Resource Quality, Agricultural Productivity, and Food Security in Developing Countries

Keith Wiebe and Abebayehu Tegene[1]

Abstract: Raising agricultural productivity improves food security both through increased incomes for farmers and through increased food supplies for consumers. Productivity depends in turn on a variety of factors, including the quantities of fertilizer, water, and other inputs used in agricultural production. Recent advances in data and analysis show how productivity also depends critically on the quality of inputs used, including the quality of natural resources such as land. Within Sub-Saharan Africa, the productivity of agricultural land is found to be 28 percent higher in countries with favorable soils and climate than it is in countries with poor land quality, everything else being equal, and in Asia the difference is 34 percent. Productivity is especially responsive to increases in the use of fertilizer and irrigation in countries with poor land, while productivity in countries with good land is more responsive to improvements in labor quality and transportation infrastructure. Reductions in the incidence of armed conflict are important in both sets of countries.

Keywords: land quality, agricultural productivity, food security.

Resource Quality and Agricultural Productivity

Sustained growth in agricultural productivity is critical to improving food security for two reasons. First, growth in agricultural productivity translates into increased food supplies and lower food prices for consumers. Second, growth in agricultural productivity means higher incomes and thus improved ability to purchase food and other basic necessities, for many food-insecure people who earn their livelihoods through agricultural production.

Agricultural productivity depends in turn on a variety of factors. Recent studies (e.g. Craig, Pardey, and Roseboom, 1997, and Frisvold and Ingram, 1995) indicate that most differences in agricultural productivity, whether across households or countries or over time, can be attributed to differences in the quantity of conventional inputs used in agricultural production, such as land, labor, fertilizer, and machinery. But agricultural productivity also depends critically on the quality of inputs used, including the quality of natural resources such as land. As simple as this statement seems, the influence of resource quality on agricultural productivity has received insufficient attention in the past because appropriate data have been scarce. However, recent advances in data and analytical methods (see box, "Data and Methods") allow improved understanding of the ways in which agricultural productivity and food security are affected by differences in the quality of resources. Distinguishing the relative impacts of input quantity and quality is important in determining appropriate policy measures to improve agricultural productivity and food security.

Soils and Climate

Land—embodying soils, climate, and other characteristics—is one of the most basic resources used in agricultural production. Figure A-1 illustrates global differences in land quality, based on assessments by USDA's Natural Resources Conservation Service of the suitability of soils and climate for agricultural production. Extensive areas of high-quality land are evident in North America and Europe. Land is of lower quality, on average, in Latin America, Asia, and Sub-Saharan Africa, and is poorest of all in North Africa, the Middle East, and Central Asia.

Figure A-2 illustrates global differences in average annual rainfall. Rainfall may be more equitably distributed on a global scale than is high-quality land, but substantial variations remain within regions and countries. Latin America receives abundant rainfall, on average, with the exception of northern Mexico, northeastern Brazil, and the western coast of South America. Western and central Africa receive more rain than northern, eastern, and southern parts of the continent, while southeast Asia and adjoining areas receive more rain than northern and western portions of India and China.

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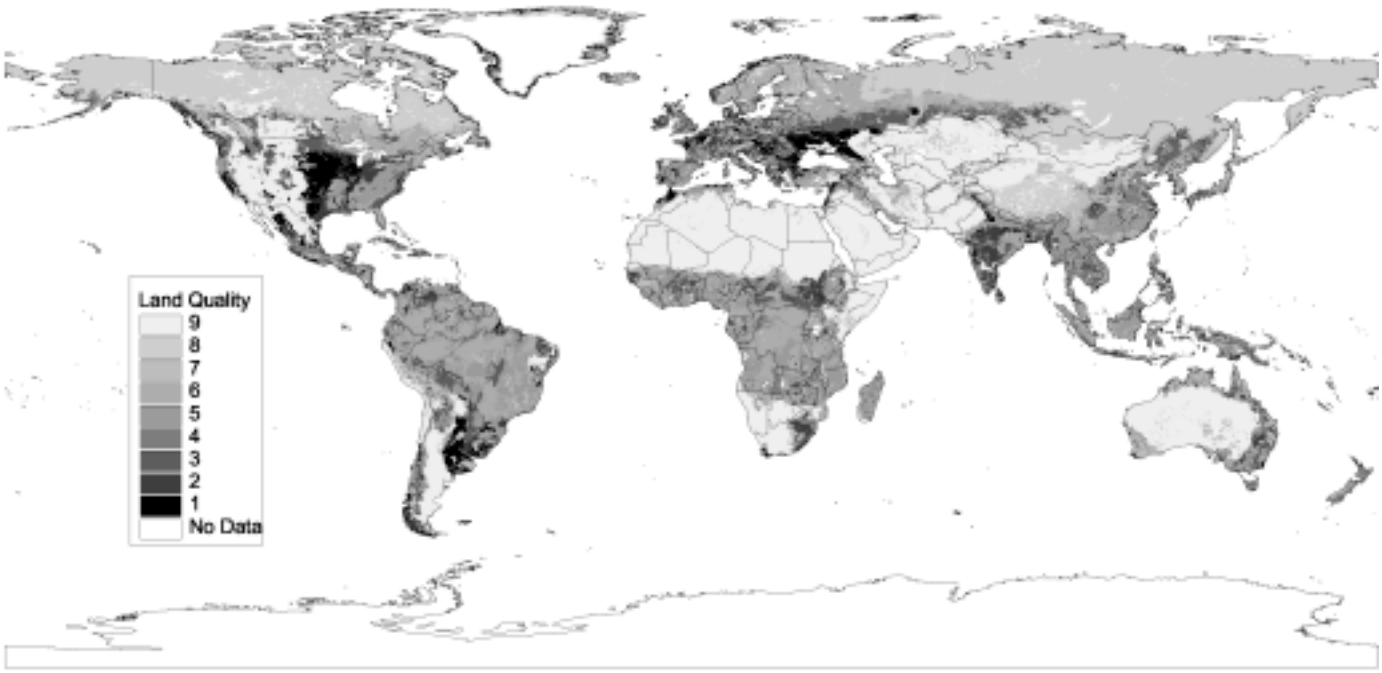
Figure A-1

