Achieving Sustainable Food Security for All:

The Role of Policy, Global Public Goods,

Property Rights, and Collective Action

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Abbreviations

ACC/SCN	U.N.Administrative Committee on Coordination / Subcommittee on Nutrition
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
GM	Genetically Modified
IARC	International Agricultural Research Center
IFPRI	The International Food Policy Research Institute
IMPACT	the International Model for Policy Analysis of Agricultural Commodities and Trade
IPM	Integrated Pest Management
ORAP	Organization of Rural Associations for Progress
PROGRESA	(Mexico) Education, Health and Nutrition Program
TB	Tuberculosis
USDA	The United States Department of

Achieving Sustainable Food Security for All: The Role of Policy, Global Public Goods, Property Rights, and Collective Action

Executive Summary

In 1996-98, 792 million people in developing countries — 18 percent of the population of the developing world — were chronically undernourished. By 2015, it is projected that 576 million people (or one person in 10) in developing countries will remain food insecure, far short of the World Food Summit goal of cutting hunger in half by no later than 2015. A substantial majority of food insecure people will continue to live in South Asia and Sub-Saharan Africa. The 150 million malnourished preschool-aged children in developing countries face premature death and impaired physical and mental development. The International Food Policy Research Institute (IFPRI) projects that 132 million preschoolers will be malnourished in developing countries by the year 2020. Hundreds of millions of people in developing countries have inadequate intakes of vitamins and minerals, with severe public health consequences.

Food availability in the developing world is adequate to provide everyone with the calories they need if the food were distributed according to need. By 2020, food availability per person will increase in all regions.

Hundreds of millions of people are, nevertheless, food insecure because they cannot afford to buy all the food they need and do not have access to the resources to produce it for themselves. Besides poverty, the causes of food insecurity include powerlessness, conflict, discrimination, demographic factors, and unsustainable natural resource management. Global social and economic forces will affect future food security, including projected rises in food demand, globalization, falling aid (and declining aid to agriculture), debt, technology, global climate change, and health issues.

The center of gravity of poverty — and therefore hunger — will remain rural for the next 35 years. Broad-based agricultural and rural development is essential to the livelihoods of food insecure people. Growing farm demand will generate employment, income, and growth economy-wide. Sound public policies are needed to support agricultural and rural development. These must facilitate development

of well-functioning and well-integrated markets. Key public policies and investments must assure access to technology and productive resources for poor farmers; access to credit for small-scale farmers, traders, transporters, and processing enterprises; extension services and technical assistance; and primary education, health care, clean water, safe sanitation, and good nutrition for all. Programs must be implemented within a framework of good governance, as well as trade, macroeconomic, and sectoral policies that do not discriminate against agriculture. Policies, programs, and projects must engage low-income people as active participants. Currently, governments in food insecure countries are spending 7 percent or less of their budgets on agriculture.

Public investment in agricultural research that can improve small farmers' productivity in developing countries is especially important for food security. Efforts to improve longer-term productivity on small-scale farms, with an emphasis on staple food crops, livestock, fisheries, and agroforestry as well as high-value cash crops, must be accelerated. Policies must expand and guide research and technology development to solve problems of importance to poor people. The private sector is unlikely to undertake much research needed by small farmers in developing countries because expected profits are unlikely to cover the cost of investment. However, gains to society and to poor people are high. Pro-poor agricultural research must join all appropriate scientific tools and methods — including agroecology, conventional research methods, and modern agricultural biotechnology — with better utilization of indigenous knowledge. Agricultural research and development must put farmers in decisionmaking roles. They must be fully informed about their options for improving productivity, reducing risks, and increasing the well-being of their families.

A high degree of complementarity amongst agricultural development, poverty reduction, and environmental sustainability is more likely to be achieved when agricultural development is broadly-based and inclusive of small- and medium-sized farms, market-driven, participatory and decentralized, and driven by technological change that enhances productivity but does not degrade the natural resource base. In order to achieve this, policymakers must understand the ways in which property rights and collective action issues influence whether farmers are willing to adopt natural resource management practices and technologies. In addition, agricultural research must pay greater attention to sustainability features of technology and to problems of resource-poor areas. Policies should support integrated soil fertility management, integrated pest management, and comprehensive water policy reform to help save water, improve use efficiency, and boost crop output per unit of water, while reducing the risk of armed conflict

between countries sharing surface or ground water sources.

