studies have calculated the nutritional values of indigenous foods, many of them used seasonally (Robson and Elias 1978), and traditional diets that selectively use a wider range of foods witin local ecosystems than is common under modern cropping systems. Although anthropologists are accustomed to lauding their merits, and the types of traditional wisdom which preserves knowledge of their edibility, whereabouts, and nutritional value, recourse to them may be limited in the future due to shortage of land for foraging, herbicides which eliminate edible herbs in field systems, and decreasing cultural knowledge as people move away from their biological and cultural sources.

Alternatively, anthropologists have looked into the cash income strategies of households in particular environments: how they decide to allocate their land, labor (time), and other inputs among cash versus food crops, cultivation versus other activities (gathering, marketing, wage labor) to produce income in kind (food) or income to buy food. Ogbu, among others, notes that those societies which have access to markets to both sell and buy foodcrops seem not to suffer seasonal hunger (Bohannon and Bohannon; Netting 1968), but consideration of household income strategies are far more

complex. As already noted, the sexual division of labor in agriculture has been coupled with the labor migration of males which both reduces the numbers of consumers and introduces remittances to the home. However, it would appear that remittances are not sufficiently secure to ensure household survival, either because the men do not earn enough, they do not send sufficient remittances home, or what they earn is not put into food or sufficient quantities of the right kinds of foods.

The division of labor, access to land, labor, productive resources, and income between the sexes, as well as responsibility for providing food and food money is also complex in African households (Jones 1983; Guyer 1980), and it is probably best not to generalize about "strategies;" complexities must be sorted out in each individual case. Ordinarily, it is taken as a given that money earned by a woman will be put directly into food, whereas that of a male will not (e.g., Tripp 1981), but the details of how food purchase arrangements are worked out, and under what circumstances there are dual (male and female) household budgets versus integrated ones (even where there is a division of expenditure) are complicated. Expenditure arrangements may involve females maintaining the household, while males pay for maintaining residences, school fees, taxes, and equipment repair. In situations of increasing immersion into the cash economy, opportunities for income diversification may also expand, involving sometimes separate, sometimes cooperative labor of males, females, and children. The extent to which children are pressed into either income earning activities, child care, or household maintenance are similarly important for understanding seasonal income earning and food strategies. It is not clear under what circumstances the bargaining power between men and women over access to

resources and control of income change. All involve consideration of the household unit as one of production, consumption and child-rearing (see below).

Among the income earning strategies which help seasonally supplement shortfalls in home-produced food, income from wage labor, or social network sources of food, are, for men and women, sale of animals, retail of goods bought in bulk, and beermaking. Alverson (1978), for example, was told by Tswana men in South Africa (out of a sample of 2400, only 25% were self-sufficient in food),that when food supplies were insufficient to provide subsistence, their predominant recourse was to market animals, although many left for wage labor, some labored in the subsistence sector, and others borrowed from relatives. Enterprising individuals could also "break bulk", or throw beer or parties for cash income. The latter cash operations replace traditional non-cash social mechanisms of establishing credit. Here, the socioeconomy has been tranformed so that banking cash to draw on in future seasons of hunger is considered better security than social goodwill. Women supplement their own or household income through small scale food processing (Simmons 1975; Basson 1981), small stockkeeping (Alverson 1982; Nimmis 1982) and trade (Tripp 1981). Women's work in trade and agriculture has sometimes been faulted as taking women's time away from child care and household food preparation to the nutritional detriment of children (Popkin 1980). Additionally, children may suffer hunger, exposure, and illness while the mother works, and therefore be at greater nutritional risk than the child of the non-working mother. However, the particular skill of the mother at managing work and chid care, along with the cultural mechanisms for providing surrogate mothers of greater or lesser quality are

also significant in nutritional and health outcomes, and there may be significant intracultural variation in time and resource management.

In addition to income, the other strategy of provisioning food is social. While the patterns of who eats, resides, and works together has been described for some individual cases (see Messer 1983), there are few studies detailing the actual timing and quantity of food received and redistributed by households in African communities. Nor are there good studies of the importance of feasting in seasonal food intake (other than those already cited above)[1] and whether feasting in a season of plenty actually builds up credit for receiving food at some later point in time (Sharman 1970). From studies of reactions to disaster, we know that mechanisms of food sharing seem to work up to the point where all perceive food stress to redistribute food from those who have to those who have not. However, we do not know what level of resources triggers the decision to begin antisocial behavior. Nor is it clear that women plan such strategies (see Sharman 1970). Along with changing hospitality rules, eating behavior of individuals may also change. People in most cultures seem well aware of their needs for energy and other nutrients, and consciously restrict activity is possible when they are short of food. It is not clear whether they still follow the pattern of gorging in times of plenty and absteming at other times as was noted in some societies (see footnote 2).

Additional social mechanisms include fostering or sending out children, although it is not clear that this is a seasonal or more permanent strategy

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[1]In Mexican societies, institutionalized food sharing that goes on during feasting has been analyzed as taking palce at times of the year when the population is most in need of protein and nutrients. High quality protein and vitamin-rich foods are assembled and distributed during such festival cycles (Diskin 1978; Greenberg 1981).

for both spreading child labor around, and securing their nutrition if mother (household) cannot provide.

As food shortages worsen, people may expand the socioeconomic networks on which they rely for aid, turning first to kin and trade partners in localities less seasonally affected, then to tribal or regional sources of supply. Migratory labor, particularly of males has been noted as a strategy for developing contacts for employment, loans, and residence on a longer term basis, but such contacts may also be seasonally important. Finally, people rely on seasonal grain from state grain boards or relief efforts implemented nationally or internationally (Ogbu 1973; Nurse 1975). Scudder (1962) among others has noted that such broader based relief efforts have made it possible for people to survive in areas where formerly seasonal risk was too great.

To summarize, there is a quantity of diverse literature on gathering, food production, cash production, social food flows (who owes what to whom, although little tabulation of what proportion of nutrient intake these constitute) and household adjustments over the seasons in the African literature. There is also a growing literature on both men's and women's activities in towns, and the household relationships between rural and urban areas. As Africans appear to be increasingly dependent seasonally and in many cases all of the time on market food, however, there appears to be little information on how people make food decisions once they are dependent on the market, either in whole or in part. Against this background, we can consider some of the concepts and methods which anthropologists have used to describe the ecology of food production, cultural classifications, and nutritional consequences of food selection.

DIETARY SELECTION

Ecological and Economic Dimensions

Strategies of evaluating native food choices from their own and from scientific perspectives leads to a search for material and "cultural" factors that govern food choices (e.g. "taste", "prestige"). Optimal foraging theory and related linear programming techniques are useful in setting up testable hypotheses of how peole may maximize return (measured in calories, protein, or some combination of elements) to effort (measured in energy, time, or some combination of effort/expenditure) in choosing what, where and how to acquire their diets. Cultural data suggests that people allocate their time and energy (and in the case of market economies, their money) to meet certain taste preferences, like that for fat or for variety, with foods that can garnish an otherwise more monotonous diet. Such factors may help "explain" departures from optimal or optimum foraging or other food acquisition patterns predicted by linear programming models (Jochim 1981; Johnson 1980, 1982). A weakness of such models is that people choose foods, not energy or other nutrients in their dietary selections.[2]

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[2] Ecological models have also examined native versus scientific judgments of "hunger" with uneasy results. The brave soul who tries to consider the merit of the native's and the materialist's evaluations of "hunger" relative to available food resources may still receive criticism for suggesting that what the native says (for example, the stated "hunger for meat") is ever a motivation for behavior but also for suggesting anything else but hunger for protein might motivate certain food acquisition behaviors (Johnson 1982). Although several investigators have questioned whether it is physiological or psychological perceptions which structure seasonal "hunger" (Ogbu 1973; Holmberg 1950; W.Shack 1971), in each case calories, protein, fat, or salt is seasonally short in supply (see also Jochim 1981). What have not been sufficiently studied are cultural rules regarding seasonal under- or over-eating, due to perceived food scarcity. Psychological anthropological studies have suggested from time to time that seasonal hunger and food anxieties may be so pervasive that peple will make

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Economic considerations may be considered according to the same model. Availability of foods in the market environment and the relative cost in time and money of acquiring and then processing them are considerations in cash as well as subsistence economies. As already mentioned, seasonality of wild and cultivated resources and scheduling of food acquisition activities among different resources have been basic factors inteh evolution of diets both in the Old World and the New (Flannery 1973). With the expansion of the modern market system and cash economies, limitations of seasonality have to some extent been overcome. In their place, limitations on cash income and lack of cultural knowledge about nutritional needs and the nutritional contents of foodshave become key factors in the construction of diets.

Cultural-Symbolic Dimensions

Traditional knowledge and beliefs about the qualities of foods may affect eating behavior in particular seasons. In addition to certain foods marking the seasons and their ceremonial consumption marking social group membership, cultural perceptions of the seasons and which foods are appropriate (healthful) to consume then may affect seasonal protein and micronutrient consumption, with in some cases salubrious, in others, deleterious effects. Foods may be classified according to a number of cultural factors that can be constructed from sensory data and other cultural information.

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no effort to increase their food supply if they believe, however falsely, that such efforts would be subject to pilferage by vermin or people (DuBois 1941; 1977). D.N. Shack (1969) and W. Shack (1971) analyzed the personality characteristics, ordinarily abstemious eating behaviors but also ritual gorging of the Gurage of Ethiopia as also due to seasonal hunger anxieties; at the time of the studies, also social fictions, manufactured from historical memories of warfare, raiding, and wait out of line with the current conditions. The adaptive value of such eating habits for times of dearth and how rapidly these perceptions and eating behaviors change under conditions of changed environment or food availability have not received further study.

Hot-cold classifications, as they interrelate domains of food, helath, and social relations are among the most discussed in the literature. Hot-cold values, which refer to an intrinsic quality rather than temperature or spiciness,. are ideally prsent within the human body in approximte balance. Too much heat or cold, caused by overconsumptin of either hot or cold substances, overexertion (overheating the body), overexposure (to climatic or other heat or chills), an illness agent that is classified as giving rise toheat or cold within the body, or usually a combination of these factors produces an imblance that is believed to result in illness. Seasonal beliefs that either hot or cold foods are bad for adults or children may prevent the acceptance of a high nutrient blend (as experienced by India's Project Poshak) or the consumption of high quality protein. In certain instances, such beliefs and practices have been analyzed as healthful, in that they prevent the consumption of potentially contaminated sources of protein during the season of heat. In terms of seasonal diet, however, one would expect such rules to be significant primarily where individuals are ill. Moreover, their operation is restricted to certain parts of the world. In India, seasonality and hot-cold food classifications would be important to consider in evaluating eating habits and nutrition; in Africa they would not; in Latin America, they would probably be important for the seasonal consumption of groups experiencing seasonal illness, for which dietary restrictions often are applied.

Other characteristics that affect cultural and individual food choices are health factors as culturally construed. These include concepts of "safe" or "harmless" foods (foods that do not make one sick) as well as foods that are believed to be positively good for health and well-being;

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i.e. "nutritious," "vitamin-rich," and "tonic" foods. Staples of the diet are often classified according to their "fillingness", i.e. the ability to produce and sustain feelings of satiety. People may value foods of high bulk which provide a turgid feeling to slow hunger pangs over the ordinary staple in times of dearth, either by substituting a coarse staple for a more refined one, or by grinding grain more coarsely (Colson 1979). Overall, however, we lack convincing models to predict food choices, particularly under cultural circumstances of moving from home production to market food supplies. People acquire ideas about the healthfulness of foods from diverse sources. Currently, in both Western countries and the Third World, information about the nutritional value of foods seems to be derived from advertising, medical personnel, as well as from accumulated cultural hearsay. Even where people demonstrate scientific nutritional knowledge, considerations of flavor and cost seem to take precedence over criteria of healthfulness (Dewalt and Pelto 1976). Tastes for sugar, fat, and salt seem to be biological, but also culturally ingrained.

Problems of nutritional adequacy in diets provided by the marketplace can be viewed as basically similar in the different parts of the world. The central issue is the nutritional quality of foods substituted for those of the traditional diet.[3]

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[3]Industrialized societies have (at least for the time being) removed the danger of starvation which was a constant threat to most primitive societies. Science and technology have greatly enhanced the efficiency of food production and preservation and have increased the number of nutritious food stuffs available. Concomitantly, however, there has been a marked increase in the production of food of low nutritional quality. Moreover, these foods have been made attractive and appetizing with the result tht their consumption has increased at the expense of better quality foods. In order to assure an adequate intake of essential nutrients, it has become necessary to divide foodstuffs into groups accoding to their destinctive nutritional qualities and to formulate dietary rules designed to assure a

Similarly, allocation of non-food-related activities influences how much time people can schedule for food acquisition and preparation and consequently affects food selection and nutritional value of diets in modern market economies. In general, it has been noted that households are more likely to eat more expensive calories when they shift from subsistence agriculture to cash-cropping. In a Philippine study, it was suggested that income may have to double to maintain "subsistence" levels of calorie intake (Omawale 1980). All studies of seasonal hunger note that food prices rise as food supplies dwindle, so that calories and protein are least affordable when cash flow is also at its nadir.

Even with some cash available for food purchase, the selections people make may not be nutritionally optimal. Some of this occurs because of seasonal hunger. Richards (1939), for example, reported how the Bemba would pay outrageous prices for fish, after they had been living on a monotonous vegetarian diet for some time. Other choices may be poor because of lack of information on better nutritional values. Still others may have to do with prestige factors. In Latin America, it has been noted how people tend to forego consumption of wild greens in season, because their consumption is considered to be a sign of poverty (Messer 1978; DeWalt et al., 1980). Certain staples, both for their taste and prestige value, are considered to be preferable to others. People will purchase them over lower value staples if they have sufficient funds. Such changes in staple have been suggested as a measure of poverty (socioeconomic stratification). It will be impor-

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balanced intake of food from each of these groups." (Draper 1977:315). Although one might argue that the Eskimo case which she describes would be the extreme for unfamiliar foods, selecting an adequate diet is still a problem for Africans and Asians at the marketplace with limited resources.

tant to explore its utility as a measure of seasonal shortfall as well.

DIMENSIONS FOR ASSESSING CHANGES IN FOOD AND NUTRITION

Household Economic Strategies

Land, credit, exchange labor, migration, education and social networks are all mechanisms which households use to "get by" economically over seasons of uncertain or variable resource availability. Size of the production and consumption units may expand to accommodate more labor and consumers or shrink to allow the household to survive on more limited resources according to flexibililty rules which can be interpreted to either favor or interfere with health and nutrition. Conceptual units of domestic groupings--social groupings that enable individuals, in association, to perform the tasks of living--that may prove useful for future analysis, include (see Messer 1983:10):

1. Eating units - defined with respect to (a)production units (or common budget units); (b)residential groups, further defined according to whether (i) all members eat together or (ii) some east together with others eating outside and foraging outside according to fixed rules and including (iii) non co-residents who receive food from this co-resident hearth; (c)kinship linkages among people; (d)child-care units; (e)child-feeding habits, or rules for when, what and how children should eat and who should feed them.
2. Food budget units - defined according to (a) who is responsible for seeing how a particular kinship, coresdient, or ctivity group or

child/set of children are fed; (b) from whose earnings the food budget derives; (c)who makes the food-related decisions at every step from food production or acquisition to distribution and consumption.

3. Child-rearing units - in relation to (a) where a child eats; (b) what a child eats; (c) formation of food habits as part of enculturation, socialization, and personality formation.

4. Social networks - (a) those which in nformal times provide flexiliby and options for meeting food needs and (b) those to which individuals resort in times of food scarcity and dearth. Among the conceptual questions to be investigated in each case are the rules and practices for (i) making demands on kinship relations, (II) shuffling of house-hold membership by out-migration of certain members at times of diminishing resources of on a more continual basis in search of improved food resources, or (iii) reorganization of eating and work groups although the residential group may remain the same.

In the case of extreme food shortages, an additional feature we want to understand is under what circumstances such rules, along with hospitality rules break down, such that households refuse to accept additional consumers, and individuals refuse to share resources and tasks with others, so that the only solutions are migration, or some other form of drawing on wider social networks.

It is also important to note that in calling these units between the individual and the community "household units" we not restrict our analysis to actual units of co-residence, since sharing of resources in many cases takes place among networks of people related by blood or marriage who share resources but not residence. For example, those responsible for providing

for the very young and the very old may not be coresidential with them, but honor such obligations. Such relationships may involve lateral kin, or intergenerational links.

Child-shifting, as a mechanism for distributing or sharing the responsibilities for and benefits of children. Such strategies remove children whom a parent is unable to provide for adequately to a unit where the child will be provided for and to which the child-poor household can turn for sustenance at a later point in time.

Labor migration outside of the area is a second mechanism. Such migration may contribute in the short term to former residential unit food security. Alternatively, remittances may build future food security for a principle during times of increased stress, for example, for women during child-bearing years. Migration can only be activated, however, if a social support system is viable.

Energy

Energy is an additional dimension by which anthropologists have evaluated the strategies and efficiency of human food systems at both the household and the population level. Most analysts have tried to calculate and compare the "energy costs" of different food systems; in particular, to interrelate local, regional, national, and international levels of energy flow through world economic and food system models. Such models remain preliminary, in part because of the difficulty of ascertaining accurate cash and caloric energy costs of activities related to food production, processing, and distribution (transportation). Practical and ethical dilemmas of calculating human, animal, and fossil fuel energy expenditures in the same equation, and of evaluting the "human cost" of producing food "more efficiently"

by human or bestial power, also arise. Although several studies were designed to demonstrate the local ecological, energy, and nutritional impact of agricultural change, calculations are lacking of energy and other nutrient cycles of major cultivens such as maize under different agricultural technologies. Esimates are also missing of the cash, energy, and nutrient costs of consuming "the same" diet when locally produced or purchased from increasingly nonlocal sources. Correspondingly, there have been few attempts to document in energy or other nutritional terms the impact of the loss of (food) self-sufficiency when local populations become "hooked" on consumed goods (including purchased foods) or are otherwise integrated into the larger cash economy. Input-output analyses of energy flow have been proposed to analyze energy balance of individuals and households within the same culture under variant conditions of subsistence production to cash employment (Eide and Steady 1980), but the models employed are primitive, and do not specify sufficiently production, consumption, or the social organization of activities, food distribution, or seasonal surpluses and deficits.

Dietary Structure

Ordinary daily rounds of meals and snacks, as well as annual cycles of feasts and fast days, in combination with classifications of individual foods comprise a group's "food habits." How often one eats, the times of day or night that one eats, the kinds of food one eats in general and on each eating occasion, and with whom one eats are ways of communicating information about one's own social and cultural identity and relationship with others. The "food code"--the kinds of food (for instance, cooked vs. uncooked) one consumes at particular times of the day--and the individu-

als one invites to share each repast are basic to deciphering the cultural ruels of etiquette, identity, and membership in social groups (Douglas 1972), but they also provide a good index of the kinds of social and nutritional changes which take place over a seasonal cycle. Dietary structure also provides an measure of the types of changes which take place as people move from subsistence to cash purchases of foods, and from rural to urban areas.

Food patterns are constructed by encoding foods according to their proper place in the diet. Foods may be classified as 'meal items," including staples such as cereal grains, tubers, and plantains; "relishes" (i.e. preparations eaten along with staples) and "condiments" such as salt, mineral earths, and chili peppers; or as categories apprpriate for particular meals (Lewin 1943). Alternatively, they may be deemed "snack foods," i.e. those that are "uncooked," consumed without the major cooked staple, or eaten outside the regular meal settings. Seasonally, staples may change from the more to less preferred, and consume snacks in lieu of meals during the day (e.g., Ogbu 1973). If women do not have the energy to gather ingredients and prepare a relish, eaten in a set proportion to the staple, they may not prepare a meal at all (Richards 1939).

How many meals are prepared and their timing during the day are also culturally determined. The number, timing, structure, and ocontents of meals may be relatively fixed, or vary thorughout the year according to seasonal resources and festivities. As just noted, many African horticultural societies adjuste downward from two meals to one meal a day and rely on mor or less palatable wild foods as harvest stores are depleted (Fortes and Fortes 1936; Ogbu 1973). Rationing for the purpose of extending limited

resources, is common in most cultures without unlimited foods supplies, although the timing of such rationing and the mechanisms by which people compute how much food to allow to daily meals have not been carefully studied. If firewood or other fuel supplies are short or expensive or both, and if the food provider-preparer has other work responsibilities, the number of meals defined as "cooked food" may be restricted. Employment or school schedules also affect how wrk or meals structure the day in modernizing societies.

Another way to conceptualize or measure changes in diet and estimate nutritional value is by measuring dietary complexity. Nutritionists have tried to quantify some of these qualitative aspects of dietary patterns and relate them to nutritonal content and adequacy of diets. "Food diversity indices" or"dietary complexity" scores that calcualte the numbers of different food items consumed by individuals or households over a given period of time, have been used as a surrogate measure of nutritional adequacy of diets (Schorr et al.1972; Romero de Gwynn and Sanjur 1974; Sanjur and Romero 1975; Caliendo et al. 1976). The usual suggestion is that those eating more of different kinds of foods are nutritionally better off than those eating a monotonous diet. However, increasing complexity may not always be an accurate indicator of improving nutrition. Simply put, whether eating more and different foods improves nutrient intake and nutritional balance will depend on the types of foods selected, and for what foods they are being substituted. Although dietary complexity scores have been used in one Mexican case study to screen hosueholds for malnutrition within a poor community where increased complexity indicates a diet with greater variety and consequently superior nutritional value, a later study indicated that

increasing complexity scores at the level just above subsistence did not always mean a nutritional improvement over a more boring home produced subsistence diet. The choices at food as well as the amount of cash available to purchase an adequate diet were significant (DeWalt 1984a, b).

Nutrition, Social Stratification, and Economic Development

The nutritional impact of highly mechanized "Green Revolution" agriculture affects seasonality of agriculture, as well as post-harvest employment. Changes in labor scheduling, particularly coordination of labor, mechanical, and irrigation efforts affect seasonal employment, as well as social organization of production in many of the rice areas (see e.g. Lindenbaum). More generally, mechanical harvesting and processing removes seasonal employment for poor women (e.g., essays in Winikoff, 1975; also Hewitt de Alcantara 1976). Regional development projects aimed at impoving earning capacity and nutritional-health status of the rural poor have also had mixed success, when measured in terms of children's nutritional status. Evaluations of two carefully planned Mexican regional development projects indicated that people thrust into cash cropping scheme may benefit when they can still produce some of their own food and when they have improved health facilities that prevent nutritional losses due to infection (Brown 1978; Dewey 1980). But, whether cash adequately compensates them for seasonal shortfalls in subsistence production has not been carefully analyzed. Prices of basic foodstuffs, the exchange value of what they produce, depend on a complex of landholding, market, and employment variables, as well as food practices, all of which affect food intake and nutritional status. There are few instances analyzing these in detail.

Affecting the dietary and nutritional adequacy of both adults and children also may be who benefits from the additional cash income. The impact of women's work and income on the nutrient intakes of household members, either because women allocate more of their income directly to the food budget or because they make the intra-household distribution of food more equitale when they contribute to the food budget, has been suggested in several studies. The seasonal dimension involves the timing of women's income flows, and the reliability of food over the annual cycle. Any arrangement that decreases the amount of control women have over the returns for their labor (e.g., where they work in someone else's field rather than their own to produce the same crop income) donates some of the value of their labor (product) to another owner/manager. Similarly, if purchased food is always higher in price than food produced at home, then there must be compensation in women's income proportional to the relative food price differences to make up the diffrence in food available under the new versus the previous system. Seasonal effects on diet of particular patterns of labor force participation include: Are women used to earning a small amount per day or week, say, through food processing? If so, plans to automate food processing will interfere with their daily economic earnings and most likely with the nutritonal wellbeing of their offspring who count on their earnings for food. Are the crops that women garden ordinarily sold in small amounts; again, to meet immediate food budget needs? If so, then any scheme that concentrates earnings from crop harvests, even if the earnings are superior, will interfere with ordinary seasonal nutritional budgets in the absence of other steps to inculcate nutritional and economic planning (Jones 1983).

An area which merits further research is the possible nutritional and cash benefits of home gardens.

The Significance of Illness

Seasonal shortfalls in food supply may also be exacerbated by illness of adult earners. In subsistence agriculture, the ill, those recently relieved in childbirth, plant less, weed less, and never catch up (e.g., Scudder 1962). While it is self-evident that those working in the cash economy will suffer similar detriments to earning power and household food supply in the presence of illness, both because of decreased income and elevated medical bills, there are few studies detailing these predicaments, and especially their seasonal hazards.[4]

COPING WITH HUNGER

Colson, citing her own research and others, has noted that through repeated visits to a "self-sufficient" society, you learn that "there is no such thing as a normal year" (1979:18). In both the Old and New Worlds, the elderly report how in former times they knew hunger from the vagaries of the weather; in more recent times, they face the same uncertainties, coupled with the vagaries of the international economy, with its upward and downward swings. Coping in bad years employs many of the same strategies that people use to cope in lean seasons. It is therefore useful to review them, their capacity for meeting food needs under various conditions in different

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[4]Cosminsky and Scrimshaw (n.d.) have provided one case study on a Guatemalan plantation, examining seasonal illness of principal male and female adult earners, effects of illness on household income, effects of reduced income on household diet and nutrition, and under what circumstances households can catch up in income and nutrition under seasons of greater work availability for the healthier earner, if such exists, in the family. In Guatemala, it may be ntoed, there are recognized "slack" periods in employment accompanied by reductions in food intake, but no labelled "hungry season."

environments, and how they are changing under economic development conditions.

1. The Expansion of Diet by Foraging. Seasonally, people who are food short or lack variety in comestibles, expand their diet to include seasonal plants and animals, and in times of hunger, less desirable unsown foods available year round in their territories.

Even what was available of these foods, "often a valuable source of supply, but always an uncertain one" were used less. Moreover, people, if they lacked salt and fat in their diets, described themselves as "hungry" and no amount of other foods could satisfy their hunger (see also Ogbu 1973). Although, with reason, many Africanists have lauded the plant and animal knowledge of native peoples, and their abilities to fall back on bush resources both seasonally, and in years of dearth (Grivetti 1978; Brokensha and Riley 1980; Brokensha et al. 1980), others have pointed to their limited ability to meet seasonal or permanent food shortfalls, particularly under circumstances of growing population and decreasing bush land availability. Problems include both loss of the species on which people relied, through overexploitation, or through alternative uses of the territories for agriculture, pasture, or other operations. Deforestation, use of herbicides in agriculture are particularly destructive. Alterratively, even where the species still exist, there may be loss of knowledge about the potential comestibles, given modern

schooling of the young, their lack of contact with the old, or with their bush lands. While anthropologists and geographers rightly urge the conservation of these native emergency or usual seasonal foods in any land development programs, the fallback position, "let them eat weeds" is probably of little long run utility.

Outside of subsistence agriculture, foraged foods may still be an important food resource, but subject to the same limitations of availability and preferences. DeWalt (1984a,b), working in Mexico, considered gathering as one of the four mechanisms by which food entered rural Mexican households--along with home production, purchase, and gifts--but both she and Messer (1972) noted that they may be considered "low prestige" and therefore avoided by the upwardly mobile, even if they lack good nutritional substitutes. Nevetheless, it is possible that supplying traditional foraged products to those in towns may become an occupational specialization of those lacking other sources of cash, and a limited source of food to those who cannot afford to purchase other vegetables.

2. The Shift from more to less preferred foods. This incorporates the first category, but also the shift in the types of cultivated or purchased foods consumed. In maize eating areas, the shift from maize to sorghum, in rice eating areas, the shift from more to less preferred varieties of rice, and finally from rice to manioc are ways people deal seasonally or over the years with insufficient food or income to consume preferred staples. To expand feelings of fillingness, people may also change the manner of preparation, shifting from pounding grain, to grinding on a stone quern, which produces a coarser product, but one with more bulk (Colson 1979).

3. Reduction in the numbers of meals per day, the quantity of food per

meal, and the types of foods consumed. Rationing may begin within a certain number of months after the harvest, if outside sources of food once local food stores have been consumed cannot be anticipated.

4. People begin to slaughter animals for food and to trade animals for grain (Colson 1979). This has been mentioned as a major mechanism for meeting shortfalls in local food production in villages in Southern Africa practicing a mixed economy. Thirty-one percent of Alverson's (1978) sample reported their most common means of coping if harvest was insufficient as sales of stock to raise money for purchased foods, although the small numbers of people who could afford to keep livestock in this instance makes this option of limited applicability. Because they rely on income from sales of animals, pastoralists may try to keep varieties which will provide a reasonable return under variable conditions, and stress quantity over quality since they rely on trade of animals to tide them over bad years. Trading contacts both supply pastoralists with grain, and also may provide them with refuge in case of diaster (Colson 1979).

5. Occupational Diversification: Stepping up production of crafts. In African societies, the end to local subsistence crafts production in favor of purchasing commercial goods for cash, has greatly reduced this option. Since the 1920s, with the beginning of wage labor in mines, African villages have switched from local village production to commercial production, with a resulting increased need for cash to purchase cloth and other goods, and reduced income within the villages. Although some peoples report that they step up craft production when they anticipate a bad harvest season--while they still have the energy--(Scudder 1962) and in some locations, crafts have been revived to serve a tourist market, crafts production is no

longer the occupational diversification which gives people work seasonally, and cash annually for food purchases. Alternatively, the types of raw materials which people used to produce crafts in bad times may no longer be available because of overexploitation. Gudeman's (1981) study of a Panamanian agricultural settlement noted how the reeds traditionally wover into pieces for hats no longer were available, and so ended one type of seasonal employment. Thus the means of production and the markets for crafts seem to have atrophied. Although some analysts predict that if times are sufficiently bad, such traditional skills and industries might be revived, the circumstances of such economic reversals or their impact on local food consumption have not been reviewed (Cooper 1982:309).[5]

6. People sell valuable possessions. Although in Africa this refers mainly to valuables, such as jewelry, purchased during good times to tide one over the bad (Colson 1979), in Asia this may mean mortaging land or future crops seasonally or permanently to money lenders or wealthier villagers who help tide one over a bad season (Chen et al. 1979).

7. The final result of dearth in bad seasons or over bad years is the settings of food consumption change: occasions for food sharing diminish, and people retreat toward nuclear or individual units, and theft increases. People's "breakup into small family groups which comb the region, the refusal to share food with others..."(Colson 1979:20) describe famine, but could equally well be applied to seasonal hunger. Unproductive members (the old and the very young) are sent away to where there may be more food. In

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[5]"There is evidence that food production and even long-dormant craft production can be revived as cash-crop production drops, and it would not be surprising if these trends deepened in parts of Africa, while in other a basic transformation of relations of production took place" (Cooper1982:309-). (suggested for Senegal, Ghana)

the old days, people would sell their children as slaves in return for grain, and in some cases, children are still pawned for food (Alverson 1978). What is unclear is that point at which such breakdown in cooperation takes place. Men may go out in search of migrant wage labor, or families might move to where they have previously established bonds, using the seasonal migration of some members of the household to become familiar with possible opportunities.

Moreover, the traditional social relations, which allowed for seasonal or otherwise periodic tapping of food resources from areas less subject to seasonal or famine year shortages, have also been destroyed by "development" in many cases. Raiding between villages is past history. Thus, people must turn to labor outside of their immediate household economy to tide them over; or, as a last result, either some or all members of a household must move. Men went out in search of migrant labor employment. Left more food at home for the families. Or, families would move to where they had previously established bonds.

Now, the strategy is more: grow cash crops, to save in a good year, so that you can buy government subsidized grain in a bad year:"Tonga coping methods are, therefore, now strongly affected by the exisitence of a relief system that removes some of the responsibility for long-term planning to ensure that they survive when their crops fail." (p.27) Probably the most vulnerable societies are those which are in transition; traditional mechanisms for coping gone; new mechanisms not yet established.

CONCLUSIONS AND RECOMMENDATIONS

Policy to address seasonal hunger can examine sociopolitical, technological, and organizational efforts. Key questions to keep in mind when

considering not only seasonal strategies for providing food security, but food provision strategies generally, are: What constitutes a "good" or "adequate" diet from the native and the nutritional point of view? How is this provided (from home production or market sources)? How do such concepts and nutrient intake change under conditions of changing income and sources of foods? In the larger view, whether we are looking at seasonal or more permanent changes in cycles of diet and nutritional status, it is important to understand what factors determine dietary diversification and consequent nutritional intake at regional, seasonal, and household levels.

In evaluating development policies, we must examine how changes in income strategies affect the household as a local for social distribution of food, communal mechanisms of social security, and relationships between rich and poor. In examining whether the gains of projects are targeted successfully toward poor families, we must also note how such gains are translated into nutritional objectives. It may be that instead of seasonal hunger, people now suffer mild to moderate malnutrition all of the time. Given the numbers of regional development schemes which have been analyzed to have failed nutritionally, it should be possible to explore and avoid the conditions which give rise to permanent nutritional deficits.

Throughout the world, food producing societies which suffer seasonal hunger seem to lack adequate storage facilities. Technology to improve storage would seem to be an important step to improve food security. There is also a pressing demand for opportunities for occupational and income diversification. These are less easily addressed by a technological solution.

There should be special attention to male and female economies in

development, health, and relief efforts.

Health programs should be scheduled so that they do not interfere with the work schedule of adults, so that they address the major seasons of children's illness, and so that they can be implemented.

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INTERNATIONAL
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INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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SEASONAL CYCLES OF NUTRITION AND RESOURCE PROCUREMENT IN LESOTHO

by

Rebecca Huss-Ashmore

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SEASONAL CYCLES OF NUTRITION AND RESOURCE PROCUREMENT IN LESOTHO

The past ten years have seen a notable increase in the number and variety of researchers involved in the study of seasonality. While current visibility of the topic is probably partly backlash against its former invisibility, there are more respectable reasons for its emergence. The elevation of seasonality to a fashionable research topic is also the result of a widespread realization that synchronic and normative data are inadequate for predicting human behavior. As a result, there is now a growing interest in the social and natural sciences in the modeling of complex human systems. With the refinement of computer simulation, cyclic and long-term trends in the economics and ecology of resource utilization can be predicted with increasing accuracy. The inclusion of seasonal oscillation is therefore a strategy for improving the realism of such models.

At a less theoretical level, there is also a growing realization that seasonal changes in the human environment have the capacity to affect health and productivity. Both wet-dry and hot-cold seasonality affect the survival and transmission of disease organisms. Seasonal changes in diet and work load are related to alterations in metabolism, to weight gain and loss, and to possible changes in

susceptibility to infection. While industrial societies have generally developed means for buffering the most extreme effects of seasonality, many traditional societies have not (or at least, have not for all members). It is therefore in such societies, where resources are scarce and medical technology rudimentary, that seasonal changes in diet and disease are most likely to affect human welfare. Particularly in developing countries, the combination of these factors may lead to seasonally reduced working capacity, with negative results for the security of food supply.

Despite an increased awareness of the importance of seasonality for studying human systems, little is currently known about the ways in which populations monitor and cope with fluctuation. The longitudinal nature of seasonal research and the interdisciplinary nature of the data required make the study of seasonality an expensive enterprise, both in terms of time and of resources. Most studies of seasonal phenomena have therefore been limited to the measurement of a very few variables, such as food intake, child growth, market prices, or the incidence of infectious disease. Such data are a critical baseline for documenting the magnitude of seasonal impact in any given population. However, while there is a clear need for more and better measurement of individual variables, there is also a need for integration of those variables.

The study of "seasonal hunger" is a problem area

particularly in need of conceptual integration. There is currently wide latitude in the way the concept is defined, as well as disagreement on its causes, consequences, and significance. This paper gives a brief overview of seasonal hunger as a problem in African societies. Preliminary data from Lesotho are then used to build a model of seasonal interactions in that society. The implications of this model for further research and for understanding seasonal hunger are discussed.

."Seasonal Hunger" in Africa.

The existence of a hungry season has been documented from societies in settings as diverse as pre-industrial North America, the Indian sub-continent, and all regions of Africa. It is in Africa, however, where the phenomenon seems most pervasive. In fact, in some African societies, the word for hunger in the local language is also used to designate a particular time of year (Ogbu 1973). Richards' (1939) classic study of the Bemba was one of the first to emphasize the high intra-annual variability of African diet. Since that time, researchers and administrators working elsewhere in Africa have reported that local diets also vary with the seasons. Most of these accounts are anecdotal and report merely that at a certain season people seem thin or tired, that they grumble a lot about the lack of food, that children are fretful, adults querulous. Despite this, Marvin Miracle asserted to the FAO in 1961 that reports of a hungry season in Africa were to be

discounted. First, he argued, there was no evidence for its existence. Second, if it did exist, people would expect it and would therefore produce and store enough to prevent a shortage.

Miracle's dubious argument exemplifies some of the problems with studies of seasonal hunger. First, the existence of a hungry season in any society depends very much on how it is defined and measured. One common measure used is the seasonal change in diet or in food supply. Ogbu (1973), for example, indicates that the hungry season in West Africa is a time when people switch from preferred food sources to those that are less preferred but more easily stored. Research in Lesotho and Swaziland shows that wild foods are increasingly used as supplies of cultivated foods become short. Richards (1939) notes not only a change in the type of foods consumed, but also a reduction in amounts. Number of meals per day are reduced, with old people occasionally going without food for an entire day. Food is cooked less often, and there is an increase in the number of foods consumed as snacks.

The magnitude of fluctuation in food intake varies in different ecological settings. A recent survey of 25 nutrition studies in Africa for which seasonal data were available indicated that the percentage of calorie requirements fulfilled averaged 92% in the dry season and 85% in the wet season (Schofield 1974). However, nutritional survey in Swaziland found a range of caloric

variation from 90% to 108% over the year (Jones 1963). In Northern Nigeria, where climatic fluctuation is more extreme, Simmons (1976) recorded a range of intake from 2458 Kcal to 1949 Kcal per day over the course of the agricultural year.

But is this hunger? Certainly shortages great enough to require the elderly to fast for a day imply discomfort, if not physiological stress. However, substitution of staples or of wild for cultivated relishes is less clearly a hardship. So far, the nutritional effect of such substitution is unknown. Similarly, there is little information on the health consequences of seasonal caloric fluctuation of the magnitude recorded for African societies. The degree to which such average variation reflects functional impairment is therefore uncertain.

This brings us to the second point implied by Miracle's argument, that is, the ability of human groups to cope with seasonality. The vast majority of human populations live in seasonally fluctuating environments. For most human groups, changing climate, resources, and disease load are an accepted feature of the annual cycle. Adaptation to these sequential changes has obviously formed part of the human evolutionary record. We would expect humans to have developed strategies for dealing with this fluctuation such that it is not life-threatening for the majority of members. Evolutionary theory predicts that adaptation to static conditions will be accomplished most efficiently through genetic change. However, responses to fluctuating

conditions are less likely to be biologically imbedded. Responses to fluctuation need to be reversible, that is, capable of being turned on and off with changing conditions. While some of these responses are likely to be biological (storage of body fat, for example), the majority are behavioral.

Behavioral responses to seasonality include division of labor for food production, variation in crop mix and diet, seasonal migration, storage, and food-sharing networks. To the degree that behavioral strategies protect the population against environmental fluctuation, biological changes should be minimized. Conversely, where biological consequences of seasonality are prominent, it may signal the failure of traditional coping strategies. The failure of these strategies can be linked to rare or extreme environmental variation, or to changes induced by modernization.

One of the most frequently documented biological responses to seasonality is a change in body weight. Indeed, this seasonal change in weight (or rate of weight gain) is often used to define the existence of seasonal hunger. For example, the Ghana Nutrition Survey found that there was not only a slowdown in the growth of pre-school children during the summer months, but that children in the Northern and Forest Zones actually lost weight at that time (Davey, n.d.). The famous studies by Fox (1953) and Haswell (1953) in the Gambia showed that adults lost weight steadily during the first eight months of the year, and then gained

sharply after harvest. Total weight fluctuation was as high as 9 or 10 lbs. Hunter's (1967) study of Northeast Ghana found that 94% if adults in the community lost weight seasonally, and that the average loss was approximately 6% of body weight. Nurse (1975) showed similar patterns of weight fluctuation for migrant workers in Malawi. In Lesotho, Cohen and Clayden (1978) found a bimodal pattern of weight loss in preschool children, with up to 20% of children losing weight in late summer and early spring.

The significance of this seasonal weight fluctuation is not clear. For adults, at least, a certain degree of change in body weight can evidently be tolerated without undue hazard. In fact, lowered weight may be adaptive during periods of food shortage, in that the smaller muscle mass requires less energy for maintenance (Thomas 1975). Only if weight loss affects work performance, resistance to disease, or fertility can it be shown to be dysfunctional in the short run. Such functional impairment is considered to be the result of very severe weight loss, such as is found in starvation (Keys, et. al. 1950, Huss-Ashmore 1981).

The effects of weight loss and inadequate diet on young children are more immediate. The synergism of malnutrition with infection is well known, such that moderately to severely undernourished children are at a higher risk of mortality. This is exemplified by data from South Africa showing that the seasonal increase in malnutrition in black and coloured children is accompanied by a seasonal increase

in childhood mortality (Waldemann 1973).

Whether defined on the basis of fluctuating diet or body weight, there is ample evidence for the existence of a hungry season in many parts of Africa. The seriousness of this problem, however, remains problematical. Seasonality obviously does not affect all members of a society equally. Children may be expected to fare differently from adults, and men may be affected differently from women. Similarly, those portions of the society with greatest access to resources should be less vulnerable to the negative impact of seasonal shortage. Therefore, those most likely to experience seasonal stress are those with least physical or economic resilience. In practice, this means an increased likelihood of periodic health problems for women and children among the rural poor.

If the impact of seasonal hunger differs for different portions of a society, its causes can be expected to vary as well. Seasonal change in food intake and nutritional status is not merely a matter of food supply. Environmental factors such as disease load, and economic factors such as time constraints and labor requirements, also vary across the population and the annual cycle. For many of the African societies studied, it appears that the rainy season is the time of greatest stress, since it combines low pre-harvest food reserves with high work requirements and high exposure to disease vectors. For these societies, seasonal hunger becomes symbolic of general seasonal

ill-health.

Further, food supply itself is not merely a matter of differential food production. Miracle's assertion that hunger can be cured by increased production is a bit of economic wisdom that deserves to be challenged. As Pellett (1982) has recently pointed out, malnutrition is not simply a problem of production, but is also a problem of maldistribution of food resources. These inequalities of distribution may exist across social classes, within households, and across seasons. Greatest stress can therefore be predicted for dependent members of low-income households with highly seasonal resource fluctuation.

Thus while average figures for caloric adequacy and weight loss may imply an insignificant impact of seasonal hunger for a given population, disadvantaged members within that population may experience stress as severe. The ability of these members to cope with seasonal fluctuation may be the best measure of the success of a food system. Where these members consistently suffer biological disruption on a seasonal basis, such that health and function are impaired, a failure of traditional adaptive strategies can be inferred.

In Lesotho, traditional strategies for securing food supply have been increasingly supplanted by strategies for securing cash. While cash income has acted to even out fluctuation for households with a sufficient supply, it has also served as a further disincentive to an already marginal

agricultural system. Examination of seasonal interactions in Lesotho indicates that rapid modernization may increase household food security in the short run, but at the risk of increased long-term uncertainty.

.Seasonality in Lesotho.

Lesotho is a small, mountainous, independent kingdom, entirely surrounded by the Republic of South Africa. Its three million hectares increasingly fail to support a population of 1.3 million people, almost all of them ethnically Basotho. Ninety percent of that population is rural, engaged in subsistence farming of maize, wheat, sorghum, beans, and peas. Cattle, sheep, and angora goats are grazed in the mountains and high interior plateaus. Despite this agricultural emphasis, agriculture is not the most important economic activity of the population. At any given time, approximately 60 percent of the adult males are absent, employed in the Republic of South Africa as migrant laborers. Seventy-one percent of the average rural family's income derives from remittances from that labor (van der Wiel 1977).

Food supply in Lesotho is a matter of continuing concern. Until 1928, Lesotho exported food crops (maize and wheat), but since that time it has imported an increasing proportion of its staple foods (Murray 1981). Agricultural policy since 1975 has emphasized the need for self-sufficiency in grain and vegetable production. However, despite this emphasis, maize yields fell yearly

from 1977 through 1982, while amounts of imported grain increased (GOL 1983). In 1980, for example, Lesotho produced 105,000 metric tons of maize. In the same year, approximately 70,000 metric tons were imported, of which 7000 were donated as food aid (GOL 1980). Donated foodstuffs increased by 150% in the five years following 1977.

While health in Lesotho is considered good by African standards, this is primarily due to the absence of tropical diseases. However, infectious diseases are a significant problem, particularly for children. Respiratory, digestive, and childhood infections account for approximately 40% of mortality in children under 5 (GOL 1979). For all ages, respiratory diseases are the leading cause of outpatient visits. Malnutrition is also a significant cause of morbidity and mortality in the population. Approximately 23% of preschool children are believed to be undernourished, either underweight or stunted (UCLA 1977), while malnutrition is considered to be the primary cause of mortality in 23% of hospital deaths for children under 5. In people aged 5 and over, malnutrition and anemia account for 8.5% of outpatient visits.

In order to assess the impact of seasonality on this population, approximately 1000 rural women and their pre-school children were weighed monthly during 1981 and 1982 as they attended a Mother-Child Health clinic in the eastern mountain district of Mokhotlong. These

women were drawn from 40 villages, from one-half hour to two days' walk from the clinic. Each village attended the clinic as a group, once a month on an assigned day. Women were weighed without shoes or heavy outer clothes. Children were weighed by the clinic staff. During the visit, each child was seen by the nurse and received such innoculations as were appropriate to its age. While some of the women attended each month during the study period, most did not, and many were irregular attenders.

Other data gathered from the clinic population included fuel use, food cooked on the day before clinic (as a proxy measure of food supply), measures of socio-economic status, and complete fertility histories. In addition, a sample of 20 women in a single village were studied intensively to determine food intake and work schedule. Food intake was measured through one 24-hour recall interview monthly, followed by a five-day self-report food diary. Time allocation was determined from one recall interview per month followed by one day of self-report. Both food and work data were supplemented by direct observation. While the analysis of these data has only begun, the preliminary results can be used to construct a model of possible seasonal interactions in this community.

While 20% undernutrition is an average figure for this population, this rises seasonally to at least 50% in some of the remote mountain villages. Data from the eastern mountain region show that greatest incidence of weight loss

in preschool children is seen in late summer (March). Cohen and Clayden (1978) analyzed weight data from 1243 children attending a well-baby clinic in this region. Children who had lost weight since the last visit were reported in terms of rates per 1000 visits of children weighed. Figure 1 indicates the timing of weight loss for this group. In addition to the sharp peak in March, there is also a broad period of weight loss in winter and early spring (Figures 1 and 2).

The weight of adult women also varies over the year, with periods of low weight in December and January, and again in June (Figures 3 and 4). When the timing of weight loss for these two groups is compared (Figure 5), it appears that the seasonal pattern for women differs from that of children. Table 1 presents data for a sub-sample of women attending the clinic in the middle of the month, on a randomly chosen clinic day. For the five villages attending on that day, there were 90 women who had at least five non-pregnant weights over the course of an observation year. Average weight fluctuation for this group over the year was 2.87 kg., or approximately 5% of body weight. Sixty percent of this group experienced a weight fluctuation of 3 kg. or less.

The timing of weight fluctuation for women and children was compared to seasonal patterns of food intake, climate, disease, and workload. It was expected that caloric intake for women during the late summer would be significantly

reduced. However, for the five women analyzed to date, there is no distinct seasonal pattern to the caloric content of the diet. Daily variation within the month is higher than variation between months. In fact, variability is perhaps the most salient characteristic of these diets. Day-to-day variation of over a thousand calories is not uncommon for any individual, and variation between individuals is similarly striking. Table 2 presents caloric intake data for two women in the sample, one representing an unusually high intake, and one a very low intake. The only notable concordance is the low caloric intake for both in July, at the end of the harvest period.

While the caloric content of the diet for this group was not clearly seasonal, composition of the diet varied markedly over the year. The staples of the diet are papa, stiff boiled maize meal, and moroho, boiled cabbage or other greens. From April through October this is supplemented by likhobe, dried beans, peas, and maize kernels, reconstituted and boiled. Although beans and peas are easily grown and stored, the supply is usually used by late spring. Summer protein sources are limited primarily to wild greens, mostly the leaves and inflorescence of cucurbits, chenopodium, and amaranth. Total variety of foodstuffs is also seasonal. Least variety (or greatest monotony) occurs in mid-summer, particularly for those households without gardens.

Climatic seasonality is closely related to the seasonality of disease. Patterns of temperature and

rainfall in Lesotho are unimodal and co-variant; that is, there is a single rainy season, coinciding with a single hot season (Figures 6 and 7). This hot rainy period also coincides with the peak of gastro-intestinal diseases in this population. If these patterns are compared to the timing of low weight, it can be seen that there is a good fit for children (Figure 8), but not for women (Figure 9). Late summer weight loss in children directly follows a peak in diarrheal disease (Figure 10). Weight loss in spring is preceded by an increase in pneumonias, other respiratory diseases, and acute childhood infections (Figure 11).

In contrast to children, patterns of low weight in women appear most closely related to the seasonality of the agricultural work cycle. The agricultural calendar for the study area shows two periods of heavy labor demand during the year. One is in November and December, the cultivation (hoeing) period for maize and sorghum (Figure 12). The second and most strenuous season is the period of harvesting and threshing, from April through June. While the traditional farming pattern calls for equal participation by men and women in these last activities, widespread labor migration has changed this picture. The peak of male outmigration is in January, prior to the beginning of the harvest. Because a high percentage of adult males are absent, harvesting has become an increasingly female activity. Women report spending up to eight hours a day in the fields during this time, plus up to two hours walk to

reach the field. When the agricultural year is divided into periods of high, moderate, and low agricultural activity, low weight for women is seen to occur at the ends of peak labor periods (Figure 13). Thus while seasonal hunger in Lesotho is related to the cycle of production, these data suggest that it is the process and not the output which is most critical.

In addition to agricultural labor, there are other work tasks which have a seasonal impact on the nutritional status of women. Probably the most important of these is the gathering of fuel for cooking. During the winter, while cattle are kept in the village, the usual cooking fuel is lisu, compacted cattle dung dug from the household kraal. Because it is readily available and burns slowly with an even heat, it can be used for the prolonged cooking of such items as dried beans. In the summer, however, cattle are removed to high mountain pastures. This significantly reduces the fuel supply, and increases the reliance on wood and brush. These not only require more time to gather, they are also less satisfactory for long slow cooking. Constraints on time for gathering and cooking could therefore accound for seasonal changes in the protein sources in the diet.

These constraints may also account for the high fluctuation in daily intake seen during periods of heavy labor. Women do not cook every day when they are in the fields, relying some days on leftovers or on donations of

cooked food from a relative to feed themselves and their children. This pattern of dietary intake has no apparent ill effects on the health of adult women. Stores of muscle and body fat are adequate at all seasons. However, children, with their smaller energy reserves, can ill afford to fast. Uncertain daily provisioning by overcommitted mothers may result in uncertain daily intake for their children. Coupled with seasonal outbreaks of infectious disease, even minor deficits can result in loss of weight.

Thus seasonal hunger in Lesotho can be seen as a problem in the maintenance of adaptive flexibility. On one level, the high rate of male labor migration is a successful strategy for coping with uncertainty. Cash received in the industrial sector of South Africa can be cycled through the domestic economy. In bad years or bad seasons, food supply can be maintained through purchased staples. However, the heavy investment in one single strategy can reduce the viability of other traditional strategies for resource procurement. This in turn has a negative impact on those portions of the population who must rely on these traditional strategies. In Lesotho, these portions of the population are women, children, the ill, and the elderly, who cannot migrate but must by law remain at home.

Viewed schematically, labor migration can be seen as increasing the rate of capital penetration in rural Lesotho, primarily through the medium of remittances and the increased expectations of returning miners. This process is

further hastened by the current government emphasis on expanded communications, education, health services, and consumer goods in the rural areas. On the other hand, male outmigration also affects agriculture, decreasing crop yields and increasing reliance on herding, with accompanying environmental degradation.

The pronounced seasonal shortage of male labor also increases women's workload, at least on a seasonal basis. This in turn decreases the amount of time available for domestic chores, including child care, personal sanitation, and food preparation. Food preparation is further controlled by the availability of fuel, itself a product of women's labor. The result is seen in lowered levels of health and nutritional status in the rural population.

.Conclusions.

Because of the preliminary nature of the data reported here, the scenario just presented must be regarded with caution. It is presented more as hypothesis than as conclusion. However, even a preliminary analysis can indicate the complexity of seasonal interactions in rural Africa. For Lesotho, seasonal variation in body weight and nutrition is probably not simply a matter of food supply. While intake is obviously important, it is conditioned by social and economic factors.

Evaluation of this model will require both the analysis of a larger sample and the introduction of supplementary

data domains. In particular, the seasonality of income and labor remittances is unknown. With wage labor as such a prominent economic strategy, the timing of remittances may be critical for the supply of both household food and labor supplies. The influence of seasonal fertility, itself a result of seasonal labor migration, should also be considered as a factor in seasonal weight gain and loss. Moreover, little is currently known about seasonal fluctuation in diets of children. Seasonal preferences for weaning and food supplementation could substantially influence timing of weight loss in children. However, current observations suggest that time and energy constraints on women's labor may prove to be critical variables in defining the existence of a hungry season. Prevalence of disease may be equally important in determining its severity.

John Ogbu, himself an African and a social scientist, has counseled against judging seasonal hunger purely on caloric grounds. Important as these may be, they do not give an adequate picture of either the social or nutritional impact of seasonal fluctuation. This observation can be expanded here to say that even caloric calculations should not be limited to food. The impact of energy expenditure and of fuel supply on diet and nutritional status cannot be ignored. If uneaten food has no nutritional value (a common assertion among nutritionists), in this case, uncooked food will not be eaten. Understanding this complex of

relationships should help in understanding the phenomenon of seasonal hunger, both its continued existence and its probable impact as a human adaptive constraint.

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Table 1.

MONTH OF LOWEST WEIGHT

Villages 1-5, Women

Month	Number
January	21
February	0
March	0
April	9
May	9
June	15
July	9
August	0
September	6
October	1
November	6
December	14
Total N =	90

WEIGHT FLUCTUATION

(W_{max}-W_{min})

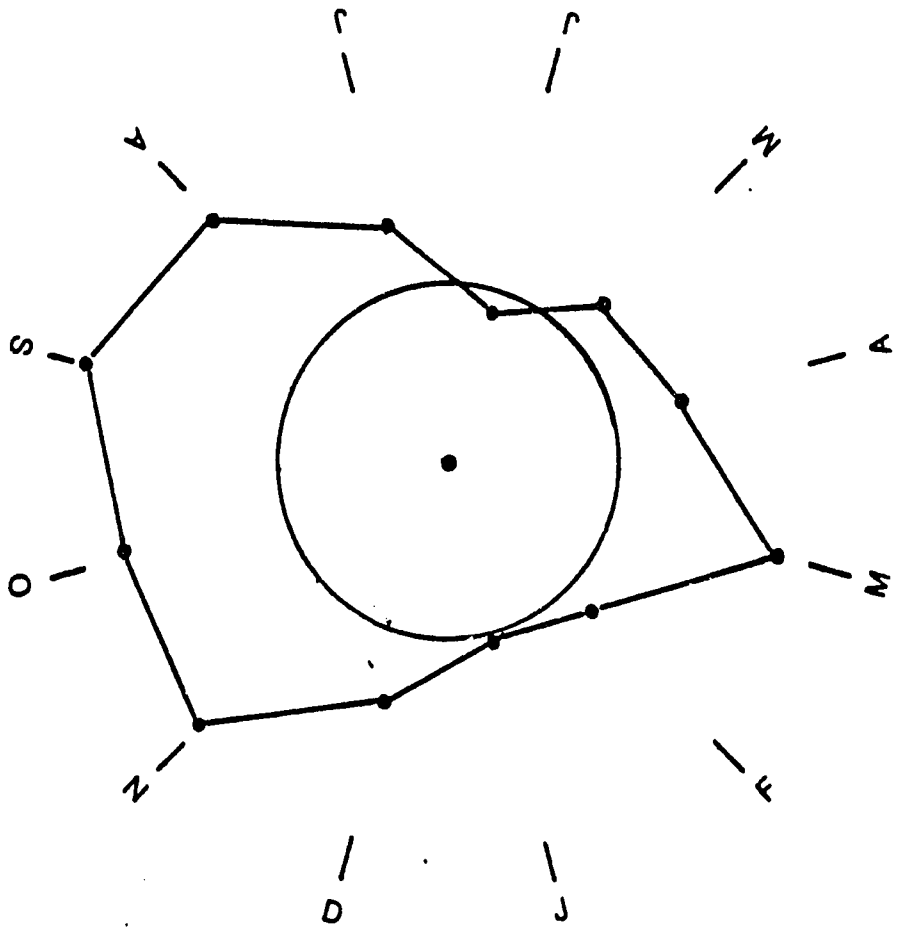
Amount (kg.)	Number
1	18
2	33
3	12
4	11
5	8
6	4
7	2
8	2
Total N =	90

Mean weight lost = 2.87kg. (approx. 5% body weight)

	Matsēpo		Matahleho		
Month	Calories	Weight	Calories	Weight	Average Calories
April	864	57 kg.	2461	63.3 kg.	1662
May	1176	58.5	2192	--	1684
June	1099	57.8	2095	--	1597
July	806	53.2	1584	64.0	1195
August	1051	53.7	2447	63.9	1748
September	1085	53.4	2401	65.5	1743
October		54.5		--	
November	1127	52.9	2659	--	1893
December	1117	50.5	1879	--	1523
January	1217	51.1		63.2	
February	949	52.2	2973	--	1961
March	----	52.5	2789	--	----
April	947	--	2465	65.5	1706
Height:	158.5 cm		165 cm.		

Weight and Average Monthly Caloric Intake of Two Basotho Women, 1981-1982.

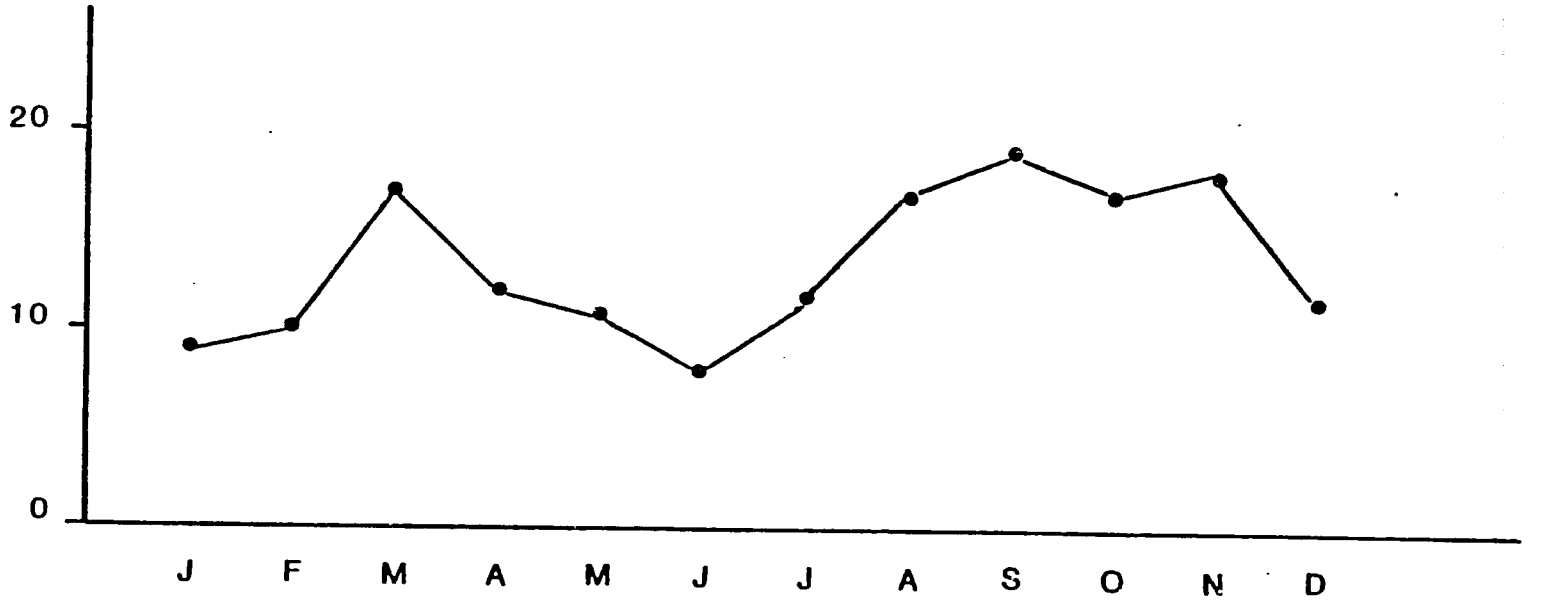
Figure 1.



PER CENT CHILDREN LOSING WEIGHT

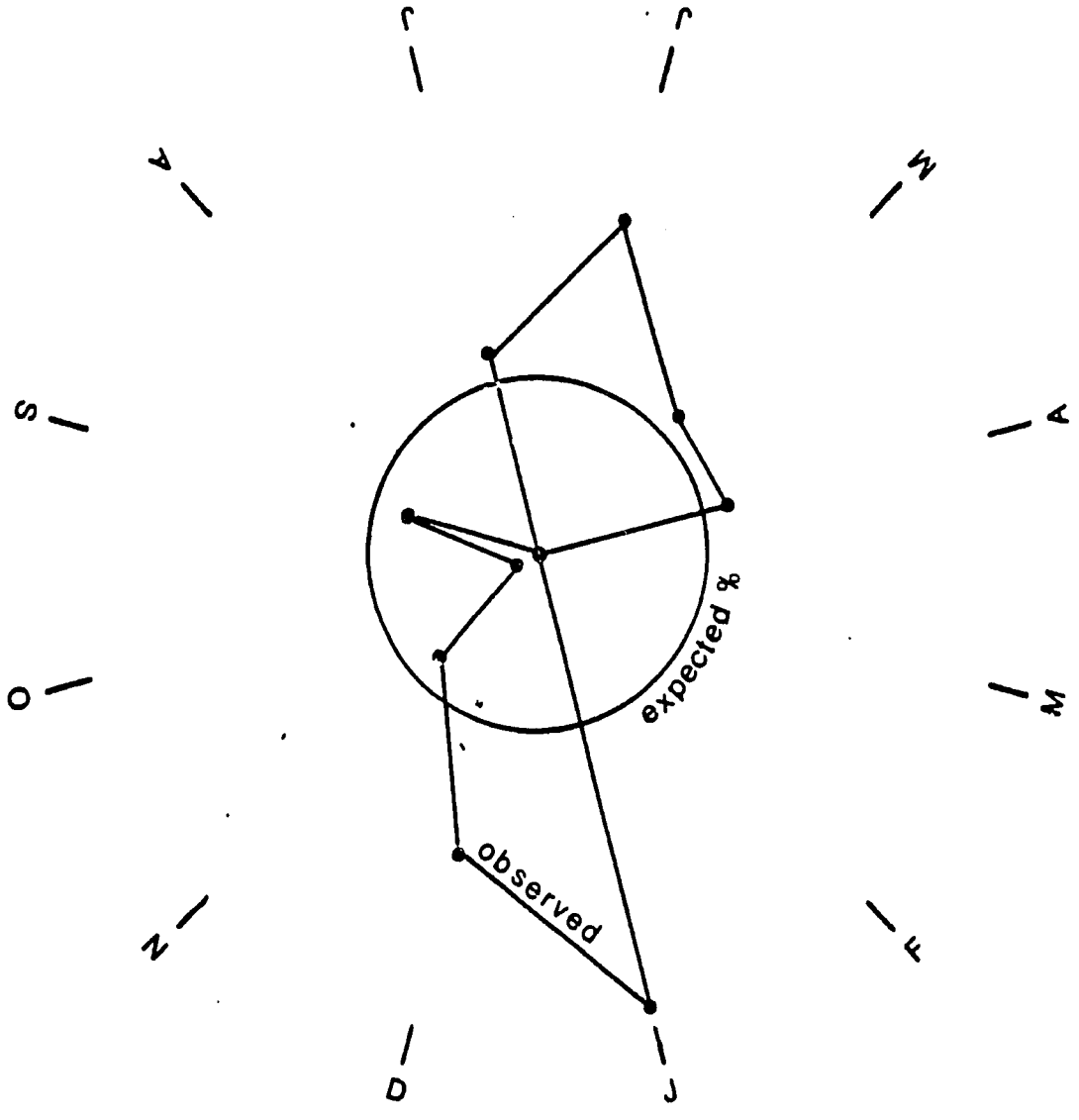
(BY MONTH)

Figure 2.



PER CENT CHILDREN LOSING WEIGHT

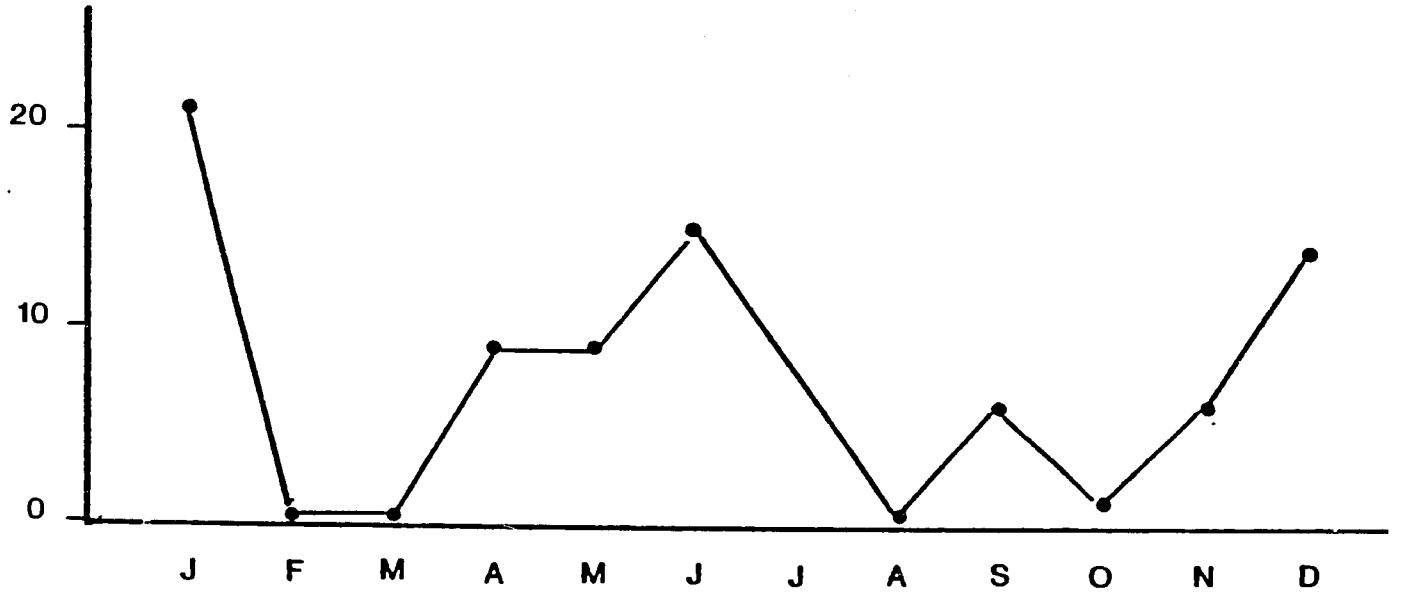
Figure 3.



PER CENT WOMEN WITH LOWEST WEIGHT

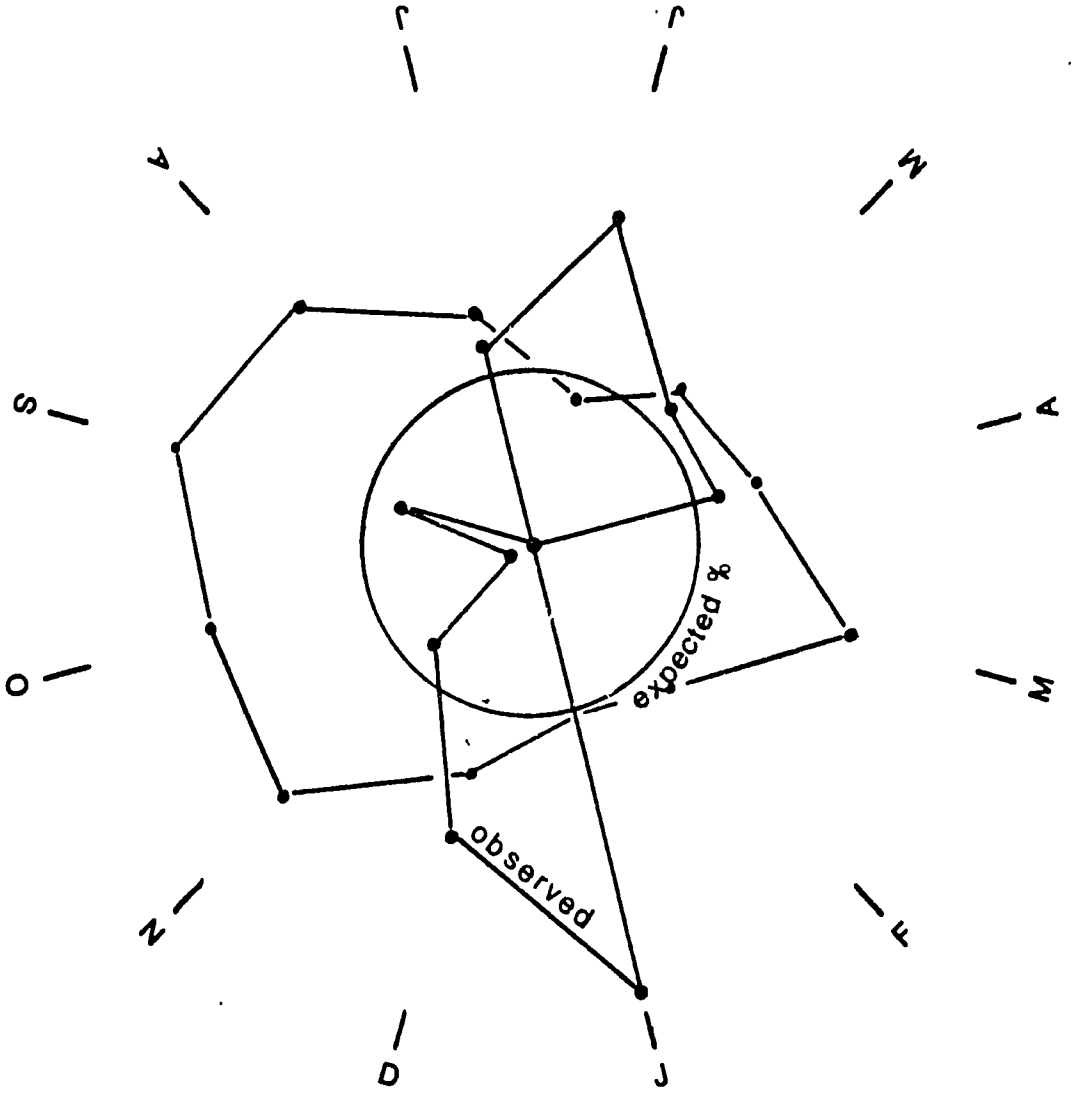
(BY MONTH)

Figure 4.



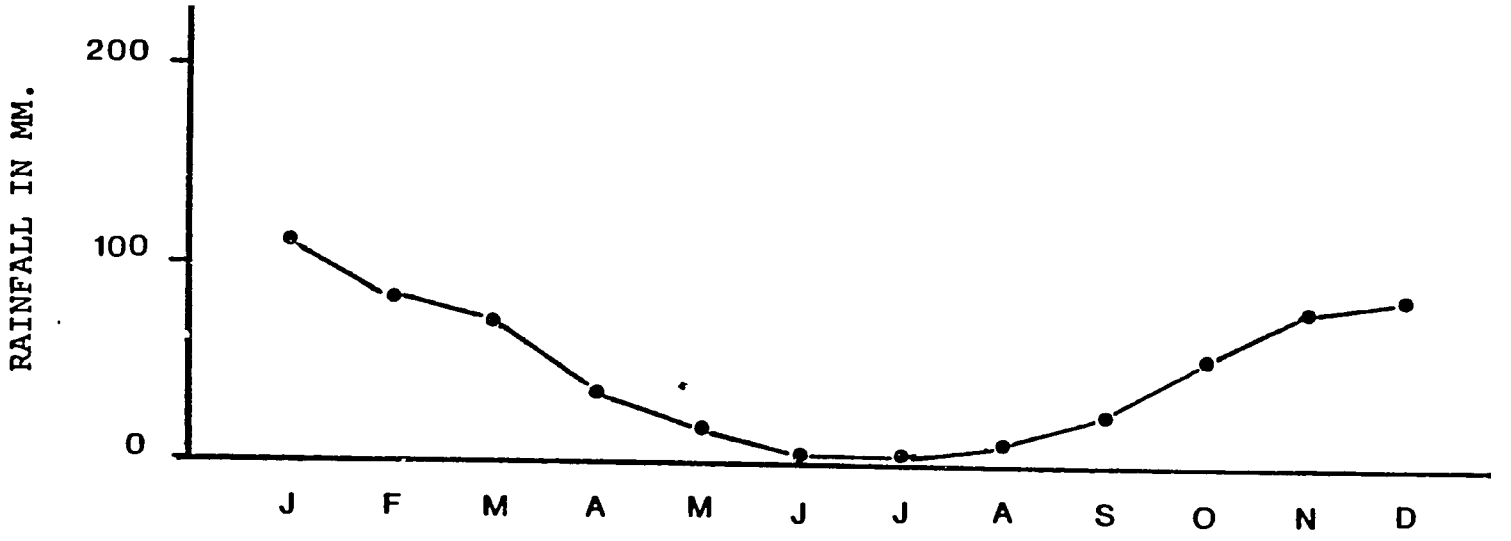
MONTH OF LOWEST WEIGHT FOR WOMEN

Figure 5.



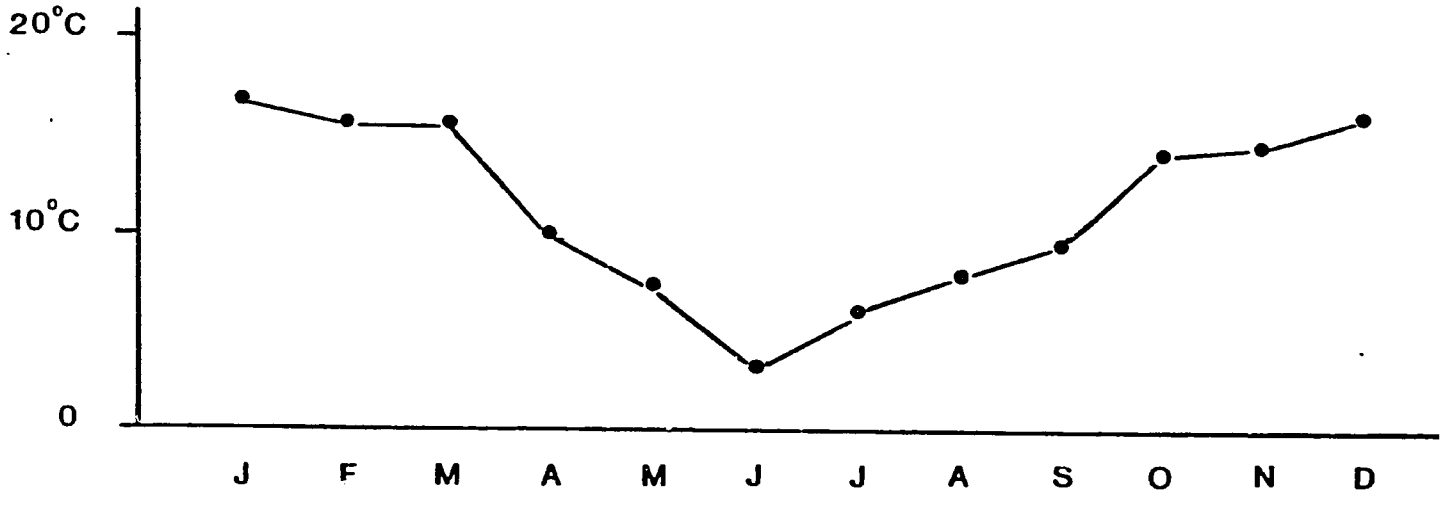
COMPARISON OF WEIGHT LOSS PATTERNS FOR
WOMEN AND CHILDREN

Figure 6.



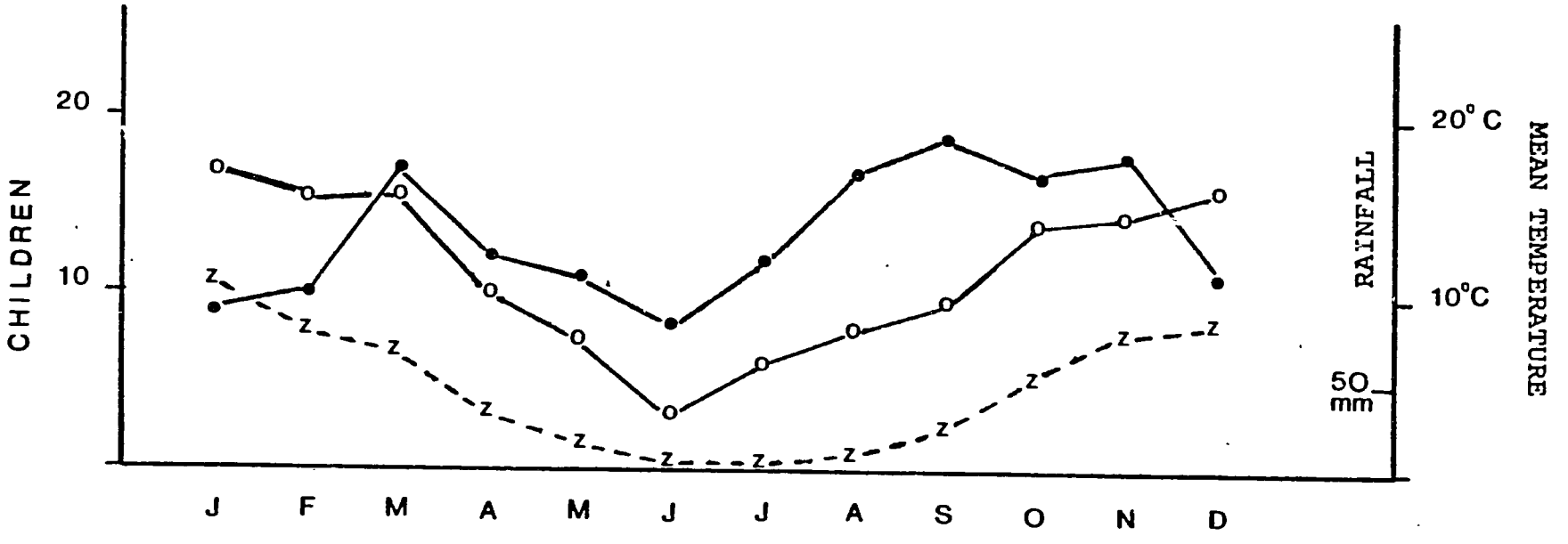
MEAN MONTHLY RAINFALL

Figure 7.



MEAN MONTHLY TEMPERATURE

Figure 8.


CHILDREN
20
10
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50
mm
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MEAN TEMPERATURE
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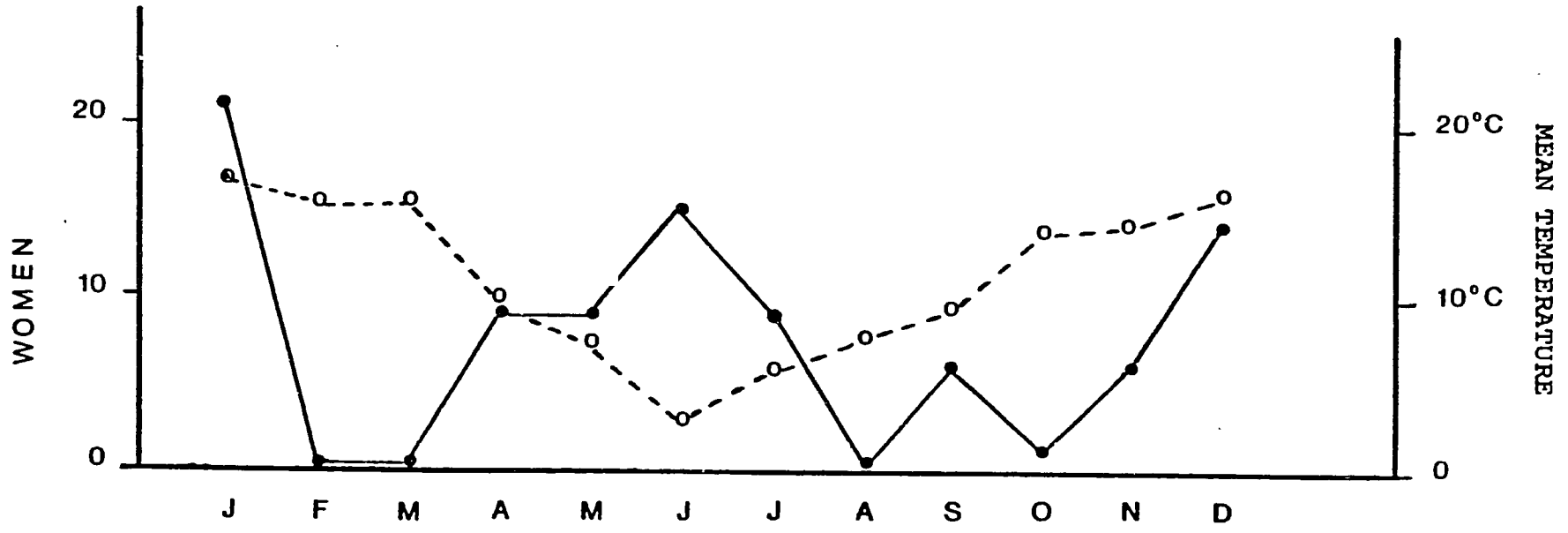
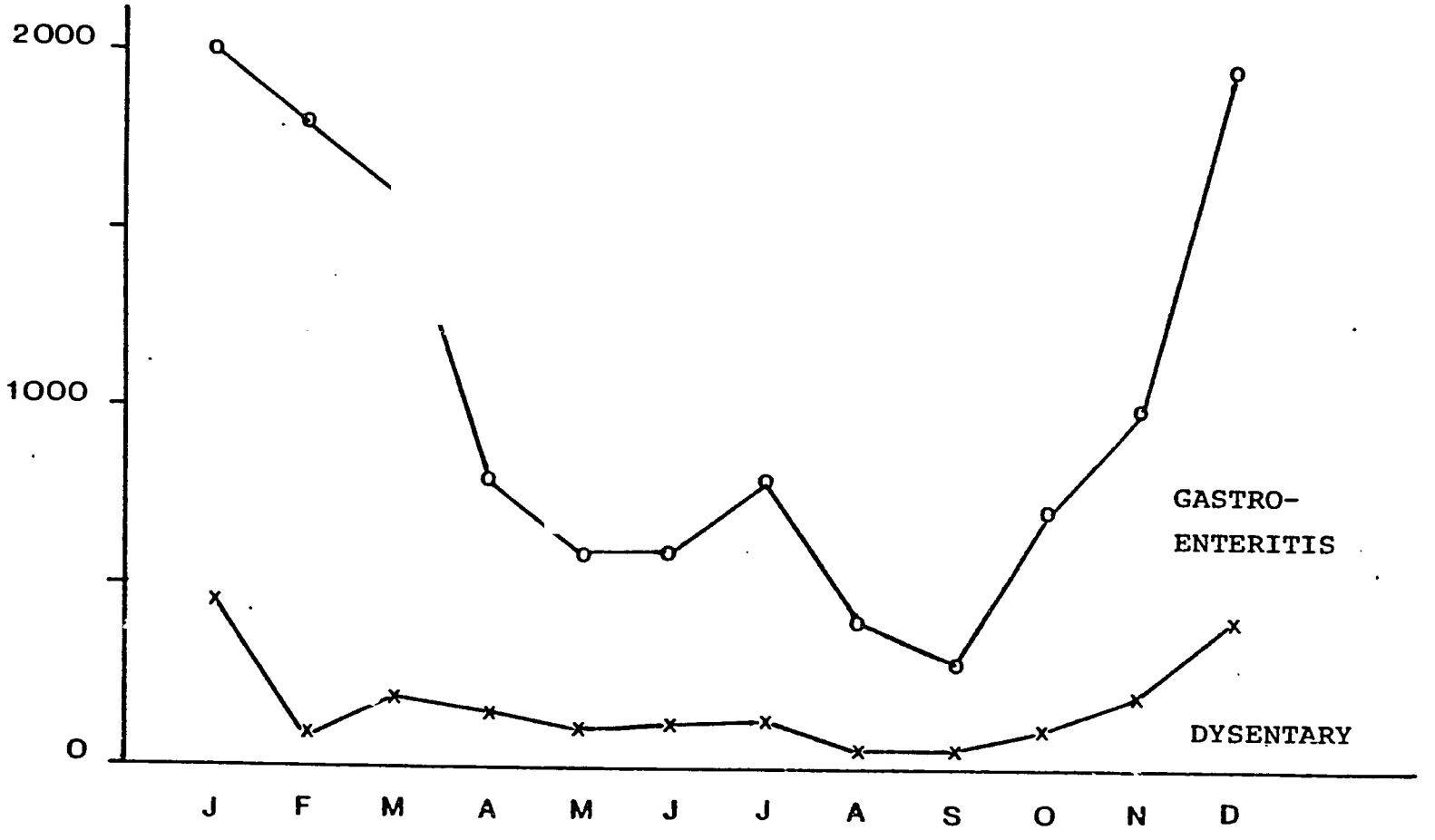
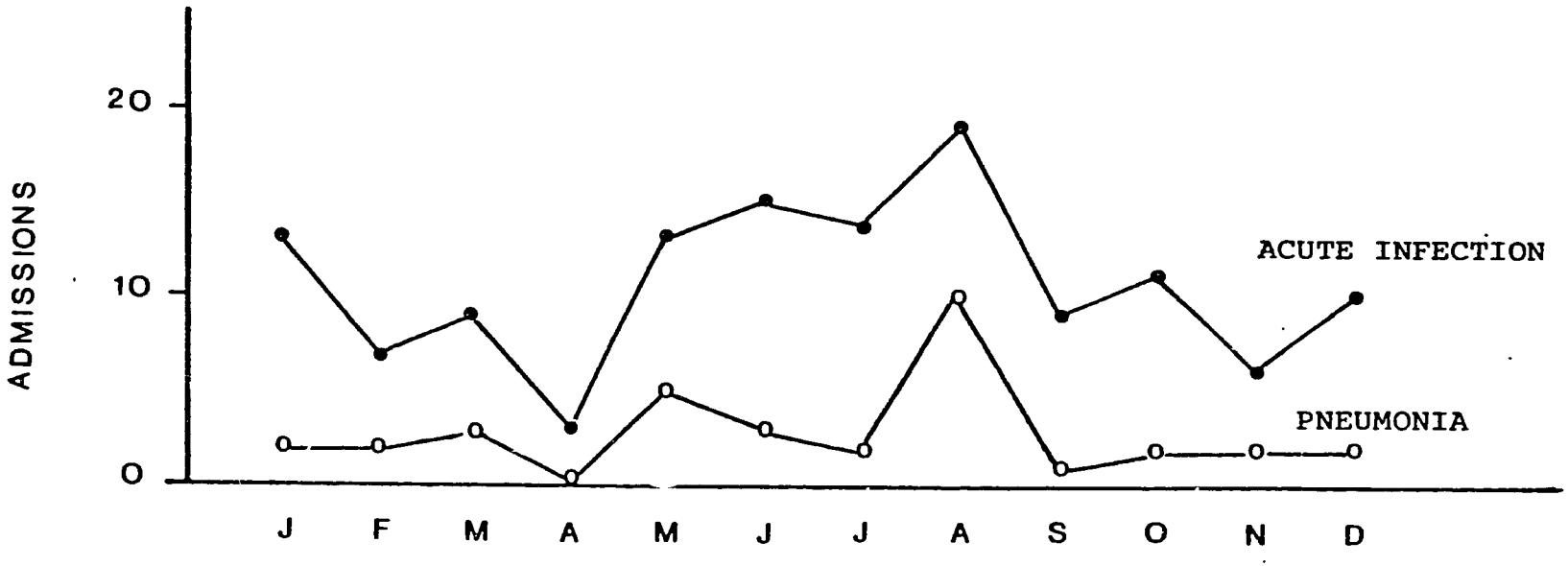
Figure 9.





REPORTED CASES OF INTESTINAL DISEASE: ALL LESOTHO

Figure 11.



HOSPITAL ADMISSIONS: MOKHOTLONG CHILDREN

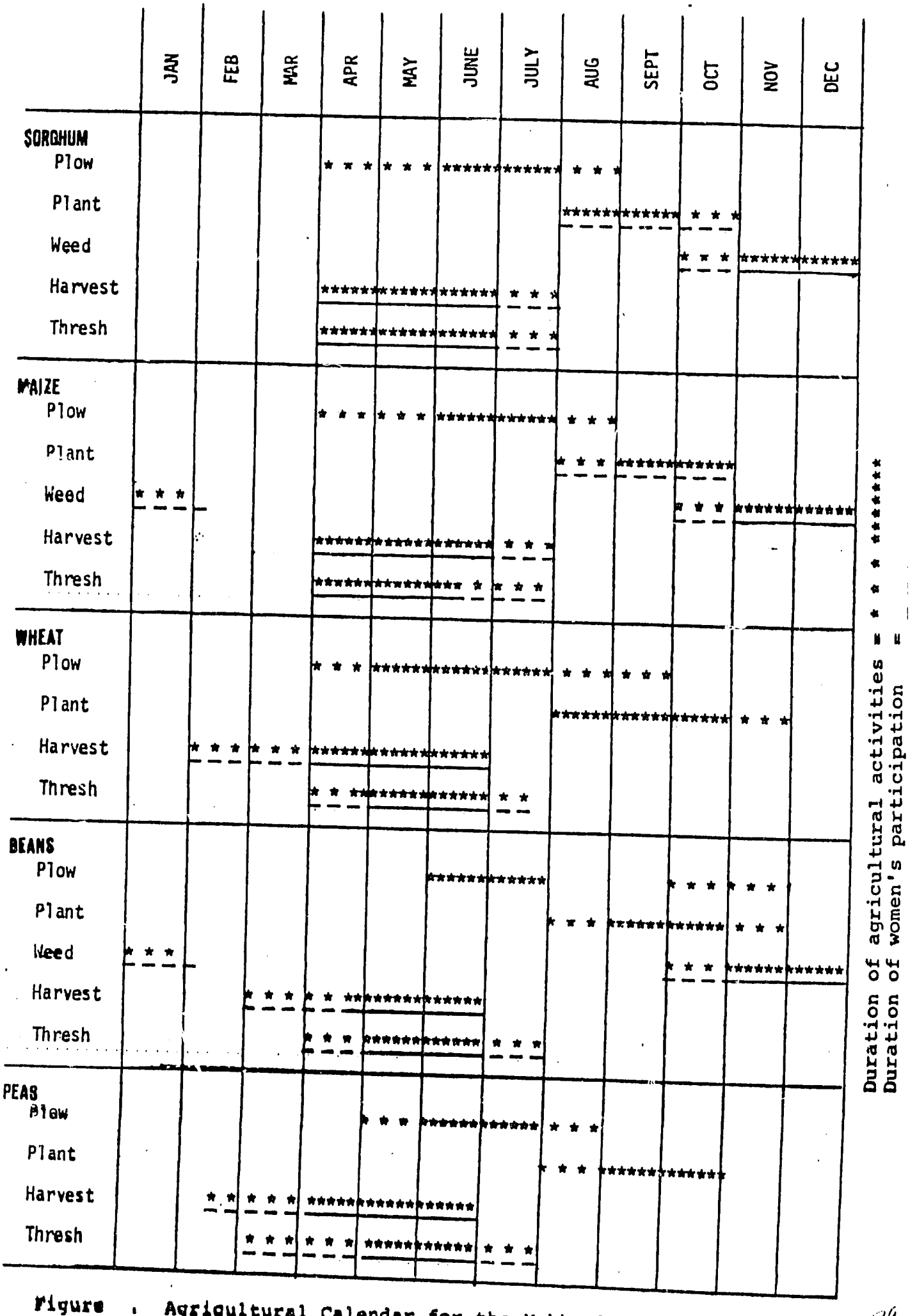
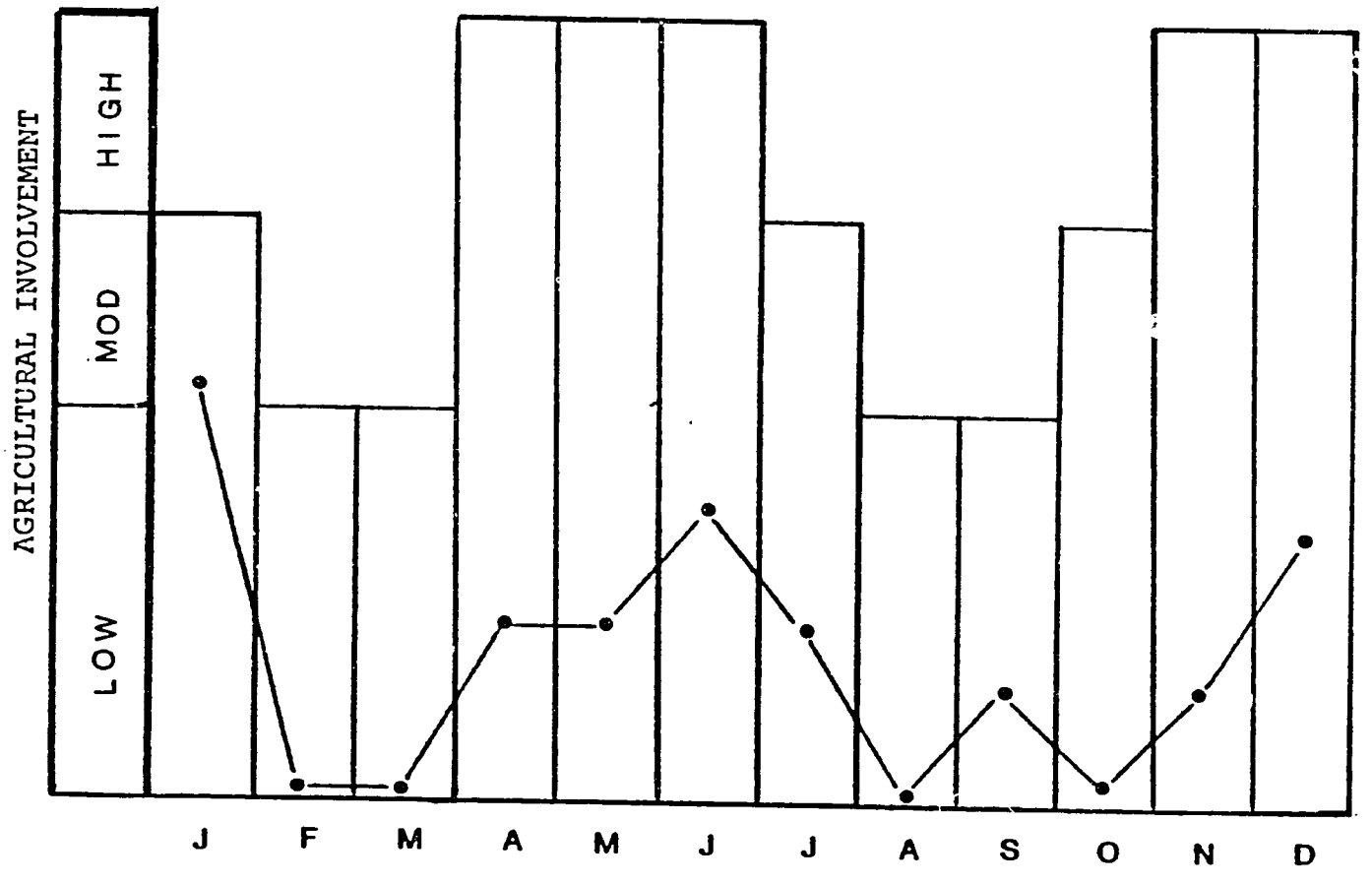
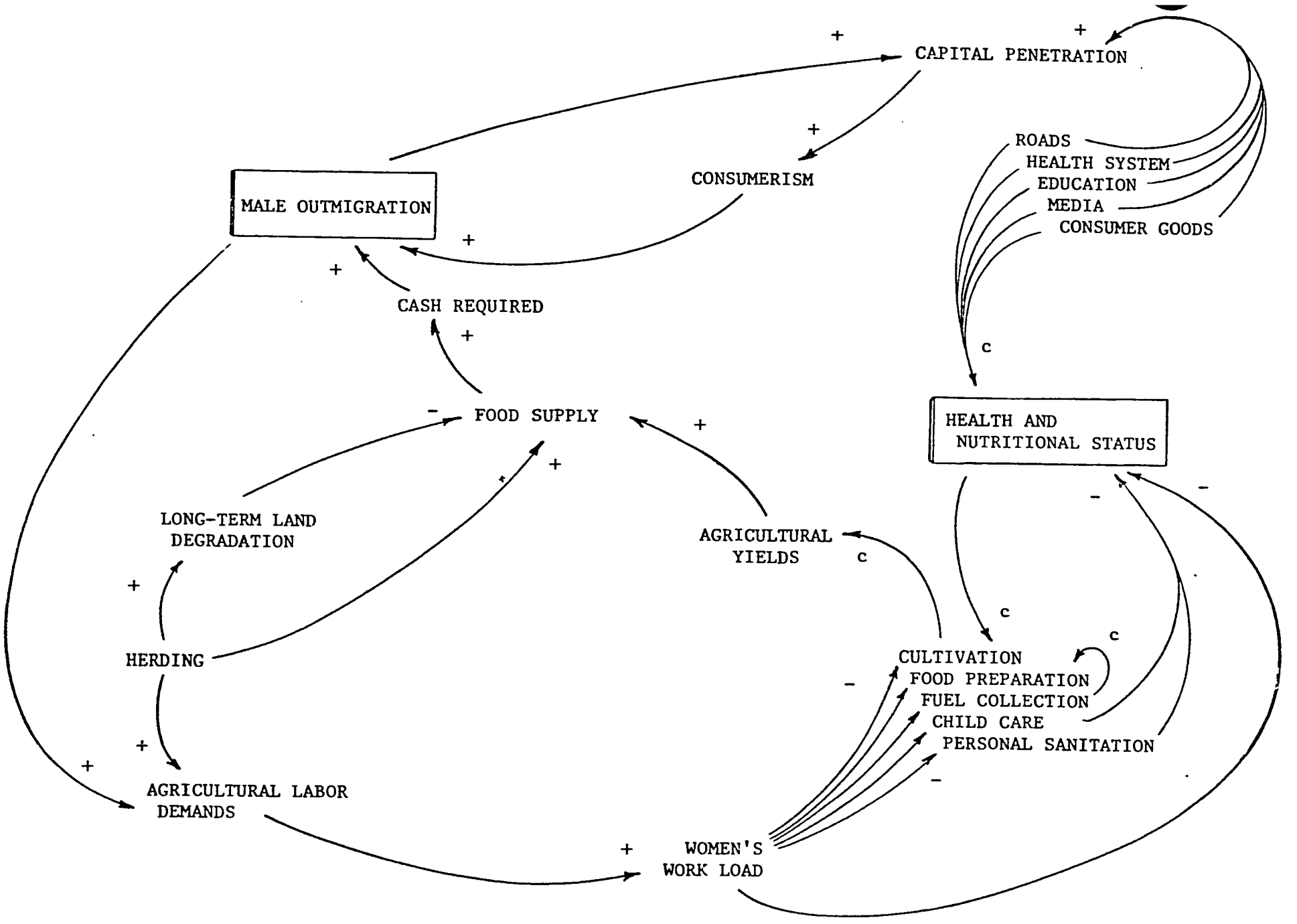


Figure . Agricultural Calendar for the Mokhotlong Valley

Figure 13.



