FOOD Insecurity and Stochastic Aspects of Poverty

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I. Introduction

Recent literature on the economics of poverty and hunger has advanced the level of policy dialogue regarding the role of government in economic development (e.g. Dreze and Sen, 1989, 1990; Ravallion, 1987, 1992). One of the conclusions to emerge from these studies is that poverty alleviation strategy should move beyond the promotion of income growth even as modified by the conventional tools of income redistribution.

The general trend in global food production relative to population has been favorable throughout most of this century. In spite of occasionally significant variations in production, the cushioning effects of foodgrain carryovers and the demand adjustments in response to the occasionally very high prices have meant that global food security — in the sense of supplies potentially available to serve world consumers' basic needs — has also been trending toward greater safety.

As dramatized by the recent events in Somalia, however, famines and undernutrition problems persist. Almost inevitably, as judged from several case studies of significant famines (i.e., major realizations of food insecurity), severe nutritional crises arise from various economic difficulties experienced by households (Sen, 1980, 1981; Otten, 1986; Shepherd, 1988; Bohle et al., 1991), often with origins in political conflict. Dreze and Sen (1989) categorize them into two general types. One is the problem of widespread, persistent deprivation. The other is the issue of fragility of individual security. Following the earlier work by Sen (1981), they note that these problems can be addressed, respectively, by the "protection" and "promotion" of "exchange entitlements". As protection of exchange entitlement is intrinsically a short-term problem, consideration must be given to stochastic aspects of poverty; promotion is a long-term issue, which has to be dealt with by stimulating general economic growth and prosperity.

Similarly, there is a tradeoff between investing in measures that will offset the short-term effects of fluctuating prices and incomes and measures that increase average food production and incomes (Timmer, 1980; Valdes, 1981; Clay et al., 1981). Investing in buffer stocks or other stabilization schemes — instead of agricultural research, infrastructure, and other ingredients of rural development — may possibly increase short-term food security at the expense of long-term solutions. In order to begin to evaluate how alternative policy instruments affect short-run vs. long-run security and how they influence various consumer groups, a framework is needed that relates household food security to its underlying components.

At the outset it must be observed that variations in environmental conditions are indeed an intrinsic feature of life — especially for those living close to the margin of survival in rural communities, where most famines occur. Any analysis that ignores the essentially stochastic structure of food insecurity is incomplete. Relatedly, policy analysts have to take particular care that policies considered do not intrude deleteriously into the planning that responsible individuals will naturally undertake to attempt to ensure their own food security.

As detailed in the following review of the literature, most works on food security have a macroeconomic orientation, whereas most discussions of famine are rather microeconomic. The intention here is to seek a more unified approach to the economic issues in food insecurity among low-income rural households.

II. Some Welfare Economics of Food Insecurity

The literature of the economics of food insecurity is diverse in several respects (e.g., Currey, Ali and Khomen, 1981), and ranges from international trade and liquidity issues at the national level (Sarris and Taylor, 1976; Konandreas, Huddleston and Ramangkura, 1978; Reutlinger, 1978; Sarris, 1980; Scobie, 1981; Chisholm and Tyers, 1982) to household survival issues at the local level (Jodha, 1978; Currey, 1976; Foster, 1978,1992; Sen, 1980). There have been some attempts to span these levels by variously linking micro- and macro-level models of the food economy (Scandizzo and Knudsen, 1980) with increasing recognition of the stochastic or random influences that are so crucial to understanding the nature of food insecurity problems (Adelman, Berck and Gordon, 1982).

While noting the importance of entitlements in the promotion and protection of social security, Dreze and Sen (1989) note that it is ultimately human capabilities that matter rather than entitlements *per se*. In the capabilities approach, income and employment strategies are complemented by particular attention to nutrition, health and education (see also Johnson and Clark, 1982). A distinction is made between *growth-mediated security* and *support-led security* (alternatively, *long-run* and *short-run security*; Roumasset, 1982). The former relies on growth to enchance capabilities; the latter does not (see Ravallion, 1992 for further discussion).