Improvements in women's education and per capita food availability accounted for nearly 70 percent of the reduction in child malnutrition between 1970 and 1995. Public investment needs to support education as well as agricultural development.

Cost-effective interventions could significantly reduce micronutrient malnutrition. These include food fortification, supplementation, promotion of dietary diversity, and development of iron- and vitamin A-rich staple crops through both conventional plant breeding and biotechnology.

Where armed conflicts and civil strife are occurring, governments and the international community must give priority to conflict resolution and prevention. It is essential to include conflict prevention in food security and development efforts, and to link food security and long-term sustainable development to humanitarian assistance programs.

IFPRI research confirms the central role women play as producers of food, managers of natural resources, income earners, and caretakers of household food and nutrition security. Agricultural productivity increases when women get the same amount of inputs as men. Mothers' education is crucial to poverty reduction. Assets in the hands of women increase the share that households spend on education. The provision of care to children by mothers has a large and positive impact on children's nutrition status. Training poor mothers in good child feeding practices and the use of preventive health care services can greatly improve the nutrition of poor children.

Policies that allow poor people to achieve economic security are the best way to assure that birth rates will decline. It is also critical to facilitate women's access to reproductive health services, consistent with individual values and consciences.

As food insecurity urbanizes along with the general population, governments, with donor support, need to pay particular attention to improving livelihoods and employment among urban poor people.

Developing countries must be encouraged to participate effectively in the current round of global agricultural trade negotiations, pursuing better access to industrialized countries' markets. Coalitions with certain groups of higher income countries may help improve their bargaining position. Without appropriate domestic economic and agricultural policies, however, developing countries in

general and poor people in particular will not capture fully potential benefits from trade liberalization. The distribution of benefits will be determined largely by the distribution of productive assets. Developed countries must be persuaded to eliminate export subsidies, taxes, and controls. Food aid donors should provide adequate levels of food aid, on a multi-year basis as appropriate, targeted to poor groups in ways that do not displace domestic production, to those low-income countries adversely affected by trade liberalization.

Small farmers have an important role to play in mitigating global warming by sequestering carbon in their agricultural systems through cropland, forest, and pasture management strategies that result in improved soil organic matter.

When health and food insecurity problems interact and coexist among certain populations, integrated solutions can achieve multiple benefits and be more cost-effective.

Appropriate national and international policies are essential for achieving food security. By mustering the political will to make food security a higher priority, national governments and the international community can do much to hasten progress toward food security for all. **We recommend that JBIC act as a catalyst for appropriate action by taking the following steps:**

- **Target ODA to low-income, food insecure countries, especially in South Asia and Sub-Saharan Africa.**

- **Continue, with other Japanese agencies involved in development cooperation, to take a leadership role in providing ODA to agriculture by maintaining or expanding the level of resources provided to agriculture and rural development in developing countries, and by encouraging other donors to increase the level of ODA provided to these sectors.**

- **Provide a larger share of ODA to support policies and programs that can have a substantial food security impact.**

- **Join with other Japanese agencies involved in development cooperation, together with the World Bank, to encourage other donors to increase the resources provided to agricultural and rural development.**

- **Join with other donors to rethink the 20-year emphasis on reducing government's economic role, and help identify the proper role of governments in providing public goods.**

- **Assure that developing countries have access to knowledge and technology that can promote agricultural development. ODA can play an especially important role in forging public-private partnerships to assure that such public goods are provided.**

- **Support funding of pro-poor agricultural research, and play a leadership role in encouraging other donor agencies to do so.**

- **Support research that seeks to combine the best of agroecological approaches and use of external inputs, including improved seeds containing characteristics such as drought tolerance and resistance to certain pests, as such an integrative approach is likely to be the most appropriate way to assist most small-scale farmers.**