TIME AND ENERGY INVESTMENT IN AGRICULTURE (WOMEN) VS. MONTH OF LOW WEIGHT


CAPITAL PENETRATION
ROADS
HEALTH SYSTEM
EDUCATION
MEDIA
CONSUMER GOODS
CONSUMERISM
MALE OUTMIGRATION
CASH REQUIRED
FOOD SUPPLY
HEALTH AND NUTRITIONAL STATUS
LONG-TERM LAND DEGRADATION
AGRICULTURAL YIELDS
HERDING
CULTIVATION
FOOD PREPARATION
FUEL COLLECTION
CHILD CARE
PERSONAL SANITATION
AGRICULTURAL LABOR DEMANDS
WOMEN'S WORK LOAD

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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HOW TRANSITORY PATTERNS OF EMPLOYMENT AND INCOME TRANSLATE INTO SEASONAL HOUSEHOLD FOOD INSECURITY

by

Harold Alderman

and

David E. Sahn

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HOW TRANSITORY PATTERNS OF EMPLOYMENT AND INCOME TRANSLATE INTO SEASONAL HOUSEHOLD FOOD INSECURITY

Harold Alderman and David E. Sahn

INTRODUCTION

Persephone ate six pomegranate seeds in Hades and in so doing fated the world to a cycle of spring and winter. Osiris' annual death and revitalization guaranteed the cycle of the Nile's waters and the fertility of the fields. From ancient times, mankind has incorporated the mysteries of the seasons into its culture. Furthermore, a perusal of its literature from Aesop's fable of the ant and the grasshopper, to the medieval books of hours, to Kalidassa's six seasoned advice for lovers, reveals that cultures have evolved guidelines as to the proper behavior in each season. This is a theme of the current conference.

While the oscillations of the agricultural cycle may vary between years and may be modified by technical change, to a large degree this cycle is regular and known. Seasonal undulations are distinguished from the stochastic events which result in year-to-year fluctuations in agricultural output and productivity. Similarly, seasonal cycles differ from either longer-run climate cycles or of business cycles which influence industry, both of which are far less regular. Yet even outside agriculture, regular employment cycles do exist, as observed in construction, tourism, and various aspects of transportation and retailing. Given that the production process itself varies over the year for so many industries, it is of interest to study

how the modulations in the production cycle are matched by patterns in earnings and in consumption.

We will concentrate on agriculture and take the existence of a peak and a slack season as a given. We address three broad issues within such an environment. First, to what degree do wages adjust with shifting demand for labor? That is, how much more fluctuation is observed in earnings than in hours worked? Second, we look at technical and institutional arrangements to mitigate the seasonal patterns in agricultural production and employment. Third, we consider to what degree do seasonal patterns of income translate into seasonal patterns of consumption. In this regard, the major issue is to examine opportunities and modalities of savings.

1. Seasonality of Income

The effect of seasonality in agriculture on the periodicity of earnings is determined by the household's source of income. Specifically, one may distinguish between the major categories of rural income sources:

1. net agricultural profits including sales and home consumption;
2. agricultural-related wage labor; and
3. non-farm income.

In turn, different types of household will earn varying shares of their income from these sources. For example, the surplus producers will earn most of their income from sales of agricultural goods coupled with the imputed value of income from home consumption. The small and

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deficit farmer will likely earn from a mix of agricultural production and wage income. The landless laborers will in turn rely primarily on wage employment for their income. Furthermore, any of these households may receive transfer payments, although, if targeted to the poor, they are likely to be of greater importance to deficit farmers and landless laborers.

In examining the periodicity of rural incomes, the major determinants are the timing of the harvest, coupled with the timing of sales of production and the prevailing market prices, and the patterns of labor requirements in agriculture which affect wages and hours worked. These, in turn, are conditioned by a combination of climatic factors, prevailing technology in agriculture, and social relationships including asset distribution, tenancy, and class.

In considering seasonal patterns of work, and thus earnings, the farming systems, anthropological and agricultural economics literature documents extensively the undulations in labor requirements in agriculture. Agricultural calendars which detail the timing of work are frequently developed. They represent important information for formulating policies to address seasonal food insecurity in a given context. However, our purpose herein is not to report on these studies, nor recapitulate the myriad of studies which establish that seasonality in work requirements is extant in all agricultural systems; these patterns differ dramatically from one setting to another depending on the resource endowment, technology, and policy context. Instead, we will concentrate on two important issues in this paper. The first revolves around the performance of labor markets from one

season to the other, and the specific effects on seasonal wages. The second subject discussed in this paper are the opportunities and mechanisms by which households smooth out seasonal variability in earnings which may have deleterious consequences on food security.

1.1 Wage Formation

The question of wage formation in labor surplus economies has generated a large literature -- mostly from Asia -- focusing on whether surplus labor exists, and if so, why wages do not fall. Given the heterogeneity of agricultural employment and the diversity of environments, we will not attempt to answer which model of wage formation applies to which community. Rather, we will focus on the implications for seasonal earnings that the different models entail.

It is often convenient to present the alternative models of rural wages as either belonging to a set of models in which wages are institutionally and exogenously fixed or belonging to a neoclassical framework in which wages are determined by aggregate shifts in supply and demand, thereby reflecting the marginal product of the work performed. While such a dichotomy understates the range of alternatives, the neoclassical model does present a familiar base from which one can begin discussions or comparisons. In such a model, production and consumption decisions are independent maximizations of profits and household utility respectively.[1] Producers equate marginal

[1] The model is discussed in detail and tested in M. Rosenzweig, "Determinants of Wage Rates and Labor Supply Behavior in the Rural Sector of a Developing Country," pp. 211-241, in H. Binswanger and M. Rosenzweig (eds.), Contractual Arrangements, Employment and Wages in Rural Labor Markets in Asia (New Haven: Yale University Press, 1984).

returns to the market wage rate. Institutional or cultural factors are not irrelevant, but come into the model principally through the utility function of the household. For example, Moslem proscription against female market labor participation will shift the female labor supply curve inward, raising both female and male wages. Similarly, demand shifts coming from, say, off-farm alternative employment will affect wages. Thus, seasonal pattern in aggregate production shift labor demand outward and entail a pro-cyclical wage pattern.

One question of interest is the size of such a shift which depends on the magnitude of the labor supply and demand elasticities.[1] Low elasticities of labor supply with respect to wages are reported for such diverse economics as India,[2] Malaysia,[3] and Sierra Leone.[4] Similarly, rural labor demand appears inelastic in India[5] as well as

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[1] Assuming that there are no exogenous shifts in the supply of labor, the change in wages following a shift in the demand for labor can be calculated by the formula:

$$W_{t+1} = W_t[1 + \frac{D}{(e_s - e_d)}]$$

where D is the percentage change in labor demand and e_s and e_d are supply and demand elasticities.

[2] M. Rosenzweig, op. cit.

[3] H. Barnum and L. Squire, "An Econometric Application of the Theory of the Farm-Household," Journal of Development Economics 6 (1979): 79-102.

[4] J. Strauss, "Determinants of Food Consumption in Rural Sierra Leone: Application of the Quadratic Expenditure System to the Consumption-Leisure Component of a Household Farm Model," Journal of Development Economics 11 (1982): 327-53.

[5] R. Evenson and H. Binswanger, "Estimating Labor Demand Functions for Indian Agriculture," pp. 263-279, in H. Binswanger and M. Rosenzweig (eds.), op. cit.

pre-war Japan.[1] This inelasticity implies that seasonal shifts in labor demand (or supply) will have marked effects on wages. This leads to marked seasonal patterns in wages as well as sensitivity of wages to technological changes or the introduction of seasonally targeted public works in rural areas.

The neoclassical approach contrasts with the assumption of a constant subsistence wage rate found in a number of models of development including the Lewis and Fei-Ranis models. Specifically, there are two main types of models that depart from the basic neoclassical model with market-clearing wages, and no unemployment. These two types are both directly relevant to an analysis of seasonality and seasonal fluctuations in earnings among rural households. They can generally be classified as "efficiency wage" models and "implicit contracts" models.

The efficiency wage hypothesis, which purports to explain such a sticky rural wage in the context of apparently surplus labor was first presented by Leibenstein.[2] The model posits that producers do not hire labor time but units of work. The latter are assumed to be related to the former through a function which includes the calorie intake of the laborer. That is, labor power is functionally-related to nutrient consumption, which is hypothesized to be increasing at an increasing rate at low levels of intake, and thereafter, diminishing

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[1] L. Nghiep, "The Structure and Changes of Technology in Pre-War Japanese Agriculture," American Journal of Agricultural Economics 61 (1979): 687-93.

[2] H. Leibenstein, Economic Backwardness and Economic Growth (New York: J. Wiley and Sons, 1957). The theory is reviewed at length in C. Bliss and N. Stern, "Productivity, Wages, and Nutrition Part I: The Theory," Journal of Development Economics 5 (1978): 32-62.

in returns after an optimal level of consumption is reached. In this model, then, there is an optimal point below which reduction in wages lead to a sufficiently large reduction in work efficiency that net returns to the producer are reduced. This explains the rigidity in wages since lowering them below the optimal point will jeopardize nutritional status, and thus, the ability to do work.

Two conditions are necessary but not individually sufficient for the relationship to be plausible. Improved nutrition must lead to increased work efficiency in the range of consumption observed for wage laborers, and institutions must exist that enable individual producers to capture the returns to their investment in the nutrition of their employees.[1] The former, while intuitive, has proven difficult to test while the latter leads to a number of testable implications.

Of principal interest to the issue of seasonality in earnings is the prediction that efficiency concerns imply a floor level for wages, at least over low ranges of consumption. The floor is in terms of a level of consumption (and thus real income to the extent that there is a fixed relation between income and intake) which provides for nutritional adequacy. Striving to achieve this floor should encourage in-kind payment in the form of food and on-site feeding of workers or

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[1] Supportive evidence is reviewed in J. Strauss, "Does Better Nutrition Raise Farm Productivity?" Economic Growth Center Discussion Paper #457 (Yale University, 1984). See also G. B. Rogers, "Nutritionally Based Wage Determination in the Low-Income Labour Market," Oxford Economic Papers 27 (1975): 61-81.

similar mechanisms to discourage substitution of non-foods for foods.[1] Note, however, that the theory does not rule out seasonal variation of wages when the demand curve for labor shifts outward during the peak season. Like other minimum wages set by unions or by legislation, the efficiency wage implies higher earnings per employed laborer but less workers employed than the basic neoclassical framework. Whether these unemployed succumb to Malthusian forms of market clearing or eke out a subsistence livelihood in forage activities and small crafts is discussed in the literature but not resolved.

The efficiency wage theory also predicts that employers will prefer long-term contracts over daily hiring in order to capture the returns to their investment in nutrition. However, daily wages may be less under long-term arrangements as the nutritional floor wage depends on a long-term nutritional relationship. The efficiency of work which determines the optimal wage rate is a function of total consumption from all sources. This is affected by the regularity of wage employment. It is also affected by the availability of alternative employment. Wages would be lower for laborers with a small parcel of land or with more than one family member working.[2] This also implies that the employer would seek to hire small landholders before the landless, as the latter would command a higher wage. There is little

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[1] While the existence of canteens at the work place has been pointed to in support of the biological determination of wages, an equally plausable explanation is that employers are simply trying to reduce the costs of workers taking long breaks in order to have their meal, coupled with the fact that it adds further structure and sense of committment to the work place.

[2] Bliss and Stern, op. cit., discuss the conditions under which this prediction should hold.

empirical evidence that employees favor households which have greater landholdings. Bardhan[1] found a negative coefficient for land cultivated when predicting wages. However, he proposes an explanation other than nutritionally determined wages as the cause. Specifically, it is argued that it is more difficult to hire a worker who has land to care for, and thus faces risks and costs of delaying work on their own land. These same risks and costs spur the employer to pay the landless worker, who is more available, a wage premium. In other words, since recruitment costs are higher for the landed, they will be paid less, other things remaining the same.

While the floor wage is defined in terms of nutrition, it is only the nutrition of the worker and not the family that is of concern to the employer. Hence, employers should show a preference for laborers with few dependents. Rogers[2] found this to be the case in Bihar, as did Bardhan[3] for casual workers in West Bengal, although just the opposite was true for regular farm laborers in West Bengal. Also, if the probability of employment can be influenced by a worker signalling his nutritional status, workers could undercut other workers by increasing their share of family intake, especially in the off-season. The theory, then, implies interdependence of labor participation decisions by various members; and to the extent that there is a seasonal pattern to household members working, the intra-household

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[1] P. Bardhan, "Wages and Unemployment in a Poor Agrarian Economy: A Theoretical and Empirical Analysis," Journal of Political Economy (3) 87 (June 1979).

[2] G.B. Rogers, op. cit.

[3] Bardhan, op. cit., 1979.

distribution of food resources will be affected. Little research, however, has been done in this area.

Nutritionally determined wages may create conditions under which wages and employment are tied to other contractual arrangements including credit. However, other conditions may also account for such arrangements.[1] These fall in the domain of what may be referred to as "implicit labor contracts theory" (ICT), where labor services are not auctioned-off as would be goods in the market, but are exchanged for an implicit commitment for work and wages on the part of the firm for a "reasonable" time frame, with terms mutually agreed upon between employer and employee in advance.[2]

Interlinked markets which tie employment or tenancy with credit or with marketing activities may reflect moral hazard of consumption loans given to individuals with little collateral, or may reflect various types of obstacles to (a) obtaining information on the capacity of workers and (b) monitoring performance of laborers. Also, the risk-averse laborer who confronts great uncertainties in terms of the flow of income may trade his services for an insurance contract, whereby there is a tacit understanding of the firm guaranteeing to maintain wage rates, hours worked, and so forth, despite the seasonal fluctuations in the production cycle. Thus, wages no longer reflect the

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[1] See H. Binswanger and M. Rosenzweig, op. cit.; also C. Bell and T. Srinivasan, "An Anatomy of Transactions in Rural Credit Markets in Andhra Pradesh, Bihar and Punjab," unpublished working paper (Washington, D.C.: World Bank, June 1985); and P. Bardhan, "Interlocking Factor Markets and Agrarian Development: A Review of Issues," Oxford Economic Papers 32 (1980): 82-98.

[2] Costas Azariadis, "Implicit Contracts and Underemployment Equilibrium," Journal of Political Economy 83 (1975): 1183.

marginal revenue product of labor, as the contract plays a dual role -- compensating the worker for services and providing insurance against variations in income.[1] Similarly, an employer's interest in reducing search or training costs or his interest in influencing village level politics by holding out the possibility of selective privileges encourages them to enter into implicit labor contracts (ILCs).[2]

Bardhan[3] contends that implicit labor contracts are not determined by customs or subsistence needs which are invariant to changes in the demand for labor. However, the amplitude of seasonal wages is lower than would be predicted on the basis of marginal products, since the employer enters into ILCs during the slack season to save on peak season recruitment costs. The implication is that the tighter the labor market and the lower the unemployment, the more difficult peak season recruitment, leading to more tied labor contracts and lower seasonal variability. Accordingly, it is the level of employment that conditions the nature of labor relations and wages, not vice versa. If this is the case the correlations between unemployment and tied labor contracts would be expected to be negative. Thus, this model would posit that attached labor, which in turn smooths out seasonality in

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[1] Bengt Holmstrom, "Equilibrium Long-Term Labor Contracts," Quarterly Journal of Economics (392) XLVIII (1983 Supplement): 23-54.

[2] Gillian Hart, "Interlocking Transactions: Obstacles, Precursor or Instrument of Agrarian Capitalism?" Journal of Development Economics, forthcoming. Hart reviews evidence from Indonesia, Philippines, Thailand, and Chile as well as many of the South Asian examples discussed in this paper.

[3] Bardhan, 1979, op. cit.

wages, is not a manifestation of a feudal or stagnant agriculture, but quite to the contrary.

In a similar vein, the model which suggests that high recruitment costs during the peak season lead to tied labor arrangements and higher wages has important implications for the role of technological innovation on seasonality and nutrition. It can be argued on the basis of ILC theory that technology which increases peaks in seasonal labor demand will drive up wages and encourage employers to enter into contracts which will smooth the flow of income to the poor households.

Accordingly, introducing labor savings technology during the peak periods might have especially deleterious consequences in terms of seasonal food insecurity for the landless poor by raising the variability in seasonal wages. This is in contrast to the argument that care should be taken not to introduce technologies which exaggerate labor peaks.

Despite the ongoing debate on the causes of such arrangements, there is widespread evidence that interlinked factor markets are prevalent at least in Asia.[1] Furthermore, while some evidence exists that such arrangements occasionally reflect extra-economic coercion, the majority of examples appear to be voluntary agreements under which one or both parties benefit relative to untied arrangements, and neither lose. This is especially important since the enforceability of

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[1] P. Bardhan and A. Rudra, "Interlinkage of Land, Labor, and Credit Relations: An Analysis of Village Survey Data in East India, Economic and Political Weekly 13 (1978): 367-84; P. Bardhan and A. Rudra, "Terms and Conditions of Labour Contracts in Agriculture: Results of a Survey in West Bengal, 1979," Oxford Bulletin Economics and Statistics 43 (1981): 89-111. Also C. Bell and T. Srinivasan, op. cit.

"implicit" contracts is difficult. From the workers perspective, for example, it might be more advisable to reject occasional offers of higher wages so that he may get preferential contracts for "reliable," and seasonally stable contracts in the future. Similarly, the good reputation of the employer in upholding ILCs may condition the quality and cost of labor available to the firm in the future.[1]

Although long-term rural labor contracts are not necessarily tied to other factor markets, frequently they are linked to the provision of credit. Whether or not they are tied with credit, such long-term agreements may reduce risk for laborers and search costs for employers. They may serve somewhat as a labor futures market operating between seasons. It is not, however, universally reported that such contracts reduce the daily or total wage paid to the worker, that is, there may not be any risk premium at all. In any case, such arrangements have the potential to smooth the flow of labor earnings over the seasonal production cycle. They are also likely to result in downwardly rigid wages, although like the efficiency wage model, mobility in labor markets will tend to make upward movement in wages possible. Also like the efficiency wage model, the implicit contract theory raises the possibility that there may be less employment. However, once again the employer may not reduce dramatically the number of employees during the slack season so that his reputation will be maintained, reducing future cost of finding reliable and inexpensive labor.

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[1] Costas Azariadis and J. Stiglitz, "Implicit Contracts and Fixed Price Equilibrium," Quarterly Journal of Economics (392) XLVIII, 1983.

When such contracts are linked with credit, the household acquires an additional means to control the flow of consumption from one season to the next through its savings behavior which is distinct from the effect of the assured employment. The net effect of tied credit arrangements which, of course, may also be granted to casual laborers, depends in part on the conditions which motivate the linkage. On the one hand, there is the possibility of bonded labor in which the laborers debts are used to obtain a serf-like obligation to the lender. On the other hand, in models such as Hart's,[1] the credit would lead to a net addition to the households consumption as it is used to ensure political loyalty, not to extract economic concessions from the laborer.

To date, there is insufficient evidence to assess the costs of such credit to the laborer. Bardhan and Rudra's data which document that employees frequently provide credit to laborers, also documents that wages are often reduced during repayment.[2] Their studies, however, do not indicate whether such wage reductions imply interest rates above or below market contract rates. But, as institutional credit is generally unavailable or rationed for small holders and landless households, and frequently also difficult to obtain in the informal sector,[3] the face value of interest rates are not clear indicators of the value of credit to the household. When the demand

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[1] G. Hart, op. cit.

[2] P. Bardhan and A. Rudra, 1978, 1979, op. cit.

[3] C. Bell and T. Srinivasan, "Agricultural Credit Markets in Punjab: Segmentation, Rationing and Spillover," unpublished paper (World Bank, April 1985).

for credit exceeds the supply, the value to the household of the loan component of the tied wage agreement is at least as great, or greater, than the interest rate implied in the wage reduction. Under conditions in which the tying of labor and credit relationships provides a means of circumventing the laborers' lack of collateral, tied transactions tend to lower peak and raise off-season consumption by the laboring household.

Often, land is rationed to individuals as well as credit. Indeed, some models of interlocked markets depend critically upon the assumption of rationing of land for their results.[1] While the full welfare implications of such models are ambiguous without some restrictive assumptions, it is clear that the existence of such contracts should again influence the relative heights of seasonal peaks of earnings for laborers. Since labor provides income prior to harvests, the provision of land as part of a labor contract provides for a different seasonal flow of earnings than either a pure tenancy or pure labor arrangement. Since such an arrangement should also reduce the need for credit on the part of a tenant, it assists in circumventing credit and security constraints.

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[1] P. Bardhan, op. cit. (1980): 82-98, reviews his own and other models, pointing out the rigidity of assumptions used. A. Braverman and T. N. Srinivasan's, "Agrarian Reforms and Developing Rural Economics Characterized by Interlinked Credit and Tenancy Markets," in H. Binswanger and M. Rosenzweig (eds.) op. cit., pp. 63-81, present a model with rationed tenancy, although labor is not directly tied. They show that if the landlord has reduced the tenant to their reservation utility level (by limiting the size of the plot), it is then in the landlord's interest that his tenant gets as cheap credit as possible, i.e., from himself rather than from more expensive alternative sources of capital from other local moneylenders.

Despite that it may be too early in the conference for the traditional call for more research, it is clear that the empirical evidence on the welfare implications of linked tenancy, labor, and credit relations is too scarce and localized for generalizations. Nevertheless, it appears to illustrate adaptions to the imperfections in factor markets and future markets. As such, an understanding of inter-temporal contracts is essential for understanding patterns of seasonal earnings and consumption in rural areas.

The theoretical underpinnings of seasonal wage formation discussed above and its implications for the patterns of earnings are the subject of a limited number of studies which explicitly look at the seasonal dimensions of the problem. While a good number of studies do indeed describe seasonal variability in wages (for example, see Table 1), and are useful in establishing the extent of seasonal variability in wages, these same descriptive data are limited in that the underlying processes which bring about shifts in wages from one season to the next, or lack thereof, are seldom discussed. For example, Norman[1] found that in Nigeria although 44 percent of the total annual labor input occurred during June to August, the peak season of agricultural work was not characterized by a notable increase in wages, suggesting that some factors were limiting the flexibility in pricing. Similarly, the evidence on wages among the Masai in Kenya in crop year 1962/63 showed little seasonal variation, despite considerable amounts of labor

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[1] D. W. Norman, "The Feasibility of Improved Sole Crop Maize Production for the Small-Scale Farmer in the Northern Guinea Savanna Zone of Nigeria," Institute for Agricultural Research, Samaru (Zaria, Nigeria: Ahmadu Bello University, 1976).

Table 1 -- Studies of Seasonal Patterns in Wages and Hours Worked

Country	Location	Type of Measure	Years	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Quantity Measured
Bangladesh		Index	1953-68	109	108	105	100	97	94	94	95	94	95	99	106	Daily real wages for agr. labor
		"	1968-76	107	105	104	93	97	97	96	99	96	95	102	110	"
		"	1953-76	108	106	105	97	97	96	95	97	95	95	100	108	"
Bangladesh	Comilla	"	1953-76	97	97	95	94	97	105	108	105	102	90	96	94	Wages (daily)
Egypt		Piasters per day		5	4.5	5	5.5	6	7	7	7	7	11	7	6	Wages per day, children
		"		13	12.5	13.5	14.5	15	17	17	15	15	15	14.5	14	Wages per day, men
		Women		8.5	8.5	9	11	11	12.5	11	10.5	11	14.5	11.5	10	Wages per day, women
Bangladesh		Taka/day	1977-78	10.0	8.0	7.5	7.5	6.0	*	*	6.0	7.5	7.5	7.0	7.4	Ag. laborer wage rate
Nigeria	Kwadago & Jinga	Sh/day	April 67/ March 68	0.47	0.05	0.46	0.61	0.47	0.45	0.44	0.34	0.44	0.43	0.47	0.42	Ave. wage per hour
Cattle owners, Nigeria	Hawa (N. Nigeria)	Index (mean=100)		60	50	30	130	140	140	150	110	90	110	120	80	Work allocation
Non-cattle owners, Nigeria	"	"		80	60	40	110	140	120	13[illegible]	100	100	100	105	100	Work allocation
Egypt	Rural sector	Hours/8 days		19	19	20	20	21	25	34	24	26	32	20	19	Work, children
"	"	"		44	40	48	52	52	57	57	52	54	48	46	45	Work, men
"	"	"		17	16	17	18	18	21	20	18	17	23	18	17	Work, women

being hired for periods of weeding and harvesting.[1] Ryan[2] estimated a very small coefficient for a dummy variable for peak seasonal wages when estimating wage equations. Bardhan[3] also found that seasonal wages did not rise commensurate with what would be expected on the basis of supply and demand shifts, and posits possible explanations which are discussed below.

Similarly, Chaudhury[4] observed only a slight variation in seasonal wage rates, despite the fact that 40 percent of the demand for labor is during the period April to May. However, he notes that this rise is cancelled out by the high rice prices which occur during the peak seasons of labor. Thus real wages do not increase. This admonishes that examining the movement of wages, without prices, may lead to misleading conclusions about seasonal stress, and wage formation.

In Java, Indonesia, despite the fact that there was a 32 percent and 52 percent decline in hours worked in wage labor from the peak to slack season for households controlling 0.5 to 0.2, and less than 0.2 hectares of land, respectively, the percentage change in returns to labor per hour actually increased marginally from the peak to slack

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[1] Judith Heyer, "A Linear Programming Analysis of Constraints on Peasant Farms in Kenya," Food Research Institute Studies (1) 10 (1971): 55-67.

[2] James C. Ryan, Wage Functions for Daily Labor Market Participants in South Asia, Progress Report 38 (Andhra Pradesh, India: ICRISAT, 1982).

[3] Bardhan, 1979, op. cit.

[4] Rafiqul Huda Chaudhury, "Seasonal Dimensions of Rural Poverty in Bangladesh: Employment, Wages, and Consumption Patterns," Social Action 30 (January-March, 1980): 1-27.

season.[1] However, the fact that workers are engaged in fishing activities, rather than cultivation during the slack season, seems to be responsible for the higher wages and fewer hours worked, rather than the vagaries of fixed wage models. This suggests the need to examine patterns of employment commensurate with data on seasonal wages.

In Egypt, Hansen[2] observed that wages are not truncated at some subsistence level, and that there is a close association between employment and wage fluctuations. He argues that there is a shift in the demand curve for labor which brings about a highly seasonal pattern of wages. This, coupled with the fact that there are no wages reported during slack season, presumably because there is no hired labor, both of which contradict an institutionally determined wage rate, is further evidence that wages reflect their marginal product. A similar conclusion is reached by Rosenzweig.[3]

A final dimension to the seasonality of wages concerns the potential that seasonal patterns of morbidity affect labor supply, thus affecting the price of labor. Specifically, the prevalence of diseases during certain seasons has been identified as a major factor in

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[1] Gillian Hart, "Patterns of Household Labor Allocation in a Javanese Village," in Hans P. Binswanger et al. (eds.), Rural Household Studies in Asia (Singapore: Singapore University Press, 1980).

[2] Bent Hansen, "Employment and Wages in Rural Egypt." American Economic Review 59 (June 1969): 298-313. These conclusions are challenged by James Hanson, "Employment and Rural Wages in Egypt: A Reinterpretation," American Economic Review 3 LXI (1971): 492-499; and Bent Hansen, "Employment and Wages in Rural Egypt: Reply," American Economic Review 3 LXI (1971): 500-508.

[3] M. Rosenzweig, op. cit.

limiting the supply of labor. The evidence as to whether illness has its most important effect during the busy season or slack season is somewhat conflicting.[1] This contradictory evidence is partially explained by the fact that while the onset of disease indeed may be higher in peak season, there is considerable latitude for postponing treatment or overcoming morbidity through determination. Thus, both the timing of the agricultural calendar versus the seasonal pattern of morbidity, coupled with the ability of the worker to compensate for disease, will determine the magnitude and implication of work time loss and its subsequent effect on labor supply and wages.

1.2 Smoothing out the Stream of Seasonal Earnings

The decline of the marginal productivity of labor for on-farm work during the slack season often leads to a trade-off between paid employment, either on other farm or non-farm activities and working on one's own land.[2] For example, Norman's[3] data from Zaria villages in Northern Nigeria illustrate the seasonal pattern of farm versus nonfarm work, and how the total days worked vary relatively less due to the substitution between farm and other work (see Table 2). Similarly, as

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[1] John H. Cleave, African Farmers: Labor Use in the Development of Smallholder Agriculture (New York: Praeger Publishers, 1974); and see Chapter 4 of Robert Chambers, Richard Longhurst, and Arnold Pacey (eds.), Seasonal Dimensions to Rural Poverty (London: Francis Printer, Ltd., 1981).

[2] Also, see Cleave's discussion from Uganda of the tradeoffs between farm, non-farm, and leisure activities, pp. 157-190.

[3] D. W. Norman, "Labour Inputs of Farmers: A Case Study of the Zaria Province of the North-Central State of Nigeria," Nigerian Journal of Economic and Social Studies (1) 11 (1969): 9-10.

Table 2 -- Substitution of Farm and Other Work, Zaria Villages, 1966-67

Month	Family Farm Work			Other Work	Total Work
	Days worked	Hours/ day[a]	Hours/ month[a]	Days worked	Days worked
April	10.0	4.1	41	8.2	18.2
May	16.0	4.8	77	6.3	22.3
June	16.9	4.9	83	6.0	22.9
July	16.1	4.9	79	6.4	22.5
August	14.6	4.7	69	6.4	21.0
September	11.8	4.5	53	6.6	18.4
October	12.4	4.3	53	5.8	18.2
November	13.3	4.3	57	6.1	19.4
December	9.3	4.0	37	6.9	16.2
January	7.6	3.7	28	10.0	17.6
February	6.2	3.1	19	10.1	16.3
March	4.4	2.7	12	8.7	13.1
Total	138.6	4.4	609[b]	87.5	226.1

[a] Hours exclude travel time.

[b] Total hours in 1966-67 season.

Source: Norman et al., op. cit. (1969): 9-10.

labor demand declines during troughs in agricultural activity, one can expect the laborer to seek alternative areas of more productive employment, assuming wages fall commensurate with marginal value product of labor.

The need for and success of search efforts to smooth out participation rates and/or wage rates is conditioned by a myriad of factors. In Indonesia, households dependent on foodgrain markets for rice are more likely to enter into the labor market on unfavorable terms during the slack season than households producing larger quantities of rice that can be stored on farm.[1] From Egypt there is evidence that small farms more quickly reach diminishing returns to additional work on their land.[2] Thus outside wage labor during the slack season is more important to their earnings. Those without cash, facing food shortages and a lack of access to credit may also be compelled to work off the farm during the peak season to ensure their survival.[3] Concurrently, during the slack season the larger farmer is likely to respond by reducing hired labor.

Evidence from India that there is more seasonal variability in labor-per-hectare on smaller farms also suggest that the poor may be of

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[1] G. Hart, op. cit., 1980.

[2] Hanson, op. cit.

[3] Derek Byerlee and Carl Eicher, "Rural Employment, Migration, and Economic Development: Theoretical Issues and Empirical Evidence from Africa," African Rural Employment Paper No. 1, Department of Agricultural Economics (East Lansing: Michigan State University, 1972).

greater seasonal risk.[1] Lipton's[2] extensive review of a number of studies shows that the poor are more affected by fluctuations in participation and wage rates. While we will not recapitulate these findings, Lipton does point out that those most subject to seasonal variability in wage and participation rates are the casual laborers, with few non-farm assets, little land, and less irrigation.

One result of this seasonal variability is the relatively large allocation of time for job searcher during the slack season. Similarly, a greater amount of time might be spent travelling to and from work during the slack season. Both of these phenomena were observed, for example, by Hart for a Javanese village. Undoubtedly, as these search or travel costs become high enough, it discourages potential workers from seeking work. Observed differences in fluctuations on search and travel time for different population groups may reflect differences in reservation wages.

Specific strategies for smoothing seasonal production variability are manifold. Most obvious is the ability to select crops and adjust crop ratios to smooth labor requirements. Other strategies revolve primarily around improving utilization of rains. Irrigation is the most obvious means of reducing seasonality in agriculture. Other water-related measures include runoff collection and recycling, conservation of soil moisture through contour and graded bunds, and

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[1] James Ryan and R. D. Ghodake, "Labor Market Behavior in Rural Villages of South India: Effect of Season, Sex and Socioeconomic Status," Progress Report Economics Program 14 (Andhra Pradesh, India: ICRISAT, 1980).

[2] Michael Lipton, Labor and Poverty, World Bank Staff Working Paper No. 616 (Washington, D.C.: World Bank, 1983).

contour cultivation, mulching and so forth, all of which will improve the likelihood that a second or third crop can be cultivated. In addition, a variety of improved management practices which more efficiently exploits the agroclimatic environment can help reduce seasonality of work and food availability. Dry seeding, which eliminates the loss of time between the rains and planting of crops will also increase the likelihood of a second crop. Plant spacing, thinning, intensive weed management, split application of fertilizer, inter-cropping, sequential or relay cropping, and splitting of input doses may also smooth out the demand for labor and increase the number of crops harvested per year.[1] Technological advances, in terms of developing germplasm which matures more quickly and is photoperiod insensitive will also increase the likelihood of multiple cropping, thereby smoothing out income flows.

These production strategies which tend to smooth out variable labor inputs and streams of seasonal income are conceptually sound. The dilemma arises when strategies to smooth out seasonal peaks in production, and hence labor demand and income are at the expense of increases in output. For example, a change from shifting cultivation to semi-permanent and permanent cultivation systems may aggravate seasonal labor bottlenecks. The reasons are that there is: (1) less time spent clearing land, a traditional dry season activity, and (2) increased labor inputs during the rainy season for weeding. Similarly,

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[1] N. S. Johda and A. C. Mascarenhas, "Adjustment to Climatic Variability in Self-Provisioning Societies: Some Evidence from India and Tanzania," Economics Program Progress Report 48 (Andhra Pradesh, India: ICRISAT, 1983).

introducing new seeds and fertilizer, and changing the power source may shift the bottlenecks from weeding, land preparation, and planting to harvesting.[1] This type of dilemma may also be manifested in terms of selecting production augmenting technologies. For example, Day and Singh[2] found that although total demand for labor increased little with the introduction of HYVs and selective mechanization in the Punjab, the distribution of that labor was altered considerably. On the other hand, other studies have found that new technologies, especially fertilizer, have altered considerably the amount of labor required, but not changed the seasonal pattern of this demand. If tradeoffs exist between maximization of farm earnings and fluctuations in earnings of laborers, promotion of new technology consider measures to offset the negative impacts.

On-farm strategies to diversify seasonal income sources may also include shifts to cash crops and livestock production. For example, Jones reports from Mali that farmers plant cash crops after food crops are well established. Planting cash crops may not only involve producers diversifying their production, but may reduce the seasonality and employment for workers.

In Cleave's[3] extensive review of the relationship between cash

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[1] For example, Norman et al, op. cit., 1976, p. 14.

[2] R. H. Day and Indergit Singh, Economic Development As an Adaptive Process: The Green Revolution in the Indu Punjab (New York: Cambridge University Press, 1977).

[3] Cleave, op. cit.

crop and food crop production in Africa, he notes that sometimes there is, and in other circumstances, there is not, a conflict between the seasonal labor requirements for the two sets of activities. For example, cotton planted in the Sokoto province of Nigeria appears to even out labor use, while groundnuts production in the same region conflicts with production of millet. In Sudan, cotton production is shown to come into direct conflict with labor demands for production of cereal staples, while in Genieri, Gambia, both rice and groundnut production have coincident peaks in labor use. While it is possible to recount the myriad examples in the literature of either such inherent conflicts or complementarities of food and cash crops into a production system, a more interesting issue is the nature of adjustments that farmers employ to address these potential seasonal labor conflicts.

There are a variety of mechanisms to reduce the seasonal bottlenecks which arise from conflicts between cash and food crops. These revolve around both changing the timing intensity and nature of operations and adjusting cropping patterns. For example, in Kenya, the priority is given to food crops over early planting of cotton.[1] The same holds for Katsini, Nigeria, where weeding of cotton is delayed until groundnuts and millet crops are weeded. In Northern Uganda, cotton is planted two to three months later than recommended to avoid conflict with production of millet, although cotton yields are compromised. Similarly, the Sukuma farmer of Tanzania gives priority to producing the staple crop maize, which results in substantial losses in

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[1] Judith Heyer, op. cit.

cotton yields. In contrast, evidence from the Zande area of Sudan indicates that cotton production interferes with cereal staples due to coincident seasonal labor requirements. These types of conflicts can also result in changes in staple crops. The spread of plantains in Northern Uganda, for example, is attributed to the low labor requirement when cotton is grown, while in Sukumaland, Tanzania, maize has replaced millet and sorghum.[1] Other evidence from cocoa-growing areas of Nigeria and tobacco areas of Tanzania show that there has been a shift to less labor-intensive crops, such as cassava, because of seasonal conflicts in labor demand between cash and food crops.[2] Such patterns reflect labor bottlenecks and limited supplies of hired labor from the market.

There is a need to consider how well introduction of cash crops can be integrated into traditional patterns of cultivation. This involves determining how these traditional patterns can be altered to enhance cash crop production which raises income, without imperilling access to food crops. Attention needs to be focused on promoting complementarity of labor use to reduce fluctuations in seasonal requirements.

Another production strategy which deserves consideration is the "mixed farm" concept where livestock and cropping are integrated to smooth out seasonal labor demand and food availability. Once again the evidence is conflicting and outcomes contextual. In Uttar Pradesh, workers tend cattle during the slack season, which represents not only

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[1] Cleave, op. cit.

[2] Byerlee and Eicher, op. cit., p. 13.

an instrument of savings, but a source of work and income during a period of little activity in the fields.[1] Likewise, livestock and dairy sales are noted to be a source of wet season income in Nigeria.[2] In contrast, the peak month of weeding for the Fulani in Burkina Faso is concurrent with the period in which the herds require the greatest attention, because their proximity to the fields requires supervision to prevent their damaging the food crops. Thus, the integration of livestock keeping and cropping only aggravates seasonal labor bottlenecks in this case.[3]

While there is little question that the seasonality of agricultural production and the marginal product of labor are largely determined by patterns of rainfall, the choice of crop and technique, there remains another dimension to the relationship between seasonality and technical change. Specifically, not only does technology affect seasonal patterns, both of output, labor demand, and earnings, but the technical change is traditionally held to be guided by the relative prices (i.e., scarcity) of factors of production and seasonal shortages and constraints in the availability of these factors.

Thus, careful consideration must be given to tradeoffs between the introduction of technology that exacerbate seasonal shortages of

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[1] Lipton, op. cit., p. 40.

[2] Shubh Kumar, "The Nutrition Situation and Its Food Policy Links," in John W. Mellor, Christopher Delgado, and Malcolm Blackie (eds.), Accelerating Agricultural Growth in Sub-Saharan Africa (Baltimore, Md.: Johns Hopkins University Press, 1986, forthcoming).

[3] Christopher Delgado, "The Southern Fulani Farming System in Upper Volta: A Model for the Integration of Crop and Livestock Production in the West African Savannah," The African Rural Economy Paper No. 20 (East Lansing: Michigan State University, 1979).

labor in activities such as harvesting or weedings, and those that relieve manpower bottlenecks and encourage adoption of new technologies.

1.1.2 Migration

Migration, either to rural areas with cropping patterns that differ from the laborer's home region to plantations and mines, or to cities, offers the possibility of off-peak seasonal employment, hence more regular earnings. We are not referring here to transmigration or relocation, a phenomenon which appears to be more widely studied than cyclical patterns. Rather we are considering seasonal patterns of migration which are widespread, bringing laborers from rainfed regions of Bihar to irrigated tracts in the Punjab, from the Nepali hills to lumber camps in India, from Lesotho to South Africa, or from truck farms in New Jersey to orange groves in Florida.

Dry season migration to urban areas in the villages in Senegal may involve 30 or 40 percent of the active population. This enables them to earn needed cash for the next planting.[1] Similarly, in Table 3 one can note the seasonal variation in the migration in Matlab, Comilla, Bangladesh.[2] The lean season, especially during the winter months of January and February, witnesses laborers migrating to rural works projects and to other regions where crop conditions are more favorable, either because of environmental factors or adoption of new

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[1] John Waterbury, "The Senegalese Peasant: How Good is Our Conventional Wisdom?" (Princeton, N.J.: Princeton University, May 1983).

[2] R. H. Chaudhury, op. cit.

Table 3 -- Seasonal Variation of Migration+ of Adult Males (20-29) Who Moved Out for Economic Reasons Only, 1972

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Seasonal Index*	182	131	91	83	83	83	99	87	111	84	117	76

Source: Chaudhury, op. cit., p. 180. Calculated from the raw data on migration collected by the Cholera Research Laboratory, Dacca, from 101 villages of Matlab, Thana Comilla.

* Calculated as a ratio of the observed and expected numbers of events in a given month, multiplied by 100. Expected events are 1/336 of the annual total multiplied by the number of days in the given month.

\+ An out migrant is defined as one who is reported to have left the household for at least six months.

technologies which alter the agricultural calendar and overall demand for labor. Inasmuch as demand for labor is determined by cropping patterns, it is largely the technological differentiation that encourages and perpetuates seasonal migration in Bangladesh. Similarly, the extent to which ecological conditions differ in proximal regions, which encourages varying patterns of work, migration will be prevalent. As agricultural technology becomes less differentiated, the opportunities for migration will be reduced. Workers will be forced to travel greater distances and incur higher search costs for off-seasonal employment. However, to the extent that the new technology reduces seasonal labor patterns, the need for periodic migration will be reduced.

Seasonal migration may also involve workers heading to towns, plantations, and mines for work. Workers migrate to sugar factories from dry agricultural zones, as is witnessed in Maharastra and Gujarat, India.[1] Similarly, women in Java, Indonesia, find off-seasonal sources of employment on sugar plantations,[2] men in Liberia migrate to rubber plantations in search of seasonal work, and farmers in the north of Ghana migrate after the harvest to work on the perennial cash crops in the south.[3] This reinforces the potential role of cash-crop introduction and plantations in smoothing out labor demand. However, the risk

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[1] Jan Breman, "Seasonal Migration and Cooperative Capitalism: The Bardoli, South Gujarat," in Hans Binswanger and Mark Rosenzweig (eds.), Contractual Arrangements, Employment, and Wages in Rural Labor Markets in Asia (New Haven: Yale University Press, 1984): 136.

[2] G. Hart, op. cit.

[3] Connell et al., Migration from Rural Areas (Delhi: Oxford University Press, 1977).

that seasonal migration will withdraw otherwise productive labor from food crop production arises if seasonal conflicts in labor demand is extant.

Although the evidence on this potential conflict is limited, a linear programming model of seasonal migration in Ghana, from the North where subsistence agriculture predominates to the South where cocoa is grown and other food crops cultivated, indicates that optimal solutions involves patterns of extensive migration observed in reality. The contention that temporary migration is inefficient, or caused by factors such as imperfect labor markets is shown to be wrong.[1] As pointed out by Berg,[2] for West Africa in general, it is a natural adoption for laborers to seasonally migrate from the savanna zones to the forest regions where cocoa and coffee are grown. Without this type of seasonal migration, the inelastic labor supply in the forest zone would have restrained the growth of the export markets.

The prevalence of migration to areas with greater labor demand is not surprising. What is perhaps surprising is that marked regional wage differentials are observed in many areas. One possible reason for this is that lack of credit facilities and poor information impede interregional mobility of seasonal workers. Seasonal patterns are likely governed by the same factors as relocation -- the magnitude of the wage differential, the cost of job search, as well as the

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[1] Ralph E. Beals and Carmen F. Menezes, "Migrant Labour and Agricultural Output in Ghana," Oxford Economic Papers (1) 22 (March 1970): 109-127.

[2] Elliot Berg, "The Economics of the Migrant Labour System," in Hilda Kuper (ed.), Urbanization and Migration in West Africa (Berkeley: University of California Press, 1965): 160-181.

probability of success and characteristics of the family such as age of the laborers, their dependents, their landholding or tenancy rights. However, seasonal migration also differs from relocation as it is a regularly reoccurring event which provides opportunities for information gathering and -- particularly when special skills are involved -- for inter-temporal contracting. For a full understanding of the impact of such migration patterns on rural households, it is important to investigate their relationship to credit markets. For example, is credit extended to migrants for investment in travel costs as it might be for local farm employees, or can a family borrow against a migrant's expected earnings? There is some evidence from India that migrants working as sugarcane cutters receive credit from the broker who hires them.[1] Also of interest are the channels of remittances available to the migrant during his period of separation from the family. If channels are available, migration will have a different impact on seasonal patterns of household consumption than if the family must wait for the migrant's return. Similarly, the impact for household consumption differs when the migrant draws upon household food stocks for his subsistence during the migration than if he obtains food from other sources, presumably outside the village market channels. The intra-family distribution of the impact of migration remains relatively unexplored.

Under competitive assumptions, it is a relatively simple exercise to model the impact of such shifts of agricultural labor supply on the wages of laborers in the region receiving migrants as well as on the

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[1] Jan Breman, op. cit.

wages of those who remain behind. But once again, the shift in supply caused by alternative employment opportunities can be modeled according to either the neoclassical model or fixed wage models. For example, Chaudhury's[1] analysis that migrants are willing to accept a wage below that normally observed in the market, which in turn depresses wages at the destinations, corresponds to the neoclassical model. Furthermore, he argues that seasonal migrants are "less troublesome," and are more diligent workers since they are away from their families. In the nutritional wage model, migrants would not affect appreciably the wage rate at its nadir unless it is sufficiently prevalent to take the market beyond the region of low calorie consumption for which the model holds. Or, if remittances from migrants raise the consumption of family members remaining home, migration may influence wages by bringing the cost of efficient wages lower for producers. Note, then, in such as model migration may have little effect on the off-seasonal patterns of consumption for most of the household. As discussed above, a similar difference between the nutritional and neoclassical models of wages exists in the case of off-farm employment.

At the extreme, seasonal migration may become synonymous with constant wandering and homelessness. The search for work will then often include the family and involve laborers who roam from job to job, rather than to specific destinations from their home base. These mobile households, such as the Voddas of Southern India,[2] are perhaps

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[1] R. H. Chaudhury, op. cit.

[2] Connell et al., op. cit.

the most vulnerable and deprived. This partially emanates from their invisibility and difficulty of reaching in any intervention programs.

1.2.2. Food for Work and Employment Schemes

One type of off-farm employment that is explicitly designed to deal with problems of seasonal employment are employment guarantee schemes such as that existing in Maharastra State in India;[1] similarly, with many food-for-work programs. While legislation sometimes provide a floor wage, the Employment Guarantee Scheme is designed to provide unlimited employment at such a floor. While evidence on the Maharastra Scheme points to employment of 160 days per worker, there is currently little evidence as the degree such a program is utilized as a seasonal floor rather than the major source of employment for the otherwise marginally employed.

Food-for-work and other rural public work programs, on the other hand, are generally seasonal, providing in the neighborhood of one to two months employment per worker employed.[2] While the efficacy of such programs to fulfill nutritional objectives, given their short duration is not proven, they have the potential to provide a substantial portion of a laborer's off-season earnings, as well as a measur-

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[1] K. Dandekar and M. Sathe, "Employment Guarantee Scheme and Food-For-Work Program," Economic and Political Weekly 15 (1980): 707-713.

[2] A. Wijga, "The Nutritional Impact of Food-For-Work Programs," unpublished paper prepared for Netherlands Universities Foundation for International Cooperation, Wageningen, April 1983. Also, R. Ahmed and S. Kumar, "Evaluation of Food-For-Work Programs in Bangladesh" (Washington, D.C.: International Food Policy Research Institute, 1985, study in progress).

able increment to annual earnings.[1] However, unless funding is sufficient to employ all labor supplied at the wage offered, there is the need for some sort of rationing. While often wages are deliberately set below the prevailing market wage to avoid competing with private employment and to target to the most needy families, there are few studies of the administrative guidelines which determine number of days and number of people employed and trade-offs between them when local supply is excessive. With the exception of a few regions, Bangladesh and Maharastra, for example, few food-for-work programs employ a major share of a regional labor force, although they may do so on a district or village-wide level. Some programs may have an appreciable impact on off-season employment.[2]

A final consideration in implementing any sort of employment generation or food aid scheme to reduce slack season hardships is the potential such efforts may change the employer's optimum wage. That is, if in fact the efficiency wage theory holds, increasing income during the lean season through employment programs may encourage the employer to reduce payment to workers since it is now possible to gain the same level of efficiency for a lower cost. The implications of this are that if employment is provided in the slack season, the way to avoid a decline in wages is to generate enough work to absorb the

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[1] R. Ahmed and S. Kumar, op. cit. The long-run impacts of the assets created are beyond the scope of this paper.

[2] Wijga reports data on World Food Program Projects 1976-9 and projects funded by U.S. voluntary agencies in 1980. Bangladesh and Lesotho were the major recipients of aid from the U.S. in per capita terms while Botswana and Cyprus were principal recipients from the WFP. Note, however, that some projects such as Maharastra's do not rely primarily on foreign aid.

entire excess labor supply.[1] It is thus clear that the model of wage formation in a given context will condition the expected impact of seasonally targeted employment generation and food-for-work schemes.

Besides employment generation schemes, temporal targeting of other food-related programs may counterbalance seasonal earnings. Specifically, if the poor do not have access to financial intermediaries or on-farm storage facilities to assure access to food during the lean period, direct transfer payments may be appropriate. Similarly, if there is a clearly identifiable high-risk season when consumption declines, it may prove cost-effective to temporarily target food-related transfer programs.

3. The Relationship Between Income and Consumption Expenditures

In principle, wide fluctuations in earnings need not imply similar swings in patterns of expenditures. Even if a household has income only during one season, it has the potential to keep consumption fairly constant through savings and dissavings.

The basic theory of inter-temporal utility under certainty presumes that a household maximizes utility over time subject to prices in each period, earnings in each period and the interest rates which determine the potential to increase future consumption by foregoing current consumption, or the potential to increase current consumption by reducing the stream of future income. There are, of course, myriad variations and practical extensions on the basic textbook framework, some of which are discussed below.

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[1] G. B. Rogers, op cit., pp. 80-81.

One variation which is a conceptual distinct subset of the larger set of models of inter-temporal utility is the permanent income hypothesis, first introduced by Friedman. There is still much debate on how appropriate this hypothesis is for developing countries[1] (or for that matter, developed countries.)[2] In the seasonal context, to the degree that seasonal patterns are regular, they are predicted and, hence, can be considered part of permanent income. Weather shocks, however, may be transitory.[3] Moreover, the permanent income concept may also be peripheral to the seasonality concern in that it is not generalizable to households at a subsistence level of consumption. Friedman explicitly ignored the possibility that a household is unable to reduce current consumption to plan for future consumption. Furthermore, there is no particular concern in this paper with an essential prediction of the hypothesis, that savings rates are constant across income groups.

Nevertheless, tests of the hypothesis throw light on the process of adjustment of consumption across seasons. For example, Bhalla's results provide evidence that the poor are prevented by liquidity

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[1] S. Bhalla, "The Measurement of Permanent Income and Its Application to Savings Behavior" JPE 88 (1979): 722-43; S. Bhalla, "Measurement Errors and the Permanent Income Hypothesis: Evidence from Rural India," American Economic Review 69 (1980): 295-307; P. Musgrove, "Permanent Household Income and Consumption in Urban South America," American Economic Review 69 (1980): 355-68.

[2] A recent test using household data in the United States and focusing on food consumption is that of R. Hall and F. Mishkin, "The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households," Econometrica 56 (1982): 561-81.

[3] K. Wolpin, "A New Test of the Permanent Income Hypothesis: The Impact of Weather on Income and Consumption of Farm Households in India," International Economic Review 23 (1982): 583-94.

constraints from realizing planned levels of consumption.[1] That is, shocks are "absorbed to an unusual degree by alterations of planned consumption." A similar process may affect seasonal adjustments, beyond the substitution effects due to price and interest rates.

It is generally observed that savings out of transitory income is higher than that of other income even in developing countries, though not necessarily of the magnitude predicted by the permanent income hypothesis. This has implications for short-term welfare measures. Savings, however, do vary by income groups. Bhalla, for example, observes a marginal propensity to save out of transitory income for the poor of only .22 compared to .55 for well-off rural families.

The question of interest in this workshop is whether the poor can use savings or credit to smooth the peaks and troughs of consumption. If the income elasticity for food is less than one, then one would see a dampening of oscillations of food consumption relative to general earnings even if no inter-temporal planning occurred. Moreover, if families predict seasonal cycles and can plan in a manner similar to that postulated by the permanent income hypothesis, one would expect cycles in food consumption to mainly reflect price movements regardless of income streams. For example, one recent study, albeit for the United States, used a maintained hypothesis that consumption of food reflected permanent income in order to then calculate the transitory component of income.[2] Such a view, however, is hard to reconcile with

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[1] Bhalla, 1979, op. cit.

[2] M. Dynarski and S. Sheffrin, "Housing Purchase and Transitory Income: A Study with Panel Data," Review of Economics and Statistics LXVII (1985).

the often observed phenomenon of major fluctuations in total expenditures or in food expenditures in developing countries. Low correlations of consumption for the same household between survey rounds, cannot be attributed to seasonal fluctuations.[1] While such observations may reflect large random variations in measured expenditures, they may also reflect more systematic effects, a view that is supported by movements in group means as well as low correlations. The low correlations, however, imply that different households respond in different manners to seasonal effects. Currently, there are only a few data bases with which one can rigorous explain the nature of fluctuations of expenditures and to study movement of the parameters of the curve relating food consumption to income and prices using variance components or related techniques designed to combine time-series and cross-sectional data.

As mentioned above, models of inter-temporal utility generally presume access to credit. If the costs of borrowing differ amongst income groups of land ownership classes one would, quite naturally, expect inter-temporal patterns to vary amongst groups. Furthermore, if credit is unavailable or the supply is quantity constrained at a given interest rate, the appropriate interest rate for the household exceeds the nominal, or observed, rate. Evidence that credit market imperfections are more likely to be faced by the poor has already been

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[1] C. Scott, "Practical Problems in Conducting Surveys on Living Standards," in C. Scott, P. de Andre, and P. Chander, "Conducting Surveys in Developing Countries: Practical Evidence and Experience in Brazil, Malaysia, and the Philippines," Living Standards Measurement Study Working Paper No. 5 (Washington, D.C.: World Bank, 1980) discusses such correlations and their implications for the concept of income and expenditures.

discussed. In fact, this problem of limited credit is also likely to be most severe in the pre-harvest season when there is a need to purchase inputs and cash is most limited. Similarly, financing for processing, transporting, and storing crops after the harvest is also required by both farmers and traders. These two patterns combine to smooth the demand for credit; although there will be periods of low credit demand, such as just prior to harvest once inputs have been used and stocks are low.[1]

Note, also, that most models of inter-temporal budget allocation apply the simplification that returns to investments are symmetrical with the costs of borrowing. Clearly, if there are fixed costs to loaning money or to obtaining information, the returns to investing will be lower for those households whose lack of collateral also makes the costs of borrowing higher than it is for the general community. Of importance, then, for the study of seasonal consumption pattern is the prevalence and nature of financial and asset markets in low income communities. For example, are postal savings or credit unions available and trusted institutions for savings? How liquid is investment in such assets as livestock or land or in gold ornaments? Such assets are, of course, important as a hedge against uncertainty, which is a major determinant of inter-temporal allocation of expenditures. However, even when we simplify our discussion from this important topic to focus on earning and price cycles which are known with certainty, the suitability of these forms of investment for dealing with seasonal

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[1] See Leon Mears, The Rice Economy of Indonesia (Yogyakarta: Gadjah Mada University Press, 1981), for an illustration of the seasonal demand for credit.

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patterns must be addressed. For example, while cattle may be profitable investments in some environments, it may make little sense to purchase cattle after the harvest for resale 4 or 5 months later.

A variety of other mechanisms in terms of timing of purchases are available to the poor to smooth out consumption. For example, the purchase of durables and semi-durables can be timed to coincide with periods of greater income. While many non-food purchases are not discretionary (e.g., shelter, bus fare), others are amenable to reductions in accordance with the timing of income (e.g., clothing, implements). An example of such inter-period expenditure adjusting from Zaria, Nigeria[1] is presented in Table 4.

There is also considerable latitude for shifting alternative food sources in accordance with seasonal availability. This simple price response may take the form of, for example, consuming corn in the period before the rice harvest, or increasing reliance on wild roots and tubers during the pre-harvest lean season. Thus, one would expect substitution of consumption away from the more expensive commodity both within and between seasons. This substituting behavior must be distinguished from the use of grain as a potential vehicle for investment. The returns of such an enterprise should be at least equal to the opportunity cost of capital and the physical diminishing of stock. These storage concerns are discussed elsewhere and may, of course, differ by income groups. But it seems that the poor, who derive a smaller share of their income from non-labor sources, e.g.,

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[1] E. B. Simmons, "Rural Household Expenditures in Three Villages of Zaria Province, May 1971-June 1971," Samaru Miscellaneous Papers No. 56 (Nigeria: Samaru Institute of Agricultural Research, 1976).

Table 4 -- Average Household Expenditures[a] on Selected Items and Commodity Groups, by Season, Three Zaria Villages Combined, in Shillings per Household per Week

Commodity or food group	April May	June July	August Sept.	October Nov.	December January	February March
Index	108.6	102.1	108.4	100.4	86.1	94.4
All food, drink	48.80	44.67	36.15	41.53	36.03	50.71
Cereals	28.47	19.20	16.22	17.75	14.57	20.84
Guineacorn	20.77	14.68	10.40	6.96	11.24	14.61
Millet	4.24	1.75	3.31	6.94	0.69	1.85
Cereal products	2.63	6.01	2.70	2.16	3.47	5.74
Starchy roots	0.34	0.77	1.73	1.90	0.64	1.16
Housing[b]	0.16	1.58	0.33	4.99	0.41	2.74
Fuel and light[b]	2.68	2.47	4.02	4.31	3.38	5.14
Other household items	0.21	0.47	0.12	0.75	0.43	0.83
Cloth, clothing[c]	4.19	0.62	5.74	45.38	1.04	2.31
Personal items[d]	0.67	1.41	1.83	2.94	0.89	1.38

Source: Simmons, 1976, op. cit.

[a] A household average (weighted by number of persons) was calculated for each village for each bimonthly period. An unweighted average of these household averages was used here.

[b] Not including imputed expenditures for rent, household-gathered firewood, thatching grass, etc. and household-produced guineacorn stalks.

[c] Including tailoring.

[d] Mostly for hired labour, but including other farm costs for seeds, fertilizers, equipments, etc.

home production, are less likely to have grain reserves and the capital to make such purchases during the post-harvest season.

Another issue which may differ by income groups is the preference for current versus future consumption in regards to actual preference ordering as opposed to the costs of capital. This may reflect risk avoidance, but may occur even in fairly stable environments. For example, expenditure from monthly wages or transfers may not be distributed evenly over the month despite their regularity.[1] This may represent a "feast and famine" preference ordering, a type of non-linearity of inter-temporal utility under which, say, two and one units of consumption in different periods have more utility than one and a half in each, even after accounting for price and interest rate effects. While such preferences have not been formally studied they may reflect the needs of subsistence level consumers.

The evidence on the extent of seasonal fluctuations in income expenditures and consumption is quite divergent; and in general it fails to distinguish whether changes in consumption are due to variability in the price of food, or periodicity of earnings coupled with constraints in the credit market. In addition, the evidence on how different household types or population groups manifest different degrees of consumption instability is scarce.

Schofield reviewed the literature from 25 African villages to determine the differences in calorie intake between seasons On the

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[1] P. Madden and M. Yoder, Program Evaluation: Food Stamps and Commodity Distribution in Rural Areas of Central Pennsylvania, Agricultural Experiment Station Bulletin #780 (State College, PA: Pennsylvania State University, 1972).

basis of the "entire sample, a significant difference (at 1 percent) was found between the percentage fulfillment of calorie requirement in the wet (95 percent) and dry (92 percent) seasons." It is also noted that in areas with unimodal rainfall there is more variation than in areas with bimodal distribution of rain.

In another study for Africa, Kyereme[1] found that there were no seasonal changes in consumption in the Coastal Savannah Zone of Ghana. This attributed to closeness to sea and access to imported foods at cheap cost. Since all the major towns are on the coast, much of the food from the interior is exported to the coast. Processed food is also more available, and the road and marketing network are better developed. In contrast, the forest region and Northern Savannah areas of Ghana display marked seasonal changes in consumption. In the case of the forest, the poor marketing infrastructure and lack of storage facilities are implicated as the causes of seasonal variability. In the Northern Savannah, a shortage of production of the local staples, millet and rice, coupled with the poor distribution of the rice produced by large-scale absentee farmers contribute to these seasonal patterns.

In a study for Kenya, there was little evidence of seasonality in consumption, which, according to Longhurst and Payne,[2] was attributed to the bimodal pattern of rainfall. On the other hand, a review of a

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[1] Stephen S. Kyereme, "Food Consumption and Poverty Patterns in Ghana," Ph.D. thesis (Ithaca, N.Y.: Cornell University, 1984).

[2] Richard Longhurst and Philip Payne, "Seasonal Aspects of Nutrition: Review of Evidence and Policy Implications," Institute for Development Studies Discussion Paper (Brighton, England: University of Sussex, 1979).

number of studies from West Africa by Annegar[1] reveals that consumption is extremely variable in that region (see Table 5).

Data from Latin America and Asia also yield different results concerning seasonal variability in consumption. Data from Guatemala indicated no consistent pattern of seasonal energy and protein intake for households, women, and children from one year to the next. This despite that major variability occurred from one year to the next.[2] Although this was difficult to explain, the authors hypothesize that access to subsidized corn at a constant price throughout the year reduces seasonal consumption patterns. However, without data on income streams, expenditure patterns, and prices, it is difficult to explain these findings precisely.

In Bangladesh cereal and calorie consumption were highest after the two rice harvests.[3] The seasonal consumption data from the Philippines also tells an interesting story. Calorie consumption during the slack season was lower, and there was also a shift to corn away from rice. But more interesting was that the correlations of the household's consumption between one round to the next are quite low.[4] As intimated above, this can either be attributed to the error struc-

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[1] John Annegar, "Seasonal Food Shortages in West Africa," Ecology of Food and Nutrition 2 (1973): 251-257.

[2] Victor Valverde, Hernan Delgado, Rafael Flores, and Ricardo Sibrian, "Nutritional and Health Consequences of Seasonal Fluctuations in Household Food Availability," presented at UNV Conference on The Impact of the Choice of Agricultural and Food Policies on Nutrition and Health Status, March 1985, Bellagio, Italy (Guatemala: INCAP, 1985), mimeographed.

[3] Longhurst and Payne, op. cit.

[4] Marito Garcia, personal communication.

Table 5 — Food Consumption, Energy/Calorie Intakes, Food Stocks

Country	Location	Date	Unit	Source	Quantity Measured	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Gambia		1953	Calories		Intake	1,900	2,000	1,500	1,650	1,600	1,750	1,750	1,800	1,700	1,700	1,500	1,875
Gambia		1953	Calories	1)	Expenditure	1,800	1,600	1,450	1,550	1,700	1,900	1,900	1,725	1,800	1,700	1,425	1,775
Gambia		1953	Calories		Balance	100	400	500	100	-100	-150	-150	75	-100	0	75	100
Bangladesh	Char. Gopalpar village	1977	Kg/day	2)	Per capita consumption of rice (own stock)	-	.239	.220	.227	.227	.242	.236	.246	.236	.216	.211	.224
Bangladesh		1977	Kg/day	2)	Market	-	.241	.242	.225	.219	.246	.235	.239	.239	.204	.290	.229
Nigeria	Hanwa (North)	1970-1971	Index (Mean=100)	3)	Food (grain) alloc. Cattle owners	120	100	90	80	130	110	100	80	90	110	100	120
Nigeria	Hanwa (North)	1970-1971	Index (Mean=100)	3)	Non-cattle owners	130	100	70	70	120	80	80	70	90	110	100	170
Sudanic Zone		1954	Energy Intake Calories	6)	Rural laborers	2,800	2,600	2,250	1,800	1,500	1,000	800	900	1,300	2,500	3,200	3,100
Gambia		1953	Calories	1)	Rural laborers	1,868	1,997	1,499	1,575	1,575	1,740	1,776	1,811	1,694	1,794	1,531	1,868
Upper Volta	Bobo Fing	1952	Calories	4)		2,285	2,285	2,755	2,755	2,755	2,755	2,711	2,711	2,711	2,711	2,285	2,285
Senegal	Inundated valley	1962		5)		2,261	2,261	2,261	2,261	2,358	2,358	2,358	2,358	2,358	2,261	2,261	2,261
Nigeria	Dan Hayawi	1970	Calories	3)	Avg. population	1,742	2,383	1,953	1,841	1,972	2,185	1,637	2,337	1,680	1,844	2,218	1,316
Nigeria	Doha	1970	Calories	3)	Avg. population	1,846	2,291	2,428	2,569	2,789	2,426	2,266	2,945	2,958	2,661	2,254	2,915
Nigeria	Hanwa	1970	Calories	3)	Avg. population	2,054	1,951	2,478	2,867	2,622	2,601	2,958	3,382	1,997	2,173	2,187	2,464

Sources:
1) Work and well being [illegible] Savanna Ewwi (JS Weiner) original data Fox 53.
2) Seasonal Dimensions of Rural Poverty in Banglash 70 Chaudhury Social Action (3) Jan-March 80
3) Emmy B. Simmons in Robert Chambers et al.: Seasonal Dimensions to Rural Poverty.
4) Serre, 1955.
5) Boutillier, 1962.
6) Pales, 1954.

ture of the data or the fact that there are rather divergent effects on consumption of the changes in seasons.

While these studies give some insights into the extent of variability for a population, they do not distinguish between household type or income groups. On the one hand, it would be expected that the richer farm household has more liquid assets (such as cattle), greater access to credit, larger food stocks, and better access to storage facilities, which would tend to smooth out their consumption levels from good to bad year. On the other hand, the poor who are near the subsistence level will make more strenuous efforts to limit the variation in intake from one month to the next through mechanisms such as being more price responsive in terms of substituting between goods.

Two studies from Asia do provide a glimpse as to how different types of households are affected by seasonal instability. In Lombok, Indonesia, the wealthier district exhibited less seasonality in staple calorie consumption. However, the landless had less fluctuation in consumption than the smallholders, whose mean consumption was also lower.[1] Data from the Philippines on calorie per adult equivalency unit are presented for four survey rounds for longitudinal panel study (see Table 6). The first round represented a typical harvest period. The second round was a typical lean period in November 1983, although a food subsidy was provided. The third and fourth rounds were the two subsequent harvest and lean seasons, with the later occurring during a year of poor economic performance, and after the subsidy was

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[1] Steve Tabor et al., "Static and Dynamic Poverty Indicators: An Indonesian Example," Cornell Nutritional Surveillance Program, Working Paper No 9 (Ithaca, New York: Cornell University, 1983).

Table 6 -- Mean of Some Household Variables by Survey Round by Quartiles of Total Expenditure Per Capita

Survey Round	Expenditure Quartile	Variables TOTEXPC	HCCNAEU	DFXPAEU
Round 1 (May 1983) Harvest	Q1	11.66 (289)	1479.59 (289)	0.99 (289)
	Q2	19.15 (264)	1729.43 (264)	1.50 (264)
	Q3	27.92 (182)	1933.82 (182)	1.94 (182)
	Q4	47.83 (105)	1948.84 (105)	2.55 (105)
Round 2 (Nov 1983) Lean	Q1	7.84 (416)	1575.36 (416)	1.40 (416)
	Q2	19.09 (184)	1670.96 (184)	1.53 (184)
	Q3	27.60 (116)	1842.49 (116)	1.87 (116)
	Q4	47.11 (83)	1959.40 (83)	2.46 (83)
Round 3 (May 1984) Harvest	Q1	13.38 (51)	1424.27 (51)	0.86 (51)
	Q2	20.15 (174)	1593.24 (174)	1.23 (174)
	Q3	28.14 (253)	1718.37 (253)	1.61 (253)
	Q4	51.50 (298)	1884.56 (298)	2.40 (298)
Round 4 (Nov 1984) Lean	Q1	13.36 (35)	1195.98 (35)	0.71 (35)
	Q2	20.04 (170)	1498.14 (170)	1.04 (170)
	Q3	28.07 (241)	1630.29 (241)	1.37 (241)
	Q4	51.96 (306)	1863.01 (306)	2.00 (306)

removed. In general, there is little evidence that the calorie intake of the lower/higher expenditure group is more seasonally unstable. In fact, it appears that other events, such as the commencement of the subsidy in Round 2 and its removal, coupled with economic hard times, overshadow any seasonal determinants of low intakes.

It is possible to continue to recount the myriad of studies which document seasonal variability in consumption, or lack thereof (see Table 5). Doing so is considered of relatively little value for a variety of reasons, including the turnover of data, the difficulty of drawing inferences about regular patterns of seasonal variability on the basis of one-year data, problem in interpreting the implications of changes in consumption with knowledge of shifts in energy expenditures, and so forth. Rather, our purpose has been to elucidate mechanisms which households can employ to reduce seasonality in intake. Doing so will facilitate identifying policy options which give rise to an environment that expands the opportunity of households to smooth out consumption in the face of variability in agriculture and income. Therefore, it is important that further research examine more explicitly the causes of any observed seasonal variability rather than simply describing these interesting patterns.

4. Consumption Patterns and Allocation of Time

We are mainly concerned with physical consumption of food, although consumption of activities may also be a process of intertemporal decision making. Specifically, the literature on consumer choice is usually presented in terms of a household facing a given

budget constraint. In reality, however, there is a joint determination of the consumption of goods and of leisure. With leisure, L, providing utility, the consumer seeks to maximize the utility of goods and leisure subject to the constraint

(1) $pg + wL = Y_0 + wT$

where Y_0 is non-wage income and W is the wage rate. The right hand side of this equality is termed full income.[1]

The most general application of this model is the relationship between the price of leisure and consumption, as influenced by labor supply. This has traditionally involved a determination of the extent to which there is a backward-bending labor supply curve. But of interest in the domain of seasonality is the complementarity between the price of leisure and food -- the effect of wage rates on food consumption. If the price of leisure (wages) changes, one will observe the conventional income effects, and the substitution effects, as predicted by the Slutsky equation, as well as a change in the value of the time endowment which is in the same direction as the change in wages. This latter effect influences earnings and offsets the conventional real income effect.[2]

The implication for seasonality of this relationship between the wage rate and consumption concerns the effect of the changing values of market time from one period of the year to another. To the extent that alternative sources of productive employment cannot be

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[1] For a brief discussion of the use of a full income budget constraint, see A. Deaton and J. Muellbauer, Economics and Consumer Behavior (Cambridge: Cambridge University Press, 1980).

[2] Deaton and Muellbauer, op. cit.

identified and the value of time declines during the lean season, there will be a shift to either leisure, household level activities and/or social obligations which do not increase earnings. Cleave presents evidence from Uganda, Gambia, Nigeria, and Sierra Leone that ceremonial activities and social events are concentrated in the slack season. This is attributed to a combination of a lower opportunity cost of time, plentiful food after the harvest, and reduced fatigue associated with working.

The corollary of the futility of the search for productive employment during the slack season is that during the busy season the price of leisure or household-related productive activities (i.e., child care, food preparation) becomes so high that women and children who are not normally in the labor market are mobilized into the formal work force. For example, women in Kahangi and Kyarusozi, Uganda, replace leisure time with agricultural work.[1] Interestingly, there is no substitution observed away from nonagricultural domestic tasks in which they are engaged. Similarly, in Java, although the percentage change in return to labor from peak to slack season are the same for females of different classes, the percent of women who withdraw from labor force activities is considerably higher in better off households.[2] This suggests that the labor supply of women from poorer households is less sensitive to changes in wages, and that they are less likely to substitute toward other commodities when the price of

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[1] Cleave, op. cit., p. 157.

[2] G. Hart, op. cit.

leisure declines. In Egypt women and child labor acts as a buffer, entering the labor force in seasonal peaks corresponding to the wheat and maize harvest, and the cotton harvest. This is reflected in the fact that hours worked by women and children display more seasonal variability than men. Interestingly, the greater seasonality in work of women is also the case with wages, which results in men's and women's wages being nearly equal during the peak season of the cotton harvest.[1] The question remains, however, to what extent the low participation rates during the slack season are attributable to the preferences for leisure, the higher productivity of other household activities (e.g., child care, education) and household members, or the lack of demand for labor.

In a similar analysis, Spencer[2] found that an agricultural development project in Senegal exacerbated seasonal peaks in labor demand, and one mechanism used to respond by the household was the mobilization of women and children into the labor force. The consequences of such adaptation on consumption and nutrition are open to conjecture. To the extent that other important tasks such as schooling and child care are neglected, such a process may be detrimental. For example, studies indicate that women's time constraints

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[1] Hansen, 1967, op. cit.

[2] Dunston Spencer, "African Women in Agricultural Development: A Case Study in Sierra Leone," African Rural Economy Program Working Paper No. 11 (East Lansing: Michigan State University, April 1976).

during peak season interfere with breastfeeding;[1] and children tend to be weaned at the onset of the rainy season.[2] It is further suggested that during the peak season when women must work, infants are left in care of siblings; meals are cooked only once a day; and pulses are consumed less because of lengthy cooking time.[3] Other effects of the increased demand on women's time during the peak season in the agricultural season are reduced water and fuel collecting and less gathering of green leafy vegetables.[4] The converse is that the higher incomes which accompany such seasonal work by women may have major benefits to the household's ability to purchase food, access health care, improve their local environment, and other similar initiatives which may improve nutritional status. Thus caution must be used in ascribing negative connotations to responding to seasonal labor bottlenecks, especially those which arise due to agricultural development.

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[1] Lincoln Chen, A. K. M. Alauddin Chaudhury, and Sandra Huffman, "Seasonal Dimensions of Energy Protein Malnutrition in Rural Bangladesh: The Role of Agriculture, Dietary Practices, and Infection," Ecology of Food and Nutrition 8 (1979): 175-187.

[2] Alice Carloni, "The Impact of Maternal Employment and Income on the Nutritional Status of Children in Rural Areas of Developing Countries" (Rome: United Nations Subcommittee on Nutrition, April 1984).

[3] Carloni, op. cit.

[4] S. Schofield, "Seasonal Factors Affecting Nutrition in Different Age Groups and Especially Preschool Children," Journal of Development Studies (1) II (1974): 27-37.

It is also commonly observed that leisure activities are consumed differently when food is generally plentiful than otherwise.[1] To the degree that a household can reallocate food from one period to the next in order to support the energy requirements of required activities, these adjustments reflect inter-temporal utility decisions in a manner similar to physical consumption of goods. For example, Simmons[2] found that Nigerian households increase their consumption to meet higher labor demand, even in what would normally be characterized as the lean season. Although this increase in consumption was not sufficient to meet the increment in energy needs, it illustrates the ability of households to adjust their intake through seasonal storage. This finding is not unique to Nigeria, as similar results were obtained for Upper Volta[3] and Senegal.[4]

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[1] M. Immick and F. Viteri, "Energy Intake and Productivity of Guatemalan Sugarcane Cutters: An Empirical Test of the Efficiency Wage Hypothesis, Journal of Development Economics 9 (1981): 251-257; and G. Beaton, "Energy in Human Nutrition: Perspectives and Problems," Nutrition Review 41 (1983): 325-340.

[2] Emmy Simmons, "A Case Study in Food Production, Sale and Distribution," in Robert Chambers, Richard Longhurst, and Arnold Pacey (eds.), Seasonal Dimensions to Rural Poverty (London: Frances Pinter, Ltd., 1981): 73-80.

[3] J. Blanc, "Nutrition et Developpement - Reflexion sur les Aspects Economiques et l'Alimentation en Afrique de l'Ouest," unpublished Ph.D. thesis, Institut de Recherches et de Planification de Grenoble, Universite des Sciences Sociales de Grenoble, June 1969.

[4] J. L. Boutillier, P. A. Cantrelle, J. Causse, and C. Levant, La Moyene Vallee du Senegal (Paris: Ministere de la Cooperation, 1962).

5. Household to Individual Consumption

The above discussion focuses on the evidence and issues concerning seasonal variability in consumption at the household level. There is another dimension which heretofore remains unaddressed: the link between household consumption variability and that of the individual's. Just as there is considerable latitude for the household to make adjustments inter-temporally in their consumption, so too in theory can the household adjust the intra-household allocation of resources to maximize their objective function, such as nutritional well-being. There is the opportunity for the household to re-allocate household food resources so that the proportion received by individuals differs from one season to the next. There is only a modest literature on this subject, due mainly to methodological difficulties of measuring and model intra-household decision making.

In their review of the literature, Longhurst and Payne[1] found no data that supports that intra-household food distribution is skewed against children seasonally. In a later publication, however, Longhurst examined some data from Nigeria on male and female energy intake which indicated that women generally consume less than men, and that "female intake is never satisfactory and it does get relatively worse compared to male intake in the pre-harvest period" (p. 74).

In another study from the Philippines, the ratio of the calorie adequacy of the child to the household's calorie adequacy was regressed on a number of variables, including seasonal dummy variables, two of

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[1] Longhurst and Payne, op. cit.

which were from the slack season. One of these slack season dummies was during a year in which the overall economy was healthy. The coefficient was not significant, meaning that the share of household calories received by the child was not significantly different from the harvest season despite that household intake declined approximately 2.5 percent.

The other slack dummy was from a year in which a major economic downturn occurred. Although the overall household calorie intake was the same for this slack season, as the other slack season when the economy was showing greater utility, the share of calories received by the child was lower during the slack season in a period of poor economic performance than that observed during either the harvest season or slack season before the overall economic decline.[1] While it is difficult to explain this finding, it is noteworthy that there was a change in the composition of the diet during the second slack season which included relatively more corn consumption and less rice and oil consumption. It can be hypothesized that some sort of bulk constraint limited intake by children, thereby reducing their calorie adequacy relative to other members. A second possible hypothesis is that during the slack season in bad economic times, the search costs for employment rose to a point where the income earners were forced to increase their intake relative to other household members. While these hypotheses are in need of further testing, the findings suggest

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[1] Marito Garcia and Per Pinstrup-Andersen, "Consumer Food Subsidy Experiment in the Philippines," forthcoming Research Report (Washington, D.C.: International Food Policy Research Institute).

that during periods of a strong economy, intra-household distribution of calories does not change from one season to the next.

While it is not possible to reach any generalizable conclusions concerning the seasonal effects of intra-household distribution, there are a number of hypotheses which warrant further investigation. For example, if there is a change in the proportion of the household's food basket being consumed by each individual, why? One hypothesized explanation is that the share of income earned and controlled by each family member varies from one period to another. It may be that women are more likely to favor children's consumption over other members. Thus, if more income is earned by women at a given period of the year, the share of the household food resource consumed by the child of lactating women might shift accordingly. Another plausible explanation for a change in intra-household distribution could revolve around women reducing their involvement in the labor force during the slack season, thereby reducing calorie requirements, while concurrently the requirement for the more costly job search by men to maintain a subsistence level of income raises their dietary needs. Thus, the short-term impact of mothers and children reducing their share of the household's food consumption to improve the ability of the men to find a job may be compensated for by the medium-term effect of increased incomes if he is successful. In such a case, a reallocation of food resources to the men during the slack season might not be attributable to the different MPCs of men and women, as intimated above, but rather may reflect a sound nutritional strategy to aid the man in finding productive employment.

These types of hypothesized relationships need to be the subject for further research. Improved models of intra-household behavior, coupled with new data collection efforts are required.

6. Need for Further Research

The workings of the labor market and the savings and consumption behavior of households remain two areas which have preoccupied development economists. The existence of unemployment and underemployment, especially in the traditional sector, has raised the spectra that either labor could be withdrawn to work in the modern sector, or that measures should be taken to promote agricultural development that exploits underutilized labor capacity. While technological change has been visibly successful in increasing yields and outputs, equal success in terms of generating employment has not been manifest. One dimension of this disappointment in creating new jobs revolves around the constraints in doing so due to the seasonal nature of agriculture and the limitations of our knowledge concerning labor markets imposed by traditional methods of examining employment and time allocation data. There is a need to gain a better understanding of the seasonal patterns of time use and wage formation. This is especially true in the rural sector in order to both develop strategies of agricultural development that take into account seasonal pressures in labor requirements and how markets deal with such seasonality in labor peaks in terms of the formation of wages. Similarly, the introduction of innovations, either in the form of new technology or interventions which promote new crops -- e.g., cash crops -- need to take into

account the timing of those operations in terms of their effect on seasonal patterns of labor requirements.

Improved understanding of food acquisition behavior in terms of consumption and expenditure decisions over time is also an area in need of further research. This involves gaining insight into preferences over time, but more importantly, learning more about those factors which enhance the latitude of households in deciding when to consume what, despite the lumpiness of earnings. The ability to allocate income to consumption expenditures over time revolves around household savings behavior and the functioning of financial intermediaries and stocking functions. There remains much to be learned in terms of why certain households in certain circumstances maintain a relatively stable level of intake, while others do not. Improved modeling of savings and inter-temporal consumption behavior is therefore another research priority.

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agriculture is a major part of overall seasonality in developing economies and every paper need not cover every dimension of seasonality (though Alderman and Sahn usefully might insert "rural" or "agriculture" into their title if they are going so to restrict their attention). But surely there are significant seasonalities in other production activities (e.g., fishing, construction) and in weather conditions that may have significant effects on nutrition and health.

Once again, Alderman and Sahn are to be congratulated for providing a most useful survey.

Jere R. Behrman

William R. Kenan, Jr. Professor of Economics

University of Pennsylvania

9 December 1985

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Specific Questions

p.2, l. 6-8. Within the neoclassical framework, doesn't the question of "to what degrees do wages adjust with shifting demand for labor?" reduce to (a) what is the slope of the supply curve (if the curve is stable) and (b) what are the correlations in shocks to the supply and demand curves in addition if supply is not stable?

p. 5, l. 1-3. Won't "institutional or cultural factors" also enter importantly in other ways, such as those related to the demand for female labor in Moselm societies? If the demand curve shifts in, will female wages necessarily go up? If home production is about as efficient as market production, might there not be very limited inpact on market wages?

p. 7. Don't many presentations of the efficiency wage hypothesis also assume that there is a direct link between marginal income inceases and marginal nutrient intakes (beyond your two conditions)? Hasn't the first of your two conditions been tested as satisfactorily by e.g., Deolalikar and Strauss as the second, which seems different in spirit from your last sentence in the paragraph beginning "two conditions..."?

p. 8. What does the demand for labor curve look like with the efficiency wage hypothesis? Does it become horizontal at some wage? If so, does it imply "higher earnings per employed laborer but less workers employed than the basic neoclassical framework"? Do the preferred "long-term" contracts have to be explicit?

p. 9. Might workers with few dependents be prefered also because they are less likely to be absent due to care for dependents (especially infants and the aged)? On the other hand might not laborers with few dependents be less able to participate in gains from intrahousehold diversification of income and therefore require more wages because of their higher risks?

p. 11, l. 11. "However, the amplitude...." refers to a hypothesis or to an empirical "fact." If the latter is the case, how is it tested?

Discussant's Comments on

"How Transitory Patterns of Employment and Income Translate into Seasonal Household Food Insecurity"

by

Harold Alderman and David E. Sahn

This paper is an extensive and thoughtful survey on studies pertaining to seasonality in rural labor markets and possibly-associated seasonality in rural food consumption. The authors integrate well information from existing empirical studies and the implications of household-farm models regarding substitutibility across time, among activities, among consumption items, and among individuals. They repeatedly show good judgement, perspective, and caution in not jumping too quickly to conclusions based on partial considerations (e.g., the discussion on p. 52 regarding alternative interpretations of seasonal shifts in intrahousehold distribution).

While I have a number of minor questions about details to share with the authors, let me limit my attention here to three general concerns.

First, for the most part the paper focuses on seasonality regarding rural labor activities and resulting seasonality in income, with some attention to seasonality in food consumption. But it would be desirable to pursue this chain a little further, or at least indicate why the chain is of interest. Why do we care about seaonality in income and in food consumption? Presumably one answer to this question is because of concern about seasonality in nutrition and in health. The link from seasonalilty in food consumption to seasonality in nutrient intakes to seasonality in health conceivably could be so strong that all one would have to establish is that there is seasonality in food consumption in order to establish seasonality in the whole chain. But I think that this is not obvious. Recent work in rural south India by Anil Deolalikar and myself, for example, suggests that (i) though food expenditure elasticities are high, nutrient expenditure elasticities

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are basically zero as at the margin people care more about food tastes, appearance, status and processing than about nutrition (but many empirical studies overstate the nutrient expenditure elasticities because they aggregate foods in a way that ignores the increasing relation between prices per nutrient and expenditure or income) and (ii) there is not evidence of a significant relation between nutrient intakes and anthropometric and morbidity indicators of short-run health status, though there may be a nutrient impact on labor productivity. It would be useful for Alderman and Sahn to be clear about what they are assuming about the further links in the chain from labor activities to income to food consumption, though it might be beyond the scope of their paper to survey the relevant literature.

Second, I have a concern about what are the policy implications of this survey. Alderman and Sahn say that seasonality may cause a "dilemma...between maximization of farm earnings and fluctations in earnings of laborers" (p. 23), "there is a need to consider how well introduction of cash crops can be integrated into traditional patterns of cultivation" (p. 25), and "the introduction of innovations, either in the form of new technology or interventions which promote new crops...e.g., cash crops...need to take into account the timing of those operations in terms of their effect on seasonal patterns of labor requirements" (pp. 53-4). These statements left me a little uncomfortable because it seemed a little unclear to whom they are directed. For example, for whom "there is a need..." — why wouldn't cultivators automatically consider such tradeoffs? It would help my understanding if in the next revision of this paper Alderman and Sahn would clarify the policy implications, why interventions are needed (e.g., inefficiencies due to public-good characteristics of information or income-distribution concerns) and how seasonality affects the development and implementation of good policy.

Third, I have a concern about this paper, but that really is more general for the conference as a whole, regarding whether we are not overfocusing on agriculture in our considerations of seasonality and nutrition. Of course seasonality in

p. 13, l. 13. "It is not,...reduce the daily wage..." How does one know? What is the comparison? What if there is selectivity so the better workers have such contracts?

p. 17, l. 3-6. How were supply and demand shifts represented to form a basis for what was expected?

p. 23, l. 3. Is "dilemma" a good term for what just seems to be an opportunity cost (which presumably are pervasive)? Is something missing in the last sentence in this paragraph: "If tradeoffs..."

p. 25. Why is "There a need..."? A need for whom?

p. 28. What does the last sentence starting on this page mean? Is there no "risk" only if labor is not "otherwise productive"?

p. 31, l. 10-13. What does the sentence "In the nutritional wage model..." mean?

p. 37, l. 3-5. Do these low correlations refer to food quantities, expenditures on food, or nutrient quantities?

p. 50. Does Longhurst and Payne quotation refer to standardized nutrient intakes?

p. 52. Could the first hypothesis be modeled and estimated in a way to distinguish it from the second given plausible data availability?

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INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

Preliminary Draft
For Discussion Only

SEASONAL PRICE SPREADS IN BURKINA FASO: THEIR PREDICTABILITY AND RELATED POLICY ISSUES

BY

Christcpher L. Delgado*

IFPRI/FAO/AID Workshop on Seasonal Causes of Household Food Insecurity, Policy Implications and Research Needs

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It was originally planned that this would be part of the preceding paper by Reardon and Matlon; it is anticipated that in its final version it will be. Due to late arrival from Burkina Faso of Thomas Reardon, the conference drafts will be presented separately. It will soon be obvious to the reader that the present paper could not have been written without the data and comments of Peter Matlon. The absence of his name from the title page is due only to the preliminary nature of the draft.

SEASONAL PRICE SPREADS IN BURKINA FASO: THEIR PREDICTABILITY AND RELATED POLICY ISSUES

The preceding paper, written by Thomas Reardon and Peter Matlon, outlines the nature of seasonality of food consumption in Burkina Faso, and the strategies employed to ensure food security at the household level. Yet these patterns of consumption and strategies for food security can only be understood within the context of a given marketing system. Specifically, they relate to a specific temporal and spatial pattern of food prices as replicated over years.

Where food prices behave seasonally and annually in predictable ways, production and consumption decisions for grain at the household level tend to be independent. If price movements are predictable, farmers tend to provide a greater share of their own consumption from own production, other things equal, assuming that they are not perfectly risk-neutral. Thus consumption behavior becomes increasingly related to food production outcomes, itself a highly unstable variable in Burkina Faso.

Furthermore, the population group most at risk in the food security sense in Burkina Faso is almost certainly the rural poor. Lack of predictability of seasonal price movements is especially serious for them. Some preliminary evidence indicates that it is this group in Burkina Faso that sells grain after the harvest at lower prices, buying it back later in the year at higher prices (Sherman, Ellsworth and Shapiro). Lack of predictability in seasonal spreads affects this group by increasing their uncertainty as to the

optimal strategy to follow given the constraints they face, in a context where a wrong decision is especially serious.

The objectives of this paper, therefore, are to establish: (a) the magnitude of seasonal price effects; (b) whether they are predictable; (c) if not, why not; and, to a lesser extent, (d) what can be done to intervene to lessen the unpredictability of seasonal price variation. The final element of what should be done cannot be addressed here, since information on the costs and specific returns to various interventions is not available.

The Data[1/]

The rural data used are weekly price observations collected in 9 village markets over the period May 1981 to April 1985, by the International Crops Research Institute for the Semi-Arid Tropics. The data are disaggregated by week, crop, type of transaction and market. Prices and weights were explicitly checked to get careful estimates of prices in CFA francs per kilogram.[2/]

Although the data collection included five crops, only two are included here because of time and processing constraints. These are pearl millet and white sorghum, together by far the most important source of calories for human consumption in the country. They are also close substitutes. Similarly, data was collected for six types of transaction; only those four regularly collected are considered

here. These concern grain:

(1) sold by a farmer to a trader in the village;

(2) sold by a trader in the village to a consumer;

(3) sold by a "vendeuse" (note that these women are farmers coming occasionally to market to sell their own produce in small amounts) to a consumer;

(4) sold by a farmer to "vendeuses".

The data were obtained roughly every two weeks. In a normal market visit, the enumerator was instructed to ask three traders for the grain price for the most common (and, if possible, most uniform) unit of measure which they bought/sold by type of seller/buyer that day. The average price that day for the crop and type of transaction was entered. Every two months, ICRISAT supervisors anonymously purchased and resold several units of grain to the same trader in order to obtain accurate weights of the purchase and sale units. Weights of observations between these actual weighings were estimated through extrapolation.

There are many gaps in the interview dates. Most, probably greater than 80 percent, are due to the fact that the markets are extremely thin and no produce was available in the market on the day of the survey. Since the ICRISAT survey followed only transactions in the market place in this survey, maize and rice being sold by marketing parastatals at official prices were not recorded, nor were transactions within the concession. At most 20% of the gaps in dates of interview are due to personnel problems. Gaps in the sets of data entered are legitimate, and reflect the absence of those types of transactions in the market place.

The village markets followed can be characterized as follows:

Djibo: Principal regional market; located on good all-season road; market open daily but major market every 7 days; number of grain traders highly variable during the season with maximum 6-8.

Bougue: Small market serving 2-3 villages; 11 kms, from Ouahigouya/Djibo road on motorcycle path; accessible to very limited truck traffic dry season only; 1 permanent grain trader with a second occasionally present and, of course, market ladies ("vendeuses").

Yako: Principal regional market; located on good all season road; 3 day market interval; 4-6 grain traders; frequent all season truck connections.

Berenga: Important sub-regional market serving 8-10 isolated villages; 23 kms from major Yako-Ouahigouya road and 11 kms from Ouonon, an ICRISAT study village; access difficult; 4 grain traders and many market ladies according to the season, truck connections very rare and dry season only.

La-Toden: Less important sub-regional market serving 5 villages; 12 kms from all season Yako-Koudougou road and 10 kms from Kolbila, an ICRISAT study village; all season access but road not well maintained; 2 grain traders and many market ladies by season; truck connections infrequent.

Roumtenga: Minor village market 3 kms from all season Yako-Koudougou road and 5 kms from Kolbila study village; access by motorcycle; 1 grain trader not always present; market ladies present by season; truck connections rare.

Boromo: Principal regional market located on tarred Ouaga-Bobo road; 5 days market frequency but open daily on small scale; number of grain traders 4-6 and many market ladies; daily truck connections.

Pompoi: Important sub-regional market 39 kms from Ouaga-Bobo road and 9 kms from Sayero, an ICRISAT study village; all season access on good secondary road; also located on rail line; 1 grain trader and market ladies with frequent absence of grain trader after August 1983; occasional truck traffic.

Vy: Minor village market serving 4 villages 17 kms from Ouaga-Bobo road and 9 kms from Koho, an ICRISAT study village; 1 trader present until 1983, after only market ladies; access difficult by motorcycle route; truck traffic very infrequent.

The urban price data used were collected by IFPRI and the University of Ouagadougou. They concern three major markets in the capital city. The data used here are for millet, sorghum and maize, collected weekly from December 1984 to August 1985. 3/

Magnitude and Variation of Nominal Price Spreads

Seasonal price spreads were calculated by crop, market year, and type of transaction. The average seasonal spread across all markets and years is large: about 70 percent for millet and 65 for sorghum in Table 1. Average seasonal spreads of this size are not peculiar to the 1981 to 1985 period, or to Burkina Faso. Spreads of similar magnitude were observed for Nigeria in the 1959 to 1971 period (Sahn and Delgado).

Those mean spreads mask considerable variation. In the sample as a whole, the largest observed spread occurred in 1983. They were 218 percent for millet in Pompoi and 143 percent for soghum in Boromo.

Curiously, the variation of mean average price spreads appears to be greater across years than markets for millet, whereas the reverse is true for sorghum. Possibly this is because sorghum is more specific to southern markets than millet is to northern markets.

TABLE 1: AVERAGE SEASONAL SPREADS BETWEEN ANNUAL LOW & HIGH GRAIN PRICES IN 9 MARKETS OF BURKINA FASO: 1981-1985
(in percent of seasonal low price unless otherwise noted)

	I		II	
	Variation across years of yearly average across markets		Variation across markets of market averages across years	
	Millet	Sorghum	Millet	Sorghum
Mean Price Spread	70	65	70	65
Coefficient of variation (%)	41	21	17	38
Maximum Average Price Spread by year (I) or market (II)	103	78	85	108
Year (I) or Market (II) of maximum average spread	1983/ 1984	1982/ 1983	POMPOI	ROUMTENGA
Coefficient of variation of price spreads within Year (I) or market (II) exhibiting maximum average spread (%)	40	45	65	-
Minimum price spread by year (I) or market (II)	41	46	51	39
Year (I) or market (II) of minimum average price spread	1981/ 1982	1981 1982	LA TODEN	BOUGUE
Coefficient of variation of price spreads within year (I) or market (II) exhibiting minimum average spread (%)	76	77	24	40

Minimum average price spreads in the sample occurred in 1981/82. At 40 to 50 percent, they were still of appreciable magnitude. Furthermore, within 1981/82, the coefficient of variation of individual market pice spreads across markets was 76 percent. Thus, recent historical and geographical experience in Burkina Faso suggests that in the absence of pure specific information, it is difficult to guess a priori what the seasonal price spread will be in a given market and year.

A Model of Pure Seasonal Price Effects

Variation in food grain prices can be analyzed in a fashion to capture the covariance of different items of relevance (or dimensions) to foodgrain prices. A dataset covering c crops, v types of transactions, i markets, j years, and t time periods would have a maximum of c x v x i x j x t observations. The subscript t can stand for weeks, months or seasons, depending on the level of aggregation desired. The data could be regressed against an intercept term and (c-1) + (v-1) + (i-1) + (j-1) + (t-1) one-zero dummy variables used to capture the mean effects of each dimension, considered simultaneously.

Given that seasonal variation (pertaining to dimension 't') is of primary interest, a simpler procedure, more economical in degrees of freedom, would be to define a variance components model, such that:

$$P_{cvijt} = M + q_c + u_v + w_i + x_j + y_t + z_{cvijt}$$

Where:

M is the mean price of food in the sample;

q is the deviation from the mean attributable to inter-crop differences

u is the deviation attributable to different kinds of transactions (retail prices, producers prices, etc.);

w is the deviation applicable to different markets;

is the year effect;

y is the pure seasonal effect to be analyzed;

and z is the stochastic interaction term among all the elements.

The effect y_t is a "pure" effect because it is an average for season t over the entire sample, with other constant sources of variation accounted for. To isolate the y effects, the separate means for each group defined by a given set of subscripts cvij are subtracted from the corresponding raw data, yielding:

$$P_{cvijt} - P_{cvij.} = P_{cvijt.} = Y_t + z_{cvijt}$$

where dot notation denotes a mean. The P^* data were regressed against monthly dummy variables to get direct estimates of the y effects by month, both separately by market and pooled over markets.4/

These effects are shown in Table 2 where they have been divided by the mean price of the applicable grain in the sample to give the effects in percentage terms.

TABLE 2 : PURE SEASONAL PRICE EFFECTS IN BURKINA FASO, 1981 - 1985
(percent of correspoding mean prices in samples)

	May 1981 - April 1985					Dec. 1984 - Aug. 1985			
	Averages for 9 rural markets			Most Northern and Remote Market Center (Djibo)	Most Southern and Central Market Center (Boromo)	Average for 3 markets in Ouagadougou			
	Millet and Sorghum	Millet alone	Sorghum alone	Millet	Sorghum	Millet	Sorghum	Maize	All 3 Crops
Jan.	-12.3	-12.8	-11.8	-23.8	5.0	-6.6	-2.6	14.4	-8.2
Feb.	-13.2	-13.6	-12.6	-20.7	-0.5	16.4	10.6	5.1	10.5
Mar.	-3.8	-4.0	-3.5	-1.8	-10.8	-8.7	1.5	11.7	2.2
Apr.	2.0	-1.7	5.6	no obs.	-21.3	-7.9	1.2	4.6	-1.2
May	-2.8	2.1	-9.2	-12.6	-3.5	-3.3	-2.3	10.2	1.9
June	6.3	8.1	3.9	3.9	-1.7	-3.5	3.5	15.5	5.6
July	6.4	9.1	3.4	50.1	-0.1	5.5	-1.2	-7.2	-1.3
Aug.	12.2	13.3	11.0	19.3	15.5	0.6	-10.0	-8.4	-6.2
Sept.	13.6	15.1	12.0	17.5	10.9	-	-	-	
Oct.	9.4	10.1	9.2	14.0	9.7	-	-	-	
Nov.	-5.1	-6.1	-4.1	-8.3	-4.7	-	-	-	
Dec.	-8.6	-9.4	-7.5	-17.0	-12.8	11.3	3.8	17.1	-1.5
Adjusted R2 of regression	0.18	0.19	0.16	0.21	0.28	0.31	0.21	0.57	0.15
N	1136	545	591	43	92	76	76	76	228
Mean price (CFA/kg)	83.6	88.0	79.6	95.2	84.6	120	130	141	130

Source: Data estimated from regressions of prices with means for each transaction type, crop, year, and market removed, run against monthly dummy variables, with the estimated coefficients normalized by the appropriate sample-wide means.

The rural regressions are better indicators of constant seasonal effects (constant over years as well as markets) than the seasonal price effects listed for the capital city, which are based on less than one year's data. Furthermore, since these correspond to a year that only briefly overlaps with the rural sample, conclusions about rural-urban differences in seasonality are given as hypotheses rather than results.

While average constant seasonal effects across rural markets do not at first glance appear to be greatly disimilar, it is striking how different the effects are for millet in the northernmost market (Djibo), as compared to sorghum in the southernmost market (Boromo). The differences are especially striking during the rainy season, from June to August. It would appear that these two markets have little in common, cet. par, at that time.

Another striking result in Table 2, subject to the caveats expressed above, is the difference in monthly coefficient for different crops within Ouagadougou. Furthermore, these differences are even more noticeable between averages for Ouagadougou and averages for the rural markets. A preliminary hypothesis would be that urban dwellers are more open to and more able to substitute different grains as price relationships change in relation to changing availability on the market.

Yet, the relatively low adjusted R^2 figures for the estimating equations in Table 2 suggest that the constant monthly factors explain only from 15 to 30 percent of the variation in foodgrain prices, after

all other constant effects are netted out. The exception is maize in the capital city where monthly effects explain 57 percent of remaining variation. Furthermore, regressions of the raw price data for millet and sorghum in rural areas on dummy variables for all constant effects show that these effects as a whole (market, year, month, etc.) explain on average 70 to 75 percent of the total variation in foodgrain prices.

Thus, on average, pure seasonal effects for millet and sorghum in rural Burkina Faso over the May 1981 to April 1985 period account for an order of magnitude of 5-6 percent of total seasonal price variation for these grains (15 to 30 percent times 25 to 30 percent). A market agent who could have predicted with perfect accuracy all other constant effects (yearly inflation, transaction types, differentials for specific markets, and so forth) would still only be able to account for roughly two-thirds of variation in prices. Knowledge of constant seasonal effects would only help deal with a fifth of the remaining one third. Given this appreciable variation of actual seasonal outcomes around predicted outcomes in our simple model, the question arises as to the predictability of seasonal effects across markets, years, and crops.

The Predictability of Seasonal Price Effects

The chosen method for assessing the predictability of pure seasonal effects is to test for the stability of the regression coefficients in the variance components model, across markets and across years.