As Ravallion has noted, most recent discussions acknowledge the need for both approaches but differ in their emphasis. Champions of short-run or support-led security such as Dreze and Sen (1989) and UNDP (1990), tend to de-emphasize the trade-off between the two approaches whereas Ravallion (1992), World Bank (1990), and Roumasset (1982) underscore the cost of short-run food security in terms of possible long-run opportunities foregone. What is needed in order to evaluate the extent of the tradeoff are microeconomic-based models that allow various sources to be combined in the determination of the risk of food insecurity and that could facilitate analyses of the welfare costs of alternative strategies. Particularly in Africa, the pressure of rapid population growth on fragile resources seems to be mitigating against the positive Boserupian effects of population growth in other regions (Lele and Stone, 1989).

Whether the motivation is altruistic, humanitarian, or more selfish, the many food aid programs attest to society's aversion to starvation and other less terminal forms of nutritional deprivation. These concerns are heightened at times of natural and human-induced disasters, although translation of concern into effective action is evidently imperfect (Turner, 1976; Currey, 1981). Harberger (1984) conceptualized society's general worry about access to basic needs for those who "have not" as a consumption externality to those who "have". His conceptualized social demand function, which implicitly values such externalities, has been implemented by Scandizzo and Knudsen (1980) in the context of upholding minimal standards of food consumption for several national populations. Their social valuations were typically of the order of 120 percent of world foodgrain prices.

Perhaps, however, the valuation of basic needs in terms of disaster reflects additional social concerns. Consideration of the Rawlsian "original position" suggests that social justice calls for a higher priority for assisting the victims of misfortune than those who suffer from their own myopia or sloth. Accordingly, society may be more inclined to offset poverty resulting from stochastic events than that resulting from the lack of long-run entitlements.

Taxpayers' willingness to subsidize basic needs also depends on problems of the "moral hazard" type, some of which are described as leakage problems (e.g., Selowsky, 1979). In emergency situations such as famines, moral hazards presumably are reduced, and society's negative accounting of leakages and "free-riding" may figure less importantly in assessing its real social demand for food. Whatever the rationale, the key challenge for society is to match its implicit concerns and values with appropriate and timely actions to reach those of its members in need — that is, in the present context, those experiencing insecure food availability at affordable prices.

The issue of availability is deserving of closer attention. A good is "unavailable", barring theft or beneficence, if the asking price exceeds the bid price of the potential buyer. This is surely the case in a world in which, in principle, there is always enough food for all. Any unavailability of food to an individual reflects that person's unwillingness or inability to bid a sufficiently high price. The special feature of food (and to a lesser extent health care and shelter) is that continuance of the divergence in prices may lead to the expiry of the would-be buyer. Improverished people obviously have inherently low bid prices. They may seek assistance from the credit market, but here too they are likely to encounter asking prices in excess of their achievable bids, so that credit for survival is also unavailable (Moses and Pandian, 1983). Without intervention, the consequences of such divergences among asking and bid prices can clearly be disastrous.

Thus the welfare economics of food insecurity can be related primarily to effective prices facing the household at risk and to the household entitlements. Low entitlements can be the result of low permanent wealth, adverse stochastic events, or both. In contrast to the conventional welfare economics of redistribution, this paper focuses attention on the stochastic component of exchange entitlement relative to production shortfall. Understanding the interaction of the stochastic sources of income will facilitate evaluation of policies to alleviate the temporary inability of households to finance minimal food expenditures.

III. A Static Model of Household Food Insecurity

As a prelude to discussion of policy, an instructive general model of situations of food insecurity is sought. Given the complex context of particular food emergencies, the "cost" of this general model is its extreme simplicity. The "benefits", however, are tranparency, ease of specification, and workability.

Food insecurity can be related to a stochastic variable, Z, defined as:

$$Z = P_v \ (C - Q) - E, \tag{1}$$

where

P_v is the local price of the staple;

C is the household consumption "requirement" of the staple;

Q is the farm household production of the staple;

$C - Q$ is the "desired" purchases (if positive) or sales (if negative) of the staple;

E is exchange entitlement (resources available) for food; and

Z is an indication of whether it is possible ($Z < 0$) or not ($Z > 0$) for the household to purchase its desired level of consumption of the staple.

