World Food Insecurity: A Policy Dilemma

by
Mathew Shane, Terry Roe, Lloyd Teigen, and Munisamy Gopinath[1]

Abstract: Almost 1 billion people live in a state of food insecurity. The income earned by them is only slightly more than 1 percent of world GDP. Even though the resources required to feed these people adequately are small, their food deficit is persistent and difficult to solve. Solutions must involve a radical restructuring of government away from interventionist policies and towards being a facilitator of economic growth and development focusing on overcoming market failures. Resources in support of agricultural research and development (R&D) have been declining worldwide and are undermining the growth in productivity that is required in order to have further declines in real agricultural prices. These lower prices would be one important step towards improving food security by increasing purchasing power of low-income households. Reducing the number of food insecure by half as recommended by the World Food Summit requires serious commitments from both the world food exporters as well as the food-insecure countries themselves.

Introduction

There are almost 1 billion people living in a state of food insecurity, most of them living on less than $2 a day. A small share of world GDP, less than 1 percent, would go a long way towards removing this insecurity. Yet transfers of food, income, or wealth do not appear to provide a permanent solution. Long-term solutions must come from inside the food-insecure countries and result in increased productivity and income for the food insecure.

To accomplish this, a fundamental restructuring of the incentives to save and invest, as well as a reordering of priorities for public investments away from control of markets toward overcoming inadequacies in physical and social infrastructure must be undertaken. Given the radical transformation of thinking required on the part of the leadership of these countries, it is hard to see how this transformation can take place. That is the dilemma. The problem involving a small share of world GDP is so difficult to solve because the root of the problem is not resource availability, but the approach to development of many officials in less developed countries (LDC's).

Public support for agriculture has been declining worldwide. Public R&D expenditures, which were growing by 7 percent a year in the 1970's, have stagnated in the 1990's. This, in spite of the fact that it was public R&D expenditures that caused the productivity growth and led to increased agricultural output over much of the past 25 years. While agricultural output grew more rapidly than population over the past 25 years, the "surplus" was highly precarious. Of the more than tripling of output over that period, almost 90 percent went to feeding increasing populations while only slightly more than 10 percent went to increasing food availability per capita. A small change in productivity growth or other factors affecting supply would have led to a different outcome. In fact, since 1985, world agricultural production has been growing at the same rate as population.

For policy makers, the dilemma rests in a conflict between humanitarian concerns and scarce aid resources. The OECD countries want to assist countries in need, but the conventional remedies of food assistance and policy reform in the most severely affected countries appear inadequate to turn around this situation. Only new thinking and dramatic policy reform will yield positive results in the longer term. How then are we to achieve the pledge by the World Food Summit to reduce the number of food insecure by half?

Food Insecurity and the World Income Distribution

The world's income distribution is highly concentrated at low income levels. More than 4 billion people have incomes of less than $16 per day.[2] More than 3 billion live on less than $8 per day. More than 1 billion live on less than $2 per day and more than 500 million live on less than $1 per day.[3]

[1]Shane is a senior Economist at ERS, USDA. Roe is a Professor, Department of Applied Economics and Director, Center for Political Economy, University of Minnesota. Teigen is a senior Economist, ERS, USDA. Gopinath is Assistant Professor, Department of Agricultural and Resource Economics, Oregon State University.

[2]For the purposes of this paper, our international comparisons are conducted in 1994 purchasing power parity (PPP) dollars. A purchasing power dollar is an international currency that was created to compare how much of the same basket of goods can be purchased in different countries. [3]In the OECD countries, less than 20 percent of the population live on $16 per day or less.

Although it is not clear exactly at what income a person becomes food insecure, few individuals who earn $16 per day or more are food insecure. On the other hand, individuals living on $1 per day or less are almost certainly food insecure. Almost 10 percent of the world's population live on $1 per day or less and almost 20 percent on $2 per day or less. FAO's estimate of the world's food insecure population, at 860 million (FAO, 1997), puts the income of food insecure people at almost $2 per day.

While populations are concentrated at low-income levels, income earned is equally concentrated at the highest income levels. Thus 70 percent of the world's GDP is earned by less than one third of all individuals—those who earn $16 per day or more. The poorest 1 billion only earn 1.3 percent of the world's income and the poorest 500 million only earn 0.3 percent of the world's income.

Since the poor only spend a part of their income on food, the food expenditures of the poorest 1 billion represent only 0.8 percent of the world's GDP while the food spending of the poorest 500 million represents 0.2 percent of the world's GDP.

While the solution to the food insecurity problem appears to be to transfer food, income, or wealth, we argue that this is not the correct solution in the long run.

The World Food Situation

Total world food production grew 2.6 percent per year between 1961 and 1985. On a per capita basis, food production grew only 0.6 percent per year. Between 1985 and 1995, both population and food production growth declined so that they were in approximate balance at 1.7 percent per year. This slowdown in production growth, if it continues, suggests the potential for supply shortages and a worsening of the food insecurity problem.

Factors Influencing Demand

The United Nations projects that population growth will decline from the current 1.5 percent per year to 1.25 percent by 2010. At this rate, total food supplies can keep pace with population growth at current prices and incomes. However, it is not sufficient for production to grow at the same rate as population for the market to equilibrate at constant prices. Income growth generates additional demand pressures. The excess of demand growth over supply is likely to place some upward pressures on real food prices.

A variety of factors could accelerate the movement toward higher world food prices: declines in population growth rates could decline less than projected, income growth in populous countries with high relative food expenditures could be faster than expected, and world agricultural production could slow from present rates.

Of the world's poorest 1 billion people, about 42 percent reside in South Asia, about 24 percent in Sub-Saharan Africa and 16 percent in China, North Korea, and Mongolia. South Asia and Sub-Saharan Africa are the two regions with the largest number of people at considerable nutritional risk. Twenty-five percent of South Asia's population and 51 percent of Sub-Saharan Africa's population live on less than $2 per day. These are also regions with the lowest per capital income growth and the highest population growth rates.

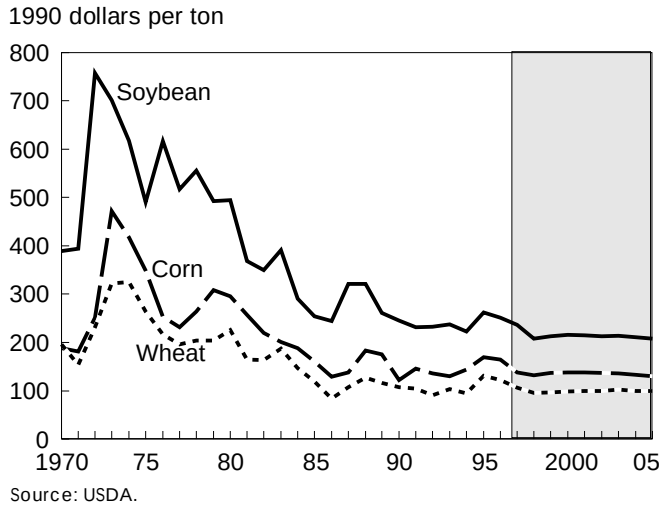
Food Prices and Capacity To Import Food

Rising incomes, stagnant per capita agricultural production, and declining stocks would lead us to expect a trend of increasing real prices. However, price trends have continued to suggest that food has become relatively less scarce over time (figure A-1, Borensztein et al., 1994).[4] A decline in the real price of food in world markets is not sufficient to ensure that food consumption per capita in low-income countries will increase. An increase in food consumption per capita depends on a number of factors, including a country's terms of trade, population growth, and growth in total factor productivity. All of these factors contribute to income and the country's ability to pay. We discuss the implications of these factors next.

Terms of Trade

Suppose a country is a net importer of food. Then, if the price of imported food falls relative to the price of a country's exports (terms of trade), earnings from a constant volume of exports can buy a larger volume of food imports. Unfortunately, this has not been the case for those countries that are at the highest nutritional risk. Many low-income countries rely heavily on exports of primary commodities (if anything at all). The price of some of these commodities has fallen even faster than that of food. Given the ultimate price insensitivity of demand for primary commodities export earnings decreased.[5]

Figure A-1--The pattern of declining real prices is slowing



Source: USDA.

[4]Grilli and Yang (1988) show that the price index of cereals exhibited a downward trend between 1900 and 1987. [5]According to the IMF (1995), non-fuel exports of primary commodities experienced large negative terms of trade effects during the early 1990's. On a regional basis, Sub-Saharan Africa experienced negative terms of trade during the late 1980's and early 1990's.

Compounding the problem for countries with the highest nutritional risk is that growth of exports per capita has not kept pace with the decline in their terms of trade so that foreign exchange earnings per capita have fallen. Burundi, Cote d'Ivoire, Kenya, and Tanzania are among the countries in Africa that have experienced a decline, not only in per capita export earnings, but in total export earnings (IMF, 1995). Thus, not only are the poor growing more dependent on food imports, their governments are less able to provide the foreign exchange to import food.

Population

Population growth has been declining worldwide and is projected to continue to decline. Between 1960 and 1977, populations grew almost 2 percent per year. Between 1978 and 1995, the growth rate had declined to 1.5 percent. Projections are always somewhat harzardous, but the UN and Bureau of the Census project the world population growth rate will decline to slightly more than 1.2 percent by 2010.

The decline in population is not uniform throughout the regions of the world. In Sub-Saharan Africa, population growth rates increased from 2.5 percent a year between 1960 and 1977 to almost 3 percent between 1978 and 1995. Projections for the region suggest continuing high population growth rates of 2.5 percent a year through 2010. Unfortunately, the regions with the highest population growth rates are also the ones with the largest food insecure populations. It is also the case that the lowest income groups within any country are also those with the highest population growth rates.

Growth in Factor Productivity

The decelaration in the growth rate of agriculture's total factor productivity (TFP) is international in nature, and associated with a decline in public and private R&D and the decline in real agricultural prices. The declining growth in TFP will cause agriculture to lose resources to the rest of the economy and will likely lead to a reduction of output growth. In the face of rising populations, world agricultural production per capita will fall, and may lead to rising world food prices. Increasing real food prices are unlikely to be a problem for the approximately 1 billion people with the majority of the world's income. However, for the remaining population, a rise in food prices can lead to considerable nutritional risk.

Changes in the rate of growth in agriculture's TFP has contributed to the slowdown in agricultural production growth. Recent evidence suggests that the productivity advantage of agriculture in major food exporting countries is declining relative to nonagricultural sectors (Gopinath, Roe, and Shane, 1996). Furthermore, the growth rate for total factor productivity has fallen in recent years. Evidence from the United States and other OECD countries suggests that agricultural R&D influences agriculture's total factor productivity growth. Declines in the growth of expenditures on R&D may thus slow agricultural productivity growth.

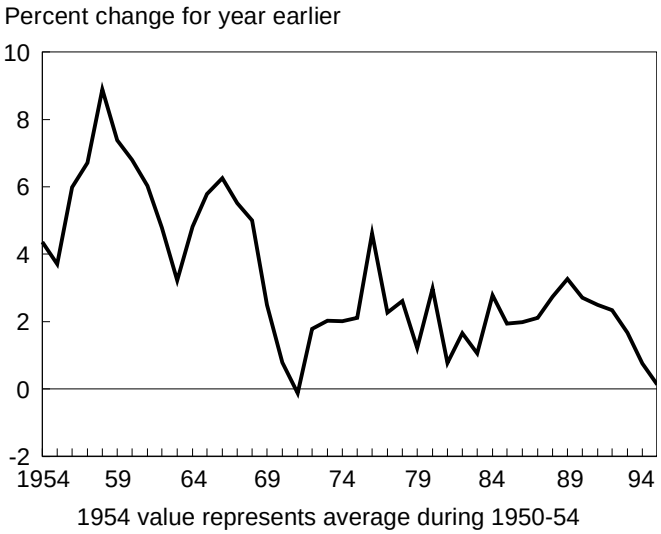
While there is considerable annual variation, annual rates of growth in TFP in the United States, France, Germany, and the UK appear to be falling. U.S. agriculture's TFP grew rapidly during 1949-1968 (figure A-3). Since then, the rate of growth in TFP flattened out. If these declining patterns continue, the long-term decline in real agricultural prices is likely to turn around.