- **Provide ODA resources to help assure that developing countries can enact and enforce effective national biosafety regulations.**

- **Support agricultural biotechnology research focused on the problems of poor farmers and consumers in developing countries.**

- **Support the implementation of appropriate policies and programs in developing countries for sustainable management of natural resources. These will include necessary attention to the ways in which property rights and collective action shape farmers' adoption of technology and natural resource management practices; appropriate investment in sustainable intensification of agriculture in less-favored areas; efforts to improve soil fertility management; integrated pest management research, program implementation, and efforts to scale up successful small-scale projects; and support for comprehensive water policy reform to help save water, improve use efficiency, and boost crop output per unit of water, while reducing the risk of armed conflict between countries sharing surface or ground water sources.**

- **Join with other ODA agencies to increase aid to education, with a focus on improving female enrollments.**

- **Support food for education programs.**

- **Join with other donors to provide urgently needed increased support to efforts to reduce micronutrient malnutrition, given the huge human and economic costs.**

- **Join with other donors to promote conflict prevention and resolution. It is essential to include conflict prevention in food security and development efforts, and to link food security and long-term sustainable development to humanitarian assistance programs.**

- **Assist efforts to create an environment in which women can realize their full potential, including reform of divorce laws, implementation of social programs that benefit women, and enactment of property rights laws that allow women to hold title to land. Project planners and policymakers need to focus on how to help both men and women.**

- **Provide resources to help assure women's access to reproductive health services.**

- **Support policies and programs to reduce urban food insecurity in developing countries.**

- **Enact a policy of "debt for food security swaps," whereby governments of low-income, food-insecure countries that receive loans for food security-related programs (as outlined in this paper) would receive either loan forgiveness or more favorable loan terms upon achievement of mutually agreed-upon sustainable food security goals and timetables. Examples of such goals would include reduced mortality rates for children under the age of five, reduction in the proportion of the population living in absolute poverty, sustained increases in yields of staple food crops, reduction in rates of land degradation, and the development of competitive local markets for agricultural inputs and produce, all achieved within an agreed-upon timeframe.**

- **Support agricultural strategies to reduce global warming.**

- **Provide aid to developing countries for capacity strengthening in the area of trade negotiations.**

- **Join with other donor agencies to address health risks that compromise food and nutrition security. Focus on health and food security synergies.**

- **Assist in efforts to prevent the spread of HIV/AIDS.**

In the table below, we summarize these recommendations, the problems they are intended to address, the focal points, and the rationale for the recommended action.

Summary of Issues Identified and Recommendations

Problem	Focal Point	Measures to Be Taken by JBIC	Rationale
Declining global levels of ODA; ODA not targeted to food insecure counties.	ODA volume; share of ODA going to food insecure countries.	Target ODA to low-income, food insecure countries, especially in South Asia and Sub-Saharan Africa.	Food insecurity is heavily concentrated in these two regions. Given the scarcity of ODA resources, it is important that they be well-targeted in terms of need. Food insecurity is a key indicator of poverty.
Substantial long-term declines in external assistance to agricultural and rural development.	Volume and share of ODA to agricultural and rural development.	Continue, with other Japanese agencies involved in development cooperation and the World Bank, to take a leadership role in providing ODA to agriculture.	The overwhelming majority of poor people in developing countries remains in rural areas, so agricultural and rural development are critical to poverty alleviation and food security. Japanese and World Bank leadership can help encourage other donors to invest in these sectors.
Declining global levels of ODA; food insecurity.	Total ODA volume; share of ODA to food security policies, programs, and projects.	Provide a larger share of ODA to support policies and programs that can have a substantial food security impact.	Food insecurity is a key indicator of poverty, and in turn contributes to poverty. Achieving the millennium development goals endorsed by the international community will require significant progress against food insecurity.