The test involves estimating seasonal effects separately for each market, using temporal price variation. The data is then pooled across markets and F-tests performed for the stability of the coefficients (i.e., whether the monthly coefficients can reasonably be supposed to be equal in different markets). Similarly, series for the different markets can be combined to estimate seasonal effects separately for each year, and the results pooled to test for stability of seasonal effects over years. The analysis below abstracts from a number of interesting econometric problems.5/ The objective is to indicate useful future areas of research.

Results are shown in Table 3. They show that in every case it is possible to reject the null hypothesis of stable monthly coefficients at 1% when pooling. However, it is not possible to reject the null hypothesis at 1% when pooling across markets.

Seasonal Changes in the Homogeneity of Seasonal Price Effects

It is possible that the lack of homogeneity in pure seasonal effects across markets is a season-specific phenomenon, rather than a year-round phenomenon as suggested by the tests in Table 3. Therefore the tests were repeated, but separately for the half of the overall dataset corresponding to the period from March to August (the hot and rainy seasons combined) and then again for the season September to February (the harvest and cold seasons).

TABLE 3 : ANALYSIS OF SEASONAL COVARIANCE IN RURAL BURKINA FASO
(F-statistics for Ho: equality of monthly dummy variable coefficients*)

	Millet	Sorghum	Pooling Across Crops
Pooling Across Markets	f(96,437) = 1.415 Reject Ho at 5%	f(96,483) = 1.000 Fail to reject Ho at 5%	f(204,920) = 1.223 Reject at 5%
Pooling across Years	f(48,485) = 3.985 Reject Ho at 1%	f(48,531) = 4.18 Reject Ho at 1%	f(108,1016) = 2.685 Reject at 1%

*Ho: $B_{ik} = B_k$ for markets (years) i and months k

Source: see text for methodology

The "exploitative trader" hypothesis is only plausible if retail prices rise faster than wholesale prices in the same market during the rainy season. Thus the hypothesis can be tested by looking at at seasonal differences in intra-market retail-wholesale spreads. The ICRISAT data permit this in a way that has not been possible before in West Africa. The issue can be examined in an informal manner by comparing seasonal averages of retail-wholesale price spreads. It will then be tested more formally in a regression framework that controls for extraneous factors.

The data underlying table 4 are derived by subracting the differences between either market ladies' buying and selling prices or traders' buying and selling prices, if they are recorded for the same day in a given market. There is no guarantee that the same market lady or trader is involved in both purchasing and selling, but that is immaterial.

The calculations show that intra-market wholesale-retail price differentials range from 7 to 33 percent, with a central tendency around 25 percent. The data generally suggest that percentage margins in the rainy season are <u>lower</u> than in other sections. This could be tested by t tests on the means (and they would show the relationship to be, in many cases, statistically significant), but it is better to defer the test to a framework where effects other than season can be controlled for.

TABLE 4 : AVERAGE PERCENTAGE DIFFERENCES BETWEEN TRADERS' BUYING AND SELLING PRICES FOR GRAIN
(1981/82 - 1984/85)
(in percent)

			Hot Season (Mar.-May)		Rainy Season (Jun.-Aug.)		Rest of Year (Harvest)	
			Mean Margin	S.D.	Mean Margin	S.D.	Mean Margin	S.D.
Drier Less Central	MILLET	Regional Center (Yako)	32.7 (N=20)	20.8	22.4 (N=29)	23.3	21.8 (N=55)	14.1
		Peripheral Mkt. (Berenga)	18.6 (N=16)	11.0	7.0 (N=7)	1.4	16.6 (N=47)	9.5
	SORGHUM	Regional Center	35.6 (N=12)	20.7	14.4 (N=21)	7.8	20.7 (N=37)	17.0
		Peripheral Market	23.1 (N=24)	12.0	13.4 (N= 9)	2.4	17.8 (N=43)	16.8
More Humid, More Central	MILLET	Regional Center (Boromo)	14.0 (N= 4)	0.98	NRT 2/	—	14.6 (N= 9)	1.3
		Peripheral Market (Pompoi)	18.4 (N= 7)	9.1	10.8 (N=12)	0.59	14.2 (N=12)	11.8
	SORGHUM	Regional Center	NRT	—	27.0 (N=10)	4.6	18.6 (N=34)	5.7
		Peripheral Market	NRT	—	13.0 (N=12)	0.89	16.5 (N=27)	3.2
Significant differences between mean margins in regional and peripheral markets. 1/			Significantly higher in regional center in two cases, insignificant in third		Significantly higher in regional center in two cases, insignificant in third		Higher in regional center in all four cases, but differences only significant in two cases (5%)	
Significant differences between mean margins for different crops in the same market			Of two cases, No significant differences		All three cases show significant differences		Of four cases, one small but significant difference and three cases with no sigficant differences	

1/ Significance tests at the 5% level based on the unverified assumption of equal variance of margins across markets within a sub-region and across seasons and years; they should not be construed as firm results. Furthermore, annual and seasonal effects are mixed together.

2/ No transactions recorded.

A striking result in Table 4 is that differentials in the regional market centers examined (Yako and Boromo) are significantly higher than in their respective peripheral markets in the rainy season, but not generally otherwise. At first glance, this may seem counterintuitive, since one would expect the downstream market to have lower differentials.

Answers to the hypotheses raised by Table 4 come from a more controlled experiment, where intra-market retail-wholesale price spreads in CFA/kg are regressed on dummy variables to account for crop, market actor, year and locational differences, in addition to seasonal differences. The results are given in Table 5.

They show that the net seasonal effect of the rainy season is still to depress the mean price differential, but that this relationship is not statistically significant. On the other hand, there is a highly significant market actor effect in all cases. This coefficient is the amount the mean overall spread in CFA/kg (the intercept) must be lowered to get the spread applicable to market ladies alone. For the overall pooled sum, we see that the mean spread applicable to market ladies is 6.5 CFA/kg (in the harvest and cold seasons of 1984/85), whereas for traders and market ladies together it is higher than the latter figure, and much higher than for market ladies alone.

TABLE 5 : DECOMPOSITION OF VARIATION IN ABSOLUTE RETAIL-WHOLESALE PRICE SPREADS FOR MILLET AND SORGHUM (1981/82 - 1984/85)
(in CFA/kg)

Dependent Variable	N	Crop Effect	** Mean Effect	Mkt. Actor Effect	Annual Effects			Locational Effects								Seasonal Effects		Adj. R^2
								Djibo		Yako				Boromo				
					81/82	82/83	83/84	Regional Center	Other	Regional Center	Other 1	Other 2	Other 3	Regional Center	Other 1	Rainy	Hot	
Pooled market lady and trader wholesale retail price spreads for millet and sorghum	299	-0.41	21.7 *	-15.2 *	8.0 *	4.7 *	-0.7	-0.6	2.4	6.9 *	4.7 *	1.3	-6.2 *	-2.5	-4.5	-0.73	0.24	0.51
ditto, millet only	147	—	19.4 *	-12.0 *	6.9 *	4.1 *	-0.7	2.4	1.3	6.5	4.2	1.2	-8.6	-6.3	-4.4	-1.0	-0.5	0.38
ditto, sorghum only	151	—	25.6 *	-20.1 *	8.9 *	4.2 *	-0.9	-7.5 *	7.5 *	5.1 *	1.7	-1.9	—	0.4	-3.1	-0.3	0.9	0.66
Sorghum only, w/o location effects	151	—	29.5 *	-2.08 *	7.1 *	2.1	-0.4	—		—	—	—	—	—	—	1.1	1.4	0.53
Sorghum only, w/o annual effects	151	—	32.3 *	-21.0 *	—	—	—	-13.0 *	-	3.2	1.2	-2.1	-4.5	-1.0	-4.8	-1.2	3.3 *	0.58
Sorghum only, w/o seasonal effects	151	—	25.8 *	-20.7 *	9.3 *	4.4 *	-0.9	-7.9 *	—	7.3 *	5.0	1.7	-2.0	-0.1	-3.6	—	-	0.67
Sorghum trader margins only	134	—	3.6 *	—	9.7 *	3.6 *	0.2	7.1 *	—	8.9 *	5.7 *	3.2 *	0.5	3.1	-1.1	-0.4	-0.2	0.53

NOTES: (*) Significant at 5% or better
(**) The mean effect pertains to the 1984/85 observations in the harvest and cold seasons and includes deviations from the overall mean for the Vv market in the Boromo sub-region.

SOURCE: OLS regression of differences between observed retail and wholesale prices in a given week and market on dummy variables for each effect.

When other constant effects are controlled for, it can also be seen that mean retail-wholesale price spreads in the regional centers continue to dominate those in the peripheral market, except for sorghum in Djibo (where sorghum is a secondary crop). Finally, there are very significant annual differences in retail-wholesale margins in CFA/kg which cannot be explained by inflation, since the earlier years have higher mean margins. The answer probably is that margins are higher in better, not worse years.

In sum, the evidence is not consistent with the view that traders jack up their profit margins either in bad years or in the lean (i.e. rainy) season. In fact, it appears that margins may even be slightly lower in the rainy season.

Other hypotheses suggested by Table 4 were: first, that the regional market centers have higher retail-wholesale price margins than their associated peripheral markets, and second, that margins are higher in the hot season. However, the statistical significance of these findings diminish (in Table 5) when the market actor effect is controlled for. In the ICRISAT data, price transactions involving market ladies lessen very noticeably in the hot season, reflecting lower activity by this group at that time. This in itself would explain a higher average retail-wholesale spread in this season. The dominance of regional center spreads over peripheral market spreads on the rainy season may stem in large part from the higher proportion of market activity carried out by market ladies in peripheral markets as compared to regional centers at this time.

Thus monopolistic practices by traders are probably not a correct explanation of seasonal differences in intra-market or inter-market price differentials. The fact that some villages are naturally isolated in the rainy season by poor infrastructure still remains a factor. Other explanations of possible relevance that cannot be explored here are that the volume of total transactions and the size of individual transactions are different in different seasons. If so, it would suggest different variances across seasons of foodgrain prices, with the associated probability of different degrees of stability across markets of seasonal price effects. Even if monopolistic traders are not a factor, it is relevant to see if spatial retail margins vary seasonally, as a possible explanation of regional differences in consumption patterns.

Seasonal Variation in Inter-Market Price Differentials

The extent and sources of seasonal variation among inter-market price differentials are investigated by calculating the differences between average retail prices in a given month in selected pairs of markets. The market pairs have been selected to include regional centers and peripheral markets in various combinations as indicated in Table 6. The spreads were regressed on dummy variables for crop, season, year and market pairs.

The results show that spreads in CFA/kg are significantly higher in the rainy season in the sample chosen. The intercept is the mean spread in the cold season of 1984/85 from the most northernly and

remotest regional center (Djibo) to the most southernly and central regional center (Boromo). Thus for these markets and time periods, intermarket retail price spreads are on average 50 percent higher in the rainy season than in the cold season. Yet it should be noted that 11 CFA/kg is roughly 15 percent of the mean price of grain in the sample, and thus pure seasonal price rises are of at least as great a magnitude percentage-wise as seasonal increases in inter-market differentials. The latter point is confirmed by a separate regression of percentage differentials (not shown), which indicates no significant effect for the rainy season.

A possible explanation of seasonal differences in market integration is that the direction of trade changes seasonally. In terms of the price data, this is equivalent to the average price differential between a pair of markets changing sign seasonally. This was tested by re-running the preceding regressions on CFA/kg margins for rainy season observations only. The results in Table 6 suggest that a seasonal change in sign for the mean price differential is in fact statistically significant (separately) for Djibo-Yako and Yako-Boromo trade. These markets corrspond to a north-south alignment of markets, and suggest that the more northern markets have relatively higher retail prices for grain in the rainy season than the southern markets. Moreover, the reverse is true the rest of the year. The strong positive coefficient for 1982/83 in the rainy season regression, compared to the negative coefficient in the all seasons regression, suggests that the change in sign was especially strong in this year.

TABLE 6 : DECOMPOSITION OF AVERAGE INTERMARKET MONTHLY RETAIL PRICE DIFFERENTIALS

Dependent Variable	Paired market average monthly spread in CFA/kg		Ditto rainy season only	
	Coeff. (B)	t for Ho: B = 0	Coeff. (B)	t for Ho: B = 0
Intercept (Mean spread Djibo-Boromo, Dec. 1984-Feb. 1985	22.2	7.23	11.3	0.33*
Deviations for:				
millet only	2.6*	1.60	- 8.6	-0.49
Hot season (March-May)	1.7*	0.57	-	-
Rainy season (June-August)	10.8	4.28	-	-
Harvest season (Sept.-Nov.)	3.1*	1.55	-	-
1981/82	2.6*	0.59	-	-
1982/83	-4.2	-1.95	-53.4	-2.33
1983/84	-12.2	-4.84	-41.2	-1.56*
Djibo-Bougue	-21.0	-5.55	-45.1	-0.81*
Berenga-Yako	-25.8	-8.53	- 8.7	-0.23
Djibo-Yako	-22.2	-6.75	1.6	-0.04
Boromo-Pompoi	-17.6	-5.85	49.2	1.34
Yako-Boromo	-33.9	-11.2	18.1	0.49
Adjusted R^2	0.24		0.22	
N	504		78	

NOTE: (*) Not statistically significant at 5%

In sum, absolute but not percentage spatial price margins increase in the rainy season. Furthermore, the direction of trade may change. The above would help explain disarticulation of seasonal price patterns over markets in the rainy season.

Conclusion

In conclusion, it appears that seasonal price changes are high, but highly variable; they are frequently swamped by other sources of price changes, such as annual effects resulting from production outcomes and overall inflation. Pure seasonal price effects are more variable across years then across markets, but it is precisely the former aspect that makes then especially hard to predict *a priori*.

The unpredictability of seasonal food price changes is especially pronounced in the rainy (or hungry) season, precisely when it matters most. The data are not consistent with the hypothesis that anticompetitive trader activity is the root of unpredictable price effects in the rainy season. In fact, traders appear to have lower gross profit margins and higher costs at that time, which may *explain* (rather than being a result of) the lower volume of trader activity commonly observed in the rainy season.

The reasons behind relatively lower predictability in the rainy season are related to differential increases in transport costs, probably to a lower sales volume, to the changing composition of market actors and types of transactions taking place in foodgrain markets at this time, and to changes in the direction of trade.

There are two policy implications for interventions designed to improve the predictability of seasonal price rises (and thus improve food security). First, attempts to "rationalize" the food trade by restricting or otherwise interfering with small informal sector traders (such as market ladies) will substantially raise marketing costs. Second, the old saw about needing better transportation infrastructure is once more upheld. There is no way around it: it is the priority in marketing interventions. Furthermore, adequate policy analysis require much better information than currently available on aggregate grain flows by location and by season.

FOOTNOTES

1/ The data was furnished by Dr. Peter Matlon of ICRISAT who personally and closely supervised its collection over the entire sample period. The section that follows is largely abstracted from a personal communication from Dr. Matlon.

2/ In mid-1981, US$1.00 was approximately worth 220 CFA; in early 1985 it was worth approximately 470 CFA. As of writing, the exchange rate is approximately 400 CFA to $1.00.

3/ This was part of a much larger data colletion exercise at the University, carried out on the IFPRI side by Thomas Reardon.

4/ It is probable that heteroscedasticity is present in the error vector of the pooled data, since foodgrain prices probably have different variances in different locations, years, and (as we shall see) seasons. The $\hat{y}$ may nevertheless be unbiased estimates of the true y ; however caution should be exercised in analyzing the variance of the $\hat{z}$ or in interpreting "significance" ratios. The discussion in text of percentage of variation explained by the regressions, as measured by R^2, should be taken as indicative of orders of magnitude.

5) A similar problem to that outlined in the various footnote arises here. It is further compounded by the attempt at using computed variances for testing. A further problem is that if the series should not be pooled (the null hypothesis of equality of

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coefficient rejected), the tests themselves are ipso facto invalid because the pooled variance will be biased (see Delgado, forthcoming (a)). Nevertheless, it is felt that the exercise is a useful indication of what would be obtained using more sophisticated methods.

6/ Interestingly, the reverse was found for 22 markets in Northern Nigeria over the period from August 1976 to March 1978 (Delgado, forthcoming (a)). In Nigeria a different set of factors influencing marketing patterns may have been at play (see Sahn and Delgado).

7/ The use of data aggregated by month may have exaggerated these by mixing temporal and spatial price differentials. In some seasons (such as the harvest) this can have substantial effect since temporal price change over one month can be major.

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INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N W
Washington, D.C 20036 U S A
(202) 862-5600
Telex 440054
Cable IFPRI

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SEASONALITY ACTIVITY PATTERNS AND HOUSEHOLD FOOD SUPPLY IN THE RURAL AREAS OF IVORY COAST

by

Ann-Jacqueline Berio
Patrick Francois
Alice Odounfa

Presented by

Paul Lunven

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Introduction: data basis and methodology

The Ivory Coast National Household Food Consumption and Budgetary Survey was conducted in 1979 by the Ministry of National Planning and Development. 1/ In addition to the usual objectives of such surveys, it had three additional goals:

- First, an evaluation of the household's food consumption in physical quantities, and of the share represented by home production in the total food supply. This was needed as an estimate of production, as a tool for planning agricultural and food policy, and for anticipating food import needs.

- Second, an understanding of the internal functioning of the households. Who does what? Who is responsible for what? Who brings money to whom for buying what? Who prepares the food and who eats it? Whose field is cultivated by whom? All questions usually dealt with in mini anthropological studies and faced here on a national scale.

- Third, an assessment of the nutritional adequacy of current food consumption patterns and intake levels.

The sample included 720 households in Abidjan and an equal number in other urban areas, which were all surveyed for one week. In rural areas, the 720 households of the sample were surveyed for a week, four times during the year in order to cover seasonal variations. The sampling frame was designed so as to ensure the representativeness of the results at urban, rural and national level.

Data collected included, beside usual socio-economic data on individuals and households, anthropometric data of all household members and the weight 2/ of all food items (plus water and fuel) entering the kitchen, person and money movements in and out of the household, plus a detailed record of the activities of the members of the households.

1/ This analysis was conducted in the framework of the on-going cooperation programme between FAO and the Ministry of Planning, Abidjan. It was possible only after the major part of the work had been carried out in Abidjan, by the staff of the Director of Statistics (Ministry of Planning) for the collection, coding, data entry and first cleaning of the data.

2/ The actual weighing by the enumerator of each food item reaching the households' kitchen was found to be the best way of approaching food consumption at household level.

Time-use data collection had been included in the survey with the objective of attributing a monetary value to all work excluded from the conventional definition of economic activities but still contributing to the national wealth. In the intent of the survey designers, such comprehensive "work activities" were to include, not only activities resulting in the production or transformation of foods, within or without the monetary circuit, but also all activities performed as services for the household. All spheres of "useful" household activities were therefore to be accounted, including for example cash cropping, (conventional "economic" activities), food production for home consumption (home production) water collection (household supply activities) or washing clothes (domestic activities).

The activities performed in the homestead - and lasting at least five minutes - were mostly observed by an enumerator who was responsible only for that household during that week. The activities performed in his absence were recorded by recall, shortly after they were performed. Household members below 10 years of age were not always included in the time-use data collection.

This survey has produced a data set, the value of which is unique in many ways:

- it is a national survey on over 2000 households. This large sample provides a picture not only of average situations, but also of differences between ecological areas, kinds of villages and types of households.

- the enumerators were stationed for one year in each surveyed village. This has allowed a high quality of the data collected mostly by direct observation.

- in the rural areas, the data collection lasted seven days, repeated four times during the year in order to reflect seasonal variations.

- data were collected on a variety of aspects of the conditions of life of the households (food intake, expenditure and income, time allocation, anthropometry). This allows the building up of a set of typologies of families for planning exercises.

The results presented here below have been weighted by the adequate sampling coefficients, in order to obtain results extrapolated to the universe (each ecological area, and the whole country).

1. Comments to tables 1.1, 1.2, 1.3 and 1.4

"Seasonality of activity patterns"

- Activities were recorded on a semi-open questionnaire, and the final analytical nomenclature includes over 200 different activities.

- They have been here grouped into five broad categories as follows:

  "rest and leisure" includes all free time spent, either resting during the day, visiting friends, or playing, but does not include social engagements considered as a compulsory activity.

  These latter activities are categorized under "social duties", which includes all religious and community activities, parties for births, marriages, and funerals.

  "personal needs" include meals and time spent on hygiene and medical care.

  "trips and travel" include all activities involving person's movements to and from the fields, markets, villages and towns, other households, by any means of transport, but mostly on foot.

- Finally, "all workload" 1/ includes tables 2.1, 2.2, 2.3 and 2.4.

  a) Labour Force Participation (i.e. production or transformtion of "economics", here mostly agriculture).

  b) Home supply activities (food gathering), hunting, fishing, water and wood collection).

  c) Domestic activities (housekeeping, cooking, washing, building and repairing the house).

Table 1.1 (also see fig 1.1)

- no seasonality for the sleeping hours

- no marked seasonality of social duties, but men are much more involved than women in socializing

- women work more than men in all quarters, 51% of their waking time against 34% (7h 50' against 5h 20' on average in the year); both sexes work more during the second quarter

- seasonality does not show very much on the national scale because it is hidden by regional differences. It is much more evident looking at the next tables, by ecological area.

- figure 1.1. bis shows energy allocation, by quarter, for all ecological areas.

1/ A-J. Bërio, The Use of Time Allocation Data in Developing Countries: from influencing development policies to estimating energy requirements. Helsinki August 1984.

Table 1.2

East Forest

- on average in the year, men work 5h 20', women 7h 40'

- men's maximum workload is in the second quarter (6h 50'), wo;en's maximum is in the third (harvest) quarter (9 hours)

- men's minimum workload coincides with women's busiest season (the third) during July through September, men work on average four hours and a half a day, while the minimum workload for women is in the fourth quarter with almost 7 hours and a half work per day

- in conclusion, men work less than women in every season. Their workload is more seasonal than women's. Their maximum workload does not reach the minimum level of women's workload.

Table 1.3

West Forest

- on average in the year, men work 5 hours a day, women over 8 hours

- men's maximum in April/June (5 hours and a half)
  men's minimum in January/March (less than 5 hours)

- women's maximum in January/March (almost 9 hours)
  women's minimum in October/December (less than 8 hours)

- little seasonality altogether in this dense forest region; again men work less than women in each quarter. Again minimum and maximum workload of both sexes do not coincide. Again men's maximum is much below women's minimum.

Table 1.4

Savannah

- on average in the year, men work 5 hours and a half, women work 7 hours 40'

- men's maximum over 6 hours and a half second quarter
  men's minimum 4 hours and a half third quarter

- women's maximum 8 hours first quarter
  women's minimum 7 hours and a half fourth quarter

- marked seasonality for men's workload (1:1.4) not so for women.

Comments to tables 2.1, 2.2, 2.3 and 2.4

"Seasonality of the breakdown of work activities into work spheres"

Table 2.1

This table shows a more clearcut division of tasks between sexes than a high seasonality of the breakdown of work activities, for the same above mentioned problem of ecological differences compensating seasonal phenomena at the national level.

Men are definitely specialized in "economic work" activities (the so-called Labour Force Participation), and women in home supply and domestic activities.

Table 2.2

East Forest

- the seasonality of men's total workload is determined by the seasonality of the agricultural work. Women's workload varies, with their involvement both in agriculture and in home supply activities

- Men's agricultural work during the end of the first quarter consists mostly of land clearing and tree felling. They carry on with this activity in the second quarter and, with the first rains, start sowing peanuts and corn. This is when their workload reaches its maximum. During the last part of the year, they harvest and process cash crop.

- Their involvement in home supply activities consists mainly of hunting, which increases during the second part of the year, to protect yam and other harvests

- as to their domestic activities (mostly building and repairing houses) this is done especially during the first part of the year, before the rainy season

- women's workload is related to the production of staple foods and varies with the agricultural calendar related to yam harvesting (second quarter) and palm oil processing idn the first quarter.

  They are left with little agricultural and home supply work during the fourth quarter and increase the time spent on domestic activities.

Table 2.3 West Forest and Table 2.4 Savannah

Comments to tables 3.2, 3.2, 3.3 and 3.4

Tables 3.1 and following show the combined result of (a) differences in workload as shown in tables 2, and (b) migration of rural adult males to town, which increases the role of women in the performance of all sectors of work activities.

As a result, although men spend on average more minutes on "economic work" activities than women in each ecological area and in each season, women are always and everywhere responsible for more than half of the hours spent on economic activities, with the exception of the first and the third quarter in West Forest, and of the second quarter in the Savannah area.

Comments to tables 4.1,.4.2, 4.3 and 4.4

"Seasonality of the composition of the households food supply"

Table 4.1 and figure 4.1 show the seasonal variations of the composition of the household food supply for all the rural areas of Ivory Coast.

There is a contrast between the first part of the year - when the importance of cereals is at its minimum (around 30%) - and the second part of the year when corn (third quarter) and rice (fourth quarter) raise it to about 40%.

The importance of roots and tubers, and of fat varies so as to compensate the seasonality of the share that cereals play in the energy supply.

Tables 4.2, 4.3 and 4.4 are to be interpreted with the help of graphs with the same numbers.

These graphs are the output of simple correspondence analysis between seasons and main food items, weighted per the energy content of each food item. They illustrate the "neighbourness" or "distance" between seasons, and between food items.

East Forest - Taking graph 4.2 as example, one can say: the composition of the household food supply in the first quarter is similar to the one in the second quarter;

- there is a contrast between first, second and fourth quarter, dominated by roots and tubers, and the third quarter, dominated by maize and peanut butter
- cassava is right in the middle of the graph as permanent store food
- note also the opposition between early yams (fourth quarter) and late yams (first part of the year).

West Forest - table 4.3 and graph 4.3

- here the opposition is between first half of the year, (when roots and tubers, pulses and seeds, and fat, reach their largest share in the total household food supply) and the second half of the year, when corn (third quarter) and rice (fourth quarter) increse tremendously the importance of cereals in the supply (over 50%).

- note seasonality of fat: 9% of total kcal supplied in the first quarter, 5% in the second, and less than 0.5% in the second half of the year.

Savannah - Table 4.4 and graph 4.4

- here contrast is between first and second, opposed to third, and to fourth quarters.

- during the first and second quarters, millet and sorghum play a role in cereal supply; late yams increase the importance of roots and tubers; fats come mostly from palm oil

- during the third quarter, local karite (butterseed butter) and peanuts raise the importance of pulses and of fat

- early yams raise the share of roots and tubers during the fourth quarter. It is also characterized by high supply of locust bean (nẽrẽ)

- note that in the Savannah, (and only there) milled rice and peanut butter are in the centre of the group.

Comments to tables 5.1, 5.2, 5.3, 5.4

"Seasonality of the origin of the household food supply"

Table 5 presents the breakdown of the household food supply - expressed in kcal - into three parts, which refer to as many different supply origins: home production, commercial purchase and presents received against no cash. This last part is mostly made of home produced presents received from other households. Table 4.5 shows first the predominance of home production in the household food supply: 81.6% of the total household food supply comes from home production, if no distinction is made for the season nor for the region.

The rest of the household food supply comes from purchased food items (14.3%) and from food presents received against no cash (4.1%). In other words, over 90% of the rural household's food supply, expressed in kcal, is supplied outside the commercial circuit, i.e. the level of food self-sufficiency of the Ivory Coast rural households is at least 0.9.

Although home production supplies are three quarters of the total energy all year round, its prevalence is more marked in the second part of the year, and minimal during the first quarter; this is also true for non commercial exchanges. Expectedly, commercial purchases reach their minimum during the fourth quarter, when they represent no more than 9.5% of the total household's energy supply, nearly twice as less as their low in the first quarter.

It is difficult to interpret these variations without breaking down the country into regions which reflect to some degree ecological and agricultural differences. Table 5.2, 5.3, and 5.4, illustrate the seasonality of the origin of the rural household's food supply in the East Forest, West Forest and Savannah, respectively.

Although the prevalence of home production remains in every season above 75% of the energy rural household supply, these tables show that the three survey regions have different seasonality patterns in the origin of the household food supply: the contrast is between the first and second part of the year in the East Forest area. In the Savannah area, the strongest differences are found within the second part of the year, when the share of the purchases goes from 18.4% in the third quarter down to 11% in the September/December period. The West Forest region shows the strongest seasonality in the share of the energy household food supply brought by commercial purchases. These represent 13.7% of the total food supply on a year basis, but 4.9% of it during the last quarter, and as much as 21.6% during the first one.

Table 6

"Seasonality of women's contribution to the household food supply"

- their percentage represents the proportion of food (expressed in kcal) brought by women, over total food arriving to the households
- note first that considering all rural areas and the whole year, women provide 62% of the energy supplied to the households
- looking at the whole country (rural areas only), they provide a larger share during the third quarter (corn, peanuts, karite)
- their share is more important in the West Forest.

1. Seasonality of time allocation of adults in the rural areas of Ivory Coast

Table 1.1 Time allocation of adult men and women 20 to 50 years old, expressed in percentage of total waking hours spent in five broad activity categories

ALL ECOLOGICAL AREAS

activity categories	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
total work load	34.4	52.6	37.9	53.1	32.2	49.3	32.7	49.0
trips and travel	9.4	5.6	8.4	6.9	8.7	7.6	7.6	6.8
social duties	5.4	2.1	5.5	2.0	6.8	3.2	4.7	2.4
personal needs	9.6	8.6	9.2	9.2	7.2	12.5	13.2	12.2
rest and leisure	41.2	31.1	39.0	30.8	39.1	27.4	41.8	29.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sleep (in minutes)	508'	517'	513'	521'	515'	518'	521'	528'

1. Seasonality of time allocation of adults in the rural areas of Ivory Coast

Table 1.2 Time allocation of adult men and women 20 to 50 years old expressed in percentage of total waking hours spent in five broad activity categories

EAST FOREST

main activity categories activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
total workload	36.9	52.7	41.4	52.3	29.5	49.4	29.7	49.1
trips and travel	10.6	7.5	9.2	8.4	10.1	8.4	8.5	7.6
social duties	3.7	1.9	2.7	1.9	5.7	3.2	5.3	2.5
personal needs	9.1	7.3	8.7	6.4	14.3	12.6	13.7	11.7
rest and leisure	39.7	30.6	38.0	31.0	40.4	26.4	42.8	29.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sleep (in minutes)	506'	523'	500'	521'	521'	530'	525'	38'

1. Seasonality of time allocation of adults in the rural areas of Ivory Coast

Table 1.3 Time allocation of adult men and women 20 to 50 years old expressed in percentage of total waking hours spent in five broad activity categories

WEST FOREST

main activity categories activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
total workload	31.2	56.4	36.3	54.8	32.6	49.6	32.2	48.4
trips and travel	8.6	2.9	5.7	3.2	6.1	4.8	4.5	4.1
social duties	4.0	1.2	2.6	0.9	4.7	1.5	2.5	1.2
personal needs	8.7	7.5	7.7	6.2	11.9	10.0	11.7	10.1
rest and leisure	47.5	32.0	47.7	34.9	44.7	34.1	49.1	36.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sleep (in minutes)	485'	498'	524'	510'	507'	498'	505'	506'

1. Seasonality of time allocation of adults in the rural areas of Ivory Coast

Table 1.4 Time allocation of adult men and women 20 to 50 years old expressed in percentage of total waking hours spent in five broad activity categories

SAVANNAH

main activity categories activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
total workload	33.1	50.1	35.1	53.3	36.8	48.9	35.9	49.1
trips and travel	8.4	4.8	8.6	6.9	8.3	8.3	8.5	7.6
social duties	7.7	2.9	9.7	2.7	10.5	4.5	5.6	3.2
personal needs	10.4	10.9	10.5	9.2	12.4	14.0	13.6	14.5
rest and leisure	40.4	31.3	36.1	27.9	32.0	24.5	36.4	25.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sleep (in minutes)	519'	517'	522'	526'	511'	514'	524'	526'

2. Seasonality of the breakdown of work acitvities into work spheres

Table 2.1 Breakdown of the workload of men and women 20 to 50 years old in the rural areas of Ivory Coast, into spheres of work activities, expressed in minutes and in percentage of the total workload (in brackets)

ALL ECOLOGICAL AREAS

spheres of work activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	245 (76.2)	112 (23.0)	307 (87.7)	171 (35.1)	257 (86.4)	171 (37.6)	250 (82.9)	122 (27.2)
home supply activities	34 (10.7)	116 (23.8)	12 (3.3)	83 (17.1)	19 (6.3)	69 (15.1)	28 (9.0)	72 (16.1)
domestic activities	42 (13.1)	258 (53.2)	32 (9.0)	234 (47.8)	22 (7.3)	215 (47.3)	24 (8.1)	253 (56.7)
Total in minutes Total percentage	321 (100.0)	486 (100.0)	351 (100.0)	488 (100.0)	298 (100.0)	455 (100.0)	301 (100.0)	447 (100.0)

2. Seasonality of the breakdown of work activities into work spheres

Table 2.2 Breakdown of the workload of men and women 20 to 50 years old in the rural areas of Ivory Coast, into spheres of work activities, expressed in minutes and in percentage of the total workload (in brackets)

EAST FOREST

spheres of work activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	278 (80.7)	151 (31.2)	337 (86.6)	183 (38.0)	222 (81.9)	160 (35.5)	225 (82.9)	120 (27.2)
home supply activities	18 (5.1)	99 (20.6)	10 (2.6)	62 (12.8)	27 (10.0)	58 (12.9)	24 (9.0)	71 (16.1)
domestic activities	49 (14.2)	233 (48.2)	42 (10.8)	232 (49.2)	22 (8.1)	232 (51.6)	22 (8.1)	252 (56.7)
Total in minutes Total percentage	345 (100.0)	483 (100.0)	389 (100.0)	481 (100.0)	271 (100.0)	450 (100.0)	272 (100.0)	443 (100.0)

2. Seasonality of the breakdown of work activities into work spheres

Table 2.3 Breakdown of the workload of men and women 20 to 50 years old in the rural areas of Ivory Coast, into spheres of work activities, expressed in minutes and in percentage of the total workload (in brackets)

WEST FOREST

spheres of work activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	241 (80.7)	53 (9.9)	261 (78.5)	146 (28.6)	249 (82.0)	145 (31.0)	265 (88.0)	193 (42.7)
home supply activities	28 (9.5)	165 (31.1)	23 (6.9)	99 (19.4)	17 (5.5)	93 (19.9)	13 (4.2)	58 (12.9)
domestic activities	29 (9.8)	313 (59.0)	49 (14.6)	265 (52.0)	38 (12.5)	229 (49.0)	23 (7.8)	201 (44.4)
Total in minutes Total percentage	298 (100.0)	531 (100.0)	333 (100.0)	510 (100.0)	304 (100.0)	467 (100.0)	301 (100.0)	452 (100.0)

2. Seasonality of the breakdown of work activities into work spheres

Table 2.4 Breakdwon of the workload of men and women 20 to 50 years old in the rural areas of Ivory Coast, into spheres of work activities, expressed in minutes and in percentage of the total workload (in brackets)

SAVANNAH

spheres of work activities	Seasons							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	212 (69.3)	97 (21.0)	300 (93.3)	171 (35.1)	329 (96.1)	211 (46.8)	305 (92.6)	201 (44.9)
home supply activities	53 (17.5)	107 (23.1)	8 (2.5)	107 (21.9)	5 (1.6)	72 (15.9)	9 (2.8)	61 (13.5)
domestic activities	40 (13.2)	258 (55.9)	14 (4.2)	209 (43.0)	8 (2.3)	168 (37.3)	15 (4.6)	187 (41.6)
Total in minutes Total percentage	305 (100.0)	462 (100.0)	322 (100.0)	487 (100.0)	342 (100.0)	451 (100.0)	329 (100.0)	449 (100.0)

3. Seasonality of the role of women in different spheres of work activities

3.1 Seasonality of the percentage contributions of adult men and women (20-50 years old) to the total workload and to each sphere of work activity
(share expressed as percentage in row, by season and by sphere of activity)

ALL ECOLOGICAL AREAS

spheres of work activities	Season							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	45.0	55.0	45.6	54.4	14.8	55.2	45.8	54.2
home supply activities	10.0	90.0	6.1	93.9	12.9	87.1	10.2	89.8
domestic activities	5.7	94.3	5.9	94.8	5.2	94.8	4.1	95.9
all work	19.8	80.2	25.1	74.9	26.1	73.9	23.3	76.7

3. Seasonality of the role of women in different spheres of work activities

Table 3.2 Seasonality of the percentage contributions of adult men and women (20-50 years old) to the total workload and to each sphere of work activity (share expressed as percentage in row, by season and by sphere of activity)

EAST FOREST

spheres of work activities	Season							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	39.4	60.6	42.7	57.3	41.1	58.9	41.3	58.7
home supply activities	5.9	94.1	6.4	93.6	18.9	81.1	11.5	88.5
domestic activities	6.9	93.1	6.7	93.3	4.5	95.5	3.2	96.8
all work	20.1	79.9	24.6	75.4	23.2	76.8	18.8	81.2

3. Seasonality of the role of women in different spheres of work activities

Table 3.4 Seasonality of the percentage contributions of adult men and women (20-50 years old) to the total workload and to each sphere of work activity (share expressed as percentage in row, by season and by sphere of activity)

SAVANNAH

spheres of work activities	Season							
	January/March		April/June		July/September		October/December	
	men	women	men	women	men	women	men	women
economic work activities	49.3	50.7	50.6	49.4	46.1	53.9	47.9	52.1
home supply activities	18.3	81.7	4.2	95.8	4.1	95.9	4.7	95.3
domestic activities	6.5	93.5	3.7	96.3	2.5	97.5	3.7	96.3
all work	22.8	77.2	27.9	72.1	29.4	70.6	28.4	71.5

4. Seasonality of the composition of the household food supply

Table 4.1 Breakdown of the rural households' food supply in Ivory Coast, per main food groups, expressed in percentage of the total food supply per season

ALL ECOLOGICAL AREAS

Food groups	Season				
	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
cereals and grain products	30.6	29.4	42.6	41.2	36.4
starchy roots and tubers	46.9	48.1	31.3	40.4	41.0
pulses, seeds	12.0	11.5	16.6	9.2	12.6
vegetables, leaves	0.6	1.1	1.5	2.3	1.4
fruits	0.1	0.3	0.1	0.3	0.2
sugar and sugar products	0.28	0.4	0.4	0.2	0.3
meat and poultry	2.4	2.7	1.9	2.7	2.4
fish, shelfish and fish products	2.1	1.9	1.5	2.1	1.0
milk, eggs	0.04	0.03	0.03	0.01	0.03
fat	4.7	4.1	3.5	1.4	3.5
drinks	0.3	0.4	0.6	0.2	0.4
condiments	0.02	0.19	0.0	0.0	0.05
Total	100.0	100.0	100.0	100.0	100.0

4. Seasonality of the composition of the household food supply

Table 4.2 Breakdown of the rural households' food supply in Ivory Coast, per main food groups, expressed in percentage of the total food supply per season

EAST FOREST

food groups / season	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
cereals and grain products	15.7	12.6	28.9	17.1	19.8
starchy roots and tubers	62.9	70.5	41.0	63.8	57.3
pulses, seeds	13.0	8.6	22.4	6.5	13.9
vegetable, leaves	0.5	1.0	1.5	3.1	1.5
fruits	0.1	0.0	0.1	0.4	0.1
sugar and sugar products	0.4	0.3	0.3	0.2	0.3
meat and poultry	2.4	2.2	2.0	3.7	2.5
fish, shellfish and fish products	2.5	2.2	1.8	2.9	2.3
milk, eggs,	0.0	0.0	0.0	0.0	0.0
fat	2.4	1.8	1.0	1.8	1.7
drinks	0.1	0.8	1.0	0.5	0,.6
condiments	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

4. Seasonality of the composition of the household food supply

Table 4.3 Breakdown of the rural households' food supply in Ivory Coast, per main food groups, expressed in percentage of the total food supply per season

WEST FOREST

food groups / season	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
cereals and grain products	37.5	32.3	58.3	64.5	50.0
starchy roots and tubers	28.6	39.2	23.9	19.2	26.8
pulses, seeds	17.8	16.8	11.3	10.9	13.8
vegetable, leaves	0.7	1.2	1.5	1.2	1.2
fruits	0.1	0.2	0.0	0.3	0.1
sugar and sugar products	0.1	0.1	0.2	0.1	0.1
meat and poultry	2.5	3.0	2.5	1.9	2.4
fish, shellfish and fish products	2.7	2.0	1.6	1.5	1.9
milk, eggs	0.0	0.0	0.0	0.0	0.0
fat	9.2	5.0	0.3	0.2	3.3
drinks	0.8	0.2	0.4	0.2	0.4
condiments	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

4. Seasonality of the composition of the household food supply

Table 4.4 Breakdown of the rural households' food supply in Ivory Coast, per main food groups, expressed in percentage of the total food supply per season

SAVANNAH

food groups / season	Jan./March	April\June	July/Sept.	Oct./Dec.	Whole year
cereals and grain products	44.6	46.1	51.0	41.9	46.3
starchy roots and tubers	42.2	29.4	22.3	37.4	32.0
pulses, seeds	5.3	10.9	11.8	10.7	9.8
vegetables, leaves	0.5	1.1	1.4	2.9	1.4
fruits	0.1	0.5	0.1	0.2	0.2
sugar and sugar products	0.3	0.8	0.7	0.12	0.5
meat and poultry	2.2	3.0	1.2	2.5	2.2
fish, shellfish and fish products	1.0	1.4	0.9	1.7	1.2
milk, eggs	0.1	0.1	0.1	0.0	0.1
fat	3.7	6.1	10.5	2.6	6.1
drinks	0.0	0.1	0.0	0.0	0.0
condiments	0.0	0.5	0.0	0.0	0.2
Total	100.0	100.0	100.0	100.0	100.0

5. Seasonality of the origin of the household food supply

Table 5.1 Percentage breakdown of the household food supply (expressed in Kcal), according to its origin: home production, purchases, and gifts received in kind

ALL ECOLOGICAL AREAS

Origin of the household food supply	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
home production	79.5	78.4	81.8	86.5	81.6
purchases	17.6	17.4	13.1	9.5	14.3
gifts received in kind (mostly presents of home produced food)	2.9	4.2	5.1	4.0	4.1
Total	100.0	100.0	100.0	100.0	100.0

5. Seasonality of the origin of the household food supply

Table 5.2 Percentage breakdown of the household food supply (expressed in kcal), according to its origin: home production, purchases, and gifts received in kind

EAST FOREST

Origin of the household food supply	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
home production	82.1	78.8	83.0	82.1	81.7
purchases	16.1	17.7	10.8	13.3	15.0
gifts received in kind (mostly presents of home produced food)	1.8	3.5	6.2	4.6	3.3
Total	100.0	100.0	100.0	100.0	100.0

5. Seasonality of the origin of the household food supply

Table 5.4 Percentage breakdown of the household food supply (expressed in kcal), according to its origin: home production, purchases, and gifts received in kind

SAVANNAH

Origin of food supply	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
home production	80.1	78.5	78.4	87.4	80.9
purchases	15.8	15.8	18.4	11.0	14.5
gifts received in kind (mostly presents of home produced food)	4.1	5.7	3.2	1.6	4.6
Total	100.0	100.0	100.0	100.0	100.0

5. Seasonality of the origin of the household food supply

Table 5.4 Percentage breakdown of the household food supply (expressed in kcal), according to its origin: home production, purchases, and gifts received in kind

SAVANNAH

Origin of food supply	Jan./March	April/June	July/Sept.	Oct./Dec.	Whole year
home production	80.1	78.5	78.4	87.4	80.9
purchases	15.8	15.8	18.4	11.0	14.5
gifts received in kind (mostly presents of home produced food)	4.1	5.7	3.2	1.6	4.6
Total	100.0	100.0	100.0	100.0	100.0

6. Seasonality of the women's contribution to the household food supply

Table 6 Contribution of women to rural household food supply expressed as percentage of total calories provided by all members of the household, per ecological area, and per season

Ecological areas	Jan./March	April/June	July/Sept.	Oct./Dec.	whole year
East Forest	48.0	51.3	69.7	58.7	58.1
West Forest	68.7	70.7	75.3	75.3	55.9
Savannah	41.2	62.0	62.9	55.2	55.9
All rural areas	51.8	59.9	69.1	63.9	61.7

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex 440054
Cable: IFPRI

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WAGES AND LABOR SUPPLY IN RURAL INDIA: THE ROLE OF HEALTH, NUTRITION AND SEASONALITY

by

Jere R. Behrman and Anil B. Deolalikar

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

Maryland Inn
Annapolis, Maryland
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Two persistent strains in the development literature are: first, there are important seasonal variations in nutritional and health status and second, there is a technically-determined link between nutritional status or health and labor effort and productivity.

The first strain has been emphasized by Chambers (1982), and Longhurst and Payne (1979), among others, and has prompted the convening of the present conference. Chambers argues that seasonal deprivation in nutrient intakes, other health-related intakes and health status are considerable, particularly during the wet season for women and children, but that urban-based social scientists underestimate these effects because of systematic biases in their observations. Longhurst and Payne emphasize that "hungry" or "lean" seasons are "an important, if not the most important determinant of nutrition in less developed countries" (pp. 39-30) with short-run productivity and welfare implications and possible deleterious longer-run effects if the body's capacity to adapt is stretched too far during seasonal shortfalls in food. But as both of these papers emphasize, there are serious deficiencies in available empirical research on such seasonality. For example, multivariate analysis with control for simultaneity is the exception rather than the rule and many data sets simply may not have data during the "bad" season because of systematic tendencies to collect information during the "good" season. A number of papers present at this conference, including our study on seasonality in nutrient and health status determinants (Behrman and Deolalikar 1985), hopefully advance the state of knowledge regarding the extent of and the determinants of seasonality regarding nutrition and health.

The second strain often is summarized as the "Wage Efficiency Hypothesis" and has been discussed by Liebenstein (1957), Mazumdar (1959), Stiglitz (1976), and Bliss and Stern (1978), among others. However it has been

subjected to little systematic empirical testing for a number of reasons. First, the nutrition/health-productivity relationship cannot be established by mere correlations between variables, since a correlation could be picking up the effect of increased productivity, and thereby income, on nutrition or health rather than vice versa. A more rigorous test involves regression of productivity indicators on the nutritional or health status of a worker, recognizing that the latter is subject to choice and hence an endogenous variable. Second, the appropriate concept of productivity is marginal, not average, productivity, which is rarely directly observed by social scientists. The measurement of marginal productivity often requires the estimation of a technical production function. Third, any study of the nutrition-productivity relationship should control for the type of task performed by a worker, since it is possible for individuals with consistently-low nutritional intakes to shift in the long run to low-effort, low-intake equilibria where their task fulfillment would not necessarily be impaired. Fourth, there may be substantial intrapersonal variations in nutrition, health and productivity, such as that due to seasonality.

No study that we are aware of has addressed all of the above problems. There are many that have been oblivious of all of them,[1] though some recent studies by Deolalikar (1984) and Strauss (1986) do advance the state of the empirical art concerning nutrition/health-productivity relations by investigations which estimate directly production relations for individuals and/or households within a framework in which the possible simultaneity of nutrition/health with productivity is controlled for directly. Deolalikar analyzes the impact of individual health indicators (height and weight-for-height) on individual market wage rates and on-farm labor productivity for a sample of agricultural households in semi-arid south India; Strauss estimates

the effect of average (over the household) per consumer equivalent caloric intake on the productivity of on-farm family labor in Sierra Leonean agriculture. Both studies estimate agricultural production functions with hired labor and non-labor inputs in addition to family labor inputs. Both find evidence of some health/nutrition effects on labor productivity. Both suffer from some deficiencies, including very limited or no exploration of seasonality.

In this paper we attempt to integrate these two strains of the literature by exploring for a rural south Indian sample what is the nature of seasonality in the effects of nutrition intakes and health status on labor market productivity as reflected in wages and labor supplies. Our exploration attempts to improve on the previous literature by treating health and nutrition as simultaneously determined with wages and labor supply, focusing on marginal effects under the maintained hypothesis that wages reflect marginal productivities — which also effectively controls for the type of tasks, and controlling for seasonality within our integrated framework.

We investigate questions such as the following. Do the impacts of nutrition and health differ between the peak and slack labor seasons? Is there evidence of differential direct links between nutrient intakes and short-run productivity with little impact on longer-run health status as might be suggested by the adaptability hypothesis emphasized by Payne and Culter (1984), Sukhatme (1982), Srinivasan (1981) and others? Are the seasonal effects different for wages than for labor supply? Do the seasonal effects differ for males versus females?

Section 1 outlines the model underlying our empirical specifications. Section 2 describes the data set. Section 3 presents and discusses our empirical results.

1. Model and Estimation

There is a long and established tradition of estimating labor supply functions and wage equations for developed countries (Kosters 1966, Ashenfelter and Heckman 1974, Schultz 1975, Mincer 1974). Recently a number of labor supply studies also have been undertaken for less-developed countries (Rosenzweig 1980, Bardhan 1979). In this paper, we apply the standard (neoclassical) labor supply framework to a traditional agricultural setting, and extend it in two ways: first, we explore the impacts, if any, of health and nutrition on individual wage rates and labor supply, and, second, we test whether the parameters of the wage and labor supply equations vary across the peak and slack agricultural seasons.

Estimated individual wage equations typically include as arguments personel characteristics of an individual such as schooling, experience, and sex. In a LDC agricultural setting, however, it is likely that the labor market offers a wage premium to healthy and well-nourished workers since many agricultural tasks tend to be physically demanding. This would be especially the case if there were a technical relationship between nutritional status and labor productivity, as posited by Bliss and Stern (1978). We therefore include health and nutrition as arguments in the individual wage rate equations that we estimate below, and expect them to have positive signs.

The labor supply decisions of an individual are determined by a comparison of his or her market and reservation wage rates (e.g., Heckman 1976). In a situation in which the major alternative to market work is work on the family farm, good health and nutrition are likely to be associated with high market <u>and</u> reservation wages, particularly if he or she belongs to a landed household. The impact of health and nutrition on market labor supply therefore is ambiguous, as it depends on the relative magnitudes of the

health/nutrition effects on market versus reservation wage rates.

Health and nutrition cannot be treated satisfactorily as exogenous variables influencing wages and labor supply in the above analysis as there is a large literature which suggests that health and nutrition are choice variables (Behrman and Deolalikar 1986). We therefore treat health and nutrition as endogenous variables in the wage and labor supply equations, and use agricultural consumption and product prices and farm assets as instruments for them (Behrman and Deolalikar 1986, Strauss 1985).

Previous studies, such as those by Deolalikar (1984) and Strauss (1986), have either included measures of health status or levels of nutrient intake as explanatory variables in their agricultural production functions or wage equations. However, in reviewing several empirical health production studies, Behrman and Deolalikar (1986) find that nutrient intakes do not adequately 'explain' health status, particularly among adults. They argue that such results suggest that short-run changes in nutrient intakes alter metabolism and are reflected in changes in energy expenditure rather than in changes in health status. We therefore have included both health status and nutrient intake as explanatory variables in our wage and labor supply equations to allow nutrient intake to have an additional impact (over and above any impact via health status) on labor productivity and supply.

Another reason for including both caloric intake and weight-for-height in the wage equation is that the two may fulfill qualitatively different needs in agricultural operations. Weight-for-height is associated with innate strength, while caloric intake is associated with energy expenditure. Agricultural tasks vary in their requirements of these two attributes.

We estimate forms of the wage and labor supply equations that allow all coefficients to differ across the agricultural peak and slack seasons. The

idea here is the tasks performed in the two seasons may differ in their requirements of innate strength versus energy expenditure (as well as other attributes such as education), and that this would be reflected in differential valuation of these attributes across the two seasons by the labor markets.

Wage equations can be estimated only for those individuals participating in the casual daily labor market and hence reporting a wage. The nonrandomness of this sample may result in biased estimates for the wage equation, particularly if labor market participation is a choice variable for the individual (Heckman 1976, Olsen 1980). We have corrected for this potential selectivity bias in our estimates by using Olsen's (1980) least-squares selectivity correction procedure.

The wage and labor supply equations are estimated jointly using the three-stage least squares estimation method to allow for nonzero error correlations across equations. The wage equation estimated is of the semi-logarithmic form since this is the functional form that has been most commonly estimated in the literature (Mincer 1974, Psacharopoulos 1982).

2. Data

We use the ICRISAT VLS (International Crops Research Institute for the Semi-Arid Tropics Village Level Studies) data set to estimate individual wage and labor supply equations. The ICRISAT VLS data are panel data that have been collected at regular intervals since mid-1975 on production, expenditure, time allocation, prices, and socioeconomic characteristics for 240 households in six carefully selected 'typical' villages in three different agroclimatic zones in SAT India. Within each village 10 households are randomly selected representatives of agricultural labor and nonland holding households and

another 30 are a stratified (by size of land holdings) random sample of cultivating households.

For the 1975-76, 1976-77, and 1977-78 agricultural years, data on daily wages received and days worked by participants in the casual agricultural labor market were collected every 2-4 weeks. Since the precise intervals between interviews varied, the wage data were smoothed and then aggregated into peak and slack seasons. Peak seasons were defined as those months when opportunity costs of labor, defined as the product of wages and the probability of involuntary unemployment, were at a peak. Slack seasons were the remaining months of the year. The peak and slack periods so defined were not congruent across villages even in the same agro-climatic zone (Ryan et. al. 1979). Table 1 reports the village-specific peak period months calculated by Ryan et. al. and used in this paper.

For the 1976-77 and 1977-78 agricultural years, four rounds of a special nutrition survey were undertaken by ICRISAT in which were recorded individual nutrient intakes in the past 24 hours and anthropometric measures of health status. Since the dates on which each of the rounds was undertaken were available, we have aggregated the health and nutrition data into the peak and slack seasons defined above. The health and nutrition data have then been merged with the wage and labor supply data. We utilize the average value for each casual labor market participant as an observation, which gives us a total of 468 individual/season observations.

We use average daily intake of calories as the relevant measure of nutrient intake. For health status we use weight-for-height, an anthropometric measure that is widely assumed to reflect short-run health status. We use the measures in their original units (i.e., calories and

Table 1. Peak and slack labor periods for adults in six SAT villages of peninsular India, 1975-76.

District Village	Category	Peak Period: Months	Peak Period: Major Operations	Slack Per months
Mahbubnager Aurepalle	Male and Females	Dec-Jan	Harvesting and threshing sorghum pearl millet, castor	Feb-April
Dokur	Male and Females	Nov-Jan	Harvesting and threshing sorghum, nursery bed preparation paddy, paddy transplanting	Feb-June
Sholapur Shirapur	Males	April-May July-Aug	Preparatory tillage, ploughing sowing pearl millet, mesta, mungbean	Dec, Feb-March
	Females	Sept Dec-Feb	Harvesting and threshing pearl millet, mesta, mungbean Sowing & harvesting wheat, sorghum, chickpea, safflower	Apr-Aug
Kalman	Males	Jan-Mar May	Harvesting and threshing wheat, sorghum, chickpea, safflower Preparatory tillage, ploughing	Aug-Oct
	Females	Mar-Apr Nov	Harvesting and threshing wheat, sorghum, chickpea, safflower Harvesting and threshing pearl millet, mesta	Oct-Dec-Jan
Akola Kanzara	Males	Mar Aug-Sept	Harvesting cotton; harvesting and threshing pigeonpea Preparatory tillage, sowing wheat, chickpea, harvesting sorghum, groundnut	Apr-Sept.
	Females	Oct-Dec March	Harvesting and threshing sorghum, groundnut, cotton Harvesting cotton	Apr-June
Kinkheda	Males	April June-July Nov-Dec	Preparatory tillage Sowing, interculturing cotton, sorghum, pigeonpea, mungbean Harvesting and threshing sorghum, groundnut; sowing wheat and chickpea	Aug-Oct May
	Females	May Sept-Dec	Field cleaning Harvesting and threshing sorghum, groundnut; weeding cotton.	Feb-Mar

Source: Ryan et. al. (1979), 372-3.

kilograms/centimeter) as well as in age- and sex-standardized units (with the Indian Recommended Daily Allowances in Gopalan, Sastry, and Balasubramanian, 1971, serving as the standard for calorie consumption and the modified Harvard standard in Ryan, Bidinger, Rao, and Pushpamma, 1984, serving as the standard for weight-for-height).

Table 2 gives the means and standard deviations by season and sex for the market labor supply, wage rate, and health and nutrition variables. Market labor supply is expressed as the number of days that an individual worked in the casual labor market as a percentage of the total number of available days in a season. Note that market labor supply is a lower bound for total labor supply, particularly in the case of individuals belonging to farm households, since it does not include work done on family farms for no wage. Ryan and Ghodake (1984) report that, over the six VLS villages, 30 and 37 per cent of available male and female labor, respectively, participated in work outside their own farms, households, and businesses during 1975-76.

The data in Table 2 show that market labor supply is 14-18 per cent larger in the peak season that in the slack season for both males and females. Women supply slightly more labor than men in both seasons, but the difference is not significant at the 5 per cent level. Ryan and Ghodake report that, in four of the six VLS villages, total female labor use on crops exceeds that of males, and in all six villages the proportion of female labor used in agriculture far exceeds the 20 per cent figures cited for Asia by Boserup (1970). Thus female labor participation, both on family farms and in the casual agricultural labor market, is pervasive in our sample.

Agricultural wages are also higher in the peak season than in the slack season (in part because of the definition of peak and slack) for both male and

Table 2. Means and Standard Deviations by Season: SAT India, 1976-78

	Slack Season	Peak Season
Daily wage rate (Rs.)		
Men	3.3 (1)	3.4 (1)
Women	2.0 (1)	2.1 (1)
Number of days worked as % of total available		
Men	39.9 (29)	45.4 (26)
Women	40.1 (25)	47.4 (27)
Average daily caloric intake		
Men	2123 (920)	2373 (880)
Women	2053 (850)	2035 (784)
Weight-for-Height (Kgs./cm.)		
Men	0.2 (0)	0.2 (0)
Women	0.2 (0)	0.2 (0)
Years of Schooling		
Men	2.5 (3)	2.6 (3)
Women	0.8 (2)	0.8 (2)
Years of Experience		
Men	20.1 (15)	19.5 (15)
Women	23.0 (17)	22.7 (17)
Price of rice (Rs/kg)	2.0 (0)	2.1 (0)
Price of milk (Rs/litre)	1.8 (0)	1.8 (0)
Price of sorghum (Rs/kg)	1.2 (0)	1.2 (0)
Price of pulses (Rs/kg)	3.6 (1)	3.7 (1)
Price of sugar (Rs/kg)	2.8 (1)	2.9 (1)
Price of bullock power (Rs./day)	10.7 (2)	11.0 (2)
Farm size (acres)	6.8 (7)	
% of cultivated area under superior soil	45.5 (50)	

Note: Figures in parentheses are standard deviations.

female labor, but only slightly (by 2-6 per cent) and not significantly. Female wages are approximately 60 per cent of male wages in both seasons.

Health (weight-for-height) appears to be largely invariant across peak and slack seasons for both males and females, while caloric intake is more-or-less unchanged across seasons for females. For males, daily caloric intake is significantly higher (by about 12 per cent) in the peak than in the slack season. This suggests that the additional calories consumed by males in the peak season may go toward satisfying the greater energy requirements in physically-demanding, peak-season, male tasks like ploughing.

3. Empirical Results

Table 3 presents the estimates for the labor supply and wage equations estimated over **all** market participants, while Tables 4 and 5 present separate estimates for **male and female** market participants. Since the peak season slope dummies were uniformly insignificant at the 10 per cent level in all the equations for all right-hand side variables other than calories and weight-for-height, we allow only the intercept terms and the coefficients on calories and weight-for-height to differ across seasons in the results reported in these tables. All other coefficients are restricted to be identical across the two seasons. In addition, since the use of unstandardized versus standardized values of calories and weight-for-height made virtually no difference in our results, we report only the estimates using unstandardized calories and weight-for-height.

The estimates in Table 3 indicate significantly (at the 10 per cent level) higher wages rates (by about 3 per cent) in the peak than in the slack season, holding all other wage-determining factors constant. In the slack

Table 3. Wage and Labor Supply Equations for All Individuals: SAT India, 1976-78*

Independent Variable	Participation in labor market (=0, 1)[b]	Log Wage Rate	No. of days worked as % of total available days
Intercept	-.174 (0.8)	-.366 (1.3)	21.4 (0.4)
Peak season[b]		.0555 (1.9)	5.19 (1.8)
Calories[a,c]		-0.117 (0.3)	49.6 (1.0)
Calories X Peak season[a,c]		1.36 (2.1)	-10.9 (0.2)
Weight-for-height[a]		2.76 (2.9)	113. (0.8)
Weight-for-height X Peak season[a]		-1.21 (2.1)	-22.9 (0.4)
Schooling		.0208 (4.0)	.838 (1.6)
Experience		.0110 (5.0)	1.16 (5.3)
Experience^{2},[c]		-1.65 (4.2)	-186. (4.7)
Caste-1[b]		.0669 (0.4)	-26.9 (1.8)
Caste-2[b]		.0846 (0.6)	-18.1 (1.2)
Caste-3[b]		.119 (0.8)	-22.2 (1.5)
Caste-4[b]		.129 (0.9)	-6.45 (0.4)
Male[b]		.474 (17.8)	-3.52 (1.2)
Price of rice	-.109 (2.1)		-23.8 (2.3)
Price of milk	.545 (10.7)		14.5 (1.5)

Price of sorghum	-.125 (1.7)		-24.1 (1.6)
Price of pulses	-.0114 (0.5)		-5.25 (1.2)
Price of sugar	.0281 (1.7)		9.97 (3.3)
Price of bullock power	-.0077 (0.7)		2.63 (1.2)
Farm size	-.0211 (18.1)		-.462 (1.2)
% of cultivated area under superior soil[c]	0.235 (0.1)		297.14 (1.0)
Selectivity correction term $(\hat{p}-1)$[d]		-.136 (1.2)	
R-Square	0.16	0.56	0.21
F-Ratio	69.2	40.5	5.6
No. of Observations	3028	468	468

Notes: *Figures in parentheses are absolute t-statistics.
[a]Endogenous variable. See text for instruments used.
[b]Dichotomous variable.
[c]All coefficients in this row have been multiplied by 10^4.
[d]Olsen's (1980) correction procedure used. $\hat{p}$ is the predicted probability of labor market participation from the equation in the first column in the table.

season, caloric intake is not a significant determinant of wages although weight-for-height is (with an elasticity at the sample mean of 0.76). However, caloric intake has a significantly larger effect on individual wage rates in the peak than in the slack season (with an elasticity of 0.27 in the peak season), while weight-for-height has a significantly smaller effect on wages in the peak season (with an elasticity of 0.40 in the peak season). Thus the roles of nutrient intake and health status seem to be reversed in the two seasons: while caloric intake is much more important in determining wages (and therefore, we assume, marginal productivity) in the peak than in the slack season, weight-for-height appears to be more important in the slack than in the peak season. (None of the four effects are observed to be negative.) One possible explanation for this finding may lie in the nature of tasks performed in the two seasons. Thus tasks normally performed in the peak season, such as harvesting (see Table 1), may require larger amounts of human energy than slack-season tasks, but may not require innate strength (which is associated with greater weight-for-height) to the same extent as in the slack season. In fact, small size may be a distinct advantage in certain peak-season tasks like harvesting and transplanting.

Interestingly, both schooling and experience are significant (at the 5 per cent level) determinants of individual wage rates even in the context of agricultural labor activities. The returns to schooling implied by our estimates are low (about 2 per cent), however, compared to estimates obtained by other studies by urban areas and nonagricultural activities (Psacharopoulos 1982). Our estimates indicate diminishing returns to experience, with a return of less than 1 per cent for each additional year of experience at the sample mean. None of the dichotomous variables for caste is significant, while sex is by far the most significant determinant of wages (with males

earning almost 50 per cent higher wage rates than females, holding other factors constant). Finally, selectivity does not appear to be a significant determinant of wages in either season.

In contrast to the wage equation estimates, the market labor supply equations show a complete absence of significant health and nutrition effects in both seasons. This might reflect the unresponsiveness of market labor supply to the market wage rate. Alternatively, it might be the case that the impact of health and nutrition on the reservation wage are positive and roughly of the same magnitude as their impacts on the market wage.

The intercept dummy for peak season is significant in the labor supply equation, indicating a greater supply of labor in the peak than in the slack season. Experience has a positive, but diminishing, effect on labor supply. There are three price effects that are significant: two are negative (for the price of rice and of sorghum), while one is positive (for the price of sugar). Since the individuals in our sample are, on average, net buyers of sugar but net suppliers of rice and sorghum, these effects are as expected. Higher prices of goods produced on the farm imply larger reservation wages for family labor and result in greater use of family labor on the family farm and lesser supply of family labor to the casual labor market. Farm size has a similar expected negative effect on market labor supply, although the effect is not significant even at the 10 per cent level.

Tables 4 and 5 present the wage and market labor supply equations separately for male and female participants. For male participants the results remain broadly similar to those discussed above (and reported in Table 3). However, for female participants, the wage equation results are quite different. With the exception of the peak season intercept dummy, which is

Table 4. Wage and Labor Supply Equations f
Men: SAT India, 1976-78*

Independent Variable	Participation in labor market (=0,1)[b]	Log Wage Rate	No. of day worked % of total available
Intercept	-.286 (1.2)	-.316 (0.7)	143. (1.4)
Peak season[b]		.0071 (0.1)	1.83 (0.3)
Calories[a,c]		-0.044 (0.1)	-10.6 (0.2)
Calories X Peak season[a,c]		0.851 (1.5)	16.6 (0.2)
Weight-for-height[a]		2.54 (2.2)	-209. (1.2)
Weight-for-height X Peak season[a]		-.988 (1.8)	33.2 (0.4)
Schooling		.0382 (5.8)	1.0[illegible] (1.2
Experience		.0258 (6.3)	1.38 (2.6)
Experience[2,c]		-3.266 (3.8)	-262.94 (2.4)
Caste-1[b]		.344 (1.4)	-53.0 (-1.6)
Caste-2[b]		.350 (1.4)	-38.5 (1.2)
Caste-3[b]		.332 (1.3)	-49.1 (1.6)
Caste-4[b]		.284 (1.1)	-22.4 (0.7)
Price of rice	-.0309 (0.5)		-40.1 (2.5)
Price of milk	.437 (6.9)		-10.4 (0.5)
Price of sorghum	-.0874 (1.1)		1.8 (0.1

Price of pulses	-.0285 (1.0)		-18.3 (2.4)
Price of sugar	.0004 (0.0)		6.59 (0.9)
Price of bullock power	.0063 (0.5)		12.3 (3.3)
Farm size	-.0168 (11.3)		-1.18 (1.8)
% cultivated area under superior soil[c]	-0.019 (0.0)		937. (1.6)
Selectivity correction term $\hat{(p-1)}$[d]		-.143 (0.7)	
R-Square	0.14	0.36	0.18
F-Ratio	30.5	7.6	1.9
No. of observations	1545	193	193

Notes: *Figures in parentheses are absolute t-statistics.
[a]Endogenous variable. See text for instruments used.
[b]Dichotomous variable.
[c]All coefficients in this row have been multiplied by 10^4.
[d]Olsen's (1980) correction procedure used. $\hat{p}$ is the predicted probability of labor market participation from the first column in the table.

Table 5. Wage and Labor Supply Equations for Women: SAT India, 1976-78*

Independent Variable	Participation in labor market (=0,1)[b]	Log Wage Rate	No. of day worked as % of total available day
Intercept	.348 (0.9)	.621 (2.3)	1.87 (0.0)
Peak season[b]		.0597 (1.6)	10.2 (2.7)
Calories[a,c]		0.533 (0.8)	143. (1.4)
Calories X Peak season[a,c]		1.041 (1.1)	-22.3 (0.1)
Weight-for-height		-.726 (0.7)	151. (1.4)
Weight-for-height X Peak season[a]		-.383 (0.5)	-22.9 (0.2)
Schooling		.0027 (0.4)	.5 (0.7
Experience		.0022 (0.9)	.987 (3.9)
Experience[2,c]		-0.584 (1.4)	-152. (3.6)
Caste-1[b]		.0245 (0.2)	-13.4 (0.8)
Caste-2[b]		-.00274 (0.0)	-3.59 (0.2)
Caste-3[b]		.0629 (0.4)	-7.65 (0.5)
Caste-4[b]		.0650 (0.4)	5.44 (0.3)
Price of rice	-.312 (3.4)		-22.2 (1.1)
Price of milk	.601 (7.5)		28.2 (1.8)
Price of sorghum	-.279 (1.9)		-26. (1.

rice of Pulses	-.0321 (0.8)		-.177 (0.0)
Price of sugar	.0525 (2.2)		6.27 (1.9)
Price of bullock power	.0004 (0.0)		-2.62 (0.7)
Farm size	-.0240 (13.9)		-.555 (1.0)
% of cultivated area under superior soil[c]	0.206 (0.1)		110. (0.3)
Selectivity correction term $(\hat{p}-1)$[d]		-.0064 (0.1)	
R-Square	0.20	0.14	0.32
F-Ratio	46.4	3.2	6.0
No. of Observations	1483	275	275

Notes: *Figures in parentheses are absolute t-statistics.
[a]Endogenous variable. See text for instruments used.
[b]Dichotomous variable.
[c]All coefficients in this row have been multiplied by 10^4.
[d]Olsen's (1980) correction procedure used. $\hat{p}$ is the predicted probability of labor market participation from column one in the table.

significantly positive at the 10 per cent level, none of the explanatory variables in the wage equation are significant. Schooling, experience, caloric intake, and weight-for-height do not appear to matter at all in female wage determination in either the slack or the peak season.

An explanation for this result lies in the segmentation between male and female tasks observed by Ryan and Ghodake (1984) for the same sample used here. They found that, of a total of 16 agricultural operations, only two — harvesting and threshing -- used both male and female labor. Five tasks -- nursery bed raising, transplanting, planting, weeding, and thinning — were almost exclusively performed by female labor, while male labor was almost exclusively used for the remaining nine operations, four of them involving bullock power. If male labor generally performs more physically-demanding tasks than female labor, it is easy to understand why it receives a premium in wages as a result of better health and nutrition and why female labor does not receive such a premium.

Notes

[1]Many of these studies are reviewed in Behrman and Deolalikar (1986).

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INTERNATIONAL
FOOD
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INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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THE COMMERCIALIZATION OF PASTORALISTS: EFFECTS OF SEASONALITY, AGE, GENDER, AND WEALTH UPON TIME ALLOCATION

by

Jean Ensminger

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THE COMMERCIALIZATION OF PASTORALISTS: EFFECTS OF SEASONALITY, AGE, GENDER, AND WEALTH UPON TIME ALLOCATION

While much has been written about labor bottlenecks and seasonal food scarcity among small-scale agriculturalists, little is known about such stresses among pastoralists, whose economies are centered around livestock. This paper presents some findings from a study of household production and consumption among a fairly typical African pastoral group, the Orma of northeastern Kenya.

Just as an analysis of seasonally induced food shortages is crucial to an understanding of the health consequences of food intake, so to is an analysis of the fluctuations in seasonal labor activities, which may necessitate that caloric intake increase to avoid seasonal energy deficits. Similarly, analysis of the division of labor (which often varies by age, sex, and wealth), adds further to our understanding of such stresses upon catagories of individuals.

It is now well established that small-scale agricultural societies commonly experience food shortages most severely during the wet season, just when labor is also in peak demand (see in particular Bayliss-Smith 1981, Haswell 1981, and other contributors in Chambers et al 1981). A similar, if not even more pronounced stress occurs among pastoralists, but for them it is during the dry season. As is the case with most pastoralists (cf. Swift 1981:84 and Ndagala 1981:188), labor activities for

the Orma peak in the dry season, just as the availability of milk (the dietary mainstay) is at its lowest level. For pastoralists the labor crisis is brought on because of the very strenuous hand digging of wells in dry river beds and the watering of stock by bucket brigade from such wells. What is worse, with the exception of the most strenuous initial effort of digging the well at the beginning of each dry season, the effort involved in well maintenance and watering increase for the duration of the dry season as wells get deeper and more cattle return from outlying areas where the remaining standing water is exhausted. At the same time that this work is intensifying, milk yields are falling appreciably from week to week. The crisis is only broken with the dramatic beginning of the rainy season when within days the need for wells and watering cease and the milk yields increase tremendously.

The data presented in this paper raise some interesting questions concerning the health consequences and "rationality" of the socially defined division of labor within the household and village. A case could be made that given the severity of seasonal food shortages, the assignment of labor activities may be at least as crucial as the intra-household division of food resources in determining who bears the most burden of stressful periods. On a number of occasions in 1980, Orma households went days with no food or with nothing but tea and sugar. Duties associated with livestock, however, could not be neglected, causing those assigned to such tasks to run high energy deficits. Palmer (1981) has suggested that in many patriarchal

societies the division of labor puts an especially severe strain upon women. Interestingly, while it is true that Orma women over thirty work longer hours than their male counterparts during the wet season when food in plentiful, this is not the case during the most stressful periods of the year. In the dry season when food is scarcest, women's labor time actually decreases, while that of men increases sharply. Similarly, the poor households work far fewer hours during both the wet and dry seasons than their better off neighbors. This does not, however, preclude the very likely possibility that they are suffering higher energy deficits. In fact, their food intake is so much lower than that of the rich during the dry season that they almost certainly are experiencing deficits. Nevertheless, were they working intensely at the same time, their condition would be worse.

After presenting the data below, I discuss several theories which could account for these tendencies in terms of the reproductive success of the population, energy optimization at the village level, and herd management strategies.

ETHNOGRAPHIC HISTORY:
FOOD CONSUMPTION AND THE DIVISION OF LABOR

The people who are the subject of this paper are the little known Orma of Tana River district, Kenya. The Orma reside between the better known Wakamba mixed agriculturalists (living to their west

and the pastoral Somali (to the east). Like their closest linguistic relatives, the Boran, the Orma are primarily cattle pastoralists; many households also keep modest numbers of sheep and goats, but camels are totally absent.

By pastoral standards, the area which the Orma inhabit is quite lush, both in terms of average annual rainfall (approximately 477 mm) and due to the numerous river systems which flow through the area and normally flood large grazing areas twice yearly. The bimodal rainfall pattern contributes to the effectiveness of the rainfall, as does the limited sloping of land over the whole district (thereby reducing run-off). The presence of the large Tana River delta in the south adds an extra dependable resource.

Among themselves, the Orma recognize three major divisions clearly distinguishable by their ecologies, river systems, and minor cultural variations. This study focuses specifically upon the Galole Orma, who live along the seasonal Galole River, and are geographically, ecologically, and culturally the intermediate group along a north/south gradient inclined toward more rainfall, sedentarization, and integration into the cash economy. Roughly 40 percent of the Galole are settled and strongly involved in the market economy; the other 60 percent are less dependent upon the market economy, to a greater extent nomadic, and generally more self-sufficient in meeting their subsistence needs. The data presented in this paper deal exclusively with the sedentary portion of the Galole population. It should be stressed, however, that without exception the Galole are practicing

pastoralists, regardless of sedentarization.

Like most pastoralists in Africa and the Middle East, the Orma have begun marketing their livestock in large numbers, thus making the transition from subsistence milk production to commercial beef production. Such a transition has profound effects upon both labor allocation and seasonal food availability, as well as consequences for wealth distribution within the community (see Ensminger 1984a). Relative to other pastoralists in East Africa, this process is more advanced among the Orma, due primarily to their close proximity to the coastal market, where demand for beef has increased in proportion to the thriving Kenyan tourist trade. As the data in this paper come from the portion of the population which is most involved in commercial production, they probably represent the trend of the future for the rest of the Orma as well as other African pastoral groups.

Until the 1940's almost no Galole Orma were permanently settled. Most pursued a nomadic pastoral lifestyle, following the rains as necessary in pursuit of grazing for their stock. During the dry season they regularly bled their stock and consumed the blood in lieu of milk, which greatly declined during the dry season. Meat was never a large part of the diet, as partoralists strongly resisted the temptation to dip into what they quite logically perceived to be their productive capital. Interestingly, however, as has been reported for other pastoral groups (Swift 1981:85), most ritual occasions when cattle were typically slaughtered (such as weddings and rain making

ceremonies) occurred during the dry season. This pattern served the dual function of distributing meat at a time when it was most needed, and of redistributing calories among the poor within the community. During severe dry seasons the Orma also traded stock for grain with their agricultural neighbors, the Wapokomo.

Many changes in these production and consumption patterns began to occur simultaneously in the early 1940's. The major causative agents behind such change were the imposition of a colonial tax (necessitating the sale of stock to secure cash), a concerted effort on the part of the colonial government to buy stock for the war effort, a severe drought, and the presence of a resident Orma trader for the first time. It was in the early 1940's that people began to consume sweetened tea as a regular part of their diet. Consumption of maize flour also increased, but did not become a staple even in the dry season at this time.

The 1940's was also the period when the Galole Orma converted to Islam and when the village which was the subject of this study became a permanent settlement. One of the biggest changes which results from the sedentarization of a pastoral production system is the separation of livestock from the village. Once pastoralists settle, livestock rapidly overgraze the area immediately surrounding the village. Consequently, most of the livestock, even a large percentage of lactating animals, are sent to remote cattle camps where they follow the rains and grazing. Those lactating animals which do remain behind also produce far less milk as a result of the less favorable grazing conditions.

Due to the decline in milk yeilds in the sedentary villages, the exchange of cattle for purchased food gradually increased over the next several decades to the point where almost all households consumed large quantities of tea and sugar. In accordance with Islam, the consumption of blood in the dry season was also eliminated nearly everywhere except in the remote cattle camps, where they had no access to purchased food. When the great Sahelian drought of the 1970's hit the area, many more people settled permanently and began consuming maize flour as a staple during the dry season, if not throughout the entire year.

To this day, the only food commodities available in the area for purchase are sugar, maize flour, rice, and dried beans. No fresh fruits or vegetables are brought in. Of the available foods, sugar and maize flour are the staples; rice and dried beens are consumed at the midday meal in lieu of maize flour only by a few wealthy families, as they are far more expensive per calorie. As was true in the past, most ceremonies for which stock are slaughtered still occur in the dry season, and serve to redistribute calories to the poor. To some extent the traditional patterns of food redistribution from rich to poor households are also practiced, albeit more through gifts of purchased food commodities than by the loaning of milking stock.

While one might expect that increased dependence upon the market for foodstuffs would ease the seasonal instability of food availability, such was far from the case in 1990 while this survey was being carried out. Kenya was at the time experiencing a moderate drought and there were cronic national food shortages

and local food rationing among the Orma. While these shortages recurred during both the wet and dry seasons, it was during the dry seasons that they were most severely felt, both because milk yields were extremely low at that time due to the drought, and because the demands for labor at the wells were so high. Indeed, even though one of the longest food shortages occurred right after the beginning of the rains in April 1980, and both rice and maize flour were totally absent from the shops for two consecutive weeks, there was little discussion of the problem in the village. Such wet season shortages are typical even in non-drought years because the road into this area is frequently cut for as many as sex weeks at a time when seasonal rivers flood. Even in the sedentary villages, wet season milk yields are still sufficient to sustain the population without supplemental purchased food. On the other hand, during the dry season food shortages are a subject of constant concern. One of my research assistants was driven to write the following in his weekly journal during the dry season (Omar Bonea, July 18, 1980):

> People in Wayu Location in general are starving because of lack of food which is almost a week now. And most people affected are the poor people who are starving mostly. Because the whole day people are fasting Ramadhan and in the evening no food they can eat, so people gets only tea to save their life.

As these changes in the production process were evolving from 1940 to the present, the socially defined division of labor was being adapted to the new sedentary lifestyle. To meet the needs for labor in the cattle camps today, the wealthier households employ large numbers of herdsmen, who typically are unmarried young men from poorer Orma households ranging in age

from 15 to 30. Women and young girls are totally absent from the cattle camps. The increasing dependence upon cattle camps has tended to separate women more from direct involvement with livestock in the production process. For example, while among the nomads women might typically herd smaller stock on a regular basis around the compound and larger stock on occasion to relieve the usual herdsmen, they are less likely to do so in the sedentary villages both because fewer stock are kept there and because the distances needed to reach grazing are far greater and require extended absences from the compound, which may be incompatible with the duties of child rearing. Because grazing conditions are more ideal in nomadic camps, stock are also less frequently separated from the village. The traditional women's task of milking is more inclined to be performed by them, rather than by young men in the cattle camps. Overall, the trend is toward increasing domestication among sedentary women; more time is spent on house construction, fetching water and firewood, and food preparation (see Ensminger 1984b, 1985a, and 1986). Draper (1975) observed a similar phenomena among !Kung hunter/gatherers as they sedentarized.

METHODS

The research upon which this study is based was carried out over more than two and a half years of continuous residence with the survey population from July of 1978 to February 1981. During that period, sufficient observations of time allocation were

collected to allow for the analysis of the data by season, age, gender, and wealth of household. While the quantitative data reported here are only for time allocation, in future works it will be possible to compare contemporaneous data on food intake with time allocation for the same households. Preliminary findings of the food consumption data indicate two general tendencies relevant to this analysis. There is a marked decrease in caloric intake during the dry season (by as much as 50 percent), and the poorest households consume approximately half as much per person as do the wealthy. In conjunction with the discussion which follows, however, it must be noted that while overall household food intake may decline with the dry season, the relative share of food which is consumed by some individuals may go up to partially compensate them for additional energy expenditure. This was definitely the case for males involved in the particularly strenuous activities of well digging and watering cattle during the dry season. Even when milk was very scarce, wives reported keeping special gourds of curds (sour milk) for the men working at the wells.

The time allocation data presented here are drawn from a larger data set of household production and consumption records collected between December 1979 and November 1980. The data collection benefitted from the fact that I had already resided in the area for nearly a year and a half when the recurrent (panel) surveying began. A larger sample of 169 households, from which the 46 sedentary households discussed here were drawn, had already been surveyed, thus providing considerable baseline

economic and demographic information (including the age, sex and wealth data reported below). The panel surveys consisted of visits every 5 days to collect data on household time allocation, food consumption, visiting, gifts given and received, and milk yields. Every 15 days data were collected on household income and expenditures, livestock mortality, fertility and transfers. Four native speaking enumerators were employed in the surveying.

The method of measuring time allocation in this study differs from that typically employed in studies by agricultural economists, who rely primarily upon self report of time spent in labor activities. The method used here is a variation of the random visiting technique popularized by Johnson (1975). For this procedure, households were clustered into groups of five to ten, and times for visiting were systematically selected on a rotating schedule to ensure that each household was visited a representative sample of times of the day and days of the week over the course of the yearly cycle. To avoid inconvenience to households, such visits were made only between 6 A.M. and 8 P.M., thus comprising a sampling frame based on a 14 hour period. The method calls for the enumerator to arrive at the household with a list of all household residents. Upon arrival, the enumerator observes and records the activity engaged in by each member at that instant. In the case of absentees, their whereabouts and activities are elicited from those present.

Each time allocation observation can be thought of as a snapshot in time, from which, with a large sample of such snapshots, one can draw a profile of how a given individual's or

household's time is spent. Such a profile may be constructed in terms of the percentage of each day spent on a given activity, or converted to hours per day per activity.

The advantages of the observation method over the self report are many. First of all, because the observation method does not require much interaction with the respondent, it reduces the problems of respondent deceit and memory loss. Secondly, it provides more accurate accounting of activities of short duration and frequent interruption (such as most domestic tasks), which are not easily acquired in self-reports. Lastly, because it can be accomplished in minutes per household, it relieves respondent (and enumerator) boredom. A major shortcoming of both methods, however, is their failure to capture "work density" (Minge-Klevana 1980:289 and Borgerhoff Mulder and Caro 1985). This is the measure of how intensively a given individual was working at whatever he or she was doing. This is a particularly limiting factor in a study such as this, which attempts to relate labor activities to energy deficits.

The data presented below are for all individuals living in 46 households in a market village at the center of the Galole Orma. The year during which most of the data were collected (1980) was one of considerable dryness, but not drought. The short rains of November and December 1979 yielded 151.4 mm rainfall, or less than would be normal. The long rains of March and April 1980 amounted to 127.3 mm, again considerably less than would be the norm. However, because 1978 and early 1979 were particularly wet and productive years, and because neither the

short nor long rains of 1979-80 failed completely, this was not a serious drought for the Orma.

The shortage of rainfall in late 1979 and 1980 did prevent the Orma from reaping any harvest from their farms along the flood plains of the seasonal Galole River. Such failure is actually the norm, however, because the Orma average only one substantial harvest in four years; their farming enterprise can best be described as opportunistic, although it does provide a welcome supplement to the diet of poorer households for a few months of those years in which they are successful.

OPERATIONALIZATION OF VARIABLES

Seasonality is defined strictly by the use of wells versus rivers or standing water. For the period during which data are available in 1980, the dry season consists of January 25 to April 10 and May 16 to August 8. The wet season consists of December 27, 1979 to January 24, 1980 and April 11, 1980 to May 15, 1980.

Wealth is a relatively easy variable to measure among the Orma because almost all assets are accumulated in the form of livestock. The Orma are heavily cattle dependent, but do keep small numbers of sheep and goats. In order to come up with a standard unit of comparison across households, small stock (sheep and goats) were converted to cattle equivalents equal to "tropical livestock units." Following the standard convention of FAO (1967), which also happens to agree with the formula the Orma themselves apply in stock trades among species, six sheep or

goats are considered equivalent to one head of cattle. Because there is large variation in household size, it would be inappropriate to use absolute wealth of household, consequently, the wealth variable reported below is based upon wealth per capita. By this criterion, households have been divided into wealth categories as follows: the "poor" or bottom 40 percent of households, the "middle" 30 percent, and the "rich" or wealthiest 30 percent of households.

TIME ALLOCATION FINDINGS

Over the course of the observation period, over 90 distinct activities were observed across all age, gender and wealth groups. To facilitate these analyses, the data have been collapsed below into two sets of tables with twenty activity categories. Tables I and II show the distributions by season, wealth and gender and Tables III and IV by season, age and gender.

The detailed data on 20 activities indicate that there is considerable division of labor by age, gender and wealth. Comparison of the data on wet and dry seasons reveals that the amount of time spent on most activities changes little with the seasons. The main exception, of course, is the digging of wells and watering of stock, which by definition occur only in the dry season. There are also relatively few age/sex cross-overs of labor allocation between seasons, that is, a job usually done by one sex in the wet season does not transfer to another in the dry

season. One exception is the slight tendency for young girls to take on a bit more of the predominately male tasks related to herding, presumably in order to free men for the extra burdens of well digging and cattle watering. Mature women, who are relieved of some of their milking and food preparation tasks during the dry season also transfer more of the responsibility for fetching water to young girls during the dry season.

For the purposes of this analysis, the three most interesting findings from these tables are the following:

1) As summarized in Table V, the very strenuous activity of digging wells and watering livestock is picked up for the most part by men over the age of 15 and predominantly by the upper wealth categories. This is particularly significant because these activities intensify in inverse proportion to food availability.

2) Due in part to the fact that many women's activities decline in the dry season, we find that female leisure time actually increases for all but young girls. For men, however, the pattern is reversed, with almost all age and wealth categories showing less leisure time in the dry season (see Table VI).

3) In most age and gender categories, the poor work far fewer hours in both the wet and dry season. Most notably, they play a relatively insignificant role in digging wells and watering stock. While much of their inactivity is explained by the fact that they have few stock and are effectively "unemployed," this would not necessarily preclude them from being

pressed into service by the rich householders who are supplementing their food consumption. This might be especially justified in the case of well-digging, as wells are used communally by groups of four or five households for both domestic purposes and for stock.

A number of conceivable explanations could account for these findings. Given the fact that the dry season is a particularly stressful period of low food availability, it makes sense to poise the question, why does women's leisure go up, while men's leisure goes down? Theoretically, both men and women could bear the stress of this period by sharing the heavy labor involved in digging wells and watering cattle, or at least by redistributing other male tasks to women. Indeed, on rare occasions women and young girls do help out in these activities; there is no taboo against their doing so. The fact remains, however, that for some reason, women are relieved of additional work during the most stressful time of year. The same is true of all but 15 to 29 year old poor men.

Given that women bear children, one might be inclined to consider the implications of such a division of labor for reproduction. Whether couched merely in structural-functional terms (Radcliffe-Brown 1935) or sociobiological theory (Chagnon and Irons 1979), one could argue that individuals, if not the society as a whole, better ensure their reproduction by shifting teh most strenuous work furing the most stressful time of year to non-reproductive individuals. This being the case, however, it would also be consistent with such a theory to expect that

non-reproductive women take some of the work burden from women who are still reproductive (between the ages of 15 and 44). In fact, the data for 7-14 year old girls support this theory, as their leisure time declines in the dry season. As indicated above, however, most of their additional work is herding, which relieves males, not women. Furthermore, for women of post-childbearing age (45-65), just the opposite occurs. The leisure time of women over age 44 goes up far more during the dry season than does that of women of child bearing age. Were the system oriented toward shifting labor away from reproductive women during the most stressful time of year, the logical labor pool to carry out their activities would be older women who are experienced in those tasks and already so engaged. Thus, while there may be partial support for such theories, the data do not seem completely consistent.

An alternative explanation comes from focusing upon the optimization of scarce food resources, rather than upon reproductive success. Studies of human physiology indicate that more efficient use of caloric intake is achieved by bodies which rely more heavily upon fat oxidation for the generation of energy than upon glycogen depletion. Overall, those most efficient in such processing are males beyond the age of puberty and up to the age of 70 (James Hagberg, Washington University Medical School, personal communication). It has also been demonstated with marathon runners (Holloszy et al 1977), that once a body is trained, in other words, in a consistent work mode, it functions far more efficiently than does the untrained body. In other

words, there would be metabolic efficiencies involved in utilizing fewer numbers of "trained" individuals and maximizing the number of individuals in a "resting state." This theory could account both for the allocation of the stressful work to men rather than women, and for the the limited activities of the poor. The poor are in effect "turned off" during the most stressful period of the year, and calories are channelled instead into a smaller number of individuals, who do most of the work. Given that the wealthy do subsidize the caloric intake of the poor through traditional redistributive practices, and given that food is extremely scarce during some periods, it would make sense for them to maximize the use of energy through the socially defined division of labor.

It is also conceivable that another end is being served by the current behavior pattern. One might well ask why the rich don't choose to hire the poor to do the strenuous work for them, even is this would necessitate a greater caloric allocation during the dry season. To some extent this is what occurs in the remote cattle camps. It is quite possible that such a strategy would not be effective in teh permanent villages where hired lkaborers would be too easily distracted by their own households and obligations to pay meticulous attention to the needs of their employer's herds. In this respect, livestock systems differ considerably from farming systems, because the consequences of neglect can be enormous. One herder, for instance, lost half his herd of sheep and goats to wild dogs merely because he left them unattended for one hour to investigate the arrival of a landrover

in the village. Herd owners who pay personal and constant attention to their stock, even to the point of watering them themselves, may reap substantial gains by so doing, and this may be sufficient incentive to endure considerable personal hardship.

CONCLUSIONS

Comparing the current conditions of the Orma to the past, we find that sedentarization, in combinations with the transition from subsistence milk to commercial beef production, has definitely exacerbated the problem of a labor bottleneck during the period of the year when food is scarcest. It is more difficult to say that dry season food resources are now more scarce than was the case in the past, but given the decline in milk yields, abandonment of blood in the diet, and the unreliability of roads and the market, this is also very likely to be the case.

The division of labor currently in use by the Orma does not place the most severe burden upon women, as has been observed in other societies. In fact, women's leisure time increases during the most stressful months, while that of men declines. Poor householders are also not unduly stressed by excessive work during these periods, although they may well be suffering serious enegy deficits given their low caloric intake during the dry season.

While the data on the division of labor are consistent with

what one would expect if the society was attempting to maximize caloric efficiency, alternative explanations are also possible. By avoiding strenuous labor during periods of high food insecurity, women and nursing infants may enjoy higher fertility and well-being. From a purely management perspective, the existing division of labor may also contribute to a higher stock survival rate by ensuring that those with the greatest economic interests in their stock (primarily men) are most directly responsible for them.

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TABLE I

DRY SEASON: PERCENTAGE OF TIME* SPENT IN TWENTY ACTIVITIES BY GENDER AND WEALTH FOR INDIVIDUALS AGED 7 TO 64

	DRY SEASON					
	MALES			FEMALES		
	Poor	Middle	Rich	Poor	Middle	Rich
Livestock Herding						
Herding Cattle	4.8%	10.6%	6.1%	0.0%	0.6%	0.0%
Herding Calves	0.7%	2.0%	1.8%	0.5%	1.9%	0.9%
Cattle Camp	2.1%	19.3%	31.0%	0.0%	0.0%	0.0%
Herding Sheep/Goats	8.5%	8.2%	6.9%	2.6%	2.5%	0.2%
Sheep/Goat Camp	0.5%	3.5%	6.2%	0.0%	0.0%	0.0%
Building Corrals	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Dig Wells/Water Stock **	5.3%	11.8%	12.9%	1.6%	2.6%	2.3%
Other Direct Production						
Milking	0.9%	0.8%	0.5%	2.6%	5.0%	3.2%
Horticulture	0.7%	0.2%	0.1%	0.0%	0.0%	0.3%
Wage Labor	3.9%	2.7%	0.3%	0.0%	0.3%	0.0%
Professional Trader	2.5%	0.2%	1.6%	0.0%	0.0%	0.0%
School						
Government School	4.8%	8.2%	6.3%	0.0%	0.6%	0.7%
Quaranic School	1.1%	1.5%	0.6%	1.2%	0.7%	0.7%
Domestic						
House Building	0.0%	0.0%	0.0%	2.1%	1.6%	3.5%
Fetching Water	0.7%	0.3%	0.1%	10.8%	12.4%	17.8%
Gathering Firewood	0.0%	0.0%	0.0%	1.8%	1.2%	1.4%
Making Mats	0.0%	0.2%	0.0%	8.0%	7.6%	6.3%
Food Preparation	0.5%	0.2%	0.0%	4.5%	6.6%	5.8%
Other	3.9%	1.3%	1.7%	8.4%	8.8%	10.5%
Leisure and Social	59.3%	28.9%	23.9%	56.9%	47.7%	46.4%
N	437	595	1470	573	879	1081

*Based on a 14 hour day from 6 a.m. to 8 p.m.

**These figures do not include time spent watering stock in the cattle camps, which is recorded above under "cattle camps".

TABLE II

WET SEASON: PERCENTAGE OF TIME* SPENT IN TWENTY ACTIVITIES BY GENDER AND WEALTH FOR INDIVIDUALS AGED 7 TO 64

	WET SEASON					
	MALES			FEMALES		
	Poor	Middle	Rich	Poor	Middle	Rich
Livestock Herding						
Herding Cattle	4.9%	11.7%	5.0%	0.0%	0.0%	0.0%
Herding Calves	0.6%	1.3%	1.4%	0.0%	0.0%	0.0%
Cattle Camp	1.2%	16.3%	33.8%	0.5%	0.0%	0.0%
Herding Sheep/Goats	5.5%	9.6%	3.9%	1.4%	1.8%	0.0%
Sheep/Goat Camp	0.0%	4.6%	7.9%	0.0%	0.0%	0.0%
Building Corrals	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%
Dig Wells/Water Stock	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
Other Direct Production						
Milking	0.0%	0.4%	1.6%	2.3%	4.4%	8.9%
Horticulture	4.9%	4.6%	1.3%	1.4%	2.6%	0.0%
Wage Labor	0.0%	2.1%	0.2%	0.0%	0.7%	0.0%
Professional Trader	2.4%	0.4%	1.4%	0.0%	0.0%	0.0%
School						
Government School	3.1%	3.4%	1.4%	0.0%	0.0%	0.2%
Quaranic School	0.4%	2.5%	3.3%	0.0%	1.5%	1.7%
Domestic						
House Building	0.0%	0.0%	0.0%	2.8%	4.0%	2.3%
Fetching Water	3.1%	0.0%	0.8%	11.2%	11.8%	12.3%
Gathering Firewood	0.6%	0.0%	0.0%	2.3%	1.5%	2.3%
Making Mats	0.6%	0.0%	0.0%	11.7%	9.6%	7.0%
Food Preparation	0.6%	0.0%	0.2%	8.4%	8.1%	10.4%
Other	3.7%	4.6%	2.5%	7.5%	7.0%	9.2%
Leisure and Social	68.9%	38.5%	35.2%	50.5%	46.3%	45.5%
N	164	239	636	214	272	470

*Based on a 14 hour day from 6 a.m. to 8 p.m.

TABLE III

DRY SEASON: PERCENTAGE OF TIME* SPENT IN TWENTY ACTIVITIES
BY GENDER AND AGE FOR INDIVIDUALS AGED 7 TO 64

	DRY SEASON							
	MALES				FEMALES			
	Age 7-14	Age 15-29	Age 30-44	Age 45-64	Age 7-14	Age 15-29	Age 30-44	Age 45-64
Livestock Herding								
Herding Cattle	9.2%	8.5%	2.8%	0.4%	0.6%	0.0%	0.0%	0.0%
Herding Calves	4.3%	0.2%	0.5%	1.2%	0.4%	0.9%	2.3%	2.0%
Cattle Camp	4.9%	46.0%	11.8%	3.9%	0.0%	0.0%	0.0%	0.0%
Herding Sheep/Goats	16.6%	4.7%	0.8%	1.2%	3.5%	0.8%	0.3%	0.0%
Sheep/Goat Camp	4.3%	7.1%	0.3%	1.6%	0.0%	0.0%	0.0%	0.0%
Building Corrals	0.0%	0.0%	0.3%	0.0%	0.0%	0.1%	0.0%	0.0%
Dig Wells/Water Stock	3.6%	12.8%	19.1%	16.7%	3.5%	2.3%	1.3%	0.0%
Other Direct Production								
Milking	1.1%	0.6%	0.5%	0.0%	1.7%	5.2%	4.8%	0.8%
Horticulture	0.1%	0.1%	0.8%	0.4%	0.4%	0.0%	0.0%	0.0%
Wage Labor	0.0%	0.4%	7.8%	0.8%	0.0%	0.0%	0.3%	0.4%
Professional Trader	0.1%	2.0%	2.5%	1.6%	0.0%	0.0%	0.0%	0.0%
School								
Government School	16.7%	2.8%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%
Quaranic School	2.4%	0.4%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%
Domestic								
House Building	0.0%	0.0%	0.0%	0.0%	1.1%	3.0%	5.3%	1.2%
Fetching Water	0.6%	0.1%	0.3%	0.0%	7.6%	17.3%	7.5%	5.9%
Gathering Firewood	0.0%	0.0%	0.0%	0.0%	1.0%	1.6%	1.8%	1.6%
Making Mats	0.1%	0.0%	0.0%	0.0%	5.0%	9.1%	4.5%	9.5%
Food Preparation	0.1%	0.0%	0.5%	0.0%	3.5%	6.0%	10.1%	4.4%
Other	0.3%	1.1%	3.7%	9.3%	7.2%	11.0%	11.6%	6.7%
Leisure and Social	35.6%	13.4%	49.1%	63.0%	51.0%	42.8%	50.5%	67.6%
N	796	1050	399	257	721	966	398	253

*Based on a 14 hour day from 6 a.m. to 8 p.m.

TABLE IV

WET SEASON: PERCENTAGE OF TIME* SPENT IN TWENTY ACTIVITIES
BY GENDER AND AGE FOR INDIVIDUALS AGED 7 TO 64

	WET SEASON							
	MALES				FEMALES			
	Age 7-14	Age 15-29	Age 30-44	Age 45-64	Age 7-14	Age 15-29	Age 30-44	Age 45-64
Livestock Herding								
Herding Cattle	6.4%	8.7%	4.7%	1.0%	0.0%	0.0%	0.0%	0.0%
Herding Calves	3.5%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cattle Camp	3.8%	48.2%	15.3%	1.0%	0.0%	0.3%	0.0%	0.0%
Herding Sheep/Goats	14.3%	2.7%	0.0%	0.0%	2.8%	0.0%	0.0%	0.0%
Sheep/Goat Camp	7.3%	8.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%
Building Corrals	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.9%
Dig Wells/Water Stock	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other Direct Production								
Milking	1.6%	0.7%	1.8%	0.0%	1.8%	10.1%	4.4%	5.7%
Horticulture	1.9%	1.1%	6.3%	4.7%	1.4%	0.3%	1.9%	1.9%
Wage Labor	0.0%	0.2%	2.9%	0.0%	0.0%	0.0%	1.3%	0.0%
Professional Trader	0.0%	1.6%	3.5%	1.0%	0.0%	0.0%	0.0%	0.0%
School								
Government School	5.1%	1.3%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%
Quaranic School	7.6%	0.7%	0.0%	0.0%	4.2%	0.0%	0.0%	0.0%
Domestic								
House Building	0.0%	0.0%	0.0%	0.0%	1.1%	4.2%	4.4%	0.9%
Fetching Water	2.9%	0.0%	0.6%	0.0%	16.1%	11.3%	9.5%	6.6%
Gathering Firewood	0.0%	0.0%	0.6%	0.0%	1.1%	2.7%	1.9%	2.8%
Making Mats	0.0%	0.0%	0.6%	0.0%	5.6%	12.8%	6.3%	5.7%
Food Preparation	0.3%	0.0%	0.6%	0.0%	3.2%	11.1%	15.2%	10.4%
Other	0.3%	2.7%	6.5%	8.7%	5.6%	8.9%	10.1%	9.4%
Leisure and Social	45.1%	23.6%	56.5%	81.7%	57.0%	38.2%	44.9%	55.7%
TOTAL	315	450	170	104	286	406	158	106

*Based on a 14 hour day from 6 a.m. to 8 p.m.