Global land quality

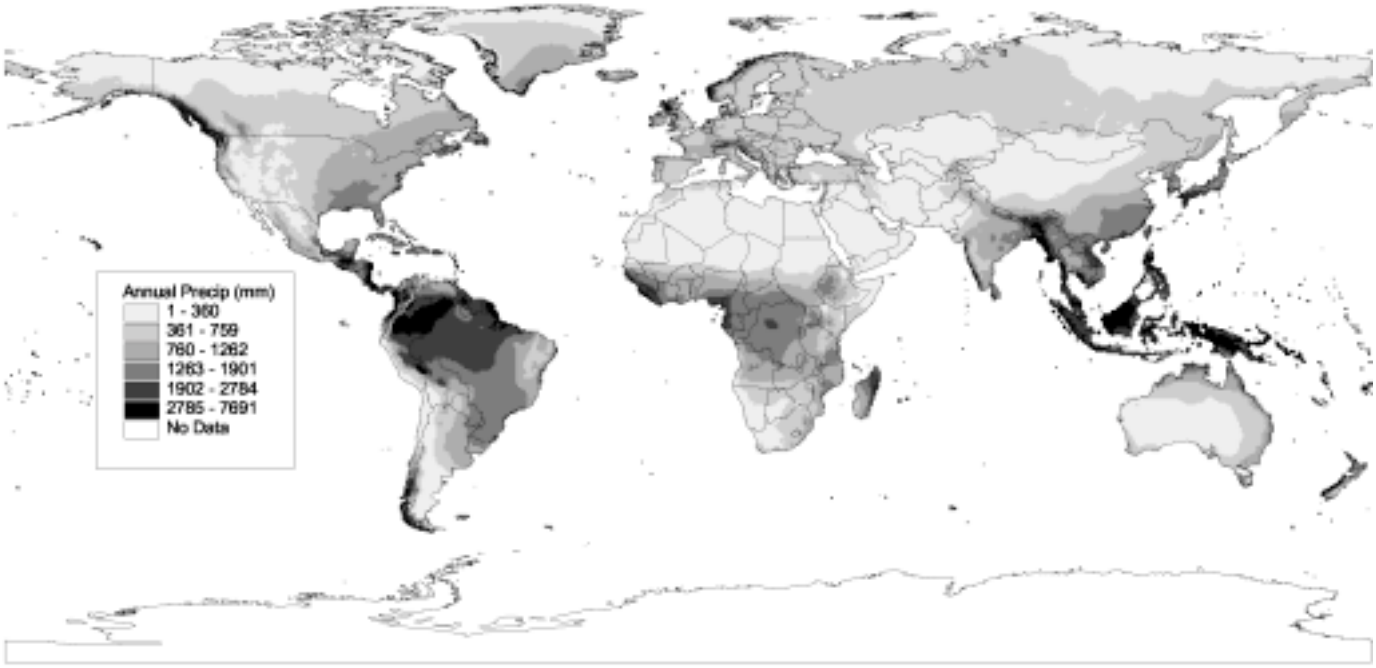


Note: Land quality class 1 represents the land most suitable for agricultural production, i.e. having the fewest inherent soil and climate constraints.

Source: NRCS/USDA.

Figure A-2

Global mean precipitation, 1961-96



Source: Climatic Research Unit, University of East Anglia.

Poor soils and climate do not make agricultural production impossible, but they do mean that costs of production are likely to be higher and/or that yields and net returns are likely to be lower than they would be under more favorable conditions. (In other words, agricultural productivity is likely to be lower.) Figure A-3 illustrates where crop production actually dominates the landscape, based in part on land quality and rainfall patterns, along with other physical and economic characteristics. Large concentrations occur in North America, Europe, India, China, Brazil, and Argentina; cropland is more sparsely distributed in Africa and the Middle East.