The risk of food insecurity (R) may now be defined as the probability (Pr) that the value of the production deficiency, $F = P_v (C - Q)$, is greater than the food exchange entitlement, E, where it is assumed that, at these levels of consumption, all of E is, if necessary, expended on food (cf. Selowsky, 1979). That is,

$$R = Pr(Z > 0). \tag{2}$$

In terms of the earlier discussion, this measure of risk is also the probability that the bid price of food, $P_{bid} = E/(C\text{-}Q)$, is less than the "asking price", P_v.

In the simplest static representation, then, the sources of food risk are the stochastic variables, Q, E, and P_v. Of these, production, Q, is the most straightforward, being a direct function of a number of stochastic inputs such as rainfall. Exchange entitlement, E, can be thought of as the sum of a fixed endowment and a random component. Thus, $E = E_o + Y$, where Y is the random component of income.

Dynamic considerations have been abstracted away in this model in order to simplify it to its key essentials. However, this is not to deny the importance of adaptive adjustments made in the face of emerging crises. Households will make a sequence of carefully thought-out decisions on trimmed consumption levels, asset liquidations, employment seeking or contracting, migration for various family members, and so on. Jodha (1975) has instructively documented such decisions for farm families in Western Rajastan. To represent such dynamic effects in this model would require minimally the specification of (a) an intertemporal utility function for the household, (b) foodgrain storage and related decision rules, (c) labor markets over time, space, and climatic regime, (d) markets for assets, emphasizing the wedge between buying and selling prices as influenced by climatic adjustments, and (e) the credit market and government interventions for disaster relief. In short, a large number of complex relationships and parameters would be required to attain a more realistic description of famine dynamics. Alamgir (1980) described an econometric model for Bangladesh that features several of such aspects.

The static determination of district or village price for the staple, P_v, is bounded by the buying price, P_b, and the selling price, P_a. Formally,

$$\begin{aligned} &P_b;\ C < C_b \\ &P_d;\ C_b \le C \le C_s \\ &P_s;\ C > C_s \end{aligned} \tag{3}$$

$$P_b = P_w + t_1, \tag{4}$$

where P_w is the national border price or the price in the internationally-linked market center and t_1 is the marketing cost to the district in which all households are assumed to be identical. The selling price is

$$P_s = P_w - t_2, \quad (5)$$

where t_2 is the marketing cost of selling the staple to the market center. The household demand function for the staple food is

$$P_d = D_v(C), \quad (6)$$

and the critical points, C_b, below which the household attempts to buy the staple and C_s, above which the household sells it are defined by

$$P_b = D_v(C_b); \text{ and } P_s = D_v(C_s) \quad (7)$$

Graphically, all this could be represented by a demand (prices as ordinate, quantities as abscissa) horizontal at P_b on the left, then downward sloping to another horizontal segment at P_s.

The consumption requirement, C, is regarded here as a known constant. In fact, it is anything but constant, varying widely between individuals and over time for individuals (Srinivasan 1981, 1982). The FAO-WHO-UNU (1985) report on protein and energy defines energy requirements as "the 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 allow the maintenance of economically necessary and socially desirable physical activity." Sukhatme and Margen (1982) suggest that consumption requirements might best be represented as a stationary autoregressive or moving average stochastic process, particularly for daily or weekly energy balances. Payne (1989) suggests that it is more appropriate to use a more dynamic view of the relationship, and one that recognizes the human subject as part of a system that includes the fluctuating demands of his or her annual work pattern. The temptation to embody such an assumption in the present model is resisted, mainly because the applicable interval of time is unstated but will implicitly be rather longer in perspective, and a year is taken in the next section. Over a long interval the assumption of constancy is, from the Central Limit Theorem, more defensible; although, in recognition of the randomness and homeostatic tendencies, a rather lower constant value should be chosen than the conservative FAO-WHO requirement of about 2.5 kCal/d.

IV. Stochastic Specification of the Model

Having now identified the major types of insecure food situation through noting the components of a general static model, further implementation depends in the first instance on adding detail on its probabilistic structure. Such specification is a necessary step to quantifying the food insecurity risks faced by communities of given economic and agricultural characteristics.