U.S. TFP is explained by investments in public and private R&D, rural infrastructure, and by the embodied technological advances in material inputs (Gopinath and Roe, 1996, figure A-2 and A-3). In the 1950's and 1960's, investments in rural infrastructure played a dominant role in TFP growth while public and private R&D played a larger role in later years.

While detailed estimates are not available for other exporting countries, it appears likely that they follow a similar pattern. The decline in TFP growth is associated with a decline in the growth of public R&D expenditures. Alston and Pardey (1966, p. 47) state: "During the 1980's, research expenditures in developed countries grew at only one-quarter the rate experienced during the 1960's; for developing countries the rate of growth slowed to around 2.7 percent per annum during the 1980's, as compared with 7.0 percent during the 1960's." Private sector R&D spending has increased in proportion to public sector spending. In the 1990's, the public sector spent $0.79 for every dollar spent by the private sector, while in earlier periods the public sector spent $1.06 for every dollar of private R&D (Alston and Pardey, p. 56).

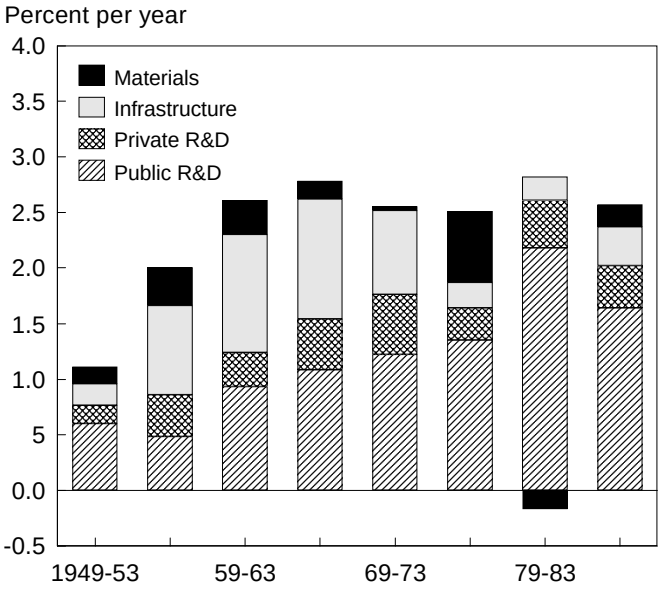
If the efficiency gains in the non-agriculture sector of the major food exporting countries do not spill over to the least developing countries, the rise in real prices of food are unlikely to be matched by a rise in their real incomes, further exacerbating the nutritional status of the poor.

Figure A-2--Growth in U.S. public expenditures on agricultural R&D has declined since the 1950's*



*Public expenditure on agricultural R&D is measured in 1992 dollars.
Five-year moving average.
Soure: Alson and Pardey (1996) and USDA.

Figure A-3--Contributions to agricultural TFP growth in the United States



Source: Gopinath and Roe, 1996.

What Can Policy Do?

We can characterize the lowest income countries of Africa and Asia where food insecurity is concentrated in the following way: overall income and agricultural production have been growing, but at a slower rate than population growth. Thus per capita incomes and per capital agricultural production have been falling. Furthermore, these countries have been highly inward-oriented so that total trade as a share of GDP has been falling. This pattern is dramatically different than that of the OECD countries and the fast growing newly industrialized countries, where per capita incomes and trade as a share of GDP grew rapidly, and agricultural production per capita increased. The real issue is what explains these differences and what can be done in the low-income, food insecure countries to reverse this long term pattern of decline. Although no short answer will suffice, there are some broad characterizations that point at a solution. Indeed, the economic history of countries such as South Korea, China, and Chile imply that solutions are possible.

In the short term, providing food, income or wealth transfers is possible and plausible. However, food insecurity and poverty are a sign that the economic system is not working well. Providing transfers can help overcome inadequacies in the short run, but cannot overcome the fundamental problems of poor and food insecure economies. Indeed, no externally imposed solutions can accomplish this. Only radical transformations of these systems can alter the negative path that these economies have been on for the past 25 years or more.

Let us focus on Sub-Saharan Africa. Over the past 25 years, per capita income and per capita agricultural production declined at the same time agricultural output and GDP increased by almost 2 percent per year. Can trade and investment policies raise economic growth rates in Sub-Saharan Africa enough to affect the individuals at nutritional risk? Using a dynamic computable general equilibrium framework for Sub-Saharan Africa, we show that trade liberalization and removing the bias in investment policies alone are not enough to turn around the situation in Sub-Saharan Africa.

Based on the simulations, trade liberalization adds 0.6 percent to per capita income growth rates. This policy change causes resources to move toward export sectors such as cocoa and nuts. The combination of trade liberalization and pro-agricultural investment in rural public goods adds 1.0 percent to the base growth rate of real income per capita. Real per capita income growth of only 1 percent a year helps the situation from getting worse, but is not sufficient to significantly reverse the nutritional situation. More fundamental remedies are required. What might these be?

Countries such as South Korea, China, and Chile, which have gone from low rates of economic growth to high rates, underwent a fundamental transformation in the approach of government to economic development. Government policy went from one of intervening in markets to create rent-seeking opportunities to facilitating development by creating institutions and reversing market failures. Measures included formation of specialized financial institutions, organized commodity and futures markets, and government organizations to provide marketing information to purchasers. These countries also went through a transformation from being inward oriented to being outward or even export oriented. The net effect of this transformation was to dramatically increase investment opportunities. The response to those opportunities was an approximate doubling of domestic savings rates from less than 15 percent of GDP to more than 30 percent of GDP (table A-1). In addition, the government's change from being a bottleneck to being a facilitator of economic activity opened the domestic economy to large amounts of direct foreign investments. Thus from both domestic and foreign sources, there was a huge increase in investable resources. The opening of the economy to international forces also opened the domestic economy to technological transfer and increasing productivity growth. The total effect of these changes has created 5 to 10 percent extra growth in GDP per year. It is this kind of a growth change that is needed to overcome the food insecurity problem in low-income countries.

Implications for Food Security

Given this perspective, what is the likelihood of dramatic changes in food insecurity as proposed by the World Food Summit? Trade liberalization is already a major and complicated step. It necessitates numerous and often politically unpopular changes in policy: the removal of protection of inefficient industries, short-run increases in food prices, and refocusing the tax system on income, value-added, or sales taxes and away from foreign trade taxes. This places pressure on the wealthy and politically influential. Yet, trade liberalization alone will not provide food security to those nutritionally deprived in the 1990's especially if the long-term downward trend in real food prices is reversed.

Table A-1--Developing Countries: Trade Orientation and Economic Performance (annual percent change)

	1974-85	1986-92
Strongly outward-oriented		
Real GDP growth	8.0	7.5
Real per capita GDP growth	6.1	5.9
Total savings / GDP	30.3	34.0
Total fixed investment / GDP	30.1	28.8
Capital-output ratio	1.3	1.4
Total factor productivity	2.6	3.8
Stongly inward-oriented		
Real GDP growth	2.3	2.5
Real per capita GDP growth	-0.3	-0.1
Total savings / GDP	13.7	10.9
Total fixed investment / GDP	16.3	14.1
Capital-output ratio	2.0	2.8
Total factor productivity	-0.4	0.3

Note: Developing countries are classified as "strongly outward-oriented" if trade controls are nonexistent or minimal, and "strongly inward-oriented" if overall incentive structure strongly favors production for domestic market.

Source: World Development Report, 1994, p. 76.

Combining trade liberalization with removing the government policy bias against agriculture will similarly not solve the problem in spite of the fact that this requires even more politically unpopular changes in policy.

Changes of the magnitude that will solve the problem involve a rethinking of the fundamental approach of government. However, the situation that is evolving in many of these countries is clearly unacceptable. Populations who are already poor and food insecure are faced with the prospect of becoming poorer and even more food insecure. Surely under these circumstances, leadership, in at least some of these countries, will see the appropriate path to a brighter future and be willing to make the hard choices necessary to make it happen.

References

Alston, Julian and Philip Pardey (1996). *Making Science Pay*, AEI Press, Washington D.C.

Borensztein, E., M.S. Khan, C. M. Reinhart, and P. Wickham (1994). *The Behavior of Non-Oil Commodity Prices*, Occasional Paper 112, IMF, August.

Delgado, Christopher L. and John W. Mellor (1997). "A Structural View of Policy Issues in African Agricultural Development: Reply," *American Journal of Agricultural Economics*, 69(2):389-391.

Gopinath, Munisamy, Terry Roe and Mathew Shane (1996). "Agricultural Competitiveness: The Case of the U.S. and Major European Countries", Staff Paper, USDA/ERS, Commercial Agricultural Division, Washington, D.C.

Gopinath, Munisamy and Terry Roe (1996). "Sources of Sectoral Growth in an Economy-Wide Context: The case of U.S. Agriculture," *Journal of Productivity Analysis*, Forthcoming, 1997.

Gopinath, Munisamy, Terry Roe and Erinc Yeldan. "Level Versus Rates Effects on Sectoral Growth: A Cross Country Analysis," Working Paper, Department of Applied Economics, University of Minneapolis, St. Paul, 1996.

Govindan, Kumaresan, Munisamy Gopinath and Terry Roe (1996). "Growth Accounting, Supply Response and Factor Returns in General Equilibrium: The Case of Indonesia," *Journal of Asian Economics*, 7(1):77-95.

Grilli, Enzo R. and Maw Cheng Yang (1988). "Primary Commodity Prices, Manufactured Goods Prices, and the Terms of Trade of Developing Countries: What the Long Run Shows," *The World Bank Economic Review*, 2(1):1-48.

International Monetary Fund (1995). *World Economic Outlook*, Washington, D.C.

International Food Policy Research Institute (1996). 2020 *Vision*, Washington, D.C.

Kelley, Allen C. and Robert M. Schmidt (1994). "Population and Income Change: Recent Evidence," IBRD Discussion Paper, No. 249.

Meadows, Dennis L. et al. (1972). *The Limits to Growth*, Universe Books, New York.

Rajapatirana, Sarath and Asad Alam (1993). "Trade Policy Reform in Latin America and the Caribbean in the 1980s", World Bank Working Paper, WPS 1104, Washington, D.C.

Teigen, Lloyd (1996). "Estimating Income Distribution Profiles Using the Gamma Function", Working Paper, USDA/ERS, Washington, D.C.

UNDP (1995). *Human Development Report 1995*, New York.

World Bank (1996a). *World Development Report*, Washington, DC.

World Bank (1996b). *Commodity Markets and the Developing Countries*, Washington, D.C.

Yeldan, Erinc, Terry Roe, and Sherman Robinson (1996). "Trade Liberalization, Accumulation and Growth in An Archetype Model of Africa, South Asia, East Asia and Latin America," Background paper prepared for the *IFPRI 2020 Vision Conference*.

Yen, Steven and Terry Roe (1989). "Estimation of a Two-Level Demand System with Limited Dependent Variables," *American Journal of Agricultural Economics*, 71(1):85-98.

Can Regional Policy Initiatives Help Achieve Food Security in Southern Africa?

by
Michael A. Trueblood[1]

Abstract: This article reviews three different regional policy options that might be used to address food insecurity for the Southern African countries. The options that are explored are a regional strategic grain reserve, a food import insurance program, and a free trade zone. Compared with other regions, these options are particularly attractive due to a common staple (white maize), very high national (but not regional) production variability, and strong regional institutional ties. Some preliminary analysis is provided; questions are highlighted for future research.