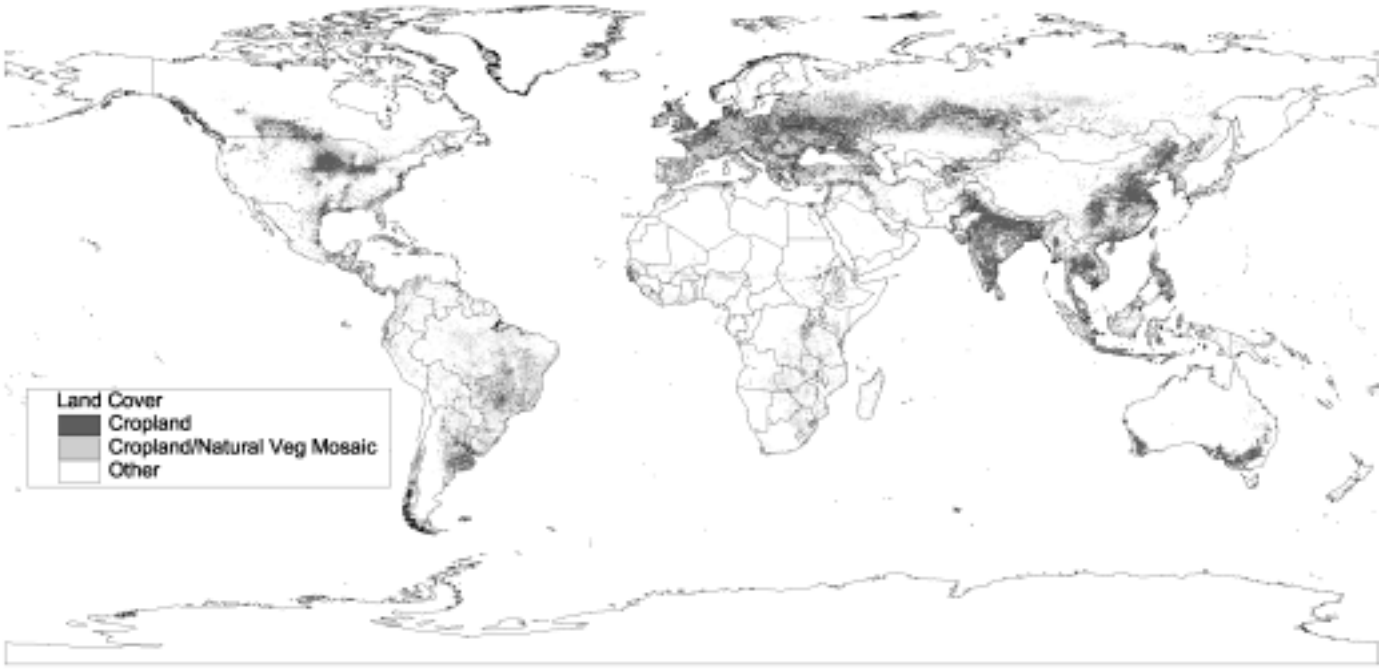
Combining this information on soils, climate, and land cover allows us to compare the quality of cropland by country and region. While the quality of all land is, on average, lowest in the Middle East and North Africa, the quality of cropland is lowest in Sub-Saharan Africa. In 12 of 38 Sub-Saharan African countries studied, less than 1 percent of cropland is classified in the top three land-quality classes, and the median share of cropland that is classified in the top three land-quality classes in Sub-Saharan African countries is about 6 percent (fig.A- 4). This compares with a median of 16 percent in Asia (where 7 of 17 countries studied have more than a quarter of their land in the top three classes), 19 percent in the Middle East and North Africa (where 3 of 8 countries studied have more than a quarter of their land in the top three classes, and 27 percent in Latin America (where 12 of 19 countries studied have more than a quarter of their land in the top three classes). By contrast, the median share of high-quality cropland was 29 percent in the high-income countries, as defined by the World Bank (where 13 of 22 countries studied have more than a quarter of their land in the top three classes) and over 50 percent in Eastern Europe (where all six countries studied have more than a quarter of their cropland in the top three classes).

Not surprisingly, econometric analysis of 110 countries during 1961-97 (see box, “Data and Methods”) reveals that after taking into account other factors such as input levels, differences in the quality of cropland soils and climate are significantly related to differences in agricultural productivity. Within Sub-Saharan Africa, the productivity of agricultural land is 28 percent higher, on average, in countries with high land quality than it is in countries with poor land quality. The productivity difference attributable to high land quality is 34 percent in Asia, and 22 percent in the high-income countries. (In Latin America, where most countries lie above the global median in terms of land quality, only the best soils and climate are significantly associated with increased agricultural productivity.)

These findings confirm our expectations and provide for the first time an empirical estimate of the significance that differences in the inherent physical quality of soils and climate have on agricultural productivity. Perhaps more important, however, are the insights they provide into the impact on agricultural productivity of more conventional inputs, such as quantities of land, labor, fertilizer, and machinery.

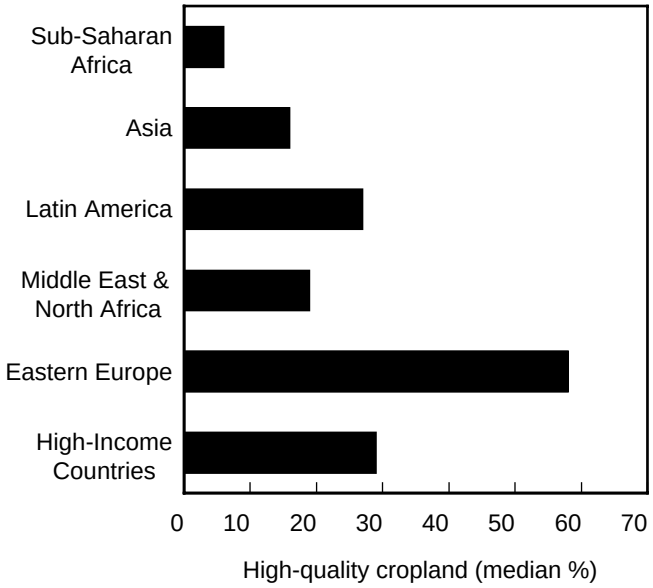
Figure A-3

Global distribution of cropland



Source: USGS/UNL/JRC Global Land Cover Characterization.

Figure A-4
Cropland quality



Conventional Inputs and Other Factors

To capture these impacts, we included in our econometric analysis country-level measures of conventional agricultural inputs like agricultural land, labor, tractors, livestock, and fertilizer. We also included factors such as annual rainfall on cropland, the percentage of each country's agricultural land that is classified as arable land or permanent cropland, the percentage of arable land or permanent cropland land that is not irrigated, life expectancy and illiteracy rates (as measures of labor quality), an indicator of the occurrence of armed conflict (as a measure of institutional stability), and road density and cumulative agricultural research and development expenditures (as measures of infrastructure). (Data on agricultural research and development expenditures were available only for 1961 through 1985, but they revealed a significant and positive association with agricultural productivity during that time.)

Within each region, countries were classified according to the share of their cropland that is highly suitable for agricultural production (see box, "Data and Methods"). Countries where this share exceeds the median value for their region were identified as having good soils and climate; those with less than the median were identified as having poor soils and climate. Each group of countries was then analyzed separately to compare the impacts of individual factors on agricultural productivity by region and land-quality class.