TABLE V

DRY SEASON: PERCENTAGE OF TIME MEN RESIDENT IN THE VILLAGE* DEVOTE TO DIGGING WELLS AND WATERING STOCK BY AGE AND WEALTH

	WEALTH OF HOUSEHOLD		
	Poor	Middle	Rich
Ages 7 - 14 N=732	1.3%	5.3%	4.3%
Ages 15 - 29 N=501	6.8%	27.7%	29.9%
Ages 30 - 44 N=357	5.4%	23.0%	31.7%
Ages 45 - 64 N=247	10.2%	16.4%	29.2%
N	432	462	943

*Data on the percentage of time spent digging wells and watering stock by those resident in the cattle camps are not available. However, the only age/wealth group affected is rich 15 to 29 year olds. Poor and middle income households rarely send men to the cattle camps unless they go as hired laborers and older and younger men almost never reside in stock camps.

TABLE VI

MALES: PERCENTAGE OF TIME SPENT IN LEISURE AND SOCIAL ACTIVITIES BY WEALTH, SEASON AND AGE

	POOR			MIDDLE			RICH		
	Wet	Dry	Change	Wet	Dry	Change	Wet	Dry	Change
Ages 7 - 14	72.4	68.6	-	34.8	24.6	-	41.2	29.4	-
Ages 15 - 29	50.0	25.4	-	26.8	13.3	-	20.9	12.5	-
Ages 30 - 44	58.1	58.4	+	52.9	45.6	-	57.0	45.4	-
Ages 45 - 64	87.2	66.7	-	64.5	64.9	+	91.2	56.0	-
N	164	437		239	595		636	1470	

INTERNATIONAL
FOOD
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RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex 440054
Cable IFPRI

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A REVIEW OF THE MAGNITUDE, CAUSES, AND IMPLICATIONS OF SEASONAL PRICE VARIABILITY

by

David E. Sahn

and

Christopher Delgado

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A REVIEW OF THE MAGNITUDE, CAUSES, AND IMPLICATIONS OF SEASONAL PRICE VARIABILITY

INTRODUCTION

The purpose of this paper is to raise the most important issues concerning the seasonality of food prices, review existing literature on the subject, and present limited empirical data concerning some of the more interesting issues. The purview is limited to identifying the causes and consequences of seasonal price variability and identifying policy options for reducing these price movements and/or mitigating their negative effects.

The variation in seasonal food prices, both at the farmgate and in the retail markets, is a central factor in determining household food security. This is because food prices cut with a two-edged sword: they determine the flow and amount of income received for food crops by agricultural households, and they affect the ability to purchase food for households which participate in retail markets as consumers.

The underlying issue is to what extent seasonal price changes result in food insecurity and whether smoothing out of prices would stabilize and/or increase household food consumption. The answer is conditioned by the size, time, and predictability of seasonal price changes of staple food, and the ability of the household to adjust to these changes either through commodity substitution, adjusting timing of earnings, or inter-period savings. Thus, the problems are: (1) whether and under what circumstances seasonal price increases represent a threat to household food security; (2) what are the levels of price increases expected according to economic theory; (3) are those observed

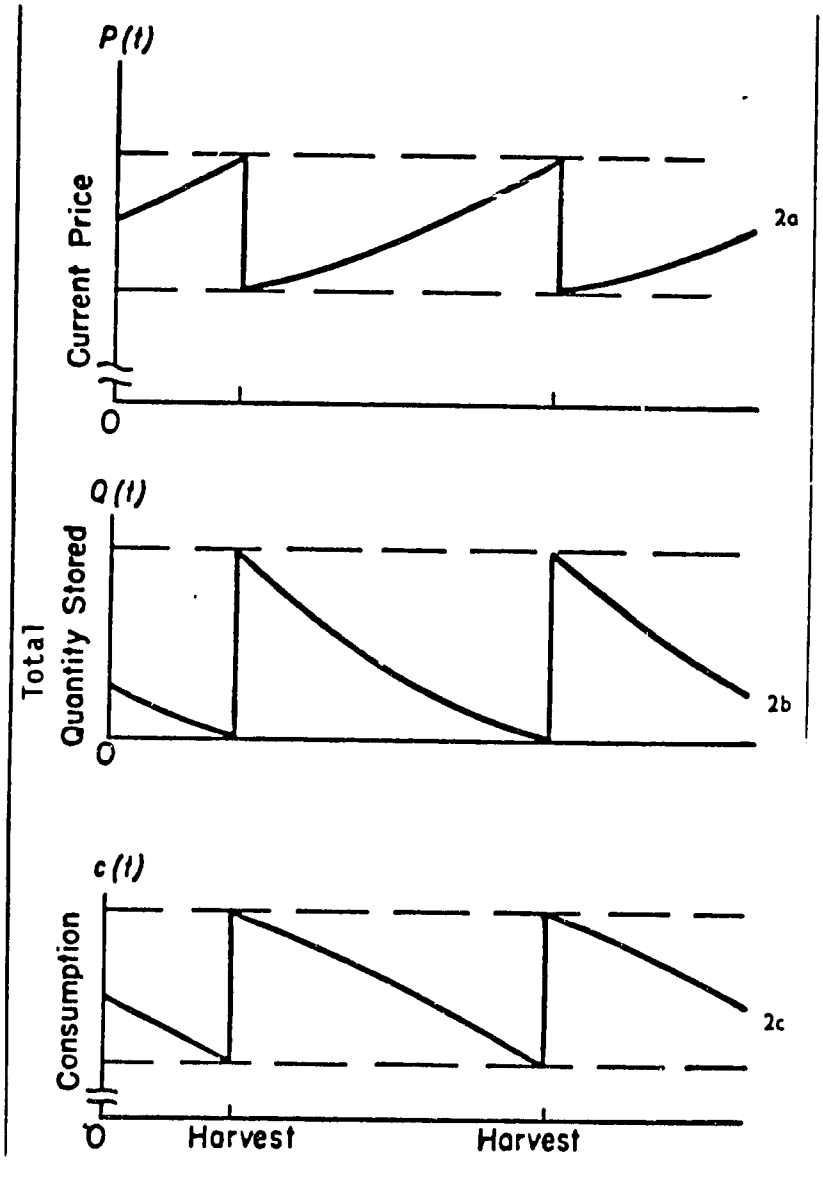
exorbitant in comparison, and if so, why; and (4) whether the price increases observed are stable from one year to the next, and if not, why.

1. ELEMENTARY MODEL OF SEASONAL PRICING

We begin with a brief theoretical discussion of the causes of the price fluctuations observed in the real world. The challenge is to develop a theory which explains the inter-temporal prices observed in markets as they relate to supply, demand, and market behavior so that policies can be formulated to either reduce or stabilize seasonal price movements.

In Figure 1, the expected seasonal relationship between prices, quantity stored, and consumption of a food crop from one harvest to the other is depicted. This highly simplified, illustrative model assumes an instantaneous harvest and a uniform demand schedule throughout the seasons. As suggested by negative price elasticities for food crops, as the price of a commodity rises, its consumption decreases. This raises the issue of the extent to which substitute commodities are available to the consumer, what are the cross-price elasticities, and are the price movements of substitute commodities pro- or counter-cyclical. If the covariation between substitutes is significant and positive, the nutritional consequences of price changes are likely to be more severe. This drives home the importance for food security of examining both the seasonality in prices of a given food and its substitutes. Figure 1 also shows that while the stock of grain reaches its pinnacle after the harvest, it decreases steadily until it reaches

Figure 1 -- Seasonal Patterns with Instantaneous Harvest[a]



[a] If positive storage is to pay, price must be rising at a rate given by transport-through-time storage costs. Anticipating the new harvest's depressing of price, storage carryover becomes zero.

zero, right before the next harvest. This movement is just the opposite for prices which increase from one harvest to the next, due primarily to the cost of storage.

It is assumed in the simplified scenario that the rate of increase in the price of commodities is equal to the costs of storage from one period to the next, plus normal profits of the traders. Storage costs include fixed costs, such as wages for permanent workers, rental value of go-downs and other physical infrastructure, taxes, and variable costs such as interest payments of borrowed capital, weight loss due to drying and infestation, insurance, variable labor costs, and variable material costs such as the depreciation of storage bags.[1] In addition, there is undoubtedly a marginal risk aversion factor which needs to be taken into account. It is a relatively straightforward accounting problem to determine real storage costs. Calculating normal profit, however, implies that the entrepreneurial and managerial functions of traders can be assigned a factor cost, and that this will include the estimation of the return for the risk they incur in their stocking activities.

One of the major issues is the extent to which observed fluctuations in seasonal prices correspond to the inter-temporal price equilibrium predicted by the costs of storage plus a "reasonable" residual represented by normal profits.

Table 1 estimates the minimum storage costs for six months of commodity storage under a variety of assumptions concerning interest

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[1] It is reasonable to assume that most marginal costs of storage are nearly fixed. The exception is when warehouse capacity is reached, thereby causing a trader to rent or purchase new space.

Table 1 -- Estimated minimum cost of storage for six months at various interest rates and rates of loss of stored product a/

Interest Rate Per Month b/	Storage Loss			
	30 percent	10 percent	5 percent	None
0	30	10	5	0
1	52	18	12	6
2	61	25	18	13
3	71	33	26	19
4	81	41	33	27
5	91	49	41	34
7	113	67	58	50

a/ Storage loss figures in column heads are percents of amount originally purchased; cost of storage figures in the body of the table are percents of the purchase value of the amounts left for sale at the end of six months.

b/ Calculations assume interest is compounded monthly.

Source: William Jones, Marketing Staple Food in Tropical Africa (Cornell University Press, 1972).

rates and losses due to pests and shrinkage. Note, this does not include a variety of other costs mentioned above such as rent, a premium for risk, and labor costs. Given that these are of secondary importance, as compared to interest charges and storage losses, the table's rough estimates are illuminating. If interest rates are three percent per month, and 10 percent of the original amount purchased is lost to drying and insects, prices can be expected to rise 33 percent in six months. Similarly, if losses are on the order of 30 percent and monthly interest charges are two percent, the expected off-season price will be 61 percent higher than only six months previously at harvest time. When the other storage costs and profits are added, these fluctuations are even higher. A 50, 60, or even 100 percent increase in off-seasonal prices is not an unthinkable prospect, even in an efficient and competitive market. With this stylized model in mind, we examine price movements for a few commodities in a handful of countries.

2. THE EXTENT, NATURE, AND STABILITY OF SEASONAL PRICE MOVEMENTS

In this section of the paper, we examine the magnitude and nature of seasonal price variability. It will not be possible here to determine the causes of seasonal price movements. Rather, some specific hypotheses will be tested, including:

1) Seasonal price variability is highly unstable from year to year.
2) Seasonal variability in prices is greater than spatial variation.

3) Marketing margins are altered by seasonality.

4) The random component of variability is greater in one season than another.

The first hypothesis will be tested using simple descriptive data on prices gathered on a number of countries as part of a large FAO price policy study presently underway. These data are available for either a single market or an average of markets in the country. In addition, we examine all four hypotheses using two more detailed and comprehensive data sets of disaggregated price data. The former are on pearl millet and white sorghum for Nigeria obtained from Hays.[1] The latter are from the ICRISAT West African Economics Program for Burkina Faso.[2] The Hays data pertain to monthly wholesale price data from Nigerian Crop and Weather reports for 15 town market centers, for the period 1958 to 1965 and 1969 to 1971. The intermediate period is missing due to the Civil War. The data cover a broad spectrum of ecological areas spread over all of the North. The ICRISAT data are weekly data for millet and sorghum for nine markets, disaggregated by type of transaction, crop, and market, over the period May 1981 to April 1985. The ICRISAT data are analyzed more fully in Reardon. Delgado, and Matlon.[3] They include observations for three major

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[1] H. M. Hays, The Marketing and Storage of Foodgrains in Northern Nigeria, Miscellaneous Paper No. 50 (Zaria: Institute of Agricultural Research, 1977).

[2] T. Reardon; C. Delgado; and P. Matlon, "Seasonal Consumption Issues in Burkina Faso," prepared for the workshop on Seasonal Causes of Household Food Insecurity, Policy Implications, and Research Needs, Annapolis, Maryland, November 1985.

[3] Reardon, Delgado, and Matlon, 1985, op. cit.

regional market centers. These are, in ascending order of annual rainfall and of centrality with respect to infrastructure: Djibo in the (Sahelian) north, Yako in the Northern Mossi Plateau (dry Savanna) and Boromo (wooded Savanna), on the tarred Ouagadougou-Bobo Dioulasso highway, toward the fertile southwest. Data is also included for one or several peripheral markets within the orbit of each regional center.

2.1 The Extent and Predictability of Seasonal Price Changes FAO Price Data

In Table 2, data are presented on the nature and extent of seasonal price variability and instability. Rather than using actual prices in this exercise, the matrix of prices was first converted into a matrix of price index numbers defined as follows:

$$(1) \quad S_{ijk} = \frac{M_{ijk}}{\sum_{i=1}^{13} M_{\alpha jk}} \times 100$$

where:

α = the prices for commodity k during month i, the six months previous to and after it.

S_{ijk} = seasonal price index for month i, in year j, for commodity k.

M_{ijk} = price in month i in year j of commodity k.

This procedure standardizes the data for comparisons across countries and reduces the inflationary component of the data.

Following the column which indicates the number of years of data analyzed, column 1 presents the maxima of the range of the seasonal increase in the price index over the years, with column 2 being the

Table 2 -- The Extent and Stability of Seasonal Price Increases, Based on the Range of Price Index Values[1]

Country	Commod.ty	Whole-Sale/ Retail	No. Years	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]	7[g]	8[h]	9[i]	10[j]	Frequency of High-Priced Month												Frequency of Low-Priced Month											
														J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Brazil	Millet	W	7	23.9	11.4	16.4	4.3	0.3	17.1	1.7	5.3	5.2	1.0	1	1	2	0	1	0	0	0	0	1	0	1	0	0	0	0	2	0	1	0	1	2	1	0
Ivory Coast	Millet	R	12	79.9	0.9	25.1	28.2	1.1	70.8	0.1	12.5	19.4	1.5	3	1	0	0	1	1	2	2	1	0	1	0	4	2	2	0	0	2	1	1	0	0	0	0
Niger	Millet	R	14	468.6	13.3	85.5	113.5	1.3	468.6	3.3	51.5	118.0	2.3	1	1	1	1	1	1	3	3	1	0	0	1	2	3	0	0	0	0	1	1	1	2	2	2
Niger	Sorghum	R		188.7	26.3	65.0	37.0	0.6	87.3	3.3	22.6	24.9	1.1																								
Brazil	Rice	W	7	48.1	9.0	19.2	13.3	0.7	24.0	0.9	6.2	7.2	1.3	3	0	0	0	0	1	0	0	0	1	0	2	0	0	2	0	0	2	0	1	1	0	1	0
Brazil	Rice	R	7	19.2	6.6	12.2	4.0	0.3	4.8	0.9	2.2	1.3	0.6	3	1	0	0	0	1	0	0	0	0	1	1	0	2	0	0	0	1	0	1	2	0	0	1
Costa Rica	Rice	R	7	24.1	1.2	6.0	7.6	1.3	24.1	0.1	4.8	8.1	1.7	2	0	0	0	0	0	1	1	0	1	1	1	1	1	0	1	0	1	0	1	1	0	1	0
Dom. Rep.	Rice	R	6	24.4	4.4	12.9	7.3	0.6	9.5	1.1	5.2	2.8	0.5	1	0	1	1	0	1	1	1	0	0	0	0	1	1	0	2	1	0	1	0	0	0	0	0
Indonesia	Rice	R	8	40.6	17.5	24.1	8.9	0.4	8.1	2.4	4.7	1.9	0.4	3	0	0	0	0	0	1	0	0	0	1	3	0	0	0	3	2	1	1	1	0	0	0	0
Ivory Coast	Rice	R	11	89.0	11.2	41.8	26.8	0.6	89.0	1.0	15.1	25.1	1.7	2	4	0	0	2	1	0	0	0	1	0	1	4	0	0	1	0	1	0	1	1	1	1	1
Korea	Rice	W	5	29.3	3.9	17.6	9.1	0.5	9.0	1.0	4.7	3.0	0.6	1	1	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	2
Niger	Rice	R	19	81.4	10.4	36.9	20.1	0.6	40.7	1.6	11.7	8.8	0.7	1	0	0	3	0	2	2	4	1	1	5	0	3	1	4	1	3	0	0	1	1	2	0	3
Philippines	Rice	W	3	11.7	7.7	9.5	1.7	0.2	3.9	2.3	2.9	0.7	0.2	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1
Philippines	Rice	R	5	56.9	3.4	16.3	20.4	1.3	11.4	1.1	3.6	3.9	1.1																								
Sierra Leone	Rice	R	15	96.0	11.8	46.6	26.0	0.6	48.0	4.7	12.2	10.4	0.9	1	0	0	0	1	3	1	1	4	2	1	1	1	3	5	3	0	0	0	0	0	0	2	1
Tunisia	Rice	R	8	6.9	0.5	4.8	2.7	0.6	6.9	0.1	1.8	2.3	1.3	4	1	0	0	0	1	0	1	0	0	0	1	2	1	0	0	0	1	2	0	0	0	0	2
Costa Rica	Maize	R	5	32.5	3.7	14.1	10.7	0.8	5.4	0.8	3.1	1.7	0.5	1	0	0	0	0	1	0	0	1	0	0	2	1	0	2	0	0	0	1	0	0	0	0	1
Dom. Rep.	Maize	W	12	98.7	29.9	53.8	17.6	0.3	32.9	5.3	13.1	7.0	0.5	1	0	0	1	4	4	0	1	0	0	0	1	0	2	0	0	0	0	0	0	3	3	3	1
Indonesia	Maize	R	8	46.1	15.1	26.3	11.0	0.4	11.8	1.6	5.3	3.3	0.6	3	0	0	0	0	0	0	0	0	3	2	0	0	0	1	0	5	1	0	1	0	0	0	0
Ivory Coast	Maize	R	12	96.0	4.6	33.0	27.2	0.8	48.0	0.4	14.9	13.9	0.9	4	0	1	0	2	1	1	2	0	0	1	0	5	0	2	0	1	1	1	0	0	0	1	1
Banyladesh	Wheat	W	10	216.6	21.0	79.7	58.6	0.7	54.1	2.1	19.1	17.9	0.9	2	2	0	0	0	3	3	0	0	0	0	0	1	0	1	1	0	0	1	1	0	0	1	4
Brazil	Wheat Fl.	R	8	30.0	7.4	15.8	8.1	0.5	5.0	1.4	2.8	1.3	0.5	1	0	0	0	1	0	1	0	0	0	0	4	2	0	0	1	0	2	0	1	0	0	0	2
Ivory Coast	Wheat Fl.	R	11	27.8	0.3	7.3	8.0	1.1	27.8	0.1	4.5	8.5	1.9	7	0	0	0	0	2	0	1	1	0	0	0	3	0	2	1	2	0	0	1	0	0	0	2
Philippines	Wheat Fl.	W	14	48.9	0.1	15.5	15.8	1.0	33.3	0.02	7.4	10.3	1.4	2	0	2	0	0	0	1	2	1	0	0	6	3	0	0	0	2	1	0	3	0	1	3	1
Tunisia	Wheat Fl.	W	8	17.4	2.5	9.6	6.1	0.6	2.5	0.2	1.4	0.9	0.7	7	0	0	0	1	0	0	0	0	0	0	0	4	1	0	0	0	0	1	0	0	0	0	2
Tunisia	Wheat Fl.	R	5	10.7	5.8	8.3	2.5	0.3	10.7	1.0	5.9	4.9	0.8	3	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	1
Brazil	Sugar	R		111.9	4.3	27.1	34.9	1.3	55.9	0.7	10.3	18.7	1.8																								
Costa Rica	Sugar	R	7	27.8	-	10.1	11.8	1.2	27.8	-	6.0	9.8	1.6	1	0	1	0	0	0	1	3	0	0	0	1	1	1	0	1	2	0	0	0	0	0	0	2
Indonesia	Sugar	R	7	40.4	1.9	10.5	11.7	1.1	20.2	0.7	3.9	6.3	1.6	4	0	0	0	0	0	0	0	0	0	1	2	3	1	0	0	0	0	0	0	0	2	1	0
Ivory Coast	Sugar	R	11	34.1	0.1	9.4	12.5	1.3	34.1	0.1	7.3	13.4	1.8	8	0	0	1	0	0	0	0	0	0	1	1	5	1	0	0	1	0	3	0	0	1	0	0
Sudan	Sugar	R	10	40.4	-	14.6	13.2	0.9	13.8	-	3.4	4.2	1.2	6	0	0	0	0	1	0	1	0	0	0	2	2	1	0	2	0	0	2	0	0	0	0	3
Tunisia	Sugar	W		17.4	2.5	9.6	6.1	0.6	2.5	0.2	1.4	0.9	0.7	8	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	1	0	0	0	0	1

1 The range of price index is defined as follows: $\left(\frac{\text{Max}\ (S_{ijk}) - \text{Min}\ (S_{ijk})}{\text{Min}\ (S_{ijk})} \times 100\right)$.

a Maxima of the range over j years.
b Minima of the range over j years.
c Average of the range over j years.
d SD of the range over j years.
e Coefficient of variation of the range over j years.
f-j Corresponds to a through e, except that each is divided by the number of months between Max (S_{ijk}) and Min (S_{ijk}).

corresponding minima. In these two columns, one can see how much difference there is in the range of seasonal price indexes during the years for which data are available. In column 3, the mean value for the range of seasonal increases in the price index over the years is presented. The next two columns are the standard deviation and coefficient of variations of the range of increase of the seasonal price index over the year for which data are available. Columns 6 through 10 correspond to 1 through 5 with the exception that they are rates of price increase per month, rather than absolute levels of increase over the calendar year.

Finally, the distribution of the number of months corresponding to the annual price index of maxima and minima, respectively, is presented. Unlike the other columns which illustrate the instability in the range of seasonal price increases, this tells the frequency of maxima/minima prices occurring in a given month.

The data suggest four general findings. First, the average range of seasonal index values indicate that prices increase rapidly during the year. Second, the range of maxima and minima and the high variances indicate that there is considerable instability in the amount of seasonal price increase that occurs from year to year. Third, the distribution of the months of maxima and minima over years suggests that it is difficult to predict the month of the seasonal high/low price. This implies that consumers, sellers, and storers of foodgrains all face considerable uncertainty as to when the high or low price will occur. This obviously makes it difficult for the consumer to budget and adjust expenditures to cope with seasonal fluctuations, for the

producer to know when it is to his advantage to sell his crop, as well as for the trader to engage in temporal arbitrage. Fourth, averaging the seasonal price increase over a number of years will obscure the fact that the actual seasonal price increases will be much greater/lesser in any given year. Fifth, given the variability in the price index maxima and minima from one year to the next, the number of interceding months between the maxima and minima is quite unpredictable.

2.2 The Extent and Predictability of Seasonal Price Spreads: The Burkina Faso and Nigeria Cases

The more detailed data from Nigeria and Burkina Faso allow us to take a detailed look at the extent and predictability of seasonal price spreads in an area of the world where the seasonal effects on economic life are as large as anywhere and food security is an immediate and pressing concern.

Since both rainfall and agricultural labor input are concentrated in a single season (primarily June to August on the savanna belt of West Africa), it might be expected that annual price series would be characterized by unimodal maxima and minima. Yet this is not always the case. In Northern Nigeria, out of a total of 330 annual price series examined for both crops, 15 percent had multiple maxima and 13 percent had multiple minima. In unimodal years, the seasonal high price is usually observed in July, with a large variance around this mode. In bimodal years, maxima are typically seen in April and August. As can be seen in Table 3, there is also considerable variation in the

Table 3 — Seasonal Maxima and Minima in 330 Annual Price Series for Northern Nigeria
(January = Month 1, etc...)

	Mean of Max. Month	St. Dev. of Max. Month	% of Annual Series	Mean of Min. Month	St. Dev. of Min. Month	% of Annual Series
SINGLE MODE						
Maxima and Minima						
Millet	6.917	2.86	42%	7.869	3.135	47%
Sorghum	7.558	2.493	46%	6.331	4.246	41%
DOUBLE MODE						
Maxima and Minima						
First Mode						
Millet	4.313	2.304	7%	4.409	3.534	3%
Sorghum	4.500	2.838	6%	3.22	2.367	8%
Second Mode						
Millet	8.617	2.536		10.000	1.692	
Sorghum	8.921	2.318		9.940	2.590	

Source: Calculated from data for 15 markets, 11 years, and two crops in the Appendix to Hays. Months are numbered from one to twelve.

lowest price month. For millet the average seasonal low (in August) follows hard on the heels of the average seasonal high in July.

The seasonal price swings for semi-arid West Africa are typically very large. Table 4 shows that the average in the Nigeria data set was 75 percent for millet and 68 percent for sorghum, over an 11-year period. However, these figures include an element of annual inflation, although typically only 3 to 4 months' worth, since that is the average duration between annual highs and lows. There is also considerable varition in the magnitude of percentage seasonal price spreads. From the data in the table, it would appear that this variation is greater over years than across locations; this will need to await a more formal model for statistical confirmation.

Although not shown, the 1981 to 1984 seasonal price spreads in Burkina Faso were of the same order of magnitude, frequently in excess of 100 percent, especially in 1983, a very bad drought year. The data on price maxima and minima in Nigeria suggest that speculating on the timing of these phenomena carries a non-negligible degree of risk. This will be shown more fully in the next section, with the aid of a formal definition of seasonality.

2.2.1 The Magnitude of Pure Seasonal Price Effects

Variation in foodgrain prices can be analyzed in a fashion to capture the covariance of different items of relevance (or dimensions) to foodgrain prices. A data set covering c crops, v types of transactions, i markets, j years, and t time periods would have a maximum of c x v x i x j x t observations. The subscript t could stand for weeks,

Table 4 — Average Seasonal Spreads Between Annual Low and High Grain Prices in 15 Markets of Northern Nigeria: 1958-65, 1969-71
(In Percent of Seasonal Low Price Unless Otherwise Indicated)

	(I) Variation across years of yearly average across markets		(II) Variation across markets of market average across years	
	Millet	Sorghum	Millet	Sorghum
Mean price spread	75	68	75	68
Coefficient of variation (%)	20	25	15	16
Maximum price spread by year (I)	104	101	99	91
Year (I) or market (II) of maximum spread	1969	1969	DAUDAWA	DAUDAWA
Coefficient of variation of price spreads within year (I) or market (II) exhibiting maximum average spread (%)	44	36	51	63
Minimum price spread by year (I) or market (II)	56	48	56	52
Year (I) or market (II) of minimum spread	1961	1960	POTISKUM	AZARE
Coefficient of variation of price spreads within year (I) or market (II) exhibiting minimum average spread (%)	35	39	37	43

months, or seasons. The data could be regressed against an intercept term and (c-1) + (v-1) + (i-1) + (j-1) + (t-1) one-zero dummy variables used to capture the mean effects of each dimension, considered simultaneously.

Given that seasonal variation (pertaining to dimension t) is of primary interest, a simpler procedure, more economical in degrees of freedom, would be to define a variance components model, such that:

$$P_{cvijt} = M + q_c + u_v + w_i + x_j + y_t + z_{cvijt}$$

where:

M = is the mean price of food in the sample;

q = is the deviation from the mean attributable to intercrop differences;

u = is the deviation attributable to different kinds of transactions (retail prices, producer prices, etc.);

w = is the deviation applicable to different markets;

x = is the year effect;

y = is the pure seasonal effect to be analyzed; and

z = is the stochastic interaction term among all the elements.

The effect y_t is a "pure" effect because it is an average for season t over the entire sample, with other constant sources of variation accounted for. To isolate the Y effects, the separate means for each group defined by a given set of subscripts cvij are subtracted from the corresponding raw data, yielding:

$$P_{cvijt} - P_{cvij\cdot} = P^*_{cvijt} = y_t + z_{cvijt}$$

where dot notation denotes a mean.

This exercise was performed separately for the data from Nigeria and Burkina Faso. The P^* data were then regressed against monthly dummy variables to get direct estimates of the y effects by month, both separately by market and pooled over markets.[1] These effects are shown in Table 5, where they have been divided by the mean price of the applicable grain in the sample to give the effects in percentage terms.

The interpretation of the figures in Table 5 would be that the expected value of price fall for millet from July to September in Northern Nigeria, for example, is 33 percent, other things equal. The early millet harvest in Nigeria occurs in August, whereas millet in Burkina Faso is typically harvested in November.

The relatively low adjusted R^2 figures for the estimating equations in Table 4 suggest that the constant monthly factors explain only from 15 to 25 percent of the variation in foodgrain prices, <u>after all other constant effects are netted out</u>. Indeed, regressions on dummy variables for all constant effects of the raw price data for Burkina Faso show that these effects as a whole (market, year, month, etc.) explain on average 70 to 75 percent of the variation in foodgrain prices.

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[1] It is probable that heteroscedasticity is present in the error vector of the pooled data, since foodgrain prices probably have different variances in different locations, years, and (as we shall see) seasons. The $\hat{y}$ may nevertheless be unbiased estimates of the true y; however, caution should be exercised in analyzing the variance of the z or in interpreting "significance" ratios. The discussion in text of percentage of variation explained by the regressions, as measured by R^2, should be taken as indicative of orders of magnitude.

Table 5 — Pure Seasonal Price Effects in Semi-Arid West Africa
(to nearest percent of corresponding mean price in sample)

	Average of 15 markets over 1958 to 1965 and 1969 to 1971, Northern Nigeria (market town monthly wholesale prices)			Average of 9 markets, May 1981 to April 1985, Burkina Faso (weekly rural retail prices)		
	Pearl Millet	White Sorghum	Both crops	Pearl Millet	White Sorghum	Both Crops
Jan.	- 4	-10	- 7	-13	-12	-12
Feb.	- 2	- 9	- 6	-14	-12	-13
Mar.	- 3	- 9	- 6	- 4	- 4	- 4
Apr.	0+	- 5	- 2	- 2	6	2
May	5	1	3	2	- 9	- 3
Jun.	15	13	14	8	4	6
Jul.	17	15	16	9	3	6
Aug.	7	11	9	13	11	12
Sep.	-16	2	- 7	15	12	14
Oct.	-12	4	- 4	10	9	9
Nov.	- 5	- 5	- 5	- 6	- 4	- 5
Dec.	- 2	- 8	- 5	- 9	- 8	- 9
Adjusted R^2	0.26	0.23	0.20	0.19	0.16	0.18

Source: Entries are from regressions of prices with means for each transaction type, crop, year, and market removed, ran against monthly dummy variables, with the estimated coefficients normalized by the appropriate sample-wide means. Price data sources are Hays for Nigeria and the ICRISAT West Africa Economics Program for Burkina Faso.

Thus, on average, pure seasonal effects for millet and sorghum in Burkina Faso over the May 1981 to April 1985 period account for an order of magnitude of 5 percent of total seasonal price variation for these grains (15 to 25 percent times 25 to 30 percent). A market agent who could have predicted with perfect accuracy all other constant effects (yearly inflation, transaction types, differentials for specific markets, etc.) would still only be able to account for roughly two-thirds of variation in prices. Knowledge of constant seasonal effects would only help deal with a fifth of the remaining one-third. Given this appreciable variation of actual seasonal outcomes around predicted outcomes in our simple model, the question arises as to the predictability of seasonal effects across markets, years, and crops.

2.2.2 The Predictability of Seasonal Price Effects

The chosen method for assessing the predictability of pure seasonal effects is to test for the stability of the regression coefficients in the variance components model, across markets and across years. The analysis below and in Table 6 is for Northern Nigeria, but similar results were obtained for the Burkina Faso data.

The test involved estimating seasonal effects separately for each market, using temporal price variation. The data is then pooled across markets and F-tests performed for the stability of the coefficients (i.e., whether the monthly coefficients can reasonably be supposed to be equal in different markets). Similarly, series for the different markets can be combined to estimate seasonal effects sepa-

rately for each year, and the results pooled to test for stability of seasonal effects over years. The analysis below abstracts from a number of interesting econometric problems.[1] The objective is to indicate useful future areas of research.

The results are shown in Table 6. They show that in every case it is possible to reject the null hypothesis of stable monthly coefficients: across years, across markets, and even across crops in the Nigeria sample. Informally speaking, it seems clear that it is much harder to pool seasonal price effects over years than across markets, as is to be expected. The above all suggests important differences in the seasonality of prices stemming from interactions between constant seasonal effects and the other constant effects. Specifically, the basic relationship of the constant effects to each other appears to change over the sample time period. Most likely this involves interactions between constant location effects and years. The obvious candidate would be changes in the structure of production outcomes among locations in different years. Other possibilities would be new infrastructure created during the sample period, or change in the distribution of traders over markets, and so forth. Further work

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[1] A similar problem to that outlined in the various footnote arises here. It is further compounded by the attempt at using computed variances for testing. A further problem is that if the series should not be pooled (the null hypothesis of equality of coefficient rejected), the tests themselves are ipso facto invalid because the pooled variance will be biased (see C. Delgado, "A Variance Components Approach to Foodgrains Market Integration in Northern Nigeria," forthcoming (a)). Nevertheless, it is felt that the exercise is a useful indication of what would be obtained using more sophisticated methods.

Table 6 -- Analysis of Seasonal Covariance in Northern Nigeria
(F-Statistics for H_0: Equality of Monthly Dummy Coefficients*)

	Millet	Sorghum	Pooling across Crops
Pooling across markets	$f(168,1800) = 1.17$ Reject H_0 at 10%	$f(168m1800) = 1.28$ Reject H_0 at 5%	$f(348,3600) = 1.98$ Reject H_0 at 1%
Pooling across years	$f(120,1848) = 4.90$ Reject H_0 at 1%	$f(120m1848) = 5.57$ Reject H_0 at 1%	$f(252,3600) = 6.28$ Reject H_0 at 1%

* H_0: $B_{ik} = B_k$ for all markets (years) i and months k

Source: See text for methodology. Raw monthly wholesale price data for 15 markets in the period 1958-1965 and 1969-1971, published by Hays.

would involve specifically testing these hypotheses with numerical explanatory variables.

In sum, actual seasonal price variation is not easily forecastable from previous experience or experience in other markets nearby. Variation in the magnitude of seasonal price spreads and the timing of optimal sales and purchases are hard to predict due to high variability. Furthermore, even successful predictions are likely to be overshadowed by other sources of variability, such as annual production outcome.

2.2.3 Rural-Urban Differences in Seasonal Price Effects

If rural areas show significant differences in the seasonality of foodgrain prices, it is to be expected that differences between rural and urban areas will be even greater. It is to be expected that urban price seasonality will be of lesser magnitude, for five reasons. First, urban markets are more likely to be well integrated with a number of rural markets, each with slightly different agricultural cycles. This distribution of supply peaks throughout a country can reduce the need for storage in urban areas. Second, urban dwellers may be more accepting of a variety of foodstuffs. They may, therefore, display greater tendencies to substitute between commodities, thereby reducing swings in prices as demand is dampened. Third, merchants in urban areas are likely to be greater in number and efficiency and, therefore, more likely to arbitrage over time and do so at a lower cost Fourth, much thinner markets may exist in more remote regions, thereby leading to extreme shortages and more precipitous increases in off-seasonal

prices. Fifth, food imports to smooth out seasonal gaps in supply typically pass first to urban, then to rural areas. The same may be true of food aid, especially in drought years when rural price seasonality is greatest.

2.2.4 Seasonal Differences in the Homogeneity of Seasonal Price Effects Across Markets

In rural areas especially, it is possible that seasonal price patterns are different in one season, but not another. An example would be the case where dry season price rises occur predictably and uniformly across years and markets, but rainy season price behavior is erratic.

Testing for seasonal differences in homogeneity of seasonal price patterns across rural markets was done in great detail in Delgado[1] for weekly producer price data for millet and sorghum covering the period August 1976 to March 1978 for 22 villages in Northern Nigeria. A variance components model similar to the one discussed above was fitted[2] for each market, and tests conducted for homogeneity of seasonal effects across villages, separately within each major season. The latter were defined as two major six-month periods: August to January (the harvest season) and February to July (the post-harvest season).

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[1] Delgado, forthcoming (a), op. cit.

[2] Except that seasonal effects were estimated by fitting polynominal trends to $(y_t + z_{cijt})$, instead of dummy variables, due to the short time period represented by a single season.

The results show that while it is not possible to reject the null hypothesis of equality of seasonal effects in the post-harvest season at 10 percent, it is universally possible to do so in the two harvest seasons modelled. In other words, it is reasonable to assume that seasonal effects (separately for each crop) are the same across villages in the post-harvest season, but different across villages in the harvest season.

Differences in the homogeneity of seasonal price effects across markets that vary by season are especially interesting from the policy standpoint, since they are indicative of seasonal differences in market integration. If seasonal price effects are equal in two markets, allowing for other constant effects, it may be either that the markets are integrated or that prices behave separately but equally in the two markets. On the other hand, if seasonal price effects are different between two markets, other things being equal, it would appear that they are not well integrated.[1] Further research should then focus on why seasonal differences in foodgrain market integration occurs.

2.2.5 Conclusions from the West African Case Studies

Briefly, several conclusions emerge from the Nigerian and Burkina Faso case studies:

1) Nominal seasonal price spreads for grain in semi-arid West Africa are important, averaging from 60 to 100 percent in the samples considered.

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[1] Delgado, forthcoming (a), op. cit.

2) Yet the predictable, constant seasonal price effects suggest spreads of less than half this magnitude. The difference is attributable to annual and locational effects and their interaction.

3) Generally, it is a risky business to be a temporal grain speculator in West Africa. There is high variation in the timing of seasonal highs and lows over years.

4) Seasonal effects also vary substantially over markets, although on closer examination this in itself is primarily a seasonal phenomenon. Thus, it may be easier to predict seasonal price behavior in some seasons than others, especially on a month-to-month (a fortiori week-to-week) basis.

5) Similarly, it is probable that the price integration of markets varies across seasons.

3. THE RULE OF IMPERFECT MARKETS IN DETERMINING SEASONAL PRICE INCREASES

Given the magnitude and instability of seasonal price increases, there is a need to explain more fully the causes. Therefore, below we provide some theoretical background which will allow one to make normative judgments about the functioning of food markets based on prices actually observed. This will facilitate determining when, and delineating what policies are required to avoid any deleterious effects of seasonal price fluctuations on household food insecurity. A central hypothesis in the literature is that these unstable seasonal patterns are attributable to "evil traders" exploiting the vulnerable consumer and producer. We shall review the evidence on this and then

in the next section offer an alternative, the anticipatory price model which is predicated on inaccurate expectations causing seemingly random fluctuations in the pattern of seasonal prices.

It is often contended that traders exploit farmers by purchasing the agricultural commodities directly at the harvest period when prices are low. Households are vulnerable to such practices because they are in need of capital or do not have adequate on-farm storage capacity. Concurrently, it is argued that exploitative traders drive commodity prices up through collusion.[1] Thus, consumers faces inordinately high prices in the pre-harvest season, further imperilling their nutritional well-being.

Taken to the extreme, the poor performance of foodgrain markets can contribute to the gradual disaccumulation of wealth. The farmer is forced to sell off assets to pay back creditors and to make up for low profits which accompany depressed prices. The loss of such assets further erodes the potential earnings of the household. When the next planting season arrives, even more must be borrowed; or when the next harvest arrives, a larger share of the reduced-size crop must be sold off for cash at low post-harvest prices. A downward spiral of disaccumulation is fueled by each succeeding seasonal cycle. The spectre of low price distress sales to oligopsonist traders and/or precipitous price increases in the lean season are part of a larger non-competitive market structure that allows merchants engaged in temporal arbitrage to reap large profits.

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[1] See, for example, Frank Ellis, "Report on the West African Grain Stabilization Project," USAID,May 1972 (mimeographed).

3.1 Results from the Literature on Imperfect Grain Markets

There have been a number of studies which explore market efficiency in terms of storage costs versus the seasonal increase in prices. Lele[1] examined whether there are competitive markets in India. The correspondence between the seasonal price increase with the costs of storage plus normal profits was determined. The data from Table 7 point out the large variability in the gross rate of margin on the investment of traders. In four out of the 10 years, traders apparently took a loss, even in terms of their variable costs, let along the fixed overhead of staying in business. In four years, however, profits are extremely high. There is an overall reasonable 11.7 percent gross rate of margin on investment, which would be lower if fixed costs were taken into account.

These data intimate that it is not reasonable to draw conclusions concerning the efficiency of markets based on one or two years of data. Rather, one must look at a series of years to determine the average profit to storage. The India data also suggest that there was a problem of incorrect anticipations of supplies during most of the 10 years for which data are presented. Undoubtedly, traders would not have operated at a loss in four of those years if their knowledge was better. Likewise, farmers would have delayed their sales of grains if they would have anticipated the steep price rises of 1958/59 and 1964/65. This last point of how farmers, like traders, confront great

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[1] Uma Lele, Foodgrain Marketing in India, Private Performance and Public Policy (Ithaca, N.Y.: Cornell University Press, 1971), pp. 119-178.

Table 7 -- Estimated gross margin of margin from wheat storage, Moga, 1955-56 to 1965-66

Year	Gross margin per quintal	Gross rate of margin on investment
	(Rs)a/	percent b/
1955-56	8.45	27.79
1956-57	4.34	11.10
1957-58	-5.40	-11.54
1958-59	17.89	44.95
1959-60	-1.79	-4.02
1960-61	-0.58	-1.35
1961-62	1.63	3.89
1962-63	1.83	4.34
1963-64	14.35	33.32
1964-65	13.52	27.17
1965-66	-3.94	-6.65
Average	4.75	11.7

a/ Average for January-March period. The gross margin per quintal is the difference between the actual price and estimated variable costs of storing a quintal of wheat until the off-season.

b/ Average for January-March period; estimated by taking the gross margin per quintal as a percentage of the cost of storage including the initial price of the grain.

Source: Lele, 1971, op. cit.

uncertainty in terms of seasonal price movements also serves as an explanation for heavy market arrivals after the harvest. Some have used such data as evidence of distress sales, collusion of merchants, and the limited holding capacity of farmers. However, the alternative explanation implicit in their behavior is that it may be attributable to avoiding the risks of monumental losses that holding grain portends in intermittent years. Traders may be better equipped and skilled both in terms of their ability to defray risk and perform market reconnaissance than farmers.

Another study in what was formerly East Pakistan[1] and Nigeria[2] examined the extent to which the costs to storage corresponded to the seasonal rise in prices. They make the point that market arrivals are staged, often over a period of months. Thus, the intra-year timing of purchases and sales determines profits and losses, not the total off-seasonal price rise. Without these data, incorrect conclusions concerning the level of profits may be reached.

For example, the estimated costs to storage are compared to the actual price increases from 15 local markets in Nigeria (see Table 8 for millet data). In most markets for both sorghum and millet, the actual average increase in prices over the entire season exceeded those costs of storage. However, in other markets, traders would take a loss. One can also see that the extent to which the seasonal price

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[1] Mohammad Osman Farruk, Structure and Performance of the Rice Marketing System in East Pakistan, Cornell International Agricultural Development Bulletin 23 (Ithaca, New York, 1972).

[2] H. M. Hayes and J. H. McCoy, "FoodgrainMarketing in Northern Nigeria: Spatial and Temporal Performance," Journal of Development Studies, Vol. 14, No. 2, pp. 182-192.

Table 8 - Net Seasonal Rice in Millet Price Expressed as a Percentage Greater (or Less Than) Than Expected Price, 1960-70 and 1970-71[a]

Market	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar	April	May	June	July	Aug.	Av.
					1969-70							*year*	
Katsina	–	11	13	15	3	2	–4	–5	–3	20	–4	–11	4·1
Kafin-soli	–	2	2	0	10	8	6	4	2	0	–2	–15	1·5
Daudawa	–	10	16	13	30	28	25	37	20	14	29	–5	19·7
Sokoto	–	–2	–4	–6	14	18	32	14	12	9	7	5	9·0
Gusau	–	—	–5	7	15	26	23	20	18	24	29	16	17·3
Kano	–	50	–4	–6	–5	4	–4	–6	–7	8	–7	0	2·1
Gumel	–	—	19	8	5	36	104	86	25	3	42	38	36·6
Damburta	–	86	80	61	56	58	54	87	70	83	73	114	26·7
Birnin Kudu	–	–3	–26	1	5	36	2	–20	–3	25	5	17	3·4
Azare	–	6	21	17	15	12	17	14	19	24	28	18	17·4
Potiskum	–	14	12	10	7	19	16	14	12	7	30	22	14·8
Maiduguri	–	5	–10	–17	–50	–21	–30	0	–2	–7	–5	–11	–13·4
Dawra	–	17	9	20	31	19	–5	1	7	5	11	0	10·5
Birnin Kebbi	–	–2	13	9	8	2	38	35	33	51	100	37	29·5
Zaria	–	–2	8	–6	4	2	0	7	5	3	1	–1	1·9
					1970-71								
Katsina	–	40	47	43	20	18	9	9	11	37	19	2	23·2
Kafin-soli	–	30	37	43	40	36	55	62	68	64	95	44	52·2
Daudawa	–	–2	–21	–23	–9	0	10	18	161	88	32	30	25·8
Sokoto	–	29	–4	0	21	34	32	29	39	39	36	34	26·3
Gusau	–	0	–3	–2	6	10	8	13	11	9	24	40	10·5
Kano	–	–2	–9	–8	–10	–1	–3	19	17	–8	0	–1	–5
Gumel	–	–3	5	2	33	30	27	24	21	48	45	38	24·5
Damburta	–	—	–3	19	39	72	41	85	85	127	102	97	66·4
Birnin Kudu	–	30	44	49	46	47	9	6	0	–13	3	1	20·2
Azare	–	–2	–5	0	–2	–5	–4	–3	–1	1	3	1	–1·5
Potiskum	–	—	–4	0	–6	–8	–4	–8	1	–1	0	7	–2·3
Maiduguri	–	–2	–11	–19	–60	–25	–37	–58	–34	–28	–23	–13	–28·2
Dawra	–	—	13	22	14	12	14	9	17	42	43	25	21·1
Birnin Kebbi	–	–2	1	7	–8	–10	–11	11	14	7	2	–1	9
Zaria	–	—	8	5	–6	–2	2	–6	–11	5	16	14	2·5

[a] Crop year begins with September.

rise is greater than that expected on the basis of storage is determined by the timing of sales. Furthermore, evidence of the continuous grain flow from the farm to urban storers, the fact that most farmers in the areas of Nigeria being studied store most of what they produce and had access to a number of market outlets, on-farm grain stores were adequate in capacity and quality, and there was no evidence of sales being tied to the need to pay back credit, are not characteristic of a system of monopoly control.

A variety of other studies have set out to examine whether price increases were excessive in comparison with costs of storage. For example, Ejiga[1] determined average cowpea prices for each month over a 15-year period to determine seasonal price indexes.[2] He found that the number of years in which there is a profit from storage only slightly exceeds years in which there is a loss. Although, on the average, the mean storage costs are only around one-half to one-third of the mean price difference. Similarly, other evidence from Africa concerning seasonal price increases is found in the studies done in the six capital cities in the Sahel. The seasonal price increases which ranged from 25 percent in Bamako and N'djamena to 45 percent in Niamey make it hard to see how traders could even make a profit, let alone windfalls from speculation.

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[1] Nathaniel Ejiga, "Economic Analysis of Storage, Distribution and Consumption of Cowpeas in Northern Nigeria," Ph.D. thesis, Cornell University, 1977, pp. 271-313.

[2] These were calculated by expressing the monthly price as a percentage of the average price.

A study by Southworth et al.[1] in Ghana concluded that merchants are not exploiting farmers and consumers through making purchases at lower prices and accumulating stocks to obtain a return in the excess of the cost of storage. Similarly, the possibility of farmers colluding to raise prices is dismissed.

Waterbury[2] discusses the basis for the model of the improvident Senegalese peasant being exploited by oligopsonistic traders and money lenders. In reflecting upon the conflicting evidence, it is concluded that there still remains some circumstantial evidence that structural problems result in farmers resorting to distress sales and facing great hardships during the hungry season. However, the need for further study is evident.

In addition to the evidence from South Asia and Africa cited above, other studies from Southeast Asia tend to support the argument that traders, in general, are not the exploitative agents responsible for off-season price increases.[3,4]

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[1] Ray Southworth; Williams Jones; and Scott R. Pearson, "Food Crop Marketing in Atebubu District, Ghana," Food Research Institute Studies, Vol. XVII, No. 2, 1979.

[2] John Waterbury,

[3] Leon Mears, The New Rice Economy of Indonesia (Yogyakarta, Indonesia: Gadjah Mada University Press, 1981).

[4] Leon Mears, Rice Economy of the Philippines (Quezon City, Philippines: University of the Philippine Press, 1974).

3.2 Results from the West African Case Studies With Respect to the Causes of Instability in Seasonal Price Increases

The most obvious explanation of seasonal differences in foodgrain market integration in West Africa is the difficulty of communications with outlying areas during the rainy season. This is undoubtedly a major factor in many locations. Yet the example in the previous section showed that in one case, at least, market integration was worse in the harvest season, the majority of which lies outside the rainy season. Possible explanations of this are differing mixes by villages of old and new grain being sold at this time, leading to apparently different price levels in different villages, whereas in fact different commodity bundles are involved.[1] Another possibility is that farmers in different locations have different immediate cash needs once the new harvest is in, leading, in the absence of credit markets, to different incentives to sell. Still other possible explanations are the presence of different types of market action in different seasons, and different volume and individual size of transactions.[2]

These issues will be investigated further in the paper for this conference by Ellsworth and Shapiro.[3] It is also worth noting here some results from the ICRISAT price data for Burkina Faso.[4] These

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[1] Delgado, forthcoming (a), op. cit.

[2] Ibid.

[3] L. Ellsworth and K. Shapiro, "Seasonality in Burkina Faso Grain Marketing: Farmer Strategies and Government Policy," prepared for the workshop on Seasonal Causes of Household Food Insecurity, Policy Implications and Research Needs, Annapolis, Maryland, 1985.

[4] Reardon, Delgado, and Matlon, op. cit.

concern: the volume of transactions by season as measured from enumerator success in obtaining price information by transaction; seasonal variation in retail-wholesale price spreads within a given market; and seasonal variation in retail price spreads between markets.

Seasonal differences in grain sales behavior by farmers could explain seasonal differences in market integration defined operationally as similar temporal price movements within seasons. The evidence on this is mixed. Work by Hays in Northern Nigeria in 1970-71 shows that net farm sales were evenly distributed between the harvest and post-harvest season as defined above.[1] A similar result pertains to the samples considered for Northern Nigeria in 1976/77 by Delgado.[2] Yet work by Sherman in the Mossi plateau of Burkina Faso in 1978/79 shows a noticeable concentration of farm grain sales in the harvest season.[3]

The ICRISAT data on farm sales is not currently available for analysis. However, enumerators in the 1981/85 price survey were instructed to obtain observations, if possible, on various types of retail and wholesale grain transactions. While weekly data for certain transactions may be missing for certain months in the sample for reasons other than absence of these transactions, there is probably a high correlation between the distribution over time of the type of

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[1] Hayes, 1977, op. cit.

[2] C. Delgado, "Foodgrain Market Integration in Northern Nigeria: Implications for Subregional Equity Concerns," ICRISAT, forthcoming (b).

[3] J. Sherman, "
Ph.D. dissertation, University of Michigan, 1983.

transactions recorded and the distribution over time of the type of transactions taking place.

Analysis of the frequency of distribution of price data in the ICRISAT sample by transaction type strongly suggests that whereas retail grain sales by "market ladies" account for a large share of the rural retail grain trade in the harvest season from September to January, they play a much lesser role in the post-harvest season thereafter. This is probably due both to a decrease in retail sales activity at that time and to a greater relative importance of grain traders per se in retail marketing at that time. Thus market actors may be different in different seasons.

Another explanation for seasonal difference in market integration that has been suggested is that traders seek to lower the grain market during the time of scarcity of grain in the post-harvest season.[1] Yet analysis presented in Reardon, Delgado, and Matlon[2] strongly belies this hypothesis. Regression analysis of the differences in traders' buying and selling prices for grain for a given week in a given market against dummy variables for crop, market actor, year, location, and season were performed. Although there was a tendency for intra-market spreads to be lower in the rainy season and higher in the hot season (the two three-month components of the post-harvest season), these deviations from the overall average spread were not statistically

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[1] B. Harris, "There is Method in My Madness: Or Is It Vice Versa? Measuring Agricultural Market Performance," Food Research Institute Studies 2, XVII, 1980.

[2] Reardon, Delgado, and Matlon, op. cit.

significant. Thus traders' margins, as a group, within a given village, were not higher in one season compared to another.

Another argument might be that the net direction of trade changes seasonally, leading to differences in market integration as defined above.[1] This was tested by regressing differences in retail prices for grain in a given week between pair of markets against dummy variables for the various constant effects.[2] In this case, at least one season was quite significant in explaining differences in absolute margins between markets. Rainy season margins were on average more than 10 CFA/kg higher than mean margins ceteris paribus across the sample of paired villages considered. Yet when it is considered that this is less than fifteen percent of the overall mean price of grain in the sample and that rainy season seasonal price effects are at least as large as this, it can be seen that traders' percentage inter-village margins were probably lower in the rainy season. This hypothesis has in fact been supported by similar regressions with percentage spreads as the dependent variable. Furthermore, the rainy season is a time when traders' costs are likely to be higher. While the latter may shed light on why there tend to be less grain traders active in the rainy season, it also suggests that they are not responsible for the high price season price rises observed.

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[1] For an example of how a change in market direction affects the seasonality of prices, see C. Peter Timmer, "A Model ofRice Marketing Margins in Indonesia," Food Research Institute Studies, Vol. XIII, No. 2, 1974, pp. 145-167.

[2] Reardon, Delgado, and Matlon, op. cit.

3.3 Conclusions on the Role of Imperfect Markets in Determining Seasonal Price Patterns

Three major lessons emerge from the review of the literature on competitiveness of markets. First, any analysis of seasonal price data must conform to the following conditions: data must cover a number of years; more than one market location should be used as the basis for judgments; account must be made of the timing of sales and purchases; the costs to storage including a risk premium must be taken into account. Examining and assuring the efficiency of commodity markets should also be complemented by a similar analysis of capital markets. Together, they determine whether the farmer receives and consumer faces a fair price.

Second, much of the individual country data support the conclusions that "private marketing (in Africa) is generally competitive and affords farmers a rather high share of the consumer's dollar which assure supplies to urban areas at reasonable prices" (p. 117).[1] Traditional markets appear to be functioning effectively and stereotypes of oligopolistic tendencies causing and benefiting from dramatic seasonal price increases are wrong.[2] The tendency to infer that traders are reaping abnormal profits in general emanates from problems both in the data and assumptions made in the analysis as discussed above. Therefore, there is a need to determine on a country by country basis the

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[1] William O. Jones, 1984, pp. 113-125.

[2] See Uma Lele, op. cit., pp. 500-505; Carl K. Eicher and D. C. Baker, Research on Agricultural Development in Sub-Saharan Africa: A Critical Survey, MSU International Development Paper (East Lansing: Michigan State University, 1982).

extent to which markets are competitive in order to formulate policy options to smooth out price variability or reduce its instability.

While the evidence of competitive commodity markets has been discussed, and the absence of competition is shown to be a poor explanation for the instability of seasonal pricing for one year to the next, there is a need to consider other theoretical explanation for such price patterns.

Two sets of conclusions emerge from the detailed case studies of price patterns in West Africa. First, it does not appear that this stems from anti-competitive trade behavior. Rther, it is probably the unattractiveness of doing business at this time that accounts for a seasonal fall in the number of traders active. Second, further research to explain the seasonal variation of foodgrain prices in West Africa across locations and years should focus on quantifying the interaction effects between locations and years. It should also seek to measure seasonal differences in market activity that would account for seasonal interactions with both locations and years.

4. ANTICIPATORY PRICE MODEL

It is important to consider in greater detail the theoretical basis for the instability observed in off-seasonal price increases. Thereafter, we can identify policy options to deal with both the magnitude and instability of seasonal price changes.

An assumption underlying the elementary model discussed above is that in competitive markets, the price rise from post- to pre-harvest will be determined by the cost of storage in a typical year. This may

be true if one averages monthly price over 10 or 15 years. However, in any given year, this is unlikely to be the case. The picture of erratic behavior in seasonal prices from year to year requires an explanation so that appropriate policies can be formulated.

The basic idea is that if markets are competitive, and there are a large number of producers and traders, seasonal prices will be determined by the intersection of the supply and demand curves at a given point in time. This simple construct does not account for the fact that these conditions are determined by expectations regarding future shifts in the supply and demand schedules. Unlike determining a spatial equilibrium where the farmer or trader can predict the costs of marketing in one market versus the other, it is not quite so easy to foresee the total size of the present harvest and that of the future crop, or the amount of imports/exports and government intervention through open market operations. Although the economics of inter-temporal price equilibrium, where information and expectations are perfect, is analogous to spatial equilibrium, the former is considerably more complex due to the difficulty of predicting the future.

A theory of inter-temporal price formation must take into account uncertainty as to what the future will bring. Such a framework was developed by Working[1] and expanded upon by Bouis[2] and Goldman.[3] Its

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[1] Holbrook Working, "A Theory of Anticipatory Prices," American Economic Review, Vol. XLVIII, No. 2, 1958.

[2] Howarth Bouis, "Seasonal Rice Price Variation in the Philippines: Measuring the Effect of Government Intervention," Food Research Institute Studies, Vol. XIX, No. 1, 1983, pp. 81-92.

major contribution is that seasonal fluctuations in prices are not attributable only to actual supply and demand forces bringing about an equilibrium, which implies a price, to which the storage costs are added over time. Rather, since the supply and demand conditions in the future are not known with certainty, and they are the subject of constant revision during the year, prices fluctuate in response to changing anticipations of, rather than actual, supply and demand forces.

4.1 Supporting Evidence for Anticipatory Price Theory

There has been a limited amount of research to support empirically the theory of anticipatory price formation discussed above. This is partially explained by the dearth of good seasonal price series, as well as the problems inherent in quantifying expectations and changes therein.

One attempt to try to understand the causes of instability in the seasonal variations in prices from year to year is the work done by Lele[1] in India. It was thus concluded that:

> "Arrivals and crop size thus generally serve as poor explanations of the year-to-year variability in the pattern or extent of seasonality in the prices of the three major cereals (p. 172).

Another study by Bouis[2] in the Philippines provides some of the

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[3] Richard Goldman, "Seasonal Rice Prices in Indonesia, 1953-69: An Anticipatory Price Analysis," Food Research Institute Studies, Vol. XIII, No. 2, 1974, pp. 100-162.

[1] Uma Lele, Foodgrain Marketing in India, Private Performance and Public Policy (Ithaca, N.Y.: Cornell University Press, 1971): 172.

[2] Howarth Bouis, op. cit., 1983.

best empirical evidence in support of the anticipatory price model and illustrates the role of trade policy in effecting seasonal price changes. Data on the seasonal increase in retail rice prices is presented in Table 10. These were as high as 78 percent in 1973 and actually declined in other years.

The instability in the seasonal price changes is attributed to the government's ineffective and erratic management of buffer stocks and imports, and not monopolistic behavior of traders. Government intervention in markets seemed to have aggravated the problem of instability in seasonal price fluctuations be creating less certainty as to supplies of rice. This made for more drastic and more frequent adjustments in expectations by traders who not only had to form expectations for yields but anticipate the unpredictable level and timing of imports and market operations. Recently, there has been an increase in irrigated land which raises output in the dry season. This, coupled with the fact that the Philippines is approaching self-sufficiency, has reduced the role of government imports in stabilizing supplies and perforce, the level of seasonal price variability.

A similar attempt to examine the determinants of seasonal price fluctuations in the Philippines indicated that the difference between the actual and expected production, minus the change in government stocks and the quantity of rice purchased and sold by the government in a given year will determine seasonal price hikes. The smaller the deviation from unexpected supply, the less the price fluctuations; and

Table 9 -- Philippine Rice Imports by Month, 1961 to 1973
(thousand tons of milled rice)

	Month												
	J	F	M	A	M	J	J	A	S	O	N	D	Total
1961						9	41	34	71	32			187
1962													0
1963						16	24	60	29	43	80	5	257
1964					24	37	66	74	21	78			300
1965			27	73	68	75	105	94	85	9	34		570
1966							8	27	46	27			108
1967			16	19	15	57	58	71	44	13			293
1968													0
1969													0
1970													0
1971				2		22	14	61	23	64	118	64	368
1972	57	22	54	36	58	54	40	50	26	16	16	29	458
1973	12	14	8	5	10	12	39	67	63	41	26	9	306
Total	69	36	105	135	175	282	395	538	408	323	274	107	2,847

Source: Bouis, 1983, op. cit. Monthly distribution of imports in 1961 from Sri-on Sonboonsup and Delane E. Welsch, 1975, Thai Rice Export Data, 1955-1972, Department of Agricultural Economics, Kasetsart University, Bangkok, Thailand; total imports in 1961 and all data for 1962 through 1971 from Leon A. Mears, Meliza Agabin, Teresa Anden, and Rosalinda Marquez, 1974, Rice Economy of the Philippines, University of the Philippines Press, Quezon City, Philippines; for 1972 and 1973 from the National Food Authority.

the greater the government intervention, the less the seasonal price increases.[1]

In a study from Indonesia, Goldman[2] tested the anticipatory price hypothesis, focusing on the uncertainty created by the volatile dry season rice crop, as well as the maize crop and stabilization operations. Unlike the experience in the Philippines, the production instability, rather than uncertainty connected with imports, buffer stock operations or marketplace inefficiencies, contributes mostly to the irregular pattern of seasonal rice prices.

Evidence in Bangladesh also suggests that anticipations concerning supply and demand determine off-seasonal price increases.[3] The greater the levels of rice production and ration distribution, the more the supply exceeds expectations and the lower the seasonal price increases. Conversely, the higher the value of jute production, a good proxy for producer liquidity and earnings, the more the demand exceeds that normally expected, and the greater the seasonal price increases.

4.2 Implications of the Anticipatory Model for Policy Making

The above discussion has implications for identifying policy options to reduce the size and variability in seasonal price increases.

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[1] Unnevehr L. J., "The Effect and Cost of Philippine Government Intervention in Rice Markets," Working Paper No. 9, Rice Policies in Southeast Asia Project, IFPRI, International Fertilizer Development Center and IRRI, p. 21.

[2] Richard Goldman, 1974, op. cit.

[3] Raisuddin Ahmed, Foodgrain Supply, Distribution, and Consumption Policies Within a Dual Pricing Mechanism: A Case Study of Bangladesh, Research Report 8 (Washington, D.C.: International Food Policy Research Institute, 1979).

First, the anticipatory price model emphasizes the role of government in collecting and disseminating reliable information. Instability in intra-year variability in prices stems from uncertainty as to the size of the next period harvest. To the extent that government agricultural information systems can improve crop forecasting, and thereafter government disseminates that information, the uncertainty will be reduced. Doing so will allow traders, farmers, and consumers to adjust their sales and purchases in the face of greater knowledge and more accurate expectations. This will reduce the number and magnitude of adjustments in commodity prices. Off-seasonal price increases will more closely match the costs of storage.

A second and related outcome of improved crop forecasting and information dissemination would be reduced risk involved in storing commodities. If storers were more certain of the extent of off-seasonal price increases in a given year, the probability of taking tremendous losses which may deplete their working capital is reduced. By lowering risk, there will be a commensurate decline in the costs to storage.

The third point relates to the fact that different patterns of seasonal production directly impinge on the magnitude of intra-year price changes as well as their predictability. The simplest case is a unimodal climate without irrigation and only one crop per year. Due to the large storage costs from one year's post-harvest to the next year's pre-harvest period, there is little storage-related connection between the two harvests. Therefore, the model would predict that there should

be a relatively steady price increase from the surplus to deficit season, although the magnitude of this increase should be quite high.

In contrast, consider the situation where there is a wet and dry season crop. The latter is more subject to the vagaries of the short rains and irrigation. While the overall increase in prices during the year may be less, the unpredictability of the second harvest coupled with the fact that the wet and dry season markets are storage-related, raises the potential for greater variability in price increases from one year to the other. The second harvest, therefore, may increase uncertainty and add further instability into seasonal pricing.

Fourth, implicit in all the points above is the connection between intra-year and inter-year supply and demand instability. The extent to which there are major year-to-year fluctuations will condition seasonal price changes. If the former could be smoothed out, seasonal price increases would still exist. However, they would be more predictable and of an overall smaller magnitude than is witnessed presently.

5. GOVERNMENT INTERVENTION TO SMOOTH SEASONAL FLUCTUATIONS

In this section of the paper, we examine the role of government in addressing seasonal price variability. Two important distinctions must be made in terms of the purpose of such efforts. The first concerns that governments may seek to simply reduce the level of uncertainty about seasonal price increases without reducing the average price rise expected on the basis of storage costs and normal profits. The goal may be to stabilize the inter-year variability in off-seasonal price increases so that they more closely reflect storage costs. The

alternative is to reduce seasonal price movements below a level which is attributable to the costs of storage and normal profits.

The second distinction is between government achieving either of these objectives through direct versus indirect intervention. The former involves active intervention in markets as a buyer and seller of foodgrains. The latter, indirect approach recognizes that there are imperfections which can be remedied by promoting certain conditions which will have an effect on market performance, and thus prices, without direct involvement in procurement and sales of commodities.

We begin by discussing the role of government interventions directly in commodity markets. This is followed by a discussion of alternatives which employ indirect methods of market intervention.

5.1 Direct Government Intervention to Reduce Price Spreads

When markets are competitive, the increase in off-season prices is commensurate with the real resource costs. Reducing seasonal price spreads will have true economic costs. These will take the form of a subsidy: the government can pay traders to reduce off-seasonal prices; or alternatively, the government can directly subsidize consumers by entering the grain markets as a buyer and seller. In this latter case, the state marketing agency can purchase grain in the season of plenty, driving up prices. The grain procured can thereafter be sold during the lean season at a price lower than the resource costs to storage. In such a case, the average annual price for the commodity is the same without intervention, when inter-temporal prices approximately reflect

storage costs. The implicit subsidy borne by the Treasury, however, is a result of reducing the variations around the mean.

In order to understand the costs which the government will incur in any effort to intervene in commodity markets to stabilize prices, and the relationship of such a policy to the activities of private traders, refer to Figure 2. It depicts the supply and demand curves for marketing services. The demand for these services arises from both producers and consumers of a commodity; the private traders are the producers who supply the service. Before government intervention in inter-temporal markets, the price spread between Period 1 and Period 2 (where the former equals the post-harvest period and the latter the pre-harvest period) is determined by the costs of storage plus normal profits. It equals M*. Government can decide that this spread is too high. If it chooses to limit the margin to M_1, for example, it must purchase $Q_1 - Q_2$. Private traders will only handle Q_2. Less efficient storers are squeezed out of the marketplace. The costs involved in this intervention may also be shown in the figure. The implicit subsidy borne by the government equals AFGC. To the extent that government marketing activities are more efficient than those of private traders, this subsidy is reduced.

Thus, in an environment where government intervenes to stabilize prices over and above that provided by traders, this will undoubtedly reduce the incentives to arbitragers. The inevitable result is that government's role in the market will increase beyond original expectations. This can be illustrated by realizing that the quantity of inter-temporal arbitrage is a function of the difference in the

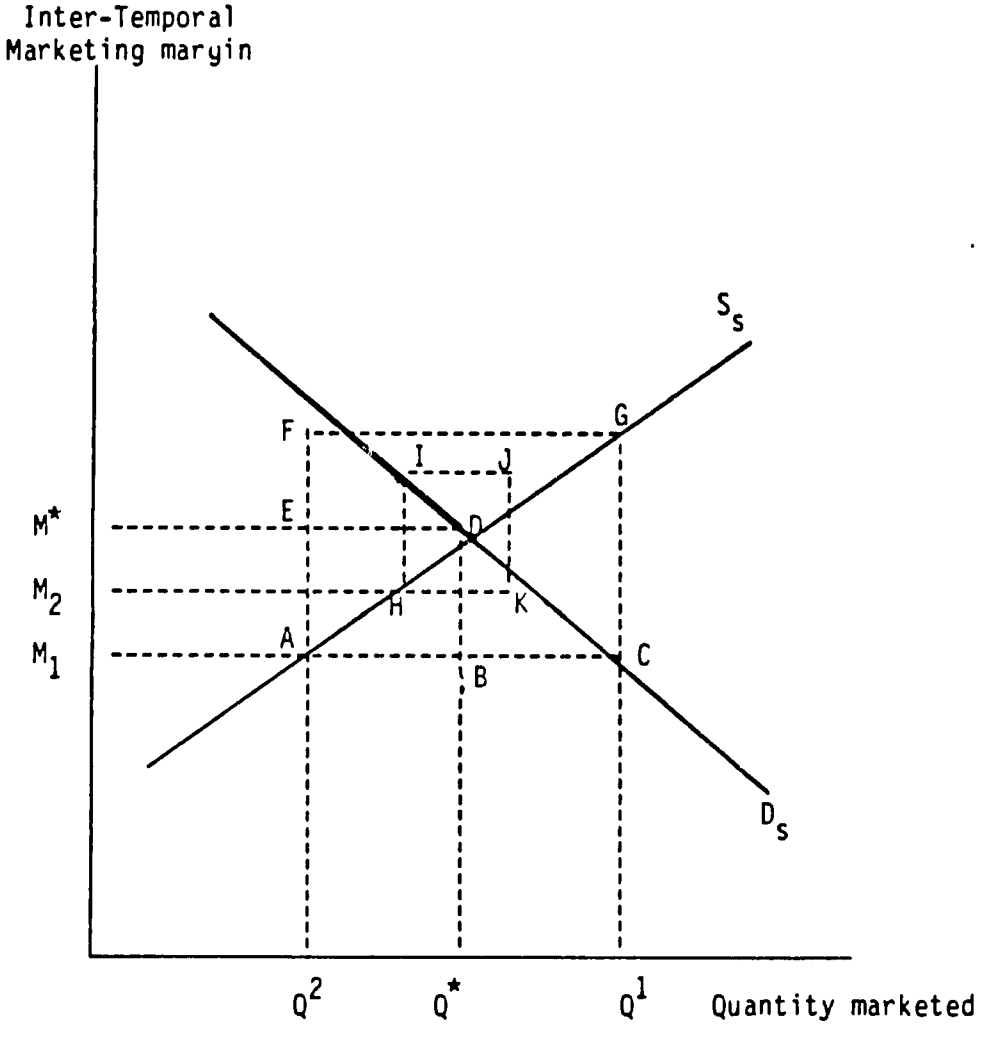

Fig. 2. The effect of government intervention to reduce inter-temporal marketing margins.

purchase and sale price of a commodity. If government intervenes in the market by storing and subsequently releasing stocks, thereby reducing the dispersion in prices between the two periods, the response of private traders will be to reduce their storage. The government grain authority will then have to store not only the amount originally estimated to maintain the desired price spread but also the amount by which the private sector reduces their activities as well.

The issue of whether there is a one to one trade-off between government stockpiling and the reduction in the storage of private traders remains an area in need of further empirical investigation. Theoretically, under competitive private storage trade, there will be a complete substitution between private and public trade. However, this is not the case if there are imperfections in private storage trade.[1]

In any event, if government is committed to and capable of adhering to a storage rule which involves complete seasonal stabilization of prices, it will eventually reduce greatly or eliminate private storage activity. This will prove an expensive enterprise, especially since marginal costs to price stabilization increase as one moves toward complete stabilization. The more efficient storers are squeezed out of the market as the seasonal price spread becomes less and less, and the cost per ton of smoothing out prices will rise. This can also be illustrated in Figure 2 by noting that the implicit subsidy of a

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[1] See Alexander H. Sarris, Commodity-Price Theory and Public Stabilization Stocks," in Food Security: Theory, Policy, and Perspective from Asia and the Pacific Rim, ed. by Anthony H. Chesk and Rodney Tyers (Lexington, Mass: Lexington Books, 1982), pp. 105-128.

stabilization scheme that reduces the seasonal price spread to M_2 is HIJK. This area is considerably smaller than AFGC - HIJK, which represents the marginal cost of reducing the seasonal price spread by $M_1 - M_2$ which equals $M_2 - M^*$. Therefore, a major factor which will determine the costs to seasonal stabilization is the rate the government allows prices to rise during different seasons of the year.

As intimated above, the cost of stabilization results from the government purchasing food crops directly after harvest, driving up prices, and then selling later in the year at a price lower than that which would include storage costs. In addition, as a result of producer prices being driven up by procurement operations, a response in terms of marketed supply can be expected. Given that the elasticity of marketable supply is positive, farmers will market a larger share of their output than without a stabilization program. Thus, the higher the marketed supply response, the more grain to be handled by the government. This leads to higher costs of seasonal stabilization than anticipated solely on the basis of current levels of marketing.

While the government may find the costs of seasonal stabilization acceptable, there may be problems raising the capital for such policies. If, for any reason, government is not willing or able to support the floor price (or ceiling) that it has set, the consequences may be serious. To illustrate, note in Figure 3 that in the absence of government procurement, the price received by a farmer is P^*. Now, let it be assumed that in order to reduce seasonal price differences it is determined that the price after the harvest must be raised to P_1. This would demand that the government purchase $Q_1 - Q_2$. However, if

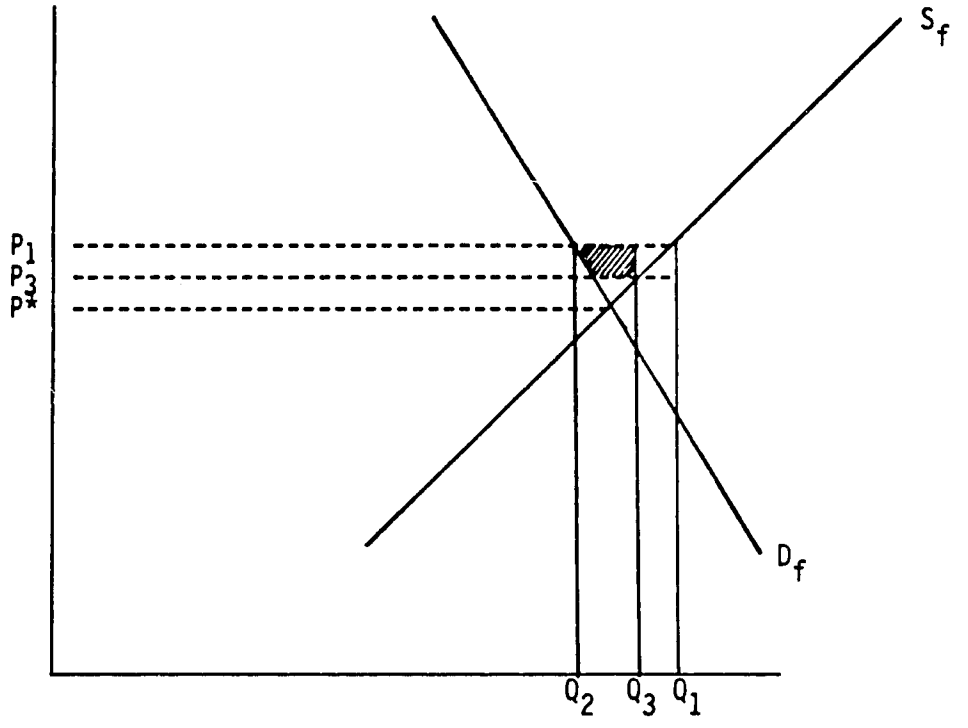

Figure 3. The effect of inadequate intervention on producer prices.

they only procure $Q_3 - Q_2$ due to logistical difficulties or budgetary constraints, the market price will be P_3 while the official government price will be P_1.

Implicit in such a situation is a form of rationing for the opportunity to sell at the floor price. The question then becomes which farmers get closed out of the opportunity to receive the government price.

One may hypothesize that it is the small farmer who does not have access to grain procurement agencies. In a similar vein, it is the small farmer who is most likely to suffer the consequences of low harvest-time prices. Their ability to store grain is probably less; they are also more likely to be in need of cash, making them more vulnerable to exploitation. Seasonal stabilization will likely have negative distributional impacts if rationing does indeed occur.

The budgetary costs to government intervention to smooth out seasonal price increases can be calculated most simply as follows:

$$(1) \qquad C = Q\,(N_i - S_i)\,P_h$$

where:

C = total government subsidy

Q = quantity of grain procured

N_i = normal storage costs including interest, depreciation, etc. for i months

S_i = actual seasonal price increase for i month

P_h = harvest season price

There are a few examples where data permit actually estimating these costs. In the Philippines, Unnevehr[1] calculated the implicit cost of the subsidy required to smooth out seasonal prices, and expenditures on stabilization activities. A regression model was employed to estimate the total amount of government procurement required to eliminate seasonal price increases. The results indicate that eliminating seasonal price increases would have required that a considerably greater quantity of cereal grains be procured by the government than was the case. In 1980/81,for example, the price tag would have been ₱183.2, rather than ₱ 95 actually spent (see Table 10).

In a similar study, Siamwalla[2] has estimated the cost incurred in Indonesia in attempting to smooth out seasonal fluctuations. In Table 11, the implicit subsidy borne by the treasury to reduce off-seasonal prices is shown. In columns (1) and (2), theactual prices and the estimated prices without government intervention, respectively, are shown for the year 1979/80. The third column presents the difference. When the value is positive, the government is purchasing rice at a price higher than that which producers would be getting otherwise. There is an implicit subsidy to farmers. When the value is negative, the government is selling rice at a subsidized price to consumers.

The fourth column indicates the net stocking activities of BULOG. Once again, a positive number indicates the amount of rice being

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[1] Laurian Unnevehr, "The Hidden Costs of Philippine Government Intervention in Rice Markets" (Los Banos: International Rice Research Institute), mimeographed.

[2] Ammar Siamwalla, "Public Stock Management and Its Implications for Prices and Supply," prepared for IFPRI workshop on Food and Agricultural Policy, 1984, pp. 9-12.

Table 10. Estimated Cost of the Marketing Subsidy, 1973/74 to 1980/81

Crop Year	Loss a/ (₱/ton)	Government b/ Intervention (000 tons rice)	Actual Marketing Subsidy c/ (million ₱)	Estimated NFA Profits d/ (million ₱)	To Eliminate Seasonal Price Increases: Government Intervention e/ (000 tons rice)	Marketing Subsidy f/ (million ₱)
1973/74	65.3	22.0	1.4	51.2	284.[illegible]	59.9
1974/75	96.0	95.9	9.2	-0.5	404.9	91.4
1975/76	74.6	163.9	12.2	4.9	375.2	102.8
1976/77	32.6	198.8	6.5	15.5	465.5	127.6
1977/78	20.8	136.7	2.9	11.7	534.5	138.3
1978/79	22.7	74.7	1.7	6.2	560.9	158.1
1979/80	248.3	268.2	66.6	-24.2	416.2	141.2
1980/81	373.5	250.1	95.3	-45.4	467.8	183.2

Source: Unnevehr, op. cit.

a/ The difference between the normal price increase (26.1%) needed to cover cost of eight months storage and the actual seasonal price increase, multiplied times the actual price/ton in November.

b/ The amount of rice both procured and distributed within the crop year.

c/ Loss times the intervention quantity.

d/ The difference between the actual seasonal price increase and 15.6% (6% interest and 10% losses over 8 months) is multiplied times the actual price in November to obtain the profit per unit stored. This is multiplied times the intervention quantity to obtain total profits.

e/ The quantity the government must buy and sell within the crop year in order to eliminate the seasonal price increase. This is estimated from the model in Table 8.

f/ The normal price increase (26.1%) is multiplied times the actual price in November to obtain the loss per unit stored, and this is multiplied times the estimated intervention quantity necessary to eliminate the seasonal price rise.

Table 11: Calculation of Implicit Subsidy on Storage, Indonesia, 1979/80

Month	Actual Price	Price Without Subsidy	Difference (1)-(2)=(3)	Net Bulog Operation (Sale-Purchase+)	Total Subsidy (3)x(4)=(5)
	(Rp/Kg)	(Rp/Kg)	(Rp/Kg)	(Tons)	(Million Rp)
April 1979	156.61	146.67	9.94	31,528	313.4
May 1979	165.56	151.86	13.70	67,276	921.7
June 1979	172.45	157.24	15.22	22,947	349.2
July 1979	178.37	162.78	15.59	-4,356	-67.9
August 1979	180.89	168.52	12.37	1,766	21.8
September 1979	181.64	174.44	7.20	1,831	13.2
October 1979	181.78	180.87	0.91	-5,129	-4.7
November 1979	182.65	187.19	-4.50	-4,069	18.3
December 1979	185.01	193.73	-8.72	-2,172	19.9
January 1980	185.96	200.48	-14.52	-1,989	28.9
February 1980	187.54	207.47	-19.93	1,248	-24.9
March 1980	187.60	214.68	-27.08	-45,993[a/]	1,245.5
Carryover	(187.60)	(214.68)	-27.08	-62,888	1,703.0
Total Subsidy					4,536.4

Source: Columns (1) and (4) are from Uben Parhusip, "Intra-Year Movement of Rice Prices in Indonesia," paper presented at the Rice Policy in Indonesia workshop, Jakarta, January 25-28, 1984, Tables 16, 27, and 28; Storage cost data used in calculation of column (2) are from Table 7.7 of Mears, New Rice Economy, page 262. The interest rate used is 36 percent per year.

a/ The figures here do not show the net operation in this month as BULOG was then already engaged in buying the new year's crop which came somewhat earlier. It is equal to the month's gross distribution, assuming that BULOG disposes the old rice first before it sells the new rice.

purchased at too high of a price, and the negative quantity is the tonnage being sold at too low of a price to cover storage costs. The final column thereafter indicates the total value of the subsidy. The total cost of the storage subsidy was Rs. 4.5 billion, which equals only $7.2 million.

Procurement in Indonesia has expanded five or sixfold in the years which have ensued since these data. Nevertheless, stabilization policies have exerted a small drain on the national budget. There are important and generalizable lessons that come out of the Indonesian experience. First, is that there are a number of prerequisites to an effective government stabilization policy. These include that: (a) the market intelligence on prices must be accurate, (b) procurement operations must be well-timed, and (c) confidence in the government's performance must be high in order to establish credibility. In the absence of such conditions, government interference in markets will undoubtedly only increase speculative behavior and exacerbate abrupt seasonal price changes. So, while an agency like BULOG has been able to perform its function relatively well, the fact that it has unlimited access to credit from the central bank and is extremely efficient are characteristics of its success which may be difficult to repeat elsewhere.[1]

A second consideration is that over time there is inevitably a growth in the stores that government must assume, even if the floor and ceiling prices are maintained. This can be attributed to farmers learning how to exploit the implicit subsidy offered by reducing the

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[1] Siamwalla, 1984, op. cit.

gap between intra-year floor and ceiling prices. When government first enters the market, many farmers are accustomed to holding stocks for a latter point in the year. They initially are not confident that a flat seasonal price could be maintained. Farmers are reluctant to liquidate their annual holdings, especially when it will require identifying alternative investments. As time passes, and credibility is attached to government storage activities, old habits will give way to sell more and more, earlier and earlier after the harvest, to exploit the subsidized prices being offered.[1]

A third consideration is that a key ingredient to the success of government stabilization activities is that targets are set in terms of floor and ceiling prices, not quantities. This procedure is in contrast to many countries where a fixed amount of money is allocated to import or purchase grain. As noted by Siamwalla, it may prove less expensive to have a procurement system with an open-ended commitment than one where allocations are fixed because in the case of the latter, speculators can exploit the fact that as budgetary resources near depletion, there will be major movements away from price targets.

Therefore, the key aspect of any government intervention is credibility. In environments characterized by rapid inflation, instability in annual production (e.g., regular droughts), severe budgetary and foreign exchange constraints, as well as limitations in

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[1] This scenario was given as explanation for the experiences in Korea when the kpercentage of rice production purchased by the government has steadily increased since seasonal stabilization policies were initiated. See Tolley, A. S., Thomas, V., and Wong, C. M. Agricultural Price Policies and the Developing Countries, World Bank, Johns Hopkins University Press, Baltimore, 1982.

physical infrastructure and managerial capacity to command sufficient control over markets, there will be uncertainty about public storage rules. If constraints on government limit its ability to carry out a predictable policy, intervening directly in grain markets is not advisable.

5.1.1 Relationship of Stabilization Policy to International Trade

In the preceding discussion, the focus was on the gains, costs, and appropriateness of stabilizing seasonal prices. However, the discussion was presented in terms of the role of government in storage and its relationship to private traders. There is, however a further dimension to the issue of seasonal price stabilization -- that of international trade.

The nexus of the relationship between government's involvement in storage and international trade is that most countries either receive foreign assistance (i.e., food aid) or engage in other foreign transactions. With few exceptions, governments in developing countries attempt to exert monopoly over these foodgrain imports and exports[1]. Public institutions are, therefore, inextricably linked to the storage function. So, with the exception of those countries which do not rely

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[1] Indeed, there are many cases where this is not feasible. For example, despite attempts by the Government of Nepal to limit foreign trade of food grains to an authorized marketing corporation, the vase open boarder with India precludes enforcements of trade restrictions. Arbitragears from both country engage freely in their activities.

on trade, any discussion of seasonal stabilization should not ignore foreign transactions.

To begin to understand this relationship, the following equation is instructive:[1]

(1) $S_{t-1} + P_t + M_t = S_t + C_t$

where:

S_t = stock at the end of period t

P_t = domestic production during period t

M_t = net imports during t

C_t = domestic consumption during t

Rearranging (1) we get:

(2) $C_t = P_t = M_t - \Delta S_t$

where

ΔS_t = increase in stocks during t.

The lesson from (2) is that if the government chooses to reduce the present and future gaps between consumption and production, there are two options. The first is to change the stocks, by either increasing storage (positive ΔSt) or drawing down existing stocks (negative ΔS_t), as discussed above. The second is to adjust the levels of imports.

This close relationship between storage and trade suggests that either can be employed to reduce the gap between seasonal supply and demand. It should also be recognized that the role of imports in reducing seasonality of supply is highly time dependent, requiring the ability to respond rapidly to the vagaries of domestic output. The

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[1] Siamwalla, 1984, op. cit., pp. 1-2.

timing of imports must, however, be timed to address expected seasonal shortages.

There are a number of examples of how countries time trade opportunities to correspond to seasonal shortages. In Indonesia, the heaviest period of imports is from November through March, in keeping with the lean season before the harvest.[1] Imports have been well-timed in Bangladesh to correspond to July through August when prices are at their peak. In the Philippines, 68 percent of the imports arrived between June and October in seven out of the nine years for which data are available.[2]

In the Gambia, the months of June through September are stressful periods because of the lack of availability of sorghum and millet. The timing of rice imports corresponds well with this hungry period. The imported rice undoubtedly helps to stabilize millet and sorghum prices.

While the above examples illustrate the principle that imports can be timed to correspond to the lean season, three related concerns remain. First is to consider the seasonal prices of rice on international markets. The lowest FOB price in Bangkok, for example, is at the beginning of the year, following the harvests of the major rice exporters -- Thailand, Burma, Philippines, and South Korea.[3] Rice purchased at this time would arrive in a country like Indonesia after the pre-harvest shortages. Thus, there is the dilemma that

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[1] Leon Mears, 1981, op. cit.

[2] Howarth Bouis, 1983, op. cit.

[3] Leon Mears, 1981, op. cit.

timing purchases so that arrivals arc during the lean season may result in paying a premium in terms of international prices.

Second is that the volume of imports, not only its timing is paramount to stabilize seasonal prices. The Bangladesh case, for example, indicated little relationship between volume of imports and domestic shortfalls. The relationship between efforts to reduce inter-year instability through trade, and the timing of those imports to mitigate seasonal price rises, reinforces the relationship between the stochastic fluctuations in yearly output and seasonality.

Third, if expectations for imports during certain periods of the year are created, and then do not materialize, this in fact could have more grave consequences for seasonal price stability than no imports whatsoever. This was demonstrated in the Philippines with regard to the anticipatory price model discussed above.[1] If imports arrive too early, the government must either pay the cost of storage or release them onto the market. The former has a cost to the government, and the latter will make it more difficult for traders to formulate reasonable expectations. Conversely, late market arrivals of imports will portend precipitous seasonal price increases. The timing of imports, therefore, is a fundamental complement of any strategy which exploits the opportunity for trade to smooth seasonal prices.

5.2 Indirect Role of Government in Reducing Seasonal Price Increases

There are alternatives to government intervention as a buyer and seller in markets to reduce the extent and instability of seasonal

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[1] H. Bouis, 1983, op. cit.

price increases. These may be divided into two categories: the first is concerned with increasing the competitiveness of markets, and marketing opportunities for farmers; and the second revolves around development of infrastructure and providing subsidies which may reduce storage costs and lower seasonal price spreads.

There are a variety of reasons why commodity markets may not be competitive and efficient, and why the costs of inter-temporal arbitrage may be high. First, any storage operation requires access to credit. If credit is rationed, or access is impeded, the competition among traders is reduced. Similarly, poorly functioning capital markets may drive up the price of credit, thereby increasing the major cost to seasonal arbitrage. This is regardless of whether there is competition among traders. Thus, any government effort to improve access to, and lower the costs of capital will facilitate lower storage costs. In this context, it may be possible to provide subsidies in the form of credit to private traders in a competitive situation. However, care should be taken that access to such subsidies is not rationed, thereby reducing efficiency and equity in marketing.

A second indirect area for government intervention concerns addressing infrastructural constraints which reduce the ability of the farmer to respond to market signals. This includes promoting and improving availability of on-farm storage facilities. In addition, removing transportation bottlenecks which dissuade the farmer from bringing crops to wholesale markets where a fair price can be received is commended. It is precisely such impediments as on-farm losses and

transaction costs which may contribute to the farmer's decision to sell his crop directly after the harvest at depressed prices.

Another important factor to promote competition and efficient markets revolves around the question of intelligence and dissemination of information. Improving communications and reliable information about the forces which affect prices will go a long way to reducing risk and speculative gains and losses.

Other measures which may be taken by government may include actual construction or operation of warehouses to assure that farmers and traders have access. This, once again, will reduce the constraints to entering into storage operations because the initial capital outflows and risk of constructing facilities is borne by the government.

In sum, indirect measures are designed to promote competitive markets and reduce the costs of storage by lowering the risks, constraints, and transaction costs faced by farmers and traders engaged in inter-temporal arbitrage. This approach, is juxtaposed with that of direct government intervention in procurement and sales. To quote Jones[1] as follows:

> "There is a great difference between price stabilization that consists of buying and selling at fixed prices over a period of weeks, months, or years and price stabilization that attempts to reduce lags and restrain over-reaction to changing market conditions. The first transfers the risk of price change from farmers and merchants to government at the risk of progressive distortion of supplies from requirements. The second increases the reliability of prices as indicators of the relationship between supply and demand, and in this way it enhances their adjustment. The first destabilizes, the second equilibrates."

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[1] Jones, op. cit, p. 133.

These remarks go beyond elucidating a divergence in approach, and espouse a conviction that government's role should be in facilitating the activities of the private entrepreneur. This viewpoint clearly needs to be the subject for further discussion and analysis based on individual country case studies, such as those presented later in this workshop.

INTERNATIONAL
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INSTITUTE

1776 Massachusetts Avenue N W
Washington D C 20036 U S A
(202) 862-5600
Telex 440054
Cable IFPRI

Preliminary Draft
For Discussion Only

THE INTERPLAY OF SEASONAL STABILIZATION OF RICE AND CORN PRICES IN INDONESIA

by

C.P. Timmer and Chrisman Silitonga

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

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SUMMARY

1. Rice and Corn play an important role as source of energy in Indonesian diets as indicated by the fact that about 70 percent of calorie requirements in consumption is supplied by these commodities. In various places in Indonesia consumers consume rice and corn in different amounts and forms. Geographycally, for people in the Eastern part of the country consumption of non-rice is evident while people in the Western part have a rice consumption pattern. The difference, however, can be explained by the environmental favourability to growing either paddy or corn. The Western part of the country inherits more fertile land and more reliable rainfall suitable to grow rice. This enables people to consume relativelv higher amounts of rice, even if it is noted that in certain provinces (West Sumatra and Aceh) people consume the highest per capita of rice, as much as 160-180 kg/year, possibly the highest consumption of rice in the world.

2. Rice and corn are largely produced in Java which is only 6 percent of the total size of the country but inhabited by 60 percent of the Indonesian population. With limited size, it is reasonably understood that paddy and corn crops are grown in the same field under crop rotation systems. The proportion of corn planted in dry land is relatively small in Java. Beside those people in East Indonesia who are mostly known as non-rice eaters, people in rural areas in certain places in West Indonesia including Java also consume a quite reasonably high quality of corn as part of their staple food. This paper focuses on the analysis of this particular group especially by looking at their various responses to obtain calorie requirements at different seasons and prices.

3. Analysis on production changes and intertemporal food price changes, coupled with the change in expenditures (income) for foods, summarizes the followings;

3.1. Rice and corn production supports each nother as indicated by the data and its analysis. Based on time series data it is shown that pre-harvest of paddy in February-March coincides with shortfall of corn supply, while on the other hand, during November-December, as rice supply is in shortfall a peak of corn harvest is noted. Averagely, when rice harvest is 70 percent, corn is 10 percent, and corn is 90 percent when rice harvest is only 30 percents.

3.2. Income. Consumption relationship is analyzed by using various Susenas data to show consumers' response to price. It is found that corn consumption tends to decrease while rice consumption is still showing an upward movement as income increases. Further analysis also shows an increased consumption of corn at the higher income earner class which possibly is explained by the various forms of corn consumed at different income class levels.

3.3. The importance of corn is accentuated by the large volume it fills in the off-harvest, or preharvest "hungry season" which falls between the dry season corn harvest, with its reduced yields, and the main rice harvest of March-April. Corn consumption in Java is greatest during the period from January to March because of greater per capita consumption as well as because additional numbers of people are eating corn. The seasonal adjustment is largely the consequence of shifts in the relative prices among the main staples. Corn consumption peaks around the main harvest, a time when corn prices fall, but declines in the subsequent months as rice from the main harvest reaches the market and its price declines relative to that of corn. Some of the lower consumption of corn toward the end of the year is probably due to a seasonal decline in the overall consumption of starchy staples. Farmers' reaction to market prices is therefore influenced by their traditional forecast on crops per-

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formances in the subsequent harvest season. Once they feel assured of a good perfonmance of rice crops in the coming harvest they will at the same time also start marketing corn from their household stock.

3.4. This paper reconfirms the findings of previous studies which correspond to income and demand for corn and rice. Inspite of a similar change in the direction of corn and rice consumption with respect to the change in income, however, the analysis stresses the lesser income elasticity, even with a negative indication with respect to demand for corn, while with rice such is not always the case. A slight different trend in corn consumption is noted at the higher income class, in which the demand for corn tends to increase.

4. In the past few years there is a trend that utilization of corn in connection with the growth of the livestock sector has started to shift as a commercial crop. This has been made possible also by the success of farmers in increasing the production of rice and making rice relatively available in such quantity and at such price as required by consumers and thereby slowly bringing about a decline in the consumption of corn.

This may be pointed out by the fact that regions previously not so familiar with rice cultivation have now gradually started to replace non-rice products with rice crops. The weather and irrigation facilities as well as facilities for rice planting have recently also become relatively more appropriate compared with previous years. However, the government does not intend to stop promoting the increase of corn production as there shall remain a big demand for this commodity coming from the sector of livestock, and corn in the amout of 50-70,000 ton per year shall continue to be imported.

5. In connection with such problems as developing lately within the food system in Indonesia, a more in-depth study would be required through research which, among other things, shall be as follows :

5.1. In a situation where Indonesia since the early 80s has begun entering a rice self-sufficiency era, it seems that the role of non-rice commodities has started to decline in Indonesian diets particularly for lower-income groups.

In this case, there is a great possibility that a turning point would again occur where people who initially consumed non-rice commodities would become rice-eaters and which further shall also cause the said level of rice self-sufficiency to beocme a shortfall of rice.

Care shall be required here in stipulating food pricing policy as a balancing instrument for both food and feed commodities.

Currently applicable approaches to the stipulating of basic prices seem to be no longer relevent if such were based only on the production cost approach, but must also take in consideration the existing inter-commodity relationships.

5.2. The problem of cost efficiency, particularly in the food trading system, shall continue to act as constraints to the government in its efforts to enlarge Indonesia's food surplus market share in the International market. The cost price of rice Indonesia, for instance, is almost 2 times the price of rice in the International market, and ± 45% of the said price is absorbed in the chain of trade. By always being alert that this cost of marketing is much affected by various varibles, there certainly are some variables that could be pressed. This would require a study on the economics of the grain's post-harvest performance.

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5.3. A relationship between income and cross elasticities of various food grains in the final situation would be much needed, the more so in a situation where Indonesia is entering a situation that is constituting a turning point from a situation of deficit to self-sufficiency.

While food production is ever increasing and demand is rising at a relatively slower rate, these result in a necessity to conduct a study for the preparing of consumption controls and markets for food commodities. The above study would be more meaningful if it is viewed from this standpoint, that such study on consumption patterns with class income as background has never been satisfactorily performed.

Absence of such study has resulted in the fact that policies followed by the government are usually becoming very general in nature and as such have given the impression that there exists a bypassed society that never has benefited from any social welfare, scheme.

5.4. These notwithstanding, the problem of food should not be seperated from any policy in the production sector. There exists a temporary desire of observers to see this present increase in rice production averaging between 6-8% slowed down, at the most not to exceed the population growth of 2-3% per year, so the problem of surplus would thus not become too big a burden to the government. Experience has shown that overcoming the impact of surplus is more difficult than overcoming the impact of deficit.

In this case, some thought would be required in stipulating a policy that would be appropriate in the sector of production to face a relatively constant consumption, and the excessive burden of subsidy must be spent by the government in the production sector.

5.5. Finally, the problem of post-harvest technology including the problems of preservation and food technologies would be very prominent in the coming years. Diversification of food products would be urgently needed as it seems that consumers in urban areas would continue consuming non-rice commodities even though in different forms from those consumed by lower-income communities.

The prominent problem in this connection is with regard the possibilities for facilitating development in the sector of post-harvest food technologies that simulataneously would increase the added value of the food grain that would be received by farmers.

THE IMPORTANCE OF RICE AND CORN IN FOOD ECONOMY

1. Rice and Corn have been for long a time considered as primary sources of carbohidrate in Indonesian diets. Based on current data, calory consumption per capita since 1970 has improved from 2097 calories to 2628 calories in 1981 or an increase by 2.5% per year during the period of ten years. About 70 to 80% of these calories were accounted for by cereals and starchy foods as is obvious in Table 1.

Table 1 : Average Calorie Intake/cap. in Indonesia 1970-1981

Year	Cereal (Cal)	Starchy food (cal)	Sub Total (cal)	Others (cal)	Grand Total (cal)
(1)	(2)	(3)	(4)	(5)	(6)
1970	1416	239	1655(76.92)	442	2097
1971	1397	231	1628(78.68)	441	2069
1972	1366	229	1595(77.93)	457	2052
1973	1563	260	1823(81.13)	424	2247
1974	1501	265	1766(78.56)	484	2248
1975	1475	242	1717(79.86)	433	2150
1976	1451	262	1713(76.78)	518	2231
1977	1519	256	1775(76.71)	549	2314
1978	1586	246	1832(75.80)	585	2417
1979	1566	232	1798(73.63)	644	2442
1980	1612	240	1852(72.00)	718	2570
1981	1631	219	1850(70.39)	778	2625

Source : Welfare Indicators, CBS, 1983.
Number in brackets is percentage of col. (4) to (6)

One important point as evident from Table 1 is a downward trend of cereals and starchy foods shares to sustain total calorie intake from 79% in 1970 to 70% in 1981. Having compared this fact with other relevant data, the decrease have been compensated for by the increased share of nuts/oilseeds from 5.7% in 1970 to 12% in 1981. In addition, improvement of the oils and fats share were also experienced from 4.72% in 1970 to 7.53% in 1981. Relative importance of meats, eggs and milks were also improved by the increase of calorie intake, subsequently from 20.1 and 3 cal/cap. in 1970 to 25.6 and 7 cal/cap. in 1981. These facts, however, indicated the likely more widespread of calorie supplied by vegetable and non-vegetable foods.