The major sources of random variation are, in terms of the symbolic variable names introduced above, P_w, and thus the more range-constrained P_v, and Q and Y. Of these, with a convenient "small country" assumption, P_w and Q can comfortably be regarded as statistically independent, especially contemporaneously and avoiding any effects of lagged supply response. However, it is likely that production, Q, and random non-staple income, Y, are strongly positively correlated. This would especially be the case for rural laborers whose employment and income will suffer with slumps in agricultural output. Urban workers probably enjoy relative statistical independence between incomes and domestic (and international) agricultural production.

Barring "mixed" specifications, there are two major sets of stochastic specifications to consider, namely, discrete vs. continuous distributions. With the general necessity of accounting for statistical dependence, this implies, for empirically tractable and workable specifications, the use of ad hoc discrete joint distributions and the presently exemplified multivariate normal (continuous) distribution, respectively. These thus devolve to a bivariate distribution for Q and Y and a marginal distribution for P_w under the intuitive argument of the previous paragraph.

A specification involving normal distributions is presented to correspond broadly with an illustrative case of a household subsisting on a small farm with about one hectare of arable land in, for example, the highlands of Ethiopia or Nepal. Take (annual) staple requirements for the household as $C = 1200$ kg of grain based on a simplification that it is wheat at the UN agency rating of 3.15 kCal/kg, and production, Q, to vary normally. Let entitlement consist of "nest-egg" savings of \$100 (E_o) and a random component Y (perhaps from any required liquidation of livestock). The world price of the staple is P_w. The normal (N) parameters (mean, standard deviation) for each of the random variables are: Q is $N(1500, 400)$, Y is $N(300, 100)$, P_w is $N(0.35, 0.05)$ and the correlation between Q and Y is $r = 0.8$. Market price P_v is truncated to be strictly positive and embodies the asymmetric transaction costs depending on the alignment of Q with C. The deterministic transaction costs are $t_1 = 0.1$ and $t_2 = 0.2$ (kg), reflecting the remoteness and undeveloped transport and marketing infrastructures.

Further simplification is immediately introduced in the process of price determination for the staple. It is assumed either because supply is very inelastic in the short run, or demand over the range C_b to C_s is very inelastic, that $C_b = C_s$, and accordingly price fluctuates between P_b and P_s depending on local production attainments. This simplification permits the focusing on a representative household situation without facing the challenge of appropriate aggregations to the district level.

Computation of R, even with such a simplified continuous specification, is not trivial and is best tackled through a Monte Carlo sampling (n = 1000) procedure. Such an approach was implemented and yielded the following summary statistics: $R = 0.024$ and $Pr\ (Q < C) = 0.220$, while the simple correlation between Q and P_v is -0.65.

In all, there are 11 parameters in this model and it is simple to re-run the Monte Carlo simulation with, say, +10 percent one-at-a-time changes, to explore the sensitivity of the risk index to changes in the parameters. Sensitivity is most informatively expressed as elasticities of R with respect to positive changes in the parameters, and these are ranked in descending order (elasticities in parenthesis). E [] denotes expected value and S [] standard deviation. The results for the elasticities are, from highest positive through largest negative: C (8.8); $S[Q]$, $E[P_w]$ (5.0); $S[Y]$ (3.3); r (2.5); $S[P_w]$ (1.7); t_1, t_2 (0.8); E_o (-0.8); $E[Y]$ (-2.9); $E[Q]$ (-3.8).

Thus, to reduce R with the greatest impact, reductions in the high positively elastic parameters, can be contemplated. Changes in some of the parameters, notably $E\ [P_w]$, r, and, unless it is reinterpreted as it is done below, C, are not very feasible policy targets. Income redistribution may help through changes in E_o and $E[Y]$. Note that R is more sensitive to changes in $E\ [Q]$ and $S\ [Q]$ than it is in most other parameters. Both of these, although E rather more easily than S, might be at the focus of crop improvement programs. Reduction of $S[Y]$ through income stabilization policies may also have a role to play. Evidently, it is necessary to consider any such changes in a real-world context of the effectiveness of policies concerned with food markets, income, research, and so on, and these issues are explored in the next section.