In Sub-Saharan African countries with good soils and climate, agricultural land productivity rises significantly with increases in quantities of labor, livestock, tractors, fertilizer, and annual rainfall. Productivity also improves with irrigation, labor quality (in the form of longer life expectancy and higher literacy rates), and transportation infrastucture and falls significantly with the occurrence of armed conflict. In Sub-Saharan African countries with poor soils and climate, productivity responds even more strongly to fertilizer application, irrigation, and political instability, but it is not sensitive to improvements in tractors, labor quality, or infrastructure. Overall, the results suggest a land quality-related hierarchy of constraints limiting agricultural productivity in Sub-Saharan Africa. In countries poorly endowed with soils and climate, basic inputs such as fertilizer, water (in the form of irrigation), and institutional stability are more important than they are in countries that are relatively well endowed. The evidence suggests that only when these constraints have been overcome do factors such as labor quality, road density, and mechanization become significantly associated with improvements in agricultural productivity—as they are in countries with better soils and climate.

Similar patterns characterize other developing regions. In Latin America, increases in labor, fertilizer, and irrigation are associated with increased productivity of agricultural land in countries with poor soils and adverse climate but not in countries with good soils and beneficial climate. Improvements in literacy and transportation infrastructure are associated with increased productivity in countries with good soils and climate but not in those that are poorly endowed. In Asia, additional land, labor, and roads increase agricultural productivity in counties with good soils and climate but not in those that are poorly endowed, where productivity is relatively more sensitive to increased irrigation. (Specifically, productivity is positively related to an increase in irrigated area, but some authors (e.g. Rosegrant 1997) have noted that degradation of irrigated areas through waterlogging and salinization is also a significant and growing problem.) In the Middle East and North Africa, agricultural productivity is sensitive to levels of labor, tractors, and literacy in well-endowed countries but not in countries with poor soils and climate, where (as in Asia) productivity is relatively more sensitive to increased irrigation.

Analysis of inherent land quality thus improves our understanding of the impacts on agricultural productivity of factors over which policy makers exercise at least some influence. The policy implications of these findings will be discussed further below. Analysis of differences in land quality across countries and regions also provides an initial indication of the potential impact on agricultural productivity of changes in land quality (i.e. land degradation) over time. Data on land degradation rates and impacts remain even more scarce than data on land quality, but most studies to date have found that global average productivity losses due to processes such as soil erosion, nutrient depletion, and salinization are small (on the order of 0.1 - 0.2 percent per year) in relation to historic gains in productivity (on the order of 2 percent per year) due to improvements in technology and input use (den Biggelaar et al. forthcoming, Crosson 1997; Byerlee, Heisey, and Pingali 1999; Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1999). Nevertheless, in some areas with poor or fragile soils and inappropriate agricultural management practices, productivity losses could be significantly higher

Data and Methods

We examined the impact of resource quality on the productivity of agricultural land, using for the first time recent global data on soils, climate, and land cover. We began with data developed by Eswaran et al. (1997), who combined FAO's Digital Soil Map of the World and associated soil characteristics (e.g. slope, depth, and salinity) with spatially referenced longrun average temperature and precipitation data to establish nine land quality classes in terms of their suitability for agricultural production (fig. 1). Wiebe et al. (2000) then overlaid these land quality classes with political boundaries and global land-cover data generated from satellite imagery with a resolution of 1 kilometer United States Geological Survey/University of Nebraska-Lincoln/Joint Research Centre of the European Commission (USGS/UNL/JRC, 1999). They focused on cropland identified according to the International Geosphere-Biosphere Programme land cover classification scheme (fig. 2). The result is a dummy variable based on the share of each country's cropland that is found in the three best quality classes. Countries where this share exceeds the median value for their region are identified as having good soils and climate; those with less than the median are identified as having poor soils and climate.

This static measure, based on cross-country differences in inherent soil and climate characteristics, supplements existing time-variant quality indicators such as the percentage of agricultural land that is cropped (or irrigated) and long-term average or annual rainfall. To better capture this last effect, we also developed a high-resolution measure of annual rainfall by aggregating and overlaying monthly precipitation data on a 0.5-degree grid (fig. 3; Climatic Research Unit 1998) with national boundaries and cropland as described above. The result is a country-specific, time-variant measure of rainfall on cropland.

The dependent variable in our analysis is the productivity of agricultural land, measured as the value of total agricultural production (the sum of price-weighted quantities of all agricultural commodities, expressed in international dollars, after deductions for feed and seed) per hectare of agricultural land (the sum of arable land, permanent cropland, and permanent pasture). Other variables include country-level indicators of agricultural labor, tractors, livestock, and fertilizer, as well as measures of the quality of labor, the institutional environment, and infrastructure. The data are combined in an econometric analysis of 110 countries during 1961-97. Additional detail is provided in Wiebe et al. (2000).

(Scherr 1999, Lal 1998). That such conditions are found in parts of Sub-Saharan Africa, where productivity levels are already low and the need for growth is correspondingly high is cause for concern.

Implications for Food Security and Policy

As noted earlier, agricultural productivity is important for food security both through its impact on food supplies and prices and through its impact on the incomes and purchasing power of those whose livelihoods depend on agricultural production. Through its effect on agricultural productivity, land quality is thus related directly to both food availability and food access. Land quality is, on average, lower in low-income, food-deficit countries than it is in high-income countries, and agricultural productivity is more sensitive to differences in land quality. These relationships have important implications for policymakers concerned with improving food security, both through protection and/or improvement of land quality itself and through recognition of the distinct roles played by more conventional agricultural inputs in areas that differ in land quality.