Another piece of information highlighted by Table 1 is that, on the average since 1973 calorie intake of Indonesian diets has continously exceeded 2,100 cal/cap/day as recommended by nutritionists to be the minimum requirement level. A question which is still unexplained in Table 1 is, how sufficient is the level of calorie consumption on residential basis as it relates to rural-urban income level.

2. It is also interesting to specify what cereals and starchy foods that have contributed to calorie consumption. Table 2 presents information regarding the contribution of specific food commodities in terms of rice equivalent. Some remarks concluded from Table 2, among others are:

   a. Larger contributors to calorie intake of cereals and starchy foods were, rice by 75 - 82%, corn by 7 - 12%, cassava by 4 - 9%, wheat flour by 4 - 8%, sweet potatoes by 1 - 2%.

   b. Energy availability resulting from rice and corn seems interchangeble, supporting one another as indicated by the facts that, the decrease of rice sourced-calorie is clearly offset by the increase of corn sourced-calorie and the same is true in reverse. Meanwhile, wheat flours sourced-calorie tends to go up to indicate a growing preference of the population

Table 2 : Consumption/cap. of selected food items
1976 - 1984

YEAR (1)		RICE (2)	CORN (3)	SWEET POTATOES (4)	CASSAVA (5)	WHEAT FLOUR (6)	TOTAL (7)
1976	- Kg/year	114.30	17.58	10.82	47.67	6.95	
	- Rice Eqr./year	114.30	16.76	2.92	12.39	6.65	153.02
	- Cal/day	1143 (75)	168 (10)	29 (2)	124 (9)	67 (4)	1531
1978	- Kg/year	110.76	13.06	5.72	40.92	8.41	
	- Rice Eqr./year	110.76	12.41	1.54	10.64	8.04	143.39
	- Cal/day	1108 (77)	124 (9)	15 (1)	106 (7)	80 (6)	1434
1979	- Kg/year	106.60	14.35	5.72	43.73	8.77	
	- Rice Eqr./year	106.60	13.63	1.54	11.37	8.42	141.56
	- Cal/day	1066 (75)	136 (10)	15 (1)	114 (8)	84 (7)	1416
1980	- Kg/year	110.76	14.35	6.24	27.92	9.42	
	- Rice Eqr./year	110.76	13.63	1.62	7.26	9.04	142.37
	- Cal/day	1108 (78)	136 (10)	17 (1)	73 (5)	90 (6)	1424
1981	- Kg/year	117.00	11.23	3.64	20.23	9.64	
	- Rice Eqr./year	117.00	10.67	0.98	5.26	9.25	143.16
	- Cal/day	1170 (82)	107 (7)	10 (-)	53 (4)	93 (7)	1432
1984	- Kg/year	106.60	17.56	5.72	22.41	9.64	
	- Rice Eqr./year	106.60	16.68	1.54	5.83	9.25	140.00
	- Cal/day	1066 (76)	167 (12)	15 (1)	58 (4)	93 (8)	1400

Source : "Rice Prices, Labour Wage and Related Consequences" mimeographed paper Research centre of Dept. of Agr., July 1985

Number in bracket is percentage calorie of each commodity to total (col. 7)

to wheat products, as indicated by the continous increase of wheat grain imports from 988,000 tons in 1976/77 to over 1.5 million tons in 1982/83.

c. The role of sweet potatoes and cassava in Indonesian diets is still relatively unchanged in the last ten years and even has a tendency to be replaced by the increased consumption of rice, corn and wheat flour. This phenomena seemingly confirms the negative income elasticity of cassava and sweet potatoes particularly for low income groups as proved by various studies.

d. However, recent observation tentatively indicated that consumption of rice tends to shrink in 1984 inspite of an increase in its production by 7 - 8% from the previous year level, precisely from 23.96 million tons in 1983 up to 25.98 million tons in 1984. Deeper analysis to take up this observation and its further consequences is being conducted. At the same time it is also noted the increased consumption of non-rice foods in staple food.

e. Additional conclusion clarified by Table 2 was the relatively wider fluctuation of corn consumption as compared with rice in year to year outlooks. The underlying reason to this, however, can be explained by the facts that corn production management is more uncertain than of rice. As far as the climate is favorable, to grow paddy is assumed more profitable than corn due to the relative certainty in its price and market as controlled by the government. Further evaluation on various data published by CBS, shows the change in corn production from 1978 to 1983 was -28.86% to 61.52%, a cumulative change of 90.38%, where on the other hand rice production changed from -1.93% to 12.81% which brought about a cumulative change of 10.88%.

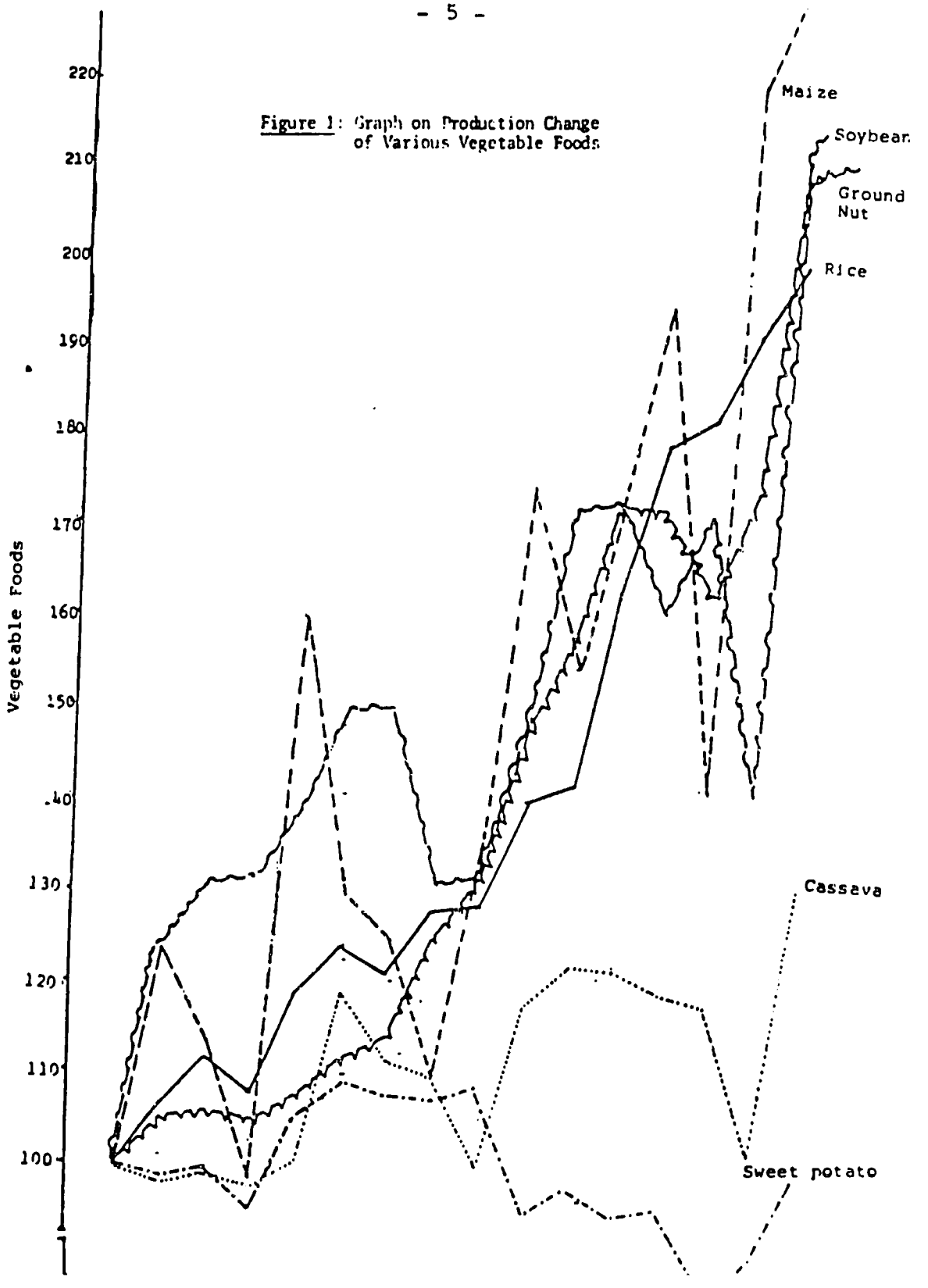


Figure 1: Graph on Production Change of Various Vegetable Foods

Other non-rice commodities such as cassava, groundnuts and sweet potatoes appeared to experience inelastic production and have smaller cumulative changes as indicated by percentage changes of 8.98%, 20.76% and 27.02%, respectively. This can be explained by recalling their small contribution in Indonesian diet.

Graphycal presentation on production change index is presented in Figure 1. Conspiciously, irregular pattern of corn production is clearly emphasized. Close outlook into the corn production pattern shows that increase in production within one year is ussually followed by its decrease in the following year. On the other hand, the change in rice production moves in a regular trend which continously increases at increasing rates since 1976. In contrary the change in cassava and sweet potatoes production is relatively less substantial, as shown by the lower graphs in Figure 1.

3. Table 3 and Table 4 illustrate the performance of production, the change of harvested area and productivity of six food commodities. The two tables summarize the followings :

   a. The increase of corn by 236% is the highest among essential food commodities in the last 15 years. This is followed by rice which is increased by 212%.

   b. Increase in rice production in certain years is also followed by the increase in corn production as pointed out in 1970, 1973, 1974, 1977 and 1978 onwards. This is understandarable since paddy and corn are usually planted in the same acreage at different seasons.

TABLE 3 : PRODUCTION AND ITS CHANGE
1960 - 1984
(million ton)

YEAR (1)	RICE (2)	CORN (3)	CASSAVA (4)	SWEET POTATOES (5)	SOYBEAN (6)	GROUND NUTS (7)
1969	12.249 (100)	2.292 (100)	10.913 (100)	2.260 (100)	0.389 (100)	0.267 (100)
1970	13.140 (107.27)	2.825 (123.25)	10.471 (95.98)	2.175 (96.24)	0.489 (128.02)	0.281 (105.24)
1971	13.724 (112.04)	2.606 (113.70)	10.690 (97.92)	2.211 (97.83)	0.516 (132.65)	0.284 (106.37)
1972	13.683 (107.63)	2.254 (98.34)	10.385 (95.13)	2.066 (91.42)	0.518 (133.16)	0.282 (105.62)
1973	14.609 (119.25)	3.690 (160.99)	11.186 (102.46)	2.387 (105.62)	0.541 (139.07)	0.290 (108.61)
1974	15.726 (124.71)	3.011 (131.37)	13.031 (119.36)	2.469 (109.25)	0.589 (151.41)	0.307 (114.98)
1975	15.185 (123.97)	2.903 (126.66)	12.546 (114.92)	2.433 (107.88)	0.590 (151.67)	0.380 (142.32)
1976	15.845 (129.36)	2.572 (112.22)	12.191 (111.67)	2.381 (105.35)	0.522 (134.19)	0.341 (127.51)
1977	15.876 (129.61)	3.143 (137.13)	12.488 (102.44)	2.460 (108.85)	0.523 (135.49)	0.409 (153.18)
1978	17.525 (143.07)	4.029 (175.78)	12.902 (118.18)	2.083 (92.[illegible]7)	0.617 (156.61)	0.446 (167.04)
1979	17.825 (145.91)	3.606 (157.33)	13.751 (125.96)	2.194 (97.08)	0.680 (174.81)	0.426 (158.80)
1980	20.163 (164.61)	3.991 (174.13)	13.726 (125.73)	2.079 (91.99)	0.653 (167.87)	0.470 (176.03)
1981	22.286 (181.94)	4.509 (196.77)	13.301 (121.84)	2.094 (92.65)	0.704 (180.98)	0.475 (177.90)
1982	22.837 (186.44)	3.235 (141.14)	12.988 (118.97)	1.676 (74.16)	0.521 (133.93)	0.437 (163.67)
1983	23.961 (195.62)	5.095 (222.29)	11.651 (106.72)	2.044 (90.44)	0.568 (146.01)	0.469 (175.65)
1984	25.980 (212.10)	5.412 (236.61)	14.702 (134.67)	2.257 (99.87)	0.783 (201.28)	0.535 (200.37)

Source : Government Financial Statement and RAPBN Tahun 1985/86 p. 232
Number in brackets is index of production change based on year 1969 = 100

Table 4 : Productivity and harvest area of [illegible] commodities 1969-1973

YEAR (1)		RICE (2)		COIN (3)		CASSAVA (4)		SWEET POTATOES (5)		GROUND-NUTS (6)		SOYBEAN (7)	
1969	A :	8.014		2.435		1.467		369		372		554	
	Y :	1.53		0.94		7.44		6.12		0.71		0.70	
1970	A :	8.135	(1.51)	2.939	(20.70)	1.398	(-4.70)	357	(-3.25)	380	(2.15)	695	(25.45)
	Y :	1.62	(6.88)	0.96	(2.13)	7.49	(0.67)	6.09	(-0.49)	0.74	(4.22)	0.72	(2.86)
1971	A :	8.324	(2.32)	2.626	(-10.65)	1.406	(0.57)	357	(0)	376	(-1.05)	680	(-2.16)
	Y :	1.65	(1.85)	0.99	(3.13)	7.60	(1.47)	6.19	(1.64)	0.75	(1.35)	0.76	(5.56)
1972	A :	7.898	(-5.12)	2.160	(-17.75)	1.468	(4.41)	338	(-5.22)	354	(-3.58)	697	(2.50)
	Y :	1.67	(1.21)	1.04	(5.05)	7.07	(-6.97)	6.11	(-1.29)	0.80	(6.67)	0.74	(-2.63)
1973	A :	8.403	(6.39)	3.433	(58.94)	1.429	(-2.66)	379	(12.13)	416	(17.51)	743	(6.60)
	Y :	1.74	(4.19)	1.07	(2.88)	7.81	(10.47)	6.30	(3.11)	0.70	(-12.50)	0.73	(-1.35)
1974	A :	8.509	(1.26)	2.667	(-22.02)	1.509	(5.60)	330	(-12.93)	411	(-1.20)	768	(3.36)
	Y :	1.80	(3.45)	1.13	(5.60)	8.63	(10.50)	7.48	(18.73)	0.75	(7.14)	0.77	(5.48)
1975	A :	8.495	(0.16)	2.445	(-8.32)	1.410	(-6.56)	311	(-5.76)	475	(15.57)	752	(-2.08)
	Y :	1.79	(-0.5)	1.19	(5.31)	8.90	(3.13)	7.82	(4.54)	0.80	(6.67)	0.78	([illegible]
1976	A :	8.360	(-0.48)	2.095	(-14.31)	1.353	(-4.04)	301	(-3.21)	414	(-12.84)	646	(-1
	Y :	1.89	(5.59)	1.23	(3.36)	9.01	(1.24)	7.91	(1.15)	0.82	(2.50)	0.80	(2.56)
1977	A :	8.360	(-0.11)	2.567	(22.53)	1.364	(0.81)	326	(8.30)	507	(22.46)	646	(0)
	Y :	1.90	(0.5)	1.22	(-0.81)	9.15	(1.55)	7.55	(-4.55)	0.81	(-1.22)	0.81	(1.25)
1978	A :	8.929	(6.81)	3.025	(17.84)	1.383	(1.39)	301	(7.67)	506	(0.20)	733	(13.47)
	Y :	1.96	(3.16)	1.33	(9.02)	9.33	(1.97)	6.92	(-8.34)	0.88	(8.64)	0.84	(3.70)
1979	A :	8.803	(-1.41)	2.594	(-14.25)	1.439	(4.05)	289	(-3.34)	473	(-6.52)	784	(6.96)
	Y :	2.03	(3.57)	1.39	(4.51)	9.55	(2.36)	7.64	(10.40)	0.89	(1.14)	0.87	(3.57)
1980	A :	9.005	(2.30)	2.375	(5.44)	1.412	(-1.88)	276	(-4.50)	506	(6.98)	732	(-6.63)
	Y :	2.34	(15.27)	1.46	(5.04)	9.72	(1.78)	7.53	(-1.44)	0.93	(4.49)	0.89	(2.30)
1981	A :	9.382	(4.19)	2.955	(8.04)	1.388	(-1.70)	275	(-0.36)	508	(0.49)	810	(10.66)
	Y :	2.38	(1.71)	1.50	(2.74)	9.58	(-0.98)	7.53	(1.06)	0.93	(0)	0.87	(-2.25)
1982	A :	8.988	(-4.20)	2.061	(-30.25)	1.324	(-4.61)	220	(-0.20)	461	(-9.25)	606	(-25.18)
	Y :	2.54	(6.72)	1.57	(4.67)	9.80	(2.30)	7.62	(0.13)	0.95	(2.15)	0.86	(-1.15)
1983	A :	9.102	(1.27)	3.018	(46.44)	1.185	(-10.50)	261	(18.64)	484	(4.99)	633	(4.45)
	Y	2.63	(3.54)	1.68	(7.00)	9.83	(0.31)	7.83	(2.76)	0.97	(2.10)	0.90	(4.65)

Source : APBN 1985/1986, p.238
A = Area (Ha)
Y = Productivity (Y/Ha)
Number in brackets is percentage change of A & Y from previous years.

c. Further clarification on productivity and production appears in Figure 2a through Figure 2f which explains the relative importance of productivity as compared with acreage as a source of production growth. In the last fifteen years, various improvement in foodcrops have been widely practiced at the farm level such as better seeds, better cultivation and better irigation. As is obvious from Figure 2 the change in foodcrop areas is relatively unchanged except in certain years due to favorable climates. Table 5 clarifies the change in productivity and harvested areas of 6 foodcrops from 1969 to 1983.

Table 5 : The Change of Area and Productivity
1969 - 1983

COMMODITY	AREA (%)	YIELD (%)
(1)	(2)	(3)
Rice	(- 5.12) - 6.81	(-0.50) - 15.27
Corn	(-14.31) - 58.94	(-0.81) - 9.02
Cassava	(-10.50) - 5.60	(-0.98) - 10.50
Sweet Potatoes	(-12.93) - 18.64	(-8.34) - 10.40
Groundnuts	(-12.84) - 25.45	(-2.63) - 5.56
Soybean	(-12.93) - 18.64	(-8.34) - 10.40

Figure 3 is a simple way of comparison analysis between (A) and (Y) to result in production. It shows wider year to year change in planted area compared with productivity change.
From 15 years observation it is concluded that nearly 95% change in productivity is positive while about 60% of other foodcrops (except rice and corn) shows negative area change. This confirms previous studies which proved that substantial shares of productivity to result in continous increases in production.

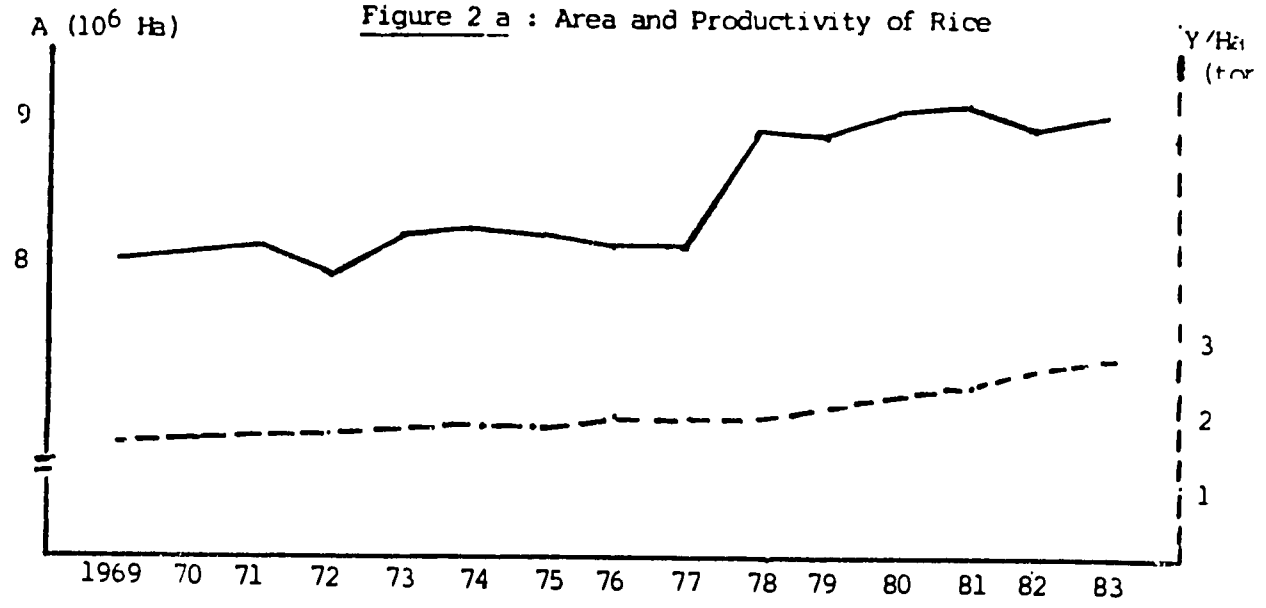


Figure 2 a : Area and Productivity of Rice

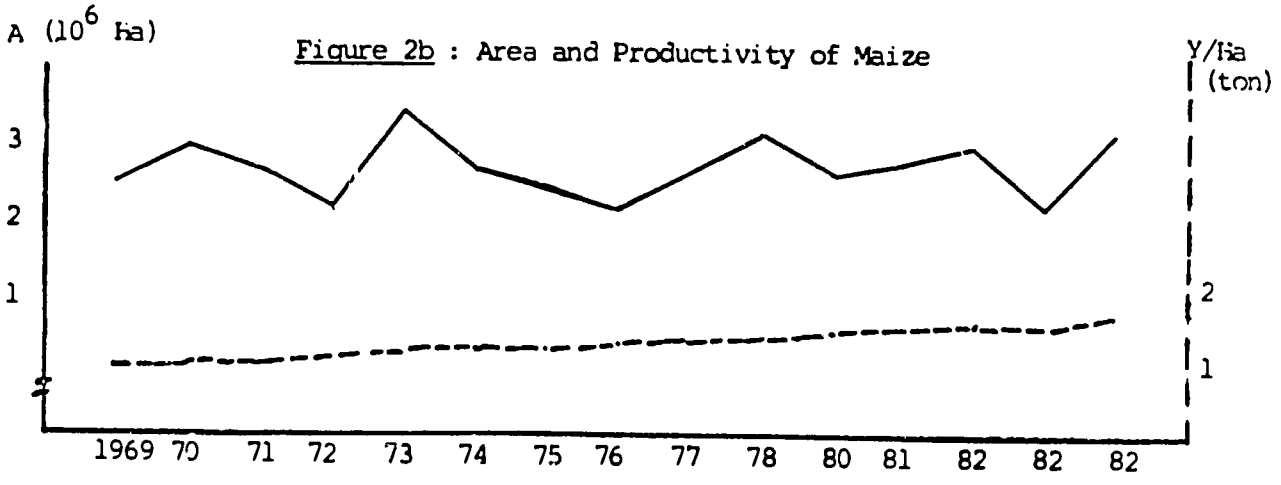


Figure 2b : Area and Productivity of Maize

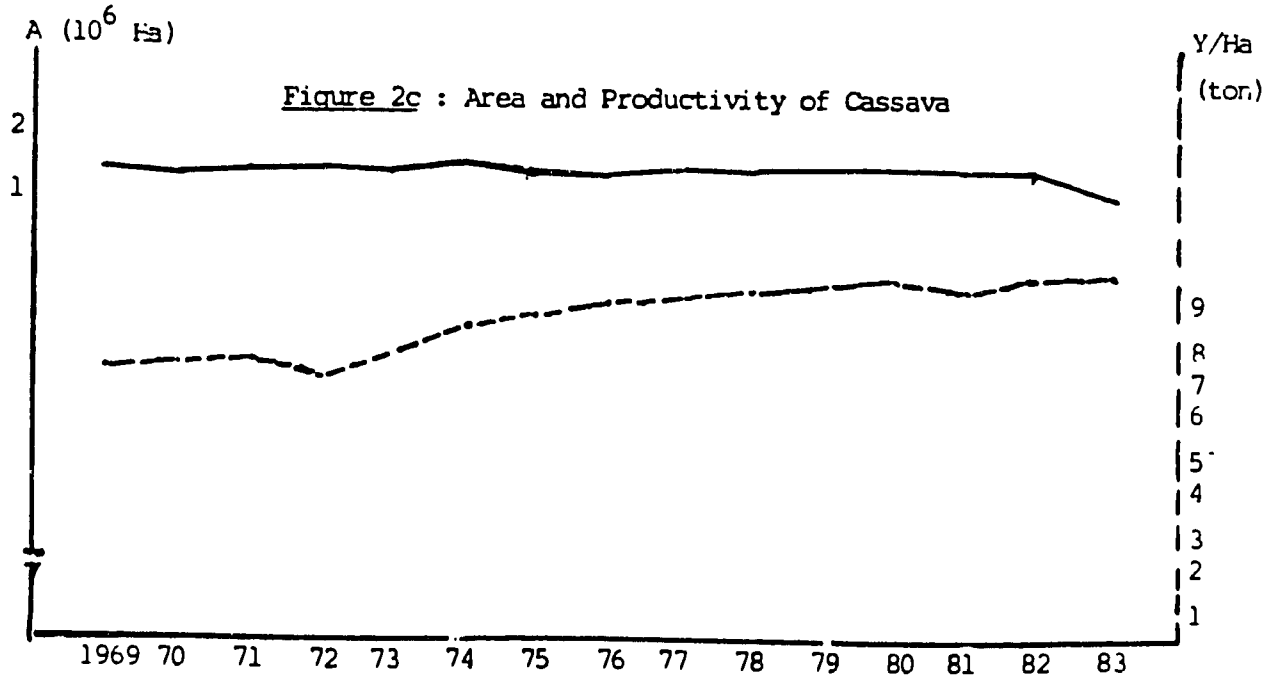


Figure 2c : Area and Productivity of Cassava

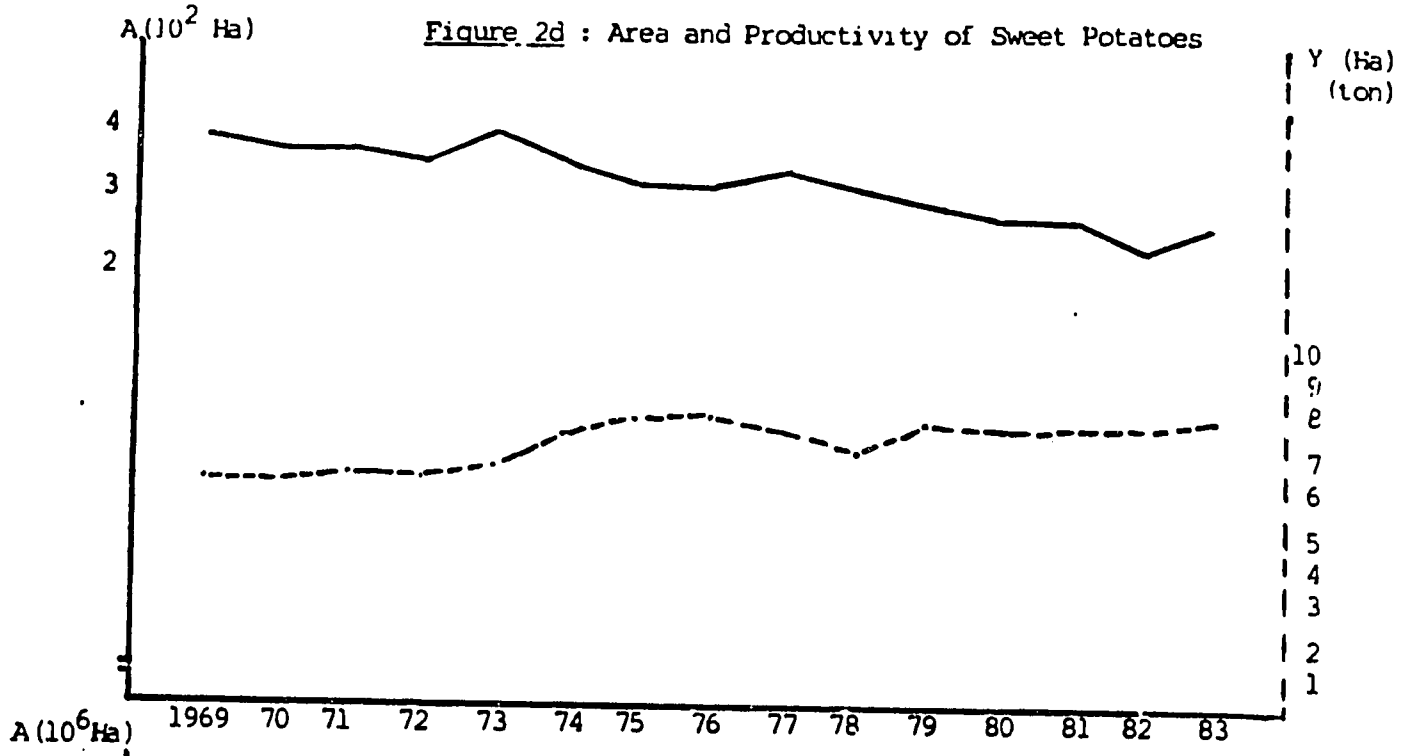


Figure 2d : Area and Productivity of Sweet Potatoes

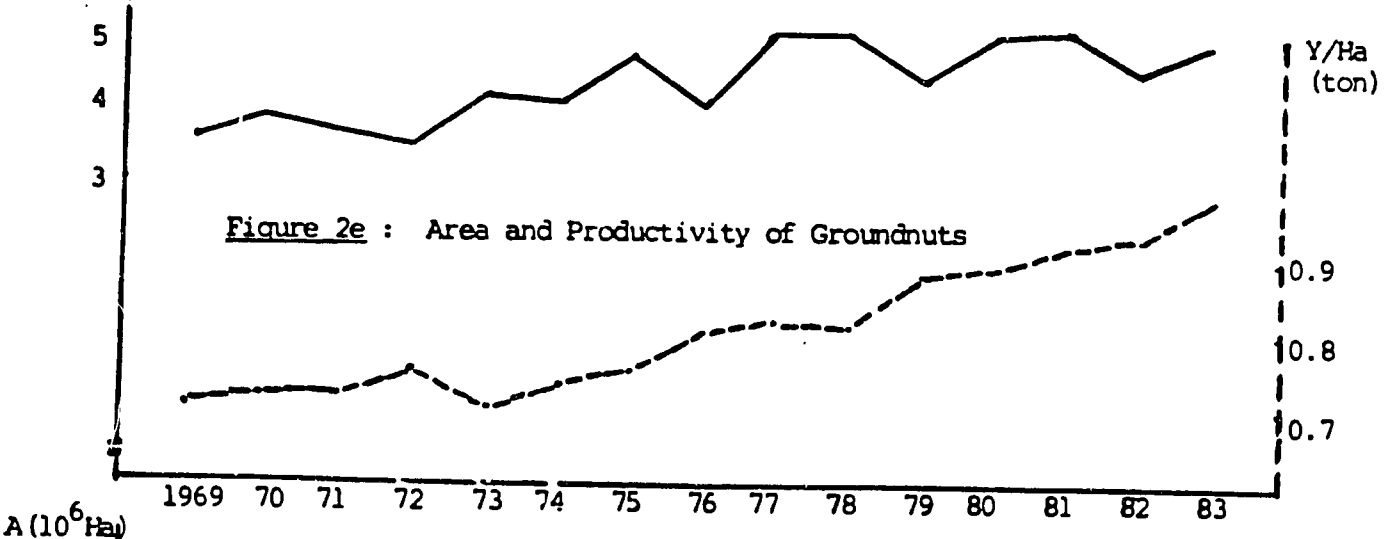


Figure 2e : Area and Productivity of Groundnuts

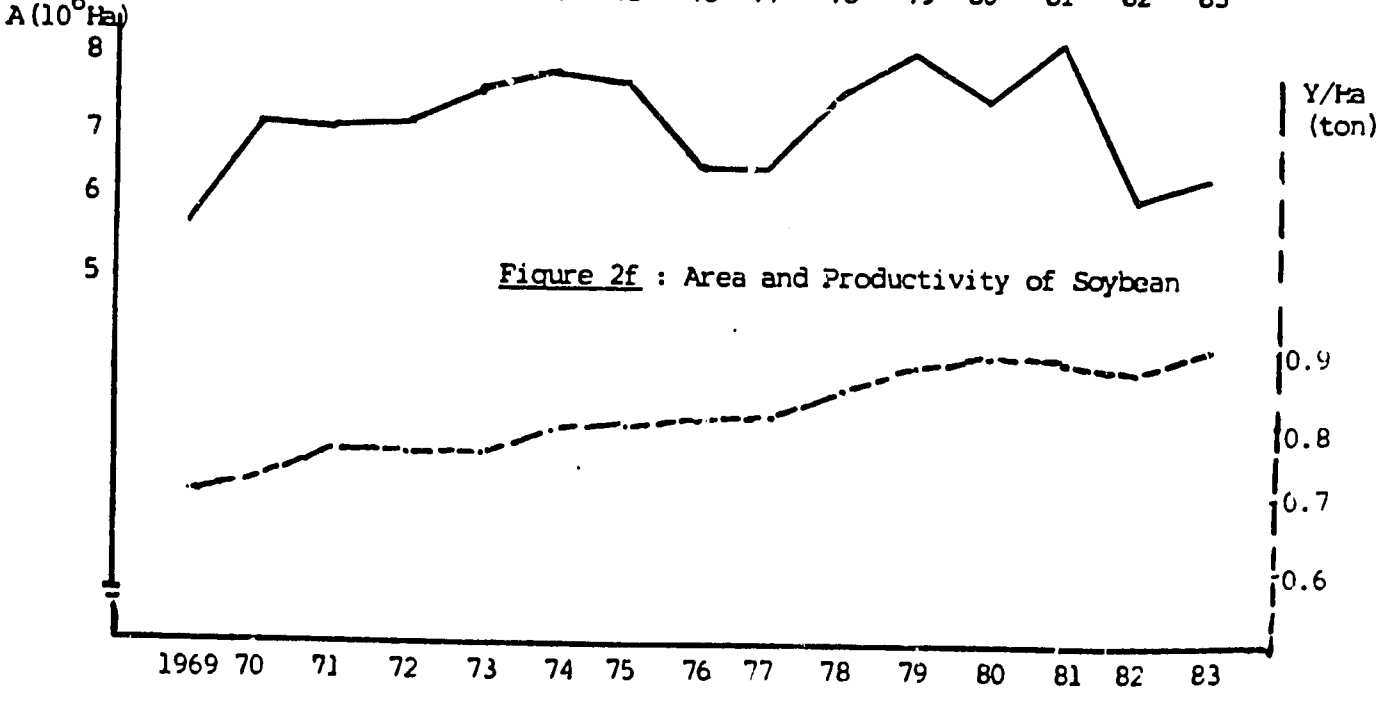


Figure 2f : Area and Productivity of Soybean

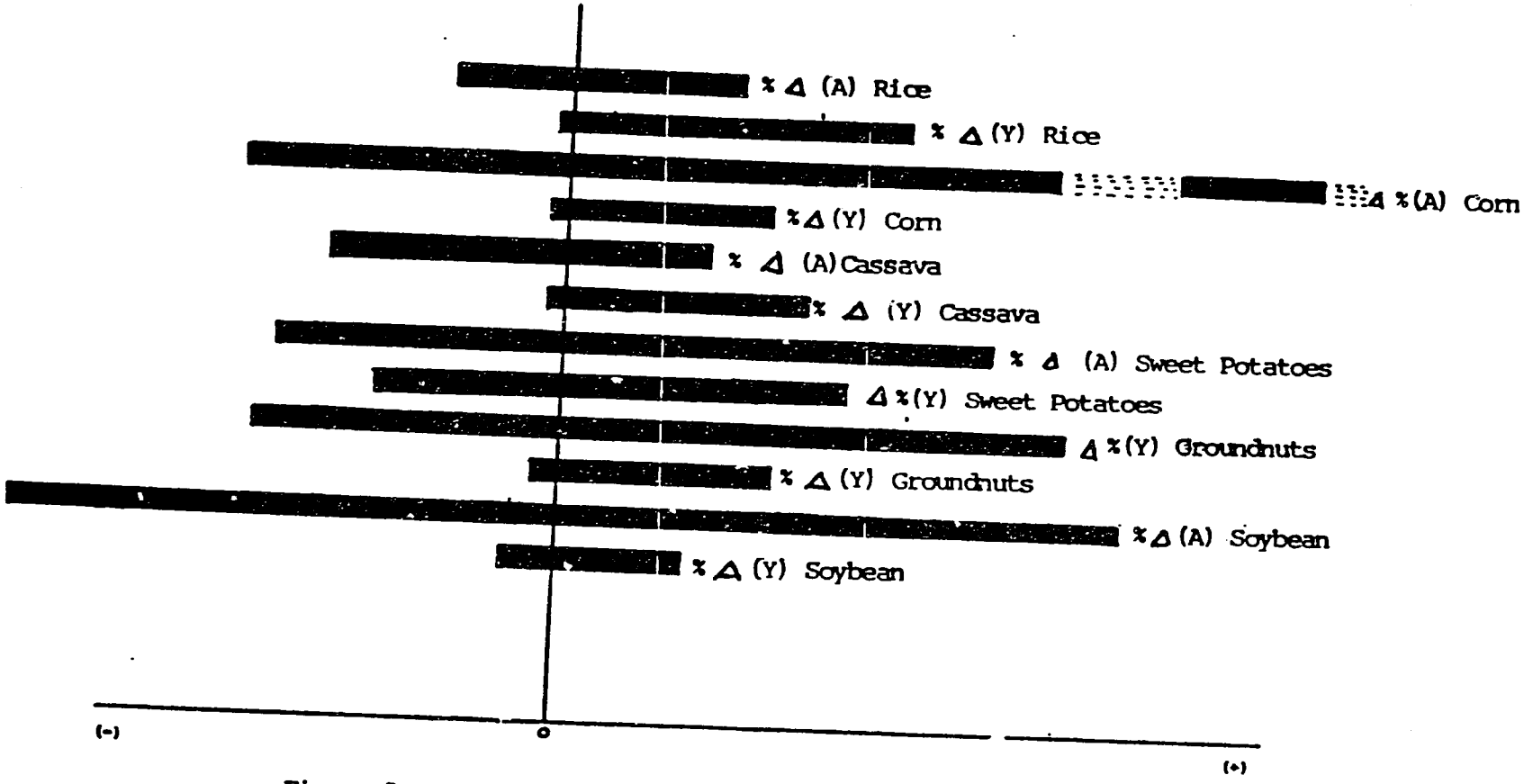


Figure 3 : The Change of Areas and Productivity of 6 foodcrops
1969 – 1973

4. As has been explained earlier, food is still assumed as a leading expenditure in household economy. People in rural areas spent about 69.2% of their monthly income for food in 1981. This is slightly decreased from the 74.1% previous year level. On the other hand, people in urban areas spends about 54.1% of their monthly income for food or a decrease by 9% from the previous year level. The national average expenditure for food was 64% in 1981, a decline by 7.5% from the previous year level. At current prices, total cash spent for food in rural areas was Rp 5,336 in 1980, augmented to Rp 6,020 per month in 1981. On the other hand, in urban areas, this expenditure was also increased from Rp 5,780 in 1980 to Rp 6,574 per month in 1981. More detailed assessment on recent data concludes that about 61.5 to 64.5% of food expenditures is addressed to cereals, fish, milk and eggs, vegetables and industrial foods. The percentage of the latter is relatively unchanged from previous years.

To end up this part it would be considerably useful to summarize information with regards to consumption per capita of selected essential food commodities as is obvious in Table 6.

Tabel 6 : Consumption/cap/year of selected essential food commodities [a] (in kg)

YEAR	RICE	SHELLED CORN	CASSAVA	SWEET POTATOES
(1)	(2)	(3)	(4)	(5)
URBAN				
1979	107.5	1.9	10.6	3.3
1980	106.8	2.0	8.0	3.3
1981	113.3	1.1	5.8	1.7
RURAL				
1979	106.4	18.0	56.5	6.4
1980	111.5	19.1	33.9	6.8
1981	115.4	22.4	28.5	4.5
URBAN + RURAL				
1979	106.7	15.0	47.8	5.9
1980	110.4	15.3	28.1	6.0
1981	114.9	17.6	23.5	3.8

Source : National Economic Survey, CBS, Various Issues

a) Industrial food is excluded

Table 6 signifies higher consumption/capita of foods in rural areas compared with urban areas. This can be explained by the fact that most of the foods flow from rural to urban areas. In contrast, imported foods are largely consumed in urban areas. More adequate supply at lower prices brought about the higher consumption of foods in rural areas. Additional evidence explained by Table 6 is that corn consumption in rural areas is averagely ten times higher than in urban areas during the three years of observation. Since 78 - 81% of the total population live in rural areas, one can approximate that 114 to 118 million people consume 2.5 to 2.6 million tons of corn in rural areas. Roughly, this figure is much lower than 4.5 million tons of production in 181. It is now clear that about 60% and 2.0% of corn is consumed in rural and urban areas while the rest is used in industrial sectors. Up to this point, it is necessary to continue on questioning, how many people in rural areas on per capita income basis consume corn as their staple food. Besides, it is also helpful to understand the consumption pattern of the poor in urban and rural areas in securing their food requirement.

II. Corn and Rice Consumption System

1. Since rice and corn have an important share in Indonesian diets, price and consumers' income play as primary variables which could explain consumption changes and the background of government food policies. Government intervention in rice marketing evolved since the Dutch occupation period and is more systematically implemented from the First Five Year Plan onwards. On the other had, involvement of government in non-rice commodities, particularly corn, started in 1977 and has expanded to other secondary foodcrops in 1979 by the setting of floor prices for selected non-rice commodities.
   Floor prices as implemented by the government aim at two important objectives :

   first, to protect farmers from uneconomical prices which tend to decrease below the cost of production during harvest time,

   second, to control urban prices which tend to exceed the purchasing power urban people and feedmillers during off-harvest time.

   The two objectives led the government to apply a storage rule which emphasizes the principle consequences of pricing policies, that is, to purchase during the time of surplus and to dispose during the time of food shortage. Therefore, as far as market elements are concerned, government interest in food marketing is to stabilize market prices for the benefit of farmers, consumers without necessarily squeezing the participation of private food traders.

2. Floor price setting practiced by the government since 1969 is assumed as a more reasonable approach in the long history of Indonesian food policy as it aims to rehabilitate the foodcrops sector which is suffering from inappropriate management during the era of the old order regime. The level of

floor price is determined by the government in such a way so as to stimulate farmers in boosting their food production. Hence, cost of production and other farm expenditures were also taken into account in the technical determination of the floor price.

By the same argument, the ceiling price level which is fully controlled by the government for the benefit of urban consumers is also set up by considering consumers' purchasing power and desirable consumer price index.

3. As has been deliberated earlier most of the rice production was used as human consumption where on the other hand corn was possibly used for the 6Fs (Food, Feed, Fat, Fuel, Fructose (sugar) and input for Factories). However, the utilization of corn for fructose and fuel is rarely exploited since the country is endowed with adequate natural resources to produce oil and sugar. Nevertheless, since 1980 corn utilization is concentrated only to food and feed which brings about a slight different policy for corn as compared with other food commodities.
of the 27 provinces there are seven provinces in the country where people consume corn in a relatively higher proportion, in spite of the fact that corn potentially grows in all other provinces. Under normal weather condition demand for corn can be sufficiently met by local supplies. Otherwise, inter-island trade is called for by the government or by private traders to move corn from the main producing areas to consuming areas. Table 7 lists the amount of corn in inter-island trade since 1975 to 1981. During a shortage of corn in the country, corn import is called for to adequatly supply demands either for feed or food outside Java.

Table 7. Domestic Corn Shipment, 1974-81

Source	1975	1976	1977	1978	1979	1980	1981
Surabaya	5,012	22,940	21,234	14,685	10,867	22,881	37,394
Other East Java	2,927	4,631	5,763	5,013	3,419	4,791	10,753
Belawan	8,967	55,997	15,120	13,428	20,669	9,878	7,053
Ujung Pandang	1,545	1,322	1,644	7,210	9,144	3,329	12,461
Noth Sulawesi	1,089	172	3,893	6,455	3,493	3,364	15,421
Lampung	-	-	6,215	11,032	12,377	8,562	6,290
Other	36,345	11,432	11,994	16,858	15,313	13,471	14,272
Destination							
Jakarta	6,618	20,771	13,915	17,502	17,502	11,082	26,764
West Java	-	100	6,215	7,218	12,298	8,550	6,526
Surabaya	4,910	37,917	7,382	17,168	14,291	3,790	8,945
Other, East Java	5,428	19,150	13,875	9,957	4,311	10,323	26,468
Bali	1,161	2,493	3,469	4,541	2,649	4,523	9,601
Other	37,768	16,063	21,037	21,835	24,231	28,008	25,340
Total	55,885	96,494	65,893	74,681	75,282	66,276	103,644

Source : Central Bureau of Statistics, "Inter-Island Trade," various issues.

4. Although corn is a secondary foodstuff to rice, it is a major source of calories and protein in the Indonesian diet. According to the food balance sheet corn directly consumed by humans accounts for about 10 percent of all calories and protein available for consumption. By the 1980s increasing amounts of corn were also consumed indirectly in the form of poultry meat and eggs, pork, and dairy products.

While survey data show that average per capita availability of corn ranges from about 15 to 20 kilograms annually, this average disguises corn's importance as a staple in certain regions, at particular times of the year, and for low-income consumers.

While almost all corn is consumed in the producing areas, Table 8 shows that less than one-half is consumed by producers from their own production. That just over one-half of consumption comes from market purchases is an important consideration in evaluating altered consumption patterns in response to changes in consumer incomes and food prices. In most provinces consumers are connected to, if not dependent upon, markets in meeting their desired levels of corn consumption. To some extent poor farmers with severe cash constraints sell corn in one season and buy corn for home consumption in another. But landless agricultural laborers and other poor groups in rural areas account for much of the consumption from market sources. Yogyakarta, with only 7 percent of consumption originating from market puchases, is exceptional for major producing areas on Java. Farm households in sorrounding areas, areas of poor subsistence farmers who rarely engage in non-family labor, produce almost all the corn in that province. By contrast, East Java has the highest proportion of consumption from market sources. This province has the most trading activity, shows the strongest taste preference for corn by the

Table 8 : Source of Acquisition

Province	Purchased	Own-Produced	Others (gifts)	Total
Central Java	56.4	42.0	1.6	100.0
Yogyakarta	7.2	91.4	1.5	100.0
East Java	62.6	35.3	2.1	100.0
Nusa Tenggara Timur	18.8	78.6	2.6	100.0
North Sulawesi	42.0	55.3	2.7	100.0
Central Sulawesi	29.5	67.1	3.5	100.0
South Sulawesi	26.4	70.6	3.0	100.0
Southeast Sulawesi	21.2	78.7	0.1	100.0
All Indonesia	50.8	47.0	2.2	100.0

Source : Central Bureau of Statistics, SUSENAS raw data for 1976, assembled by Richard Monteverde in the Corn Economy of Indonesia, 1985.-

nonfarming community, and has the most assured flows of corn to the market because of the off-season harvests on irrigated sawah.

5. It is also interesting to know the change of corn consumption from 1976 to 1978 on a provincial basis. This is shown in Table 9.

Table 9 : Consumption of corn (Grain Equivalent) by province 1976 - 1978

	Corn Grain Equivalent	
Province	1976	1978
Central Java	21.4	30.0
East Java	47.4	45.1
Nusa Tenggara Timur	7.3	7.1
North Sulawesi	4.7	3.6
South Sulawesi	7.0	5.0
Other	12.2	9.2
Total	100.0	100.0

Source: Central Bureau of Statistics, SUSENAS 1976, 1978

In terms of total amounts of corn consumed, East Java is the most important center, followed by Central Java and South Sulawesi in proportions that closely approximate their shares in total production. On a per capita basis, however, corn is a much more important staple in Nusa Tenggara Timur, North Sulawesi and Southeast Sulawesi; in these regions per capita corn consumption is from three to four times the national average.

6. The importance of corn is accentuated by the large volume it fills in the paceklik, or preharvest "hungry season," which falls between the dry season corn harvest, with its reduced yields, and the main rice harvest of March-April. The strong seasonality of consumption of corn is evident from Table 10. Corn consumption in Java is greatest in the period from January to March because of greater per capita consumption as well as additional numbers of people eating corn. The seasonal adjustment is largely the consequence of shifts in relative prices among the main staples. Corn consumption peaks around the main harvest, a time when corn prices fall, but declines in subsequent months as rice from the main harvest reaches the market and its price declines relative to that of corn. Some of the lower consumption of corn toward the end of the year is probably due to a seasonal decline in overall consumption of starchy staples.

7. Some of the seasonality of corn consumption is determined as much by the special difficulties of storing corn as by the seasonal patterns in production and consumption of the other principal staples, rice and cassava. As has been familiar to all farmers corn is difficult to dry since the main harvest occurs during the rainy season and thus cannot be stored for more than a few months. Losses in storage by farm households are high, and thus they usually store only a minimum of

corn beyond a necessary security stock. Consequently, the seasonal pattern of corn consumption corresponds with a slight lag to the seasonal production pattern.

Among the Javanese, preferences for corn are strongest in East Java. Table 10 shows that, compared with other provinces on Java, East Java has a larger proportion of people consuming corn and a smaller seasonal drop-off as consumers switch to other staples in response to relative price changes. A larger proportion of people remain corn consumers throughout the year in the centers of consumption in the outer islands, partly because of limited access to rice, which is the preferred staple, in these areas which are not well suited to rice production. On the outer islands, the peak in corn consumption, which corresponds to the major harvest in these regions, usually comes later in the year than for Java.

Table 10. Seasonal Variation in Percentage of Corn Consumers, by Quarter, 1978

Province	Share of Population Consuming Corn (percent)				Annual Average
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	
Central Java	38.2	21.0	10.0	12.9	20.5
D.I. Yogyakarta	31.5	10.3	3.4	1.1	11.5
East Java	42.6	26.7	27.3	30.5	31.8
Nusa Tenggara Timur	36.4	45.7	62.6	48.5	48.2
North Sulawesi	26.7	36.4	37.6	44.0	36.2
Central Sulawesi	14.7	17.3	15.2	18.1	16.3
South Sulawesi	25.9	24.9	14.9	14.2	19.9
Southeast Sulawesi	34.5	52.3	38.9	39.9	41.1

Source : Central Bureau of Statistics, SUSENAS raw data for 1978.

III. Consumption Analysis

1. Using SUSENAS data of 1976, 1978, 1980 and 1981 as basis to some extend, it is now possible to further analyze the change in consumption of rice, corn over time at different expenditure levels. Table 11 summarizes information on consumption of three food commodities on different expenditure basis. A little difficulty laid in interpreting the data due to inconsistency of expenditure class over time. For instance, data on 1976 recorded consumption per capita started with Rp 1,000,- of monthly expenditure as the lowest bound and ends up with over Rp 15,000 as the highest bound. On the other hand consumption in 1981 started with Rp 3,000 of monthly expenditure as lowest bound up to over Rp 40,000 as the highest bound. In spite of some underlying justifications background this classification, however, in judging such data needs further clarification before closer outlook is taken up on Table 11. Simple graphycal presentation of this Table is plotted in Figure 4 to summarize tentative conclusions;

a. Urban consumers belonging to under 4,000 to Rp 4,999 class level consume higher per capita of rice than those of rural consumers. Beyond this expenditure class level, however, people in rural areas show higher consumption of rice than those of urban consumers. This could perhaps be explained by the facts that low income earners in rural areas have much opportunities to diversify their foods, which is not always the case of those in urban areas.

b. Consumption of corn and cassava in urban areas for each expenditure class level is lower then those in rural areas. This obviously confirms previous assumptions which emphasized the relative importance of corn and cassava for rural people as source of their daily diets. Data also noted the upward trend of corn consumption at higher expenditure class levels, but this does not necessarily conclude that this group tend to shift away from rice. This could probably be explained by recalling that high income earners have more chances to diversify their food towards better quality, particularly of corn.

c. Data also notes steeper upward slope in the change of rice consumption in rural areas compared with urban areas during the period of 1976 through 1981. This corresponds to some previous empirical studies which found more elastic income with respect to demand for rice in rural areas.

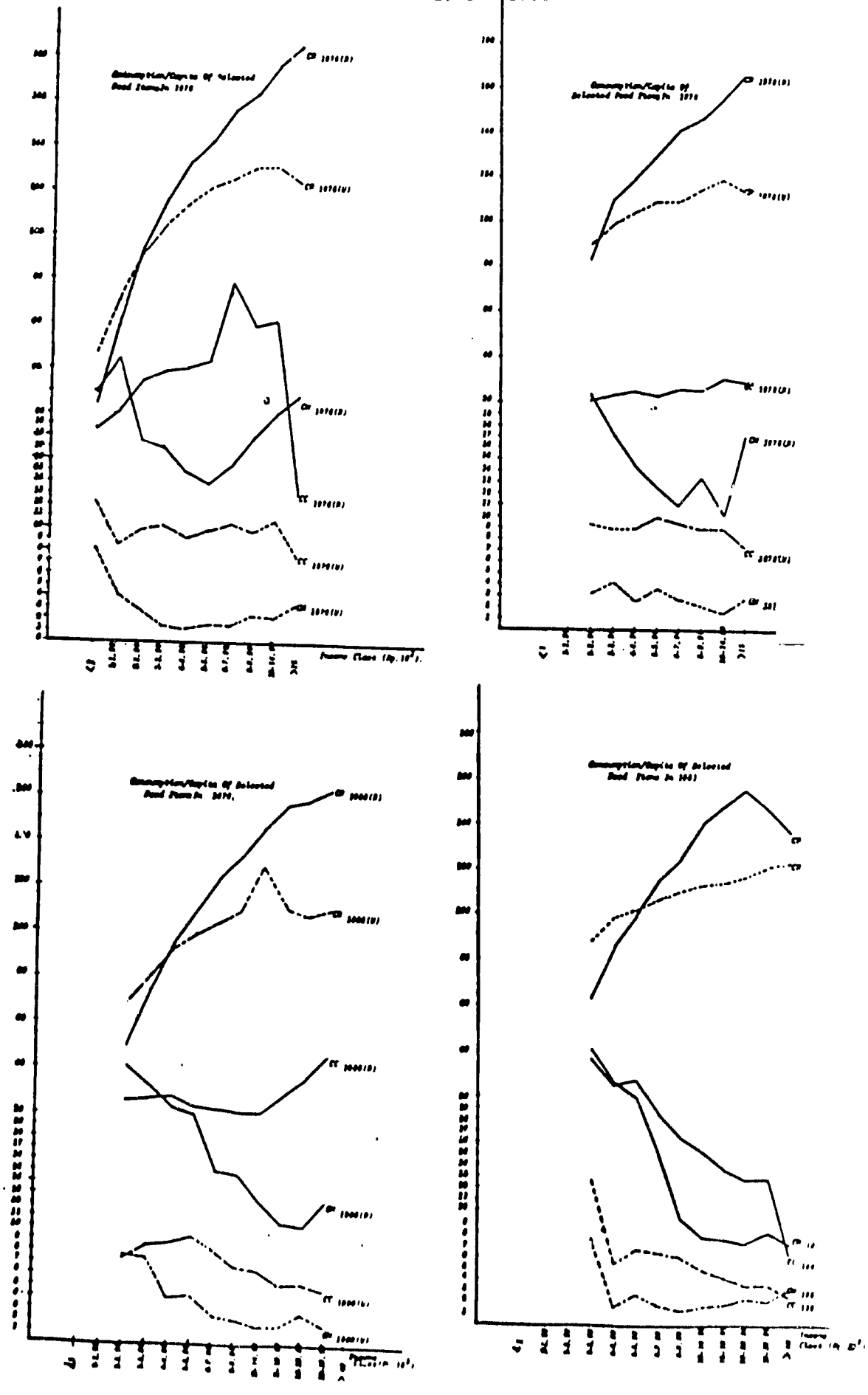
2. Further observation is made on Table 11 by the inclusion of general consumer price index as correcting factor. Based on the 1976 price index level, indexes for 1978, 1980 and 1981 were 86, 114 and 50 respectively. This adjustment needs to be accounted for since consumers purchasing ability are strongly influenced by current market prices which in turn affect consumers real income. In other word, current consumers income as approximated by monthly cash expenditures need to be deflated by the consumers price index to result in real cash expenditure at 1976 prices. In this case, adjustment is made in such a way to explain the change in the level of rice consumption at constant cash expenditures. This adjustment brings about a modification on expenditure class composition instead of the consumption level in 1978 onward. This is shown in Table 12.

3. Table 12 presents a modified class of expenditure with related consumption level. To clarify, adjusted Table 12 is plotted in Figure 5. With the help of Table 13 which consists of CBS study on income as it corresponds to the poverty picture in Indonesia it is now possible to combine the two data to result in the composition of cash expenditures of poverty and "comfortable" classes for consumption. To simplify the analysis Table 13 necessarily points out income classes into two categories, namely poor and "comfortable".

Table 11 : Consumption of selected food items at different expenditures per month

Expenditure/month (Rp.)		RICE (Kg)				CORN (Kg)				CASSAVA (Kg)			
		1976	1978	1980	1981	1976	1978	1980	1981	1976	1978	1980	1981
< 1.000	Urban	46.90				8.27				12.22			
	Rural	24.54				18.51				29.02			
1.000 - 1.999	Urban	71.24				4.26				8.42			
	Rural	61.62				21.06				44.82			
2.000 - 2.999	Urban	91.31	88.40	68.85		2.86	3.12	7.75		9.78	9.36	7.33	
	Rural	93.96	83.20	50.38		17.84	23.92	41.55		33.96	20.80	25.32	
3.000 - 3.999	Urban	104.78	98.80	80.96	88.87	1.30	4.16	7.59	7.54	10.24	8.84	8.63	12.64
	Rural	115.44	109.20	74.62	63.36	17.06	17.16	32.86	40.19	38.43	22.88	26.16	38.22
4.000 - 4.999	Urban	113.88	104	94.12	98.33	1.09	2.60	4.00	1.82	9.10	8.84	8.84	5.56
	Rural	132.18	119.60	94.48	86.37	14.82	14.56	23.86	27.66	40.20	23.92	26.99	27.14
5.000 - 5.999	Urban	120.28	109.20	98.64	101.56	1.35	3.64	4.26	2.91	9.88	9.88	9.26	6.71
	Rural	141.91	130	108.84	99.42	13.78	12.48	20.64	21.32	43.26	23.40	24.39	22.78
6.000 - 7.999	Urban	124.12	109.20	104.72	106.96	1.30	2.60	2.29	1.92	10.35	9.36	6.06	6.60
	Rural	155.38	140.40	123.60	114.04	15.44	10.92	15.65	15.08	77.95	26.00	23.82	18.67
8.000 - 9.999	Urban	126.28	114.40	109.62	109.15	2.24	2.08	2.13	1.46	9.78	8.84	6.97	6.03
	Rural	162.60	145.60	133.54	128.75	17.68	13.52	14.77	9.57	54.91	25.48	23.56	16.64
10.000 -14.999	Urban	129.22	119.60	129.22	112.00	2.08	1.56	2.08	1.66	10.92	8.84	6.40	4.94
	Rural	175.19	156.00	145.34	139.24	20.23	10.40	12.43	7.90	61.46	30.16	23.24	15.24
>15.000	Urban	123.97	114.40			3.38	2.60			7.49	6.76		
	Rural	184.03	166.40			27.82	17.16			13.00	29.12		
15.000 -19.999	Urban			111.85	114.92			1.72	1.98			5.41	4.37
	Rural			156.21	148.77			10.66	7.80			29.02	13.78
20.000 -29.999	Urban			108.74	117.52			2.76	2.39			5.51	3.69
	Rural			156.73	154.39			10.45	7.38			31.93	12.90
> 30.000	Urban			110.08				1.98				4.99	
	Rural			163.23				12.69				42.24	
30.000 -39.999	Urban				121.26				2.08				3.69
	Rural				146.33				8.11				12.95
> 40.000	Urban				121.73				3.17				2.55
	Rural				135.67				7.23				6.19

Figure 4 : Consumption Capita of Selected Food Items 1976 - 1981



Tabel 12 : Adjusted consumption/capita/year of selected items based on monthly expenditure on food.

Expenditure/month (Rp)		Rice (Kg)				Corn (Kg)				Cassava (Kg)			
		1976	1978	1980	1981	1976	1978	1980	1981	1976	1978	1980	1981
1.000	Urban	46.90											
	Rural	24.54				8.27				12.32			
1.000 - 1.999	Urban	71.24	88.40		88.87	18.51				29.02			
	Rural	61.62	83.20		63.36	4.26	3.12		7.54	8.42	9.36		12.64
2.000 - 2.999	Urban	91.31	98.80	68.85	98.33	21.06	23.92		40.19	44.82	20.80		28.22
	Rural	93.96	109.20	50.38	86.37	2.86	4.16	7.75	1.82	9.78	8.84	7.33	5.56
3.000 - 3.999	Urban	104.78	10.4	80.96	101.56	17.84	17.16	41.55	27.66	33.96	22.88	25.32	27.14
	Rural	115.44	119.60	74.62	99.42	1.30	2.60	7.59	2.91	10.24	8.84	8.63	6.71
4.000 - 4.999	Urban	113.88	109.20	99.12	106.96	17.06	14.56	32.86	21.32	38.43	23.92	26.16	22.78
	Rural	132.18	130	94.45	114.04	1.09	3.64	4.00	1.92	9.10	9.88	8.84	6.60
5.000 - 5.999	Urban	120.28	109.20	98.64	109.15	14.82	12.48	23.86	15.08	40.20	23.40	26.99	18.67
	Rural	141.91	140.40	108.84	128.75	1.35	2.60	4.26	1.46	9.88	9.36	9.26	6.03
6.000 - 7.999	Urban	124.12	114.40	104.72	112.00	13.78	10.92	20.64	9.57	43.26	26.00	24.39	16.63
	Rural	155.38	145.60	123.60	139.24	1.30	2.08	2.29	1.66	10.35	8.84	8.06	4.94
8.000 - 9.999	Urban	128.28	119.60	109.62	114.92	15.44	13.52	15.65	7.90	77.95	25.48	23.82	15.24
	Rural	162.60	156.00	133.54	148.77	2.24	1.56	2.13	1.98	9.78	8.84	6.97	4.37
10.000 - 14.999	Urban	129.22	114.40	129.22	117.52	17.68	10.40	14.77	7.80	54.91	30.16	23.56	13.78
	Rural	175.19	166.40	145.34	154.39	2.08	2.60	2.08	2.39	10.92	6.76	6.40	3.69
15.000	Urban	123.97				20.83	17.16	12.43	7.38	61.46	29.12	23.24	12.90
	Rural	184.03				3.38				7.49			
15.000 - 19.999	Urban			111.85	121.26	27.82				13.00			
	Rural			156.21	146.33			1.72	2.08			5.41	3.69
20.000 - 29.999	Urban			108.74	121.73			10.66	8.11			29.02	12.95
	Rural			156.73	135.67			2.76	3.17			5.51	2.59
30.000	Urban			110.08				10.45	7.23			31.93	6.19
	Rural			163.23				1.98				4.99	
30.000 - 39.999	Urban							12.69				42.28	
	Rural												
40.000	Urban												
	Rural												

Figure 3 : Adjusted Consumption/Capita of Selected Food Items (based on Table 4)

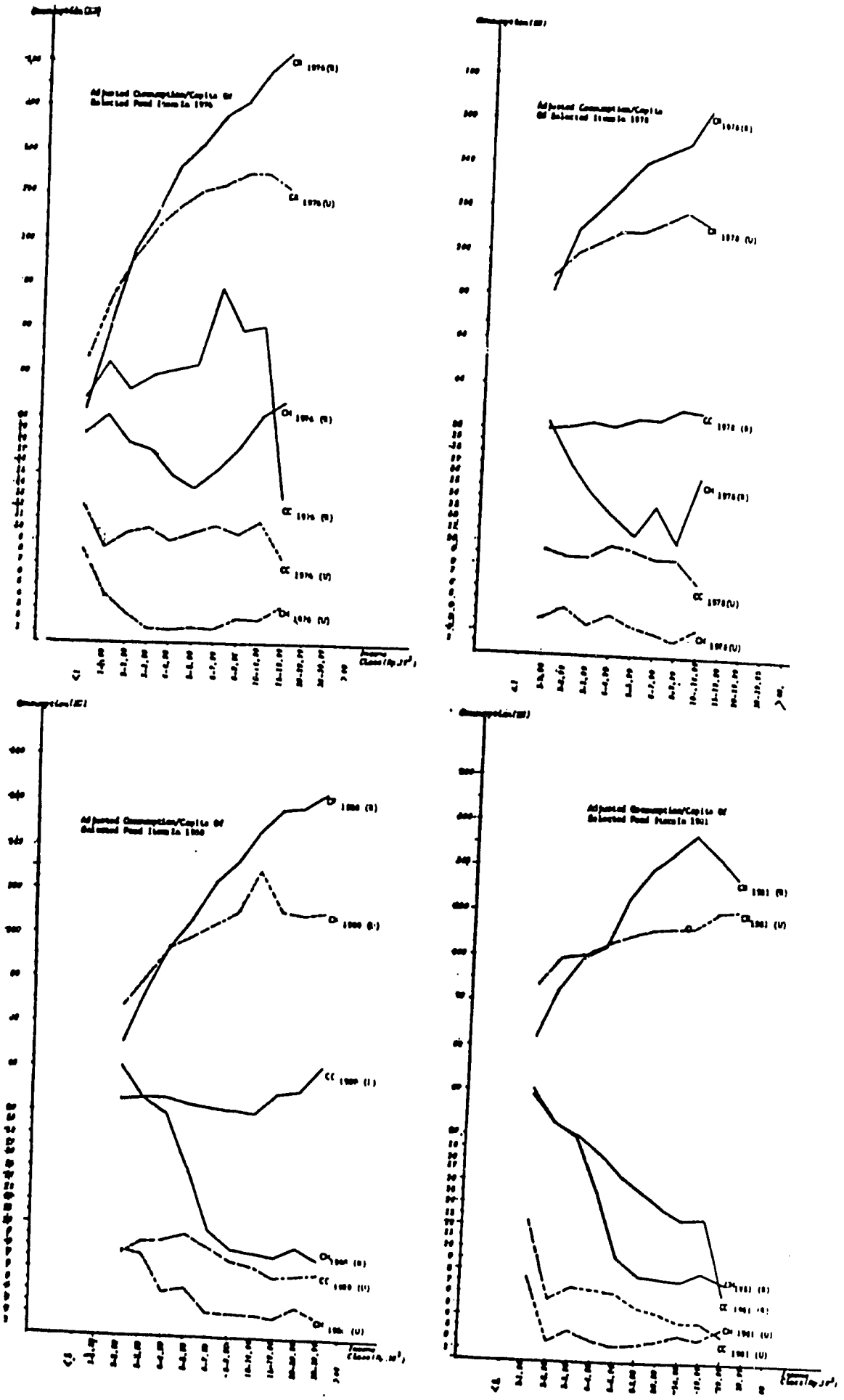


Table 13 : Poverty Classes based on Minimum Calorie Requirement on Food and Non Foods*

Years	Residence	Extreemly poor (2,100 cal) (Rp)	Correction factor (%)	Poor
1976	Urban	4,654	15.93	5,395
	Rural	3,150	6.12	3,343
1978	Urban	5,147	16.00	5,971
	Rural	3,343	6.25	3,552
1979	Urban	7,148	16.15	8,302
	Rural	4,985	6.46	5,307
1981	Urban	9,727	17.96	11,474
	Rural	6,270	6.53	6,679

Source : Income Distribution Indicators, CBS, 1985

* Poverty bound as used by CBS is based on the capability to meet minimum standard calorie/day (2,100 cal).

4. Classification of poor and "comfortable" is made since the number of studies with different approaches and definitions would not be possible to be presented in this paper.

   Adjustment on poor and comfortable level by taking CPI into account is summarized in Table 14.

Table 14 : Grouping of Poor and Comfortable level 1976-1981 (adjusted)

Year (1)		Poor (2)		Comfortable (3)	
1976	Urban	Group of	Rp 5,000 - Rp 5,999	Group of	Rp 6,000
	Rural	Group of	Rp 3,000 - Rp 3,999	Group of	Rp 4,000

(1)		(2)		(3)	
1978	Urban	Group of	Rp 5,000 - Rp 5,999	Group of	Rp 6,000
	Rural	Group of	Rp 3,000 - Rp 3,999	Group of	Rp 4,000
1980	Urban	Group of	Rp 8,000 - Rp 8,999	Group of	Rp 9,000
	Rural	Group of	Rp 5,000 - Rp 5,999	Group of	Rp 6,000
1981	Urban	Group of	Rp10,000 - Rp14,999	Group of	Rp15,000
	Rural	Group of	Rp 6,000 - Rp 7,999	Group of	Rp 8,000

5. The following Table 15 shows an upward change in the level of the poor in urban and rural areas as time changes. Plotting this data in Figure 6 shows that,

   a. Poorers in rural areas continously increase their rice consumptio since 1976 to 1981 and decrease their corn and cassava consumption as income rose.

   b. Poorers in urban areas below Rp 2,000/month cash expenditure consume more rice than those in rural areas at the same expenditure. It is also obvious that the rural poor at this expenditure class compensate their calorie inadequacy by consuming more corn. On the other hand poorers in urban areas concentrate their source of energy from rice as corn and cassava consumption decreases.

   c. Up to a certain level "comfortable" urbans tend to lower their rice consumption at least increasing at a slower rate. Data also note an increase of corn consumption as rice consumption decreases. This might be argued by the fact that more highly processed corn products are more available in urban markets instead of corn grain as it is largely sold in rural areas.

The analysis mentioned above confirms the assumption in which rice and corn at certain expenditure class levels at different seasonal periods support one another as a source of energy, particularly for poorers either in urban or rural areas.

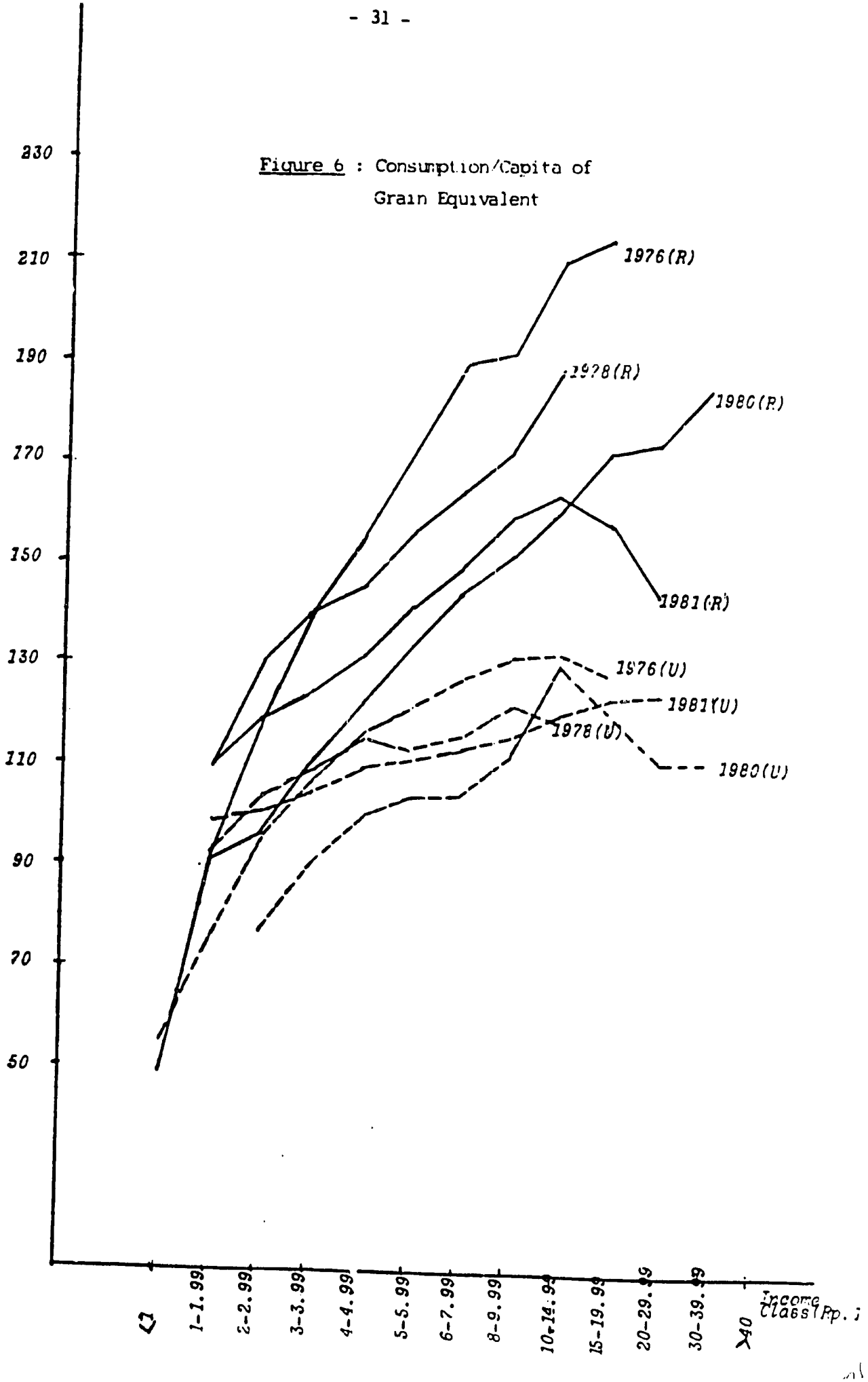


Figure 6 : Consumption/Capita of Grain Equivalent

Table 15: Consumption of Grain Equivalent (adjusted from Table D)

Income Class (Rp.)		Grain Equivalent (Kg) 1976	1978	1980	1981
(1)		(2)	(3)	(4)	(5)
<1.000	Urban	55.43			
	Rural	49.89			
1.000 - 1.999	Urban	77.51	93.66		99.13
	Rural	92.64	111.00		110.86
2.000 - 2.999	Urban	96.53	104.88	78.00	101.42
	Rural	119.86	131.10	96.00	119.27
3.000 - 3.999	Urban	108.58	108.64	90.28	105.97
	Rural	141.68	141.65	112.21	125.23
4.000 - 4.999	Urban	117.15	115.18	100.00	110.40
	Rural	156.11	147.59	123.74	132.93
5.000 - 5.999	Urban	123.99	113.97	104.96	112.02
	Rural	165.61	157.15	134.41	143.82
6.000 - 7.999	Urban	127.90	117.81	108.87	114.79
	Rural	189.20	164.68	144.29	150.48
8.000 - 9.999	Urban	132.81	123.25	113.35	117.86
	Rural	192.87	173.28	153.34	159.55
10.000 - 14.999	Urban	133.81	118.45	132.76	120.69
	Rural	210.06	189.83	162.84	164.51
15.000	Urban	129.01			
	Rural	213.60			
15.000 - 19.999	Urban			121.81	124.14
	Rural			173.45	157.20
20.000 - 29.999	Urban			112.71	125.36
	Rural			174.49	144.05
30.000 - 39.999	Urban			113.18	
	Rural			185.65	
>40.000	Urban				
	Rural				

6. For all income groups, dry corn grain is the most important base for household preparation, but its proportion of total corn consumption at different income levels varies considerably. For the poorest income strata, dry corn grain accounts for close to 80 percent of total quantities, but at higher income levels, this proportion falls as flour and fresh and dry cob preparations claim almost 50 percent of a consumption level which is smaller in total. This is consistent with the general tendency for diets to include more vegetables and foods requiring more preparation as incomes increase. Fresh corn, served in a variety of ways as a vegetable, is generally consumed in greater amounts as income rises, though the 1980 SUSENAS gives some indication that at higher income levels other vegetables also substitute in the diet.

Consumption of corn flour, which is used for baking, similarly increases through medium income groups until it is replaced by wheat flour. In both cases, corn appears to shift from a normal food to an inferior food at about the income range that enables households to purchase higher quality substitutes and improve the basic diet.

The Food Balance Sheet issued by CBS also presents data for consumption of fresh ear corn as a vegetable, and through 1975 it estimated consumption on the basis of 5 kilograms per capita per year. It is not clear what the method was used for subsequent revision of estimating fresh ear consumption, but the results are not stable as a proportion of production or on a per capita basis. Farm families in rural areas consume most of the fresh corn, taking the ears from corn fields where dry ears will be the main harvest. Results from Corn Project farm surveys in several production areas indicate that farmers harvest notable quantities of fresh ear corn. In parts of Central Java and South Sulawesi, farm households harvest up to 6 percent of a field's yield in ears for their own consumption.

7. What happens to corn consumption when incomes and prices change ? Although price changes are roughly comparable for all corn consumers, if allowance is made for quality differences and transportation margins, the same is obviously not true of income

changes. Since income data tend to be from aggregate national income statistics, a difficult but crucial question concerns how incomes of corn consumers are linked to aggregate changes in income. This is one reason for making an intensive effort to determine who the consumers of corn are. With this knowledge it may be possible to make at least rough judgments about the links between their incomes and the performance of the overall economy.

8. Two types of information are available - time series and cross section data - for estimating price and income parameters. Time series data on corn consumption are made up from food balance sheet calculations and do not contain any information suitable for estimating disaggregated parameters. But these data do show year-to-year changes and can be used for estimating short-run parameters of change with respect to changes in incomes and prices. By estimating lag models with time series data, it is also possible under certain circumstances to derive long-run elasticities.

9. SUSENAS data, on the other hand, reflect a wealth of household-specific characteristics at one point in time (or during a given year). This wealth of variability permitted Monteverde to estimate income-class specific price and income elasticities for corn which had eluded earlier investigators. These diaggregated consumption parameters do not reflect year-to-year changes in household behavior when prices and incomes change but rather long-run adjustments to differences in these variables among different households at the same point in time. Although the historical existence of certain general consumption patterns argues that households with low incomes will tend to behave like present high-income households when the former reach the income levels of the latter, many intervening variables argue for caution in using this interpretation of such parameters too rigorously. Still, by aggregating the parameters derived from household data

using share in consumption as weights, it is possible to get long-run parameters compatible with those from time series lag models.

10. Despite the richness of Indonesian data on corn consumption, some parameters are difficult to obtain. Direct estimation of parameters disaggregated by income class for the short run is infeasible in the absence of representative, cross-section panel data over time. For the time being, intuitive insights gained from patterns that link the other three cells are likely to provide the best guidance for filling the remaining cell. For all the cells, the cross-price elasticity of corn consumption with respect to the price of rice is probably important in explaining consumption behavior. Unfortunately, cross-price elasticities are notoriously difficult to estimate, especially by income class, and thus the focus here is primarily on estimates of income and own-price elasticities.

11. Extensive work on food consumption in Indonesia has been conducted with cross section data from the various SUSENAS surveys. Cross section data have typically been used to estimate income elasticities or highly restricted forms of price elasticities. A quite different approach was used by Timmer (1978) and by Timmer and Alderman to coax directly estimated price elasticities out of cross section data. They exploited price variance existing in the SUSENAS data not only from differentials in transportation costs between market areas but also from seasonal price changes across the three sub-rounds conducted for the 1976 SUSENAS survey.

One difficulty with cross section data for such analysis is that constant tastes are assumed across the sample; corn consumption is highly regional as has been noted previously.

This problem was alleviated to a degree in the work by Timmer and his colleagues by using cell means as observations. These groupings were still disaggregated by income class, province, urban or rural location, and sub-round.

12. The model was estimated by Timmer and Alderman for rice, fresh cassava, and total calories from these two staples plus corn. Since commodity coverage was so limited, no opportunity existed for testing homogenity and adding up restrictions from consumer demand theory nor was symmetry of cross price elasticities imposed. The approach was a pragmatic effort to estimate a portion of the full matrix of price and income elasticities and did not attempt to link demand equations via demand theory.

    Results from this model were robust, but unfortunately separate results for corn were inconsistent and not reported. The model was subsequently modified by Monteverde and re-applied to derive parameters for corn. To clarify the corn consumption parameters, Monteverde applied the framework of Timmer and Alderman directly to the 54,000 and 24,000 household observations in 1976 and 1978 SUSENAS surveys, respectively. This approach yielded the negative own-price elasticities for corn grain consumption which had eluded all previous analysts. The results for 1978 shown in Table 14 reveal that poor consumers of corn are more responsive to price changes than richer consumers, which is consistent with the findings of Timmer and Alderman for rice and fresh cassava and with findings from similar analysis in other countries (Alderman; Timmer, 1981b). *

13. Separate estimates of expenditure (income) elasticities for several forms of corn consumption by urban and rural populations made by Monteverde using the 1980 SUSENAS survey are reported in Table 16. The value for corn grain consumption in rural areas shows that a 1 percent increase in income

results in a 0.75 percent decrease in corn consumed. While income elasticities for corn grain disaggregated by income are still undocumented, Monteverde indicates that they do differ across groups, but for recent data they are negative even for the lowest income bracket. Fresh corn consumed as a vegetable rather than as a starchy staple appears to be a normal goods, and even a luxury in urban areas, where it is purchased from markets rather than procured from own corn production.

Table 16. Income Elasticites by Corn Type, 1980

Corn Type	Rural	Urban
Corn Grain	-0.75	-0.82
Fresh Corn	0.39	1.20
Dried Corn with Husk	-0.34	insignificant
Corn Flour	-0.53	insignificant

Source: Estimated by Monteverde from SUSENAS raw data for 1980.

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RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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SEASONALITY IN BURKINA FASO GRAIN MARKETING: FARMER STRATEGIES AND GOVERNMENT POLICY

by

Lynn Ellsworth and Kenneth Shapiro

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

Maryland Inn
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Abstract

Burkina Faso's National Cereal Office (OFNACER) has a broad mandate that includes dampening seasonal price swings so as to help both producers and consumers. A survey of 220 farm households in 5 western Burkina Faso villages was undertaken in 1984, in part, to help OFNACER target its interventions. Two of the villages were in the northern, deficit Yatenga region; two were in the central, marginal Volta Noire; and one was in the southern, surplus Hauts Bassins.

For the sample as a whole there was some tendency for grain sales to be concentrated in the low-price, post-harvest season and for grain purchases to be concentrated in the high-price, pre-harvest season. But this pattern was not extreme. Grain sales may not be of primary importance as either a mechanism for diposing of grain or for earning income. In three villages grain sales were less than other, nonmarket grain transfers out of the household; and for the whole sample, cash receipts from all crop sales were less than other cash receipts.

The majority of households (137) were not adversely affected by seasonal price swings, either because they had minimal market transactions (25) or because they sold or bought very little grain when prices were very low or high respectively (112). A small group of households (15) seemed to time their sales to take advantage of the seasonal price rise. These were wealthy farmers with above average total sales. One group of 27 households did seem to suffer from the sell low and/or buy high syndrome. They are poorer than average and cultivate less land than average.

The poor farmers who were suffering from seasonal price movements may be an appropriate target for OFNACER intervention if equity or welfare considerations are deemed important. Locally administrated cereal banks in deficit villages may help OFNACER or work parallel to it. Other supply response analyses of the survey data, plus the secondary importance of grain sales as an income source, and the fact that grain prices have already risen significantly both absolutely and relatively do not support intervention to increase producer incentives. Finally, the survey was not designed to measure the full cost of traders' holding grain through the year and hence there are no recommendations concerning interventions to deal with possible exploitation by traders nor possible physical/structural inefficiency in the marketing system.

Seasonality in Burkina Faso Grain Marketing: Farmer Strategies and Government Policy

by

Lynn Ellsworth and Kenneth Shapiro[1]

In the early years of the Sahelian drought, Burkina Faso (then Upper Volta) and Niger were encouraged by donor agencies to establish national cereal marketing organizations with broad and ambitious mandates to help both producers and consumers. Burkina Faso created the Office National des Cereales (OFNACER) in January, 1971. The objectives and authority of OFNACER have varied over the past 15 years, but generally included the following: (1) stabilizing grain prices within and across years; (2) offering producers a high enough price to elicit increased production; (3) offering consumers a "fair" price; (4) decreasing exploitation by traders who were thought to be a major cause of price fluctuations, of low producer prices, and of high consumer prices; (5) distributing food aid; (6) maintaining a security stock, and (7) supplying deficit areas.

With the benefit of hindsight, many observers (including some of the aforementioned donors) believe that national marketing organizations are probably unable to be important, efficient actors in African grain economies. In addition, several research projects have cast doubt upon the assumption that African traders are seriously exploiting consumers and producers. Thus, in 1985 we face the question of what role government should play in domestic

[1]The authors are graduate student and professor, respectively, of Agricultural Economics at the University of Wisconsin-Madison.

staple food marketing. This conference, in effect, examines one part of that question: How can governments improve food security by dealing with seasonality (seasonal variations in price and availability) in their domestic grain economy?

The objective of this paper is to help answer that question for Burkina Faso by examining the marketing behavior of farmers surveyed in the western part of that country in 1984. The first section presents background information on the sample villages and their grain economies. The second section discusses the nature of seasonality, while section three considers reasons for government intervention. The fourth section examines the sample's seasonal pattern of grain sales and purchases and concludes that the situation is not so extreme as generally thought. Nonmarket transfers are analyzed next and are shown to be quite important compared to grain market transfers. The fifth section disaggregates the sample according to the different strategies that farmers seem to be following. This is done in an effort to help the government target specific policies at specific groups, rather than trying to be all things to all people. The final section discusses policy options and places primary emphasis on assisting poor consumers in deficit regions. Local cereal banks or other village-based operations may be important in helping these consumers.

The Survey Villages and Their Grain Economies

Two hundred and twenty farm households were sampled in five villages across three ecological zones.[2] Between 42 and 51 farm-households are in

[2]The survey was undertaken by the University of Wisconsin under subcontract to the University of Michigan contract No. 686-0243-C-00-2063-00 with the U.S. Agency for International Development. This contract funded the Research Component of the Burkina Faso Grain Marketing Development Project.

each village sample. The two northernmost villages studied, Mené and Bougouré, are in the Yatenga region in the northern reaches of the Sudanian savanna zone, bordering the drier Sahelian region farther north. Annual rainfall is between 500 and 800 mm, the lowest and least reliable of the areas studied. The rainy season is typically shorter than in the other villages. Yatenga has recently been a grain importer, and prices here are typically higher than in the central or southern areas of Burkina Faso, although they exhibit a similar seasonal pattern.

Two villages, Tissi and Dankui, are in the west central Volta Noire region, an area that often exports grain and has more fertile soil. While it is also in the Sudanian savanna, the area receives slightly more rainfall than the Yatenga villages to the northeast. In recent drought years, such as the survey year, this area has become less of a surplus exporting region.

The southernmost village, Baré, is in Hauts Bassins in the northern Guinean ecological zone, which is wetter and more humid than the Sudanian savanna where the other villages lie. Baré has often been a grain exporter.

Almost all households in all five villages purchased grain. In contrast, there were significant numbers of grain sellers in only two of the villages. For the sample as a whole, about 15 percent of the grain[3] harvest was sold, but the southern surplus village of Baré dominates these statistics. The Baré sample sold 22 percent of its harvest while none of the other four village samples sold more than 10 percent. A contemporaneous survey by Purdue University and SAFGRAD in relatively favorable environments found sales

[3]Millet and sorghum are the most important grains followed by maize. There is also a little rice.

equaling 15 percent to 25 percent of harvests in four villages in 1984.[4] These data are presented in Table 1.

Table 1.--Grain Sales and Harvests in Nine Burkina Faso Villages, 1983-1984

Village	Households in Sample	Households That Sold Grain	Total Grain Sales (kg.)	Total Grain Harvests (kg.) by all Sample Households	Sales/ Harvest%
Mené	46	7	1,175	37,319	3.1
Bougouré	42	6	75	8,017	0.9
Baré	50	47	30,001	136,003	22.1
Tissi	40	24	2,043	21,247	9.6
Dankui	42	3	506	18,620	2.7
Dissankuy	27	13	4,859	32,809	14.8
Nedogo		28	8,033	38,873	20.7
Poédogo	75	18	8,799	35,355	24.9
Diapangou		22	9,765	45,800	21.3
Total	322	168	65,256	374,043	17.4

In the five surplus villages (Baré plus the Purdue/SAFGRAD villages) the average selling household sold 480 kg of grain. In the four deficit villages the average was only 95 kg.

Analyses by Szarleta[5] and Pardy[6] indicate that marketed surplus in these nine villages is not significantly price responsive. (Their analysis

[4]Pardy, Christopher. 1985. "Cereal Sales Behavior Among Farm Households in Four Villages of Burkina Faso." The villages are Dankui, Dissankuy, Nedogo, Poédogo, and Diapangou.
[5]Szarleta, Ellen. 1985. "Increasing the Marketed Surplus of Cereal Grains in Burkina Faso: An Identification of Farmer Response."
[6]Pardy, Christopher. Ibid.

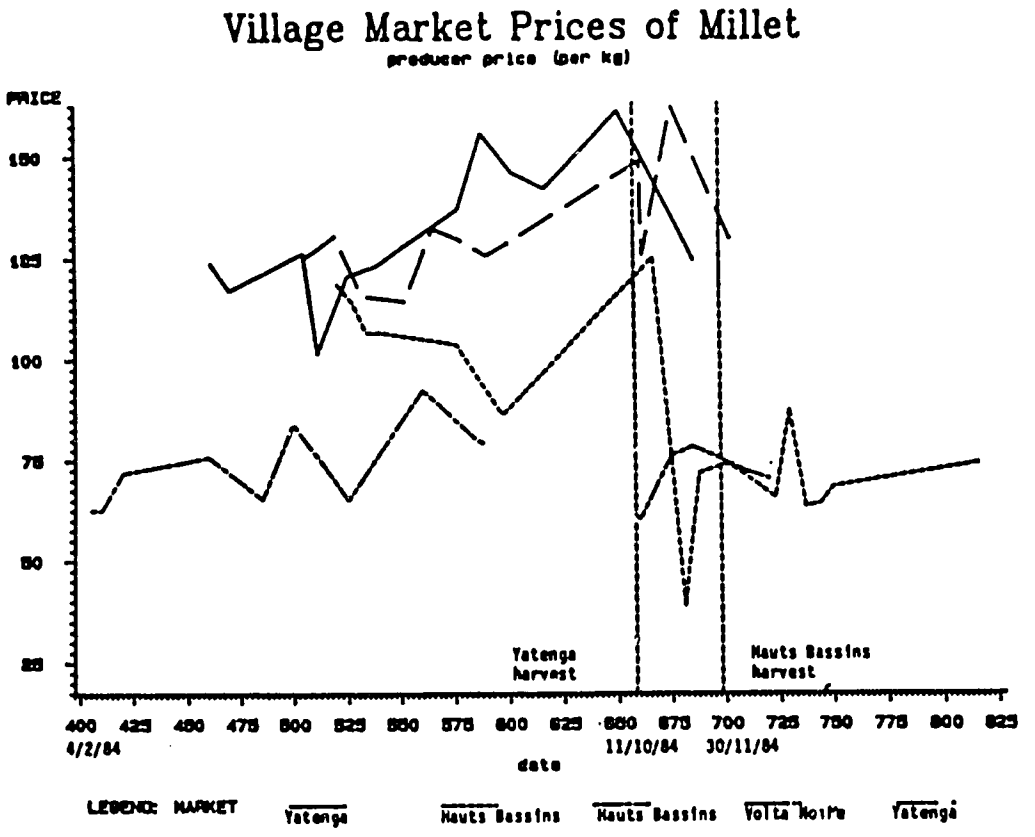
was limited to seasonal and spatial price differentials within one year.) The overwhelmingly most important determinant of sales was harvest. This of course has implications for the importance of price policy vs. research and extension for increasing marketed surplus, an issue to which we return in the analysis of seasonality.

The Nature of Seasonality

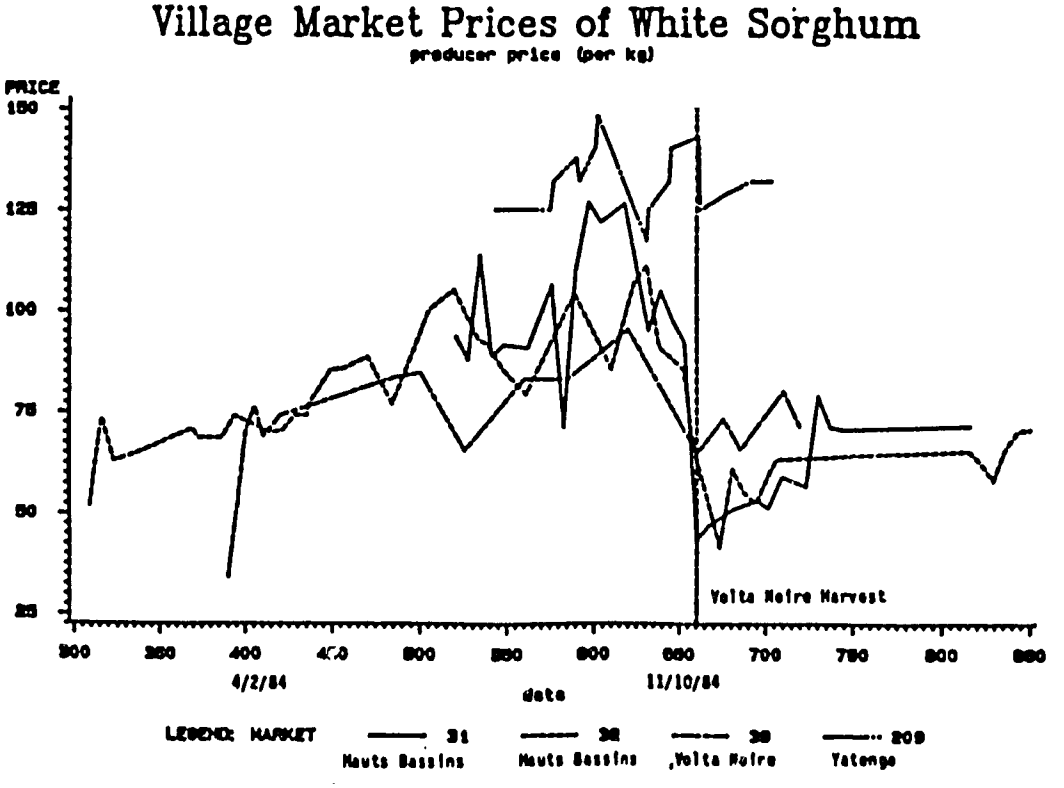
In the five villages studied under this project, the rainy season typically lasts between 134 days in the most southerly village of Baré and 100 days in the most northerly villages of Bougouré and and Mené. "Normal" annual rainfall in Baré is 1100-1200 mm and in Mené 500-800 mm. The rains begin in May or June and end in September. The main grain harvests begin in October or early November, with some maize harvested in September. Grain prices in markets serving the sample villages plummet at harvest time and then increase throughout the next twelve months reaching a peak in October. Increases of 50 percent in consumer and producer prices are not uncommon. See, for example, Graphs 1 and 2.

The welfare and incentive implications of these price patterns may be causes for government action. As discussed more fully below, there is a tendency for farmers in our sample to concentrate sales in the six months after the harvest, and there is an even stronger tendency for them (not necessarily the same individuals) to buy more just before the next harvest. That is, the data offer some support for the hypothesis that African farmers sell low (post-harvest) and buy high (pre-harvest). However, this picture must be disaggregated before it can provide useful policy guidance.

Graph 1



Graph 2



1. Source: Survey data.

Seasonality and Government Interventions

In a well functioning economy, the price of grain should rise after the harvest to reflect the costs of holding that grain. These costs typically include the cost of using a storage facility, interest (paid or foregone), shrinkage and spoilage, the risk of theft or other losses, and so forth. In Africa some suggest that an added cost is the amount of grain that a family may be forced to give away to relatives or others if the family in question is seen to have a large amount in storage.

There are at least four circumstances under which one might consider seasonal price increases to be a problem that government should attempt to ameliorate. The first might be called the exploitation situation in which the seasonal price increase is far in excess of the costs of holding grain. Collusive behavior by traders might cause such a situation. Unfortunately, we do not have adequate information on the costs of holding grain in Burkina Faso to permit any conclusions about this. A second situation relates to inefficiency. Government might wish to act if the costs of holding grain could be lowered by more than the costs of, e.g., improving storage facilities or improving money markets. Again, we do not have sufficient information on these latter costs of improvement. A third situation relates to equity. Government might wish to act if poor producers and poor consumers were suffering considerably from seasonal price movements. The next section presents information relevant to this issue. A fourth possibility given high priority by some is that farmers may lack sufficient incentives. If producer

prices were higher, the argument goes, there would be a large supply response, much of which would be marketed. This is a broader question than seasonality, but low post-harvest prices may be relevant. Some attention is devoted to this subject below.

Seasonality in Grain Sales and Purchases

Perhaps the most common characterization of staple food marketing in Africa is that farmers sell in the post-harvest, low-price season and buy in the pre-harvest, high-price season. Explanations for this supposed pattern include outdated notions of peasant irrationality, sales tied to paying off loans, taxes, pent-up demand for cash purchases, fear of having to share surplus grain as the hungry season approaches, seasonal variations in access to buyers and sellers, and others. This section first documents the seasonal pattern of transactions in the five villages studied under this project. The conventional wisdom is borne out for purchases more strongly than for sales, but there are large amounts sold and bought in all seasons.

As shown in Graphs 1 and 2, grain prices start falling rapidly in October in the markets serving the surplus villages. Thus the post-harvest "quarter" is defined as October 11 to December 28. The remaining quarters are Jan-March, April-June, and July-October 10. The seasonal transaction pattern for the total sample is shown in Table 2.

The sales pattern appears more evenly distributed than is typically thought. The largest grain sales do not occur immediately post-harvest, but rather in the following quarter. No quarter has less than 17 percent of sales and none more than 33 percent. The purchase pattern follows expectations more

Table 2.--Grain Sales and Purchases by Quarter For Five Burkina Faso Villages[1], 1984.

	Jan-Mar	Apr-June	July-Oct		Oct-Dec
Sales[2](kg)	9,520	4,885	6,347	HARVEST	7,811
Purchases[3](kg)	25,366	35,846	57,158		12,085

[1]Mené, Bougouré, Baré, Tissi, Dankui.
[2]Sorghum, Millet, Maize
[3]Sorghum, Millet, Maize, Rice, Food Aid, Miscellaneous Foods

closely with most grain purchased in the pre-harvest period. The range is from a high of 43 percent pre-harvest to only 9 percent post-harvest.

This picture of seasonal transactions is modified if one looks at individual household behavior. Table 3 shows the number of households that made the largest amount of their sales or purchases in the quarter shown.

Table 3.--Number of Households with Their Largest Volume of Sales and Purchases in Each Quarter in Five Burkina Faso Villages.[1]

	Jan-Mar	Apr-June	July-Oct		Oct-Dec
Sales[2]	21	5	8	HARVEST	35
Purchases[3]	45	61	64		7

[1]Households selling more than 25 kg and buying more than 50 kg.
[2]Sorghum, Millet, Maize
[3]Sorghum, Millet, Maize, Rice, Food Aid, Miscellaneous Foods

Examination of individual household selling patterns reveals that the post-harvest quarter is indeed the heaviest sales period for the largest number of households, and that the two post-harvest quarters are the heaviest sales period for 81 percent of farmers selling more than 25 kg in the year. Purchase data at the household level show that many households do buy heavily before the high-price, pre-harvest season, but the pre-harvest season does show the greatest number.

In sum, the seasonal transaction patterns observed in the five sample villages provide some support for the conventional wisdom that African farmers sell low and buy high. However, the pattern is not extreme and there is evidence that some farmers contradict it. For example, 22 of the 68 households that sold more than 25 kg, made less that 15 percent of their sales in the post-harvest quarter. That is, almost one third of the sellers did not sell very much at the worst time with respect to price. This subset of households is investigated further below.

Disaggregating by village provides further insights into seasonal patterns. Tables 4 and 5 show, by village, the number of households whose heaviest sales and purchases occur in each quarter. The sharpest differences are between Baré, a relatively wealthy, surplus village, and the others which

Table 4. Number of Households with Their Heaviest Grain Purchases in Each Quarter, by Village.[1,2]

	Jan-Mar	Apr-June	July-Oct		Oct-Dec	Total
Mené	12	16	13		2	43
Bougouré	16	21	8	HARVEST	0	35
Baré	14	6	9		4	33
Tissi	5	8	15		0	28
Dankui	8	10	19		1	38
Total	45	61	64		7	177

[1]Sorghum, Millet, Maize
[2]Households buying more than 50 kg.