Problem	Focal Point	Measures to Be Taken by JBIC	Rationale
Low and declining public investment in agriculture in developing countries.	Donor policies.	Join with other donors to rethink the 20-year emphasis on reducing government's economic role.	Public investment in infrastructure, agricultural research, health, and education is critical for agricultural development and food security. Donor policies of the past two decades have driven declines in such investment.
Market incentives are inadequate to assure that poor people in developing countries have access to knowledge and technology that can promote sustainable agricultural development.	Agricultural research.	Assure that developing countries have access to knowledge and technology that can promote agricultural development that benefits poor farmers and consumers.	ODA can play an especially important role in forging public-private partnerships to assure that such public goods are provided. Such research has high social rates of return and can play a critical role in achieving sustainable food security.
Poor farmers in developing countries need access to all relevant options for solving their problems.	Agricultural research.	Provide resources to support agricultural research that seeks to combine the best of agroecological approaches and use of external inputs, including improved seeds that are drought tolerant and pest resistant.	Such an integrative approach is likely to be the most appropriate way to assist most small-scale farmers in developing countries.

Problem	Focal Point	Measures to Be Taken by JBIC	Rationale
Developing countries lack the financial and human resources to enact and enforce biosafety regulations.	Biosafety regulation.	Provide financial and technical assistance.	Developing the capacity to enact and enforce such regulations is essential if developing countries are to be able to safely handle products derived from biotechnology and engage in their own biotechnology research.
Modern agricultural biotechnology may help poor farmers and consumers address their problems.	Agricultural research.	Provide assistance to support appropriate research.	Poor farmers and consumers in developing countries should not be denied access to a technology that may benefit them, even if that technology is controversial in developed countries.
Natural resource degradation in developing countries.	Natural resource management.	Support the implementation of appropriate policies and programs in developing countries for the sustainable management of natural resources, with particular attention to land, water, and pest management. Particular attention must be given to the ways in which property rights and collective action shape natural resource management. Appropriate investment is needed in less-favored areas.	Sustainable food security can only be achieved if strategies are pursued so that agricultural growth, poverty alleviation, and environmental sustainability complement one another. This is especially important in less-favored areas, which are home to many millions of food insecure people.

Problem	Focal Point	Measures to Be Taken by JBIC	Rationale
Lack of universal primary education, especially for girls.	Primary education.	Join with other ODA agencies to increase aid to education, with a focus on improving female primary enrollments.	Girls' education has been shown to improve overall well-being in developing countries.
Food insecurity; lack of universal primary education, especially for girls.	Education.	Support food for schooling programs.	Such programs can improve nutrition and boost enrollments in poor communities.
Micronutrient malnutrition affects hundreds of millions of poor people, with serious economic and health consequences.	Micronutrient interventions.	Join with other donors to provide urgently needed increased support to efforts to reduce micronutrient malnutrition.	Given the huge human and economic costs, reduced micronutrient malnutrition would have multiple benefits.
Conflict is both a cause and an effect of food insecurity.	Design and implementation of development policies and programs.	Join with other donors to promote conflict prevention and resolution.	In order to break the links between conflict and food insecurity, it is essential to include conflict prevention in food security and development efforts, and to link food security and long-term sustainable development to humanitarian assistance programs.
Gender discrimination contributes to food insecurity.	Change discriminatory laws and practices; implement projects and programs in ways that help both men and women.	Assist efforts in developing countries to reform divorce laws, implement social programs that benefit women, and enact property laws that allow women to hold title to land.	Empowerment of women is essential for food security, poverty reduction, and sustainable economic growth.

Problem	Focal Point	Measures to Be Taken by JBIC	Rationale
Rapid population growth contributes to food insecurity.	Women's access to reproductive health services.	Provide resources to help assure women's access to these services.	Poverty is a key driver of population growth, but providing women the resources to make their own choices about the size of their families is an important means of reducing rapid population growth in poor countries and communities, as well as an important part of an integrated approach to public health.
Urban food insecurity is growing.	Policies, programs, and projects targeted to food insecure urban populations.	Provide assistance to such programs.	The center of gravity of food insecurity in developing countries will remain in rural areas for the foreseeable future, but urban food insecurity is growing, and differs significantly from rural food insecurity in that urban people depend to a much greater extent on food purchases rather than self-provisioning.
Unpayable debt burdens drain resources from development; food insecurity.	Debt relief measures.	Provide debt forgiveness or more favorable loan terms to governments that meet mutually agreed-upon food security goals and timetables.	Such an approach offers significant incentives to governments of food-insecure countries to enact appropriate policies and implement appropriate programs.