In Sub-Saharan African countries with relatively poor soils and adverse climate, for example, the policy-sensitive variable most strongly associated with agricultural productivity is irrigation, followed by armed conflict and fertilizer use. Among the policy measures most important for increased agricultural productivity in those countries are thus investments in the efficient delivery and use of water and fertilizer, combined with efforts to improve institutional stability through the cessation of armed conflict. In Sub-Saharan African countries with good soils and climate, these factors remain important, but agricultural productivity becomes relatively more sensitive to improvements in labor quality and infrastructure. Policymakers in those countries may need to focus additional resources on investment in education, health, extension services, and transportation.

Similar conclusions apply in other regions as well. In Latin American countries with relatively poor soils and climate, agricultural productivity and thus food security are likely to respond most strongly to policy measures to improve efficiency in the use of fertilizer and water and to reduce the occurrence of armed conflict. In Latin American countries with better land, productivity responds much more strongly to improvements in labor quality, infrastructure, and mechanization, suggesting the need for investments in education, transportation, and capital. Improvements in irrigation, education, and conflict reduction are important in Asian countries with poor land, while improved transportation remains important in Asian countries with good land. Increased application of fertilizer is not associated with improved agricultural productivity in Asia, regardless of land quality, reflecting the relatively high levels of use already observed there. In the Middle East and North Africa, not surprisingly, improvements in irrigation offer the greatest potential gains in agricultural productivity.

Results and implications are generally consistent with the expectation that the greatest improvements in agricultural productivity will be realized by relaxing the constraints that bind most tightly and those constraints will vary from region to region according to differences in resource endowments and other factors. Neither is it surprising that the quality of soils and climate should play a key role in defining these differences. Yet only recently, with improvements in spatial data and methods, has characterizing these differences with increased precision at the multi-country scale become possible. Analysis to date supports the conclusion that policymakers in low-income, food-deficit countries face a hierarchy of priorities that depends critically on the quality of soils and climate but that is broadly consistent across regions. Continued research will be needed to further refine our understanding of the relationships of resource quality, agricultural productivity, and food security.

References

Byerlee, Derek, Paul Heisey, and Prabhu Pingali (1999). "Realizing Yield Gains for Food Staples in Developing Countries in the Early 21st Century: Prospects and Challenges." Presented to the Study Week on Food Needs of the Developing World in the Early 21st Century, the Vatican, January 27-30.

Climatic Research Unit (1998). Climate Impacts LINK Project (U.K. Department of the Environment Contract EPG 1/1/16), Climatic Research Unit, University of East Anglia.

Craig, Barbara, Philip G. Pardey, and Johannes Roseboom (1997). "International Productivity Patterns: Accounting for Input Quality, Infrastructure, and Research." *American Journal of Agricultural Economics,* Vol. 79, pp. 1064-76.

Crosson, Pierre (1997). "Will Erosion Threaten Agricultural Productivity?" *Environment*, Vol. 39, No. 8, pp. 4-31 (October).

den Biggelaar, Christoffel, Rattan Lal, Keith Wiebe, and Vince Breneman (2001). "Soil Erosion Impacts on Crop Yields in North America." *Advances in Agronomy,* Vol. 72, No. 1, pp. 1-52, 2001.

Eswaran, Hari, Russell Almarez, Evert van den Berg, and Paul Reich (1997). "An Assessment of the Soil Resources of Africa in Relation to Productivity." *Geoderma*, Vol. 77, pp. 1-18.

Frisvold, George, and Kevin Ingram (1995). "Sources of Agricultural Productivity Growth and Stagnation in Sub-Saharan Africa." *Agricultural Economics* Vol. 13, pp. 51-61.

Lal, Rattan (1998). "Soil Erosion Impact on Agronomic Productivity and Environmental Quality." *Critical Reviews in Plant Sciences* Vol. 17, No. 4, pp. 319-464.

Pinstrup-Andersen, Per, Rajul Pandya-Lorch, and Mark W. Rosegrant (1999). *World Food Prospects: Critical Issues for the Twenty-First Century*. Food Policy Report, International Food Policy Research Institute, Washington, DC.

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

Scherr, Sara J. (1999). *Soil Degradation: A Threat to Developing-Country Food Security by 2020?* Food, Agriculture, and the Environment Discussion Paper No. 27. International Food Policy Research Institute, Washington, DC. February.

United States Geological Survey/University of Nebraska-Lincoln/Joint Research Centre of the European Commission. (1999). "Global Land Cover Characterization. U.S. Geological Survey, University of Nebraska-Lincoln, and European Commission's Joint Research Center <http://edcwww.cr.usgs/landdaac/glcc/glcc.html>.

Wiebe, Keith, Meredith Soule, Clare Narrod, and Vince Breneman (2000). "Resource Quality and Agricultural Productivity: A Multi-Country Comparison." Selected Paper presented at the Annual Meeting of the American Agricultural Economics Association, Tampa, FL, July 31, 2000 <http://agecon.lib.umn.edu/aaea00/sp00wi01.pdf>.

Vulnerability to HIV/AIDS in Sub-Saharan Africa

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Abstract: Labor is the vital component of agricultural production in Sub-Saharan Africa. If size and structure are changed productivity of the labor force will directly affect food production and consumption in the region. Sub-Saharan Africa, with 11 percent of global population, has an estimated 73 percent of global HIV/AIDS—related infections. Little is known about the net affect of HIV/AIDS on the agricultural economy, but vulnerability to food insecurity will certainly increase in the severely affected countries. The estimated health and productivity costs of the epidemic will have long-term implications on the economic growth of the countries.

Keywords: Sub-Saharan-Africa, AIDS, HIV, population growth, food production, food consumption, labor productivity.