Food security is a high priority issue for nearly all governments around the world. Food security can be defined as "access by all people at all times to enough food for an active and healthy life" (World Bank, 1986). This definition encompasses both the supply (aggregate availability) and the demand (access) dimensions. Numerous policy instruments have been proposed to address food insecurity and find alternatives to relying on food aid. This article examines some regional policy initiative proposals (as opposed to national level proposals) for the Southern Africa region that focus on the supply dimension. The options that are examined include establishing a regional strategic grain reserve, implementing an international food import insurance program, and establishing a free trade zone.

The Southern Africa region is particularly well-suited to regional food security initiatives for the following reasons: 1) the countries share in common a staple food commodity, white maize (which is not widely traded on the world market); 2) grain production tends to be highly volatile at the national level but not at the regional level; 3) there are fairly strong regional institutions already established, namely the Southern Africa Development Community (SADC) (created in 1980) and the Southern Africa Customs Union (SACU) (created in 1910);[2] and 4) much of the warfare in the region has finally ceased (although peace remains fragile in Angola). Furthermore, with the recent change of government in South Africa, which led to its joining SADC, many observers now believe that there is much greater hope of achieving the food security goals set forth by SADC members in the early 1980's.

[1]An agricultural economist with the Marketing and Trade Economics Division, ERS, USDA. [2]The SADC countries now include Angola, Botwsana, Lesotho, Mauritius, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. The SACU countries are confined to South Africa, Namibia, Botswana, Lesotho, and Swaziland.

This article briefly reviews the root causes of food insecurity in Southern Africa. Then different policy options are examined that address the problems of food insecurity in the region. For each option, preliminary economic analysis is provided when available. Further research needs are identified in the summary.

Assessing the Problem

The countries in the Southern Africa region are among the most food-insecure countries in the world. Most of these countries have very low per capita incomes and display low average nutritional levels.

Generally speaking, food supplies come from two primary sources, production and trade. Grain production has been increasing in Southern Africa, but it has not kept pace with population growth, leading to declining per capita production. Grain production in this region is also distinguished by its relatively high variability. This means that in a down year many people are vulnerable to hunger and sometimes even famine.

Many trade-related factors contribute to variable food supplies. These factors include volatile food import prices, unstable export earnings, and high debt service obligations from previously accumulated debts. Although real grain prices have been declining for decades, price variability has increased in the past 20 years for these commodities. It is expected that price volatility will increase even more in the coming years as major grain exporters continue with policy changes that result in lower stock holdings.

Strategic Regional Grain Reserve Option

One policy option to address food security is the creation of a regional strategic grain reserve. The option has been considered in previous studies for different geographic regions (for example, the Sahel by McIntire, 1981) and has the

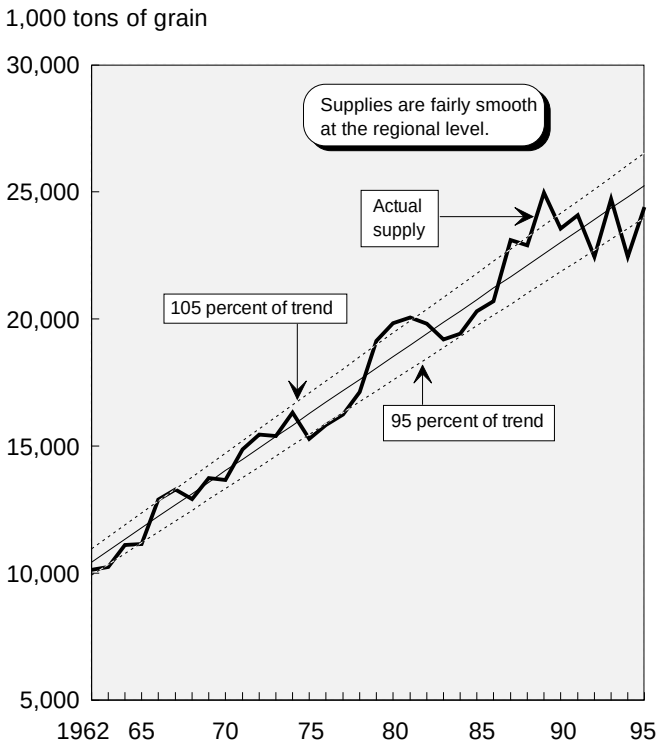
appeal of its direct food tangibility. In addition, this proposal has appeal for the Southern African region, whose consumers have in common similar tastes favoring white maize as a staple crop. As white maize is not widely traded outside of the region, it would appear to be a good candidate for a reserve. Furthermore, this buffer stock option has the merit that regional production variability is proportionally smaller than country level variability (see table B-1).

Unlike most earlier proposals, this policy proposes that a regional buffer stock be created as opposed to national level buffer stocks. There are two mechanisms discussed in the literature: quantity-based rules and price-based rules that determine when stocks are bought and sold. Given the regional dimension of this proposal, it makes more sense to think in terms of quantity-based trigger rules (that would avoid problems with exchange rates and inflation). Precedents for analyses of quantity-based trigger mechanisms include Walker, Sharples, and Holland (1976) and Reutlinger, Eaton, and Bigman (1976).

At the regional level, it is clear that grain supplies have been relatively smooth, rarely deviating outside of 5 percent of the trend use (see figure B-1). This suggests that it should be possible in principle to better stabilize national level grain supplies, which have been much more volatile. The challenge, however, is to devise a grain stocking arrangement for each country that can achieve this objective.

For the purpose of demonstration, one type of storage rule is discussed below. Let us first define supply as random production plus a trend level of imports. Now suppose that historically each country had abided by the following interannual grain storage rule:

Figure B-1--SADC Grain Supply Trend



Source: USDA data base.

If supply is:

greater than 120 percent of trend supply, then store amounts greater than 120 percent of trend supply;

less than 80 percent of trend supply, then release grain to reach the 80- percent level of trend supply;

Table B-1--Cereal Balance Information, Southern African Countries, 1993-1995

	Production	Net imports *	Food aid imports	Utilization**	Population	Per capita util.	Production coefficient of variation
	---------- 1,000 MT ----------				--Millions--	-- Kg/cap --	1962-1995
Country							
Angola	294	468	247	762	9.80	78	0.257
Botswana	48	148	8	176	1.43	123	0.698
Lesotho	164	188	31	344	1.94	177	0.261
Mauritius	2	230	1	232	1.12	207	0.933
Malawi	1,585	400	154	1,934	9.73	199	0.241
Mozambique	869	435	315	1,302	17.35	75	0.230
Namibia	85	108	0	178	1.58	112	0.310
South Africa	12,160	-1,210	0	11,101	40.29	276	0.309
Swaziland	88	80	9	168	0.94	179	0.918
Tanzania	3,791	170	59	3,932	27.99	141	0.512
Zambia	1,292	203	25	1,512	9.19	165	0.371
Zimbabwe	2,043	49	9	2,229	10.98	203	0.371
Region	22,420	1,269	858	25,540	132	193	0.243

* Negative values indicate exports.

** Utilization = Production + imports + beginning stocks.

Sources: USDA, FAO for Botswana, Mauritius, and Namibia.

between 80-120 percent of trend supply, then do nothing.

In this rule it is assumed that each country commits to a trend level of imports. This is a simple modification of the rule discussed by Newberry and Stiglitz (1981, pp. 406-409), in that imports are also considered as a source of supply. This means that production variability is what drives supply variability and therefore stock decisions. Other scenarios could be considered using other stocking rules, such as allowing wider or narrower bands to act as trigger mechanisms.

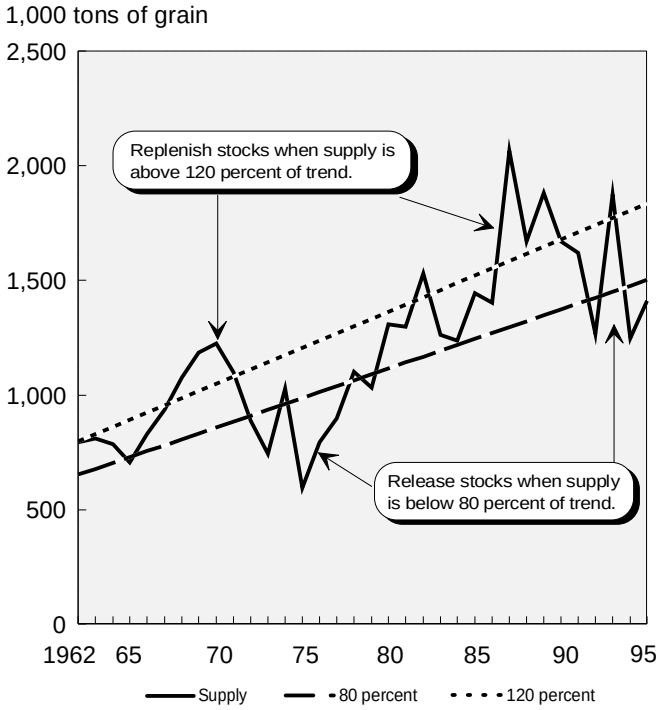
With the benefit of historical data, we can compare the results of these storage rules with the actual data, thereby providing important counterfactual analysis.[3] Figure B-2 shows how the stocking rules are applied in the case of Zambia. When grain consumption levels, driven by production levels, exceed the upper bound trend, then a country contributes to the regional grain reserve. When consumption levels fall below lower bound trends, then the country withdraws from the regional grain reserve. It is clear that these stocking rules do lead to smoothed consumption at the aggregate level, which presumably would lead to less price volatility and individual consumption variability.[4]

Developing a cost-sharing arrangement for such a scheme has proven to be difficult in the past. To develop a cost-sharing mechanism under the program, the individual country's costs and benefits have to be estimated. Previous studies have compared the welfare effects to producers, consumers, and governments. In the case of a region, that would entail making the calculations within and across countries. Earlier studies (McIntire, 1981; Reutlinger, 1984) have found that while the buffer stock program is overall beneficial to a country, it is not as beneficial as other food security programs. Furthermore, benefits can be high if consumers are very unresponsive to price changes (such as in the case of staple foods), but costs typically rise sharply at higher levels of food security (Houck and Ryan, 1979). Buccola and Sukume (1987), for example, found that holding large grain stocks was prohibitively expensive for the case of Zimbabwe.

Food Import Insurance Option

An import insurance program is another approach to achieve food security. The rationale for this program is that international grain prices are subject to wide fluctuations. Food security is at risk when grain prices reach their upswing

Figure B-2--Zambia's Stocking Rules--A Hypothetical Scenario



Source: USDA data base.

peaks, which inhibits each country's capacity to import the necessary grain volumes, and domestic production in a given year is low. This proposed policy mechanism could be implemented by a regional or international organization and is basically a financial program.

Suppose again that a set of policy rules were adopted by each government for a self-financing program. For the sake of example, let the rules be as follows:

If import needs:

exceed the threshold of 1 standard deviation above trend level imports, then receive reimbursement of actual costs exceeding the threshold costs;

fall below the threshold of 1 standard deviation below trend level imports, then pay into a fund the actual costs below the threshold costs;

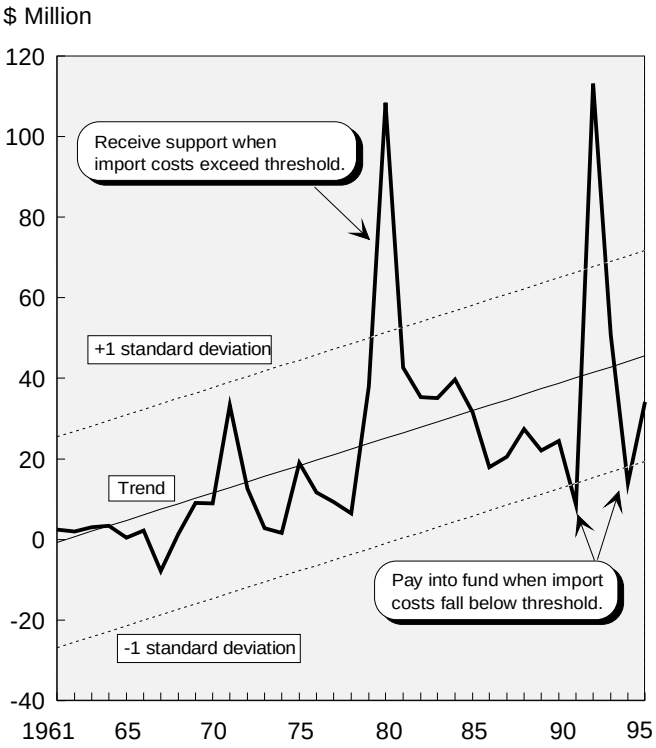
are between plus or minus one standard deviation, then do nothing.[5]

An example of this rule is shown for the country of Zambia in figure B-3. Table B-2 and figure B-4 show the results of the rule for the region had it been adopted historically. As a counterfactual exercise, the results suggest that nearly every country would have saved millions of dollars on its food import bills, although some more than others. Our analysis shows that the exporting countries (South Africa and

[3]Houck and Ryan (1979) distinguish three categories of stocking models. The model presented here is in the tradition of Waugh (1967) of identifying appropriate stock levels based upon historical time series analysis. The other model categories are simulation models (a good example for three Southern African countries is Pinckney (1993)) and dynamic programming optimization models (a thorough treatment can be found in Gardner, 1979).[4]This implies that some countries would need to absorb to some extent the peaks and valleys (but less than without the buffer policy option). In reality, there would need to be more complex policy interaction between stocks and trade, such as that considered by Reutlinger, Eaton, and Bigman (1976). This type of interaction will be considered in a later study.