Table 5. Number of Households with Their Heaviest Grain Sales in Each Quarter, by Village.[2]

	Jan-Mar	Apr-June	July-Oct		Oct-Dec	Total
Mené	2	0	3		0	5
Bougouré	0	0	0	HARVEST	1	1
Baré	16	4	4		23	47
Tissi	1	1	1		9	12
Dankui	2	0	0		1	3
Total	21	5	8		34	68

[1]Sorghum, Millet, Maize
[2]Households selling more than 25 kg.

are poorer and either chronically or occasionally deficit in cereals. The largest number of Baré households made their heaviest purchases between January and March rather than waiting until later in the season when prices were higher. In the other four villages the following two quarters, of progressively higher prices, saw the largest number of households making their heaviest purchases. Comparative analysis of sales is difficult because two thirds of those who sold over 25 kg were in Baré. Comparing Baré with Tissi, the village with the next most sellers, reveals that proportionately more Baré farmers avoid making their heaviest sales in the post-harvest quarter. Thus the relatively well-off, surplus village seems to suffer least from the strong seasonality in grain prices. The "sell low, buy high" characterization fits Baré less well than it does the other poorer, deficit-prone villages.

Grain Marketing Compared to Other Grain and Cash Transfers

Other grain and cash transfers provide a useful perspective on the importance of grain marketing. Income derived from grain sales by the sample was small compared to total cash receipts. Grain and other crop (e.g. cotton and peanuts) sales together amounted to only one third of other cash receipts.

Grain sales (kg) in the four deficit villages were smaller than the amount of grain those villages gave in nonmarket transfers. In contrast, grain purchases in those villages far exceeded grain received from nonmarket sources. These data are summarized in Table 6.

Table 6. Market and Nonmarket Grain Transfers (kg)[1]

	Sales	Purchases	Nonmarket Transfers In	Nonmarket Transfers Out
Mené	1,175	30,340	1,817	476
Bougouré	75	18,420	1,894	596
Tissi	2,043	24,163	8,847	14,593
Dankui	506	15,576	591	1,913
Total	3,799	88,499	13,149	17,578

[1]Source: Szarleta, Ellen. Ibid.

The seasonality of other transfers has elements similar to the seasonality of grain marketing. As shown in Table 7, nonmarket grain transfers peak in the post-harvest season, with the pre-harvest season being next in importance. This is consistent with Saul's contention that payments for agricultural work and "obligatory" gifts result in high transfers around the harvest, and that these are subsequently sold and swell the post-harvest sales glut.[7]

This point is reinforced by the reasons farmers offered for the transfers they gave in different seasons. A "gift" was cited more often in the post-harvest quarter than in any other quarter; and during the post-harvest quarter, "gifts" were cited more than any other reason. Paying a work party was cited far more in the pre-harvest quarter than in any other quarter, and during that quarter it was the most commonly cited reason. It is also during the pre-harvest period that emergency help is cited much more (81%) than in

[7]Saul, Mahir. 1985. "The Marketing of Grain in Upper Volta."

Table 7. Nonmarket Transfers of Grain and Money by Quarter[1,2]

Total	Jan-Mar	Apr-June	July-Oct		Oct-Dec
Grain Received (kg)	2,192	1,656	4,153	HARVEST	7,590
Grain Given (kg)	5,601	801	5,867		11,458
Money Received (1000 CFA)	1,484	3,691	1,399		899
Money Given (1000 CFA)	1,228	2,294	1,187		570

[1]Mené, Tissi, Dankui, Bougouré with minimal data for Baré.
[2]Amounts given do not match amounts received because of inflows and outflows to and from the sample.

any other quarter, but it is cited for only 9 percent of the total number of transfers in the pre-harvest quarter. In the second quarter after the harvest, i.e., January to March, funerals are cited as the main reason for gifts given. In the following quarter relatively little cereal is transferred and various reasons are given (e.g., "maintain relations," "miscellaneous payments," "other".) In sum, there is a substantial interhousehold, nonmarket movement of grains with the stated reasons varying through the year. In the pre-harvest it is payment of work parties, then in post-harvest it is gifts, then funerals in January-March, and finally a variety of reasons in April-June when the volume transferred is low.

With regard to money transfers, perhaps the most interesting fact is their concentration between April and June. Some of this may represent gifts aimed at helping families buy cereal as the hungry season approaches. The data have not yet been analyzed to the point of being able to see the role of remittances from family members away from home. The reasons for money given in transfer do not show very clear seasonality.

Household Variations in Marketing Patterns

Some households appear to suffer from the "sell low, buy high" syndrome while others avoid the worst effects of seasonality and still others seem to take advantage of seasonal price movements. The government of Burkina Faso would be able to target its interventions more efficiently if it could identify different marketing patterns and the types of households pursuing each one. This section presents one effort to do this.

Fifteen households had a sales pattern that took advantage of the seasonal price increase. They made more than 60 percent of their sales in the six months preceding the harvest, i.e., during the higher price periods. This group is wealthier and perhaps more market-oriented than the rest of the sample. While comprising only about 7 percent of the 220 households in the sample, they own 25 percent of the samples' cattle and 10 percent of the value of durable goods, and they account for 38 percent of the total sales by sample. The average household in this group sold 944 kg. of grain compared to a sample average of 155 kg. (among those who actually sold any grain, the average amount sold was 389 kg.).

In contrast to this group are 27 households that seem to be taking losses because of the seasonal price movements. This group includes those that buy more than 60 percent of their year's purchases in the six months prior to harvest and/or make more than 60 percent of their yearly sales in the six months after the harvest.[8] These households are extremely poor in cattle but are slightly above average in value of durable goods. They have a relatively small area under cultivation (6.33 ha vs. the sample mean of

[8]The latter criterion also requires at least 100 kg. of sales in the year.

7.62 ha) even thought their family size is larger than average (7.89 consumer equivalents vs. 6.86 for the sample). Also, they have more of their land in cash crops (cotton and peanuts) than average (13% vs. 10%). The average amount sold and purchased by these households is close to the sample mean.

There are two types of marketing patterns that seem to imply neither significant gains nor losses from seasonal price movements. A group of 25 households are fairly autarkic, making no purchases and selling less than 100 kg. during the year. They cultivate more land (8.07 ha) than the sample average and have less of it in cash crops (7% vs. 10% for the sample). These households have considerably fewer cattle than average (.38 head vs. 1.91 per household) but about the same value of durable goods. Another group, comprising slightly more than half the sample (112 households), managed to avoid taking losses caused by seasonal price lows or highs. They either made less than 15 percent of their total sales in the three months after the harvest or they made less than 15% of their total purchases in the three months prior to the harvest.[9] That is, they avoided the worst price periods for their sales and/or purchases. However, they were not particularly adroit in concentrating their sales in the high price period. In most respects this group was similar to the sample mean, which is not surprising since they are the majority of the sample.[10]

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[9]That is, a "sales-loss avoider" household made less than 15 percent of its total sales in the post-harvest quarter and did not take sufficient losses in purchases to be classified with the prior group having more than 60 percent of purchases in the pre-harvest period. Similarly for "purchase-loss avoiders."

[10]Another group of households that closely resemble the sample average are best characterized by their pattern of buying heavily during the low price season.

The above characterizations of grain marketing patterns may be useful in guiding government interventions to target groups that need help. Perhaps the major finding here is that 137 of the 220 households either do not interact significantly with the grain market or manage to avoid taking major losses from seasonal price movements. A very small group seems to benefit from those movements, and about 12 percent seem to be suffering from them. This latter group may be the appropriate target for government action related to seasonality.

Conclusions and Policy Implications

Government interventions in grain marketing may be motivated by four circumstances related to seasonality. As discussed above, these have to do with exploitation, inefficiency, equity, and incentives. Our survey did not gather data to assess the extent to which traders may be exploiting producers and consumers by exaggerating seasonal price swings, nor do we have data to determine whether government efforts to overcome market inefficiencies would cost more or less than resultant benefits in the form of decreased costs of holding grain from one season to the next. Examination of farmers' marketing patterns and other transfers does offer information concerning the equity and incentive issues.

Aggregate data show some concentration of sales in the low price, post-harvest periods and a concentration of purchases in the high price, pre-harvest periods. However, the pattern is not extreme. Disaggregation by types of marketing patterns reveals that most farmers sampled were probably not significantly affected either positively or negatively by seasonal price

movements in 1984. A small group of poor farmers seem to have suffered and they could be the target of interventions motivated by equity considerations.

Incentive arguments find little support in our analysis. The group of farmers that were able to take advantage of seasonal price increases were the group with the largest sales per household. Government efforts to increase post-harvest prices are unlikely to provide meaningful incentives to these large sellers since they evidently have the ability to hold most of their grain until prices rise later in the year. For the sample as a whole, cash receipts from crop sales were small compared to other cash receipts and hence grain marketing may not be a key economic activity that is likely to respond strongly to price incentives. In addition, the supply response analyses of Szarleta and Pardy do not show price to be a dominant factor. Finally, official producer grain prices in Burkina Faso have already been rising rapidly both absolutely and relative to other crops. For example, from 1971/72 to 1984/85 the official producer price of millet rose from 12 CFA/kg to 80 CFA/kg while the official cotton price rose from 32 CFA/kg to 80 CFA/kg.[11]

Thus our research provides support only for equity based interventions by OFNACER with regard to seasonality. In a small crop year such as the survey year, OFNACER has less need to influence producer prices because free market prices are relatively high. However, OFNACER can play a major role in lowering high, pre-harvest consumer prices in deficit regions. OFNACER's impact has been supplemented recently by local organizations such as cereal banks that try to stockpile grain for subsequent village purchase in the

[11]Moussie. 1985. Untitled Report on OFNACER, P. 64.

pre-harvest season. Many small, locally administered cereal banks may ultimately be able to fulfill this function more efficiently than a centrally administered, national organization like OFNACER. At present a working relationship is developing between the two that may prove valuable to each.

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INSTITUTE

1776 Massachusetts Avenue, N W
Washington, D C 20036 U S A
(202) 862-5600
Telex 440054
Cable IFPRI

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THE IMPACT OF IRRIGATION ON SEASONAL FOOD AVAILABILITY, FARM INCOME AND LABOR DEMAND IN THAILAND

by

Dow Mongkolsmai and Mark. W. Rosegrant

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and Research Needs

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INTRODUCTION

Monsoon Asia is generally characterized by distinct wet and dry seasons, which are associated with wide seasonal fluctuations in agricultural production, farm income, labor use, wages and prices. Irrigation is perhaps the most obvious instrument for attempting to reduce the fluctuations between peak and slack seasons. In this paper, the impact of irrigation in Thailand on seasonal food availability and prices, farm income, and labor demand is examined.

The first section briefly describes the development of irrigation in Thailand, while the second section explains the effect of irrigation on macro-level food availability and prices. The next section uses a farm-level analysis to examine the impact of irrigation on production, farm income, and labor use. In the fourth section, seasonal labor migration is examined, followed by general conclusions.

IRRIGATION DEVELOPMENT IN THAILAND

Early investments on irrigation schemes in Thailand were concentrated on large projects and major water distribution systems in the Central Plain. Consequently, the benefits of such investments were largely to increase yield of the wet season rice crop in the Central region by improving the reliability of water supply. It was in the early 1970s that the emphasis was shifted to smaller projects to provide water delivery network at the farm level in the already existing large irrigation schemes in the Central Plain, and to other regions of the country. However, while the latter half of 1970s saw a rapid increase in dry season rice cropping area especially in the Central Plain, this was only a small part of the total irrigated areas (19% in 1982), whereas a large part was still under one crop a year due to lack of water in the dry season and a lack of tertiary canals in large parts of the gravity flow systems to deliver water to the fields. Even in the wet season, the degree of water control still depends partly on rainfall.

The regional disparity in irrigated areas as shown in Table 1 suggests that a major part of the irrigation benefits goes to rice which is mainly cultivated in the Central Region. Upland crops especially those grown in the North and Northeast receive relatively less benefits from irrigation.

The benefits of irrigation include not only double cropping of rice in the Central Plain and a modest expansion of upland crop cultivation in certain parts of the North and Northeast, but also an increase in rice

yield per hectare in both the wet and dry seasons. The increase in rice yield has come about because irrigation has induced a shift in planting technique from broadcasting to transplanting, a shift from traditional to modern rice varieties, and increased use of fertilizer and other chemical inputs. The wet season rice yield per hectare in irrigated areas during the latter half of 1970s averaged 2.72 tons which was almost doubled the rainfed yield of 1.47 tons. Moreover, rice yield in the dry season, which averaged 3.75 tons per hectare, was significantly higher than the wet season yield, due to the greater use of modern inputs and high yielding varieties with higher solar radiation and better water control in the dry season.

Total rice production increased from an average of 13.9 million tons in 1971-75 to 15.9 million in 1976-80 and 18.1 million in 1981-83. The contribution of the dry season crop has increased from 6.3 percent to 10.5 and 12.4 percent of the total crop during the same periods. The difference in yield per hectare between the wet and dry seasons as well as an expansion in rice double cropping area are important factors which account for such an increase in the dry season production.

The impact of irrigation on rice output has further implications on seasonal food availability and prices for consumers. On the production side, double cropping of rice and changes in production methods imply a change in labor requirement and earnings, as well as a change in income of farm households.

FOOD AVAILABILITY AND FOOD PRICES

The increased rice output in the wet season as well as the dry season cropping made possible by irrigation has increased the supply of rice available for domestic as well as foreign consumers. This is because output growth rate exceeded population growth rate and an increase in export has absorbed the output expansion more then proportionately. The proportion of rice output that was exported has increased from 9 percent in 1971-75 to 15 percent in 1976-80 and 19 percent in 1981-83. This increase in export is mainly contributed by the dry season crop, as can be seen by its output growth rate of 16.1 percent per annum during 1976-83, in comparison with that of the wet season crop of only 2.8 percent per annum.

Since the supply of rice to domestic market comes mainly from the wet season crop,[1] which is purchased and stored by rice traders and the government in the beginning of the season for gradual release throughout the year, the output of the dry season crop does not seem to have a significant effect on the domestic seasonal rice availability especially in urban areas.

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[1]This is largely a response to the preference of domestic consumers for the local variety grown in the wet season.

However, whether or not the dry season crop exerts an influence on seasonal rice price variations would depend on the size of the dry season crop relative to the wet season crop. If there is only one rice crop a year, when the output is placed on the market in about February after the wet season harvest, the large supply will push price down and in each month that follows, it is expected that price will increase by at least the cost of storage, until the wet season harvest of the following year. Thus, storage allows a constant supply of rice to be released to consumers throughout the year at rising prices from the beginning to the end of the marketing season. Expected monthly prices may be formed and deviations from such expectations would be due to deviations of supply and demand from the expected levels.

With two crops of rice in a year, the price pattern may become somewhat different. When the dry season crop is placed on the market in about June or July, if it is large relative to the wet season crop, the seasonal price increase may be dampened by the low price of the dry season crop. Hence, the difference between the highest price, relative to the annual average, and the lowest price relative in any crop year can be expected to be smaller than in the case of only one crop a year. However, if the dry season output is very small relative to the wet season output, the effect on the price pattern may not be significant.

To examine the price variations in the Thai case, the monthly retail price data for 5% white rice between 1966 and 1983 are used to compute the seasonal price rise (defined as the difference between the highest and the lowest real monthly prices relative to the 12 month centered moving average, and expressed as a percentage of the lowest price relative). It is found that the seasonal price rise declined from 29 percent of the lowest price relative during 1966-70, when dry season cropping was insignificant, to 20 percent in 1971-75, 11 percent in 1976-80 and 13 percent in 1981-83, as the dry season rice output became increasingly important.

However, it cannot be readily concluded that double rice cropping has reduced the seasonal variations in rice price during a crop year. By inspecting the price relatives (monthly deviations from the average) it is found that there is no clear pattern of the high and the low months (Chart 1). For some years, the low month preceeds the high month and for some other years, the reverse takes place. The number of months between the high and the low price relatives in different crop years also varies greatly. Moreover, the difference in price relatives between high and low months are rather small, especially since 1975. This is likely to be a result of the government rice export tax policy which tends to stabilize domestic rice price at a low level, rather than a result of the dry season crop entering the market.

According to Goldman (1974), the seasonal price rise in Indonesia is influenced by the deviations of wet season rice production and of dry season rice production from expectations, as well as by the yield of maize which is a major substitute for rice, and by the amount of rice injected by the government for price stabilization. Following this model, an attempt was made to estimate regression coefficients for similar variables in the Thai case.

The Thai rice production data suggest that the deviations of wet season rice from expectations, up to 1975, were larger than the dry season production deviations. After 1975, however, the dry season deviations tended to increase somewhat and became larger than the wet season production deviations in some years. But with the dry season output being rather small (9-13 percent of the total annual output) the effect of its deviations may not be significant.

Apart from production deviations in each cropping season, two other variables were also included in the Thai case instead of the maize yield and rice injection by the government used in the Goldman model. These are the deviations of rice export from expectations and the deviations in rice export price. Since there is no substitute for rice in the domestic consumption, yield of other crops are not included. The market operation variable is replaced by the export deviations, since it may represent variations in domestic availability, and by the rice export price deviations, the direction of which affects domestic

price but the variations in the export price are toned down by changes in rice export taxes.

Most of the regression results show that none of the variables have a significant relationship to the seasonal price rise. However, in some of the regressions, using standardized seasonal price rise as a dependent variable (storage cost assumed constant) and after correcting for autocorrelation, the deviations of wet season production and of rice export from expectations were significant variables. Therefore, the effect of rainfall, which largely influences variability of the wet season crop, and the deviations in export which are directly related to domestic availability tend to be more important factors explaining seasonal price rise for consumers than the dry season production deviations or export price deviations. The latter result is likely to be due to the government rice export tax policy which regulates domestic prices in such a way that their seasonal movements are not related to export price movements.

Thus, it seems that the dry season cropping made possible by irrigation in limited areas in the Central Plain has not exerted much influence on the seasonal movements in domestic price for rice consumers. It is rather at the farm level that the impacts of irrigation on rice production are likely to have important effects on labor use and farm income.

RICE PRODUCTION, LABOR USE AND FARM INCOME: FARM LEVEL ANALYSIS

With an increase in cropping intensity and changes in production methods brought about by irrigation, the use of inputs and their earnings can be expected to change. Among these inputs, changes in labor requirements will be treated in the most detail, because of their implications for the problem of seasonal labor migration, and because of the impact of labor demand on the groups of rural people who are most vulnerable to food insecurity problems, i.e., landless laborers and rainfed farmers.

Since irrigation facilities are not well distributed among regions, it is found that the unirrigated areas which depend entirely on rainfall for cultivation are mainly located in the Northeast and, to a smaller extent, in the North and South of Thailand. It is mainly in the Central Region that changes in cropping intensity and planting methods have taken place, and hence changes in labor utilization. Thus, it should be noted that the impacts of irrigation that will be discussed are primarily limited to the Central area and the magnitude of the benefits should not be overstated or generalized for the whole country.

The impacts of irrigation on output and labor utilization in rice cultivation can best be seen by comparing rainfed and irrigated areas, and wet and dry seasons. Since about 80 percent of the total dry season rice is grown in the Central Plain, data from the field survey undertaken in this area will be used as the basis for analysis. More specifically, it is the area in the Chanasutr Project under the Greater Chao Phya Project in the Northern part of the

Central Plain. The Chanasutr Project covers an area of 84,320 hectares in 4 provinces, and the intensive water distribution network has been constructed in about 28.5 percent of the total project area by 1982.

The total sample size from irrigated areas in Chanasutr was 60 farm households, half of them being with and half without on-farm development or land consolidation.[2] The 65 samples from rainfed farms were taken from Takli district in Nakornsawan, where soil and weather conditions are similar to the irrigated areas.

The comparison between the two sample groups in the dry season 1982 and wet season 1982/83 yields the following results:

Cropping intensity, defined as cultivated over landholding areas, has significantly increased with irrigation. The rainfed farms grew rice only in the wet season in 77 percent of the landholding area, and maize and sorghum in 8 percent of the area. Since no crops were grown in the dry season, the total cropping intensity was 85 percent in 1982.

Irrigated farms, on the other hand, grow rice as the main and the second crops. In areas without land consolidation, wet season rice took up 92 percent and dry season rice 73 percent of the total land holding. The other crop grown was sugarcane in a very small area. The total cropping intensity was 168 percent.

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[2] Land consolidation involves construction of minor irrigation systems to supply water to each farm, minor drainage system to remove excess water from each field, rearrangement of farm holdings between newly constructed irrigation ditches and drains, and land levelling to improve on-field water control.

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In land consolidation area, cropping intensity was even higher, at 192 percent, with rice accounting for 95 percent in the wet season and 89 percent in the dry season, plus some sugarcane and bean. (See Table 2)

Note that the percentage of rice cropping area is highest in land consolidated area and lowest in rainfed areas. The cropping intensity tends to increase with the increase in the level of water control, not only because Chanasutr had more adequate water supply for dry season rice, but also because land consolidation has been developed there for a number of years.

Cropping pattern. The data shown in Table 3 indicate that as the level of water control increases, the cropping pattern changes from one rice crop a year toward greater double cropping of rice or rice and upland crops. In the rainfed areas, 83 percent of the farms grew only one crop of rice and 12 percent grew rice and one upland crop in a year. In irrigated areas, before irrigation, 58 percent of the farms grew only rice and 16 percent grew two crops of rice, but after irrigation, in 1982, 92 percent practised double cropping of rice.

Similarly, in land consolidation areas, the percentage of double cropping of rice in Chanasutr increased from zero before land consolidation to 86 percent in 1982.

Planting methods. In all the rainfed areas, only dry soil broadcast planting is practised, but in irrigated areas, there has been a shift in rice planting method to transplanting and, to a small extent, to puddled soil broadcasting system (see Table 4). With land consolidation, however, there is a further shift from transplanting to puddled soil broadcasting. This new broadcasting method provides a high yield per hectare due to a larger number of stems in the plot as well as to large amounts of fertilizer and chemical inputs applied. This technique requires a well levelled field and a good water control system to drain out water before broadcasting and to increase the water level with the height of the growing plants. Hence, it is adopted in over 70 percent of the land consolidated areas in Chanasutr. In irrigated areas without land consolidation, puddled soil broadcasting can be practised in a more limited area, depending on the degree of water controllability, i.e., 28 percent in the wet season and 30 percent in the dry season.

The different planting technique also contributes to a difference in yield. Dry soil broadcasting rice grown in the rainfed areas gives the lowest yield per hectare.

Production and Yield. The wet season irrigated yield of 2.9 tons per hectare of planted area was more than twice the rainfed yeild of 1.2 ton per hectare. With land consolidation, the wet season yield (3.8 tons per hectare) was even greater than in irrigated areas without land consolidation, but the difference is less than that between rainfed and irrigated yeilds. The dry season yield (3.9 tons per hectare) in irrigated areas was generally higher than the wet season yield and higher in areas with land consolidation than without.

The difference in yield between the rainfed and irrigated farms was due not only to greater application of chemical inputs in the latter, but also to the difference in rice varieties and planting methods. Irrigated farms grow transplanted or puddled soil broadcast rice and use more modern varieties than rainfed farms, resulting in higher yields.

Moreover, the high percentage of damaged area also contributes to the low rice yield per hectare. The damaged area was 26 percent of planted area in the rainfed as compared with 10-14 percent in irrigated areas. Although both the rainfed and irrigated areas are similarly infested with rodents and insects, rainfed areas are also more vulnerable to weather condition and hence harvested area is much lower than the planted area.

Labor Use in Rice Production. Where the broadcasting technique is applied, the man-days per hectare of area planted will be smaller than if transplanting is practiced. Thus, the man-days used in planting tend to be less in rainfed and land consolidated than in irrigated without land consolidation areas where transplanted rice is predominant.

The total man-days used per hectare in rainfed areas were very low, i.e., 34 as compared with 62 in irrigated areas and 48 in land consolidated areas in the wet season. Labor used for planting was 12.5 man-days per hectare in irrigated as compared with only 1.0 in rainfed and 4.3 in land consolidated areas. The man-days used for crop caring, however, tend to be larger in land consolidated areas (23.0) where large amounts of fertilizer, weedicides and other inputs are used relative to other areas (12.6 in rainfed and 14.7 man-days per hectare in irrigated areas).

In the dry season, man-days per hectare are higher than in the wet season (71.4 and 57.6 in irrigated and land consolidated areas respectively). It is noted that crop caring takes more man-days per hectare in the dry season than in the wet season. This is because area planted is less in the dry season and the problems of insects and pests are usually more severe in this season, so the farmers tend to spend more time in the fields between planting and harvesting than in the wet season.

Hired labor is used mostly for planting and harvesting while family labor is mainly used for crop caring. The proportion of family labor relative to hired and exchanged labor was highest in the rainfed and land consolidated areas. Since hiring of labor for harvesting and transplanting in irrigated areas is usually on a per hectare rather than on a daily basis, there tends to be a large number of laborers working on one hectare at any one time, while the number of days is not reduced proportionately. When converted to man-days per hectare the figure tends to be high, especially in the irrigated area which relies mainly on hired labor for harvesting.

Hired labor receives a larger share of output when irrigation increases due to a shift in rice planting methods. The increased demand for hired labor is satisfied by labor from nearby villages in the same province in areas where dry season crops are not grown.

Prices and Wages. There was no significant difference in farm prices in the areas surveyed in the same cropping season. The land rent per hectare, however, tends to increase with the levels of water control, i.e., higher in irrigated than rainfed, and in land consolidated than irrigated areas especially in the wet season. Wage rates per man-day and per hectare are not much different between the rainfed and irrigated areas, with an average of about 40-50 baht per man-day and 750 baht per hectare.

Distribution of Paddy Output. Farm households tend to sell most of their dry season rice output and retain less than 10 percent for seeds, consumption or rent payment. The wet season crop was retained in a higher proportion than the dry season crop and about 85 percent was sold. Rainfed farms, having only the wet season crop, sold half of the output, retained 30 percent for consumption, 11 percent for seeds and the remaining was stored for future sale and rent payment.

Cash Cost per Hectare of Paddy Production. These costs consist of wages, machine rental, land rent, fuel for machines, fertilizer and other chemical inputs, seeds, depreciation of equipment and interest on loans.

In the wet season irrigated areas, wages account for 37 percent, fertilizer 21 percent and machine rent 15 percent of the total cash cost. In land consolidated areas, wages were a smaller proportion at 27 percent, but farmers spent more on fertilizer (33 percent) and the same percentage on machine rent. In the rainfed areas, on the other hand, the largest item was machine rental, whose share of the total cash cost was 41 percent, while the shares of fertilizer, wages and interest were 7 percent, 24 percent and 12 percent respectively.

Cash cost per hectare of planted area in the wet season was lower than in the dry season, mainly due to a greater use of fertilizer and other chemical inputs in the dry season. The cash cost per hectare

in the rainfed area was lowest at 1,664 baht and increased with the level of water control, i.e., 3,800 baht per hectare in irrigated and 4,700 in land consolidated areas.

Cost per ton of paddy output, however, did not differ much between the wet and the dry seasons. Although the cost per hectare was higher in the dry season, yield per hectare was also higher. For rainfed areas, however, cash cost per ton of paddy output was highest, inspite of the lowest cost per hectare. This is due to the low yield in rainfed areas.

Farm Household Gross Cash Income. The gross annual cash income per household in 1982/83 was about 68,000 baht in irrigated and 11,000 baht in rainfed areas. While the wet season and dry season contribute an almost equal share to gross annual cash income in irrigated areas, the dry season income only provided 7 percent of the annual cash income of the rainfed farms.

The largest source of household income was the sale of paddy, contributing about 90 percent of the total income in each cropping season in irrigated areas but only 65 percent in the wet season rainfed areas. Other sources include income from other crops and livestock which provided about 24 percent of the total cash income in the rainfed areas in each season and 14 percent in land consolidated areas in the dry season. Livestock and non-farm employment were the major sources of income for the rainfed households, not only in the dry season when

rice cannot be grown, but also in the wet season, because paddy sale brought only 65 percent of the total income.

Net Cash Income of Households. After deducting paddy production cost from the gross annual cash income from sale of paddy, the net cash income from paddy is found to be about 28,000-30,000 baht per household in irrigated areas but even slightly negative for the rainfed farms. Cash income from other sources, although approximately the same in rainfed and irrigated areas, were only 4,300 baht per household, resulting in a very low net cash income for rainfed farms compared with 35,000 baht in irrigated and 39,000 in land consolidated farms.

SEASONAL LABOR UTILIZATION AND SEASONAL MIGRATION

The above results have clearly indicated that irrigation has an effect on seasonal labor requirements in two respects. Double cropping of rice in certain intensively irrigated areas in the Central Plain has increased labor employment in crop production during the dry season. Moreover, the increased use of fertilizer and chemical inputs required for high yielding varieties and the shift to transplanting method in irrigated areas also result in a larger labor requirement for planting and crop caring in both seasons. The variations in employment per farm between seasons have been reduced, but the extent to which this is so in aggregate terms depends on the area brought into cultivation in the dry season.

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Rainfed farms in unirrigated areas, on the other hand, exhibit a strong seasonality in employment since labor is engaged in agriculture only in the wet season and seek non-agricultural employment in the dry season. During the wet season, moreover, there is a peak labor requirement for transplanting and harvesting of rice during which hired labor is employed to supplement family labor. For other operations, such as land preparation and crop caring, however, family labor is mainly utilized.

It has been shown that in the Central Plain, the dry season crop requires more labor than the wet season crop.

Thus, the implication is that there is a potential for additional employment creation by a further expansion of the dry season rice cultivation.

In the Northeastern region, which is primarily a rainfed area, on the other hand, dry season cropping was less than 1 percent of the wet season cropping area and in about 8 percent of the irrigated area of the region, there is much less potential for the dry season rice to absorb labor during off season. Hence, non-farm employment or unemployment seem to characterize the dry season activities in the Northeast. Labor tends to migrate seasonally to the Central region for farm or other work in the dry season and return for the planting season for both rice and upland crops in May-June.

Agricultural employment again expands from August when some upland crops are brought into the market and other crops are being planted. There is a high labor requirement for transportation and trade of agricultural products. During the harvest of rice and upland crops in November and December the labor requirement in agriculture is rising rapidly but after harvest labor begins to move out of agriculture to industry or service in the rural areas, while some seek employment in urban areas, especially Bangkok. Thus, there are large variations in labor use between seasons in the Northeast and also the North. Consequently, in the Northeast, the lowest income area, non-agricultural income constitutes more than 50 percent of the total household income as compared with about 28 percent in the Central region.

Wages tend to be different between the Northeast and the Central regions, although they are not so between rainfed and irrigated areas in the Central Plain. Due to higher labor demand in irrigated areas in the Central region, rural wages tend to be higher than in the Northeast, but even in the Central irrigated areas rural wages have been rather stable and real income of labor have increased only slightly.

Table 12-13 provides data on wage rates, supply of hired labor and labor demand as calculated by Trairatvorakul (1984). It was found that the seasonal variation of total labor demand for the Northeast and the Central Regions correspond well with the cropping season.

Table 12 suggests that wage rates tend to be lower for most operations in the Northeast than in other regions. Wage rates are higher for spraying of chemical inputs in all regions, due probably to

high danger involved and hence the skill required for the task, and lowest for weeding and fertilizer application. Wages in the Central region are highest for land preparation and spraying.

The proportion of hired and family labor are also different among areas. Hired labor takes a proportionately large share in comparison with family labor in more commercialized (Central and Bangkok) areas.

A study by Panpiemras (1985) has identified the irrigated areas of the Upper North and the Chao Phya area of the Central region as labor-short areas. These are areas where farmers benefit from the opportunity to employ modern agricultural techniques as well as to grow a second crop. The study investigated labor demand for sugarcane tapioca, pineapple and dry season rice whose cultivated area expanded several folds over the past few years. Labor requirement is high for planting and harvesting of these crops such as the local labor supply could not meet the demand and labor therefore had to come from the labor surplus agricultural areas in the Northeast. Migrant labor requirements were estimated for each of the crops and it was found that sugarcane plays an important role in the absorption of migrant labor because labor requirement of sugarcane plantation is very high during suga cane cutting and truck loading stages between December to April.

Migrant labor requirements for tapioca and pineapple are not as concentrated in certain time period as for sugarcane. Dry season paddy area, however, utilises mostly local labor from nearby provinces in the Central region rather than migrant labor from the Northeast.

CONCLUSION

The above discussion has pointed out that the direct benefits of irrigation are mainly to allow double cropping of rice in the Central Plain and to increase rice yields in both seasons. As a result, there has been a significant increase in rice production in the past decade. This increase in the rice output, especially that of the dry season, has been more than proportionately absorbed by an expansion in rice export, while the larger wet season crop mainly serves domestic consumption. Hence the impact of irrigation on the seasonal food availability to the domestic consumers, especially those in urban areas, tends to be small.

Despite the rapid expansion in rice double cropping in the Central Plain during the 1970's, the double cropping area is still very small compared with the irrigated areas and the total rice planted area in the wet season. The dry season output contributes only about 12 percent to the total annual rice output in 1981-83. Thus, although there has been larger deviations in the dry season output in the latter half of 1970's than previously, such deviations do not seem to exert any significant influence on the domestic price rises.

The impacts of irrigation can be more clearly seen at the farm level. The data from the field survey in Chanasutr Project area in the Central Plain for the crop year 1982/83 reveal that there has been a change toward greater cropping intensity in irrigated areas and an increase

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in double cropping of rice. In the area studied, cropping intensity nearly doubled with the introduction of irrigation. In rainfed areas, residual moisture is inadequate even for secondary non-rice crops in the dry season.

In addition to providing a second crop, irrigation provides wet season yields which are two to three times greater than in rainfed areas. As a result, despite higher variable costs, net farm income is much higher in irrigated areas, and is distributed more evenly across seasons. Rainfed farms are proportionately more reliant on non- and off-farm income, receiving nearly half of gross cash income from these sources, compared to an average of less than 10 percent in irrigated areas. However, while rainfed farms rely proportionately more on off- and non-farm income, in absolute terms income from these sources is no higher than for irrigated farms. Rainfed farmers are unable to compensate for low farm incomes with income from other sources.

The relatively low yields and reliance on a single crop causes rainfed farmers to retain a much higher proportion of production, selling only half of production, while irrigated farms retain only 10-15 percent of each crop.

In addition to the direct impact of irrigation on yield and production, irrigation shifts the seasonal pattern of labor use in the wet season. Planting methods and labor requirements for planting are directly related to irrigation quality. In rainfed areas, dry soil broadcasting is used exclusively, while in irrigated areas without land

consolidation, a mix of methods is used, with transplanting predominant. Labor use for land preparation and planting is therefore substantially larger. In land consolidation areas, the better quality of water control permits a shift to puddled soil broadcasting, which reduces labor use relative to other irrigated areas. Labor use remains, however, larger than for rainfed areas.

The labor requirement for crop care also increases with irrigation due to increased use of fertilizer and chemical inputs. Overall labor use in irrigated areas is thus much larger. This greater demand for labor is largely filled by hired labor, so wet season irrigation increases the wet season total wages received by hired laborers in addition to the impact on dry season labor use.

The rainfed farms exhibit a strong seasonality in employment since they have to resort to non-farm work or even being unemployed in the dry season, while the irrigated areas open an opportunity for agricultural employment throughout the year. The stronger demand for labor increases average wages as well. Thus, labor from the rainfed areas in the Northeast tends to migrate seasonally to the Central Region, and especially to Bangkok, for employment in agriculture, industry or services. In the Central Region, on the other hand, high labor requirements for the dry season rice cropping are met mostly by labor from the nearby provinces in the same region. This suggests that irrigation stabilizes seasonal demand for labor, boosts wages for hired labor, and reduces seasonal out-migration of agricultural workers.

Chart 1

Months of Highest and Lowest Price Relatives (PRELBK2)

	Ap.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1966								0		X		
1967									X	0		
1968							X				0	
1969	0					X						
1970										X		0
1971							X					0
1972	0				X							
1973							0				X	
1974							0					X
1975	X							0				
1976					0					X		
1977		0							X			
1978					0				X			
1979		0							X			
1980							0					X
1981		0								X		
1982				X				0				
1983						0				X		
1984								0				X

X = highest price relative

0 = lowest price relative

TABLE 1

IRRIGATED AND RICE PLANTED AREAS, THAILAND, 1982.

	Regions				
	North	Northeast	Central	South	Whole Kingdom
Irrigated Area ('000 ha.)	746 (22.5)	438 (13.2)	1,845 (55.6)	291 (8.8)	3,320 (100.0)
Rice Planted Area ('000 ha.)					
- wet season 1982/83	2,112 (23.5)	4,257 (47.4)	1,964 (21.8)	654 (7.3)	8,987 (100.0)
- dry season 1983	66 (10.4)	35 (5.5)	507 (80.0)	26 (4.1)	634 (100.0)
% Irrigated Area/ Wet Season Planted Area 1982/83	35.3	10.3	93.9	44.5	36.9
% Dry Season Planted Area 1983/Irrigated Area	8.8	8.0	27.5	8.9	19.1
% Double Cropping Rice Area	3.1	0.8	25.8	4.0	7.0

Source : Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, Agricultural Statistics of Thailand, Bangkok, 198[illegible].

Table 2

Cropping Intensity

	Rainfed	Irrigated	Irrigated with Land Consolidation
Cultivated Area as Percentage of Total Landholding (%)			
a) Dry Season 1982			
Rice	-	73.46	88.93
Bean	-	-	0.36
Sugarcane	-	0.92	3.57
Total	-	74.38	92.86
b) Wet Season 1982/83			
Rice	76.84	91.72	94.64
Maize	6.23	-	-
Sorghum	1.56	-	-
Sugarcane	-	2.10	4.46
Total	84.63	93.82	99.10
Total Cropping Intensity (%)	84.63	168.20	191.96

Source: Survey data.

Table 3

Cropping Pattern, Crop Year 1982/83

	Rainfed	Irrigated	Irrigated with Land Consolidation
Cropping Pattern (Number of Farms)	58 (100.00)	26 (100.00)	28 (100.00)
1. Rice (one crop)	49 (83.05)	1 (3.85)	-
2. Rice-Rice	-	24 (92.30)	24 (85.72)
3. Rice-Bean	1 (1.69)	-	2 (7.14)
4. Rice-Maize	4 (6.78)	-	-
5. Rice-Sugarcane	-	1 (3.85)	2 (7.14)
6. Rice-Sorghum	2 (3.39)	-	-
7. Rice-Maize-Sorghum	1 (1.69)	-	-
8. Maize	1 (1.69)	-	-

Source: Survey data.

Table 4

Planting Methods Used

(% of area planted)

	Rainfed	Irrigated	Land Consolidation
Dry Season 1982			
Dry Soil Broadcasting	-	21.7	6.0
Transplanting	-	48.5	20.7
Puddled Soil Broadcasting	-	29.8	73.3
Total		100.0	100.0
Wet Season 1982/83			
Dry Soil Broadcasting	100.0	23.3	7.9
Transplanting	-	48.6	17.3
Puddled Soil Broadcasting	-	28.1	74.8
Total	100.0	100.0	100.0

Source: Survey data.

Table 5

Production and Yield of Rice

	Rainfed	Irrigated	Irrigated with Land Consolidation
Wet Season 1981/82			
Production (tons)	335.85	423.41	323.56
Planted Area (ha.)	294.72	155.84	92.16
Yield (ton/ha. of planted area)	1.14	2.72	3.51
Harvested Area (ha.)	196.88	145.51	85.20
Yield (ton/ha. of harvested area)	1.71	2.91	3.80
Dry Season 1982			
Production (tons)	-	349.75	336.93
Planted Area (ha.)	-	89.44	79.68
Yield (ton/ha. of planted area)	-	3.91	4.23
Harvested Area (ha.)	-	82.08	74.72
Yield (ton/ha. of harvested area)	-	4.26	4.51
Wet Season 1982/83			
Production (tons)	286.72	322.71	320.48
Planted Area (ha.)	244.80	111.68	84.80
Yield (ton/ha. of planted area)	1.17	2.89	3.78
Harvested Area (ha.)	181.76	100.16	77.28
Yield (ton/ha. of harvested area)	1.58	3.22	4.15

Table 6

Use of Inputs for Rice Cultivation

Input Items	Dry Season 1982		Wet Season 1982/83		
	Irrigated	Irrigated with Land Consolidation	Rainfed	Irrigated	Irrigated with Land Consolidation
1. Land					
Area Planted (ha.)	89.44	79.68	244.80	111.68	84.80
- Owned (%)	95.89	80.92	90.13	91.83	82.08
- Rented (%)	4.11	19.08	9.87	8.17	17.92
Area Harvested (ha.)	82.08	74.72	181.76	100.16	77.28
Damaged as Percentage of Planted Area (%)	8.23	6.22	25.75	10.32	8.87
2. Labor					
Total man-days/Area Planted (ha.)	71.36	57.57	34.03	61.95	47.77
Family Labor (%)	45.31	60.16	60.43	40.94	58.37
Hired Labor	51.58	37.32	28.56	54.48	39.92
Exchanged Labor (%)	3.11	2.52	11.01	4.48	1.71
Man-days per Hectare of Land Used in Each Operation					
- Land Preparation	2.52	1.60	1.19	2.11	2.08
- Water Pumping	2.88	0.80	-	5.67	0.37
- Planting	14.00	5.33	0.95	12.46	4.29
- Crop Caring	22.60	28.89	12.62	14.65	22.97
- Harvesting	28.59	20.32	26.10	30.07	18.47
- Threshing	4.35	2.89	0.88	4.04	2.26

Table 6 (continued)

Input Items	Dry Season 1982		Wet Season 1982/83		
	Irrigated	Irrigated with Land Consolidation	Rainfed	Irrigated	Irrigated with Land Consolidation
3. Machine					
Land Preparation:					
Machine-hours/Area Planted (ha.)	12.70	9.64	5.29	11.17	10.66
Machine-hours					
- Own (%)	83.80	63.54	19.14	80.77	63.72
- Hired (%)	16.20	36.46	80.86	19.23	36.28
Threshing: Machine-hours/Tons of Rice Output	0.72	0.59	1.00	1.81	0.65
Machine-hours					
- Own (%)	9.09	28.30	17.14	18.18	39.13
- Hired (%)	90.91	71.70	80.00	79.92	60.87
- Exchange (%)	-	-	2.86	1.89	-
4. Chemical Inputs					
Fertilizer (kg./ha.)	256.60	369.20	72.77	216.06	351.41
Insecticides					
kg./ha.	9.38	9.43	0.94	-	9.90
litre/ha.	1.04	0.81	0.28	0.96	0.70
Weedicides					
kg./ha.	4.67	11.99	0.62	1.35	9.94
litre/ha.	0.69	1.60	-	0.84	1.60
Pesticides					
kg./ha.	0.68	0.30	0.78	0.78	0.42
litre/ha.	0.31	0.36	-	1.54	0.29
Others					
kg./ha.	-	0.27	14.13	-	0.27
litre/ha.	2.23	1.12	0.43	2.05	

Table 7

Price of Paddy, Wages and Rent

	Wet Season 1982/83			Dry Season 1982	
	Rainfed	Irrigated	Irrigated with Land Consolidation	Irrigated	Irrigated with Land Consolidation
1. Farm Price of Paddy (Baht/ton)	2,833	3,015	2,896	2,542	2,237
2. Land Rent					
Rent paid in					
- Cash (%)	60.00	57.14	77.78	50.00	77.78
- Kind (%)	40.00	42.86	22.22	50.00	22.22
Cash Rent per ha. (Baht)	1,375	1,563	2,275	2,656	2,469
In-kind Rent per ha. (kg.)	438	1,000	1,250	900	1,090
3. Wages					
a) Planting					
Wage per Man-day (Baht)	40	38	50	58	45
Wage per Hectare (Baht)	-	840	713	813	588
b) Harvesting					
Wage per Man-day	35	30	40	33	-
Wage per Hectare (Baht)	660	775	700	744	669
4. Machine Rental					
a) Small Tractors (Baht/ha.)	568	844	1,250	906	1,250
b) Large Tractors (Baht/ha.)	675	613	625	556	625
5. Price of Inputs					
a) Fertilizer (Baht/kg.)	4.90	4.40	4.00	4.20	4.20
b) Insecticides (Baht/kg.)	n.a.	5.80	4.60	n.a.	20.00
c) Weedicides (Baht/kg.)	40.00	n.a.	16.70	16.70	16.70

Table 8

Distribution of Paddy Output

Distribution (%)	Rainfed	Irrigated	Irrigated with Land Consolidation
Dry Season 1982			
1. Sold	-	91.98	91.58
2. Retained for Seeds	-	3.49	3.98
3. Retained for Consumption	-	1.95	2.90
4. Payment of Rent	-	2.58	1.54
5. Stored for Future Sale	-	-	-
6. Others	-	-	-
Total	-	100.00	100.00
Wet Season 1982/83			
1. Sold	50.01	85.48	91.57
2. Retained for Seeds	10.75	4.42	3.65
3. Retained for Consumption	29.71	4.70	2.76
4. Payment of Rent	2.78	3.55	1.70
5. Stored for Future Sale	5.74	1.85	-
6. Others	1.01	-	0.32
Total	100.00	100.00	100.00

Table 9

Costs of Paddy Production

Baht per ha. of planted area

	Dry Season 1982		Wet Season 1982/83		
	Irrigated	Irrigated with Land Consolidation	Rainfed	Irrigated	Irrigated with Land Consolidation
Wages	1,735	1,288	401	1,425	1,276
Machine Rental	534	726	690	566	723
Land Rent	95	434	136	128	408
Fuel for Tractors and Water Pumps	495	318	21	328	264
Fertilizers	1,062	1,558	122	802	1,543
Insecticides, Pesticides, etc.	174	376	31	145	222
Seeds	65	36	18	14	31
Equipments (depreciation)	8	4	2	0	3
Interest on Loan[1]	672	304	209	360	215
Others	28	27	34	24	19
Cash Cost per Hectare of Planted Area	4,868	5,071	1,664	3,792	4,703
Cash Cost per Ton of Paddy Output	1,245	1,199	1,421	1,312	1,244

Table 10

Farm Households' Gross Cash Income by Source

(Baht)

	Rainfed	Irrigated	Irrigated with Land Consolidation
Dry Season 1982			
1. Farm Income	10,500 (22.58)	874,232 (97.64)	861,953 (94.46)
- Sale of Paddy	-	817,762 (91.33)	731,223 (80.13)
- Other Crops	-	49,970 (5.58)	125,730 (13.78)
- Livestock	10,500 (22.58)	6,500 (0.73)	5,000 (0.55)
2. Off-Farm Income	-	1,600 (0.17)	32,880 (3.60)
- Employment in Rice Farms	-	400 (0.04)	6,480 (0.71)
- Tractor Rentals	-	1,200 (0.13)	26,400 (2.89)
3. Non-Farm Income	36,000 (77.42)	19,600 (2.20)	17,765 (1.95)
- Employment	33,000 (70.97)	11,800 (1.32)	15,665 (1.72)
- Trade	-	3,000 (0.34)	-
- Others	3,000 (6.45)	4,800 (0.54)	2,100 (0.23)
Total Cash Income	46,500 (100.00)	895,432 (100.00)	912,598 (100.00)
Cash Income per Household	788	34,440	32,593

Table 10 (continued)

(Baht)

	Rainfed	Irrigated	Irrigated with Land Consolidation
Wet Season 1982/83			
1. Farm Income	548,730 (89.00)	838,695 (96.94)	914,020 (92.87)
- Sale of Paddy	398,640 (64.66)	831,695 (96.13)	849,870 (86.35)
- Other Crops	107,090 (17.37)	500 (0.06)	22,150 (2.25)
- Livestock	43,000 (6.97)	6,500 (0.75)	42,000 (4.27)
2. Off-Farm Income	14,315 (2.32)	4,500 (0.52)	46,800 (4.76)
- Employment in Rice Farms	10,315 (1.67)	4,500 (0.52)	30,800 (3.13)
- Tractor Rentals	4,000 (0.65)	-	16,000 (1.63)
3. Non-Farm Income	53,445 (8.67)	22,000 (2.54)	23,425 (2.38)
- Employment	49,945 (8.10)	14,200 (1.64)	19,225 (1.95)
- Trade	-	3,000 (0.35)	-
- Others	3,500 (0.57)	4,800 (0.55)	4,200 (0.43)
Total Cash Income	616,490 (100.00)	865,195 (100.00)	984,245 (100.00)
Cash Income per Household	10,449	33,277	35,152
Total Annual Cash Income	662,990	1,760,627	1,896,843
Annual Cash Income per Household	11,237	67,716	67,744

Table 11

Farm Households' Annual Cash Income Net of Paddy Production Costs

(Baht)

	Rainfed	Irrigated	Irrigated with Land Consolidation
Household's Annual Cash Income from Sale of Paddy	6,873	63,441	56,468
Annual Cash Costs of Paddy Production per Household	7,024	33,033	28,674
Net Cash Income from Paddy	-151	30,408	27,794
Cash Income from Other Sources	4,364	4,275	11,276
Total	4,213	34,683	39,070

Source: Tables 9 and 10.

From Trairatvorakul (1984)

Table 12—Manual wage rate by region and operation, 1975 and 1976

Operation	Northern		Northeastern		Central and Eastern		Southern	
	1975	1976	1975	1976	1975	1976	1975	1976
	(baht/day)							
Land preparation	20.00	21.04	15.00	15.04	22.30	24.80	20.00	20.00
Planting	20.18	23.28	15.00	14.96	20.00	20.00	20.00	22.00
Weeding	15.00	17.60	10.05	13.52	15.00	17.28	20.00	20.00
Spraying	25.00	30.72	20.00	20.88	29.36	29.36	25.00	27.56
Fertilizer application	15.00	17.60	10.05	14.32	15.00	16.08	20.00	20.08
Draining	15.00	20.08	15.00	15.04	20.00	24.16	20.00	20.00
Harvesting	15.00	18.00	15.00	15.84	20.00	20.00	20.00	22.00
Threshing	14.55	15.84	15.00	15.84	20.00	20.32	20.00	22.44

Source. Data supplied to the author by Thailand, Ministry of Agriculture and Cooperatives.

Table 13—Wage rates and supply and demand of labor, by month and region, 1975/76

Month	Northern			Northeastern			Central and Eastern		
	Wage Rate	Supply of Hired Labor	Total Labor Demand	Wage Rate	Supply of Hired Labor	Total Labor Demand	Wage Rate	Supply of Hired Labor	Total Labor Demand
	(baht)	(person-days)		(baht)	(person-days)		(baht)	(person-days)	
October	15.00	1,055	21,992	11.70	1,808	44,646	16.67	1,005	14,429
November	14.78	6,754	38,025	15.00	11,569	62,975	20.00	6,435	20,916
December	14.78	5,699	24,570	15.00	9,761	52,989	20.00	5,430	22,236
January	14.78	5,699	29,871	15.00	9,761	43,837	20.00	5,430	19,171
February	14.00	0	26,599	11.50	0	37,192	16.50	0	15,327
March	14.00	0	21,926	11.50	0	26,482	16.50	0	11,944
April	14.00	0	28,665	11.50	0	29,208	16.50	0	5,496
May	21.04	158	16,333	15.04	271	50,898	24.80	151	9,664
June	21.04	158	22,533	15.04	271	39,215	24.80	151	10,721
July	23.28	5,541	33,038	14.96	9,490	46,487	20.00	5,279	23,565
August	23.28	5,541	25,490	14.96	9,490	45,513	20.00	5,279	16,060
September	18.40	1,055	37,272	14.29	1,808	45,425	19.17	1,005	11,047

Month	Southern			Greater Bangkok		
	Wage Rate	Supply of Hired Labor	Total Labor Demand	Wage Rate	Supply of Hired Labor	Total Labor Demand
	(baht)	(person-days)		(baht)	(person-days)	
October	20.00	408	4,836	16.67	418	5,445
November	20.00	78	7,649	20.00	2,674	13,419
December	20.00	78	978	20.00	2,256	7,428
January	20.00	498	2,212	20.00	2,256	6,445
February	20.00	420	5,177	16.50	0	4,808
March	20.00	420	3,848	16.50	0	4,116
April	19.50	0	2,066	16.50	0	2,477
May	19.50	0	1,663	24.80	63	2,613
June	19.50	0	1,843	24.80	63	3,924
July	20.00	12	198	20.00	2,193	5,216
August	20.00	12	298	20.00	2,193	6,710
September	22.00	408	3,236	19.17	418	2,968

Source: Calculated from data in Thailand, National Statistical Office, "1975/76 Socioeconomic Survey Data Tape," Bangkok, 1976, and other sources explained in the text.

Note: Greater Bangkok includes the Bangkok metropolis and the provinces of Nonthaburi, Pathumthani, and Samut Prakan.

From Panpiemras (1985)

Table 14 Cultivation pattern for different crops

Crop and activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Dry season paddy[a]												
— Harvesting, threshing loading[b]						XXXX	XXXX					
— Up-keeping			XXXX	XXXX	XXXX							
— Transplanting[b]												
— Preparation of feeding bed		XXXX										
— Preparation of land		XXXX										
2. Pineapple[c]												
— Harvesting[b]		XXXX	XXXX	XXXX								
— Weed clearing[b]			XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX			
— Fertilizer applicating			XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX			
— Planting	XXXXX											XXXX
— Preparation of land											XXXX	
3. Tapioca[c]												
— Harvesting										XXXX	XXXX	XXXX
— Fertilizer applicating			XXXX	XXXX	XXXX	XXXX						
— Weed clearing[b]			XXXX	XXXX	XXXX	XXXX						
— Planting	XXXX											XXXX
— Preparation of land											XXXX	
4. Sugarcane[d]												
— Cutting	XXXXX	XXXX	XXXX	XXXX								XXXX
— Up-keeping				XXXX	XXXX	XXXX	XXXX	XXXX	XXXX			
— Planting				XXXX	XXXX							
— Preparation of land		XXXX	XXXX	XXXX								

[a] Waurawan Supachanya and Prayong Netayarak, Pattern and Result of Off-farm Work, Faculty of Economics, Thammasat University, Bangkok, July 1979, pp 43, 129.

[b] Activities which required high labor.

[c] Cultivation of these 2 crops derived from the cropping pattern of most farmers in the provinces of Chon Buri and Prachuap Khiri Khan based on the field study of Development Studies and Information Division NESDB. In other areas the cropping pattern may differ.

From Panpiemras (1985)

Table 15 Estimation of migrant labor requirement 1981

Cultivated area	Activities with high labor requirement	Required labor (person)	Migrant labor	
			amount (person)	percentage
Sugarcane	sugarcane cutting and loading	160,000[a]	115,000	70
Tapioca	weed clearing	70,000[b]	35,000	50
Pineapple	weed clearing	46,000[c]	20,000	43
Dry season				
Paddy	harvesting	90,000[b]	18,000	20

[a] Whole Kingdom

[b] Eastern region only

[c] Eastern and Central regions

Source: Estimated by the research team.

Appendix

I. Regressions to Assess the Impact of Different Variables on Season Prices, 1967-1983

1. DEPBK = f(QRCEW1, QRCED1, QRXE1, CRXP)
2. DEPBK = f(QRCEW2, QRCED2, QRXE2, CRXP)
3. DEPBK2 = f(QRCEW1, QRCED1, QRXE1, CRXP)
4. DEPBK2 = f(QRCEW2, QRCED2, QRXE2, CRXP)

where DEPBK = percentage seasonal price rise, Bangkok, in crop year (April-March), alternative 1

DEPBK2 = percentage seasonal price rise, Bangkok, alternative 2

QRCEW1, QRCED1 = deviations of wet season/ dry season rice production from expected production, as a percentage of expected crop year production, alternative 1

QRCEW2, QRCED2 = deviations of wet season/dry season rice production from expectations, as a percentage of expected crop year production, alternative 2

QRXE1 = deviations of rice export from expectations, as a percentage of expected export, alternative 1

QRXE2 = deviations of rice export from expectations, as a percentage of expected export, alternative 2

CRXP = rice export price deviations

II. Seasonal Price Rises (DEPBK, DEPBK2)

5. DEPBK = $(PRELBK_H - PRELBK_L)/PRELBK_L$

6. DEPBK2 = DEPBK/NM

7. PRELBK = REALBK/MAR

8. REALBK = (MRPBK/FPIXR) x 100

where $PRELBK_H$, $PRELBK_L$ = highest and lowest monthly price relatives, respectively, within the crop year

NM = number of months between the low and the high price relatives (between $PRELBK_L$ and $PRELBK_H$

REALBK = real monthly price of rice, Bangkok

MAR = 12-month centered moving average of real prices

MRPBK = current monthly price of rice, Bangkok

FPIXR = monthly food price index, excluding rice

III. Deviations of rice production from expectations (QRCEW1, QRCED1, QRCEW2, QRCED2)

9. QRCEW1 = [(RPROTW-QRCWP1)/QRCTP1] x 100

10. QRCED1 = [(RPROTD-QRCDP1)/QRCTP1] x 100

11. QRCEW2 = [(RPROTW-QRCWP2)/QRCTP2] x 100

12. QRCED2 = [(RPROTD-QRCDP2)/QRCTP2] x 100

13. QRCWP1 = exp (a+b YEAR) from LN(RPROTW) = f(YEAR)

14. QRCDP1 = exp (a+b YEAR) from LN(RPROTD) = f(YEAR)

15. QRCTP1 = QRCWP1 + QRCDP1

16. $QRCWP2_t = (QRCWP1_t + RPROTW_{t-1})/2$

17. $QRCDP2_t = (QRCDP1_t + RPROTD_{t-1})/2$

18. $QRCTP2_t = QRCWP2_t + QRCDP2_t$

where RPROTW = rice production, Thailand, wet season

RPROTD = rice production, Thailand, dry season

QRCWP1 = expected rice production, wet season, alternative 1

QRCDP1 = expected rice production, dry season, alternative 1

QRCTP1 = expected rice production, crop year, alternative 1

QRCWP2 = expected rice production, wet season, alternative 2

QRCDP2 = expected rice production, dry season, alternative 2

QRCTP2 = expected rice production, crop year, alternative 2

IV. <u>Deviations of rice export from expectations</u> (QRXE1, QRXE2)

(same methodology as for computation of deviations of rice production from expectations)

Table A1

Percentage Seasonal Price Rise

	as % of lowest price relative	standardized
1966 - 70	.2911	.1515
1971 - 75	.2041	.0870
1976 - 80	.1068	.0166
1981 - 83	.1285	.0880

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INTERNATIONAL
FOOD
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RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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THE IMPACT OF TECHNOLOGICAL CHANGE IN RICE PRODUCTION ON SEASONAL FLUCTUATIONS IN FOOD CONSUMPTION AND CALORIE DEFICIENCIES: THE CASE OF NORTH ARCOT, INDIA

by

Per Pinstrup-Andersen
Mauricio Jaramillo

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1. INTRODUCTION

Seasonal fluctuations in energy intakes and expenditures, along with seasonality in the occurrence and severity of diarrheal and other diseases, are a major cause of malnutrition among the rural poor in many regions of developing countries (Chambers, Longhurst, and Pacey, 1981, Longhurst and Payne, 1979, and Payne, 1985). Seasonality in energy intakes is closely associated with seasonal fluctuations in the ability of low-income households to acquire food. The ability to acquire food at a particular point in time, in turn, is influenced by household food stocks and purchasing power, as well as food prices and food availability in local markets. Thus, changes in the food system that alter the seasonal fluctuations in any of these four factors may result in changes in the nutritional status.

Technological change, such as the replacement of traditional with modern varieties and introduction of irrigation, has been very effective in increasing the yields and production of various crops -- notably rice and wheat -- as well as incomes of farmers in developing countries (Pinstrup-Andersen, 1982, and Pinstrup-Andersen and Hazell, 1985). However, the impact on food consumption and nutrition, including their seasonal fluctuations, is poorly documented.

This paper presents the results from an analysis of the impact of technological change in rice production in North Arcot, India, on seasonal fluctuations in household level food consumption and calorie deficiencies. The paper is divided into eight sections. A brief

description of the survey area and households is provided in the next section. Then follows an analysis of changes in rice acreage, yields, production, and sale. Section four analyzes changes and seasonality in household incomes (approximated by total expenditures) followed by a discussion of seasonal fluctuations in the price of rice, ragi, and total calories consumed. Household energy consumption and its seasonal variation are analyzed in section six and seasonal fluctuations in the magnitude of apparent energy deficiency are analyzed in section seven. The last section provides a brief summary and conclusions.

2. DESCRIPTION OF SURVEY AREA AND HOUSEHOLDS

The North Arcot district, located in the southern Indian state of Tamil Nadu, is the area of concern in this study. Tamil Nadu has about 8 percent of India's population and produces around 12 percent of the country's rice, yielding a net surplus of 20 to 30 percent of its output. Its competitive advantage in rice production, along with the advent of the high-yielding varieties (HYVs) and the resulting yield increases, allowed it to become a net exporter in the mid-70s. The per capita arable land (.15 hectare) is lower than that of most other states in India.

The North Arcot district, in the north of the state, has a large proportion of small farmers. The average holding operates 1.6 hectares, but more than 50 percent of the farmers operate less than 1 hectare. It is an important rice-producing area with paddy being grown on more than 40 percent of the total arable land.

A light southwest monsoon from July to September and the northeast monsoon from October through December provide more than 90 percent of the average 1,000 millimeters of annual rainfall. The long dry season (January-June) provides strong sunshine which is favorable, given good irrigation, to crop growing and ripening. The weather regime allows 3 crops to be planted each year:

Season 1 (Samba) - sown in July-August and harvested in December-January;

Season 2 (Navari) - a smaller crop that stretches through the dry season from December-January through May; and

Season 3 (Sornavari) - which goes from May-June through September.

Traditional varieties were more season-specific than HYVs with respect to length of growing season. This fact, together with the greater availability of better irrigation infrastructure which allows for year-round irrigation, has caused the crop seasons to become less well-defined in later years.

Table 1 presents descriptive characteristics of the households studied. A household is defined as a group usually living together, sharing a kitchen, and contributing and drawing from the same resource pool. The 1973/74 data comes from a study by a team from Madras and Cambridge universities (Farmer, 1977), whose findings indicated that only about 10 percent of the farmers had adopted HYVs; the 1973/74 results presented in this paper, however, come only from those households that had not adopted HYVs at the time of the 1973/74 survey. The 1982/83 and 1983/84 data come from similar surveys undertaken by IFPRI and Tamil Nadu Agricultural University (TNAU). Households from those

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Table 1 — Descriptive characteristics of the sample households

	Village Group 1 73/74			Village Group 1 82/83			Village Group 1 83/84		
	Number of house-holds	Mean number of persons per house-hold	Mean operated hectares per farm	Number of house-holds	Mean number of persons per house-hold	Mean operated hectares per farm	Number of house-holds	Mean number of persons per house-hold	Mean operated hectares per farm
All households*	45	4.41		72	5.30		72	5.49	
Small rice farmers	15	4.41	.57	11	4.53	.51	11	4.63	.50
Large rice farmers	6	5.66	1.65	21	6.63	2.69	21	6.79	2.70
Landless laborers	17	4.08		22	5.06		22	5.40	

	Village Group 2 73/74			Village Group 2 82/83		
	Number of house-holds	Mean number of persons per house-hold	Mean operated hectares per farm	Number of house-holds	Mean number of persons per house-hold	Mean operated hectares per farm
All households*	56	4.32		118	5.29	
Small rice farmers	10	4.35	.62	25	5.07	.60
Large rice farmers	5	6.48	1.92	26	7.21	2.79
Landless laborers	25	3.62		45	4.83	

Includes those below plus two other smaller household groups: non-rice farmers and non-agriculturalists.

Note: mall rice farmer is defined as one that operates 1.01 hectares or less. Large farmers rate more than 1.01 hectares.

same villages studied in 1973/74 were interviewed in 1982/83 but the values obtained were biased by a severe drought. Consequently, a subsample composed of the households from village group 1, was resurveyed the following year.

Out of the 11 villages surveyed in 1973/74 and 1982/83, 8 were chosen for this study and further subdivided into 2 groups for purpose of the analysis. Village group 1 includes households from 5 villages with poorer infrastructure and less intensely irrigated agriculture than those of the 3 villages that make up group 2; indeed, they were the 5 poorest villages in the whole sample. The 3 villages in group 2, on the other hand, have much better infrastructure and irrigation facilities that allow them to have high cropping intensity year-round and a more diversified crop mixture. These features, along with their closer location to market centers, put them in an advantageous income position since even the landless laborers are better off than the landless in village group 1 due to better year-round employment opportunities.

The impact of the 1982/83 drought was augmented by the fact that the area had not completely recovered from a similar drought 2 years earlier. The rainfall of 1980/81 was 27 percent below the normal 1,000 millimeters per year; 1981/82 was a normal year; but in 1982/83 the rainfall fell again below normal (about 24 percent below). As a result, yields were 40 percent lower than normal, and only 25 percent of the mean paddy area was planted with rice. Season 1, the monsoon season, was negatively affected by the lack of rain; but it was seasons 2 and 3 that were affected the most since they depend heavily on tank irrigation and there were only 30 days of tank water at the

end of the rain, as opposed to 120-140 days in a normal year. The 1983/84 rainfall was about 50 percent above normal, so high that some of the season 2 rice yields were reduced by excess rain.

The sample included households representing all occupational groups, 3 of which are studied in this paper: small rice farmers, defined as those operating less than 1.01 hectares; large rice farmers; and landless laborers, who represent the poorest strata of the society. Table 1 presents number of households, mean household size, and mean farm size for each of three consumer groups by village group and year. It shows that the average household in 1982/83 and 1983/84 has about 1 more member than the average household of 1972/73. It also shows an increase of about 1 hectare in the average operating holding of large farmers during the same decade.

3. RICE ACREAGE, YIELDS, PRODUCTION, AND SALE

As discussed in the previous section, there are three rice growing seasons in North Arcot (Table 2). Rice yields increased considerably as a consequence of modern varieties and improved water control. Thus, in spite of the severe drought in 1982-83, yields were higher in that year than it was prior to the introduction of modern varieties (Table 3). Since yields were severely affected by droughts in 1982-83 and excess rainfall during the second season of 1983-84, it is impossible to isolate the net effect of technological change on yields. However, a comparison of yields during the first season in 1983/84 with yields in all season of 1973/74 provides a reasonable approximation since the climatical conditions were "normal" for both

Table 2 — Average Rice Acreage (ha) per Farm by Season

	Village Group 1 73/74			Village Group 1 82/83			Village Group 1 83/84		
	Mean over all sample farms	% sample farms planting	Mean over planting sample farms	Mean over all sample farms	% sample farms planting	Mean over planting sample farms	Mean over all sample farms	% sample farms planting	Mean over planting sample farms
Season 1	.08	28.6	.29	.22	47.1	.47	.74	97.1	.76
Season 2	.37	90.5	.41	.08	29.4	.27	.36	73.5	.49
Season 3	.09	28.6	.32	.05	20.6	.25	.04	11.8	.37
Other				.09	20.6	.44	.06	8.8	.68

	Village Group 2 73/74			Village Group 2 82/83		
	Mean over all sample farms	% sample farms planting	Mean over planting sample farms	Mean over all sample farms	% sample farms planting	Mean over planting sample farms
Season 1	.22	55.6	.39	.32	70.6	.45
Season 2	.70	94.4	.74	.16	39.2	.41
Season 3	.19	61.1	.30	.16	29.4	.53
Other				.21	37.3	.55

Table 3 -- Rice Yield (kg./ha) by Season

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
Season 1	1997	2036	3143	2966	3119
Season 2	2338	2735	1888*	2620	2957
Season 3	2266	2894	n.a.	2605	2751
Other		2360			3024

* This low value is due to flooding caused by too much rainfall.

periods. If this comparison is accepted as a norm, the modern varieties and associated improvements in water control and fertilizer usage caused a 43 percent increase in rice yields in the non-irrigated areas.

Rice production during the drought year was slightly below that obtained during the normal year without new technology, but increased dramatically during the first season of 1983/84 (Table 4). This is reflected in rice sales which were about the same for the drought year and the year without modern technology but almost four times higher during 1983/84 than in 1973/74 in spite of excess rainfall during the second season of 1983/84 (Table 5).

Thus, in conclusion, yields were influenced by a variety of factors, including the introduction of modern varieties, expanded fertilizer usage, improved water control, droughts, and excessive rainfall. Available data do not permit an exact estimation of the net effect of technological change but it has clearly been large, virtually offsetting the negative effects of a severe drought. Rice production has increased dramatically due to yield increases, higher levels of cropping intensity, and a larger acreage dedicated to rice. Most of the production increase appears to have been sold.

4. HOUSEHOLD INCOMES

Estimates of household incomes that are earned primarily from self-employment, including farming, are usually subject to large errors because of the difficulties of obtaining correct data. Estimates of total household expenditures usually yield better approximations of

Table 4 — Average Rice Production (kg) Per Farm By Season

	Village Group 1 73/74		Village Group 1 82/83		Village Group 1 83/84	
	Mean over all farms	Mean over planting farms	Mean over all farms	Mean over planting farms	Mean over all farms	Mean over planting farms
Season 1	182.51	638.80	303.81	645.60	2111.22	2175.20
Season 2	746.07	824.60	205.88	700.00	700.29	952.40
Season 3	241.09	843.80	147.06	714.30	85.29*	725.00*
Other			204.42	992.90	66.67	566.67
Total/Farm/Year	1169.62	1228.10	861.19	1394.30	2946.80	2946.80

	Village Group 2 73/74		Village Group 2 82/83	
	Mean over all farms	Mean over planting farms	Mean over all farms	Mean over planting farms
Season 1	680.00	1224.00	875.86	1240.80
Season 2	2101.67	2225.30	511.37	1304.00
Season 3	582.51	953.20	466.09	1584.70
Other			604.91	1623.70
Total/Farm/Year	3124.20	3124.20	2458.26	2558.60

* These figures are so small because the 1983/84 survey did not cover the complete harvest.

Table 5 -- Rice Sales (rupees/household/year)

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
Current rupees					
Large farmer	982.90	1292.60	3757.60	4489.50	3827.50
Small farmer	-107.60	182.[illegible]0	1322.70	92.00	586.80
All rice farmers	222.90	911.10	2920.60	1770.30	2239.00
Deflated rupees*					
Large farmer	982.90	772.72	2254.11	4489.50	2288.08
Small farmer	-107.60	109.22	793.46	92.00	350.79
All rice farmers	222.90	544.66	1752.01	1770.30	1338.47

The rural price index used to deflate series throughout this paper is 100 for 1973-1974, 167.28 for 1982-1983, and 166.7 for 1983-1984. (Commissioner of Statistics, Government of Tamil Nadu. Season and Crop Report. Various issues). The exchange rate is currently 11.9 rupees per dollar. The 73/74 data did not provide rice sales figures; therefore, those presented here are approximations (net revenue from rice minus value of consumption) which assume no carry-over stock from one year to the next. A small farmer is defined as one that operates 1.01 ha or less. Large farmers operate more than 1.01 ha.

purchasing power, particularly among the poor whose savings are very limited. Thus, in this study, total expenditures are used instead of direct income estimates. As shown in Table 6, total household expenditures increased dramatically for households in the villages of group 2 during the ten-year period 1973/74-1983/84. Thus, after accounting for inflation, average total expenditures for all sample households tripled. The largest absolute increase occurred for large farmers while small farmers experienced the largest percentage increase (250%). Among the three groups of households, landless labor has the lowest income and although their real incomes increased in the villages of group 2 during the 10-year period, they became worse off relative to both small and large farmers. In the villages of group 1, their incomes increased less than inflation resulting in a deterioration of 19 percent in real purchasing power.

The seasonal fluctuations in total household expenditures were very small for landless labor and small farmers prior to technological change and increased considerably between 1972/73 and 1983/84 (Figures 1 and 2). On the other hand, while larger for all survey years, there is no indication that the magnitude of seasonal variation increased among large farmers. One explanation for this differential response is that the larger farmers used savings and adjustments in fluid assets to counter increased seasonal fluctuations in incomes. Furthermore, larger farmers are more likely to spend on consumer durables that can be purchased during periods of high incomes. This would explain the larger seasonal fluctuations in total expenditures.

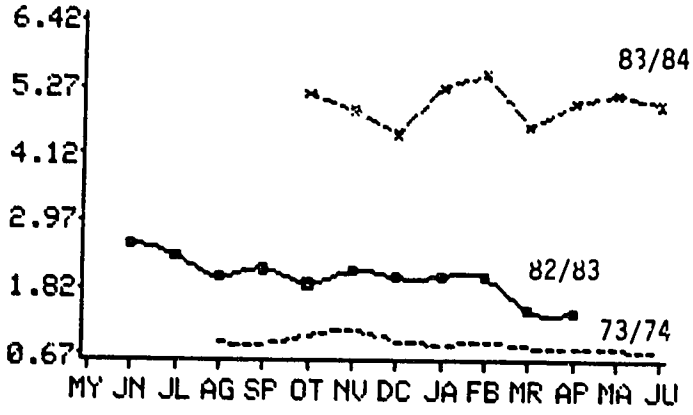
Table 6 -- Total Yearly Expenditure - Rupees per Capita

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
			(Current Rupees)		
All households	339.82	739.86	1677.54	486.18	822.35
Small farmers	315.00	722.70	1834.86	472.31	859.58
Large farmers	541.30	857.02	1896.91	842.06	1078.58
Landless	296.02	603.71	1359.63	428.88	583.27
			(Deflated Rupees)		
All households	339.82	442.30	1006.31	486.18	491.61
Small farmers	315.00	432.04	1100.68	472.31	513.87
Large farmers	541.30	512.34	1137.91	842.06	644.79
Landless	296.02	360.91	815.60	428.88	348.69

Figure 1 -- Total Household Expenditure, Village Group 1 (Current Rupees/Person/Day)

Moving Averages

FIG A. GROUP 1 SMALL RICE FARMERS



Detrending Residuals

FIG B. GROUP 1 SMALL RICE FARMERS

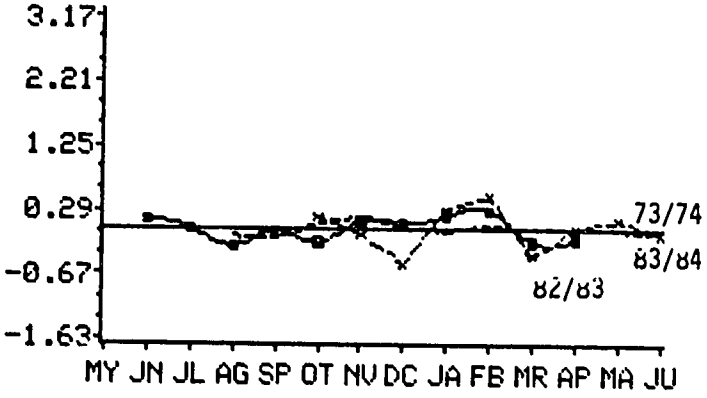


FIG C. GROUP 1 LANDLESS LABORERS

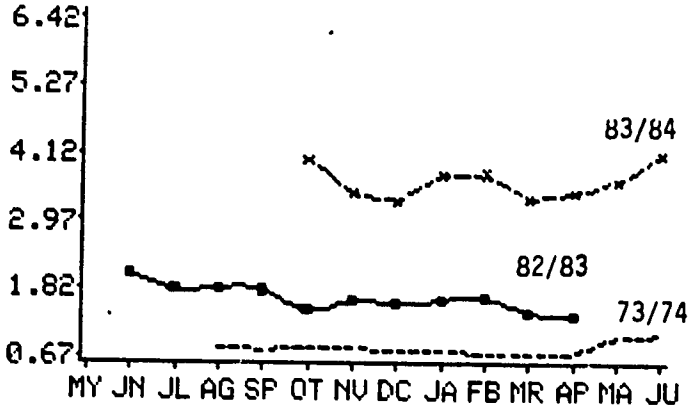


FIG D. GROUP 1 LANDLESS LABORERS

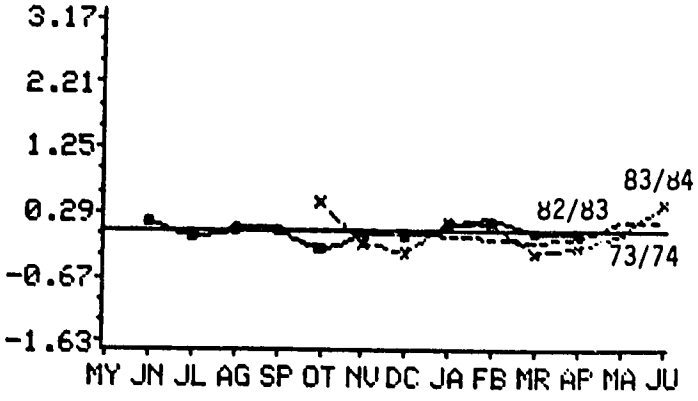


FIG E. GROUP 1 LARGE RICE FARMERS

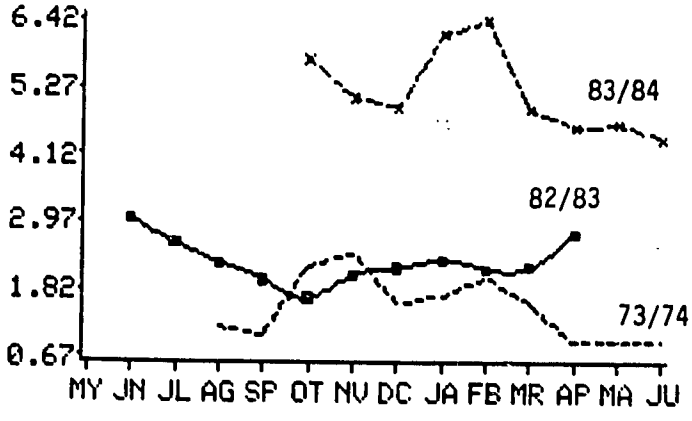


FIG F. GROUP 1 LARGE RICE FARMERS

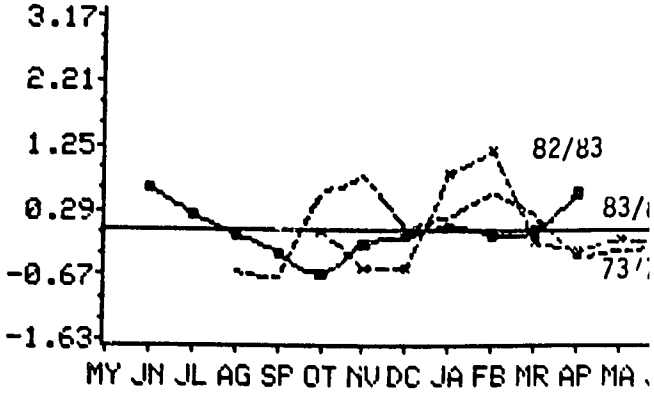
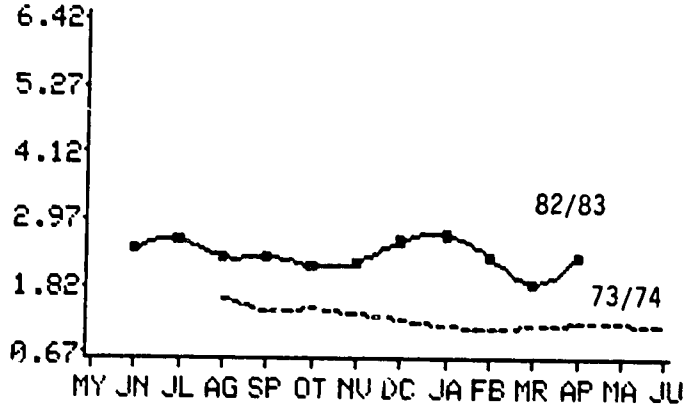


Figure 2 -- Total Household Expenditure, Village Group 2 (Current Rupees/Person/Day)

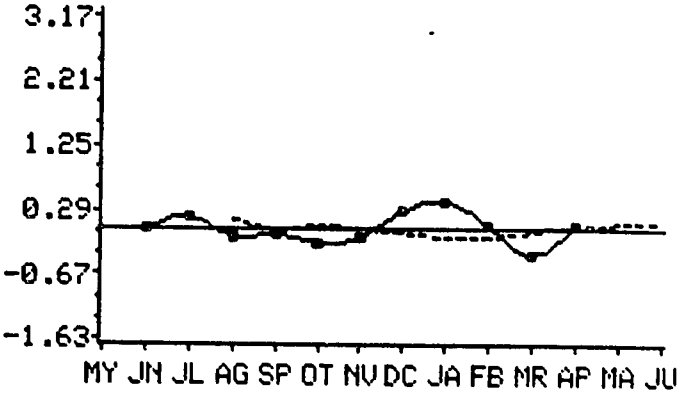
Moving Averages

FIG A. GROUP 2 SMALL RICE FARMERS



Detrending Residuals

FIG B. GROUP 2 SMALL RICE FARMERS



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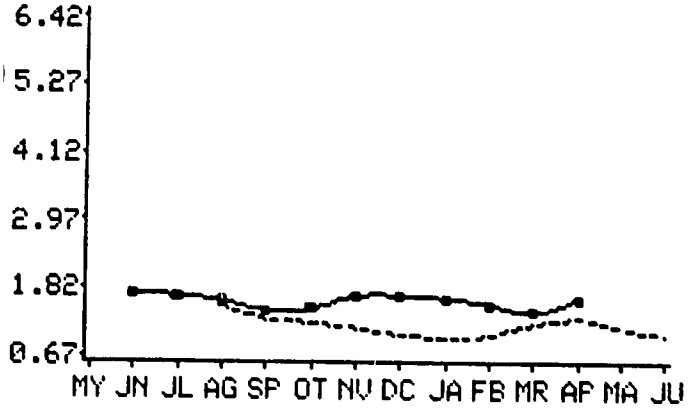

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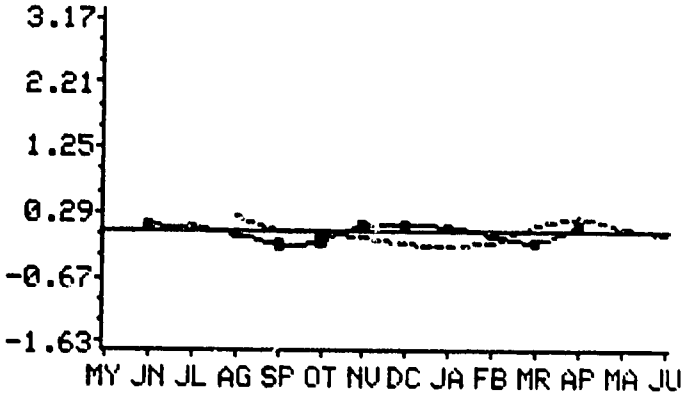
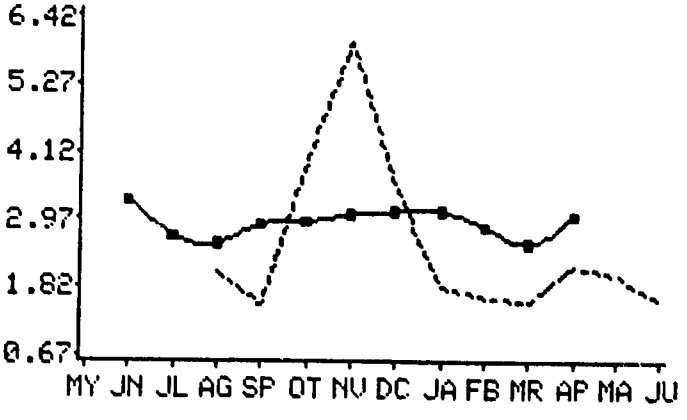


FIG E. GROUP 2 LARGE RICE FARMERS



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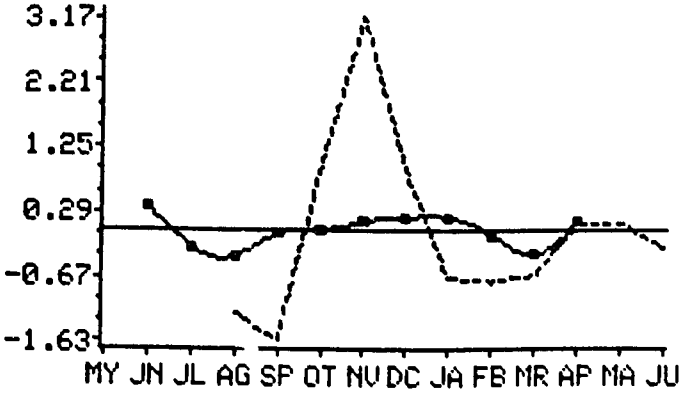

Deteriorations in real incomes among the landless labor households in the irrigated areas are reflected in large increases in the proportion of incomes spent on food (Table 7). Similarly, improvements in real incomes of small farmers are reflected in reductions in the budget shares used for food. The relatively large increases in the budget shares used for food among large farmers were unexpected and are probably -- at least in part -- due to a higher rate of savings which increases the difference between incomes and total expenditures. Further research will be undertaken on this matter.

5. PRICES AND COMMODITY SUBSTITUTION

The budget shares for food are also influenced by the changes in food prices relative to the prices of other goods. Consumer prices for rice increased less than other prices during the study period. Thus, the deflated rice price fell by 35 percent between 1973/74 and 1982/83 but increased by 28 percent between 1982/83 and 1983/84 (Table 8). The cost per 1,000 calories of the total diet also increased less than the consumer price index between 1973/74 and 1982/83 but this decrease in the real calorie price was more than offset by increases from 1982/83 to 1983/84. Thus, over the study period as a whole, the cost of the diet expressed per unit of calories increased by 33 percent.

The decreases in rice and total calorie prices from 1973/74 to 1982/83 and the increase from 1982/83 to 1983/84 explain in part why a lower share of the budget was allocated to food in 1982/83 than in the other two study years (Table 7).

Table 7 -- Expenditure on Food as a Percentage of Total Expenditure

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
			(Percent)		
All households	75.20	72.10	75.30	73.70	72.90
Small farmers	76.90	72.90	75.30	79.40	72.50
Large farmers	57.70	66.40	77.10	60.40	69.40
Landless	82.90	76.00	75.00	76.10	82.60

Table 8 -- Paddy, Rice, and Calorie Prices

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
			(Current rupees)		
Farmgate paddy price per kg	.896	1.603	1.524	.896	1.603
Consumer rice price per kg	1.954	2.154	2.758	2.080	2.216
Cost per 1000 calories*	.640	.920	1.420	.690	.890
			(Deflated rupees)		
Farmgate paddy price per kg	.896	.958	.914	.896	.958
Consumer rice price per kg	1.954	1.288	1.654	2.080	1.325
Cost per 1000 calories*	.640	.550	.852	.690	.532

* Cost per 1000 calories = (expenditure on food/total calories consumed) 1000.

Note: The hulling ratio of paddy is .67 - i.e., rice = paddy * .67.

Changes in the average price of the calories making up the diet reflect both changes in the commodity composition of the diet and changes in the prices of individual commodities. During the study period, the diet composition changed considerably. Although the absolute amount of rice increased, its share of total calories declined sharply, particularly during the last year (Table 9). This decline is due to substitution toward a more diversified diet, a phenomenon that usually occurs with increasing incomes. Increased availability of subsidized wheat during the latter stages of the drought along with lower rice production also played a role and it is expected that the calorie share occupied by rice in 1983-84 will increase when the availability of subsidized wheat is reduced.

Primarily due to the drought and resulting depletion of stocks, rice consumption decreased dramatically among rice farmers in the villages of group 2 during 1982/83, while no such decline was observed in the villages of group 1. However, by the middle of 1984, rice consumption had regained its pre-drought levels (Figures 3 and 4). Severe declines were also observed among landless labor households during 1982/83 primarily because the labor demand for harvesting and incomes -- much of which is in the form of rice -- declined drastically.

The seasonal patterns in rice consumption differ between pre- and post-modern varieties and between the villages of group 1 and group 2. Prior to the introduction of modern varieties, seasonal variation among small farmers in the villages of group 2 appears to be limited to a low right before the harvest in January and a high after the July

Table 9 -- Daily Energy Obtained from Rice Consumption

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
			(Calories/head)		
All households	754	1008	1096	766	1142
Small farmers	750	1058	1163	874	1124
Large farmers	840	1156	1551	1128	1230
Landless	669	887	812	653	1041
			(Percent of Total Calories)		
All households	68.4	62.6	44.1	51.9	62.6
Small farmers	73.1	64.1	44.6	51.4	62.5
Large farmers	68.5	63.7	52.6	62.5	57.1
Landless	63.2	62.6	38.1	47.9	64.2

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Figure 3 -- Household Rice Consumption, Village Group 2 (Calories/Person/Day)

Moving Averages

Detrending Residuals

FIG A. GROUP 1 SMALL RICE FARMERS

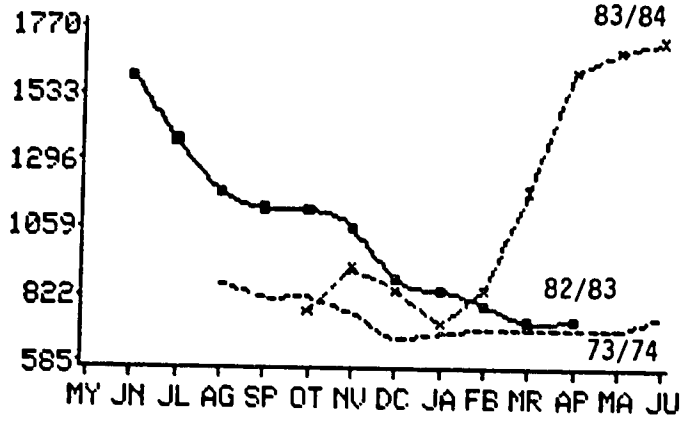


FIG B. GROUP 1 SMALL RICE FARMERS

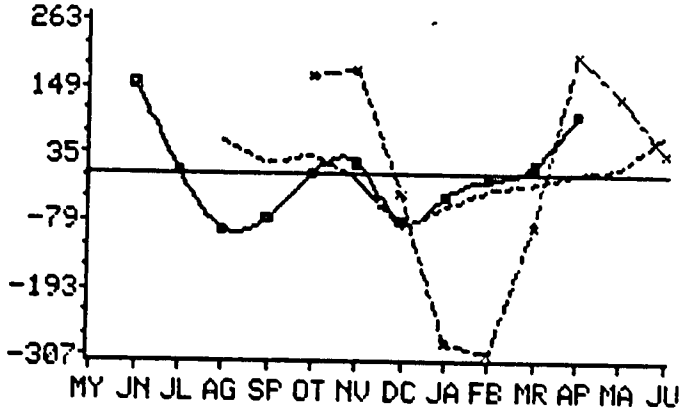


FIG C. GROUP 1 LANDLESS LABORERS

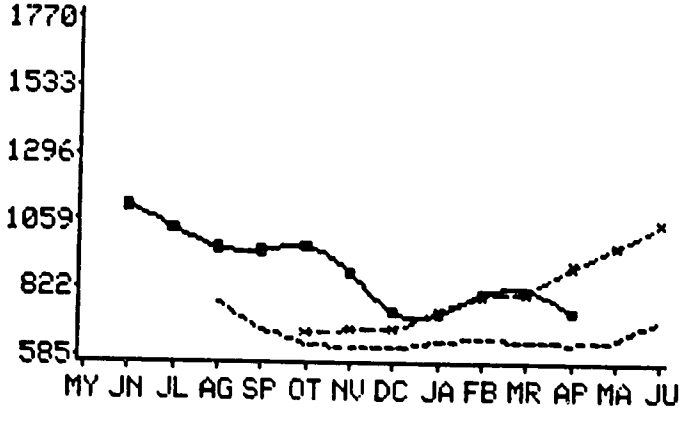


FIG D. GROUP 1 LANDLESS LABORERS

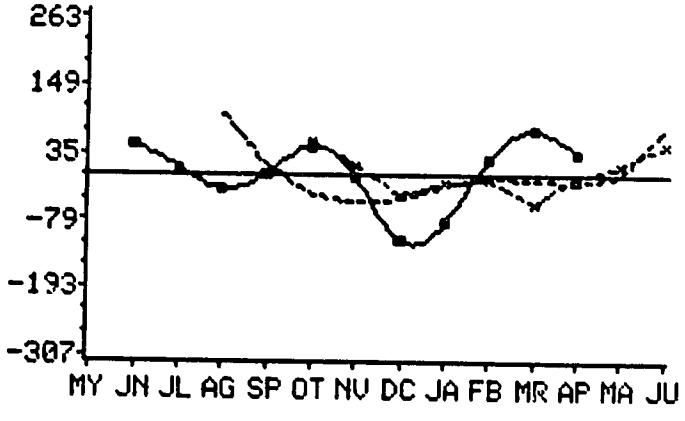


FIG E. GROUP 1 LARGE RICE FARMERS

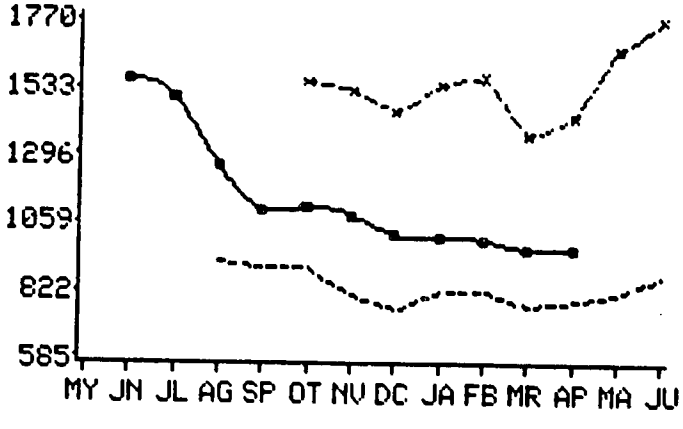


FIG F. GROUP 1 LARGE RICE FARMERS

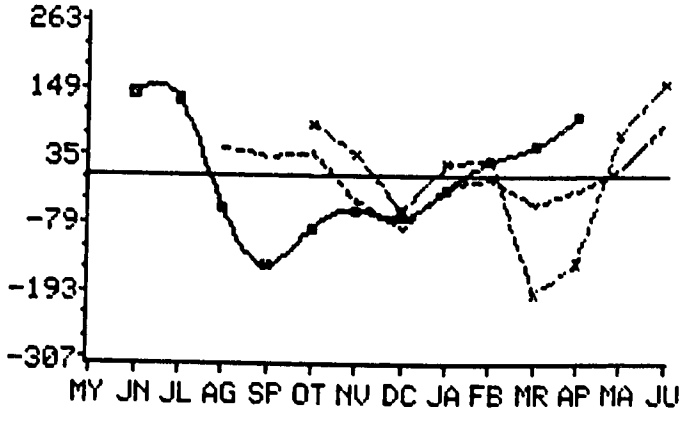
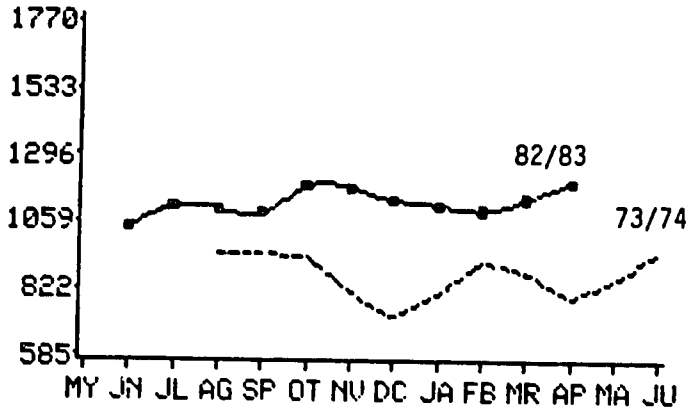


Figure 4 -- Household Rice Consumption, Village Group 2 (Calories/Person/Day)

Moving Averages

FIG A. GROUP 2 SMALL RICE FARMERS



Detrending Residuals

FIG B. GROUP 2 SMALL RICE FARMERS

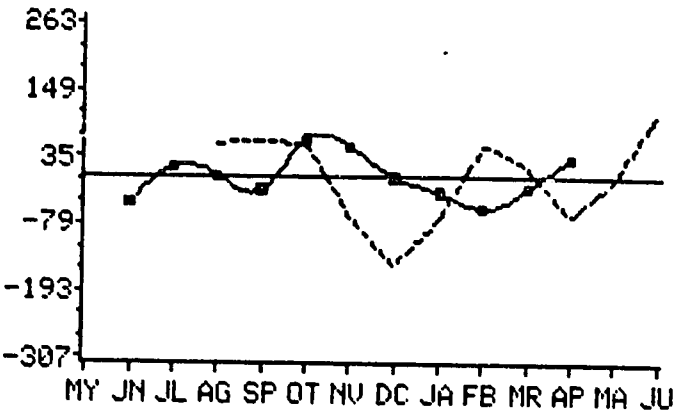
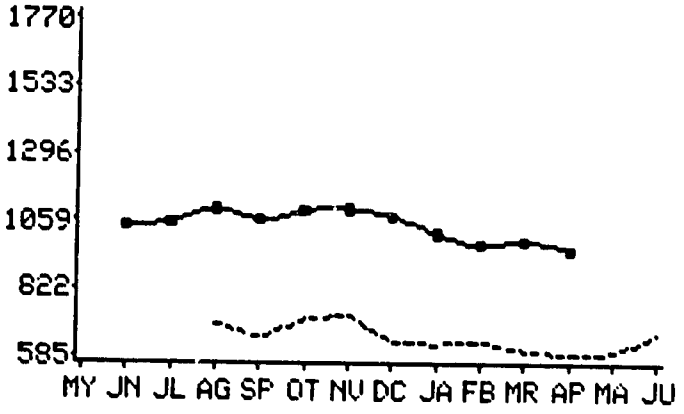


FIG C. GROUP 2 LANDLESS LABORERS



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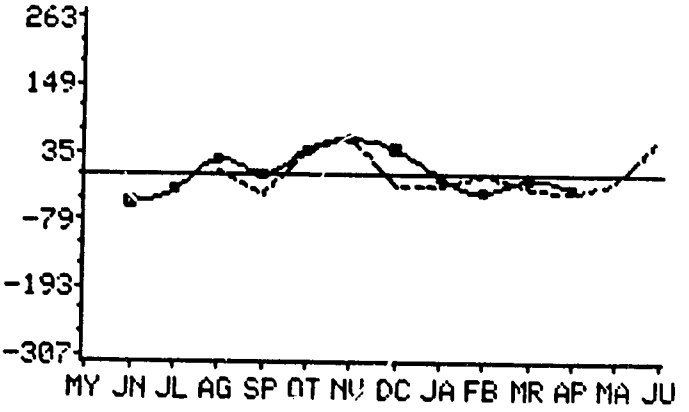


FIG E. GROUP 2 LARGE RICE FARMERS

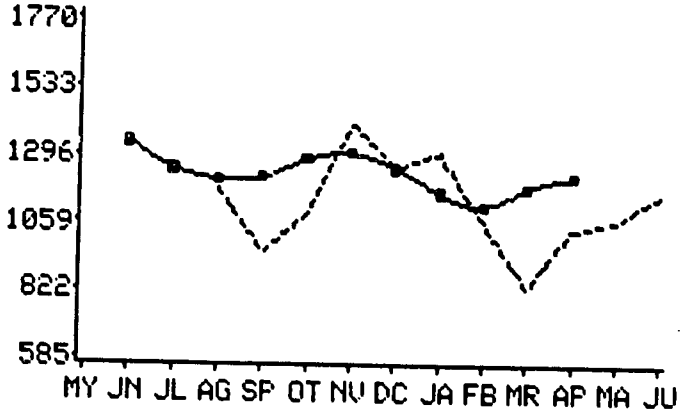
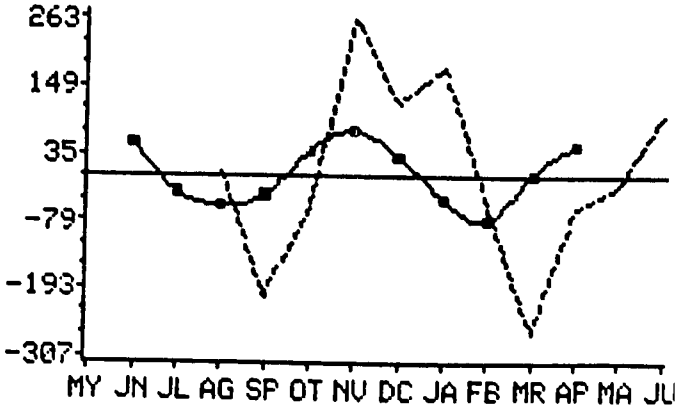


FIG F. GROUP 2 LARGE RICE FARMERS



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harvests (Figure 3). In contrast, during the two years after the introduction of modern varieties, two distinct seasonal cycles appear with lows in July/August and December/January. Landless labor shows similar seasonal patterns but of smaller magnitude. The seasonal patterns do not appear to have changed among large farmers but the magnitude has increased.

In the villages of group 1, the seasonal patterns did not change significantly (Figure 4). The magnitudes are larger among the farmers than among the landless and it appears that they decreased from 1973/74 to 1982/83.

Seasonal fluctuations in the prices of rice, ragi, and total calories are shown in Figure 5. The seasonal patterns differ considerably between 1973/74 and 1982-84. Only one seasonal cycle appears for rice in 1973/74 with low prices during November/December. The other two years each show two seasonal cycles with lows in October/November and March/May. These months of low rice prices correspond roughly to the months of high seasonal rice consumption (Figures 3 and 4). Thus, it appears that the low prices are caused by seasonality in rice supply and in turn results in seasonality in consumption.