Problem	Focal Point	Measures to Be Taken by JBIC	Rationale
Global climate change.	Agricultural practices.	Support agricultural strategies to reduce global warming.	Agroforestry and other agricultural strategies can help rural communities cope with the impact of climate change on agriculture and can help reduce greenhouse gas emissions.
Developed countries' trade policies discriminate against developing countries.	Capacity-strengthening programs related to international trade negotiations.	Provide aid to developing countries for capacity strengthening in the area of trade negotiations.	Developing countries need improved access to developed country markets if they are to benefit from globalization. Many developing countries lack capacity to comply with global trade rules or participate effectively in negotiations.
The interaction of inadequate dietary intake and disease lead to malnutrition, disability, economic losses, and death.	Investment in overcoming health risks in developing countries.	Join with other donor agencies to address health risks that compromise food and nutrition security. Focus on health and food security synergies.	The benefits of good health and nutrition for economic growth cannot be overstated; progress against hunger and poverty depends on a response to health and nutrition concerns.
HIV/AIDS pandemic.	Preventing the spread of the virus.	Provide assistance to such efforts.	HIV/AIDS is having a devastating impact on agriculture, nutrition, and food security, especially in Africa, where food insecurity is growing.

Achieving Sustainable food Securlty for All: The Role of Pollcy, Global Public Goods, Property Rights, and Collectre Action

1 Introduction

Five years ago at the World Food Summit in Rome, Italy, the high-level representatives of the international community declared the current state of global food insecurity "unacceptable," and pledged concerted action to reduce the number of people living in hunger by half by no later than 2015. Addressing the Summit on behalf of Japan, Mr. Takao Fujimoto, then the Minister of Agriculture, Forestry, and Fisheries, emphasized that "food…is the basis of human existence …." (FAO 1996b). The Minister went on to state:

> *In particular, the target in the Rome Declaration to reduce the number of undernourished people by half by not later than 2015 is an extremely valuable political benchmark along the line of the new development strategy based on an output-oriented approach which Japan has been emphasizing. Therefore, we fully support it and will make our utmost efforts towards its realization.*

Since then, the world has made only slow progress toward the Summit's vision of "food for all." According to the Food and Agriculture Organization of the United Nations (FAO), if the goal is to be attained by the target date, 20 million undernourished people must achieve food security annually, but during the first half of the 1990s, only 8 million people a year were leaving "the prison of hunger" (FAO 2000b). The needed acceleration in the pace of hunger reduction will require a stronger effort and higher priority on the part of governments in the South and North alike, civil society, and the private sector. The costs of failure will be considerable: diminution of human rights and dignity, significantly reduced economic development, lost human potential, foregone trading opportunities, violent conflict, and natural resource degradation.

As the world's largest donor of official development assistance (ODA), and the largest bilateral donor of ODA to agriculture and rural development, we recommend that Japan take a leadership role in creating a food secure world. ODA loans from the Japan Bank for International Cooperation (JBIC) offer an

important vehicle for exerting that leadership.

2 Food Security Defined

There are many definitions of food security, but most are similar to that adopted at the World Food Summit: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996a). This definition is in keeping with the principle that everyone has a basic human right to access to adequate food and nutrition, to freedom from hunger, and to general human dignity.

In addition, food security is generally conceived to have three critical aspects (sometimes called the *three A's*): food ***availability***, ***access*** to food, and ***adequate*** utilization of food. Thus, even when enough food is available for everyone to meet their needs, food insecurity may persist either because of inadequate access (whether by means of production, purchase, or transfer programs), or because of failure to consume sufficient quantities of food or a balanced diet (Kracht and Schulz 1999; Tweeten and McClelland 1997).