The skeleton of the preceding model provides some guidance as to where observers should look for problems of food insecurity. First, there is the ratio of expected subsistence production to expected requirements among small-scale farmers in basically agrarian societies ($E[Q]/C$). Until recent times, this ratio was close to unity in many parts of the world. The green revolution, expanded irrigation areas with better management, and other investments that embody new technologies have led to a significant improvement in many parts but not in all. The first place to look at is where these improvements have not been accomplished, and there are indeed many such technological and investment backwaters (World Bank, 1980). Almost tautologically, there are backward areas, remote from the center, at the tail end of irrigation systems, or — even more significantly — beyond any access to public irrigation facilities, often growing traditional crops such as sorghum that have not been significant beneficiaries of modern technological improvement (Currey, 1980; Lipton, 1983) though much of the population of these areas has benefitted indirectly from improvements in the real wage due to outmigration and increased food supply (Otsuka et al., 1990). The semi-arid parts of all the continents provide conditions such that, when exacerbated by the high population growth rates to be found in much of Africa, parts of South America, and South, West, Central, and East Asia, the search is narrowed considerably.

Second, related to this effect of mean or average productivity is the matter of variability of production ($S[Q]$ above). Yields are typically more variable under dryland than under irrigated cropping. Under dryland conditions, they mirror variation in environmental variables such as precipitation and severity of frosting (Anderson, 1979), and one suspects that yields and yield variability are therefore inversely correlated across locations. This suspicion is supported by the cross-country empirical equations of Anderson and Scandizzo (1984) featuring measures of variation in foodgrain production (see also Arthur, 1981).

Third, there are the linkages of regional to world markets (captured by t_1 above). These linkages are multifaceted and, in the context of food insecurity, relate not only to the flow of desired commercial imports of food, but also to information on needs and to the ease and timeliness of access to emergency food supplies. With the typically weak political position of people "invisible" in remote areas, it is not too surprising that, as Eberstadt (1982, p.43) has observed, children in rural areas grow more slowly, are shorter and lighter, and die earlier. In short, in spite of the dramatized extremes of urban poverty, much of the prevalent food insecurity is found in remote rural areas. Fourth, interrelated with but perhaps even more important than any of the above in identifiying food-insecure troublespots is the poverty of individuals at risk (E_o, $E[Y]$ above; see Sen's (1981) and Dreze and Sen's (1989) forceful marshalling of case-study evidence). Given the limitations of data on income distributions, there are many indicators of poverty that hint at likely problems of food insecurity — although, unfortunately, few take cognizance of the variablility that individuals face in their incomes ($S[Y]$ earlier). The indicators must be interpreted, however, against a background of governments' concerns in the matter. Witness the experience of Kerala, and Sri Lanka, and (in recent times) probably China in minimizing food access problems in spite of low income levels.

Fifth, several aspects of local infrastructure (captured by t_2 above) can be critical in moderating circumstances that would otherwise be insecure. The importance of the quality and reliability of connections to the outside have already been noted, but much can also be done locally. The foremost factor is the scope for and performance of local storage of food. Can what is grown or imported be kept safe from vertebrate and invertebrate acquisitors, as well as from flood, fire, and rain? Regrettably, the answer to this question tends to be negative in just those regions identified by other factors as likely to be at risk. The food difficulties of the disadvantaged poor thus tend to be compounded multiplicatively in their incidence.

Sixth, the effectiveness of the array of possible interventions in the name of food security is critical in determining who is at risk. In terms of the preceding notation, these range from (a) cheap food ($E[P_w]$ above), perhaps provided by international agencies (i.e., political friends or through international agencies), through (b) price stabilization ($S[P_w]$ above, directly through buffer stocks held, for example, in the OECD countries or indirectly through IMF emergency food finance facilities to cushion balance-of-payments problems, to (c) local food distribution programs, which are equivalent to reducing the market demands for requirements (C). The failings of these both broad and targeted programs have been many and are widely documented (e.g., Sinha, 1976; Spitz, 1976, 1981; Reutlinger, 1977; Hay, 1978; Stevens, 1979; Siamwalla and Valdes, 1980; Dreze and Sen, 1989).