During 1973/74, seasonal patterns in ragi prices followed those of rice prices. Thus, consumers were faced with high prices for both rice and ragi in August to October. The congruence is less pronounced for the other two years. The seasonal patterns in calorie costs are similar for 1982/83 and 1983/84 but both are different from those for 1973/74. The latter are closely associated with the seasonal patterns in rice and ragi price because of the high budget share going to those

Figure 5 -- Real Prices of Rice, Ragi, and Total Calories -- deflated to 1972 level
(Rupees/1000 Calories)

Moving Averages

Detrending Residuals

FIG A. CONSUMER PRICE OF RICE

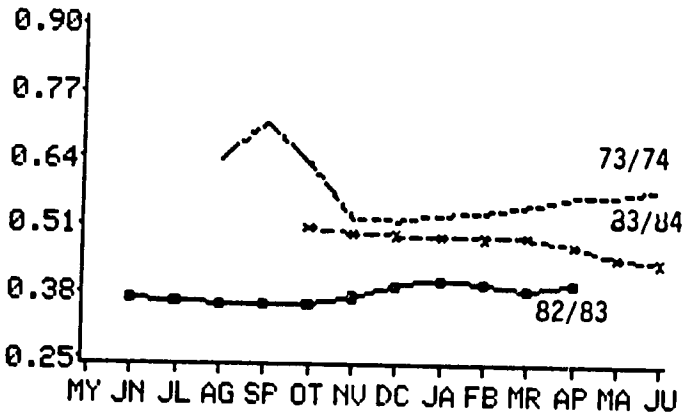


FIG B. CONSUMER PRICE OF RICE

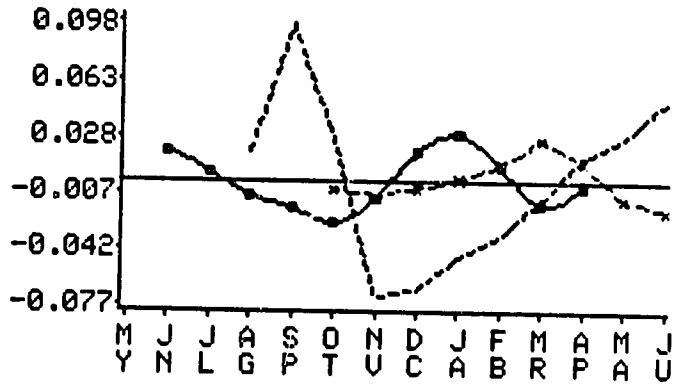


FIG C. CONSUMER PRICE OF RAGI

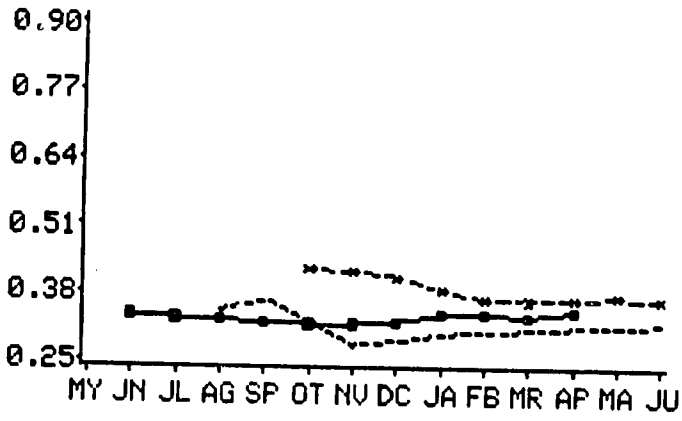


FIG D. CONSUMER PRICE OF RAGI

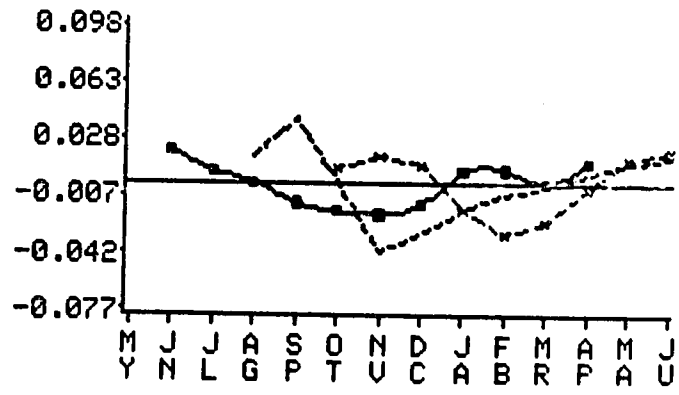


FIG E. MEAN COST PER 1000 CALORIES

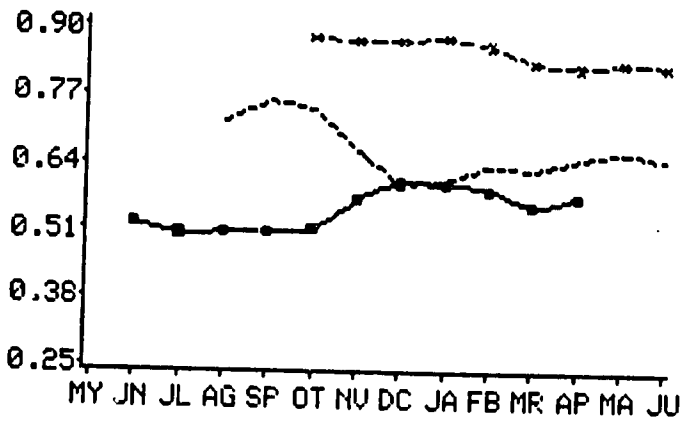
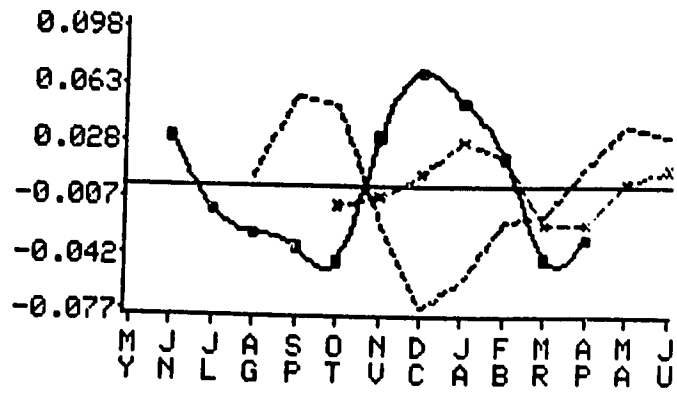


FIG F. MEAN COST PER 1000 CALORIES



two commodities. The drastic change in the diet composition shown in Table 9 made the calorie price less dependent on rice prices but does not seem to have lowered the magnitude of its seasonal variation (Figure 5).

6. HOUSEHOLD ENERGY CONSUMPTION

Dramatic increases occurred in household energy consumption during the study period. Thus, calorie consumption more than doubled for all household groups in the villages of group 2 between 1973/74 and 1983/84 (Table 10). The negative effect of the drought in 1982/83 was more than offset by positive effects brought about by other factors during 1973/74-1982/83, leaving the 1982/83 consumption level considerably above the 1973/74 level. The negative effect of the drought cannot be isolated from other effects, such as increased availability of wheat and rice from public distribution outlets, on the basis of available data.

The seasonal fluctuations in household energy consumption are shown in Figures 6 and 7. Although there are three harvest seasons, it appears that only two seasonal cycles occur in annual energy consumption. The consumption is generally below average right before the harvest in January, increasing to a maximum after the May harvest. It then falls below average, reaching a low level right before the August harvest and increases to a high level in October-November.

In order to compare seasonal variations across years and household groups, attempts were made to remove two other sources of variation from the data. First, month-to-month variations were reduced through

Table 10 -- Daily Energy Consumption

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
	(Calories/head)				
All households	1102	1611	2484	1476	1824
Small farmers	1026	1651	2606	1702	1798
Large farmers	1226	1814	2948	1805	2153
Landless	1058	1416	2134	1364	1622

Figure 6 -- Total Household Energy Consumption, Village Group 1 (Calories/Person/Day)

Moving Averages

Detrending Residuals

FIG A. GROUP 1 SMALL RICE FARMERS

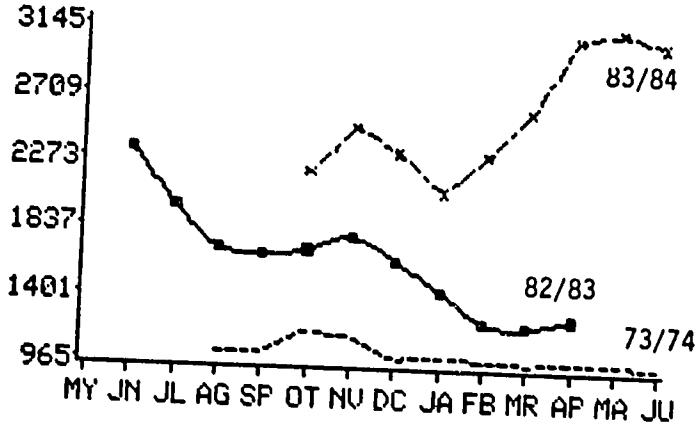


FIG B. GROUP 1 SMALL RICE FARMERS

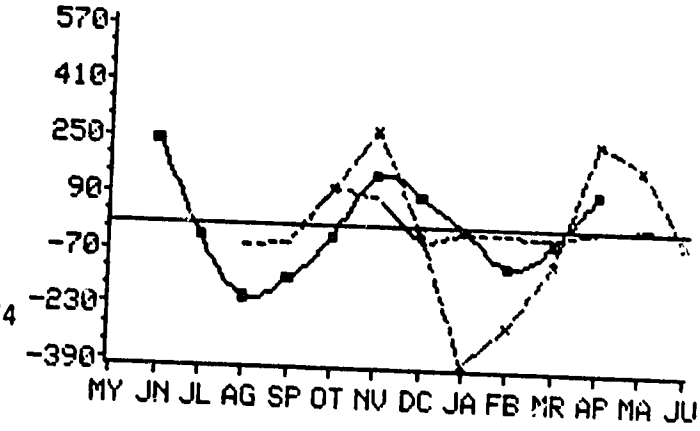


FIG C. GROUP 1 LANDLESS LABORERS

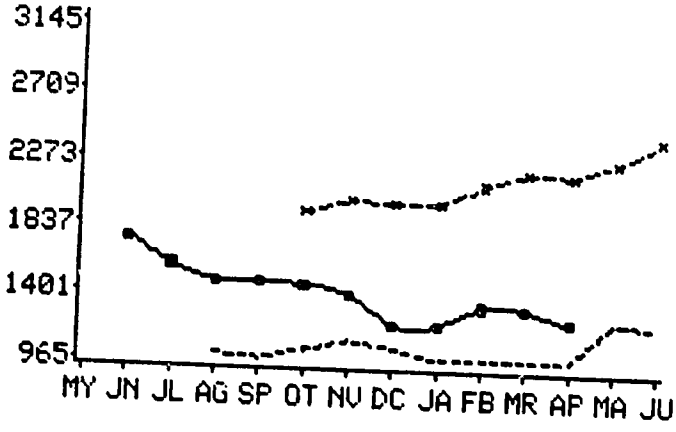


FIG D. GROUP 1 LANDLESS LABORERS

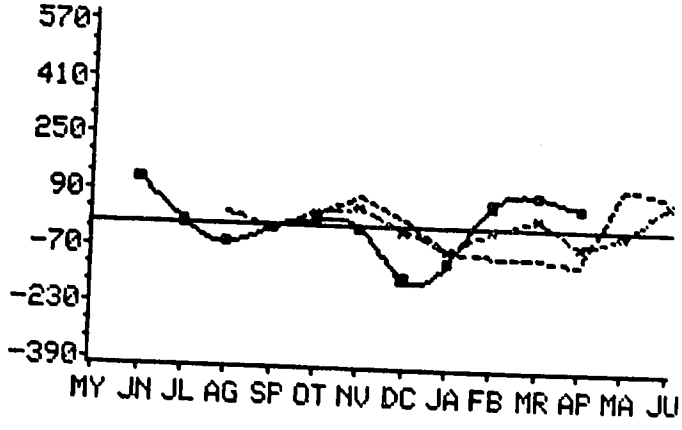


FIG E. GROUP 1 LARGE RICE FARMERS

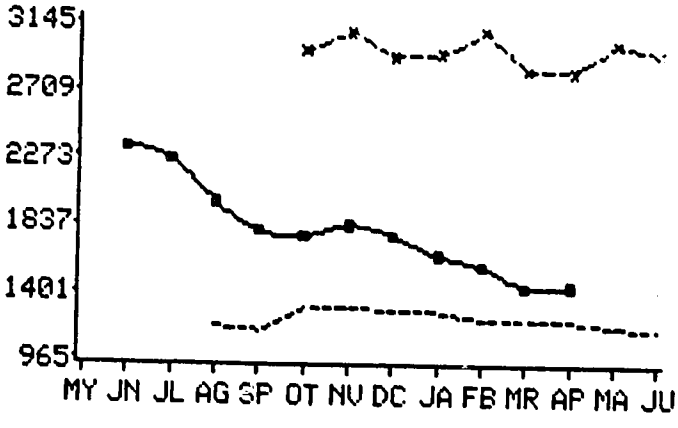


FIG F. GROUP 1 LARGE RICE FARMERS

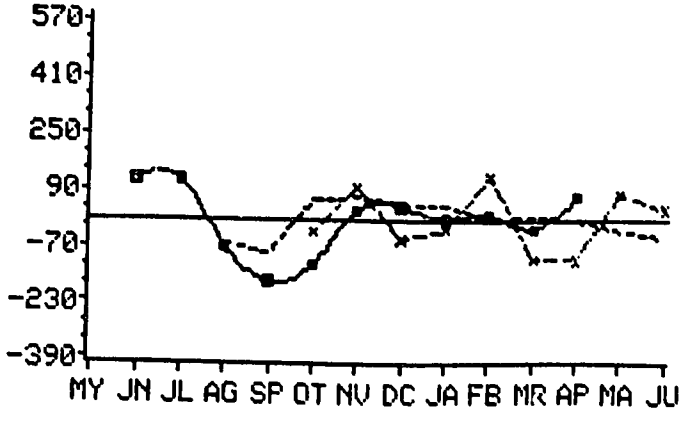


Figure 7 -- Total Household Energy Consumption, Village Group 2 (Calories/Person/Day)

Moving Averages

Detrending Residuals

FIG A. GROUP 2 SMALL RICE FARMERS

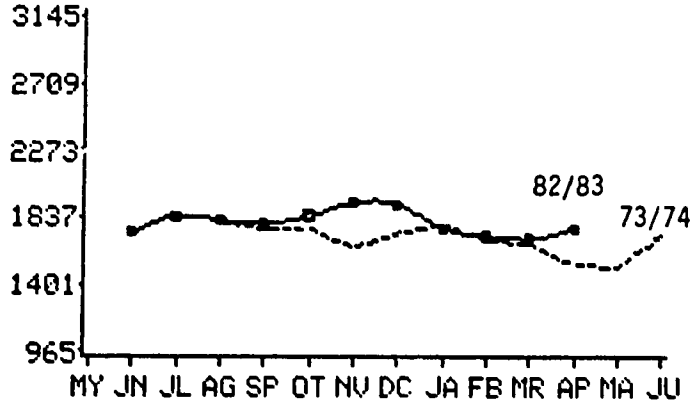


FIG B. GROUP 2 SMALL RICE FARMERS

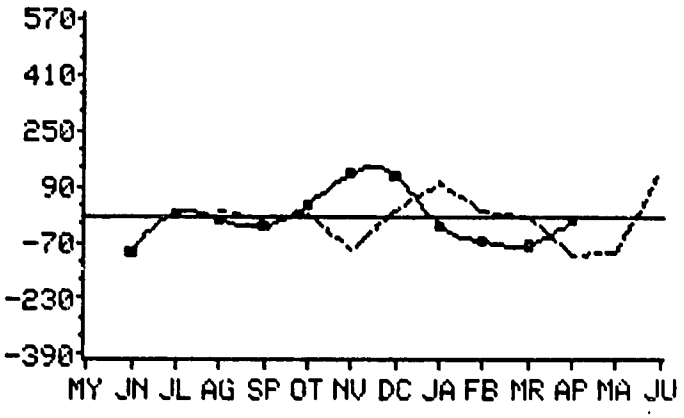


FIG C. GROUP 2 LANDLESS LABORERS

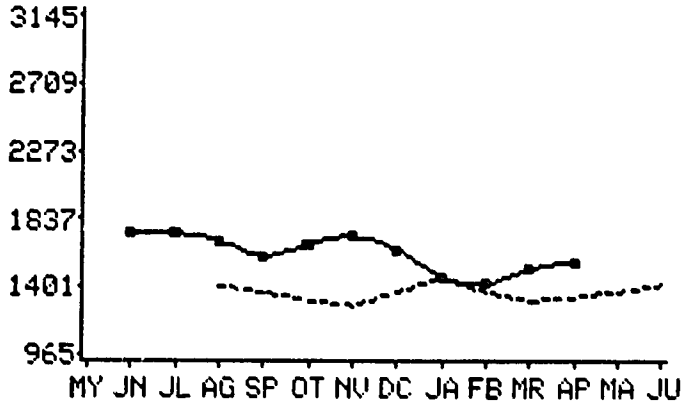


FIG D. GROUP 2 LANDLESS LABORE

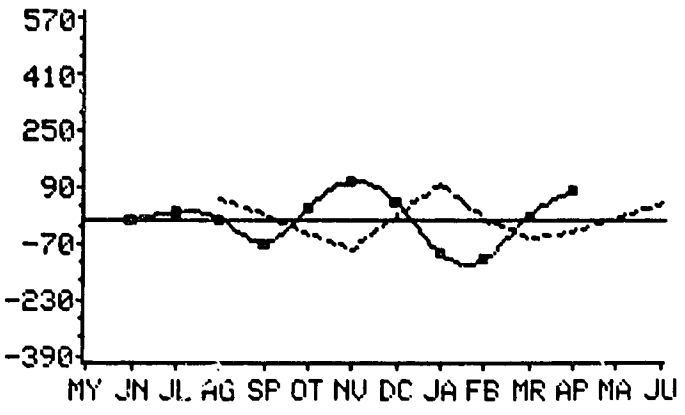


FIG E. GROUP 2 LARGE RICE FARMERS

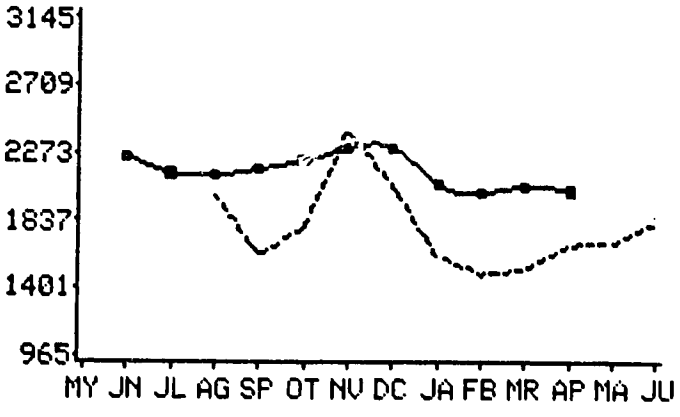
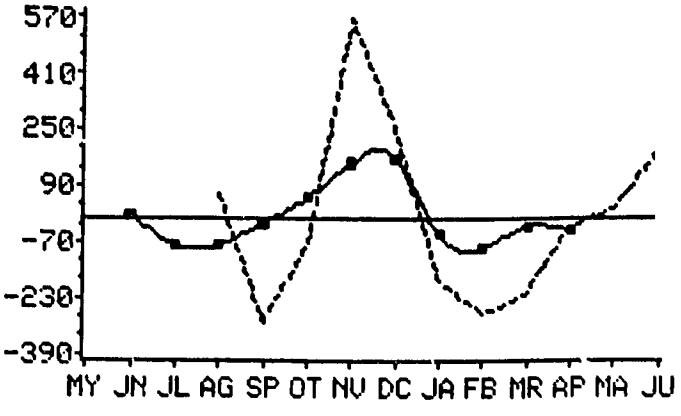


FIG F. GROUP 2 LARGE RICE FARMERS



the development of two-month moving averages. Second, the effects of trends were isolated by means of linear regression. The effects of this trend were deducted from the two-month moving averages of actual observations in order to isolate the seasonal variations. A trend line was estimated for each household. The average trend coefficients are shown in Table 11. The trend was not statistically significant for most households during 1973/74 and the value of the trend coefficient was low. A much stronger trend was found in 1982/83 for the villages of group 2 primarily because of the drought, the effect of which increased during the year. Thus, the monthly decrease in household calorie consumption over the year for households in these villages was 78 calories/person/day. An increasing trend of almost the same magnitude was found for the subsequent year as the effects of the drought subsided. The decrease during 1982/83 was much less in the villages of group 1 primarily because the drought had much less impact on rice production.

Trend lines were also estimated on the basis of monthly averages of household observations in each group. The estimates, which are shown in Table 12, are very similar to those obtained from individual household trends and are shown primarily because statistical tests can be run on whether the trend coefficients are significantly different from zero. A very significant trend was found for all groups in the villages of group 2 during 1982/83 and for all groups, except large farmers during 1983/84. A highly significant negative trend was also found for the villages of group 1 during 1982/83 although not all groups were equally affected. This confirms that the irrigated farms

Table 11 — Mean of Household Time-Trends for Two-Month Moving Averages of Consumption (calories/pers

	Village Group 1					
	1973/74		1982/83		1983/84	
	Mean Trend Coefficient	% of households with significant trends b/	Mean Trend Coefficient	% of households with significant trends b/	Mean Trend Coefficient	% of households with significant trends b/
All groups below	1.48	20.0	-77.60	78.2	60.05	46.2
Small farmers	-12.79	26.7	-95.24	81.8	122.30	45.5
Large farmers	-4.63	0.0	-91.33	85.7	-0.80	42.1
Landless	14.68	21.1	-56.63	69.6	81.48	50.0

	Village Group 2			
	1973/74		1982/83	
	Mean Trend Coefficient	% of households with significant trends b/	Mean Trend Coefficient	% of households with significant trends b/
All groups below	- 2.01	14.6	-18.69	27.8
Small farmers	-22.11	40.0	- 7.99	24.0
Large farmers	-19.00	0.0	-16.70	23.1
Landless	7.95	7.4	-25.64	32.6

a/ Based on household specific linear regressions specified as $c = b_0 + b_1 t + e$ where

c = daily per capita household calorie consumption
t = month (t=1...12)

The numbers shown in this table are the values of b_1 averaged over all households in each group.

b/ Si cant at the 90% level.

Table 12 -- Time-Trends of Two-Month Moving Averages of Household Means of Calorie Consumption a/

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
All groups below	-.41	-71.57*	65.61*	-10.69	-15.85*
Small farmers	-11.88**	-93.16*	124.36*	-18.56*	-6.95
Large farmers	-4.22	-84.59*	-9.14	-30.10	-17.52**
Landless	15.68**	-44.13*	56.90*	1.59	-26.88*

* Significant at @ < = .05.

** Significant at @ < = .1.

a/ Based on group, not household-specific, linear regressions using monthly means for households in the group.

were affected by the drought but much less so than those in the villages of group 2.

In order to analyze whether technological change and drought influenced seasonal variations in household energy consumption, the standard deviation (s.d.) and the coefficient of variation in percent of the average value of the observations (c.v.%) were estimated around the trend and tested for significant difference between years and between groups. Two statistical tests were applied. Test I is based on the following regressions:

$$s.d. = f(TEX, HH, D_1); \quad s.d. = f(HH, D_2)$$

$$c.v. = f(HH, D_1); \text{ and } c.v. = f(HH, D_2)$$

where

s.d. = standard deviation around the trend of two-month moving averages of observations of household calorie consumption (calories/person/day)

c.v. = coefficient of variation around the same trend (percent)

TEX = total household expenditures (Rs/person/day)

HH = household size

D_1 = a set of dummies for years and village groups

D_2 = a set of dummies for household groups.

The coefficients for D_1 and D_2 were tested for significant difference between years and household groups, respectively. The results are shown in Table 13. The significant increase in the standard deviation between 1973/74 and 1983/84 indicates that the magnitude of seasonal variation in calorie consumption increased with technological change both in irrigated and non-irrigated areas. The

Table 13 -- Average of household level standard deviations (s.d.) and coefficients of variation (in %) (c.v.) for annual trends of two-month moving averages of total calorie consumption/person/day and test I for statistical significance.

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
			(s.d.)		
Groups					
All household	139.9^{ab}	276.6^{bf}	333.3^{af}	197.8^{e}	275.9^{e}
Small rice farmers	102.4^{abd} ∂	278.7^{b} α	360.5^{a}	195.4^{de} α	272.2^{e}
Large rice farmers	117.5^{bd}	303.9^{b} αβ	386.3 β	370.3^{de} αβ	280.1^{e} β
Landless laborers	176.7 ∂	251.0^{f} β	273.8^{f} β	166.7^{e} β	275.6^{e} β
			(c.v.%)		
All household	12.7^{b}	18.2^{bfg}	13.7^{f}	13.4^{e}	15.8^{eg}
Small rice farmers	10.1^{ab} ∂	17.7^{b}	15.4^{a}	12.7 α	15.5
Large rice farmers	9.6^{bd} β	18.3^{bfg}	13.3^{f}	21.0^{de} αβ	13.6^{eg} β
Landless laborers	15.8^{d} β∂	18.2^{f}	13.1^{f}	12.2^{de} β	17.2^{e} β

Note: Test I is explained in the text. The following pairs of estimates were tested for statistically significant differences: (1) Within each group of households in Region every year was tested against every other year; (2) Within each group of households, Region 1 was tested against Region 2 for the same year only, e.g., Region 1 against Region 2 for 73/74; and (3) Within each year, every sub-group of households was tested against every other one. Significant differences are shown in the table with matching letters as follows:

Letter	Region	Year	Versus	Region	Year
a	1	73/74	versus	1	83/84
b	1	73/74	versus	1	82/83
d	1	73/74	versus	2	73/74
e	2	82/83	versus	2	73/74
f	1	82/83	versus	1	83/84
g	1	82/83	versus	2	82/83

α small versus large farmers
β large farmers versus landless labor
∂ small farmers versus landless labor

standard deviation increased for all groups, except large farmers in irrigated areas. The increase was large and significant among small farmers for all three years and in both regions. Thus, the standard deviation more than tripled from 1973/74 to 1983/84. The magnitude of seasonal variation in calorie consumption by landless labor households was higher than that for the farmers prior to the modern technology and lower after the technology was introduced.

The increase in seasonal variations was accompanied by increasing annual average consumption. This implies that the magnitude of seasonal variations relative to the mean consumption (c.v.%) need not have increased. As shown in Table 13, the seasonal fluctuations relative to the mean were higher in 1982/83 than both before and after. This is explained partly by the lower mean consumption level in 1982/83 than in the subsequent year and partly by the higher fluctuations in rice production due to the drought. The increase in the c.v. between 1973/74 and 1982/83 was smaller in the villages of group 1 than in villages of group 2 because the effects of the drought were less severe in the former.

As discussed earlier, a comparison between 1973/74 and 1983/84 is likely to provide a better indicator of the effects of technological change than comparisons with 1982/83. Only small farmers show a significant increase in the c.v. between those two years but the increase is large (50%). Landless labor households reduced the seasonal fluctuations in calorie consumption relative to the annual mean between the two years, although the decrease is not statistically

significant. Landless labor households were higher than both small and large farmers in 1973/74 and lower ten years later.

Results from an alternative test -- Test II -- of significant differences between years, regions, and groups are shown in Table 14. In this case, the means were tested directly by means of Tukey's test (Tukey, 1953) without isolating the effects of total expenditures and household size as in Test I. It appears that failure to control for the effect of variations in total expenditures and household size reduces the number of statistically different means of standard deviations and coefficients of variations. This is not surprising since the coefficients for total expenditures and household size estimated in the above specified regressions for s.d. were highly significant. These coefficients were positive for total expenditures indicating that, within a certain household group, those with higher incomes also have higher seasonal variations in food consumption. This was particularly pronounced for landless labor. The coefficients for household size were negative implying that larger households have lower seasonal variation in food consumption. Since food consumption is expressed per capita, this is probably explained by household externalities and lower levels of consumption per person in larger households.

7. APPARENT ENERGY DEFICIENCIES

Although changes in average calorie consumption for each group reported in Table 10 and Figures 6 and 7 provide indications of the degree of household level calorie sufficiency rates, group averages do not show the distribution of these rates among households. Thus, to

Table 14 -- Average of household level standard deviations (s.d.) and coefficients of variation (in %) (c.v.) for annual trends of two-month moving averages of total calorie consumption/person/day and Test II for statistical significance.

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
			(std)		
Group					
All groups below	139.9[ab]	276.8[b]	333.3[a]	197.8[e]	275.9[e]
Small rice farmers	102.4[ab]	278.7[b]	360.5[a]	195.4 α	272.2
Large rice farmers	117.5[abd]	303.9[b]	386.3[a] β	370.3[d] αβ	280.1
Landless laborers	176.7	251.0	273.8 β	166.7[e] β	275.6[e]
			(c.v.%)		
All household below	12.7[b]	18.2[bf]	13.7[f]	13.4	15.8
Small rice farmers	10.1[b]	17.7[b]	15.4	12.7 α	15.5
Large rice farmers	9.6[bd]	18.3[bfg]	13.3[f]	21.0[d] αβ	13.6[g] β
Landless laborers	15.8	18.2	13.1	12.2[e] β	17.2[e] β

Note: Test II is explained in the text. The following pairs of estimates were tested for statistically significant differences: (1) Within each group of households in Region every year was tested against every other year; (2) Within each group of households, Region 1 was tested against Region 2 for the same year only, e.g., Region 1 against Region 2 for 73/74; and (3) Within each year, every sub-group of households was tested against every other one. Significant differences are shown in the table with matching letters as follows:

Letter	Region	Year	Versus	Region	Year
a	1	73/74	versus	1	83/84
b	1	73/74	versus	1	82/83
d	1	73/74	versus	2	73/74
e	2	82/83	versus	2	73/74
f	1	82/83	versus	1	83/84
g	1	82/83	versus	2	82/83

α small versus large farmers
β large farmers versus landless labor
∂ small farmers versus landless labor

complement earlier indicators, Table 15 shows the proportion of households with calorie consumption below 100 and 80 percent of energy requirements, respectively. During 1973/74, more than 95 percent of all households in the villages of group 2 consumed less than 80 percent of requirements. By 1983/84, this figure was lowered to about 28 percent. The worst situation was found among landless labor where almost 40 percent of the households still consumed less than 80 percent of requirements in 1983/84.

The initial situation (1973/74) was much better in the villages of group 1 than in group 2 but the improvements by 1982/83 were less, thus reducing the difference between the two groups of villages.

There was a sharp increase in the proportion of both small and large rice farmers consuming less than 80 percent of energy requirements during 1982/83 and an even sharper decrease after the drought (1983/84) (Figures 8 and 9). The rate of deterioration during 1982/83 was less for landless labor primarily because the level was high prior to that year. However, the improvements after the drought were impressive also for that group. The seasonal variation in the proportion of households consuming less than 80 percent of requirements was higher in 1982-84 than in 1973/74 primarily because such a large proportion was below 80 percent throughout the latter year. The two seasonal cycles are similar to those for average calorie consumption shown in Figures 6 and 7. Among small rice farming households, severe calorie deficiency was most widespread during August/September and January/ February.

Table 15 -- Percentage of Households Consuming Below 80 and 100 Percent of RDA for Energy

	Village Group 1			Village Group 2	
	73/74	82/83	83/84	73/74	82/83
	(Percent of Households Below RDA)				
All households	97.7	81.6	44.9	90.4	74.1
Small farmers	99.4	77.4	38.1	81.7	77.4
Large farmers	98.6	75.1	24.0	78.0	55.1
Landless	97.5	90.7	60.7	95.9	85.5
	(Percent of Households Below 80% of RDA)				
All households	95.6	65.4	27.6	73.9	55.9
Small farmers	99.4	58.1	25.7	51.3	53.4
Large farmers	97.2	55.1	7.1	64.0	37.7
Landless	94.1	79.5	39.3	79.0	68.8

* The per capita recommended daily allowance (RDA) for energy is 2200 calories, taken from Gopalan C. et.al., "Nutritive Value of Indian Foods," National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, 1981, p. 27.

Figure 8 -- Percent of Total Households Consuming Less Than 80% of Energy Requirements, Village Group 1

Moving Averages

Detrending Residuals

FIG A. GROUP 1 SMALL RICE FARMERS

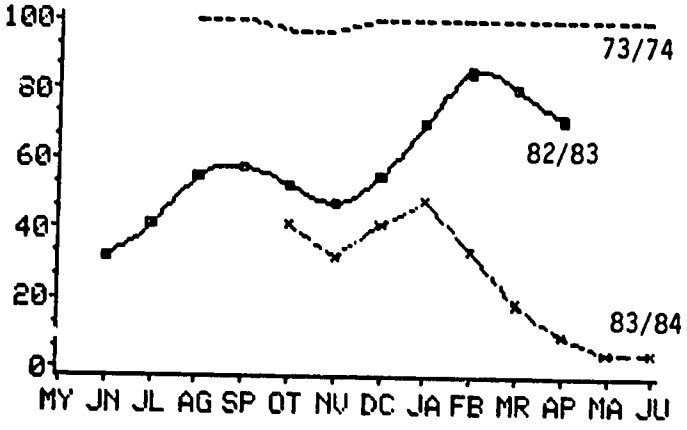


FIG B. GROUP 1 SMALL RICE FARMERS

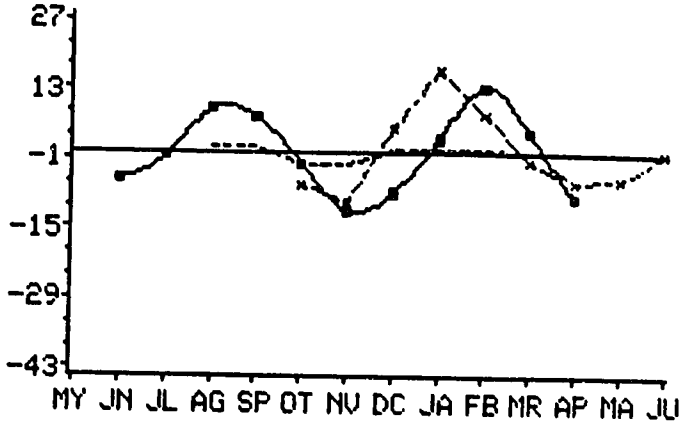


FIG C. GROUP 1 LANDLESS LABORERS

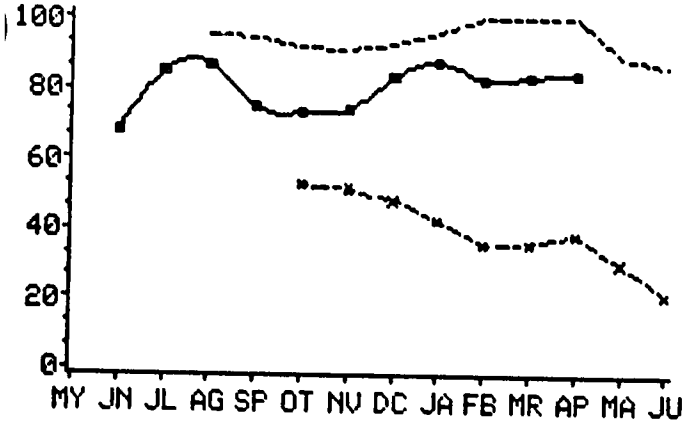


FIG D. GROUP 1 LANDLESS LABORERS

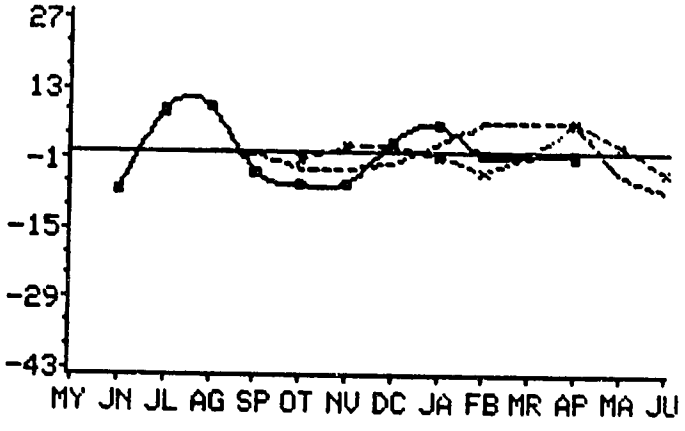


FIG E. GROUP 1 LARGE RICE FARMERS

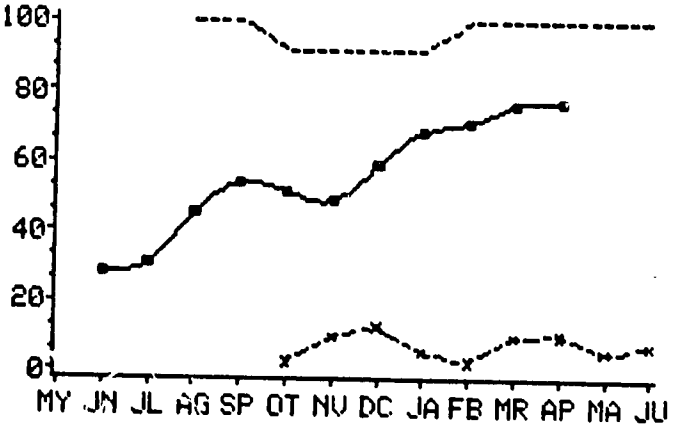


FIG F. GROUP 1 LARGE RICE FARMERS

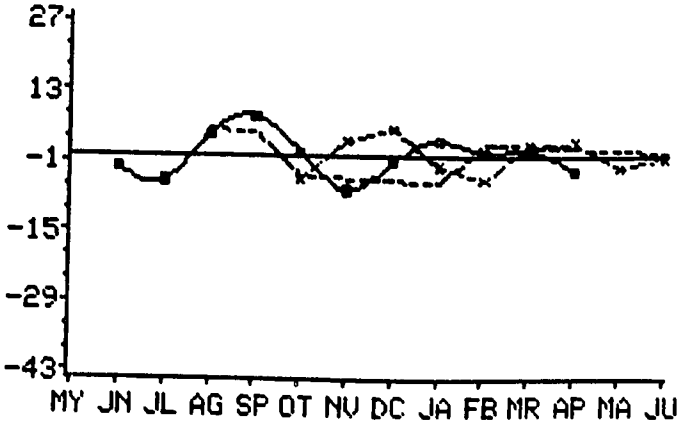


Figure 9 -- Percent of Total Households Consuming Less Than 80% of Energy Requirements, Village Group 2

Moving Averages

Detrending Residuals

FIG A. GROUP 2 SMALL RICE FARMERS

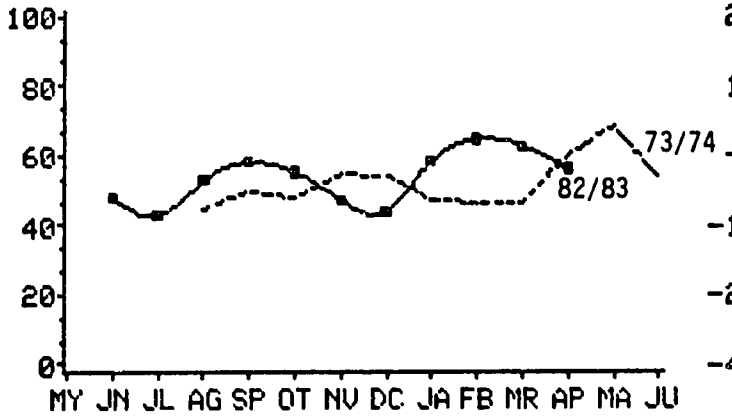


FIG B. GROUP 2 SMALL RICE FARMERS

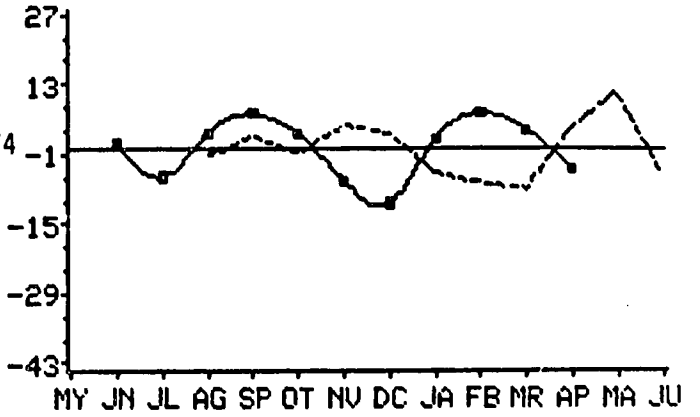


FIG C. GROUP 2 LANDLESS LABORERS

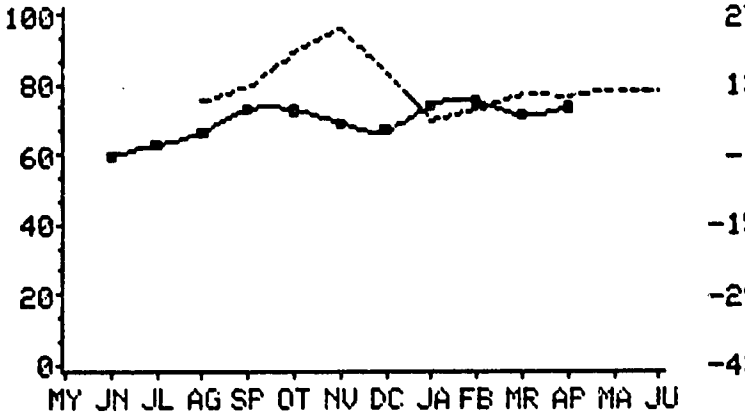


FIG D. GROUP 2 LANDLESS LABORERS

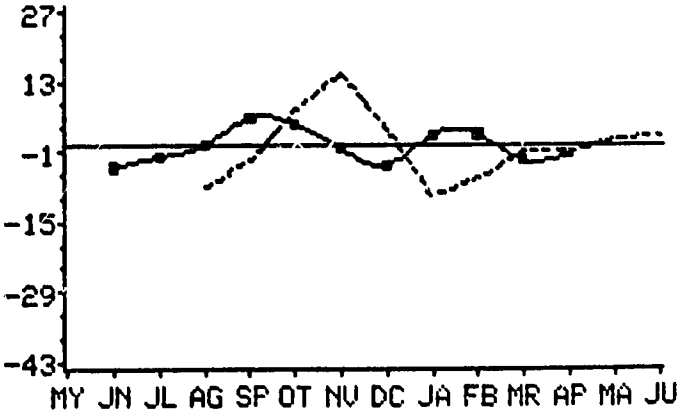


FIG E. GROUP 2 LARGE RICE FARMERS

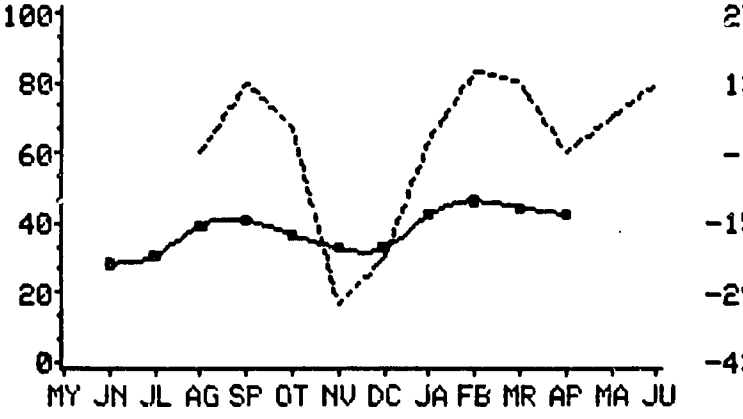
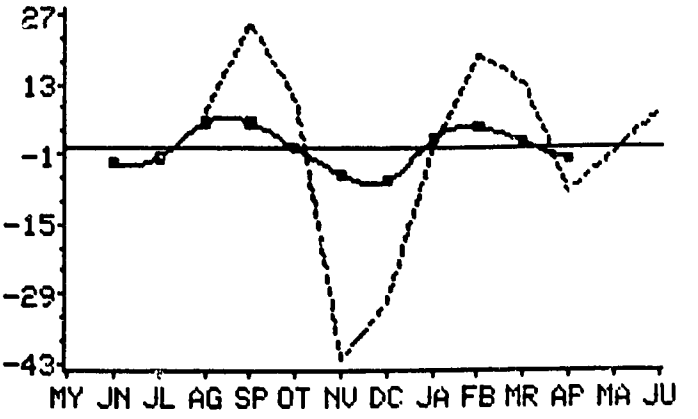


FIG F. GROUP 2 LARGE RICE FARMERS



8. DISCUSSION AND CONCLUSIONS

Although climatical variations including a major drought during the study period make an exact estimate of the impact of technological change very difficult, it appears that rice yields have doubled and production tripled in the non-irrigated villages during the ten-year period. The increase in yields is largely due to the introduction of modern varieties, increased fertilizer usage, and improved water control while increasing cropping intensity contributed to higher production.

During the same period, household incomes (approximated by total expenditures) increased by about 400 percent in nominal terms and tripled in real terms (after deflation by the price index). Deflated consumer prices for rice fell during the period while the unit cost of the calories consumed increased primarily because of a very pronounced change in the commodity composition of the diet away from rice.

Total energy consumption increased dramatically and the proportion of the households in the non-irrigated villages that consumed less than 80 percent of energy requirements fell from 96 to 28 percent; a very impressive improvement indeed. Primarily due to the drought, the energy consumption deteriorated rapidly during 1982/83 but the losses were regained during the subsequent year.

So, it may be concluded that the annual food consumption greatly improved and that a large part of this improvement is due to yield, production, and income increases which in turn resulted at least in part from technological change. But the average annual food consumption may cover large variations during the year. How were these

variations affected by technological change? As a general rule, their absolute magnitudes increased but, except for small farmers, the increase was not significantly different from the increase in average annual consumption, i.e., the magnitudes of seasonal variation in percent of the annual mean consumption did not change as a consequence of technological change except for small farmers. Furthermore, in spite of larger absolute seasonal variation, calorie consumption was higher after technological change than before for all months and groups.

The drought caused significant increases in seasonal fluctuations of calorie consumption both in absolute and relative terms for all groups except landless labor. The seasonal fluctuations in the proportion of households not meeting 80 percent of their energy requirements also increased over the study period. Changes in the patterns of seasonal fluctuations in total expenditures, rice and calorie prices, rice consumption, and total calorie consumption were also observed. In general, it appears that seasonality in most of these factors consisted of one annual cycle prior to the introduction of modern technology changing to two after the technology was adopted. This is in contrast to three annual cycles in rice production. Except for rice prices, there is no indication that the one cycle prior to new technology was more severe than the two that followed. The principal reason for the change in the number of cycles appears to be that improved water management and varieties with shorter growing period permitted an increase in cropping intensity and less concentration of production in one season. However, more research is needed to identify

the causes of the changes in the magnitudes and patterns of the seasonal fluctuations identified in this paper.

Ongoing research must be completed before the policy implications can be clearly identified. However, measures to encourage more efficient use of available irrigation facilities, to expand livestock production, and to use creatively the public food distribution systems offer obvious opportunities.

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INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

Preliminary Draft
For Discussion Only

INDIGENOUS VERSUS INTRODUCED SOLUTIONS TO FOOD STRESS

by

Jon R. Moris

IFPRI/FAO/AID Workshop on Seasonal Causes of
Household Food Insecurity, Policy Implications
and Research Needs

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1. Seasonality in the African Tropics

The fact of there being a marked seasonality in food production within the African tropics has long been recognized, and is evidenced by the prevalence of indigenous terms for the "hunger period" when food is insufficient to meet daily needs. It is also readily apparent from gross rainfall statistics, which show that a four month dry season is typical over much of the continent and five or six months are not uncommon.[1] However, our main focus in this paper is not the fact of extreme fluctuations in food availability at the local level, but rather how indigenous and introduced technologies have been employed by households to cope with this typical circumstance. While "drought" marked by a failure of an entire season has received considerable attention in the semi-arid areas of Africa, the more routine "hunger period" has not.[2] How are typical fluctuations in food supply buffered by local economic and social systems so that producers survive in good health from one growing period to the next?

In examining the mechanisms for surviving extended periods of food deficit, we should note that the degree of stress which is experienced will be a function of several, interrelated aspects:

1) The adequacy of food supplies at the start of each dry season, reflecting within-season variations during the usual growing period.
2) Available technologies for food storage at the local level, reflecting also the crops grown.
3) The strategies at household and at community levels for insuring food security.
4) The length of time between harvest and when fresh food supplies become available--depending on the mix of enterprises as well as on climate.
5) The energy demand required for production at times of food scarcity, also a function of the mix and scale of production activities (an aspect explored by Bayliss-Smith, 1981).
6) The positive and negative influences of participation within a larger economy in regard to food security.

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[1] For reviews of seasonality in African rainfall, see Walsh (1981), Katz and Glantz (1977) on the Sahel, and Tyson (1979) on Southern Africa.

[2] In the huge literature on African drought sources relevant to this paper include Apeldorn (1981), Patton (1971), Hitchcock (1979), Akong'a (1982), Wisner and Mbithi (1974), Wisner (1977), O'Leary (1980, 1984), Campbell (1978), Franke and Chasin (1980), Shepherd (1975) and the Botswana Society (1979).

Before turning to options for counterbalancing seasonal food deficits, one should emphasize that the degree of stress occasioned by seasonality (and other related causes) has almost certainly been underestimated. Here our discussion will draw mainly upon areas of East and Southern Africa with which the author is most familiar, but evidence will also be adduced from the Sahel, where seasonality is even more pronounced.

First, gross rainfall statistics aggregated into the usual monthly totals are insensitive indicators of actual crop moisture deficits. Long run means reflect the influence of atypical high rainfall periods, e.g. in Northern Kenya, where Conant shows for several years at all reporting stations in at least two thirds of months the actual rainfall received was less than the mean (Conant 1982). Over much of East Africa, rainfall stations tend to be located near settlements, which in turn were dictated by available rainfall and water. A more serious deficiency is the concealment of shorter dry periods within the 30 day totals. Under conditions of rapid runoff, high evaporation, and high daily temperatures, even a 5-10 day dry period can result in partial and even total crop failure (depending upon the crop, its growth stage, and soil types). The most striking difference from much temperate zone farming is the very low soil moisture status at the start of the season, leaving plants extremely susceptible if rainfall is interspersed with periods of hot, dry weather. When this happens, farmers must replant; and by the second or third replanting will have exhausted their seed. In addition, maize (the continent's most important staple food) is particularly sensitive to moisture deficits at tasselling, and, like most other grains, to a shortfall at the ripening stage. The critical stages where monthly totals may mask damaging moisture deficit are if there is a delayed or uncertain start of the rains, an in-season dry spell, or an early termination. This is true even for "minor" crops like beans (which because of fast maturation may be important in breaking the "hunger period"): Due's survey of bean growing in two Morogoro villages of central Tanzania found that failure of the early rains was either the first or second most important problem mentioned by farmers (Due et al. 1983:15). Similarly, in my own field interviews on the slopes of Mt. Kenya, I found farmers could discuss in detail the signs they watched for in judging when t

rains had "really" begun (Moris 1970). A within-season drought in January-February is a common occurrence throughout much of central and southern Africa, where there is an extended rainy season starting in October and terminating in May. Occurences of all three kinds become clearly evident when rainfall is aggregated according to pentades (five day intervals), particularly if a computer program is used to scan for rainless pentades where either the preceding or following pentade was also dry.

Second, the adequacy of household members' food intake must be weighed against the demand for energy output (Bayliss-Smith 1981)-- a key relationship in hand cultivation, where there are pronounced labor bottlenecks at planting and weeding times. Land preparation, planting and weeding occur at the end of the food storage period, when a household's foodstocks are likely to have been exhausted. How a family copes during this period of extreme labor demand will greatly affect their overall nutritional well-being. It will also strongly influence the output from their next season's crop, which depends on a maximum labor input at this period. It is a reasonable hypothesis that under varying cultural regimes, households may schedule and carry out the heaviest tasks differently, leading to a marked difference in the perceived strain of doing land preparation. This point was made some years ago in a classic comparison of Lele and Bushong cultivation from the Kasai (Douglas 1962: 219-220):

> The Bushong plant five crops in succession in a system of rotation that covers two years. They grow yams, sweet potatoes, manioc, beans and gather two and sometimes three maize harvests a year. The Lele practice no rotation and reap only one annual maize harvest. If we examine the two agricultural cycles, we see that the Bushong work continuously all the year, and that the Lele have only one burst of activity, lasting about six weeks, in the height of the dry season.

Third, it should not be assumed that food is evenly distributed within household units, or that everyone eats the same foods. Arhem reports (Arhem et al. 1981:38-46) that among the Ngorongoro Maasai of Tanzania, the percentage frequency of consumption of staple foods differed quite markedly between adult men, adult women, and children. For men, milk was the dominant food (47% of consumption occasions), followed by grain-based foods (32%) and meat (21%). For adult women,

grain-based foods predominated (51%), followed by milk (24%) and meat (24%). Grain-based foods were also most commonly consumed by children (49%), followed by milk (45%) and occasionally meat (6%). As for the amounts consumed, Arhem concludes "the dry season pastoral diet is deficient in energy but rich in proteins" (1981:51). In this instance, however, the intra-household differences correspond roughly to work output: while women do more work than Maasai men, a woman's diet is also higher in energy-rich foods. Arhem's general point is that at the height of the dry season pastoralists experience a pronounced energy imbalance, even when participating in a larger market economy. This also explains the vulnerability of women, children, and the aged who are left behind at the household's base camp if a seasonal deficit stretches into a prolonged drought.

These examples illustrate that the "hunger period" first brought to academic attention in Audrey Richards' classic study (1948) of the Bemba retains its relevance today. Under either agricultural, mixed, or purely pastoral subsistence strategies, mechanisms which insure an adequate food supply during the prolonged time of food deficit remain extremely important. This is so for basically two reasons. First, some of the earlier adjustments (to be reviewed below) are no longer available to all households. And, second, imperfections in the national marketing system or other emergent economic constraints deny poor consumers or those in remote areas the possibility of relying on modern sector alternatives--a deteriorating supply situation made worse by the adverse economic trends African countries are experiencing. On the downside, the inability of poorer households to counteract food deficits at this time explains why they are often forced into highly inequitable short-run "solutions" which deepen their poverty--a point made in the excellent volume by Chambers, Longhurst and Pacey (1981), required reading on our topic. However, the deficiency in institutional arrangements also influences the "upside": where risks are high and commercial food supplies insufficient, even "progressive" farmers may be unable to make a permanent transition into larger-scale, commercial production (the situation in Zambia documented by van Donge, 1982).

2. Indigenous Solutions to Seasonality

Measures a household might adopt to offset the risks of drought are also effective in counteracting or ameliorating the "hunger period". We can usefully distinguish five production options (some of which are sub-categories of the others):

1) diversification
2) root crops
3) exploitation of vertisols
4) livestock enterprises
5) bush collecting

1) Diversification

In traditional African farming, households often grew a wide array of crops, sometimes spread over two or more ecological zones. Obviously, crops differ in their moisture and soil nutrient requirements. By growing a range of crops with different response characteristics, farmers ensured some yield under a broad spectrum of seasonal conditions. Diversification could also take the form of staggered planting, so that portions of each crop were planted at dates which bracketed the onset of the growing season. Plots might be located along the catenary sequence, allowing a better match of crops to soil type and increasing the chances that a disaster at one site (flooding, monkeys, etc.) would not destroy the entire season's output. Farmers often adopted the same strategy within even a single field, practising intercropping, relay cropping, crop succession, and sometimes the planting of different crops around the field border (Keswani and Ngunguru 1982).

These tactics, which have been documented by many observers in different parts of Africa, are usually explained as risk-minimizing devices. By the same token, they directly influence the household's food security through diversifying the sources of food, and extending the period when it is available. They are evidence of a deliberate choice by farmers not to optimize production of the highest yielding crop, diverting effort to safeguarding a minimum food supply and insuring that the labor force has access to some sources of energy at the critical "food gap" period.

For example, among the Meru of Kenya agriculture was spread over eight ecological zones. Bernard identifies three crop complexes suited to the homestead, intermediate, and lowland areas, each made up of eleven or more traditional crops (Table 1). In total, the Meru grew sixteen food crops and several non-food ones as well (Bernard 1972:52, 146). The full array is seldom capture in farm-economic surveys, particularly those aimed at computing farm budgets and annual income. In a similar area of Embu, I found (1965-68) that field enumerators soon lost patience and simply stopped recording "minor" or "women's" crops. Furthermore, Bernard's listing glosses over varietal distinctions, which were (and are) especially important for some root crops and legumes. A nutritional survey of the Shambaa in northern Tanzania found people had ten varieties of bananas, some used in cooking and others eaten fresh (Schlage 1969:64). Most homesteads in East Africa grow several types of beans, and various spices, fruits, and semi-wild vegetables often overlooked in official surveys.

One strongly suspects that this diversity is adjusted to increase food availability throughout the year, but only a few studies contain the documentation to prove the point. Lagemann's (1977) study of farming in Eastern Nigeria graphs the main harvest and storage periods for some thirteen staple and leaf vegetable crops (Table 2). It can be seen that in most months at least four of these are in harvest, and November is the only month with only a single main crop (yams) ready for harvest (1977:41).

As one becomes more familiar with African peasant farming systems, the apparent diversity which at first seems so haphazardous can be seen to have an underlying structure, what Ruthenberg termed "hidden order in seeming chaos." The patterns he identified from a pioneering study of ten Tanzanian farming systems include (1968:331-333):

- Adaptation of cropping to different soils within a catena.
- Adaptation of cropping in concentric belts.
- Adaptation of planting to different rainy seasons.
- Adaptation of cropping by changing the composition of mixed crops.
- Adaptation of cropping by staggered planting.
- Adaptation of cropping by crop rotation.

TABLE 1.

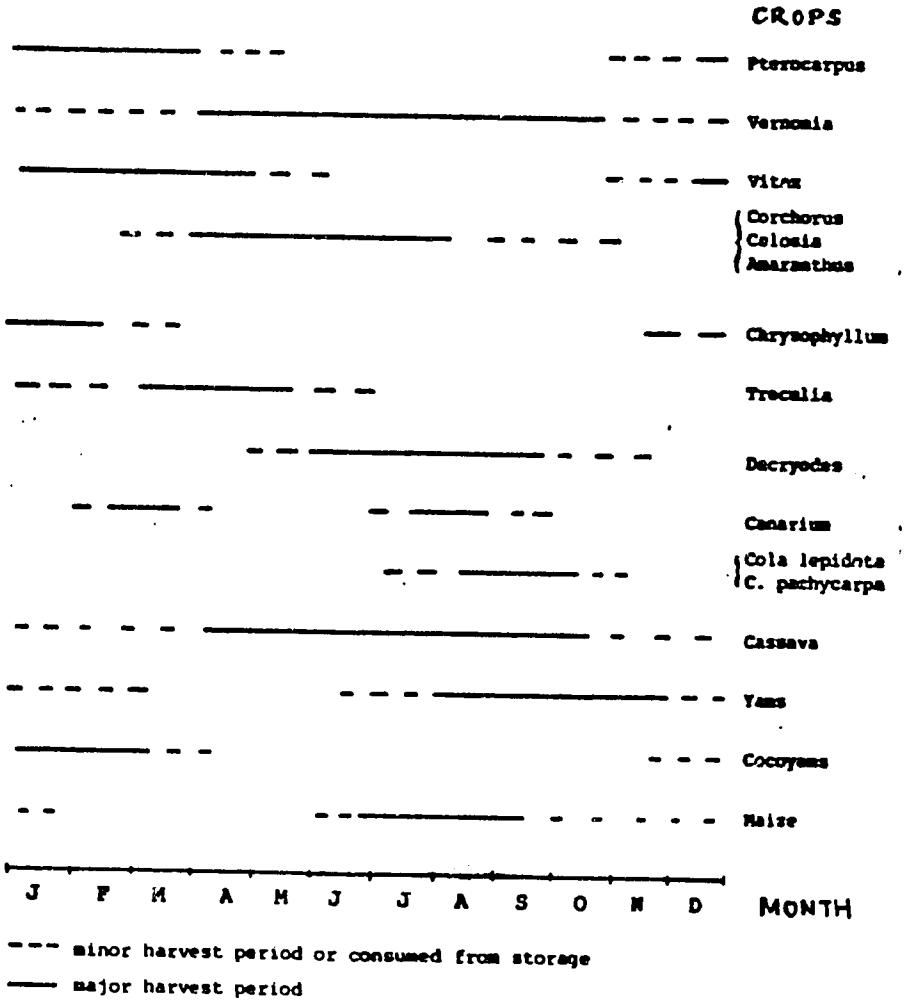
CULTIVATED CROPS OF MERU[a]

	Highland		Lowland
	Homestead zone	Intermediate zone	
cereals:			
		millets: bulrush foxtail finger	millets: bulrush foxtail
		sorghum	sorghum
	maize?	maize?	
pulses:			
		pigeon peas cow pea hyacinth bean haricot bean	pigeon peas cow pea black gram green gram haricot bean
roots:			
	yam taro sweet potato cassava	sweet potato	
other:			
	bananas pumpkin gourd sugar cane tobacco miraa (ghat)	tobacco	pumpkin castor gourd tobacco

[a]Source: Frank Bernard (1972) East of Mount Kenya: Meru Agriculture in Transition. IFO-Institut, Afrika Studien, no. 75. Munich: Weltforum Verlag, p. 52.

TABLE 2.

AVAILABILITY OF MAJOR CROPS BY MONTH (E. NIGERIA)[a]



[a]Source: Johannes Lagemann (1977) Traditional African Farming Systems in Eastern Nigeria: IFO-Institut Afrika-Studien, no. 98. Munich: Welforum Verlag, p. 41.

Expanding on his third and fourth points, what we observed in Embu and parts of neighbouring Kitui and Machakos in Kenya was a sequential pattern of farm decision-making, evidenced in response to changing climatic circumstances. One needs to realize that an opportunistic, hierarchical approach to production decisions actualized over an entire season can give a quite different outcome from monthly input budgets derived from an idealized "optimal" income determined in the usual way. Farm management as usually taught is basically an exercise in deriving time-phased input and enterprize mix targets from an anticipated yield, typically represented by mean totals per hectare. (This is, of course, how planning would be done if farmers were paid salaries!) In real life, there is tremendous variation in possible yields (which we will document later), information is poor, and risks high. Farmers allocate their inputs under an intersecting matrix of constraints—soil moisture status, pest outbreaks, an unexpected sickness, lack of ready cash, etc. —which can change quite rapidly. The necessity of having enough food to survive the hunger period remains an ultimate objective, of course, or the farmer would have to withdraw from the game. However, in the short run attention is concentrated on the varying mix of constraints and events, which can have quite different implications depending upon the stage of crop maturity. One can model this kind of day-by-day opportunistic planning s a hierarchical sequence of "yes-maybe-no" decisions subject to different constraints, but such analysis is only just now being applied to understand peasant farming (see especially work by Christina Gladwin and other anthropologists).

For example, in the 1960s and 1970s the Kenya Ministry of Agriculture was promoting high maize populations planted in pure stands. Farmers disagreed emphatically, claiming that the mean rainfall was seldom actually experienced—ridiculing the Ministry's recommendation that all planting should be done on March 15 of each year—and that an interplanted stand at lower populations had a far better chance of surviving in adverse seasons. In the season observed, there was

a dramatic shift in weather with a premature onset of drying winds. Our lowland farmers rushed into their fields to thin their crop stands, while others began planting sweet potatoes and other minor crops they said could still be established with residual soil moisture in the valley bottoms. A more recent study in the same area by Franzel (1984) looked specifically at reasons given for and against adopting an early maturing variety of maize. Franzel found that while farmers do grow some of the Katumani maize recommended by the Ministry of Agriculture, they do so for reasons related to food security, not yield. Two separate decisions are involved: i) which maize variety to grow for its earliness properties, and, ii) which as their main crop. Both "progressive" (40%) and "poor" (60%) farmers plant about an acre to Katumani, despite their view that it yields less and stores more poorly than the longer-maturing local variety (1984:202). The reasons they have in mind are different, however (1984:203):

> Low income farmers have more of a propensity to grow Katumani for early maize because they lack regular sources of income, and thus have the most to fear if they run out of food. Over 90% of the farmers in both groups claim that Katumani yields less than other available varieties during the long rains. However, the fear of exhausting home-produced food supplies before harvest time is so high that most low income farmers are willing to grow at least some Katumani.
>
> Planting Katumani also makes sense for high income farmers. Between August, when Katumani is ready to harvest, and September, the principal month for harvesting, maize prices typically fall 20 to 30%. It is likely that the cost savings from growing Katumani, in terms of not having to purchase maize during August, outweigh its yield disadvantage. The decision tree shows that only five farmers who had tried Katumani felt that its yield was so low as to outweigh the benefits of earliness. It is significant that all five of those farmers were high income; since they have access to cash for purchasing food whenever necessary, they are less concerned with the benefits of earliness than are low income farmers.

In addition to the sequential aspects of peasant farming, there is also an underlying spatial structure often evidenced. Crops which are used continuously by the household, which are easily damaged by vermin, or whose harvest requires a large effort tend to be planted nearby, with others located at greater distance (Ruthenberg 1968:331).

In Kenya, we found that farm surveys generally overlook the horticultural "woman's" crops planted close to the house, perhaps consisting of a mixture of individual plants each with a specific purpose.[1] Beyond the intermediate zone of arable field crops, one would find the grazing lands of goats and calves, and still farther out the limit of the area grazed by cattle. This pattern of production within concentric belts, varying from an intensively used area around the house to lightly utilized bushland is a well-known feature of African shifting cultivation, found wherever land has not yet emerged as the limiting factor (Okigbo 1984). An excellent source mapping the distribution of crops in Zande homesteads is de Schlippe (1956). He documents that where a woman and her children constitute semi-autonomous production units (as they do in most of Tropical Africa), the homestead layout and its selection of crops will reflect its social composition.

2) Root Crops

Aggregate estimates suggest that root crops are more important in Africa than in any other continent, exceeding even Latin America's consumption (Table 3). FAO estimates for 1974 indicate that root crops provide about 40% of total calories in Zaire, Ghana and Togo (Goering 1979:3); even in other countries usually thought of as grain producers, the actual contribution of root crops exceeds what outsiders might anticipate. A recent FAO/Ministry of Agriculture study in Tanzania suggests that there are more root crops produced than cereals, 217 kg per caput vs. 185 kg for cereals in 1980 (1984:22). The term "root crop" is actually a misnomer, including as it does bananas as well as cassava, potatoes, sweet potatoes, and cocoyams (aroids). "Starchy staples" might be a better designation, if one considers the key role such crops play in African peasant agriculture.

Of these, cassava is by far the best studied. Its popularity among small holders as a "famine breaking" crop arises from its low labor requirements and the fact it can be left alive in the ground until needed for consumption during the peak of the dry season and the start of the next growing period. However, its extreme productivity in calories yielded per

[1] Beyer (1980:37) quotes Noel Vietmeyer to the effect that when the National Academy of Sciences asked for a listing of underexploited tropical plants, over 2,000 species were suggested.

TABLE 3

ROOT CROP PRODUCTION IN THE TROPICS[b]

(million metric tons)

	Cassava	Potato	Yam	Sweet Potato	Other root Crops[a]	Total
Africa	45.1	1.7	18.7	5.2	3.9	74.6
Tropical America	36.9	8.6	0.2	3.9	0.8	50.4
Near East	1.1	3.1	—	0.5	—	4.7
Far East	21.1	6.9	0.1	7.7	0.2	36.0
Other	0.1	--	--	0.2	—	0.3
Total	104.3	20.3	19.0	17.5	4.9	166.0
% of total:	63	12	11	11	3	100%

[a]Includes taro, arrowroot, arracocha, yam beans, oca, olluca and *Xanthosoma*.

[b]*Source*: T. James Goering (1979) *Tropical Root Crops and Rural Development.* World Bank Staff Working Paper No. 324. Washington, D.C.: The World Bank, p. 15.

hectare in comparison to alternative crops must also be a significant consideration (Table 4). The FAO statistics show it returns ten times the gross weight and three times the energy yield per hectare of maize.

Bananas are often also a very popular crop wherever rainfall is sufficient for their production, having a traditional role in the seasonal food budget much like that of cassava (note that both crops can be dried and stored for extended periods). Bernard describes the situation in traditional Meru life as follows (1972:52-53):

> Of the crops mentioned above, certainly the most important to the Meru was the banana. It helped bridge food shortages between seasons; it provided famine relief in dry years; and it was a social stabilizer and a measure of time. A Meru man was not ready to marry until his banana plantation (rurigo) had become established. Once growing, bananas promoted a sense of permanency... In describing his tenure to a piece of land, a man might remark, "Look, my grandfather planted those bananas. Yes, we have been here a long time."

Note also that as used locally in African communities, bananas were not treated as a single crop but instead as an array of types suited to quite distinct purposes.

A feature of root crop production in East Africa is the very wide range in actual yields being realized at the farm level. For example, Swanberg and Hogan estimate that the difference in cassava yield (kgs ha) is 1,400 versus 5,000 kgs under "traditional" versus "improved" methods (1981:16). In farm visits within Embu, we found great differences in the degree of attention accorded to such crops. For some farmers, at least, they were planted as an insurance in case the dry season was prolonged or the early crop of cereals failed.

Another aspect of production was (until recently) the complete disinterest shown by many Ministries of Agriculture. I found certain older farmers eager to discuss the special techniques necessary to get high yam yields, but this was not a topic the Ministry dealt with. Others expressed a scorn towards both the Ministry and their own children, whom they accused of having been "spoiled" by exposure to modern education and science, which paid no attention to their own empirical observations.

TABLE 4

ENERGY AND PROTEIN YIELDS[a]

(per hectare)

Crops	Tons	Energy (MJ)	Protein (kg)
Cassava	80	300,000	160
Sugar-cane	31	250,000	--
Potatoes	35	100,000	500
Maize	8	100,000	460
Soya beans	2.5	36,000	900
Dairy cattle	10	25,000	330
Pigs	3	20,000	140
Eggs	3	20,000	140
Broilers	3	20,000	140
Beef (intensive)	1.5	10,000	70
Beef (extensive) semi-arid tropics	0.075	500	4

[a]Source: Food and Agriculture Organization of the United Nations (1984) Animal Energy in Agriculture in Africa and Asia, FAO Animal Production and Health Paper No. 42. Rome: FAO, p. 3.

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3) Exploitation of Vertisols

Vertisol areas (sometimes also termed "hydromorphic soils") possibly constitute Africa's main underexploited land resource, though until recently ignored by modern agricultural research (and by official crop recommendations). The name "vertisol" comes from the French and FAO soil classification systems widely used in Africa (in place of USDA's system). It derives from the deep, vertical cracks shown when such soils are dry, accounting for their common designation as "cracking clays". Because of this feature, vertisols incorporate organic matter from the surface—otherwise a rarity under hot, tropical conditions—and their high clay content causes slow infiltration but long retention of surface water. They form wherever the slope of the land leads to impeded drainage, sometimes on higher elevantion benches but more typically in valley-bottom and depressional areas. They vary from being highly alkaline (salt pans common to the East African Rift Valleys and the Kalahari) to highly acidic (the peat bogs of highland Ruanda or the coastal mangrove swamps of West Affica).

While vertisols vary widely in regard to soil nutrient status, depending in part on the parent material on which they are formed, their key agronomic advantage derives from their superior moisture retention. Runoff is concentrated into depressional areas, where the deep cracks store and then retain water long after the surrounding porous soils have completely dried out. On some clays, this advantage is so pronounced that a single pre-irrigation over the land surface can provide enough moisture for establishment of a crop.

Vertisols are found in all countries of sub-Saharan Africa, being one of the most prominent features of the ancient land surface. In Zambia, for example, it is estimated that 14% of the land is either "swamps" or seasonally flooded (Elling et al. 1981:103). Such "dambos" are prized for their animal carrying capacity in the dry season (FAO 1979:63-68). Elsewhere, the names differ, of course: mares and bas fonds in Francophone countries, fadamas in Nigeria, mbugas in East Africa, and vleis in Zimbabwe and South Africa. If it seems this point is being overemphasized, we might note that in

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the Zambian instance just cited, dambo lands cover 104,391 square kilometers, in area 74% as large as the country's entire cropped lands of 141,770 square kilometers (Elling et al. 1981:103-104).

A hundred years ago such areas contributed little to African food security, and were shunned by cultivators. Interviews within eastern Kenya identified the following reasons why this was so: clay soils were too heavy to work with traditional hand implements; only certain crops could stand "wet foot" conditions; cattle accumulated balls of sticky mud on their feet, leading to hoof rot; and such areas were vulnerable to raiding by rival groups (Moris 1973). In East Africa, at least, the sustained use of mbuga areas is a recent phenomenon to be viewed as an indigenous rather than traditional solution. For West Africa, Richards describes how farmers have evolved their own systems of wet-rice cultivation in valley-bottom lands, usually as a supplement to their main crop of rain-fed "upland" rice. This combination gives "a flatter labour input profile across the year than farms based entirely on upland cultivation or 'improved' practices of swamp cultivation" (1985:77). He notes that throughout West Africa small holders obtain their early season crops (which are most significant for breaking the hunger period) from the toe-slope of a catenary succession. Soil conditions are often complex at the margins of a depression, with the silty soils just above the clays being better for early season cultivation, and the clays best for extending the growth regime later on (1985:81). Richards cites Diehl's observation that in the wetter zone at the Niger-Benue confluence, farmers use the toe-slopes for yam cultivation (1985:83):

> Yam farmers derive a disproportionate part of their cash income from sales from these farms, because the crop is ready when prices are at their highest. In addition, early season farms supply planting materials for the main farm and help smooth out labour bottleneck problems.

Valley-bottom lands were prized among the Kikuyu and Embu (in 1967-72) for similar reasons, and play a key role in the drier parts of central Tanzania and in Malawi.

In recent years, the intensification of farming within vertisols has occurred in response to population growth, and also because of technological innovations. Suitably equiped tractors can work the heavy, clay soils, converting large areas to arable cultivation. In addition, farmers have learned how to construct shallow wells to draw upon groundwater for small-scale irrigation. Two areas illustrating this trend are in Ghana and Nigeria. In Ghana's northern region, the acreage of rice farmed on valley-bottom lands increased from 36,000 in 1970/71 to 140,000 in 1976/77, much of it being done by migrant labor on behalf of absentee landlords (Shepherd 1981:174-177). In northern Nigeria, it has been estimated that while fadama cultivation covered about 120,000 ha in 1958, twenty years later it had grown to 800,000 ha, vastly outstripping the expansion of "official" irrigation in Nigeria's expensive schemes (Wright et al. 1982:13). The paradox is that farmers are responding to proximate opportunities with little governmental assistance, while governments continue to fund extremely expensive formal schemes which may even flood lands already under production (the Nigerian situation).

The highlands of East Africa may also offer a prospect for more intensive use of seasonally wet "swamps" (Toksoz 1981). Human population densities in parts of western Kenya, Ruanda, and Burundi already approach the maximum carrying capacity of the land under present technologies. Bringing the underutilized swamplands into cultivation through a combination of drainage and irrigation seems an attractive possibility, though one complicated by the highly acidic condition of these peaty soils. If developed, it seems likely that the technology would need to borrow more from indigenous techniques for banana and root crop cultivation than from "modern" technologies for wet-rice cultivation (the main introduced alternative). A further difficulty to anticipate at higher elevantions is the unfavorable climatic regime, characterized by a long cool and cloudy season (responsible for the very slow maturation of the maize crop being grown in these areas).

4) Livestock

When fadama lands come under irrigation, this use conflicts directly with the principal alternate employment of valley-bottom lands: early dry season grazing for livestock.[1] Throughout Africa's Sudanic and Sahel zones, wherever rainfall is insufficient for the bush cover required by tsetse flies, mixed systems combining livestock raising with cultivation are common. Since this was also a feature of the American frontier, US observers take mixed farming for granted and comment only on the absence of livestock-raising in Africa's humid zone. For similar reasons, the external literature on African pastoralism concentrates on cattle, even though the nutritional and economic contribution of goats, sheep, and camels may be equally significant.

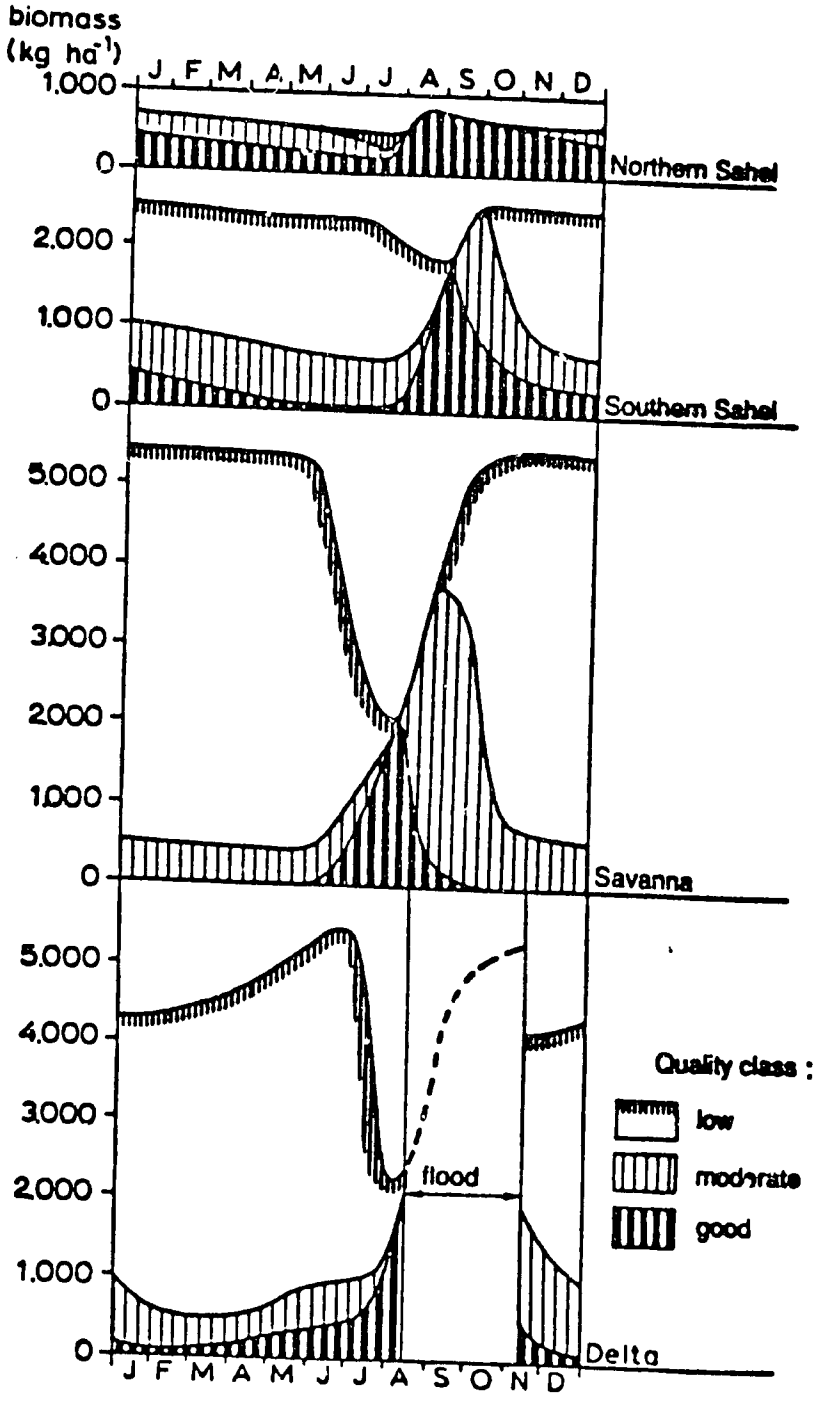
Given the enormous differences in local systems of livestock production—here see the recent works by Jahnke (1982), Sandford (1983), Dahl and Hjort (1976), and Simpson and Evangelou (1984)--one must be cautious in formulating broad generalizations about African production systems. Here we take as our focus semi-nomadic and transhumant pastoralism (like the Maasai of East Africa or the Fulani of West Africa), rather than mixed subsistence systems (like the Akamba of Kenya or the Sukuma of Tanzania).

As Swift points out, "seasonality is at the very heart of nomadic pastoralism" (1981:80). Dutch researchers (de Ridder et al. 1982) provide quantitative data from the Sahel showing the seasonal fluctuations in biomass under different ecological zones (Table 5). These underscore Swift's observation that nomadism represents a form of social organization designed to tap the huge but variable potential of rapid plant growth during the short rainy season, while utilizing an array of coping strategies to survive the long dry season when plant productivity ceases. For outside analysts, full awareness of the degree of success achieved under traditional systems was retarded by the fixation on measurements

[1] In their northern Nigeria study, Norman, Simmons and Hays (1982:111-129) found that households concentrating on fadama utilization for crops tended to be those without much involvement in livestock. Theirs is an excellent study, with a wealth of detail relating to many of the points made in this paper. Earlier accounts drawn from the same data base include Simmons (1981) and Norman (1973).

TABLE 5

SEASONAL FLUCTUATIONS IN BIOMASS[a]



[a]Source: H. de Ridder et al. (1982) Productivity of Sahelian Rangelands, vol. 2. Wageningen: Dept. of Soil Science and Plant Nutrition, Wageningen Agricultural University, p. 74.

of weight gain per animal (equivalent to the agronomist's preoccupation with per hectare yields of a single crop). Now that measurements of total biomass sustained are available, it is clear that under adverse conditions the indigenous strategies for livestock management equal or exceed the performance of "improved" methods (Penning de Vries 1983). African livestock producers who must cope with extreme seasonalities in availability of forage and water prefer hardy, light animals which can survive with a minimum of grass and water but show a rapid production response when better conditions occur. Price (1981) argues these same tendencies occur in natural systems under conditions of high seasonality (Table 6).

The question remains: How do livestock-oriented producers cope with extreme seasonality?

First, animals are herded rather than pastured. This gives a more even utilisation of plant species and a shorter duration of pasture use. During the brief growing period, it obtains maximum plant productivity while protecting the more palatable species (because animals are grazed at a walk and are not as free to concentrate on certain species).

Second, long distance trecking permits movement of herds to the areas receiving rain, and extends the radius of pastures utilized. Location of household camps at a distance from water (to which stock are taken on alternate days) further extends the utilisation radius.

Third, seasonal movement into the lower rainfall zone during the rains taps vegetation on lands which could not sustain permanent occupation, while also protecting dry season forage reserves at the main base.

Fourth, most pastoralists employ mixed herds of several species to exploit the different gestation and lactation periods, and variations in timing of livestock births. Empirical data on the demographics of mixed herds are recent, see especially studies contained in Hill (1985). Data presented by Wilson et al. (1985) show clearly that age of puberty, duration of pregnancy, length of birth intervals, life span and total fertility vary by species. They note that while it is often said that

TABLE 6

ANIMAL POPULATION ADAPTATIONS TO HABITAT EXTREMES[a]

HABITAT	Stable	Fluctuating (of temporary nature or patchy in space)
Strategy:	low energy expenditure high efficiency	high energy expenditure low efficiency
Animal characteristics:	population maintained at equilibrium level	population levels fluctuate widely; mortality rates may be high
	evolutionary pressure for population to remain close to carrying capacity, and not above	opportunistic strategy of 'boom or bust' in face of fluctuating carrying capacity
	selection for large size	typically small in size
	high competitive ability for resources	no great competitive ability
		high fecundity, short generation time, migration common

[a]Source: Mark R. Stanley Price (1981) "The Rangelands: Pastoralism and Ranching," In, Campbell and Migot-Adholla (eds.) The Development of Kenya's Semi-Arid Lands. Nairobi: Institute for Development Studies, p. 171. Derived from: T.R.E. Southwood (1976) "Bionomic Strategies and Population Parameters," In, R.M. May (ed.) Theoretical Ecology. London: Blackwell Publications.

reproduction rates for animals are low in the arid and semi-arid zones, this is strictly true only for cattle (1985:118). The fact the camels reproduce everywhere and at different seasons from cattle is especially important among milk pastoralists, but sheep and goats also show a number of advantages over cattle, see Tables 7 and 8 (from Wilson et al., 1985:136, 138).

Fifth, semi-pastoralists who keep sheep and goats gain a considerable degree of flexibility in coping with seasonal food deficits. Goats are browsers, and thrive on bushland not well suited to cattle. They can utilize the pre-rains "nitrogen flush" of anticipatory growth which some African bushland species exhibit at the end of the dry season, when grassland forage is exhausted. Goats and sheep give milk, of course, but they are also the pastoralists' main source of meat--a dietary preference which accounts for the widespread misconception that African pastoralists avoid slaughtering their stock (true only for female cattle). They represent a convenient store of savings, easily converted into either grain or cash (Schneider 1968). Indeed, I would argue from field observations that the constitute the main option for increasing the liquidity of household income in most African settings where banking is not yet effective. Smallstock were often left under the control of women, and the possibility of trading a goat or two could make a huge difference in a household's food situation. These advantages explain the persistence and expansion of smallstock production, even in environments which are favorable to cattle such as at Ngorongoro in northern Tanzania.

The conversion of livestock into grain when required in small increments remains a necessity for the survival of African pastoralism. Even with mixed herds, the milk supply is extremely variable over the season. A fairly substantial herd must be accumulated before a family can sustain themselves from livestock products over the entire year, a point emphasized by Devitt (1979) and clearly evident from the production statistics reviewed by Dahl and Hjort (1976). The ability to rely on grain foods during the period of milk deficit is a crucial advantage to producers with insufficient milking animals. If, however,

TABLE 7

COMPARATIVE PRODUCTIVITY OF STOCK UNDER SAME CONDITIONS[a]

	Camels	Cattle	Sheep	Goats
Total live weight per 100 animals (kgs)	30,700	20,600	3,000	1,800
Production: (kg/100 head/year)				
Meat	1,332	1,300	1,766	2,700
Milk	18,400	8,900	3,000	1,800
Production: (kg/kg live weight/year)				
Meat	0.04	0.06	0.12	0.21
Milk	0.60	0.43	0.59	1.50

[a]Source: R.T. Wilson, A. Diallo and K. Wagenaar (1985) "Mixed Herding and the Demographic Parameters of Domestic Animals. In, A. Hill (ed.) Population, Health and Nutrition in the Sahel. London: KPI Ltd., p. 136, drived from work by Swift and FAO.

TABLE 8

EFFECTS OF DROUGHT CONDITIONS ON MAASAI LIVESTOCK[a]

	Cattle	Sheep	Goats
Percentage of farmers owning:	60	80	90
Mean herd size before the drought (nos.)	83.7	26.7	41.0
Sales during the drought	10.7	1.7	5.4
Deaths during the drought	25.3	8.8	8.2
Mean herd size after the drought (nos.)	47.7	16.2	27.4
Herd size after the drought as a % of size before the drought	57.0	60.7	66.8

[a]Source: R.T. Wilson, A. Diallo and K. Wagenaar (1985) "Mixed Herding and the Demographic Parameters of Domestic Animals..." In, A. Hill (ed.) Population, Health and Nutrition in the Sahel. London: KPI Ltd., p. 138, derived from D.J. Campbell (1978) Coping with drought In Kenya Masailand, IDS Working Paper 337. Nairobi: Institute for Development Studies, Univ. of Nairobi.

the usual seasonal shortfall extends into a major drought, animals begin to die, prices plummet, and grain supplies disappear from local markets. Thus the very success of smallstock/grain conversion in normal seasons leaves livestock producers overextended and more vulnerable in major droughts.

A notable feature of the African production environment is the loose linkage between the livestock and grain production systems. The greater disease challenge in wet seasons (e.g. trypanosomiasis carried by tsetse flies and East Coast fever by ticks) is, of course, one cause. Another may be producers' hope of spreading risks by explointing different environments not subject to the same hazards. For whatever reasons, systems where cattle were tightly integrated into existing arable farming were uncommon in Tropical Africa, particularly so in West Africa (FAO 1983, Ruthenberg 1976:112-115). The consequence has been that the technologies for animal powered weeding have not been developed, leaving intact household's pronounced labour bottleneck. Farms also lose much of animals' manure (though here Schneider's Turu of cen Tanzania remain a notable exception). While there is no doubt but tha these are real disadvantages, it does not automatically follow that farmers can make a smooth transition into mixed-farming incorporating permanent leys. The large capital investment would be offset by greatly increased risks, and most of the advantages enjoyed by the traditional system (as outlined above) cease to apply. Ruthenberg warns "the warmer the climate becomes, the greater is the technological jump required by a regulated ley system" (1976:114). To date, well-integrated mixed farming systems for cattle and grain production are confined to Africa's highland plateaus.

5) Bush collecting

Other than the growing of smallstock, perhaps the most common "hunger period" adaptation shown in traditional African systems was for a household to turn to wild sources of food. Outside of the densely settled heartland areas, most communities lay within walking distance of a common bush or woodland zone. This was the immediate source for firewood and thatching grass, but it also contained an array of wild

foods. Often men scattered individually-owned beehives through the bush, garnering a prized commodity which could be harvested at will when food and money were exhausted. Then there were numerous edible plants--Lee records eighty-five edible species used by the !Kung bushmen (1969: 59), allowing people to concentrate on only the most palatable and abundant species, such as the prolific mongongo nuts (which provided 33% of the group's total calorific intake). Lee also argues that under their traditional regime, ! Kung foragers and hunters obtained an estimated 2,140 calories daily per adult, an amount in excess of energy requirement and harvested with only a modest expenditure of time. One would expect, therefore, that other people would also turn to wild sources of food during times of food deficit from their cultivation—precisely what Scudder (1962) documents for the Gwembe Tonga of Zambia and Newman (1970) does for the Sandawe, a group in Tanzania which were formerly hunter-gatherers. Newman warns, however, that while some wild fruits do overlap the critical period "it is highly unlikely that bush foods are of much value during occasions of severe drought" (1970:145). Probably they are more important for contributing specific nutrients to the household diet, such as the wild spinach (called mchicha in East Africa) or the vitamin-C rich seeds of the Baobab tree.

3. Social Adjustments to Seasonality

The five options we have discussed constitute the main indigenous production strategies for ameliorating seasonal food deficits. However, in any system of livelihood there can be social and economic compensatory mechanisms which cross-cut the production alternatives and which may also improve a household's ability to cope with the long dry season. Such adjustments are not the main focus of this paper, but because of their great importance in Africa merit at least some mention. Let us review briefly three such adjustments: i) reciprocal economic exchange, ii) gender-linked allocation of farming tasks, and, iii) varying modes of household integration.

1) Reciprocity

The issue of reciprocally-based economic exchange is one where anthropologists have often differed quite sharply from the prevailling paradigm in conventional micro-economics. Many anthropologists accepted the economic historian Polyani's reasoning that in earlier economic systems a market mentality had not pervaded all areas of life, and non-market modes of exchange operated in different ways (Dalton 1968). Of particular interest was the apparent importance of reciprocal exchanges ("sharing") within hunting/gathering groups (Service 1966), like the Mbuti pygmies described in Turnbull's classic (1962), The Forest People. However, a world-wide review by Pryor (1977) of the comparative importance of different modes of exchange showed that while reciprocity was once widely found, it has generally been replaced by market-based exchange nearly everywhere.

In retrospect, the "substantivist vs. formalist" controversy among economic anthropologists in the early 1960s seems simplistic: each side tried to show its approach handled all economic phenomena, and claimed it unnecessary or misleading to apply other modes of analysis. Few anthropologists working today would dispute that traditional farmers are aware of their own interests and manipulate scarce resources for their own benefit --making orthodox economic analysis a legitimate approach for understanding their economic behavior.

The intriguing question remains why a reciprocal sharing of food was such a prominent feature in African traditional systems, being nearly mandatory among both the hunter/gathers (like the !Kung bushmen when first studied by Lee) and among milk pastoralists. More recent studies by anthropologists now provide actual measurement of the amounts of food shared (among the San peoples as well as pastoral groups such as the Pakot or Turkana in Kenya), showing its key importance for food deficit households.[1] It would seem that reciprocal food sharing was less central within agricultural societies, which entered a monetary economy earlier than did either the Bushmen or the nomadic pastoralists.

[1] See Wiessner (1982) and Lee (1979) on the Bushmen; for the Turkana, see Coughenour et al. (1985), Galvin (1985), McCabe (1983) and Wienpahl (1984). For an overview of pastoral coping strategies, see Coppock et. al. (1985).

As a mode of economic exchange, reciprocity depends upon a person's willingness to give economic goods to others in expectation of receiving assistance (though not necessarily of the same type) when in need. It depends on trust, not contract. Calculation of monetary value for the things shared is, of course, possible; but it is often disapproved by those who participate. Reciprocity can co-exist with price-governed, market exchange but operates according to different principles—Polyani's basic contention. It may be institutionalized within a dyadic relationship, such as hxaro among the Bushmen (Wiessner 1982), but also takes the form of generalized sharing, either within and between groups or on the basis of age and gender categories. For generalized reciprocity to be effective economically, people must share a common moral code. If those who experience windfall gains begin to hoard them, the system will break down.[1]

Relative to our concern in this paper, the important advantages of reciprocity over price-governed exchanges are at least twofold: i) reciprocal exchanges do not require detailed knowledge of likely outputs and risks, and, ii) the "things" given and received can be of vastly different quantity and type, subject only to the limitation that participants regard themselves as having been fairly treated. (These attributes explain why reciprocal exchange is so vital within high performance management teams who must operate in an uncertain environment, a key insight in Ouichi's "theory Z" (1981). In the African context, provided all members of the group accept the necessity of sharing, people will obtain the minimum food needed for their survival as long as the group as a whole has not overreached its resource base. In adverse seasons, which arrive unpredictably, all will experience diminished consumption but nobody will starve as long as food supplies hold out. The superior performance of reciprocal exchange under highly uncertain production conditions would explain its prominence in traditional, hunting/gathering societies and its persistence to this day among East African milk pastoralists.

[1]Perhaps the reason why in so much of Africa elders complain that under monetized exchange people have become "immoral", with successful individuals stigmatized as being "greedy" or "far hearted". The functional equivalent of contract law within a reciprocally-based exchange system is either social ostracism or even witchcraft accusation, both being widespread social sanctions within traditional African society.

2) Gender-linked Task Specialization

Perhaps the food deficit situation also explains why a gender-linked division of household and farming tasks is so prominent in many African traditional cultures. As our example, let us turn once again to the Kikuyu and Kamba of Kenya, where distinct role orientations were institutionalized for men and women. Put succinctly, the ideal Kikuyu man was somebody quick-witted, adept at convincing others to act, and willing to take risks. The ideal Kikuyu woman, on the other hand, was sober, hardworking, and cautious--attributes suited for conserving household resources and minimizing risks. It occurred to Mbithi and I at the time we were studying peasant farmers in eastern Kenya that these two attitudinal complexes are congruent with different production strategies. Kikuyu and Kamba men managed the household's large stock (constituting its principal capital resources) to exploit trading opportunities and take advantage of favorable seasons. When crops were surplus, they enlarged their herds by trading upwards from grain into goats and from goats into cattle--exactly as Schneider's model of East African livestock keeping would predict (Schneider 1968). In adverse seasons, however, the frugality of Kikuyu and Kamba women became crucial. In Kamba society, it was the compound's senior wife who kept the seed for the coming season in a sealed, clay pot buried beneath her bed. She would be the one to decide when the food shortage was so severe that seed must be eaten. (Similarly, among some pastoral groups women decide how much milk to retain for their children and how much to give to the calves.) A wife cultivated her own gardens of maize and beans, from which her children and husband would be fed; she was the one with specialized knowledge about traditional and wild foods. Either orientation by itself would be inadequate under opposite seasons. The two together gave those in a traditional production unit an incentive to cooperate while retaining the flexibility to activate contradictory strategies in a highly unstable environment.

3) Loose household/farm integration

Accompanying a sharp division of tasks within the farm household was a loose degree of integration between farming enterprizes and within

the compound. Indeed, with polygamy being a common ideal, it becomes difficult to define the farm household as a unit except at certain stages in its evolution when only a nuclear family are present. Both because men concentrated on stock accumulation (where an absence of the tsetse fly permitted cattle to be kept) and because of polygamous households, a woman and her minor children constituted the primary production and consumption unit. Men, on the other hand, rotated from cooking pot to cooking pot and might be gone seeking work for months at a stretch.

Jones (1983) drawing on data from the Semry rice scheme in northern Cameroon tests the hypothesis that the amount of labor a woman contributes to her husband's rice crop depends on the rate of compensation she receives. She notes that if husbands give their wives little or no money, "then women refuse to work on their husband's rice fields the following year" (1983:174). Jones finds that a simple optimizing model explains the difference in labor allocation between married and independent women, with independent women allocating more labor to rice. She uses her data to criticize the common assumption that the African family is a homogeneous decision-making unit, which maximizes a joint utility function. She argues instead that "at the margin, a family member would rather spend an additional unit of income fulfilling his or her own obligations than give it to other family members" (1983:176).

If it should happen that the usual end-of-dry season food deficit becomes extended, with indications the drought will be prolonged, it is not unusual to find large compounds splitting into smaller units. If the family owns livestock, the able-bodied men may leave to try and exchange them for food at a distance. Alternatively, we found that in some eastern Kenya families a man might send his wives back to their natal homesteads (also often located at a distance, and thus perhaps less subject to a local drought). Akong'a (1982) mentions the traditonal practice of "pawning" a wife or daughters to somebody with food, in expectation that the household head would ransom them back once good times returned. These may seem extreme "solutions" to food deficit, but at least they were preferable to the complete breakdown of the social system which Turnbull (1972) observed among the starving Ik people of Uganda.

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4. Introduced Seasonalities

In describing the huge influence of natural factors on African agriculture, one tends to overlook the introduced seasonalities which have come about because of farmers' participation in the larger political economy. Four are particularly salient: i) the withdrawal of children from the farm labor force to attend school, punctuated by the holiday periods when they may be at home; ii) the timing of crop payments within the annual calendar, in relation to periods of cash need; iii) heightened seasonal deficits accompanying maize farming, iv) the influence of the government's financial year upon rural service organizations, most evident in remote settings.

In regard to the impact of mass schooling--with universal primary education being an official objective in several East African nations--it is easy to overestimate the direct contribution of children into farming tasks, which was seldom large quantitatively if measured by the hours worked. Three important exceptions should be noted: the strategic assistance older children offered as herders within livestock keeping systems, a similar role for adolescent boys in fishing communities, and the sometimes significant assistance rendered by teenage girls to their mothers at weeding and harvesting times. In addition, certain export crops such as tea or cotton are notorious for requiring a heavy labor input in picking, a task shared by children (Fowler 1982:62). Aside from these exceptions (to which we return below), children often did not contribute very many hours per week in actual farmwork, so that their withdrawal to attend school might seem agriculturally unimportant. In the extreme instance of Kung! hunter-gatherers, the traditional way of life left children completely free from subsistence responsibility (Draper 1976).

However, this is a misleading picture of the importance of children in the farming system, where they exercised a significant indirect influence. The tasks children performed such as crop watching or bird-scaring safeguarded the ripening field crops--very important in an environment where there were baboons or where huge flocks of Quelea birds could arrive without warning. Schooling has meant the crops favored by birds

can no longer be grown in outlying patches away from the direct view of the homestead. An even more important contribution was the time older girls spent in child-care, watching the younger children while their mothers did fieldwork. The withdrawal of older girls from the homestead greatly increases the time an adult woman with a family must spend on household maintenance and child-care activities. This provides an obvious functional reason to explain the reluctance of many African parents to have their daughters continue in school.

In farming systems where livestock are free-ranging, requiring the constant presence of a herder, older children are critically important. Their presence allows the household to split its herds into several components, with children tending the milking animals, calves and smallstock nearer to the homestead. Throughout Africa, livestock-keeping peoples (particularly the semi-nomadic cultures) have strongly resisted mass schooling. While within such systems herding is usually idealized as a male's task, these days one often sees older girls in charge of the herds because their brothers are away in school. When the herding system collapses, because of extreme drought or general insecurity, the entire production system ceases to be viable--a circumstance seen in many of Africa's drought relief camps.

Seasonality is a feature of mass public schooling in two, key respects: first, because there are holiday periods when children may return home; and, second, because usually school fees must be paid according to some administratively determined schedule. In regard to holidays, there is the obvious possibility that the school calendar might be readjusted to return children at times of peak labor demand. Here the main difficulty appears to be the variability in when peak periods occur, either spatially (from community to community) or temporally (from season to season). In regard to school expenses, these often constitute a rural family's single largest cash expenditure of the year. Subsistence farming is characterized by a marked illiquidity in regard to seasonal cash flow. There will only be certain times in the year when householders have ready cash for paying school fees and other related educational expenses.