3 The Current State of Food Insecurity and Projections to 2015/2020

FAO estimates that in 1996-98, 792 million people in developing countries — 18 percent of the population of the developing world — were chronically undernourished (Table 3.1). In the aggregate, these figures represent progress over the numbers of food insecure people and the prevalence of food insecurity in 1979-81, when 937 million people, or 29 percent of the people of the developing countries, were afflicted (FAO 2000b).

Table 3.1 Food Insecurity in Developing Countries, 1979～81, 1996～98, and 2015

(millions of people and percent of population)

Region	1979～81		1996～98		2015	
	Number	Percent	Number	Percent	Number	Percent
Developing world	937	29	792	18	576	10
Sub-Saharan Africa	125	36	186	34	184	22
West Asia and North Africa	22	9	36	10	38	8
Latin America and the Caribbean	46	13	55	11	45	7
East and Southeast Asia	406	29	220	12	144	7
South Asia	337	38	294	23	165	10

Sources: FAO (2000a and 2000b).

Food insecurity occurs in higher-income countries as well as in low-income nations. In 1997, 30 million people in the newly independent states of the former Soviet Union and countries in Central and Eastern Europe in transition from centrally planned to market economies suffered from chronic undernutrition (FAO 2000b). The U.S. Department of Agriculture (USDA) estimates that in 1999, 27 million people in the United States, including nearly 11 million children under the age of 18, were food insecure as a result of their households' inadequate resources (Andrews et al. 2000). In the 1990s, about 9 percent of Canadians relied on private food assistance, due to cuts in federal social spending, high unemployment, and low wages for low-skilled workers (Riches 1997). High long-term rates of unemployment and pressure on governments to reduce social spending in order to remain competitive in the global economy and meet European Union fiscal policy requirements have led to growth in the number of food banks and soup kitchens in Western Europe as well (Cohen 1997). However, food insecurity in developing countries generally is more severe and affects a far larger proportion of the population than it does in the developed countries.

FAO projects that at current rates of decline and without significant changes in policy at the national and international level, by 2015, the target year for halving hunger, 576 million people (or one person in 10) in developing countries will remain food insecure. This means that the international community will fall far short of meeting the World Food Summit goal (FAO 2000b). Such an outcome would be a moral failure that leaves a significant portion of humanity lacking in the essentials of life and leaves the Summit's reaffirmation of the right of every human being to adequate food and freedom from hunger ringing hollow. Worse, such an outcome will be costly for humanity as a whole: it is estimated that

adults who are below normal height as a result of chronic undernutrition are 2-9 percent less productive than well-nourished adults (Gillespie and Haddad 2000). Worse still, this failure will have resulted not from lack of resources or technical know-how, but from a lack of political will to make ending hunger a high policy priority on the part of both developing and developed country governments.

Although the aggregate trend is one of steady but slow progress against food insecurity, the story has varied considerably by region. A substantial majority of the world's food insecure population (515 million people, or nearly two of every three undernourished people) lives in the greater Asia-Pacific region. Just two countries in this region, China and India, are home to 44 percent of all food insecure people. On the one hand, these figures should not be surprising, since the region is the world's most heavily populated, and since China and India are the most populous countries. On the other hand, given economic progress in much of the region, notwithstanding the economic crisis of the late 1990s, the persistence of high levels of hunger is somewhat paradoxical. The regional total includes 155 million undernourished people in East Asia, 65 million in Southeast Asia, and 294 million in South Asia. Region-wide, the share of the populace that was undernourished fell from 32 percent in 1979-81 to 17 percent in 1996-98. By subregion, the incidence of undernutrition declined from 29 to 12 percent in East Asia, 26 to 13 percent in Southeast Asia, and 38 to 23 percent in South Asia. In the latter subregion, the continued high rate of population growth has meant that the absolute numbers of food insecure people are declining much more slowly than the reduced incidence figures might suggest. Furthermore, the absolute number of undernourished South Asians increased by 10 million between 1995-97 and 1996-98 (FAO 2000a).

By 2015, FAO projects that the Asia-Pacific region will continue to be home to 309 million food-insecure people, who will remain the majority (54 percent) of all hungry people. This figure will include 10 percent of South Asians (165 million people).