Constitutional Issues and Trickle-up Economics

Among all the sources of food insecurity analyzed above, two particular generic categories should be singled out. The first is the "clustering" of bad luck. Two or more successive years of low harvest for a region may bring particularly serious consequences. There is a tendency for low-income households to use up most of their inventories and buffering capabilities in the first adverse year. During the second or later year of low harvest, the household will be without a cushion and therefore severely exposed. Moreover, since bad luck is spatially covariant (e.g., due to adverse local weather conditions), distress sales will be relatively ineffective as buffer strategies since the price of durable goods will be depressed. Similarly as capital is destroyed by adversity the marginal product of labor will decline and employment opportunities worsen. All of these tendencies will be exacerbated to the extent that an economy is fragmented and lessened to the extent it is integrated.

A second cluster of events worthy of special attention is associated with political fragmentation. Certain groups may be unable to enter into exchange on an equal footing with others. Ironically this tends to occur with too much central control (especially in dictatorial societies without a free press, Sen, 1991) or too little central control, as in the case of the Somalia famine. Political fragmentation is most severe in times of war or chaos. The plight of the Kurds in Iraq, the Croatians in Bosnia-Herzegovina, and the Romanian gypsies in Germany suggest, as political alliances become more ethnically focused, that political fragmentation may be an increasingly common source of food insecurity in today's world.

The solution to both physical and political fragmentation is a constitution that promotes an infrastructure of cooperation. That includes a physical infrastructure of roads, bridges, ports, airports, and communication facilities; an institutional infrastructure, e.g. rules and organizations for the regulation of money and banking; and a political infrastructure that permits the broadest possible scope of exchange across lines of race, religion, and sex.

The restoration of law and order in a society will also ameliorate the tendency of poverty to "trickle up." The trickle-up effect was described by Adam Smith himself:

> Many would not be able to find employment even upon these hard times, but would either starve, or be driven to seek subsistence either by begging, or by the perpetration perhaps of the greatest enormities. .

> Want, famine, and mortality would immediately prevail in that class and from then extend themselves to all the superior classes.
>
> Adam Smith 1976, pp. 90-1; as cited by Sen, 1991.

V. Concluding Remarks

The model presented here is intended to capture the essence of food security problems in rural, especially remote, areas of poor nations. It is not surprising then, to summarize the six major features of the model discussed in the previous section, that it seems to have some predictive power in identifiying the parts of the world noted as representing specific troublespots of episodic hunger and deprivation.

Data limitations being what they are, the precision of the explanation is assessed in a necessarily subjective manner. As noted implicitly in the six points above, the risk factors may work independently but typically do so in conjunction, and thus the classical difficulties of residually imputing importance to particular factors must be confronted. The coincidence of risk factors is an unfortunate fact of life (and death), so that regions that (1) have large numbers of subsistence farmers barely producing a marketable surplus also tend (2) to have relatively variable production of staples. In many instances they are also (3) rather remote from ports and major urban centers. The poverty (and stochastic poverty) effects (4) are severe in these same areas, although they are also rampant in impact in urban areas, which are perhaps also more closely tied to international trade. The local marketing costs (5) tend to be much higher in areas remote from major centers and ports, so that all of the first five factors will tend to work together, multiplicatively more than additively, to predispose risk of food insecurity.

Many of the agricultural and pastoral regions of Africa, Asia, Latin America and the former Soviet Union that are relatively remote from principal markets are thus at primary risk. Their experience therefore depends on the final (sixth) factor, namely, the effectiveness of government intervention. The first five factors suggest a degree of remoteness that can predispose the food insecurity problems to be found in the backward areas of the regions mentioned. Unfortunately, their very remoteness is strongly associated with "political invisibility," which, for regimes hard-pressed to solve the economic problems of the burgeoning urban masses, can lead to distinct biases in public programs. Intervention can moderate these problems, as the experience of the Chinese and others substantiates (Gavan and Chandrasekera, 1979; George, 1979; Lipton, 1983). On the other hand, regimes that choose to use food shortages as a political weapon have also found that their savage intentions are easily realized in these same relatively remote areas.