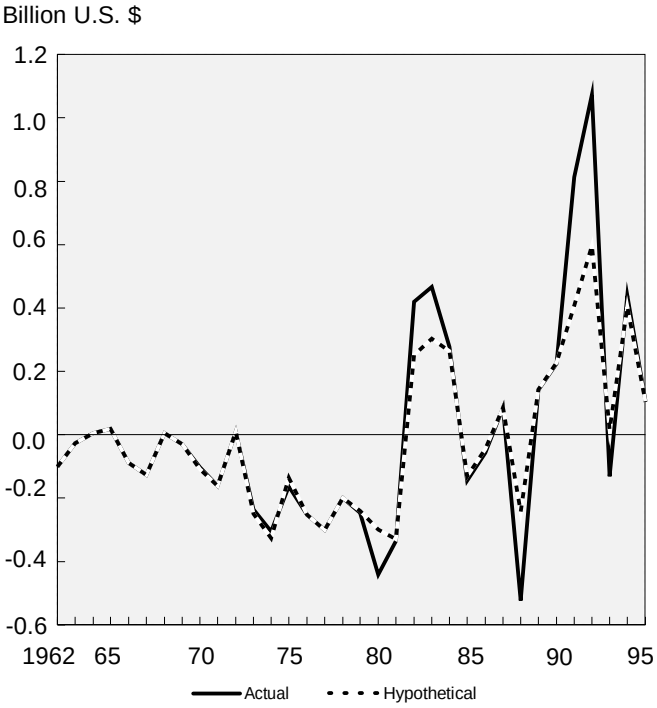
[5]Recall from statistical theory that about 67 percent of sampling variation of a normal distribution falls between plus and minus one standard deviation.

Figure B-3--Hypothetical Import Rules to Zambia



Source: FAO data base.

Figure B-4--Total Import Costs for SADC Region, Actual and Hypothetical



Source: FAO data base and own calculation.

Table B-2--Comparison of Accumulated Import Cost Savings with Insurance Program, SADC Countries

	Actual imports, 1962-1995 *	Hypothetical imports, 1962-1995 *	Savings, 1962-1995	Share of regional benefits, 1962-1995
	----------	$U.S. Million ----------		Percent
Country				
Angola	845.0	841.2	3.8	0.6
Botswana	304.3	300.0	4.3	0.6
Lesotho	357.5	354.4	3.1	0.5
Mauritius	601.2	600.6	0.6	0.1
Malawi	401.9	376.5	25.4	3.8
Mozambique	1,191.5	1,148.3	43.2	6.5
Namibia	252.1	245.8	6.3	0.0
South Africa	-5,366.6	-5,513.8	147.2	22.1
Swaziland	157.3	157.2	0.2	0.0
Tanzania	700.7	634.3	66.4	10.0
Zambia	712.5	635.3	77.2	11.6
Zimbabwe	-48.0	-336.2	288.2	43.3
Region	109.3	-556.5	665.8	100.0

* Negative values in parentheses are exports.

Zimbabwe) would gain the most, although Mozambique, Tanzania, and Zambia would also gain substantially.

Free Trade Area Option

Some analysts have also suggested that a free trade zone could go a long way towards solving food security. The rationale is that with a free trade zone, when one country experiences a production shortfall which leads to high prices, then a nearby country with a surplus (and low prices) would export their surplus to the other country, assuming that it is profitable to do so after considering transportation and transaction costs. A free trade zone would lower the trade barriers, which would increase the likelihood of nearby suppliers being able to profitably export their surpluses.

One of the important premises of free trade, though, is profitability after considering transportation and transactions costs. In the Southern Africa region, transportation infrastructure is weak, making intra-regional trade expensive (table B-3). Koester (1986) showed that the region's transportation and handling costs per ton nearly equaled the value of the bulk grain shipments per ton, making it very difficult to profitably import grain in many countries. This continues to be a major problem for the region since it implies that most countries have to rely on domestic supplies of white maize (which are unstable). Research in South Africa shows that consumers are unwilling to purchase blended white and yellow maize—which are available on the world market—without a substantial price discount (Missiaen, 1995).

With the advent of peace, many new infrastructural projects are currently being built (or re-built) (Economist, 1997). This holds promise that transportation costs will begin to go down over time. The U.S. Agency for International Development (AID) is currently sponsoring research that is estimating some of the transportation costs in the region, which will be useful for conducting updated studies of trade

Table B-3--Road Density, Selected Countries

	Kilometers per million persons, 1992
SADC:	
Angola	NA
Botswana	1,977
Lesotho	452
Mauritius	1,549
Malawi	NA
Mozambique	343
Namibia	2,722
South Africa	1,394
Swaziland	NA
Tanzania	142
Zambia	795
Zimababwe	1,406
Others:	
Uruguay	2,106
Tunisia	2,080
Turkey	5,514
Portugal	6,130
Hungary	7,756
Greece	10,341
France	13,008
United States	14,453

Source: World Bank, World Development Report 1995, Table 32.

profitability (for an analysis of East African transportation costs see AID, 1996).

Perhaps more importantly, the SADC countries have, in fact, signed a trade protocol in the past year. The treaty includes freer trade in nearly all agricultural commodities (as well as non-agricultural trade) and honors previously existing bilateral trade treaties. This treaty comes after many countries in the region recently have undertaken many domestic and trade reforms (AID, 1996b). South Africa is perhaps the best example of this, since it has abolished many parastatals (including the Maize Marketing Board in April 1997) in its effort to join GATT and the WTO.

Summary and Outlook

This article highlighted three major regional policy proposals that address food security on the supply (food availability) side. Each proposal could have numerous variations, which leaves many possible options for further analysis open.[6]

Each proposal has numerous logistical and economic questions that will be researched further over the coming year. Among the factual and logistical questions are:

- What is the grain storage capacity in each country?
- What are the costs of building and maintaining new facilities (if necessary)?
- What are the transportation costs among the countries for trade?
- What are the current grain policies and trade barriers?
- Who would implement the suggested program(s)?
- Who would enforce the policy arrangements?

Among the economic questions are:

- Which policy initiative is most cost-effective, and how do those costs compare with traditional food aid?
- What are the welfare effects for producers, consumers, and governments for each country for each proposal?
- Do any of these proposals invite rent-seeking behavior?
- What types of arrangements are likely to entice regional cooperation (or conversely what arrangements might induce sabotage)?
- How would the costs and benefits be apportioned?

The last two questions are particularly important. Economic theory suggests that countries will participate in a new arrangement if their expected position is at least as good as the current arrangement (according to the Pareto efficiency principle). If a particular country expects to be worse off while the group is better off, then, in principle, it is possible to compensate the country for its losses. Koester argues, after surveying the successes and failures of other regional arrangements, that the successful arrangements were those that divided the benefits fairly evenly (Koester, 1986).

In summary, each of the regional policy options discussed in this article—strategic grain reserve, food import insurance, and a free trade zone—has the potential to contribute significantly to food security in the Southern Africa region. Which option or combination of options can reach this goal most effectively will be the subject of future research.

References

Buccola, Steve and Chrispen Sukume. "Optimal Grain Pricing and Storage Policy in Controlled Agricultural Economies: Application to Zimbabwe", *Food Security for Southern Africa* (eds. M. Rukuni and C. Eicher). Harare, UZ/MSU Food Security Project, Department of Economics and Extension, University of Zimbabwe, 1987.

Economist. "An African Success Story." June 14, 1997, p. 47.

Gardner, Bruce. *Optimal Stockpiling of Grain.* Lexington Books: Lexington, MA, 1979.

Koester, Ulrich. *Regional Cooperation to Improve Food Security in Southern and Eastern African Countries*. Washington, DC: International Food Policy Research Institute, Research Report 53, 1986.

Konandreas, P., B. Huddleston, and V. Ramankura. *Food Security: An Insurance Approach*. Washington, DC: International Food Policy Research Institute, Research Report No. 4, 1978.

[6]One could, for example, analyze the effect of different bounds for the strategic regional reserve option or calculate the costs and benefits of different rules for the import insurance program.

McIntire, John. “Food Security in the Sahel: Variable Import Levy, Grain Reserves, and Foreign Exchange Assistance,” Washington, DC: International Food Policy Research Institute, Research Report #26, 1981.

Missiaen, Margaret. “South Africa: Ag Reforms in the Face of Drought,” *Agricultural Outlook.* Washington, DC: U.S. Department of Agriculture, Economic Research Service, July 1995, pp. 26-29.

Newberry, David and Joseph Stiglitz. *The Theory of Commodity Price Stabilization: A Study in the Economics of Risk.* Oxford, England: Clarendon Press, 1981.

Pinckney, Thomas C. “Is Market Liberalization Compatible with Food Security? Storage, Trade, and Price Policies for Maize in Southern Africa,” *Agricultural Policy Reforms and Regional Market Integration in Malawi, Zambia, and Zimbabwe* (eds. A. Valdes and K. Muir-Leresche), Washington, DC: DC: International Food Policy Research Institute, 1993.

Reutlinger, Shlomo. “Project Food Aid and Equitable Growth: Income Transfer Efficiency First,” *World Development 9* (1984): 901-911.

Reutlinger, S., D. Eaton, and D. Bigman. “Should Developing Nations Carry Grain Reserves?” *Analyses of Grain Reserves: A Proceedings* (eds. David Eaton and W. Scott Steele). Washington, DC: U.S. Dept. of Agriculture, Economic Research Service report No. 634, August 1976.

U.S. Agency of International Development. *Comparative Transportation Cost Analysis in East Africa: Executive Summary*. Washington, DC: AID, Office of Sustainable Development, Bureau for Africa, SD Publication Series, Technical Paper No. 21, June 1996.

U.S. Agency of International Development. C*omparative Analysis of Structural Adjustment Programs in Southern Africa*. Washington, DC: AID, Office of Sustainable Development, Bureau for Africa, SD Publication Series, Technical Paper No. 23, June 1996b.

Waugh, Frederick. “Reserve Stocks of Farm Products,” *Selected Writings and Agricultural Policy and Economic Analysis*: Frederick V. Waugh (eds. J. Houck and M. Abel), reprinted. Minneapolis, MN: University of Minnesota Press, 1984.

Walker, R., J. Sharples, and F. Holland. “Grain Reserves for Feed Grains and Wheat in the World Grain Market,” *Analyses of Grain Reserves: A Proceedings* (eds. David Eaton and W. Scott Steele). Washington, DC: U.S. Dept. of Agriculture, Economic Research Service report No. 634, August 1976.

World Bank. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries.* Baltimore: Johns Hopkins University Press, 1986.