Introduction

The projections of food gaps reveal the intensity of the current as well as the future food security problems in Sub-Saharan Africa. By 2010, this region is projected to account for 65 percent of the total (all 67 countries covered in this report) gap to maintain consumption and 75 percent of the gap to meet nutritional needs even though the region's population constitutes only 25 percent of the 67-country total. The region's nutrition gap, as a share of consumption (total available food supplies), is projected to exceed 10 percent by 2010. Added to the food problem is the prevalence of HIV/AIDS in the region. The future impact of the HIV/AIDS disease on food systems is of major concern because of the already low and declining per capita food consumption and the low level of agricultural productivity in the region. Also, coping with and combating the disease in rural areas where poverty is at its highest and education is at its lowest level is the biggest challenge facing both individual countries and the international community. This article reviews the historical role of population (and the labor force) in food markets in Sub-Saharan Africa and the expected impact of HIV/AIDS on the structure of the population. It also examines the likely implications of the disease on food security in highly infected countries. The final section reviews the coping mechanism and response capacity.

Background: Changes in Population Growth and Structure

Sub-Saharan Africa's population growth during the 1980s was the highest in the world—about 3 percent per year. Since then, it has declined to 2.7 percent and is projected to decline further during this decade. The high population growth in Sub-Saharan Africa resulted from sharp mortality declines in the 1950s due to improved health services. Rapid population growth occurred in industrial countries between 1890 and 1920 and was supported by strong income growth and improvements in education and health. Their experience also shows that high population growth, when accompanied by appropriate and adequate investments in agricultural technology and supportive government policies, can have a positive impact on agricultural development. In Sub-Saharan Africa, however, fertility rates have remained high, incomes have stagnated, and low education levels have persisted. Although the high population growth put additional pressure on the demand side of the food market, it has remained the key source of productivity on the production side. In most Sub-Saharan countries, modernization of the agricultural sector has not yet occurred. Limited uses of new technology and poor market infrastructures are the two characteristics that have precluded an increase in agricultural productivity (see "Resource Quality, Agricultural Productivity, and Food Security in Developing Countries" p. 24.)

Now, after a long period of dealing with the burden of growing populations, the region is facing a sharp decline in population growth rates. The problem, however, is that the decline is not a natural progression of development, but a result of the rapid spread of HIV/AIDS. The disease has major implications for the economies and agricultural sectors of Africa.

The two severely affected regions are Southern and Eastern Africa. In Southern Africa, seven countries—Botswana, Lesotho, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe—are reported to have adult HIV prevalence of

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more than 20 percent. In most East African countries, HIV prevalence is more than 10 percent. In these countries, life expectancy is projected to decline to 30-40 years instead of 60-70 years (an estimate used prior to the spread of HIV/AIDS). According to a UN report, about 55 percent of all HIV infections in Sub-Saharan Africa are among women. Peak HIV prevalence among women is at age 25, that is 10 to15 years earlier than for men, changing the structure of the population. Thus, the most productive age cohort, 15-45, is dying the fastest from HIV/AIDS. This age cohort is nearly 50 percent of the population in highly HIV/AIDS affected countries. HIV prevalence among the relatively educated as well as high-income urban population is as high or higher than among low-income and rural groups. In Rwanda, Congo, and Zambia, the level of HIV infection in the highest socioeconomic strata is two to four times higher than among those in the lowest category.

HIV/AIDS and Food Security

In the countries mostly affect by HIV/AIDS, slow growth in agricultural productivity and overall economic growth that limited purchasing power resulted in growing food insecurity over the last two decades. Even in countries such as Uganda where food supplies are projected to be nutritionally adequate, food insecurity remains a major concern because of the low and wide disparity in purchasing power. Table B-1 shows the projected nutritional vulnerability in selected countries that are highly affected by HIV/AIDS. These projections include the decline in population growth and productivity of labor, as well as can be estimated. Most of the available studies have focused on the medical costs, and there is limited information on long-term economic costs of HIV/AIDS and the variation of the effects on different groups within countries. By the same token, any quantification of the net effect of HIV/AIDS on the food system is preliminary. However, the food system will be certainly subjected to shocks that could amplify the food insecurity of many countries.

Shocks to Agricultural Productivity and Output from HIV/AIDS

The size of the supply shock depends on the extent to which HIV/AIDS reduces the productivity of the agricultural labor in rural areas. The agricultural sector plays a crucial role in the economy of African countries in terms of both sources of food and exports to finance food imports. A review of the statistics of selected countries in table B-2 shows that with the exception of Kenya, the agricultural sector provides 80 percent of grain consumption in these countries. Grains contribute as much as 80 percent of per capita calorie consumption in these countries. The share of the agricultural sector in GDP for the same set of countries is in the range of 11 percent in Zambia to 47 percent in Tanzania.

With labor as the prime component of agricultural production, the implication of the HIV/AIDS epidemic on food security of the countries could be staggering. In projecting crop production for these countries, we use an elasticity of 0.3, meaning that with a 1-percent decline in labor availability, production will decline by 0.3 percent. However, we did not account for a change in the quality of labor. In the Food Security model, the marginal productivity of labor is assumed to remain constant over the projection period. For the Sub-Saharan countries, this may be an overestimation because the decline in population growth is in part due to the spread of HIV/AIDS, which affects the most productive segment of the population. A decline in healthiness of rural populations is expected to reduce labor productivity in rural areas. The World Health Organization estimates that local losses in agricultural productivity from HIV/AIDS at the household or village level range from 10 to 50 percent in about 10 Sub-Saharan African countries.