Many difficulties pervade interventions that are intended to place food in the stomachs of the needy when their need is greatest. The nature of income distribution is such that there are many others close to such critical levels of destitution, who will understandably attempt to benefit from whatever relief is in prospect. This is somewhat analogous to the problem of the policy interference in the face of agents holding rational expectations (Kydland and Prescott, 1977).

The microeconomics of food insecurity reinforces the position of earlier authors (Bhatia, 1963; Sen, 1980, 1981) that famine and malnutrition are not so much consequences of the vicissitudes of international commodity markets as the result of production and income fluctuations in areas that are somewhat insulated from large markets and from government policies and political events that increase the degree of insulation. An integrated program for the enhancement of food security must therefore include policies designed to increase average wages, perhaps to decrease average food prices, and to improve the stability of both local food supply and employment.

Given the high costs of national price stabilization schemes (Newbery and Stiglitz, 1979, 1981; Behrman, 1984; Williams and Wright, 1991) and their effectiveness in stabilizing prices in rural areas, alternative policies decreasing local price instability need to be considered. The most cost-effective method for increasing price stability probably is to remove destabilizing government distortions. Government efforts to nationalize grain markets and to regulate prices across both space and time have the effect of eliminating the private marketing and storage sector. Rather than replacing private marketing, government efforts should be aimed at enhancing private markets through improving transportation, enforcing standards and measures in grain transactions, and implementing small-scale storage technology.

Critics of modernization in peasant societies contend that commercialization subjects consumers to the vagaries of markets and contributes to polarization and social conflict (Popkin, 1978). The above analysis highlights the opposite result. It is precisely the large wedge between buying and selling prices that allows fluctuations in domestic production to be transmitted into local prices. Policies that decrease the average costs of grain processing, handling, shipping and storage will narrow the wedge and help to insulate local prices from the fluctuations of local production.

Research and extension can also help to stabilize local production (Anderson and Hazell, 1989). This can be accomplished directly by genotypic change specifically designed to enhance stability. Pest management, disease control, and other cultural practices aimed at the source of crop damage can also diminish the impact of stochastic environmental variables.

To have the wherewithal to cope, countries need to push for economic growth generally. Particular care must be taken not to give disincentives to food producers, because the tailenders of negative protection to this sector will be at the head of those facing greatest food insecurity. Except for direct food programs, predisposing markets to work freely and effectively will help greatly. Infrastructural developments will also help in this context, although they are typically expensive and demanding of scarce foreign exchange. Whatever may be contemplated, progress will inevitably take a long time. Accordingly, it seems that the broad area of technological and related economic advancement offers the best prospects.

The impact of improved technologies can be profound, early and, compared to infrastructural development, easily accomplished. Improved germplasm with modest additional inputs can change the productive potentials of even remote areas quite dramatically. Appropriately directed extension efforts can be a key to success in such endeavors as, of course, will the research to produce something to extend. Such programs, which increase average production, enhance food security directly by lowering food prices and indirectly by improving the distribution of income (e.g., Quizon and Binswanger, 1983; Evenson, 1984), although with the qualification of potentially induced increases in variability.

Similarly, policies that enhance the demand for labor increase the entitlements of those at greatest risk of food insecurity. Improvements in agricultural technology again get high marks in this regard. Even though new technology tends to be neutral or even slightly labor-intensive, the overall improvement in productivity provides a substantial boost to the marginal product and demand for labor (Evenson, 1984). Increasing the demand for labor, along with lowering food prices, improves income distribution without sacrificing growth. It thus contributes to the permanent as well as the stochastic component of food entitlements.

Finally, an integrated food security program requires compensation to the victims of both human-induced and natural disasters. Since households that suffer from malnutrition and famine are often the victims of both food and employment shortages, it is natural to consider policies that supplement both work opportunities and food supplies (Anderson and Hazell, 1989). Food aid policies should also be evaluated in light of the food security framework suggested in the present paper.

NOTES

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