Resources, Sustainability, and Food Security

by
Keith D. Wiebe[1]

The notion of food security has expanded in recent years from a relatively static focus on food availability to one that recognizes longer term concerns about access and resources. At the same time, economists have been working to incorporate changes in the quality and quantity of natural and other resources into measures of national income and wealth. A review of recent data suggests the potential for improved analysis of sustainable resource use and food security.

Resources and Food Security

Food security is generally defined in terms of "access by all people at all times to sufficient food for an active and healthy life" (World Bank, 1986; World Food Summit, 1996). This represents a significant advance over earlier definitions that focused on global food availability, yet careful consideration of food security requires moving beyond even access to food and recognizing the choices that households and regions face when incomes fall short (Dasgupta, 1993). Of special interest are the tradeoffs that low incomes force between meeting current consumption needs and protecting the resources needed to meet consumption and other needs over the longer term.

Resources can be classified in a variety of ways. Natural resources (e.g. land and water), produced resources (e.g. roads and factories), and human resources (e.g. skilled and unskilled labor) are generally recognized, if not always easy to measure. Social resources are comprised of the institutions and cultural patterns on which functioning societies are based (Serageldin, 1996).

Resources are critical to food security because they determine the ways in which individuals, households, and countries gain access to food through production and exchange. These relationships are illustrated in the right-hand side of figure C-1. Resources are also related to food security in a second significant way. Once individuals or groups have engaged in production and exchange, they can allocate the resulting income, along with their remaining stock of resources, to consumption and investment. Consumption and investment in turn affect the quality and quantity of the human and other resources that are available in subsequent periods. These concepts are illustrated in the left-hand side of figure C-1.

Recognizing the tradeoff between consumption and investment in other resources is particularly important in poor countries and households, where small increases or decreases in the level of consumption can have large effects on health and nutritional status. Proximity to a minimum consumption threshold, representing the "sufficiency" component of food security, highlights the tradeoff between alternative forms of investment that poor households may face. Specifically, households with insufficient income may be forced to choose which forms of investment will be curtailed, and thus which types of resources will be degraded or depleted over time. For example, resource-poor households may be forced to cultivate their land intensively, thereby degrading it over time, in order to generate enough income to avoid undernourishment in the short run (Perrings, 1989; Mink, 1993). Alternatively, they may accept a certain degree of undernourishment rather than deplete their natural or produced resources. In fact, while simplistic notions of food security imply that the former strategy would be preferred, evidence (e.g. Sen, 1981; de Waal, 1989) suggests that many resource-poor households choose the latter.

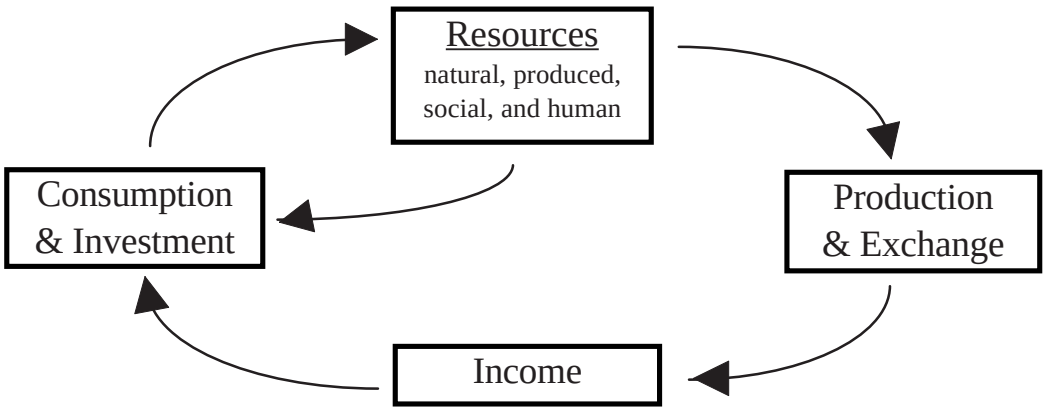
This is why it is necessary to incorporate resources into a full understanding of food security. Consumption that is maintained at sufficient levels only by irreversible degradation or depletion of natural, produced, and/or social resources will not be sustainable "at all times," and can hardly be described as part of a food-secure livelihood strategy in the long run. Likewise, protection of natural and other resources that is achieved only at the expense of necessary consumption levels, and thus minimum standards of human health, will not be sustainable in the long run either.

Trends in Food Availability and Access

As discussed in the Overview of this report, the gap between the amount of food available (i.e. production plus commercial imports) and the amount of food needed to maintain either status-quo or nutritionally adequate consumption levels is projected to increase in most of the 67 countries studied in this report over the next 10 years. The total "food gap to maintain consumption" is projected to grow from 8 million tons in 1997 to 18 million tons in 2007, most of it in

[1]An agricultural economist with the Resource Economics Division, USDA.

Figure C-1--The Role of Resources in Food Security



Source: Maxwell and Wiebe (forthcoming).

Sub-Saharan Africa and Asia. The total "nutritional food gap" is projected to grow from 15 million tons in 1997 to 24 million tons in 2007, also primarily in Sub-Saharan Africa and Asia.

Among the factors contributing to these growing food gaps are low yields for food crops (table C-1), which limit production's role in meeting food needs. Sub-Saharan African yields for cereals (1 ton per hectare), roots and tubers (8 tons per hectare), and pulses (0.5 tons per hectare) are well below world (and even developing-country) averages. While yields are higher in South Asia, access to food is limited by lower per-capita incomes (at $350 per year), and a larger share of the population (43 percent) lives in poverty. Low incomes limit poor countries' ability to compensate for production shortfalls through commercial imports. The consequences of the resulting food gaps are evident in indicators of consumption in developing countries. About 43 percent of Sub-Saharan Africa's people are chronically undernourished, compared with 22 percent in South Asia and 12-16 percent in other developing areas. The greatest numbers of chronically undernourished people live in Asia (Pinstrup-Andersen and Pandya-Lorch, 1997).

Food production, access, and consumption are important components of current food security, but it is also essential to consider the longer term interactions between food security and sustainable resource use. Recognizing the urgency of immediate consumption concerns, for example, it is not surprising that gross savings rates in Sub-Saharan Africa are less than half those in the East Asia and Pacific region. Low savings rates may reflect the short-term priority of consumption over investment in other resources, but maintenance of natural and other resources remains critical to food security over the long term. It is important to note that the gross savings rates reported in table C-1 fail to reflect changes in the stocks of many natural, human, and other resources that are associated with sustainability and food security, ranging from deforestation and carbon dioxide emissions to institutional decline and malnutrition-related disease.

Economists have begun trying to better incorporate such changes into measures of national income. For example,

Table C-1--Selected Indicators of Food Availability and Access

Indicator	Low- and Middle-Income Economies							HIE	World
	SSA	EAP	SA	ECA	MENA	LAC	All		
Production									
Cereals yields *(tons/hectare, 1996)*	1.0	3.2	2.2	1.7	na	2.5	2.6	3.3	2.9
Roots & tubers yields *(tons/hectare, 1996)*	8.0	11.0	15.3	12.7	na	11.6	11.6	17.6	13.0
Pulses yields *(tons/hectare, 1996)*	0.5	0.9	0.6	1.4	na	0.7	0.7	1.6	0.8
Income									
GNP per capita *($/capita, 1995)*	490	800	350	2,220	1,780	3,320	1,090	24,930	4,880
Poverty *(% living on < $1/day, 1993)*	39	26	43	na	4	24	29	na	na
Consumption & investment									
Undernourishment *(% chronically undernourished, 1992)*	43	16	22	na	12	15	21	na	na
Gross savings *(% of GDP, 1995)*	16	38	20	na	na	19	22	21	21
Genuine savings *(% of GNP, 1993)*	-1	21	6	na	-2	6	9	14	na

Notes: SSA = Sub-Saharan Africa; EAP = East Asia and Pacific; SA = South Asia; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and Caribbean; HIE = High-Income Economies; na = not available.

Sources: FAO (1997), Pinstrup-Andersen and Pandya-Lorch (1997), World Bank (1997a and 1997b).

adjusting estimates of savings to reflect changes in the value of natural and human resources yields the "genuine savings" data presented in table C-1. Genuine savings rates in Sub-Saharan Africa and the Middle East and North Africa are negative (as they have been for the past several decades), while rates in East Asia and the Pacific are high and rising (World Bank, 1997b). These trends suggest the need to look beyond short-term indicators of food availability and access to explore the longer term links between food security and resource use.

Resource Trends in Developing Economies

In general, resource priorities change as economies evolve. In low-income economies, priority is typically given to issues related to the management of natural resources for poverty alleviation and food security (UNEP, 1997). As economies grow, priority may shift to include resource problems associated with industrialization and urbanization, such as air and water quality and the treatment and disposal of waste. While analysis of local and national resource-use and food-security decisions requires disaggregated data, broader patterns are revealed in regional data reported by the World Bank and other sources. This section presents a brief overview of selected data from these sources to illustrate some of the resources and processes depicted in figure C-1.

Natural resources. Selected indicators of natural resources are presented in table C-2. About 11 percent of global land area is currently used as cropland, ranging from 6 percent in the Middle East and North Africa to 45 percent in South Asia. Cropland per capita ranges from 0.1 hectare in East Asia and the Pacific to 0.6 hectares in the low- and middle-income economies of Europe and Central Asia. In recent decades, cropland area has increased at 0.3 percent annually worldwide, and as high as 1.3 percent annually in Latin America and the Caribbean. This increase often represents expansion of cultivation onto marginal lands, such as those with shallow soils or steep slopes. Permanent pasture has remained relatively constant in area, indicating that the majority of the net increase in cropland area has come at the expense of areas formerly under forest or woodland cover. Deforestation has occurred most rapidly, in percentage terms, in East Asia and the Pacific and in Latin America and the Caribbean. Nationally protected areas have increased relatively rapidly in recent decades, although it is difficult to assess the true effectiveness of such protection. In any case, Rosegrant, Ringler, and Gerpacio (1997) argue that land conversion will slow in the next two decades, and will not threaten global food supplies in the foreseeable future.

Even if the rate of land conversion for agriculture slows in the coming decades, land already used for agricultural production is also subject to increasingly intensive production, which can lead to degradation via nutrient depletion and soil erosion. For example, Bumb and Baanante (1996) report that in many countries of Sub-Saharan Africa, soil nutrients are removed at rates 3 to 4 times those of nutrient replenishment, while Lal (1995) estimates that soil erosion has reduced crop yields in Sub-Saharan Africa, relative to what they would have been otherwise, by about 6 percent. Crosson (1997) counters that erosion-induced on-site productivity losses are actually quite low, less than 0.5 percent per year, although concern may still be justified where soil erosion has significant off-site effects, as well as in particular areas where soil losses are higher. Scherr and Yadav (1996) identify a number of such "hot spots" where land

Table C-2--Selected Indicators of Natural and Produced Resources

Indicator	Low- and Middle-Income Economies							HIE	World
	SSA	EAP	SA	ECA	MENA	LAC	All		
Natural resources									
Cropland *(hectares/capita, 1994/95)*	0.3	0.1	0.2	0.6	0.2	0.3	0.2	0.4	0.3
Water use *(% of annual renewable water, various years)*	1	8	12	19	73	2	6	11	7
for agriculture *(% of annual renewable water, various years)*	1	7	11	9	65	1	5	4	5
Cropland *(% of total land area, 1994)*	7	12	45	13	6	7	11	12	11
Permanent pasture *(% of total land area, 1994)*	34	34	10	16	24	29	27	24	26
Forest *(% of total land area, 1990)*	24	26	14	35	4	49	29	35	30
Nationally protected areas *(% of total land area, 1994)*	6	6	4	4	3	7	5	12	7
Cropland *(annual % change in area, 1965-89)*	0.7	0.3	0.2	0.1	0.1	1.3	0.5	0.2	0.3
Permanent pasture *(annual % change in area, 1965-89)*	0.0	-0.2	-0.4	0.0	0.0	0.5	0.1	-0.1	0.0
Forest *(annual % change in area, 1965-89)*	-0.4	-0.7	0.3	0.2	0.2	-0.5	-0.4	-0.1	-0.2
Nationally protected areas *(annual % change in area, 1972-90)*	1.9	14.0	10.7	7.3	6.9	8.0	5.6	7.1	6.3
Produced resources									
Irrigation *(% of cropland, 1989)*	1	10	28	5	6	2	6	3	5
Fertilizer consumption *(kg/arable hectare, 1992/93)*	15	206	74	57	64	52	79	112	87
Mechanization *(tractors/1,000 arable hectares, 1994)*	1		14*	18	na	12	8	31	19
Energy use *(tons of oil equivalent/capita, 1994)*	0.2	0.6	0.2	2.6	1.2	1.0	0.8	5.1	1.4
Fuelwood and charcoal *(% of total energy used, 1989)*	66	10	25	1	1	13	13	1	5

* Average for Asia as a whole.