The high rate of infection among women will, in particular, have enormous implications on nutrition and poverty. Many farms are headed by women and on other farms women provide a large portion of total labor. For example, a study of two towns in Tanzania found that women provide 48 percent of agricultural labor including land preparation, planting, weeding, and harvesting while men did most of the marketing. Economic consequences will be compounded by the fact that women are barred from owning land in many countries. If a husband dies, the wife's lack of collateral limits her ability to obtain credit to keep the farm in operation or to purchase labor-saving technology. Also, an increase in the number of orphans places a burden on healthy women in the community

Table B-1--Grain market performance profile for selected countries

Region/ country	Annual production growth		Ratio of nutritional gap in grain equivalent in year 2010 to:	
	1980-99	1989-99	Production	Imports
	Percent			
East Africa:				
Kenya	0.44	-1.04	12.12	25.21
Tanzania	2.03	0.00	33.57	353.67
Uganda	2.18	1.29	.00	.00
Southern Africa:				
Malawi	1.83	4.14	18.11	213.54
Zambia	-1.22	-3.63	69.91	356.20
Zimbabwe	-1.06	-.10	2.41	21.75

Source: Economic Research Service, USDA.

Table B-2--Agricultural indicators for selected countries

Region/ country	Grain import share in consumption 1997-99	Agricultural share in GDP 1997	Agricultural share in exports 1997
		Percent	
East Africa:			
Kenya	32.2	24.4	56.2
Tanzania	9.0	47.4	63.3
Uganda	5.2	41.4	76.0
Southern Africa:			
Malawi	12.9	44.6	76.8
Zambia	19.6	11.1	4.6
Zimbabwe	10.6	13.9	46.2

Sources: Economic Research Service, USDA and World Bank data.

who must care for the sick and dying, while simultaneously increasing their child care responsibilities. This dilemma compounds the effect of HIV/AIDS on agriculture because healthy women will have less time for farming activities.

Another factor that can worsen the situation is the likely change in cropping patterns. For example, farmers are expected to move away from labor-intensive export crops to more subsistence crops that use less labor. Among food crops, a switch from corn to cassava would conserve considerable labor. However, cassava is less nutritious than corn. Nutritional intake is already below minimum standards in several countries, including those highly affected by HIV/AIDS. In 14 of the 17 countries in East and Southern Africa, per capita daily caloric intake is below the level required to attain a minimum nutritional standard (the calories required to sustain life with minimum activity). The nutritional vulnerability of the countries is projected to grow by 30 percent in the next decade. A domino effect follows: food supply deficits and decreased healthiness impair agricultural productivity through reduced food availability, which further reduces agricultural productivity and may hasten the onset of HIV/AIDS in weakened HIV-positive people.

Effects of HIV/AIDS on Food Market Demand

One of the effects of HIV/AIDS is declining living standards and, consequently, a reduction in food demand through lower population and income growth. The bleakest economic outlook is for GDP growth to decline from its already meager pace (table B-3). In Kenya, for example, GDP will probably be 14.5 percent lower than projections that do not account for the effects of HIV/AIDS. In Tanzania, the annual direct medical costs and losses in labor productivity are projected to be 2 percent to 4 percent of GDP. These costs are very troublesome because public and private incomes in these countries have stagnated or declined in the last 20 years and any increase in public and private outlays on health care must come at the expense of investment in economic development. More immediately, many health care needs are likely to be unmet due to prohibitive costs. To put this in perspective, the average public health expenditure for the region was 1.7 percent of GDP during 1990-97 and the region's per capita GNP in 1997 was $308; thus, annual health care spending was $5 per capita. Even in a country such as Zimbabwe that is on the high end of the region's income, the per capita expenditure was not much more than $10 per person. According to available reports, the life-extending drugs costs $11,000 a year in the United States. Even at a discounted rate, their costs far outstrip health expenditures in these countries.

The implication of HIV/AIDS on the demand for food is clear. As incomes decline due to the spread of HIV, demand for food will decline, but as expected, the impact is more damaging to the lower income countries than the higher incomes. Low-income countries spend more than half of their income on food. In Africa, this share is in the range of 40 percent to 70 percent. The average income-calorie elasticity for Sub-Saharan Africa is estimated at 0.14 percent (using cross-country data). Thus, a 10-percent decline in income over the projected period will reduce calorie consumption by 1.4 percent. While this kind of decline would not affect the nutritional well being of high income countries such as the United States where per capita calorie availability is about 3,700 per day, it can have serious implication for the countries that live on the margin of the minimum calorie requirement. In Sub-Saharan Africa the average per capita calorie availability was about 2,200 per day in 1998, the lowest of all developing regions of the world. Added to the low level of calorie consumption is the quality of food consumed in the region. Cereals and starchy roots and pulses, low-cost foods, comprise 70 percent of the region's calorie consumption, while higher cost foods such as meat and dairy products that are good sources of vitamins and minerals are consumed at the lowest rates in the world.

The decline in income will have varying implications for the entire population. Skewed income distribution in these countries exacerbates the problems for the poor. In most countries, the poorest 20 percent of the population holds only 4 percent to 8 percent of total national income, while the richest 20 percent holds nearly 50 percent. This disparity in purchasing power could worsen with the spread of HIV/AIDS. The food security estimates for the year 2000 indicate that food consumption by 60 percent of Sub-Saharan Africans falls short of meeting their nutritional requirements. More alarming, however, is the depth of the problem. Food consumption of the lowest income group is estimated to be 20 percent less than the nutritional requirement in year 2000. If the income distribution worsens, the implication will be serious. In African countries, most of the poor live in rural areas. In rural areas, most farmers are subsistence producers and have limited assets to bear the reduction or loss in their productivity. For the rural landless laborer, HIV/AIDS means a severe cut in purchasing power. Also, there is no formal safety-net program to provide support for the sick and unemployed in these countries. Therefore, the family network must provide the support.

Table B-3--Social indicators in selected countries

Region/ country	Adult HIV infection rate in Dec. 1999	Per capita GNP 1998	Population below poverty line	Public expenditure on health, share of GDP 1990-97	Life expectancy at birth 1997
	Percent	US Dollars	Percent		Years
East Africa:					
Kenya	14.0	330	42.0	1.9	51
Tanzania	12.0	210	51.1	1.1	49
Uganda	8.0	320	55.0	1.9	42
Southern Africa:					
Malawi	16.0	200	54.0	2.3	43
Zambia	20.0	330	68.0	2.9	43
Zimbabwe	25.1	610	25.5	1.7	51

Source: World Development Report, World Bank, 1999.