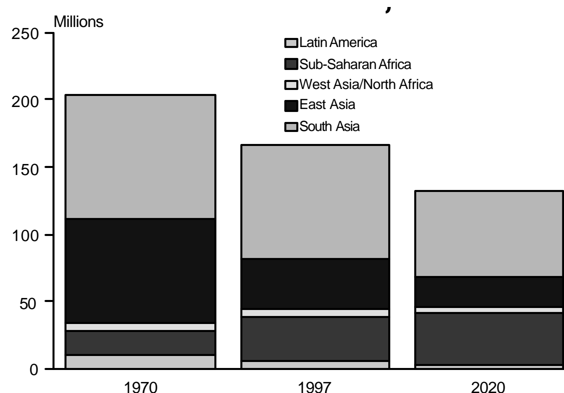
Trends in Sub-Saharan Africa have been particularly discouraging. The incidence of food insecurity declined somewhat, from 38 percent in 1979-81 to 34 percent in 1996-98, still the highest rate of undernutrition of any global region. Moreover, the number of undernourished Africans jumped by nearly 50 percent, from 125 million to 186 million. It is projected that about the same number of Africans will be food insecure in 2015, accounting for 22 percent of the region's population.

Hunger's center of gravity will remain squarely in South Asia and Sub-Saharan Africa through 2015. Many of the countries in these two regions are among the "least developed." They will require special assistance to avert widespread hunger and malnutrition in the years to come. **We recommend that JBIC target ODA to low-income, food insecure countries, especially in South Asia and Sub-Saharan Africa.** In 1996-98, the two regions combined were home to three of every five food insecure people, and by 2015, the combined figure will remain about 60 percent. However, Africa will be home to nearly one-third of the world's food insecure people, compared to less than one-fourth in 1996-98.

People with real names and faces stand behind the somewhat dry food insecurity numbers. They are such people as Kone Figue, who weeds and harvests her small rice farm in Côte d'Ivoire by hand, and seldom produces enough to feed her family of eight for a whole year (Schiøler 1998).

Of particular concern are the 167 million malnourished preschool aged children in developing countries, who account for 27 percent of all children under the age of five in the developing world (Figure 3.1) (Rosegrant et al. 2001). Malnutrition is a factor in over five million deaths of preschoolers each year, a toll equivalent to the combined populations of Yokohama and Kyoto (WHO 2001). Those who survive often fail to reach their full mental and physical potential. At least 25 percent of the burden of disease in children is attributable to malnutrition. The lower cognitive outcomes associated with malnutrition lead to lower productivity as stunted children grow to adulthood, and the significance of this problem is growing as the global economy increasingly offers a premium for knowledge-based employment (Gillespie and Haddad 2000). To put the costs another way, nations that do not assure that all their children enjoy proper nutrition sacrifice future scientists, creative artists, community and national leaders, and productive workers.

Figure 3.1 Number of Malnourished Children by Region, 1970, 1997 and 2020



Source: IFPRI IMPACT projections (July 2001).

As of 2000, according to the U.N. interagency Subcommittee on Nutrition, 53 percent of all malnourished preschoolers lived in South Asia and 44 percent of the children under five in that region were malnourished. Child malnutrition is even more concentrated in South Asia and Sub-Saharan Africa than general food insecurity: 74 percent of malnourished preschool children lived in the two regions in 2000 Administrative Committee on Coordination Subcommittee on Nutrition (ACC/SCN) and IFPRI 2000.

Projections of child malnutrition in 2020, made using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT),[1] developed at the International Food Policy Research Institute (IFPRI), indicate that the number of malnourished children in developing countries will decline by just 21 percent over 1997-2020, to 132 million. For the period 1990-2000, the reduction in child malnutrition was only 15 percent and this very modest progress is a far cry from the goal agreed upon by the international community at the 1990 World Summit for Children: to reduce severe and moderate malnutrition among children under the age of five by half by 2000 (UNICEF 2001).