Notes: SSA = Sub-Saharan Africa; EAP = East Asia and Pacific; SA = South Asia; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and Caribbean; HIE = High-Income Economies; na = not available.

Sources: FAO (1997), World Bank (1992, 1995, and 1997a).

degradation poses a significant threat due to soil erosion, nutrient depletion, deforestation, salinization, and other processes. They report that degradation of agricultural land and permanent pasture is most extensive in Africa (65 percent and 31 percent, respectively), while degradation of forest and woodland is most extensive in Asia (27 percent).

Water is abundant globally but scarce in many regions (UNEP, 1997). Only 7 percent of annually renewable freshwater is used worldwide each year. As Rosegrant (1997) explains, however, increased use is difficult because most of the remainder is lost to evaporation or flooding, or is distributed unequally relative to population or across seasons. In contrast to land resources, Rosegrant, Ringler, and Gerpacio (1997) argue that rapid growth in water demand, in combination with the high cost of developing new water sources, could threaten future growth in food production. Agriculture currently accounts for the majority of water used in most low- and middle-income regions.

One final component of natural resources is the earth's atmosphere, a global resource that is being modified by human activities on an unprecedented scale. Most notable are emissions of carbon dioxide from the combustion of fossil fuels, which are associated with global warming and its possible effects on the location, productivity, and variability of agricultural production. Given the potential for farmers to adapt over time, global warming is not expected to constitute a threat to food production on a global scale, although some resource-poor regions, particularly those in tropical latitudes, may suffer reductions in food availability and access (Darwin et al., 1995; Schimmelpfennig et al., 1996).

Produced resources. Selected indicators of produced resources are also presented in table C-2. South Asia has the highest proportion of cropland irrigated (28 percent), while the East Asia and Pacific region applies fertilizer most intensively (206 kilograms per hectare). Sub-Saharan Africa lags in irrigation (one percent of cropland), fertilizer use (15 kilograms per arable hectare), and agricultural mechanization (one tractor per 1,000 hectares of arable land). Per-capita energy use varies by a factor of 10 from Sub-Saharan Africa and South Asia to the Europe and Central Asia region, which uses energy at about half the level of the high-income economies. Even more dramatic are differences in the share of energy derived from fuelwood and charcoal, ranging from 1 percent in the low- and middle-income economies of Europe and Central Asia and the Middle East and North Africa to 25 percent in South Asia and 66 percent in Sub-Saharan Africa. Different patterns of energy use contribute to different forms of resource degradation. Fuelwood and charcoal burning contribute to deforestation, for example, while fossil fuel combustion releases carbon dioxide and other gases and solids that may affect climate.

Social resources. Indicators of social resources are important for food security in two basic ways. First, they indicate the potential for future economic growth and income generation, and thus the ability to command sufficient access to food. And second, they indicate the ability of society to compensate its members when they experience shortfalls in production, availability, or access to food. Table C-3 presents indicators of factors that affect political and economic activity, as well as indicators associated with public goods and services such as health and education. Health expenditures (both public and private) are lowest in the East Asia

Table C-3--Selected Indicators of Social and Human Resources

Indicator	Low- and Middle-Income Economies							HIE	World
	SSA	EAP	SA	ECA	MENA	LAC	All		
Social resources									
Health expenditures *($/capita, 1990)*	24	11	21	142	77	105	41	1,860	329
Water supply *(% of population with access, 1990)*	47	72	74	90	70	76	na	96	73
Sanitation *(% of population with access, 1990)*	35	85	15	85	59	69	na	86	60
Female primary education* *(% of age group enrolled, 1993)*	65	116	87	97	91	na	99	103	99
Male primary education* *(% of age group enrolled, 1993)*	78	120	110	97	103	na	110	103	109
Democracy index *(rank, 1994; least democratic = 1)*	2	na	3	4	1	5	na	6	na
Obstacles to economic activity *(rank, 1997; worst = 1)*									
Property rights/corruption	1	na	3	3	2	1	na	5	na
Taxes	2	na	2	1	3	5	na	1	na
Human resources									
Population *(millions, mid-1995)*	583	1,706	1,243	488	272	478	4,771	902	5,673
Population growth *(annual % change, 1990-95)*	2.6	1.3	1.9	0.3	2.7	1.7	1.6	0.7	1.5
Urban population growth *(annual % change, 1980-95)*	5.0	4.2	3.4	1.6	4.2	2.8	3.3	0.7	2.5
Labor force in agriculture *(% of total labor force, 1990)*	68	70	64	23	36	25	58	5	49
Adult literacy *(%, 1995)*	57	83	49	na	61	87	70	na	na
Life expectancy *(years, 1995)*	52	68	61	68	66	69	65	77	67
Disease burden *(disability-adjusted life years lost due to malnutrition-related causes, per 1,000 population, 1990)*	87	9	52	2	29	19	na	1	28

* Enrollment may exceed 100% because of the inclusion of students younger or older than the standard primary-school age group.

Notes: SSA = Sub-Saharan Africa; EAP = East Asia and Pacific; SA = South Asia; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and Caribbean; HIE = High-Income Economies; na = not available.

Sources: World Bank (1993 and 1997a).

and Pacific region, at $11 per capita. Access to clean water is lowest in Sub-Saharan Africa, while South Asia suffers the lowest access to sanitation services. Male enrollment in primary education is near complete everywhere except in Sub-Saharan Africa, but female enrollment lags in most regions.

Table C-3 also includes data on the State's performance in relation to political and economic participation. The democracy index is an ordinal ranking based on a variety of indicators described in the World Bank's 1997 *World Development Report* (1997a, p. 112), and ranges from a low in the Middle East and North Africa to a high (relative to other low- and middle-income economies) in Latin America and the Caribbean. The *Report* also presents results from a survey of business people on obstacles to economic activity. Property rights and corruption were identified as the principal obstacles in Sub-Saharan Africa and in Latin America and the Caribbean, while taxes were identified as the principal obstacle in Europe and Central Asia. (Infrastructure was identified as the principal constraint in South Asia and the Middle East and North Africa.)

Human resources. Selected indicators of human resources are also presented in table C-3. World population was 5.7 billion in mid-1995, about half of it located in Asia. Annual population growth rates vary widely across low- and middle-income economies, ranging from 0.3 percent in Europe and Central Asia to 2.6 percent in Sub-Saharan Africa and 2.7 percent in the Middle East and North Africa. Global population growth has slowed more than previously expected, to 1.5 percent per year, due to faster than expected fertility declines in South Asia and Sub-Saharan Africa (United Nations, 1996). Urban populations are growing particularly rapidly, especially in Sub-Saharan Africa, East Asia and the Pacific, and the Middle East and North Africa. Nevertheless the bulk of the labor force in the most heavily populated regions (i.e. Asia and Sub-Saharan Africa) remains in agriculture, suggesting the importance of improved agricultural performance to simultaneously increase rural incomes and urban food supplies.

In addition to indicators of quantity, table C-3 also presents crude indicators of the quality of human resources. Poverty and the burden of malnutrition-related disease are relatively high in Sub-Saharan Africa and South Asia, while life expectancy and adult literacy rates are relatively low. Similar patterns are evident in child stunting (low height for age) and wasting (low weight for height) (World Bank, 1993). The levels of these indicators are both consequences and, through their impact on labor productivity, potential causes of continuing pressure on natural and other resources in these regions (Dasgupta, 1993; Mink, 1993).

Implications for Sustainability and Food Security

The data presented in the previous section provide only a general sense of the ways in which resource indicators supplement indicators of food availability and access to provide a longer-term perspective on food security. Because of the close and reciprocal links between access to resources and access to food, it is difficult to devise a uniquely satisfactory scheme for distinguishing resource categories. Likewise, just as measures of food availability and access are insufficient to capture the notion of food security, it is impossible to equate any one resource indicator (or even any one resource category) with the notion of food security as a whole. In fact, food security is indicated not just by the quality of human resources, but rather by the extent and composition of all resources to which individuals, households, and countries have access.

The pitfalls of relying too heavily on any single resource indicator as a measure of food security are readily apparent. In Asia, for example, India and Bangladesh have the largest projected status-quo food gaps for 1997 (see statistical tables 43 and 44) and the highest shares of total land used as cropland (57 percent and 74 percent, respectively; World Bank, 1997a). The apparent correlation between these two indicators weakens in Sub-Saharan Africa, however, and fails entirely in Latin America and the Caribbean. Ethiopia and Rwanda have Sub-Saharan Africa's largest projected status-quo food gaps for 1997 (see statistical tables 10 and 13), but while Rwanda has the region's highest cropland-to-total land ratio (47 percent), Ethiopia's ratio (11 percent) is about average. Among Latin American and Caribbean countries, Haiti has one of the largest projected status-quo food gaps for 1997 (see statistical tables 57 and 61) and the second-highest cropland-to-total land ratio (33 percent), but Peru, where the food gap to maintain consumption is projected to reach half a million tons by 2007, has a cropland ratio of just 3 percent—less than half the regional average. Similar contradictions are apparent for other regions and resource indicators, suggesting the need for more sophisticated measures of the relationship between resources and food security.

One promising approach is to move beyond conventional quantity measures of individual resources, such as total land area (which is subject to wide variations in land quality), towards measures that reflect both the quality and quantity of multiple resources simultaneously. As noted previously, economists have begun trying to better incorporate changes in resource stocks into measures of national income and wealth. Table C-4 presents recent World Bank estimates of the contributions of different resource categories to wealth. Agricultural land accounts for most of the value of natural resources in most areas (Dixon and Hamilton, 1996). The share of total wealth represented by human resources is consistently high across regions, between 60 and 79 percent everywhere except in the Middle East, although total wealth varies widely. Estimates of genuine savings rates, which reflect changes in the value of human and natural resources, as well as produced resources, also vary widely (table C-1). Low genuine savings rates indicate the potential for deepening food security problems in some areas, particularly in Sub-Saharan Africa.

Such estimates are admittedly preliminary, but they offer interesting parallels between the analysis of resources and the analysis of food security. Just as the concept of food

Table C-4--Sources of Wealth

Region	Total wealth	Natural resources	Produced resources	Human resources	Natural resources	Produced resources	Human resources
		1,000 dollars per capita, 1994			Percentage of total wealth, 1994		
Sub-Saharan Africa							
East and Southern Africa	30	3	7	20	10	25	66
West Africa	22	5	4	13	21	18	60
East Asia	47	4	7	36	8	15	77
South Asia	22	4	4	14	16	19	65
Europe and Central Asia	na	na	na	na	na	na	na
Middle East and North Africa							
Middle East	150	58	27	65	39	18	43
North Africa	55	3	14	38	5	26	69
Latin America and Caribbean							
South America	95	9	16	70	9	17	74
Central America	52	3	8	41	6	15	79
Caribbean	48	5	10	33	11	21	69
High-Income Economies							
North America	326	16	62	249	5	19	76
Pacific OECD	302	8	90	205	2	30	68
Western Europe	237	6	55	177	2	23	74

na = not available.
Source: World Bank (1997b).

security has evolved in recent years from a relatively static focus on food availability to incorporate longer term concerns about access, so has interest grown in developing economic and environmental indicators that move beyond current income to reflect longer term changes in the quality and quantity of natural and other resources. While these two processes emerged from different concerns—the former primarily with hunger at the household and local levels, the latter largely with environmental degradation at the national and global levels—they are closely related.