Overall, any reduction in agricultural output and/or demand for food below the current low levels will have serious consequences for food security of the severely affected countries. Even without taking into account the side effects of HIV/AIDS, a continuation of present trends in food consumption is projected to lead to deteriorating food security in these countries. Investment and a concerted policy response by the affected governments must occur if these losses are to be minimized.

Coping Mechanism and Response Capacity

To identify coping options in dealing with the impact of HIV/AIDS on food security, one should examine forces that shape the food markets of these countries. One important characteristic of the market is that the agriculture sector is the main source of both food production and exports to finance food imports. Agricultural sectors in Sub-Saharan Africa have performed poorly and are generally characterized by (1) low productivity that is now compounded by the spread of HIV/AIDS, (2) a lack of resources and affordable technology to increase productivity, and (3) a low literacy rate that limits access to know-how and technology as well as access to knowledge for essential behavioral change. These factors reinforce each other, and altering the situation requires attacking all three problems simultaneously.

To reduce the economic costs of HIV/AIDS, African countries must design an economic strategy in which health policy is a major component. Public policy should aim at providing information wherein health is a precondition of economic wellbeing. Currently, there are success stories in the region. Uganda has launched major preventive efforts during the last decade and has managed to reduce the rate of infection. Now, the growing awareness by officials at the international level has led to an increase in financial aid to improve and expand the preventive measures to reduce the rate of infection. This should ease costs and support national programs.

Educational messages to prevent the spread of disease, if combined with economic assistance to cope with the situation, are the most efficient ways of using new resources. For example, in response to the reduction in food supplies, nutritional education, particularly the mother's education, is important to provide information on food processing and nutritional conservation. To promote self-reliance and more sustainable responses in highly affected HIV areas, governments should encourage communities to diversify their economic activities. Many communities in Africa have started income-generating activities such as raising poultry or gardening to improve their financial situation and to help families affected by HIV/AIDS. In Malawi and Uganda, village banks give small loans to households to start their own enterprise such as market trading and honey production. In Uganda, 75 percent of households who received loans recently reported that they were caring for orphans (U.S. Agency of International Development (USAID)-Impact on HIV, June 2000).

In sum, the projected long-term food outlook for these countries shows a steady increase in food gaps, both to maintain per capita consumption and to meet nutritional requirements. Sub-Saharan Africa historically has shown the smallest improvement in average daily per capita calorie consumption. The HIV/AIDS crisis, which has already reduced the supply of labor in many countries, is projected to deepen the food insecurity problems of the region. Our projections, however, do not capture the full economic implications of HIV/AIDS, such as the decline in labor quality, medical/care costs, and costs associated with change in population structure. The challenge is new and has no simple remedy. As for the agriculture sector, strategies should aim at promoting domestic production. Unless urgent steps are taken to reverse the technological stagnation in the agricultural sector, HIV/AIDS will further deteriorate the food security problem of the region. The process, however, will be long and require consistent policies and credible institutional bodies. Given current economic and resource constraints, governments will have to

make difficult choices about HIV/AIDS care, prevention, and revitalization of their economies.

References

African Development Bank (1993). "AIDS (HIV) and Development," Annual meeting symposium, Abidjan, Côte d'Ivoire, May 11.

Becker, Charles (1990). "The Demo-Economic Impact of the AIDS Pandemic in Sub-Saharan Africa," *World Development Report*, Vol.18. Elmsford, NY: Pergamon Press, pp. 1599-1619.

Chenery, H., and T.N. Srinivasan, eds., (1988). *Handbook of Development Economics*, Vol. 1. Amsterdam: Elsevier Science Publisher.

Cuddington, John T. (1993). "Modeling the Macroeconomic Effects of AIDS, with an Application to Tanzania," The *World Bank Economic Review*, Vol. 7, No. 2, May, p. 173.

Food and Agriculture Organization of the United Nations and Joint United Nations Programme on HIV/AIDS (UNAIDS) (1999). *Sustainable Agriculture/Rural Development and Vulnerability to the AIDS Epidemic.* Geneva, Switzerland, December.

Gellman, Barton (2000). "DeathWatch: The Global Response to AIDS in Africa," *Washington Post*, June 5, pp. A1, 12-13.

Guerny, J. (1999). "AIDS and Agriculture in Africa: Can Policy Make a Difference?," *Food, Nutrition, and Agriculture*, Food and Agriculture Organization of the United Nations, Vol. 25.

International Labor Office (2000). *HIV/AIDS: A Threat to Decent Work, Productivity, and Development*, Geneva, Switzerland, June 2.

Kambou, Gerard, Shatayanan Deverajan, and Mead Over (1993). "The Economic Impact of AIDS in an African Country: Simulations with a Computable General Equilibrium Model of Cameroon," J*ournal of African Economies*, Vol. 1, No. 1.

Karen A. Stanecki (2000). "The AIDS Pandemic in the 21st Century: The Demographic Impact in Developing Countries," *World Population Profile 2000*, U.S. Census Bureau, in press.

Lorch, Donatella (1993). "Uganda, Scarred by AIDS, Turns to its Youth," front page story, *New York Times*, February 23. p. 1.

National Intelligence Council (2000). *The Global Infectious Disease Threat and its Implications for the United States, Environmental Change and Security Report*, Washington, D.C.: Woodrow Wilson Center.

Way, Francis, and Mead Over (1992). "The Projected Economic Impact of an AIDS Epidemic," paper presented at the annual meeting of Population Association of America, Denver, Co, April 28-May 2.