In our Kenya farm surveys in the late 1960s, we found farmers anxious about paying school costs (uniforms, etc.) and fees (for Harambee "self-help" secondary schooling). In extreme cases, a farmer might even sell expensive dairy cattle to keep a son in Harambee school. That a farmer would make such a choice at a time when seasons were good and milk in demand indicated a strong preference for diversifying sources of family support, a tendency also found among Yoruba farmers of Nigeria as documented by Berry (1984). Walden contributes the interesting suggestion that in social settings where the claims of relatives cannot be easily refused, rural entrepreneurs deliberately convert cash into other investments to avoid having it drained away over the season by impoverished relatives (1980). As he points out, the effect of this long-run strategy for accumulation is to heighten traders' (and farmers') short-run liquidity problems: for much of the year, they simply do not have extra cash on hand. Thus whether to keep children in school or as part of a general strategy to broaden the family's support network outside of farming, African small-holders use very little money within the farming system itself <u>even when returns are high</u>. The cash-starved condition of a house hold's agricultural enterprizes means that minor differences in how crops are purchased and farmers paid can be very important. Similarly, the precise timing of when inputs must be purchased or loans repaid is vital. Against such a backdrop, the information that in recent years many African crop authorities have defaulted on their own payment obligations to farmers takes on added significance.

Another cause of increased seasonality over much of Africa is the switchover from drought-resistant sorghum and millet to drought-sensitive maize as the staple food, a trend most marked in East and Southern Africa (Miracle 1966:113). In our example of the Sandawe people, it is significant that though living in a drought-prone environment, when people took up hoe cultivation maize was their choice of staple (Newman 1970). When Masai pastoralists in Tanzania's Arusha Region take up plough farming, it is to plant maize—not sorghum or millet. The Kikuyu, Meru and Kamba people forced by overpopulation to migrate downslope into the drier lands of Eastern Kenya nevertheless plant maize, even where one crop in three fails (Wisner and Mbithi 1974).

It was noted at the beginning that maize is especially sensitive to the types of moisture shortfall which typically occur within East Africa: delayed onset of the rains, a mid-season dry period, and early termination of rainfall. Why then do farmers continue to abandon the better adapted indigenous cereals to plant a riskier introduced crop? One clue has already been given: maize is much less vulnerable to bird damage. Farmers in Sukumaland of Tanzania told researchers this was the principal reason why when children began attending school they abandoned millet and sorghum (Hankins et al. 1971:36). Another may be the ease of storing dried maize on the cob—now the "traditional" technique over much of Africa. A third reason is the preference for maize-based foods, either uji (thin greul) or ugali (thick maize porridge) in urban areas, probably deriving from the maize rations customary in the large-farming and mining sectors (from Kenya southwards). Still another influence was the US supplied famine relief maize accepted by several East African countries in the 1960s and again in 1973-74. Then, too, the national marketing boards established almost everywhere in the 1960s to handle food grains found maize much easier to handle and market (the livestock sector which might have bought surplus sorghum was still non-commercialized). In our Kenya surveys, farmers laughed when we asked if they grew either sorghum or millet, since the main use of these so-called "traditional" crops had become the brewing of illicit beer. On the few farms where patches were still grown as a food, it was invariably because the household contained some old person who insisted on having traditional food. Otherwise, maize is now the main staple (alongside rice and wheat in the urban areas) over almost all of Africa south of the equatorial forest zone. For the same reason, however, households are now more prone to food deficits and communities more dependent on receiving famine relief in adverse seasons.

When large numbers of people become dependent on administratively supplied food sources, seasonalities within the administrative system become relevant—a principal point in the important volume Seasonal Dimensions to Rural Poverty (Chambers et al. 1981). Chambers and others argue that one type of administrative seasonality is the reduced coverage of

rural services during the rainy season when travel is difficult and supplies may run short. One can add that in East Africa, where the financial year typically ends in June, the end of the rainy season in late May coincides with the period when most government offices must close their books for the year. In more remote areas, there can be a six week long period when no expenditures are permitted, followed by an additional wait for the arrival of the next year's funds. This gap exactly overlaps the time when people will be out of food as they await the ripening crops. If a crop failure occurs, by the time that officials are once again mobile a food deficit crisis may have already materialized.

The worsening economic situation of the poorer African nations accentuates the impact of these seasonalities. Rural African services are particularly vulnerable to disruption of transport and supplies, depending as they do on imported fuel, parts, and drugs. The present pattern of rural life in East and Southern Africa is a post World-War II creation, based on the ubiquitous Landrover and on a governmentally established network of rural service centers. With a strong currency and radio communication, such centers are potentially quite efficient even when serving thousands of small holders--cf. standards of service achieved in some parts of Botswana, Zimbabwe, and highland Kenya. Once fuel deliveries become unreliable and a government's whole budget absorbed into salaries, the character of its field services must change. What we see today in some countries are rusting vehicles lying unrepaired for lack of spares, fuel sales on only certain days of the week, stringent rationing of travel by civil servants, and army vehicles roaming the countryside in search of smugglers, poachers, robbers and guerillas. In the midst of a deteriorating national situation, donor sponsored projects continue to offer farmers loans and insist they should employ imported inputs in high risk, specialized farming. The introduced "solutions" to seasonal food deficit which we are about to review may have been sensible and effective in the early 1970s, when they were devised. In today's circumstances, they have become an anamoly: tribute to the blindness of external experts when confronted by rapid socio-economic change.

5. Introduced Solutions to Seasonal Food Deficits

A main thrust of the argument throughout this paper is that introduced "solutions" do not in fact outperform indigenous ones except in certain, favored situations. A grasp of this fundamental conclusion helps one to understand why so many of the official rural development projects sponsored by African governments (and external donors) have gone awry. In regard to seasonal food shortages, there are three main options for farmers: i) to commercialize their production through specialization so that they can buy food when needed; ii) to mechanize operations in order to produce more food; and, iii) to irrigate their crops, thereby reducing yield fluctuations and extending the growing season. Of these, irrigation constitutes the "privileged" technological solution, frequently suggested as the answer to Africa's food deficits (seasonal and long-term); accordingly, it will be reviewed here in some detail. However, let us first see why neither specialized export crop production nor mechanization can at present meet many small holders' food security needs.

1) Specialized/Commercial Production

A general assumption underlying most "technical packages" which Ministries of Agriculture in Africa recommend to farmers is that specialized, commercial production is essential. From colonial times onwards, it has been a common practice to divide the African countryside into zones based on a predominant "cash crop". Usually, such crops were grown for export and constituted a household's main, on-farm source of cash income. In the Sahel, for example, one encounters the "peanut" and the "cotton" zones; in Kenya, the "coffee," "tea," and "cotton" zones; in Tanzania, the "cotton" vs. the "tobacco" areas; and so it goes, country by country. At first, technical packages dealt exclusively with the recommended export crop, and the crop industry also financed the research station, cf. Ukiriguru in Tanzania for cotton or Thika in Kenya for coffee. More recently, recommendations for a predominant staple food (usually maize) were incorporated; and today sometimes a legume is also included. Nonetheless, framing recommendations for only three out of some five to ten crops does still assume the other crops are inconsequential.

There is a huge literature on the supply response of African peasant farmers, and on the economics of particular crops, beyond what we can review here. As Singh points out (1983:5), the sub-Saharan African countries are more heavily dependent on primary commodity exports for their foreign exchange earnings than is any other major world region. It is not surprizing, then, that Wheeler's empirical investigation of the sources of economic stagnation in sub-Saharan Africa finds there is "an extremely close relationship between movements in export prices and average performance throughout the 20-year period" (1984:1). If this is so at the country level, is it also true at the farm level? How adequate have been the returns from export crops like coffee, tea, tobacco or cotton? Can farmers earn enough to encourage specialization, and when this occurs will they be able to buy food when they need it?

Obviously, no single answer can be given covering all crops—annual as well as perennial--and all countries. Even so, it seems that in many African countries the problems of trade and of domestic agricultural policy intersect in such a way as to bring about unintended consequences. Wheeler describes the process as follows (1984:9-10):

> Farmers must respond to incentives to at least some degree, and for both governments and farmers, the perception of the 'adequacy' of compensation can be heavily influenced by the effective exchange rate. If the government maintains an official exchange rate which is much higher than the equilibrium rate, the likely distortions of perceived opportunity costs may lead to sub-optimal patterns of resource allocation. The artifically-low cost of imports will probably produce excess demand for foreign exchange which will force the government to undertake some sort of rationing scheme...
>
> Import restrictions may in turn produce supply imbalances and a very limited quantity of relatively high-cost domestic supplies of inputs such as fertilizer and pesticides. At the same time, an overvaluation of the exchange rate may lead to domestic-currency equivalents of international prices so low that farmers cannot even be adequately compensated for the cost of their inputs. Although governments can theoretically adjust the internal terms of trade by setting agricultural prices at higher levels, their ability to do this in practice seems quite limited. When the price problem is combined with restrictions on low-cost incentive goods...the result may be increased rural-urban migration and a substantial adjustment of family labour time toward other activities...

In evaluating farmers' well-being under individual farming systems, a major problem arises because the choice of criteria has such a large influence on the outcome. For several decades now the usual measure of technological superiority in farming has been mean crop yields per unit of land, i.e. kgs/ha. In a moment we will review figures which illustrate how the employment of this standard biases the comparison, since it pays no attention to the inputs required: specifically, to increasing levels of purchased inputs and labor. Not only are absolute levels important, with small holders seeking to minimize both types of input, but also the timing of demand can be critical. A system which gives high yields but must receive priority in a farmer's allocation of cash and labor at peak periods obviously cannot be assessed without examining opportunity costs, the performance of alternatives foregone.

Again and again in Africa we find that the supposedly superior yields of recommended technical packages either demand a substantial cash outlay at the beginning of the season when farmers are experiencing food deficit, or else require higher effort at the peak seasons. Since the periods of labor input (in land preparation and weeding) overlap those when cash is needed for improved seed and fertilizers, high requirements of these inputs are interactive. They greatly increase the strain on peasant households, particularly among the poorer one half who may be already purchasing foodstuffs. Except where there is a well organized and equitable system of production credit, the farmer faces a direct trade-off: buying nutrients to support the future crop, or feeding the workers who grow the crop.

The differences in this regard are not minor. A doubled or even trebled input requirement is not unusual in "improved" systems for export crop production. Furthermore, where local farmers operate under high levels of risk--natural but also institutional--they have extra incentive to minimize their cash and labor commitments to any single enterprize. While these are general and well-known facets of African peasant farming, it may be more convincing if we document these observations from actual field studies.

Data on returns to labor at the peak periods are often the key to understanding indigenous African farming systems. Alverson (1984:5) shows that traditional practices in Botswana give a return per labor/hr more than three times the "improved" system (Table 9). (He argues that in fact the Ministry's recommendations—from which this table are drawn—used unaccountably low estimates of traditional sorghum production, 142 kg/ha versus his own survey results for 1976/77 of 284 kg/ha.) Strikingly similar results are reported by Gathee from Kenya (Tables 10 and 11). where if a farmer who usually took three days to interplant a field with maize and beans (the indigenous practice) followed official Ministry recommendations for planting, the task would take fifteen days (1982:138). As Gathee notes in regard to his data:

> Of the three intercropped systems, the returns to planting labour are highest for system D (farmer's) and lowest for system C (recommended). A shift from D to C shows a 73% decrease in the returns to planting labour...

The conclusion one can draw is that while specialized production may give higher <u>yields</u> (though not necessarily returns) per hectare, it is likely to give lower returns to labor, <u>in a system where labor is a constraining factor</u>. Alverson notes that this would not be true if prices were raised substantially, so that profits would cover the increased inputs needed by the "improved" system. He also points out that the Ministry's insensitivity towards the labor demands of their recommended practices arises from the assumption farmers can draw upon uncosted "family labor."

Do these same relationships hold when the specialized enterprize is an export crop different from farmers' own "food crops"? Here a useful source is the review of Tanzanian input/output data provided by Swanberg and Hogan (1981), based on estimates from the Marketing Development Bureau in Dar es Salaam. Swanberg and Hogan address the question of farmers' choice of crop in a drought afflicted economy. They divide the alternatives for analytical purposes into four main categories: "swing" food crops with export prospects (maize, rice and wheat); drought crops (cassava, sorghum, millet, cow peas, and pigeon peas); oilseeds

TABLE 9

COMPARATIVE RETURNS TO 'MODERN' VERSUS 'TRADITIONAL' FARMING IN BOTSWANA[b]

Per hectare costs (pula)	Ngwakgetse IFPP[a] scheme	Bangwakgetse traditional system
Capital depreciation (10%)	7.50	2.50
Hired labor	5.97	2.48
Fertilizer	25.75	0.00
Total:	39.22	4.98
Yield per half hectare (kg)		
Sorghum	261	142
Maize	412	137
Revenue per hectare (pula):	51.45	21.57
Gross margins per hectare: (Total costs deducted from total revenue)	12.23	16.59
Total labor-time required (hr):	199	83
Cash return to labor/hr	.06	.20

[a]Integrated Farming Pilot Project at Pelotshetlha

[b]Source: Hoyt Alverson (1984) "The Wisdom of Tradition in the Development of Dry-Land Farming: Botswana," Human Organization, vol. 43, no. 1, p. 5.

TABLE 10

MEAN LABOR INPUT PER SYSTEM[b]
(man-hours)[a]

System	Planting	1st Weeding	2nd Weeding	Thinning	Harvesting	Threshing	Man-hours/ 150 m	Man-days/ ha
A	3.58	4.19	2.03	1.00	2.43	1.37	14.60	139
B	9.39	5.09	2.42	--	2.15	2.09	21.14	201
C (Min Ag)	17.15	6.15	3.16	0.59	3.97	3.10	34.10	325
D (farmers)	3.11	3.55	2.59	0.55	3.61	1.50	14.91	142
E	5.48	3.39	3.16	0.48	3.43	1.58	17.52	167

[a]All data from Katumani Dryland Research Station. System C is the one recommended by the Ministry, and D the farmers' practice.

[b]Source: J.W. Gathee (1982) "Farming Systems Economics: Fitting Research to Farmers' Conditions," In, C.L. Keswani and B.J. Ndunguru (eds.) Intercropping. Ottawa: International Development Research Centre, p. 139.

TABLE 11

MEAN YIELDS AND RETURNS TO PLANTING LABOR[a]

System	Yield (kg/ha) Maize	Yield (kg/ha) Beans	Yield value (K shs)	Yield value - Seed cost (K shs)	Returns/unit planting labor (K shs/hour)
A	4339	--	4339	4290	17.90
B	--	1723	6031	5710	9.00
C (Min Ag)	3444	768	6132	5800	5.00
D (farmers)	2800	331	3959	3870	18.70
E	3231	371	4530	4380	12.40

Note: maize price, 1 K shs/kg; beans price, 3.50 K shs/kg; maize seed, 3.50 K shs/kg; bean seed, 3.50 K shs/kg. Labor rates are 10 K shs/man-day (8 hr).Land equivalent ratios for C,D, and E are 1.24, 0.84 and 0.96 respectively.

[a]Source: J.W. Gathee (1982) "Farming Systems Economics: Fitting Research to Farmers' Conditions," In, C.L. Keswani and B.J. Ndunguru (eds.) Intercropping. Ottawa: International Development Research Centre, p. 139.

(castor, sesame, groundnuts, and sunflower), and export crops (coffee, tea, tobacco, sisal, cotton, and cashews). They point out that a simplistic comparative analysis of costs and returns under these four categories seems to show that export crops outperform all others (Table 12), giving a labor return of 10 shillings per day as against 6 shillings for the others. Export crops also return a gross margin per hectare more than twice any of the alternatives (1981:16). However, as soon as one introduces risk analysis, the situation changes dramatically (Table 13). A main reason is that there are high risks attached to annual export crops like cotton, tobacco, and pyrethrum. Even under "improved" technologies, the crops most subject to specialized production do not fare well (Table 14). Swanberg and Hogan conclude (1981:22): "Although the traditional export crops earn the largest returns to the hectare, they cost the most to produce and, hence, their return rates to capital and labor are much lower than they are for the other crops."

Another source containing actual cost data from northeast Tanzania is Glaeser's (1984) review of peasant farming among the Shambaa, valuable because it concentrates on a well-studied but poor area in the Usambara Mts. (overlapping with earlier nutritional studies published in Kraut and Cremer, 1969). Without repeating the wealth of statistical information in this study, which further support the points already made (e.g. with indications that the traditional way of growing intercropped coffee gives an average return from one hectare per workday above that obtained from a professionally-operated estate, 1984:133), one additional finding emerges. The "modern" farming system pays off handsomely in two circumstances: either when it is linked to a secure, external market (e.g. for tomatoes marketed by a local rural development project outside of the immediate area); or when the timing of rainfall coincides exactly with crop needs, giving a bumper crop capable of repaying the higher level of inputs applied. Conversely, in poor years a "subsistence" strategy based on intercropping and minimum purchased inputs gives a higher gross margin per day than does the "improved" farming strategy (1984:133). "Professional" farmers who must pay their laborers are at a marked disadvantage in a risky production environment. For most Usambara smallholders, their cash expenditures were confined

TABLE 12

COMPARATIVE COSTS AND RETURNS WITH EXISTING TECHNOLOGY LEVELS[b] (T shs/ha)[a]

	Swing Food Crops	Drought Crops	Oil Crops	Traditional Export Crops
Purchased inputs	40	7	84	600
Labor (workdays)	100	123	126	196
Gross margin	642	748	800	2000
Labor return/wkday	6/-	6/-	6/-	10/-

Note: See text for listing of crops under each category.

[a]Derived from MDB price policy reports, Dar es Salaam. Averages weight each crop equally, not by volume of production.

[b]Source: K. Swanberg and E. Hogan (1981) Implications of the Drought Syndrome for Agricultural Planning in East Africa: The Case of Tanzania. Development Discussion Paper No. 120. Cambridge. Harvard Institute for International Development, p. 16.

TABLE 13

GROSS MARGIN VARIATION ESTIMATES FOR RISK CALCULATION (T Shs/ha)[b]

Crops	Gross Margin[a]	Purchased Inputs	Standard Deviation	Coefficient of Variation	Value Product	Expected Value of the Loss Function
Cotton, Tobacco, Pyrethrum	1492	470	1790	>1.0	1962	- 225
Sisal, Cashews	912	56	365	< .5	968	- 50
Coffee, tea	2430	926	1215	.5	3356	- 330
Swing food	642	40	449	.7	682	- 17
Drought	748	7	299	.4	755	- 0.5
Oil crops	800	84	720	.9	884	- 43

[a]Gross margin = value product less purchased inputs.

[b]Source: K. Swanberg and E. Hogan (1981) Implications of the Drought Syndrome for Agricultural Planning in East Africa: The Case of Tanzania. Development Discussion Paper No. 120. Cambridge Harvard Institute for International Development, p. 19.

TABLE 14

COMPARATIVE COSTS AND RETURNS WITH IMPROVED SMALLHOLDERS TECHNOLOGIES[b]

(T Shs/ha)

	Swing Food Crops		Drought Crops	Oil Crops	Export Crops	
	w/rice	w/o rice			w/o coffee	w/coffee
Purchased Inputs	362	300	133	201	1035	
Labor (w.d.)	200	120	154	159	300	
Gross Margin	3023	2000	1995	1732	3534	4839
Labor Returns[a]	15.12	16.67	12.96	10.89	11.78	16.13
Returns to Purchased Inputs	8.35	6.67	15.00	8.62	3.41	4.68

[a]Gross margin divided by total labor. Gross margin = value product less puchased inputs.

[b]Source: K. Swanberg and E. Hogan (1981) Implications of the Drought Syndrome for Agricultural Planning in East Africa: The Case of Tanzania. Development Discussion Paper No. 120. Cambridge: Harvard Institute for International Development, p. 23. Calculated from MDB reports, Dar es Salaam.

to purchases of seeds and little else. Glaeser, too, concludes (1984:153)

> ...the transition from subsistence farming to cash crop farming--and more so from peasant farm methods of production to professional methods--offers the opportunity to increase income, but it also harbors considerable risks such as increased labor input of the extended family, capital risks that are linked to prices, and socioeconomic dependence on the lender when obtaining credit. The opportunities must be weighed against the risks when deciding on a change of production strategy. In the technological domain, it is of utmost importance to seek the methods of farming that reduce the risks in comparison to the opportunities--in other words, those which facilitate an increase in yield with relatively little additional capital and labor.

This micro-level viewpoint about the risks of premature specialization is, I submit, broadly representative of farming in much of Tropical Africa.

Of course, sometimes African farmers with larger holdings and supportive neighbours do prosper, undoubtedly: as did the better Embu farmers we studied in the late 1960s (Moris 1970), or, for that matter, the Zimbabwean refugee farmers observed in Zambia in the early 1970s. Anthony et al. (1979) describe their Mazabuka sample in Zambia as being among the best farmers on the continent, much as two decades earlier Elspeth Huxley had described the Kalenjin farmers of highland Kenya. However, it also seems significant that these cases of success for specialized, western-style mixed farming come from plateau or highland areas. Climatic variability is less than within the lowlands, and the holdings these farmers cultivate have usually been larger than four hectares, permitting more efficient use of ox-cultivation and ploughing. In such settings, a transition into "yoeman" farming based on commercialized grain production does seem feasible.

Elsewhere, the record of long-term agricultural change based upon policies of specialized grain production or the growing of export crops is much less encouraging. In revisiting Gambian villages she had studied twenty-three years earlier, Haswell found that a swing away from food crops into cash crop production had left many of the poorer families "trapped at a low level of production by shortages of labour, often caused by out-migration of able-bodied men or by chronic ill-health"

(1981:40). Haswell goes on to state:

> ...the system of agricultural production still does not guarantee to each person their daily food needs, and still relies upon the female labour force for arduous tasks in the production of food. One can only conclude that the small gains achieved from new technology and from the intensification of agriculture have favoured only a small elite, and have not proved adequate to reverse a process of social and economic decline.

In northern Ghana, too, one finds a contrast where in the mid-1970s commercialized rice farming spread rapidly (as already noted) but left peasants in the drought-prone Northeast worse off. In the north-east of Ghana's Upper Region where human populations were already dense relative to carrying capacity, Shepherd describes the impact of commercial rice farming as "an unmitigated disaster" (1981:181). As evidence for this conclusion he notes (1981:182-183):

> One of the symptoms of the poverty of the north-east's agriculture has been the extensive hungry season experienced almost everywhere annually between April and July. The effects of increased food shortage in this season have been (1) to encourage out-migration, especially of younger men controlling little compound land; (2) to increase the dependence of food deficit households on the market, and on the generosity of kin away from the immediate vicinity...
>
> During late 1976, when it was obvious to residents of the north-east that there would be famine in the north-east, single men began migrating into the Northern Region to find work harvesting groundnuts and then rice. But in 1977, with food prices in the north-east soaring way above most household's purchasing power, and with there being besides very little food in the rural markets at all by June, it was reported that whole compounds were migrating...
>
> One immediate reason for the severity of the 1974 and 1977 famines has been the government's denial of their existence: in both years food aid was sent too late, with disastrous consequences in 1977. If the famine had been recognized as such earlier, local government officers and others acting as food aid distributors would not have been so tempted to appropriate grain for their own purposes and gain. As a result local food prices would not have increased so dramatically over and above national trends.

A similar picture (though here without the complication of large-scale rice production) is painted by van Apeldoorn (1981) in his graphic documentation of the 1972-1974 drought in northern Nigeria. He points out that at first farmers sold off livestock, but once food prices had gone over 200 Naira per ton people turned to substitute foods and especially

(for the poor) to bush collecting, the "old method of survival" including (1981:48):

> ...the search for, and use of, all sorts of leaves, fruits, tree bark and roots; the intensified hunting and consumption of meat considered 'prohibited' in normal times; the use of waterlilies and fish found in drying-out streams and ponds; and the opening of insect hills to search for larvae, grass seeds and chaff.

He continues:

> What needs to be emphasised here is that, even before the 1973 drought struck, poor farmers were almost at the end of their defences. They had eaten their seed reserves and depended on 'friends' for gifts or loans of seed; they had no more livestock to sell... In more than one area people were at starvation point. For many of the poor the only resource left by mid 1973 that they could pledge or sell was their land

Apeldoorn's description of the coping mechanisms adopted by individual households (and then by individuals acting alone as the crisis worsened) expands on the traditonal strategies already discussed (1981:59-66), with the additonal options of "begging" work (kwadago) and long-distance migration being particularly important. The point relative to our analysis is simply that once a seasonal drought stretches into a major drought, the modern sector alternative of specialized production is no more viable than the traditional alternatives were except for large producers who have already accumulated sufficient food stocks to survive anyway.

As in Ghana, so also in Nigeria the slowness of the Federal Government to acknowledge that a drought had occurred in the North made the plight of affected communities much worse (Apeldoorn 1981:53-56). Thus the State now becomes the vital actor: those areas will survive which can mobilize national attention early enough so that cumbersome bureaucratic deliveries of drought relief arrive before farmers are forced to leave their lands. If, as we have just seen, the operation of market forces rapidly takes the little available food out of farmers' reach because of skyrocketing prices, it will be the adequacy of governmental actions which determines farmers' welfare.[1]

[1] A situation seemingly tailor-made for the application of Hirschman's ideas about "exit" versus "voice" as the market versus political responses to unsatisfactory service, see his discussion in Essays in Trespassing. The "solution" offered to most small holders by commercialized production in a high risk environment is to migrate!

There will be those who emphatically disagree. After all, if the introduced systems do so poorly in meeting farmers' food needs during adverse seasons, how is it that there have been highly successful rural development projects based on this approach? A partial answer is that indeed there have been very few "highly successful" rural development projects in Africa, particularly over the longer run and in the semi-arid areas where seasonal food deficits are most severe. To my knowledge there is no recent, up-to-date source listing Africa's major rural development projects, so a statistical count of "successes" vs. "failures" is not feasible. The projects I would be willing to count as "highly successful" include the BAT and KTDA programs in Kenya, CFDT cotton campaigns in parts of West Africa, and perhaps the Shell-sponsored Uboma project in eastern Nigeria.[1] Without excluding others (the author has no acquaintance with large areas of Southern and West Africa), let us look more closely at the traits shared by these four programs.

First, all had a substantial expatriate presence in their intitial stages (CFDT still does), insuring a high degree of quality control and adherence to technical norms during the difficult "teething" period. (In my view, African managers would have been under greater political pressure to diversify program support; the expatriate finds it easier to be deliberately obtuse.) Second, the evidence of success usually given consists of aggregate crop totals and yields per hectare. From my personal observations, many KTDA smallholders growing tea in highland Kenya do not find the crop especially rewarding and I suspect the same is true of CFDT-linked cotton growers in West Africa. From our analysis here, the yield figures may be valid and yet conceal low returns to farmers' labor. While three of our four successes are commodity-based, they also enjoy a monopoly in handling the crop within participating communities. Third, both CFDT and BAT have been forced in recent years to broaden out the coverage of their input supply and extension system to include food crops--further confirmation of the points we make in this section.

[1] A judgement based on personal visits to BAT (tobacco) and KTDA (tea) programs in Kenya--the KTDA is well described in the literature, see Lamb and Muller (1982)--on an extended case study presented by a senior CFDT expert at a 1984 World Bank extension conference in Kenya and on Lagemann's (1977:141-250) field evaluation of Uboma.

The analytically most significant trait which three of the four projects share is their preoccupation with intensive supervision and a tight field organization, i.e. what Ruthenberg termed production under "close supervision" (Ruthenberg 1968). Tea, cotton, and tobacco are all labor-intensive crops requiring a large effort from farm households, and tobacco and cotton also require heavy use of purchased inputs. A vertically organized parastatal can insure that farmers get the credit and inputs they need, but repayment would not occur unless the coordination and field extension guarantee high yields and good crop quality. If not, a parastatal structure alone will be insufficient: many African countries have tried to copy KTDA's and BAT's success, with economically disastrous results. The payoff from having good internal administration in such crop authorities is twofold: i) growers obtain high yields, sufficient to return a profit after deduction of high input costs, and, ii) growers are protected from high losses due to climate or unstable prices. In this situation (and this situation alone) specialized, export crop production can become a viable strategy for evading seasonal food deficits.

The more common outcome these days is a perverse cycle, wherein donor financed projects insist that small holders adopt recommended high input technical packages without reducing the accompanying institutional risks. The linear nature of the crop production process means that the beneficial effects of a given crop production service can be undermined by institutional failures elsewhere in the production chain. Most specialized, commercial crops require an array of institutional supports: certified seed, fertilizers, insecticides, land planning, disease diagnosis, crop grading, and crop purchasing. What happens when farmers are encouraged to buy fertilizer on credit, but the seed given them does not germinate? Or the seed is good but the fertilizer is late? How does a smallholder survive when the third and final crop payment which should have paid for labor on the new crop is unaccountably withheld? The deteriorating economic situation in may African countries is destroying the ability of field agencies to meet their commitments, introducing a cumulative institutional risk into the system which is hav a devastating impact on the returns from commercialized production.

2) Mechanization

Sub-Saharan Africa is generally regarded as an exception when writers compare world-wide trends in farm mechanization (Binswanger 1984:1). In black Africa there are still large areas entirely cultivated by hand; and elsewhere animal traction predominates over tractorized farming, even though the use of tractors was introduced well over thirty years ago. When farming has such a pronounced labor bottleneck, and where so much arable land remains uncultivated in any given season, one might have expected the rapid expansion of mechanized agriculture. This transition would have stimulated the rapid evolution of a commercial economy, and the increased yields would have made seasonal food deficits a thing of the past.

If this transition has not materialized, one cannot blame the African governments. There have been successive national campaigns accompanied by bulk orders for hundreds of tractors—a tactic tried in all the East African countries, in Somalia, Ethiopia, and Sudan, and in many of the West African countries too. In the mid-1960s, immediately after independence Tanzania, Kenya, Uganda and Zambia all experimented with tractorized "block farming," typically with dismal economic results.[1] Tanzania is currently in its third cycle attempt, urging tractorization on reluctant villagers despite an adverse balance-of-payments and the total failure of its two earlier mass campaigns. No doubt a similar story could be documented for many other African countries, such is the allure of tractor farming in a landscape where human energy at the peak periods is sharply constrained.[2]

Mechanization in Africa means generally either ox or tractor powered cultivation, both types being confined mostly to land tillage rather than weeding and harvest operations. The larger the capital investment, the harder it becomes to justify partial mechanization of this nature, since expanding the cultivated area simply increases the weeding and harvest bottlenecks (Newman, Ouedraogo and Norman, 1981; Norman, Simmons and Hays 1982:184-185). Here we should note that in some Francophone countries,

[1]For accounts of the East African experience with mechanization in the 1960s, see Hall (1968), Metrick (1975), Clayton (1973) and de Wilde (1967).

[2]Much the largest of Africa's mechanization schemes have occurred in the Southern Sudan, where it was hoped that large-scale tractor farming could create an African "bread basket". The Ghanaian experience is reviewed in Shepherd (1981).

official promotion of animal powered farm equipment has been more systematically pursued. Factories have been established, first in Senegal and later in Cameroon and Mali, to produce locally adapted designs, e.g. several types of multi-purpose "tool bar" (polyculteur) as well as ploughs, seeders, and carts (Le Moigne 1980). The usual problem with introduced equipment is that it is too heavy for local animals. Lacking the official support it has enjoyed in Senegal and Mali, animal-drawn equipment has received only haphazardous attention in other African countries, where tractors have been emphasized instead.

The crucial difficulty remains the low utilization rates such equipment receives. Low utilization rates have the consequence that technical efficiencies do not get translated into economic cost-effectiveness, a point Johnston stresses (1980). Johnston cites several studies from Tanzania that show with prevailing labor-capital price relationships, animal traction remains more economical than tractor cultivation. The comparison is clouded in countries where because of an overvalued currency imported equipment is cheap, and because tractors are often accorded preferential treatment (waiving of import duties, etc.). The failure of tractors despite these advantages is in part because equipment units have on average a very short working life. Many factors no doubt contribute: inadequate maintenance, poor supervision, importations of "orphaned" equipment, etc. The operational lessons are well summarized in several earlier sources, see especially de Wilde (1967:95-131) and Kline et al. (1969). Two key reports using Tanzania data are Beeny (1975) and Migot-Adholla (1975).

These days the existing problems are compounded by difficulties in obtaining fuel and spare parts, shortages being encountered almost everywhere in sub-Saharan Africa. When farmers cannot be certain of obtaining fuel, the contribution of tractor farming to relieving labor bottlenecks becomes overshadowed by the risks of total failure. At the farm level, few operators can afford the increased riskiness accompanying tractor cultivation. Nevertheless, the powerful association between tractors and "modern agriculture" will no doubt insure that tractors will continue to be imported by African governments.

3) Irrigation

Of our three main introduced options, only irrigation specifically addresses farmers' need for increased production security. Can adoption of irrigation technologies in their modern form alleviate the seasonal food deficits in African peasant agriculture? Since access to irrigation has been the key to the spread of high-yielding wheat and rice varieties in Asia, could this same "agrarian miracle" be repeated in Africa? Either way, then, by shortening the "hunger period" or by reducing the shortfall in cereal yields, irrigation seems to be an ideal technological solution.

In answer, the first point to underscore is that Africa's formal irrigation schemes have been very expensive. The figure of $ 25,000 per ha (in 1980 prices) given by Toksoz for Kenya's Bura West irrigation settlement is not unrepresentative of actual costs on many African schemes (Toksoz 1981:13). FAO (1985) gives considerably lower cost estimates, based on the World Bank's Sahel experience, ranging from $ 3,200/ha to $ 8,400/ha, but when examined on a case by case basis most of these turn out to be incomplete cost estimates, considerably exceeded by actual in-country expenditures. The FAO Investment Centre study, from which these figures are drawn, notes that as a rule African construction costs are higher than those for similar work in Asia (1985:40). However another major difference is the presence of already established irrigation bureaucracies in many Asian countries (cf. Thailand's Royal Irrigation Department). In African countries, formal irrigation schemes have often required expensive external management. A single irrigated sugar estate may require from 10-15 expatriate technical staff (cf. Ethiopia's Tendaho scheme as it was before being nationalized), employed at internationally competitive salaries. Then there are the unavoidable infrastructural costs which accompany implementation of technologically sophisticated projects in remote environments. Formal schemes usually require that the government builds roads, crop storage, staff housing, clinics, and so forth. When irrigation is so expensive and concentrated, it will necessarily be limited to a few, favored sites which then cannot afford to grow lower value food crops (Moris and Thom, 1985:46).

The cost structure explains in part why formal irrigation in black Africa is employed mainly on only three crops: rice, sugar, and cotton. Of course, there are exceptions within individual countries--irrigated sorghum in Sudan (because traditionally it was part of Gezira's rotation), irrigated coffee in Kenya, and irrigated bananas in Somalia--but on the whole these other crops (including vegetables and wheat) constitute only a minor proportion of the total. To recover their heavy investment costs, formal schemes must grow commercial crops at a high yield level. In particular, irrigated sugar estates in sub-Saharan Africa have an agro-industrial character and a centralized management antithetical to small-scale and peasant production. Even on rice schemes, farmers are often called tenants and enjoy little control over their own operations.

The second observation is, therefore, that while irrigation technologies are sometimes efficiently employed, this usually occurs in an estate setting and does not assist farmers' main food staples. Except in parts of coastal and inland West Africa, rice is not the predominant staple food in black Africa (here Madagascar with its historic ties to Southeast Asia is the striking exception). In East Africa, rice remains a luxury food enjoyed on special occasions or by urban populations. High production costs on formal schemes mean that the rice produced costs more than imported rice would, necessitating protected local markets and all the distortions these can entail. Similarly for sugar and for wheat, with the added caveat that outside of highland areas wheat does poorly in tropical Africa and is almost entirely an item of urban consumption (though a rapidly growing preference, particularly in the Sahelian countries). Only in Madagascar--Africa's second largest employer of irrigated production--do we find established peasant communities practicing irrigation and growing a crop for which irrigation technology is highly suited.

What contribution do Africa's larger irrigation schemes make to ameliorate seasonal food deficits? As noted above, the specific crops they grow usually are not targeted at reducing food deficits, nor do they save foreign exchange because of the high import content of the large scheme mode of production. For participating farmers, the rice they grow

can be retained to stabilize the household's food supply, but with low yields this may leave insufficient income to repay scheme charges and production costs. If schemes incorporate double-cycle cropping, one cycle will overlap farmers' rain-fed crop, a principle reason why several African irrigation schemes have abandoned earlier attempts to institute a double cycle. The large dams from which the more recent schemes draw their water also cut off the downstream seasonal flood, making the traditional form of decrue (or recessional) farming impractical. Here the upset has been greatest in Mali's inland delta, severely affected by upstream withdrawals during the two very dry seasons of 1983 and 1984--an impact Scudder warned against (1980). In Nigeria, as already noted, the loss of traditional decrue production has been significant; the hectares denied recessional cultivation under the new regime of stabilized flow may actually exceed what was gained by construction of the dam.[1] Furthermore, in a semi-arid environment the land flooded within the storage basin is often the very best agricultural land in the area, already under intensive fadama utilization. From a sociological viewpoint, implementation of large-scale irrigation can become an excuse to dispossess existing cultivators who were already engaged in small-scale irrigation.[2] Sometimes this outcome has been deliberately intended, but more commonly it seems to reflect officials' low regard for the efficiency of traditional technologies when contrasted against "modern", large-scale methods. In actuality, FAO figures indicate that the improvement of small-scale irrigation or minor organizational improvements to the poorly performing large systems would be far more cost effective than investment in additional large schemes (Table 15). All in all, if we take into account the high opportunity costs of water, capital, and skilled management and the high recurrent costs of large schemes, most African countries would have been better off if their large schemes had never been built. The outstanding exception is, of course, the Sudan; here the incorporation of sorghum in the official rotation was of critical importance during the extended 1984 drought (as witnessed by the author).

[1] Several useful accounts of the Nigerian experience are found in Adams and Grove (eds.) (1984) Irrigation in Tropical Africa. See also Wallace (1981) on the impact of the Kano Scheme.

[2] See Tiffen (1984), reviewing land tenure aspects of irrigation; also also Adam's horrifying account of land dispossession in the Bakolori scheme, in Adams and Grove (1984). Adams argues that for Bakalori farmers, the implementation of the scheme had the same effect as a major drought.

TABLE 15

INCREMENTAL PADDY OUTPUT REQUIRED TO JUSTIFY TYPICAL IRRIGATION INVESTMENT COSTS[a]

Rice Price (US$/t)		Desired Rate of Return 12% 180	12% 300	7% 180	7% 300
		---------t paddy/ha/yr----------			
New Irrigation					
• Partial control	(US$4,000/ha)	7.1	4.3	4.7	2.8
• Full control	(US$8,000/ha)	14.2	8.5	9.4	5.7
Rehabilitation[b]					
• Major repair	(US$1,500/ha)	2.7	1.6	1.8	1.1
• Minor repair	(US$750/ha)	1.3	0.8	0.9	0.5
Traditional Systems					
• Rising flood	(US$1,500/ha)	2.7	1.6	1.8	1.1
• Swamp	(US$500/ha)	0.9	0.5	0.6	0.3

[a]Assuming 68 percent milling efficiency and operating costs equal 30 percent of gross output value.

[b]This case assumes works over three years and full benefits in year six.

Source: FAO Investment Centre, 1985. "Irrigation in Africa South of the Sahara," p. 60. Rome: FAO.

Why is there such a large gap between "modern" irrigation and the simple technological innovations which a farmer with one to three hectares of land can afford? Basically, it would seem that the very small size of traditional holdings leaves a farmer incapable of exerting pressure upon either the commercial or the government support systems. Once again, the extreme duality in the production systems militates against demand-led technological innovation. In deciding that surface irrigation requires a degree of coordination small holders cannot readily supply by themselves, African governments become committed to the formation of intermediary, bureaucratic organizations. These soon acquire the traits of a formal bureaucracy: centralized management, salaried staff, government ownership of land, and excessive rigidity.

Another stimulus towards having a formal scheme organization is undoubtedly the extreme difficulty field agencies experience in trying to recover irrigation costs from subsistence farmers. Every time there is an adverse season, farmers default on their production loans. To civil servants, it has seemed that the only practical way to guarantee high yields and extract repayment of scheme costs is for the government to retain control over irrigated lands. Farmers thus participate as settlers--tenants, in reality--subject to eviction for non-repayment. This is the false lesson Palmer-Jones (1981) argues the Nigerian Government drew from its own early schemes. Of course, adoption of organized settlement as the institutional mode for implementing irrigation pushes up the unit costs dramtically. It also leaves salaried staff responsible for organizing a range of social and production services for which they are usually ill-prepared and underfunded (Moris and Thom 1985).

The alternative would be to develop other cost recovery devices, such as a flat water rate (as has been implemented in Zimbabwe during the past) or cost-recovery through a water users' organization (like Senegal's SAED-assisted small perimeters). Or, if the entry costs associated with adoption of irrigation could be lowered, farmers might generate their own finances and the whole issue of joint accountability could be avoided.

5. Comparative Effectiveness

To bring to conclusion our extended review of technical options --indigenous and introduced--for ameliorating seasonal food deficits, let us examine briefly their comparative performance under contemporary circumstances.

First, it should be noted that the indigenous solutions to seasonal food deficits have usually been ignored in technical agricultural research, at least until the FSR studies in the mid-1970s. Western trained soientists, whether expatriate or African nationals, were simply not prepared to take seriously the role of goats, transhumant migration, root crops, and swamp cultivation in the farming system. Now that FSR provides a conceptual paradigm for examining these features of "traditional" cultivation, the key factors are being measured within field studies. A review of scattered preliminary findings suggests that the indigenous technologics outperform the introduced ones when employed under the constraints which African small holders face.

Second, the indigenous strategies are clearly related to farmers' need to outlast the extended, energy-deficit period overlapping the end of the long dry season and the beginning of a new cycle. Even under modern conditions, failures in the larger economic system make it highly desirable that farm households pursue their own solutions to this need. It seems likely that the superiority of indigenous solutions is especially evident during the "hunger period"--though this will not be true for those large, commercialized producers whose monthly income (often from off-farm sources) buffers them from such food deficits.

Third, under conditions of increasing population and environmental stress, the indigenous solutions are no longer available to all who might desire to employ them. Three of the five solutions require access to commons resources, whose productivity falls off rapidly once over-utilization occurs. In regard to crop diversity and particularly traditional root crops, the dysjuncture between sexes and between generations may bring about a loss of valuable indigenous varieties and empirical knowledge. All five strategies are losing their effectiveness under conditions of "labor involution," though this need not have happened in all instances.

Fourth, under conditions of population intensification several of the indigenous solutions nevertheless can leave households extremely vulnerable should a seasonal food deficit be extended into a major drought. The success of such strategies during a typical dry season keeps people in place where the modern economy cannot function well if there is a failure of the entire season. This explains why it is so difficult to estimate in advance the numbers who may require assistance in a bad year, and the catastrophic speed with which a disaster spreads once the indigenous solutions collapse.

Fifth, for a variety of reasons not fully reviewed here, the likely responses at a governmental level to this situation have been (and will be) to distribute famine relief obtained on concessionary terms from external donors. Such famine relief can relax the food deficit constraint, becoming a substitute for increasingly ineffective indigenous remedies. However, the activation of famine relief cannot be initiated by individual households. What one knows about feedback within African administration suggests that the process will evidence delays, random breakdowns, corruption, and inequities. On the other hand, it has already permitted an intensification of rain-fed farming into the drier lands of the Sahel and East Africa. It is the author's view that much of the environmental degradation outsiders blame on indigenous pastoralism is actually a consequence of the spread of arable farming into high risk environments. Famine relief during minor droughts is an essential component in the process.

Sixth, under present economic conditions while recommended technical packages for export crops and maize give higher yields, they may greatly increase farmers' levels of risk. They also often do not match indigenous options in the returns to labor input, particularly labor at the seasons of peak demand. The congruence of farmers' own choices with crops which yield the most per unit of labor input suggests that labor bottlenecks are a significant consideration in their production strategies.

Seventh, while there have been some successful development projects based on export crops—notably on tea, tobacco, and cotton—these

have been characterized by tight supervision, guaranteed prices, and a well organized input delivery system. Under such circumstances, small holders can obtain yields sufficient to repay high input costs. Nonetheless, many attempts to copy the parastatal, crop authority model have failed. The key to success appears to be having a highly efficient field support system which can minimize the risks of production.

Eighth, the technical efficiency of mechanized production does not translate into economic cost-effectiveness in circumstances where only a few operations are affected and where individual farmers have very small fields. On their own, either tractor or ox-ploughing simply shift the labor bottleneck to weeding and harvest operations. Institutional innovations like block farms aimed at circumventing the small size of farmers' holdings require a high level of coordination and management. Tractor farming because of its higher costs is severely affected by climatic uncertainty and by the low utilization rates typically seen. It is also vulnerable to shortages of fuel and spare parts which accompany a deteriorating national economic situation. Such blockages affect capitalistic as well as socialist approaches, and account for the difficulty of realizing economies of scale in African farming.

Ninth, the extreme duality in African farming limits the application and diffusion of irrigation technologies. To date, irrigated production has been high cost, necessitating professional management and a concentration on three "cash" crops: rice, sugar, and cotton. Farmers whose only role is as tenants or day laborers can hardly be expected to copy the capital-intensive technology they observe within official irrigation schemes. The high costs and many organizational problems associated with these formal irrigation schemes explain why introduced irrigation technologies have not been directed towards increasing farmers' food security.

In contrast, African farmers' own, small-scale initiatives in making better use of depressional soils have allowed an intensification of farming. With or without formal assistance, this trend will continue It greatly outperforms the introduced options as a viable approach for ameliorating the impact of seasonal food deficits. However, even this

strategy cannot cope with major droughts which some analysts predict will occur with increasing frequency.

7. Conclusion

This paper has been based on a farming systems' research perspective. It assumes that African peasant farmers generally respond in rational ways to production opportunities, contingent upon the proximate constraints experienced over the course of each season. The most important of these for "subsistence" producers is the necessity of securing an adequate food supply to outlast the extended food deficit period which overlaps the end of each dry season until new crops can be eaten. Because the author's own field research (done some years ago in eastern Kenya) did not specifically address this issue, results of more recent studies in East and Southern Africa have been drawn upon also. While the evidence is scattered and somewhat inconclusive, it does support the conclusion that food deficits are a priority concern for African small holders' production strategies. Farmers rejection of introduced technical packages becomes comprehensible when we examine the returns obtained from labor at planting time and cash outlays required during the critical "hunger period". Indigenous production choices generally out-perform introduced options in these two, key areas which under conditions of increasing insecurity become more rather than less significant.

The above finding explains the widespread rejection of recommended technical packages which accounts for the disappointing performance of so many African rural development projects. By and large, recommended practices have required greatly increased labor inputs from farmers, and often also heavy cash outlays. They necessitate a dependence upon outside service agencies whose own reliability is decreasing now that many countries are in a continuing state of financial crisis. Thus on top of natural risks we must also reckon upon high levels of institutional risk within African farming. Under such conditions, entry into "modern" agricultural production makes sense only for those with a cushion of non-farm income to tide them over periods of food scarcity.

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INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 862-5600
Telex: 440054
Cable: IFPRI

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SECONDARY FOOD CROPS AND THE REDUCTION OF SEASONAL FOOD INSECURITY: THE ROLE OF AGRICULTURAL RESEARCH

by

Richard Longhurst and Michael Lipton

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SECONDARY FOOD CROPS AND THE REDUCTION OF SEASONAL FOOD INSECURITY: THE ROLE OF AGRICULTURAL RESEARCH

Richard Longhurst and Michael Lipton, Institute of Development Studies, Brighton*

This paper poses, and attempts to answer, four questions on the role of secondary food crops in alleviating seasonal food insecurity. First, what role do these crops play in the diets of populations in developing countries, especially on a seasonal basis and in providing them incomes so that they can obtain sufficient food? Second, are some crops of greater importance in the diets of poor rural people? Third, what sort of agricultural research is already being carried out on these crops to improve the diets and incomes of undernourished people? Fourth, given the answers to the first and second questions, what should be the nature, structure, type and location of investment in agricultural research in these commodities?

I INTRODUCTION

In any particular place, a secondary food crop has the following characteristics, for the average household and time:

- It provides less than, say, 20-25 per cent of energy;
- It provides less than, say, 20-25 per cent of the value of food consumption, through the value of self-consumed produce plus income either from its sale or from wage employment in growing it; and
- It uses up less than, say, 20-25 per cent of a scarce primary factor used up in cultivation; those factors would vary across places and times, and might be water, draught, absorbable nitrogen, seasonal labour, or arable land.

The emphasised words in the above paragraph all draw attention to ways in which crops can be important to sustain human life, but "secondary" and neglected by policy in general and research in particular. Thus:

(a) A crop can be secondary for every major region of the world, but vital for a few smallish countries; especially if they

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are in different continents, that is likely to lead to neglect by both national and international research, as for example into plantains.

(b) A crop may be secondary for a country, but vital to persons in part of it. If those persons, and/or other food crops, are not very mobile or for other reasons deal little in markets, national neglect of such a crop is both likely and damaging. The "false banana" (Ensete spp) in both Sudan and Ethiopia illustrates this.

(c) A crop, secondary for households as a whole in an area, can loom large for some sub-group of households - poor, multi-sibling, remote, etc. If such a sub-group both suffers nutritional risk and lacks political influence (and these two features often go together), then neglect is again likely and damaging. Almost all non-rice foodgrains, and all tubers, in Sri Lanka suffered from such neglect in the 1960s, and most do so still.

(d) A crop, normally secondary, can become very important at particular times. Cassava in most of Kenya is normally a secondary crop, but in many areas has been a reserve crop also, dug up as a main staple for use in famine years. Many pulses become major energy sources only in brief slack seasons. The pressures for research into such crops are likely to be intermittent, at best.

These four features interact. Poor people in backward areas and bad seasons are most likely to find crops, nationally "secondary" and neglected, suddenly vital and inadequate. Emphasis in this paper is on seasonal issues, and on a crop's direct rôle in energy supply; but, before turning to this, we need to look at other respects in which the above definition (p.1) points to ways in which agricultural research and policy might under-emphasise crops that are secondary in general, but vital in key respects:[1]

(e) Although a crop provides only (say) 10 per cent of dietary energy, neglect of research may, over time, readily halve that contribution. For very poor people, 5 per cent fewer calories - if not made good from other sources - can make a big difference, especially to infant mortality. Some of the minor millets in Africa have typified such sequences.[2]

(f) Some crops, secondary as energy sources, provide large proportions of micronutrients, especially vitamins: green leafy vegetables for iron, calcium and vitamin A; legumes for B; fruits for C. It may be right to neglect such crops in a public research system, partly because "luxury" demand for them stimulates private research, partly because energy shortage is much the main problem; but that approach has dangers unless the micronutrients are made good, e.g. by fortifying salt with iodine or vitamin A.

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1 "Secondariness" may apply to a crop in some places, senses, or contexts, but not others; it is thus not a "topic-neutral" concept [Ryle, 1959].

2 Especially in bad years, in places where these little-researched (but robust) secondary crops have been progressively displaced by higher-yielding (but riskier) hybrid maize.

(g) Crops, secondary for energy and micronutrients, may be major protein sources. However, this may not indicate grounds for a shift in research emphases. The justified debunking of the "protein gap" [Joy and Payne, 1975] rests firmly on findings that almost all sufferers from protein deprivation would be cured if they got enough calories [see refs. in Lipton, 1983, pp.8-9]. Moreover, underresearched secondary crops, notably pulses, often supply fewer - and costlier - protein (not just calories) per acre than the highly-researched, highly-yielding major crops, notably wheat, that are replacing them [Lipton with Longhurst, 1985].

(h) Much more important, a food crop may supply barely 10 per cent of dietary energy, yet provide more than 25 per cent of income to buy food, either from working time or from sale.[3] Such food crops are presumably valued largely for economizing land, and/or for "non-caloric" reasons (e.g. taste, straw, rotation). Should research shift towards such "low-calorie, high-effort" food crops, if it seeks to help the hungry? The implications differ radically as between three situations. (i) Where the hungry are mainly or nearly landless, and derive most income from employment by others, some of it will be farm income from working at these crops. In such cases, research that raises their profitability (unless it displaced labour) would help the poor (by inducing farm employers to raise their workers' employment income), quite possibly more than it could harm them by shifting land away from crops yielding cheaper calories. (ii) Where the hungry live by operating farms, and choose to grow and sell the "energy-secondary, high-work" crop to buy foods, an increase in research on that crop will help them if and only if its consequent extra output growth, net of energy costs of effort, as a proportion of output exceeds its price-elasticity of demand. (iii) Where the hungry live by operating small farms, and choose to grow the energy-secondary yet high-work crop for their own consumption, any successful shift of research towards it must help them - yet is unlikely to receive political support; the so-called "retreat into subsistence" is not popular among the powerful.

(i) Finally, a food crop may be energy-secondary, and even work-secondary and income-secondary, yet make major demands on a scarce factor - land, peak labour, etc. Such a crop would be grown only if much in demand for non-energy reasons (p. 3). Greater research efforts for such crops, by increasing demands on a scarce factor and encouraging production of low-employment and low-energy crops, would seldom help the poor, unless the scarce factor involved were peak, and long-run supply-inelastic, unskilled wage labour.

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3 Could such "secondary nutritious crops" in principle be non-food crops, sold to buy food? Not at the national level if the economy has significant protection or transport costs; there, income from such crops raises demand for food much more than availability. Price rises therefore offset income-based nutrition gains. That is much less true for secondary <u>food</u> crops.

In Tables 1-4 we show the evidence from FAO Food Balance Sheets as to the relative contribution to energy, protein, vitamin A and C availability for consumption by different commodities. Food balance sheet data in terms of food type, region and nutrients other than energy and protein, are not available to us for years later than 1977. (In view of the known serious deficiencies of such data, we use them only for large aggregates of countries and crops.) Excluding cereals and roots and tubers, sugars and vegetable oils, the proportion of energy availability fulfilled in developing countries by the remaining vegetable sources (pulses, roots and oilseeds, vegetables, fruit, i.e. the main categories that consist almost entirely, in all the above senses, of secondary crops) is 10% (Table 1), varying little between continents, but highest in Africa (12.9%). In view of the importance of roots and tubers in Africa, it has, compared to Asian countries, a low dependence on cereals for energy intake. Contribution to availability of protein of secondary crops (Table 2) is higher than for energy because of the contribution of pulses - 19.5% for developing countries, 20.4% for Africa - and these crops provide, for developing countries, 45% and 61% of vitamin A and C availabilities respectively (Tables 3 and 4).

Our definition (p. 1) points to four propositions, which this paper cannot fully explore. First, specific secondary crops are more important in the diets of the poor than in those of the rich. Second, there are intra-family differences in the "secondariness" of some crops; these have implications for nutrition. Third, some crops "secondary" for a region in terms of average place may, because of their frequent adaptability to semi-arid conditions, be more significant in the diets of people living in marginal ecological areas. Fourth, their importance can vary in terms of time: intra-annually, we would expect some secondary crops to be more important seasonally before the harvest than afterwards; inter-annually, we find many of the crops to be important when there are gross shortages of the main staple.

However, the data often do not permit us to say whether crops, secondary "on average", are significant for at-risk groups: poor people, small children, marginal areas, "bad" seasons or years. Limited implications only, therefore, can be drawn for policy. We have not been able at present to uncover reasonably reliable data that show the consumption of different food crops (in terms of contribution to energy and nutrient intake) by income group <u>and</u> by time of year, although we believe such data do exist and we are endeavouring to obtain this information. However, a powerful piece of aggregate evidence from the India National Sample Surveys shows that, year-round, the poorer the income group the more likely it is to be dependent on cereals for its energy supply (see Table 5). For all groups, foods such as pulses, nuts, seeds, fruit, vegetables, spices and prepared foods provided 9.5% of energy intake in rural areas, 15% in urban areas. Therefore, in terms of energy the poor find major crops to be cheaper sources of food; but

they are, of course, much more dependent within the cereal group upon items secondary at national level, such as small millets, and upon areas likely to specialise in these robust but low-value foods.

In Sierra Leone, rice consumption (the staple) per consumer equivalent generally rose with income, but not necessarily in the two highest income classes (Smith et al., 1981). For other commodities - cassava, other cereals, palm oil, groundnuts and alcoholic beverages, consumption in per kg. terms rises with income except for alcohol and cassava in the Northern Region. Few food consumption surveys have been carried out in Africa, and very few break down intake data by socioeconomic class. Therefore we have to make residual inferences from the relationship between the staple and incomes. This may give a misleading picture. In Tunisia, deficit households did not appear to attempt to maximise their calorie intake by eating cheap energy foods (e.g. cereals, sugar) rather than more pleasurable foods (pulses, vegetables, animal products). They rejected a monotonous diet in favour of a diverse one even though this meant energy requirements were not fulfilled but protein and vitamins A and C requirements were satisfied (Périssé and Kamoun, 1981).

It is not easy to pinpoint general physical features, relevant to research or other policy, of crops secondary in food consumption. These include a huge variety of crops: some with high income-elasticity (most vegetables, fruits and even pulses), some inferior goods (e.g. most minor cereals, roots and tubers). There are also many gathered foods, including wild tree crops, which are important components of the diet for some types of people - mostly, probably, in the poorest quintile - at some times.

However, it is worth pinpointing four big groups of (usually) secondary food crops, in increasing order - usually - both of labour requirements per kilojoule eaten and of firmness and consistency of intention to harvest. Gathered crops shade into wild vegetables occasionally cultivated, such as amaranthus and spinach; such foods are a decreasing share of income and diet, alongside the general erosion of common property resources, especially for the poor [Jodha, 1983]. Mixed legumes, pumpkins and melons, cultivated either over a field (Africa) or row-intercropped (Asia), are secondary in cultivation as well as for food, and are grown partly for soil fertility (especially N-fixation) or canopy effects; often, they provide reserves of foods, drawn on only in bad seasons or years. Cultivated vegetables in home gardens near the compound [UNU, 1985] loom large as micronutrient, seldom energy, sources. Non-staple root crops do usually get harvested, but are partly a reserve.

So far we have discussed secondary aspects largely in terms of food intake. Generally this overlaps with "secondariness" in production and employment generation. Most secondary food crops are grown as a subsidiary food source for auto-consumption though even some gathered foods are traded quite vigorously in the market [Fleuret, 1979, in Tanzania]. Secondary crops, however, are rarely cultivated in sole stand for commercial purposes but are usually intercropped with the main staple.

Two exceptions should be noted. Sometimes a specific marketing outlet has been defined, e.g. tomato for paste. Sometimes there is specialisation in a secondary crop among farmers with privileged access to some key input or location, e.g. vegetables grown in dry season swamps close to urban areas.

This discussion illustrates two extreme "ideal types" of crop making a "secondary" contribution to the average rural diet. One extreme is the low-status contingency crop, usually absorbing little labour-time, being planted around the compound with other crops to fill in seasonal food shortages (e.g. taro and the cereal fonios - minor millets - in some West African circumstances). The other is the high-value crop, usually vegetables, intensively cultivated throughout the year, usually with supplementary water in the dry season, for high-income urban consumers in nearby towns or even overseas (e.g. mushrooms in Taiwan). The extent to which it is attractive to farmers to grow secondary crops in the latter category depends on transportation costs (weight/volume ratio), localisation of tastes and nature of end uses. Plainly the extremes can meet - vegetables in Sri Lanka are grown for subsistence and commercial purposes, often the same vegetables, often by the same growers, sometimes (notably on workers' home gardens in up-country tea plantations) both. But normally the commercialised secondary crops and farmers are distinct from, and much more research-related than, the "subsistence" ones. The CGIAR system, we would guess, does rather little about bitter gourds!

Two further aspects of these secondary crops importantly influence the level of output and nature of use of these crops by rural people. First, many secondary crops have important "farm-system" or "household-system" features and by-products, apart from adding diversity and stability to the diet. Some are drought-resistant, assist soil conservation and minimisation of desertification, or contribute to soil fertility (by nitrogen fixation and water retention) or to reduction of pests and weeds (by influencing the micro-climate within crops). Also, some crops are valuable as medicines, resins and stimulants, as well as forage, firewood, livestock feed and housing material.

Second, these positive features of secondary crops are offset by some negative aspects. Many secondary crops contain anti-nutritional factors, harming taste and/or absorbability into the gut.[4] Most of these anti-nutritive factors can be removed by prolonged boiling or soaking, but, where household labour time and firewood are either in short supply or have a high opportunity cost, food preparation of this nature is costly.

Why do many secondary crops tend, more than major crops, to have these characteristics - taste, etc., drawbacks leading them to be acceptable, for the most part, only to the poor; cultivation advantages, obtained rather inconveniently, appealing mainly to the poor who can afford them no other way? In general, it is because undesirable taste or absorbability factors are much likelier to be tolerated (and desirable non-energy-related factors are much likelier to be sought), by both farmers and researchers, in crops that do not feed most of the people most of the time. However, research may need to offset or correct this tendency. It means that the undesirable factors tend to loom largest - and the desirable ones, to get lost - in times, places, and groups under stress that render "secondary" crops locally primary.

There are also special explanations for some common features of many secondary crops. Since they tend to grow in hostile environments, anti-nutritive factors may be "evolutionary" for symbiosis with humans, in that non-human predators are kept to a minimum. More important, however, is the toleration of undesirable features (and stress on non-food desiderata) in minor crops because farmers rely on them for food only in bad times; in years of good staple yields, farmers may not harvest their secondary crops, allowing them to be eaten by livestock or turned in for green manure (p. 4). This they can do because the amount of labour time and land use for these crops is quite small (p. 6).

Apart from the loss of common property rights in gathered products [Jodha, 1983], the consumption of cultivated secondary crops appears to be under threat and/or in decline for four main reasons. The first is income growth. Many secondary crops are inferior commodities and with income growth they are replaced in consumption by others - and thus attract even less research attention, causing renewed decline. This does not matter if

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4 Thus, cyanogenic glucosides are found in some roots and tubers and in some leaves of these crops, and in some legumes. Legumes also often contain trypsin inhibitors (these inhibit the digestibility of legumes by enzymes in the stomach). Oxalates are contained in many green leafy vegetables and these reduce calcium availability. Phenols are present in some legumes which react with plant protein making it partially unavailable. Red quinua seeds have bitter-tasting saponins which are in the seed's outer layer.

everybody's income is growing; otherwise, those left out find that, as their income stagnates or declines, so "their" crops become scarce, costly, or left behind technically.

Second, technological progress is anyway faster in some crops than in others. Major crops world-wide (or nation-wide) attract proportionately more attention for publicly financed research, and probably enjoy economies of scale (and positive externalities) in all research, as compared to localized or secondary crops. Poor rural people's crops command less political interest than urban, or better-off, people's staples. Therefore, we see cereals replacing legumes, and some major cereals such as maize replacing the minor cereals such as the fonios in West Africa. Also, processed and canned foods are in many areas, particularly in the towns, replacing traditional food crops of many types.

Third, there are changing tastes due to imports and food aid - almost by definition comprising the world's major food staples and easily-processed crops (such as wheat, maize, and to a lesser extent rice), not secondary or localised crops. Fourth - under pressure of drought, population growth, and costlier fossil fuels - secondary food crops (and the soils that grow them) are used more and more for fuel, housing, etc. rather than for energy intake.

Offsetting these factors, income-per-head setbacks in some African countries - plus the proven susceptibility of some "major" crops to drought - has turned the attention of both farmers and policymakers to "inferior" minor crops. However, the removal of the disadvantages which we have mentioned, and of the fact that with little past research attention their yields may be neither high nor rapidly improvable, cannot be afforded so readily.

II SECONDARY CROPS AND SEASONAL FOOD AVAILABILITY

We have argued that, in secondary (but not main staple) cropping, farmers can more readily prioritize issues other than that of access to adequate dietary energy. Thus secondary crops play a role, much more than proportionate to their share in food outputs, in farmers' food cropping strategies to reduce fluctuations in food supply. In this regard, they are essential components in many mixed-farming systems. The secondary mixed crop may thrive even when the main crop fails, or in its off-season.

Thus secondary crops may be inter-cropped with staples, either on farms or in small cultivated gardens close to the compound. It is possible to find vegetables in both inter-cropped situations, but more usually in the small garden plots adjacent to the house or main farm, because of their great responsiveness to nearby (low

travel-cost) labour and to household water and wastes. To a lesser extent, the same could be said for roots and tubers. However, it is more likely that legumes will be inter-cropped on the farm, as the farmers are well aware of their nitrogen fixation capability.

If secondary crops are inter-cropped on the farm then farmers can adjust the amount of time and effort they put into them depending on how the rains progress - just as they can vary the amount of time they put into the farm as a whole, depending on how their off-farm income opportunities progress. This is sequential decision-taking - better than fixed planning, as encapsulated in the title of the classic paper on 'risk and the unprofitability of compounding probabilities' [Hart, 1939].

The seasonal role of secondary crops is seen most clearly where seasonality is most marked as in, for example, the parts of West Africa where rainfall is unimodal. The role of secondary crops will vary by seasonal type between the unimodal areas of West Africa, Southern Africa and India, the bimodal areas of East Africa and the "trimodal" seasonality of Bangladesh. In unimodal West Africa the role of secondary crops is as follows:
a) to absorb slack-season labour, or to be relatively costless of labour;
b) to provide hungry-time calories, by being available for consumption before the fixed harvest of the main staple; and
c) to diversify diets and make them more palatable.
These are important for poor people who have some land, and who have few or low returns from off-farm income-earning work, to provide them with cash in the pre-harvest period.

One example of these various duties of secondary crops is shown in The Gambia by the fonios (millets) such as findi (Digiteria exalis) which are used, both as a mixed crop and (in small plots immediately adjacent to the compound) as a pure stand, to provide food before both maize and early main millet harvest. Findi has low labour requirements (especially when mixed with main cereal at the time of cereal planting), as normally goes with a quick-maturing crop, being harvested in sixty days. This low workload is important in view of the labour peaks of women caused by rice transplanting in the mid-rains in The Gambia. In one village in The Gambia, findi covered 11% of cultivated area but "cost" only 1.3% of total human energy input in subsistence farming. The ratio of energy gained to energy expended was 16.8. Late millet, on the other hand, covered a similar area but the percentage of total human energy input was 7.2% with a ratio gain of 8.1 (Haswell, 1981). Of course, the total food yield per hectare of findi is only about one-third that of millet, but the availability of small amounts of food energy at low labour-cost is an essential part of farmers' cropping strategies to provide food earlier in the season. Similarly, by early planting and manuring with compound waste, together with watering with surplus compound

water on garden plots adjacent to the compound, farmers cultivate early-maturing varieties of cereal; these, harvested green, provide food earlier in the season than the main crops; this is more labour-intensive, but the work is often combined with social activities.

Some legumes also fill seasonal gaps. The most well-known is Bambara groundnuts (Voandzeia subterranea). These short-maturing legumes can be intercropped with a cereal and harvested with ease during its second weeding, therefore saving travel time for labour that does both weeding and harvesting. The beans of the African locust bean (Parkia bigliobosa), a tree legume, mature in the dry season of February-March and if there is a drought, the deeper rooting system of the tree still permits it to provide a crop (Campbell Platt, 1980). These beans form the basis of the traditional food, dawa dawa, and small quantities supplement soups with protein and fat.

Roots and tubers are counter-seasonal simply because their harvests are not fixed. A crop such as cassava can be harvested at any period from 4 months to 2½ years (although cassava is not secondary but a staple in many parts of Africa). The introduction of Xanthosoma taro in Papua New Guinea has smoothed out many of the seasonal variations in consumption (Spencer and Heywood, 1983). Also, the sweet potato (Ipomoea Batatas) can also be harvested flexibly and can rank higher than cereal crops in terms of calories produced per acre (Bouwkamp, 1984)

Green leafy vegetables (GLV) do not contribute greatly to energy intake, but are a major source of vitamins A and C (See Tables 3 and 4). They mature in about 40 days. Some are planted by farmers in vegetable gardens; others are collected in the bush. Most can survive periods of drought; yields are much reduced, but proportionately less than for most "major" cereals and even tubers.[5] Because seed production is very sparse for these crops, few people cultivate them; most are collected from the bush. However, in Mexico, GLVs are cultivated in depressions in areas of a high water-table enabling greens to be available throughout the year (Messer, 1972). Where leafy green vegetables are growing wild without the need to plant and weed, the energy costs of production are therefore low, especially if gathered on journeys out to cultivated fields. However, in such cases, land has to be in surplus with few scavenging animals to deplete the stocks.

5 Common GLVs in Africa are species of Bidens, Corchorus, Oxalis, Solanum, Portulaca, Colocasia, and Sonchus. (e.g. in Swaziland: Antonsson-Ogle, 1984; in Tanzania, Fleuret, 1979).

Another 'type' of green leafy vegetables are leaves of staples such as cassava and maize which are a byproduct of cultivation. Like gathered plants, they make few demands on scarce land or labour.

The seasonal role of GLVs is most often as a relish to enliven monotonous diets. Their contribution of nutrient seasonality is more significant for vitamin A than for any other nutrient, because even a short period of vitamin A ingestion can be adequate for much longer, owing to the body's capacity to store this nutrient.(There is an important piece of research needing to be done on the interaction between plants, built stores, and the human body in respect of (a) efficiency, (b) desirability, (c) cost of storing important nutrients interseasonally.)

Fruits, too,have a marked seasonality. Mango, papaya and citrus fruits become available, often supplying - unlike GLVs - calories when most needed, for periods of about six weeks. At this time they are consumed in enormous quantities. As the human body has a limited capacity to build up stores of Vitamin C, this seasonal flow is important in smoothing out seasonality of supply.

Although the literature is extensive on the role of secondary crops as seasonal and famine foods, quantitative estimates of their contribution to the diet, in particular on a seasonal basis, are few. If we also wish to break down the analysis: are secondary crops more important for the poor before the main harvest compared to after, and compared to the rich? - then the number of sources is very few. Secondary crops suffer from secondary statistics, with gathered foods in particular being under-recorded, e.g. in Sierra Leone, for a wide variety of vegetables and fruits, "green leaves are important nutritionally but may be under-represented in most quantitative data" (Smith et al., p.31).

What is the evidence to assess the importance of secondary crops as seasonal foods generally? In Senegal among pastoralists energy intake marginally met requirements throughout the cool season (January to March) but intake was inadequate in the wet season (Benefice, Chevassu-Agnes and Barral, 1984). Cereals and milk supplied 73-78% of energy intake. However, in the wet season (August-September) when low cereal intake and high work requirements caused greatest energy deficit, consumption of vegetables and leaves of Cassia tora improved the supply of vitamin C. The highest level of legume intake was in the cold season of January-February. The proportion of calories met by legumes, vegetables and fruit was highest in the hungry season but the absolute amounts and proportions are very small.

In Anambra State in Nigeria where the wet season extends from April to November no difference in energy intake was observed in the two seasons but in the wet season protein, calcium and vitamin C intakes were lower and fat and vitamin A intakes were higher (Nnanjelugo et al., 1985). The main food staples were maize, yam, cassava and cocoyam with various legumes. Reduced consumption of tubers and cereals in the wet season was compensated for by increased intake of legumes, contributing 16% of energy intake in the wet season compared to 10% in the dry season.

In Northern Nigeria secondary crops (seeds, nuts and legumes, vegetables and fruits) contributed 5.7% to energy intake year-round in nutrition surveys in Zaria (Simmons, 1976) and 7.4% in Malumfashi (Longhurst, 1984). These crops provided 11.2% and 12.1% of protein intakes respectively. A recalculation of Simmons' data for three northern Nigerian villages enables a breakdown by bimonthly groups (Longhurst, 1985). This shows that the contribution of secondary crops to energy intake is at its highest in the (cereal) pre-harvest period of August-September (8.6%) compared to the post-harvest periods of October-November (4.7%) and December-January (6.6%), (See Table 6). However, the sample sizes are too small to break them down further in terms of rich and poor. Also, Simmons's survey was one of the very few where it has been shown that average energy intake rose during the period of weeding and high energy expenditure (to 2456 Kcal per capita) in the middle of the rainy season and was lowest in the post-harvest season (195[illegible] Kcal per capita). Therefore, it is difficult to say for which people any given period was a hungry season.

In The Gambia, more vegetables and fruits were consumed in the wet season (which has in this case been shown to be the hungry season), but the absolute amounts were very small (Phillips, Coles and Seaman, 1982). On average, rice, sorghum, millet, and groundnuts fulfilled over 80% of energy requirements. In the survey villages the major cash crop, groundnuts, together with cassava were important snack foods and may provide more opportunities for farmers to reduce risk in their seasonal cropping strategies, by reducing the need for comprehensive mixed-cropping with large numbers of different varieties. In general, one would expect that less seasonal and/or more robust staples would be less likely to be associated with secondary mixed crops; but this often does not work e.g. with cassava and millets, which are more often intercropped than maize (which is both more seasonally peaked and less robust).

One study has shown the relationship between seasonality and secondary (gathered and cultivated) crops, in central India (Pingle, 1975). A dietary survey was conducted on two tribal groups, the Koyas and Maria Gonds, to assess the importance of seasonal contribution of cultivated and wild foods to their dietary intake. The staple grains such as millets contributed a major

proportion of energy, protein and thiamine to the dietary intake of both tribes in the post- as well as pre-harvest seasons. Other cultivated foods like legumes, pulses and vegetables form an important source of minerals and vitamins in the post-harvest season rather than pre-harvest.

The wild foods, however, contributed a major proportion of nutrients in the pre-harvest season for both tribes with the seasonal trend more marked in the Maria Gonds (the poorer of the two groups). Gathered foods contributed 72% of energy intake and 24% of protein intake before the cereal harvest (September), compared with 2% and 4%, respectively, post-harvest (January-March) (Table 7). The richer Koya community relied on wild foods for 10% of energy and 11% of protein intake pre-harvest and for zero in both cases post-harvest. The Maria Gonds derived not only more energy and protein from wild foods but also minerals and vitamins, such as calcium, iron, B-carotene, Vitamin C and Riboflavin. This suggests that secondary gathered crops are important for the poor.

In Swaziland there are greater contrasts in nutrition between regions than between seasons with the semi arid Lowveld suited only to drought resistant crops such as sorghum and the Highveld region having ample rain and well suited to maize. In the Lowveld, fruits and vegetables are of great importance, especially gathered foods (see Table 8). Seasonal effects of calorie intake are only seen in the Highveld.

In Kenya, data from the National Nutrition Survey of 1965-66 generally supports the hypothesis that there are fewer seasonal variations in bimodal compared to unimodal situations although intake in one sublocation (Gitugi - see Table 9) was very low one month after the maize harvest. (Longhurst and Payne, 1979) In the unimodal location of West Koguta (Table 10) intakes at pre- and post-harvest periods are generally lower than at the bimodal sites (Table 11). Legumes are a staple in some locations and consumption is high during their harvesting period. However, there is no seasonal impact of fruit and vegetables.

III CURRENT STATE OF AGRICULTURAL RESEARCH ON SECONDARY CROPS

A comparison of the allocation of research funds to different crops at international and national level reveals a number of surprises. Generally, secondary crops such as those discussed here, i.e. minor roots and tubers, pulses, fruits and vegetables, receive more funds than their role in the diet appears to warrant (See Table 12). For example pulses contribute 3.7% to energy intake but receive 15% of funding. Although vegetables receive no funds in the CGIAR (Consultative Group on International Agricultural Research) system they are catered for in the AVRDC

(Asian Vegetable Research and Development Centre) in Taiwan. Rice and wheat appear to be underfunded, cereals contributing 60% to energy intake but receiving only 49% of international research funding.

However, at national level in sub-Saharan Africa the situation is completely different. In this case the congruence ratio (i.e. the ratio of research expenditure for a commodity to its economic value in the crop mix: Judd, Boyce and Evenson, 1983; Lipton, 1985), is 0.09 for cassava and 0.19 for sweet potatoes. Similar ratios are found for these two crops when data are aggregated for all developing countries. At national level in Africa rice and wheat are, respectively, adequately and "over"-researched with congruence ratios of 1.05 and 1.30 respectively; the ratio for soy beans is 23.6! Given their importance in the diet, cassava and sweet potatoes and almost certainly millet and sorghum therefore receive much less national funding than their importance deserves, even given the prospects for progress in the various crops.

But should the congruence of research outlay distribution to area or output determine levels of resource allocation in research to secondary crops? These are essentially "helper" crops, which in mixes or rotations carry out valuable functions such as fixing or restoring nitrogen, or binding soil, and which therefore help to raise yields for major crops and staples. Also, even if secondary crops "on average" contribute little to energy consumption, they help reduce the variability of energy intake by providing valuable calories in years (and perhaps seasons) when the staples fail. For both reasons - respectively in effect positive cross-elasticity from small to large outputs, and high marginal utility of secondary crops by user and time - the "over-congruent" CG investment in such crops may well be justified. Also it compensates for the "below-congruent" national investment levels - themselves "justified" by (a) perceived low returns (for one country) to investing in a crop grown in marginal areas and hence perhaps adapted to produce low and stable yields in less fertile soils, (b) low political returns to crops needed irregularly, in remote places, and/or by poor people.

IV RESEARCH REQUIREMENTS

The assessment of research requirements for secondary crops can be carried out within a cost-benefit framework, either by lowering cost or raising benefit, but the resulting ratio is affected by delay and risk (Lipton, 1985) at three stages between initiation of research and successful implementation on the farm: between initiation and completion of research, between output and adoption by farmer, and between adoption and attainment of higher ratios of farm output to farm input values. There are trade-offs between different sorts of cost, delays and uncertainty; between

the three stages; between quick and certain results; and between speed and certainty and cheapness. An important implication for research design relevant to secondary crops is whether research should be concentrated on raising output in safer areas, on raising output of safer crops in risky areas, or on reducing risk to a given crop and area. Many secondary crops are grown in marginal, especially semi-arid, locations and are also used as insurance mechanisms. If major crops were made safer, the importance of secondary crops would diminish.

Can we find some helpfully general formulation of the problem, 'Should research directors put a greater share of resources into secondary crops, especially for nutritional reasons?'? The amount of crop-specific research expenditure that should be devoted to a particular crop (or region, given the crop) depends on the product (in a Markov sequence) of three expected values or probabilities: that of success; that of adopting area, given success; and that of value added per area of adopting unit. To each of these factors, weights should be added to allow for delay, and perhaps for riskiness of research costs incurred. Each of the underlined factors may, of course, be interpreted discretely or continuously; and interactions between them, and between research (i.e. expected values, and costs) specific to different crops should be allowed for. Our nutritional emphasis indicates, moreover, that "adopting area" or "value added" should be so weighted as to favour crops providing sale of employment income for, or directly grown for self-consumption, (a) in hungry seasons, (b) by poor people, especially nutritionally-vulnerable groups (children aged 0-2 mainly).

For some research decisions, information is available to do these sums quite formally, i.e. to estimate the probabilities and delays for each crop. However, in all cases, implicit weightings are made by research station directors in determining what crops, areas, etc. to emphasise, and the sums are thus done implicitly. We can, then, re-word our earlier question: are there any general characteristics of secondary crops, relative to major crops, affecting these three factors (probabilities, delays, etc.)? And, in particular, given our nutritional priority, do secondary crops deserve higher or lower "hungry season" or "poverty group" weightings, upon their expected values of adopting area, and/or of value-added, than major crops do?

What of the first factor, probability of research "success", for secondary crops? At the first stage, initiation of research, the store of knowledge is usually less than for major crops. Fixed costs will be high to acquire this knowledge, for each wide variety of crops; and such costs, by definition, are spread over a smaller cultivated area for secondary crops.

At the second stage, adopting areas, therefore, are likely to be lower. If secondary crops are risk-averting, farmers may be slow to try something new. That is especially the case in the rather common circumstance that a secondary crop is adapted to several different mixes and (difficult) environments; widely usable research outcomes across environments, like Mexipak wheats and IR-8 or IR-20, are thus less likely, though the progress with hybrid kharif sorghums and finger millets in India is an important exception.

At the third stage, the proportion of area devoted to a secondary crop - plus likely expansion into it, induced by the innovation - is relatively low. Hence, aggregate farm output is less significantly increased even by 100% adoption.

Overall, the dispersion of environments, in which a given secondary crop is cultivated, is commonly greater (more heterogeneous) than for most major crops, though not cassava. Also, environments for secondary crops are more commonly hostile (e.g. semi-arid, swampy or otherwise marginal soils) than for major crops. Therefore, probabilities of success and benefits may be small at all three stages. However, these factors - which clearly loom large with directors of research, and with allocations of cash to and among them - are offset by seasonal, and to some extent by poverty, considerations. On seasonality of supply, secondary crops grown for consumption must, by logical necessity, stabilise (or at worst, if harvested at exactly the same time, not destabilise) the seasonal distribution of food supplies, as compared with what it would be if only a single-season main crop were harvested. This logical necessity disappears, of course, where the main crop is continuously harvested (cassava) or multiple-cropped, but even in such cases the secondary crop is often selected by farmers for its seasonally corrective impact (on self-consumption or on income from sales). Secondary crops are thus seasonally corrective at best, neutral at worst. Thus the existence of storage costs, and of imperfections in capital markets, indicates that more research resources should be devoted to secondary crops than is suggested by the probably unfavourable values of the three critical factors (p.14) without allowing for seasonality.

In terms of assessing their impact on poverty, secondary crops can be divided into three groups: those for which the income elasticity of demand in a given location at a given time, is 1 or more (luxury crops), between 0 and 1, and negative (inferior crops). The first group includes exotic vegetables and fruits, such as asparagus and strawberries: no upgrading of research outlays, over and above what the "three factors" indicate, is required in such a case on poverty grounds, as such "extra" research would not help the poor, except to the extent that poor farmers grew the crop for income (and it was in price-inelastic demand).

The third group, "inferior foods", comprises exactly the sort of crop for which research outlays enjoy little political backing, even given the values of the "three factors". Moreover, there is an obvious case for upgrading the value-added and acreage factors on poverty grounds. However, some of these "crops" are - more or less - gathered foods, used as major food sources only when cultivated crops fail; the normal approaches of agricultural research imply cultivation, not gathering. In view of the large variety of gathered crops and their ecosystems, we doubt whether "research into gathering" is in most cases a sensible goal for agricultural (as opposed to socio-economic) applied science. However, many "inferior foods" that are also secondary in a given locality - cocoyams and taro in much of West Africa; intercrops such as hulga and matki beansprouts in the millet areas of Western India; cassava in Kerala, Sri Lanka, and parts of Thailand; almost all non-rice, non-wheat cereals in Bangladesh - millets and sorghums, where farmers choose between growing these and growing low-yield but high-value local rice varieties - are cultivated, not gathered. In such cases, the concentration of likely research benefits on poor and underfed growers of such secondary crops (and consumers) justifies higher proportions of research outlay than the "three factors" alone would indicate. Where inferior foods are gathered, however, despite their relatively greater importance for the poor, it may be more cost effective nutritionally to develop marketing systems for major crops.

Many secondary food crops are in neither of these two "ideal types" (luxuries like strawberries, inferior goods like cocoyams); income elasticity of demand lies between 0 and 1. This is true for some "seasonal staples" like fonio millets in West Africa. It is often, but of course not automatically, sensible to upweight research into these secondary crops on poverty grounds.

Poverty and seasonality form reasons separately for "upweighting" research outlays on a particular crop, as compared to what the three factors indicate. We have agreed (a) that seasonality normally favours such upgrading on nutritional grounds, as a matter of logic, supported also by most of the evidence; (b) that poverty favours some secondary crops in this way (the "cocoyam" ideal type) but disfavours others (the "strawberry"). But do (a) and (b) interact, to strengthen or to weaken the case for "more research" into some secondary crops? In other words, are such crops more counterseasonal for poor than for non-poor farmers? We hope to obtain some information from unpublished Indian NSS materials here.

A prior question to ask, however, is to revert to the first factor - and to ask whether, if it is unfavourable, agricultural research into secondary crops is necessary. Perhaps these crops are secondary not because they are under-researched, but because they are unresearchable. Are the crops too varied in respect of

growing conditions - or restricted to bad conditions? Or are they low-yielding mainly because grown by poor people, who command little research (or inputs) because they have little power and political constituency? If the former, is something else required, instead of improved varieties or practices for secondary crops - e.g. better extension (quite possibly T. and V. is increasing the concentration on major crops), marketing infrastructure or processing techniques?

Also, breeding and development with "more calories" as a sole objective may not - at least for a fast-growing, middle-income, or relatively equal society - in the long run be a sufficient research rationale. How much should availability of food from secondary crops be increased? Many consumers, as soon as they are able, would like to consume higher-status, if not necessarily more nutritious, crops. As an example, Zimbabwe now finds itself with large surpluses of millet and maize on its hands after promoting the former crop in drought years and now having a good rainfall year for maize which the population prefers.

For some inferior crops, roots and tubers in particular, non (human) food uses such as livestock feed must be incorporated into their development. Therefore, benefits from increased yields to both producers and consumers may not come from plant breeding unless the infrastructure of marketing, transportation, processing and storage is set up. It should be asked if the costs of this infrastructure justify the benefits.

It may be possible to justify the development of secondary crops for efficiency as well as equity reasons. They are poor peoples' crops which by their development can reduce food imports and improving rural employment and incomes.

Finally, it should be asked if staples could be adapted to do what secondary crops do, rather than make the latter higher-yielding or more versatile. The fixed costs of starting up research on some secondary crops may be very high, given the lack of knowledge on their ecology and physiology. The unit cost of research progress in secondary crops may be very high in view of their heterogeneity - or in view of each crop's low-quality, or heterogeneous, environments. An agriculture which becomes more input and market-linked, research-based and externally oriented may lead to a weeding out of many inferior secondary crops and encouragement of superior ones. On the other hand, as research and agricultural populations "use up" homogenous environments the decline of secondary crops may be reversed. But this will have a high cost. There is also some reluctance by professional researchers to work on root crops, which have low prestige (Bouwkamp, 1984).

Would it be more cost-effective to spend research resources on "giving" maize the desirable seasonal characteristics of the fonio millets, i.e. greater stability of yield in response to rainfall variations, than on making the latter more like hybrid maize, i.e. tripling their yields? Or is the second "option" a non-starter in view of consumer preference for maize? Would improved processing techniques, for these minor cereals and legumes, benefit their poor consumers more (especially in slack seasons) than similar outlays on yield-increasing research? (Or would success in one area be likelier to induce results in the other?)

These questions have to be evaluated in the context of an analytical frame such as that suggested at the beginning of this section. This means asking how many people are (and will remain) dependent solely on legumes and fonio millets in the seasonal period so that research on maize would only divert research and benefits from them, and how close we are to increasing fonio yields compared to stabilising those of maize.

Similar questions could be asked of research programmes to increase the availability of seasonally important tree foods, or to increase yields of secondary grains and legumes without increasing seasonal labour demands. Certainly there has to be a greater understanding of the way in which farmers grow secondary crops, usually within mixtures, together with a careful assessment of what is needed. It may be more important to ensure that they are adequately recognised and protected within farmers' seasonal strategies, rather than to initiate a crash programme of yield improvement. The main "poor people's crops" - cassava, yam, sorghum, millet, maize, upland rice, rainfed wheat - are still the main priorities. But, at present, international research may not be doing enough to redress the (understandable) biases of national system against the remote, the minor, the "inferior", and the seasonal.

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TABLE 1 Source of Calories by Commodity Group (1977)

% of Calories from:	All Developing Countries	Developing Market Economies			
		Africa	Latin America	Near East	Far East
Vegetable Products	90.9	93.4	82.6	90.5	94.3
Animal Products	9.2	6.6	17.4	9.5	5.6
Cereals	60.6	47.4	39.4	61.5	67.2
Wheat	16.2	10.4	14.8	40.1	14.6
Rice	28.6	5.8	9.5	7.2	40.2
Maize	7.7	13.6	14.4	6.3	4.4
Millet & Sorghum	6.1	13.8	0.3	5.8	6.9
Roots and Tubers	7.2	20.0	6.2	1.7	3.2
Sugars and Honey	6.9	4.5	17.2	9.5	8.3
Pulses	4.2	4.2	4.4	2.7	4.4
Nuts and Oilseeds	2.2	3.4	0.7	1.8	2.1
Vegetables	1.5	1.0	0.9	2.2	1.4
Fruit	2.1	4.3	4.8	4.0	1.7
Meat, Eggs, Fish, Milk	7.8	5.7	15.0	7.4	4.5
Oils and Fats	5.9	7.2	8.2	8.5	6.2
Miscellaneous	1.7	2.4	3.1	0.6	1.0
Grand Total (Kcal/day)	2260	2205	2557	2620	2029

Source: FAO Food Balance Sheets

TABLE 2 Source of Protein by Commodity Group (1977)

% of Calories from:	All Developing Countries	Developing Market Economies			
		Africa	Latin America	Near East	Far East
Vegetable Products	79.2	80.2	58.9	78.8	84.6
Animal Products	20.9	19.8	40.9	21.1	15.2
Cereals	55.5	50.5	38.0	62.3	63.4
Wheat	18.5	12.5	15.9	43.3	17.7
Rice	20.8	4.9	7.3	4.6	31.6
Maize	7.3	14.2	14.0	5.7	4.5
Millet and Sorghum	6.8	14.7	0.3	6.2	8.4
Roots and Tubers	3.1	7.6	3.2	1.4	1.2
Sugars and Honey	0.2	0	0.1	0	0.6
Pulses	10.5	11.1	10.8	6.4	10.7
Nuts and Oilseeds	4.7	5.3	1.1	2.0	3.3
Vegetables	3.3	2.2	1.7	4.1	3.5
Fruit	1.0	1.8	2.4	1.9	0.8
Meat, Eggs, Fish, Milk	20.8	19.6	40.9	21.1	15.4
Oils and Fats	0	0	0.1	0.1	0
Miscellaneous	1.0	1.6	1.7	1.0	1.0
Grand Total (gm./day)	57.3	55.0	65.5	73.5	48.7

Source: FAO Food Balance Sheets

TABLE 3 Sources of Vitamin A by Commodity Group (1977)

% of Vitamin A from:	All Developing Countries	Developing Market Economies			
		Africa	Latin America	Near East	Far East
Vegetable Products	81.2	86.0	52.7	63.6	86.5
Animal Products	18.7	14.0	47.3	36.4	13.5
Cereals	0.7	0.8	1.5	0.6	0.4
Roots and Tubers	14.0	4.1	3.5	0.3	4.3
Pulses	0.3	0.2	0.3	0.3	0.6
Vegetables	36.0	16.8	21.1	38.6	39.5
Fruit	8.7	7.2	17.8	10.4	13.7
Meat, Eggs, Fish, Milk	17.1	13.1	44.3	29.8	11.3
Oils and Fats	14.0	48.3	9.4	13.7	9.6
Grand Total (mmg) per day	609	951	596	684.	468

Doutvr: FAO Food Balance Sheets

TABLE 4: Sources of Ascorbic Acid (Vitamin C) by Commodity Group (1977)

% of Ascorbic Acid from:	All Developing Countries	Developing Market Economies			
		Africa	Latin America	Near East	Far East
Vegetables Products	98.7	98.8	98.0	97.7	98.2
Animal Products	1.3	1.2	2.0	2.3	[illegible]
Roots and Tubers	33.8	49.4	24.5	11.6	19.6
Vegetables	41.6	24.7	18.4	53.5	48.2
Fruit	19.5	19.8	52.0	29.1	23.2
Grand total (mg) per day	77	81	98	86	56

Source: FAO Food Balance Sheets

TABLE 5: Percentage of Calorie Intake Per Consumption Unit from Different Food Groups by Per Capita Monthly Expenditure Class: All India, Rural Areas. (National Sample Survey 26th Round, July 1971 - June 1972)

Per Capita monthly Expenditure Class (Rs)	Percentage of Calories from Food Group				
	A	B	C	D	E
1. 00-15	89.4	5.2	1.2	1.9	2.3
2. 15-21	88.2	5.1	1.7	2.5	2.5
3. 21-14	87.5	5.5	1.9	2.7	2.4
4. 24-28	85.6	6.1	2.8	2.8	2.7
5. 28-34	84.8	6.3	3.2	3.1	2.6
6. 34-43	82.6	6.6	4.2	3.4	3.1
7. 43-55	80.3	7.8	5.4	3.6	2.9
8. 55-75	76.4	9.2	6.7	3.9	3.7
9. 75-100	73.8	9.7	8.4	4.3	3.8
10. 100 +	66.0	9.9	11.3	5.1	7.5
All	82.4	7.3	4.6	3.5	2.2

Food Groups

A Cereals, cereal substitutes, potato, sugar and jaggery

B Pulses, nuts and seeds

C Milk and milk products, meat, eggs and fish

D Edible oils

E Fruit, vegetables, spices and prepared foods

TABLE 6: Sources of Calories (%) By Season In Three Zaria Villages Northern Nigeria, 1970-71.

FOOD GROUP	APRIL MAY	JUNE JULY	AUGUST SEPTEMBER	OCTOBER NOVEMBER	DECEMBER JANUARY	FEBRUARY MARCH
Cereals	77.4	67.8	67.4	75.5	65.2	63.4
Cereal Products	6.0	12.7	8.5	5.5	10.4	16.2
Starchy Roots	0.6	2.2	5.1	2.2	1.6	1.8
Milk	1.0	1.3	1.2	1.0	0.8	0.9
Meat	0.4	1.0	0.4	1.1	1.0	1.5
Poultry, Fish, Eggs	0	0	0	0.5	0	0.1
Seeds, Nuts, Legumes	2.9	4.7	6.0	2.7	5.0	3.5
Fats and Oils	9.1	7.5	7.6	8.1	12.6	9.9
Vegetables, Fresh	0.2	0.5	1.6	0.8	0.4	0.3
Vegetables, Dry	1.2	1.1	1.0	1.1	1.2	1.1
Fruits	0.4	0	0	0.1	0	0
Sugar, Sweets	0.2	0.4	0.2	0.4	0.7	0.5
Salt, Spices	0	0	0.1	0.1	0	0
Snacks, Misc	0.6	0.9	1.3	1.0	1.1	0.7
Total Calorie Intake (Kcal)	2457	2311	2456	2274	1951	2137

Source: Calculated from Simmons, E.B., 1976, Calorie and Protein Intakes in Three Villages of Zaria Province, May 1970-June 1971, Samaru Miscellaneous Paper 55 Ahmadu Bello University, Zaria pp11 and 129

TABLE 7

Seasonal Intake of Nutrients Contributed (%) by Various Cultivated and Wild Foods in Maria Gonds and Koyas

I) Maria Gonds

	Energy		Protein	
	PreH	PostH	PreH	PostH
Cultivated				
Cereals & millets	86.3	89.6	75.6	76.2
Pulses	0	5.9	0	76.2
Legumes	0	0.5	0	1.7
Vegetables & GLV	0	1.1	0	1.5
Oils	0	0.2	-	-
Meat	1.7	0.8	0	0
Miscellaneous	0	0	0	0
Total	88.0	98.3	75.6	95.9
Wild				
Leafy vegetables	1.7	0	2.5	0
Tubers	4.8	0.2	6.6	0.1
Bamboo Shoots	3.8	0.1	14.1	0.6
Mahma Flowers	1.6	0	0.8	0
Fish	0	0	0.4	0
Miscellaneous	0	1.4	0	3.4
Total	12.0	1.7	24.4	4.1

II Koyas

	Energy		Protein	
	PreH	PostH	PreH	PostH
Cultivated				
Cereals & millets	84.2	81.8	79.4	68.4
Pulses	4.3	9.1	9.4	18.8
Legumes	0	5.1	0	12.4
Vegetables & GLV	0.2	0.6	0	0.4
Oils	1.3	3.4	-	-
Meat	0	0	0	0
Miscellaneous	0	0	0	0
Wild				
Leafy vegetables	0.3	0	0.9	0
Tubers	8.8	0	4.4	0
Bamboo Shoots	0	0	0	0
Fish	0.9	0	5.9	0
Miscellaneous	0	0	0	0
Total	10.0	0	11.2	0

Source: Adapted from Pingle (1975) p.199.

PreH = Pre Harvest

PostH = Post Harvest

TABLE 8: Amounts of Food Eaten by Region and Season, Swaziland, 1961.

Survey:	Highveld		Middleveld		Lowveld		Total Sample
Time of Year	End of Rains	End of Dry	Mid Dry	Begin Rains	Mid. Dry	Mid. Rains	
	May	Sept	June	Oct	Aug	Jan	
Sample Size (persons)	195	181	372	384	152	143	1427
Calorie Intake (Kcal)	2128	1898	1791	1796	1251	1245	1672
% Calorie Requirement	93	85	78	79	55	54	74
Protein Intake (gm.)	64	61	60	53	41	39	54
% Protein Requirement	108	103	102	90	69	66	93
Quantities of Food Consumed (gm/cap/day)							(%)*
Cereals	262	310	407	332	196	313	339 (75.
Starch	30	2	59	13	0	6	26 (1.8)
Sugars	5	2	6	1	0	1	4 (1.2)
Legumes and Nuts	32	18	75	15	3	34	32 (9.4)
Vegetables	30	67	34	61	459	129	164 (6.2)
Fruits	0	0	1	2	28	19	5 (0.2)
Meats	12	29	23	22	9	4	24 (3.4)
Milk	20	14	65	63	170	73	65 (1.9)
Fats and Oils	1	1	0	0	0	0	0 (0.3)
Miscellaneous	35	16	60	44	48	17	40 (0.6)

* % of source by calories

Source: Derived from Jones pp. 126-152.

TABLE 9: Seasonality of Nutrient Intake, Gitugi Sublocation, Fort Hall District, Kenya, 1965-66.

	July	September	January
Number of Eating Units	23	19	21
Energy Intake/cap. (Kcal)*	2370 (109%)	1702 (76%)	1728 (80%)
Protein Intake/cap. (gm)*	108.5 (166%)	66 (109%)	78 (125%)
Vitamin A Intake/cap. (I.U.)*	na (10%)	na (5%)	na (13%)
Source of Calories: %			
Cereals	38	58	31
Legumes	44	26	46
Roots and Tubers	11	2	13
Fruit and Vegetables	4	5	7
Animal Products	1	5	2
Others	2	4	2

* % of requirements in brackets

na: not available

July: During bean harvest, before maize harvest

September: One month after main maize harvest

January: During second bean harvest

Source: Derived from Bohdal, Gibbs and Simmons, pp. 40-49.

TABLE: 10 Seasonality of Nutrient Intake: West Koguta Sublocation, Central Nyanza District, Kenya, 1965-66. (one harvest per year)

	August	February
Energy Intake/cap. (Kcal)*	1671 (60%)	1487 (72%)
Protein Intake/cap. (gm)*	55 (88%)	52 (87%)
Vitamin A Intake/cap. (I.U.)*	596 (15%)	704 (19%)
Source of Calories (%)		
Cereals	70	65
Legumes	6	4
Roots and Tubers	12	19
Fruit and Vegetables	1	1
Animal Products	7	8
Sugar and Fats	4	2

* % of requirements in brackets

August: One month after the maize harvest

February: Seven months after harvest

Source: Derived from Bohdal, Gibbs and Simmons, pp. 54-61.

TABLE 11: Seasonality of Nutrient Intake: Masumbi Sublocation, Central Nyanza District, Kenya, 1965-66. (Two harvests per year)

	October	February
No. Eating Units	24	22
Energy Intake/cap. (Kcal)*	2498 (115%)	2471 (118%)
Protein Intake/cap. (gm)*	73 (117%)	86 (138%)
Vitamin A Intake/cap. (I.U.)*	1305 (30%)	1212 (29%)
Source of Calories (%)		
Cereals	54	77
Legumes	5	7
Roots and Tubers	30	8
Fruit and Vegetables	2	1
Animal Products	6	5
Fat	3	1

* % of requirements in brackets.

October: 2-3 months after first harvest

February: Immediately after short rains harvets

Source: Derived from Bohdal, Gibbs and Simmons, pp. 62-69.

TABLE 12: Food Sources in Developing Countries (1980) and the Approximate Annual Allocation of CGIAR Centres Expenditures (1983) by Commodity. CGIAR Funding Level (%)

Commodity	Energy Kcal/day	Energy %	CGIAR Funding Level (%)
Cereals	1412	60.1	49
Roots and Tubers	213	9.1	12
Pulses	87	3.7	15
Livestock and Products	146	6.2	23
Vegetables	35	1.5	0
Oilseeds	68	2.9	0
Sugars and honey	150	6.4	0
Fish and Seafood	15	0.6	0
Alcoholic beverages	30	1.3	0
Other foods*	193	8.2	0
TOTAL	2349		

* Fruit, nuts, animal oils and fats, stimulants and spices

Sourec: FAO, 1984, TAC, 1985 and CGIAR 1985