Specifically, both represent components of an integrated problem in resource management, in which natural, produced, social, and human resources can be used in various ways to achieve a variety of objectives, including food security (World Bank, 1997b). At the core of this problem is the concept of sustainability. Serageldin (1996) distinguishes degrees of sustainability based on whether resources are seen as substitutes or complements to one another. "Strong sustainability" requires that each kind of resource remains intact, based on the assumption that resource categories are complements rather than substitutes. By contrast, "weak sustainability" maintains the total value of resources, regardless of its composition, implying that resource categories are substitutes rather than complements, and that individual resources (and even resource categories) can be depleted without threatening wealth as a whole.

Serageldin (1996) proposes a "sensible" middle approach that requires both the maintenance of total wealth and concern with the composition of wealth, recognizing that different resource categories are both substitutes and complements, and that critical levels of each category should be defined and maintained. Such a definition begins to sound very much like evolving definitions of food (and livelihood) security, which increasingly recognize the need to meet both food and non-food requirements in order to sustain human and other resources over time. In its shared attention to critical thresholds, tradeoffs, and sustainability over the long term, the convergence between these areas of research offers promise for improved understanding of the relationship between sustainable resource use and food security in the future.

References

Bumb, Balu, and Carlos Baanante. 1996. *The Role of Fertilizer in Sustaining Food Security and Protecting the Environment to 2020*. Food, Agriculture, and Environment Discussion Paper No. 17. Washington, DC: International Food Policy Research Institute.

Crosson, Pierre. 1997. "Land Degradation and Food Security." Presentation at the International Symposium on Global Challenges in Ecosystem Management, Toronto, Canada, 25-26 July 1997.

Darwin, Roy, Marinos Tsigas, Jan Lewandrowski, and Anton Ranses. 1995. *World Agriculture and Climate Change: Economic Adaptations*. Agricultural Economic Report No. 703, Economic Research Service, U.S. Department of Agriculture.

Dasgupta, Partha. 1993. *An Inquiry into Well-Being and Destitution.* Oxford: Clarendon Press.

de Waal, Alex. 1989. *Famine that Kills: Darfur, Sudan, 1984-85*. Oxford: Clarendon Press.

Dixon, John A., and Kirk Hamilton. 1996. "Expanding the Measure of Wealth." *Finance and Development* 33(4): 15-18. December.

FAO (Food and Agriculture Organization of the United Nations). 1997. FAOSTAT Database <http://apps.fao.org>. 27 August.

Lal, Rattan. 1995. "Erosion-Crop Productivity Relationships for Soils of Africa." *Soil Science Society of America Journal* 59(3): 661-667.

Maxwell, Daniel, and Keith Wiebe. Forthcoming. "Land Tenure and Food Security: A Conceptual, Empirical, and Methodological Review." Land Tenure Center Research Report, University of Wisconsin-Madison.

Mink, Stephen D. 1993. *Poverty, Population, and the Environment*. World Bank Discussion Paper No. 189. Washington, DC.

Perrings, Charles. 1989. "An Optimal Path to Extinction? Poverty and Resource Degradation in the Open Agrarian Economy." *Journal of Development Economics* 30.

Pinstrup-Andersen, Per, and Rajul Pandya-Lorch. 1997. "Food Security: A Global Perspective." Plenary paper prepared for the 23rd International Conference of Agricultural Economists, Sacramento, California, August 10-16.

Rosegrant, Mark W. 1997. *Water Resources in the Twenty-First Century: Challenges and Implications for Action*. Food, Agriculture, and Environment Discussion Paper No. 20. Washington, DC: International Food Policy Research Institute.

Rosegrant, Mark W., Claudia Ringler, and Roberta V. Gerpacio. 1997. "Water and Land Resources and Global Food Supply." Paper prepared for the 23rd International Conference of Agricultural Economists, Sacramento, California, August 10-16.

Scherr, Sara J., and Satya Yadav. 1996. *Land Degradation in the Developing World: Implications for Food, Agriculture, and the Environment to 2020*. Food, Agriculture, and Environment Discussion Paper No. 14. Washington, DC: International Food Policy Research Institute.

Schimmelpfennig, David, Jan Lewandrowski, John Reilly, Marinos Tsigas, and Ian Parry. 1996. *Agricultural Adaptation to Climate Change: Issues of Longrun Sustainability*. Agricultural Economic Report No. 740. Economic Research Service, U.S. Department of Agriculture.

Sen, Amartya. 1981. *Poverty and Famines*. Oxford: Clarendon Press.

Serageldin, Ismail. 1996. *Sustainability and the Wealth of Nations*. Environmentally Sustainable Development Studies and Monographs Series No. 5. Washington, DC: The World Bank.

UNEP (United Nations Environment Programme). 1997. *Global Environment Outlook*. New York: Oxford University Press.

United Nations. 1996. "World Population Growing More Slowly But Could Still Reach 9.4 Billion by 2050." Press Release, Population Division, Department for Economic and Social Information and Policy Analysis, November 13.

World Bank. 1997a, 1995, 1993, and 1992. *World Development Report*. Oxford University Press.

World Bank. 1997b. *Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development*. Environmentally Sustainable Development Studies and Monographs Series No. 7. Washington, DC: The World Bank.

World Bank. 1986. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*. Washington, DC: The World Bank.

World Food Summit. 1996. *Rome Declaration on World Food Security and World Food Summit Plan of Action*. Rome, 13-17 November.

Income Inequality and Food Security

by
May Mercado Peters and Shahla Shapouri[1]

Income inequality is one of the major contributing factors to poverty and food insecurity in low-income countries. The objective of this study is to measure income inequality among countries and discuss the factors that could affect income inequality as they relate to food security. An improved understanding of these relationships will aid in projections of consumption as well as in the formulation of policies to reduce undernutrition. Income inequalty was measured by calculating the gini coefficient for a cross-section of 82 countries.

Introduction

Lack of access to food due to inadequate purchasing power has been identified as the prime cause of food insecurity. Even in countries where national per capita income is relatively high, including some in Southeast Asia and Latin America, the inequality in the distribution of income causes a substantial proportion of their populations to live in poverty and suffer from problems associated with chronic undernutrition. Projections of food availability and access in low-income countries, such as India, Pakistan, Cote d'Ivoire, Nigeria, and El Salvador, show that if food supplies were distributed evenly, all households would be able to meet their nutritional requirements. In these countries, a small reduction in income inequality, even in the absence of growth, can lead to substantial declines in poverty (Bruno, Ravallion, and Squire, 1996) and undernutrition. This article will attempt to measure the degree of income inequality; identify the key factors affecting income inequality; and link the relationship between these factors and the food security situation of developing countries. The findings of this paper can be used to explain how income inequality within a country evolves during the growth process. And, by knowing how the distribution of income will change, projections of the demand for food and the food security outlook can be improved.

Measurement of the Degree of Income Inequality

Income inequality is measured by calculating a Gini coefficient (measure of income inequality) for 82 countries using 1995 data (range of Gini is zero—complete equality—to one—perfect inequality). Of the 82 countries used in the analysis, 62 are developing countries from North Africa, Sub-Saharan Africa, Asia, Latin America, and the Caribbean. High-income countries include 17 OECD countries and 3 Asian newly industrialized countries (table D-1).

A broad range of income inequality is observed among the low-income countries analyzed (table D-2). The Gini coefficients range from a low of 0.27 in countries such as Bangladesh, Madagascar, Malawi, and Rwanda to a high of 0.54 in Guatemala. The degree of inequality also varies by region, with Asia having the lowest rate of inequality of 0.31 among low-income regions, while the average for the 13 Latin American and Caribbean countries, at 0.46, is the highest. The 17 OECD countries, while having significantly higher per capita incomes than the other countries, also exhibit significant variation in income inequality, with an average Gini coefficient of 0.32. Despite this variation, the Gini coefficients for the high-income countries are generally lower than the coefficients for the low-income countries.

Factors Affecting Income Inequality

While the Gini coefficient measures the degree of income inequality, it provides very little insight into the factors that determine it and cause it to change. A broad examination of personal income clearly suggests that income distribution is determined by the distribution of resources and assets among people and the prices received for their services. The change in the distribution of income from the rich to poor will happen when there is a change in the factors that affect the quantity, value, and productivity of assets controlled by the poor (Adelman and Morris). A recent USDA-ERS paper analyzed the significance of three broad groups of variables that could fit into this transfer principal: economic development and technology factors, economic growth variables, and socioeconomic factors. The question is, how can these factors can influence income inequality?

Economic Development and Technology Factors—Economic development, which is often measured by per capita income, is cited in the literature as one of the major determinants of income inequality. A widely held view is that economic growth at least in early stages of the development process causes income inequality to increase to the detriment of the poorest segments of the population. This is based in large

[1]Agricultural economists with the Market and Trade Economics Division, USDA.

The Gini Coefficient as a Measure of Income Inequality

The Gini coefficient has been used in nearly all research testing the relationship between income inequality and income (Braun). It is derived from the Lorenz curve, and represents the area between the diagonal and the Lorenz curve (figure D1). The Gini coefficient ranges from 0 to 1, with 1 indicating perfect income inequality. As a measure of inequality, the Gini index is more sensitive to changes in income shares in the middle of the distribution than to changes in shares at the upper or lower ends. Thus relatively small changes in its value can reflect substantial changes in the share of income received by the poorest households.

The cross-country income distribution published by the World Bank (1996) was used to calculate the Gini index for each country. The formula used was

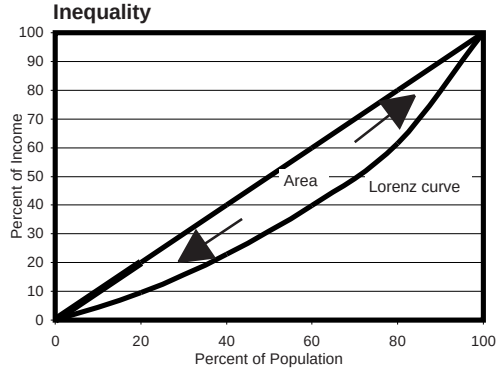
$$G_o = (2 * \text{cov} (Y_t, F (Y)) / Y)$$

where,

G_o = Gini index of income inequality
Y_t = mean income in U.S. dollars in tth quintile
F (Y) = cumulative distribution of income
Y = mean income in U.S. dollars.

Note: Further information concerning the derivation of the Gini formula used can be found in the articles by Lerman, et al., 1985.

Figure D-1-- Measuring Degree of Income Inequality



part on a conjecture made by Kuznets. He hypothesized that when national income was low, economic growth would cause income inequality to increase, but at some point during the growth process a point would be reached where continued growth would cause income inequality to begin to decline, forming an inverted U-shape. Inequality is low when national income is low because nearly everyone is living at or near the subsistence level. In the initial stages of the growth process, rapid population growth, urbanization, and industrialization lead to increased income inequality, but as the process continues, social and political factors emerge which then act to reduce income inequality.

Another development indicator is the size of the agriculture sector in relation to the rest of the economy. This is because in the early stages of the economic development, the size of the agricultural sector is large and most of the poor live in rural areas (as is true for most African countries for example). As the economic growth process progresses, labor, along with other resources, shift out of agriculture into the higher growth and higher wage sectors. This shift could cause the income/wage gap between agriculture and the high growth sectors to widen and as a consequence, income inequality to increase. At later stages of the development process (take the United States for example), agricultural productivity will converge with that of the high growth sectors, causing income inequality between the two sectors to decline (Adelman and Robinson). At this point, when the agriculture sector's size relative to the rest of the economy is small, the convergence of incomes is likely to have little effect on the overall distribution of income in the economy. As a result, one would expect a negative relationship between the relative size of the agricultural sector to the rest of the economy and income inequality.

Another significant variable is productivity of the agriculture sector. The agricultural sector in most low-income countries employs over half of the labor force. An improvement in agricultural productivity brought about by increased investment will raise incomes in the agricultural sector, thereby reducing income inequality.

Economic Growth Variables—The rate of economic growth also affects income inequality. This is because with more rapid rates of economic growth, the absorption of labor into the higher growth sectors occurs at faster rates. Unless a country is at a very low level of development, one would expect income inequality to be lower in those countries which are growing the fastest.

Another influential variable is the degree of openness to trade. This is because in developing countries trade protection lowers the return to the most abundant factor of production—labor—and increases it for the less abundant resource—capital. Therefore, with more open economies, income inequality will likely be lower.

Socioeconomic and Political Factors—Socioeconomic and political factors will have an important effect on the distribution of income in a country. The influence of the degree of social development on income inequality can be seen by comparing Sri Lanka to Brazil. Per capita income in Brazil is five times greater than per capita income in Sri Lanka. However, the degree of social development in Sri Lanka is much higher than in Brazil (Geyndt, 1996), and, in turn, the level of income inequality in Sri Lanka is much lower.

Political stability, which is closely related to economic growth and the food security situation in a country, is also very important. Political instability not only creates econom-

Table D-1--List of Countries Included in the Analysis and their Gini Coefficients

NORTH AFRICA		**EAST AFRICA**		**LATIN AMERICA**	
Algeria	0.36	Burundi	0.39	Bolivia	0.46
Egypt	0.36	Ethiopia	0.29	Colombia	0.47
Morocco	0.36	Kenya	0.51	Costa Rica	0.36
Tunisia	0.37	Rwanda	0.27	Dominican Rep.	0.46
CENTRAL AFRICA		Somalia	0.53	Ecuador	0.46
Cameroon	0.34	Sudan	0.53	El Salvador	0.46
Central African Republic	0.40	Tanzania	0.53	Guatemala	0.54
Congo (fka Zaire)	0.53	Uganda	0.30	Haiti	0.46
WEST AFRICA		**SOUTHERN AFRICA**		Honduras	0.53
Benin	0.40	Angola	0.40	Jamaica	0.38
Burkina Faso	0.40	Lesotho	0.51	Nicaragua	0.46
Cape Verde	0.34	Madagascar	0.27	Panama	0.52
Chad	0.40	Malawi	0.27	Peru	0.42
Cote d'Ivoire	0.34	Mozambique	0.51	**OECD**	
Gambia	0.34	Swaziland	0.51	Australia	0.36
Ghana	0.34	Zambia	0.40	Belgium	0.27
Guinea	0.51	Zimbabwe	0.51	Canada	0.33
Guinea-Bissau	0.51	**ASIA**		Denmark	0.32
Liberia	0.53	Afghanistan	0.40	Finland	0.30
Mali	0.39	Bangladesh	0.27	France	0.34
Mauritania	0.39	India	0.29	Germany	0.31
Niger	0.39	Indonesia	0.30	Italy	0.32
Nigeria	0.39	Nepal	0.28	Japan	0.27
Senegal	0.39	Pakistan	0.29	Netherlands	0.27
Sierra Leone	0.53	Philippines	0.37	New Zealand	0.37
Togo	0.39	Sri Lanka	0.28	Norway	0.29
		Vietnam	0.33	Spain	0.26
		NIC (other)		Sweden	0.28
		Hong Kong		Switzerland	0.36
		Korea		United Kingdom	0.37
		Singapore		United States	0.35

Table D-2--Regional Averages

Region	Number of countries	Avg Gini index	Avg GNP/cap 1995 U.S. dollars	Population in rural area 1995 Percent	1996 Freedom House Index
North Africa	4	0.36	1,298	49	5.6
Sub-Saharan Africa	36	0.42	393	71	4.9
Asia	9	0.31	439	74	4.8
Latin America	13	0.46	1,221	47	3.3
Developing Countries	62	0.41	656	65	4.6
OECD	17	0.32	22,279	20	1.2
New Industrialized States	3	0.36	15,600	9	3.3
All	82	0.39	6,083	54	3.8

The Freedom House Index (FHI) data came from "Freedom in the World: Annual Survey of Political Rights and Liberties, 1995-1996," published by Freedom House, New York. The FHI measures the degree of political freedom in a country. The index takes into account political rights and civil liberties in different countries of the world. It ranges from 1 to 7, with 1 representing the most free and 7 the least free.

ic hardship, but it places a disproportionate share of the burden on the poor—the segment of the population most vulnerable to food insecurity. For example, local wars and breakdown of law and order have disrupted the economies of Somalia and Rwanda, leading to impoverishment, famine, and widespread malnutrition.

Implication of Income Inequality On Food Security

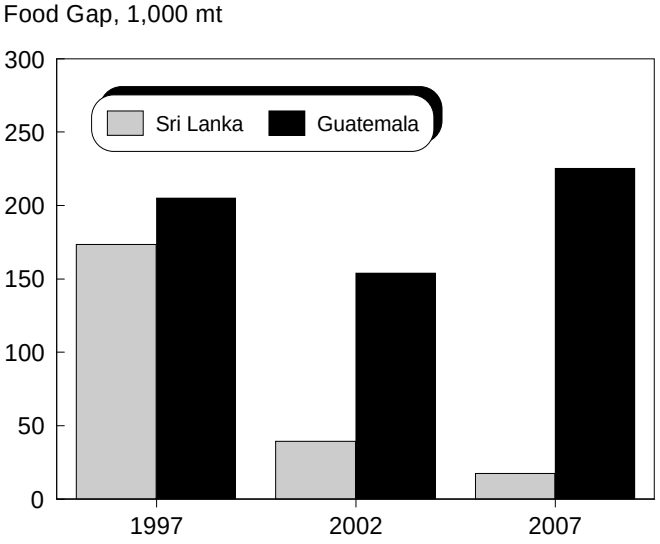
Food security is not directly determined by changes in income, but by the effect a change in income has on people's access to food. Access to food, and consequently, consumption of food, is more sensitive to changes in income the higher the income elasticity is for food. The income

elasticity for food tends to be highest for the segments of the population with the lowest incomes. As a result, a change in the distribution of income that leaves per capita income unchanged, but causes income inequality to increase, will cause food consumption of the segments of the population which are most food insecure to fall. However, as household incomes increase, the incidence of poverty and undernutrition should fall and the rate at which the demand for food increases can also be expected to slow down.

Statistics relating some of the important determinants of income inequality to poverty and food security for selected countries are shown in table D-3. The relationship of income inequality to the incidence of poverty and food security can be seen by comparing the situations in the Latin American countries of Peru and Costa Rica. Both countries have similar per capita incomes, but Peru has a much higher degree of income inequality than Costa Rica. As a result, the percentage of the population living below the poverty line in Peru, 49 percent, is much higher than in Costa Rica, 19 percent. A similar result is found by comparing the Sub-Saharan African countries of Nigeria and Kenya. Both have similar incomes, but because income inequality in Kenya is higher, the percentage of the population living below the poverty line is also much higher than in Nigeria.

Comparing Sri Lanka with Guatemala shows the importance of human development and investment in the agricultural sector to the reduction of poverty and food insecurity. Both countries have similar levels of income in terms of purchasing power parity. In Sri Lanka, investment in agriculture and education is much higher than in Guatemala (World Bank Development Report, 1997). The fertility rate in Sri Lanka is 2.3 births/woman compared to 4.7 in Guatemala; the percentage of the population living below the poverty line is lower in Sri Lanka, 22 percent versus 53 percent in Guatemala. Consequently, the food gap is much higher in Guatemala than in Sri Lanka (figure D-2).

Figure D-2--Food Gap of Sri Lanka and Guatemala



Source: USDA.

In summary, income inequality compounds the problems of food insecurity in low-income countries. Various economic, social, and political factors operating within an economy influence the distribution of income in that economy. These factors are important, particularly in developing countries, which are not only confronted with income distribution problems, but face very low per capita incomes and declining food consumption. They emphasize the importance of increasing the rate of economic growth in conjunction with investing to increase the productivity of the agriculture sector and promoting human capital development. Investing in these areas should stimulate economic growth and raise the incomes of the poor relatively faster than other income groups. It will also lead to the reduction of poverty and increase access to food, thereby reducing the main cause of chronic undernutrition.

References

Adelman, Irma and C.T. Morris. 1973. *Economic Growth and Social Equity in Developing Countries*. Stanford, California: Stanford University Press.

Adelman, Irma and Sherman Robinson. 1989. "Income Distribution and Development" in *Handbook of Development Economics, Volume II*. Edited by H. Chenery and Srinivasan, T.N. _____: Elsevier Science Publishers B.V.

Bruno, Michael, Martin Ravillion, and Lyn Squire. 1996. "Equity and Growth in Developing Countries, Old and New Perspectives on the Policy Issues." *Policy Research Working Paper, No. 1563*. The World Bank. Washington, D.C.

Braun, Denny. 1988. "Multiple Measurement of U.S. Income Inequality," *The Review of Economics and Statistics*. Vol. 70, No. 3

The Food and Agriculture Organization (FAO). 1996. Agrostat computer database. The United Nations FAO, Rome, Italy.

Geyndt, Willy de. 1996. "Social Development and Absolute Poverty in Asia and Latin America." World Bank Technical Paper No. 328. The World Bank, Washington, D.C.

Lerman, Robert I. and Shlomo Yitzhaki. 1985. "Income Inequality Effects by Income Source: A New Approach and Application to the United States," *Review of Economics and Statistics*. Vol. 67, No.1.

_____. 1996 and 1997. *The World Development Report*. The World Bank, Washington, D.C.

_____. 1996. The World Bank "STARS" computer database. The World Bank, Washington, D.C.

Table D-3--Agricultural and Economic Indicators, Selected Countries

Country	Per captia income GNP 1995	Per captia income PPP 1995	Gini index* 1995	Illiteracy rate 1995	Agricultural land irrigated 1994	Fertilizer use 1994	Ag share of GDP 1995	Population living below poverty line	Total food gap** (nutritional)	Food gap** lowest 20% of population	Children undern. 1995
	$US	$US		Percent	Percent	kg/ha	Percent	Percent	1,000 tons	1,000 tons	Percent
Asia											
Bangladesh	240	1,380	0.27	62	33.9	108	30	48	5,456	1,593	67
India	340	1,400	0.29	48	28.3	80	27	53	0	0	63
Sri Lanka	700	3,250	0.30	10	29.2	113	22	22	97	63	48
Indonesia	980	3,800	0.28	16	15.2	85	18	15	0	0	46
Latin America and the Caribbean											
Peru	2,310	3,770	0.42	11	41.0	51	7	49	466	202	11
Guatemala	1,340	3,340	0.54	44	6.5	96	25	53	483	165	n.a.
Costa Rica	2,610	5,850	0.36	5	23.8	38	15	19	n.a.	n.a.	2
Dominican Rep.	1,460	3,870	0.46	18	16.9	64	15	20	86	36	10
Sub-Saharan Africa											
Kenya	280	1,380	0.51	22	1.5	31	24	50	745	304	22
Congo (fka Zaire)	120	490	0.53	n.a.	0.1	0.5	n.a.	n.a.	2,211	679	n.a.
Tanzania	120	640	0.53	32	4.3	11	52	51	1,028	364	28
Nigeria	260	1,220	0.40	43	0.7	12	33	29	692	672	43
North Africa											
Egypt	790	3,820	0.36	49	100.0	243	16	8	0	0	10
Tunisia	1,820	5,000	0.37	33	7.8	18	15	4	0	0	8

* Calculated using World Bank data, 1996.

** Results of the 1997 ERS Food Security Assessment Model.

Source: World Bank. World Bank Development Indicators, 1997 and World Development Report 1997.