Disaggregation of these figures leads to an even more disappointing picture. Although South Asia is projected to reduce child malnutrition more rapidly through 2020 than the developing world as a whole, it will remain home to nearly half of all malnourished preschoolers, and India alone will account for more than 34 percent of the world's malnourished children. Even more alarming, the number of malnourished children in Sub-Saharan Africa is expected to rise by 26

[1] IMPACT offers a methodology for analyzing alternative scenarios for global food demand, supply, and trade, as well as child malnutrition. It covers 36 countries and regions that account for virtually all of food production and consumption, and covers 16 major agricultural commodities. IMPACT is a partial equilibrium model of the global food economy, specified as a set of country or regional sub-models, within each of which supply, demand, and prices for agricultural commodities are determined. The sub-models are linked through trade. The model uses a system of supply and demand elasticities, incorporated into a series of linear and nonlinear equations, to approximate the underlying production and demand functions. FAO base data for 1996 98 are used for figures on supply, demand, and prices. Projected numbers of malnourished children are derived from the estimated relationship between the percentage of malnourished children and average per capita calorie consumption, the percentage of females with access to secondary education, the quality of maternal and child care, as measured by the ratio of female to male life expectancy at birth, and health and sanitation, measured by the percentage of the population with access to clean water. Since each of the 36 country groups produces and/or consumes at least some of each commodity, thousands of supply and demand parameters are specified (income, price, and cross-price elasticities of demand; production parameters including crop area and yield growth trends; price response parameters; trade distribution parameters; and so forth). Parameter estimates are drawn from econometric analysis, assessment of past and changing trends, expert judgments, and synthesis of the existing literature. For a detailed description of the model see Rosegrant et al. (2001). Unless otherwise noted, IMPACT projections from July 2001 are reported in the present paper.

percent. More than three-quarters of the world's malnourished preschoolers will live in these two regions.

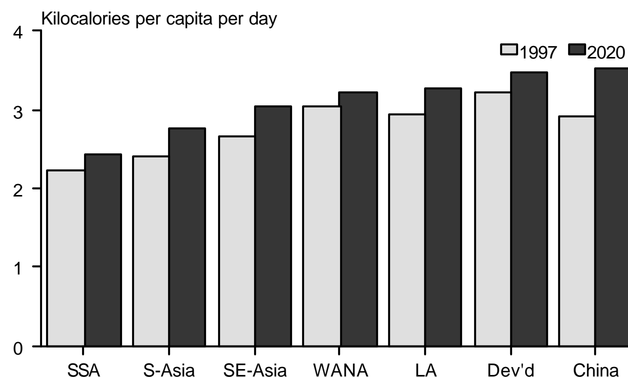
New evidence shows that low birth weight is a major contributor to child malnutrition and premature death. About one child in four in developing countries is born with low birth weight (a weight of less than 2.5 kilograms at birth), usually as a result of poor maternal nutrition both before conception and during pregnancy. In effect, malnutrition is directly transmitted from one generation to the next. Although the incidence of low birth weight in South Asia, at 21 percent, is somewhat below the rate for the developing world as a whole, the number of affected newborns in the region account for 64 percent of the worldwide total. Low birth weight at term is also common in Central and West Africa (ACC/SCN and IFPRI 2000; Flores and Gillespie 2001).

IFPRI research has examined the so-called "Asian enigma," i.e. the paradox of significantly higher rates of child malnutrition in South Asia than in Sub-Saharan Africa, even though on most indicators of human well-being (access to safe water, school enrollment, food availability per person, income per person, and degree of democratic governance), South Asians fare better than Africans. But with respect to women's social status relative to men's, as measured by the female-to-male life expectancy ratio, Africa is doing better than South Asia. Some other possible factors include climate, population density, and cultural norms that discourage sound childcare and feeding practices (Smith and Haddad 2000).

These broad patterns of current and projected food insecurity in developing countries can be analyzed in terms of the three component parts of food security. Regarding food availability, FAO estimates that in 1997, daily per capita calorie availability for the developing countries as a whole was 2,667 kilocalories, or well above the minimum requirement of 2,350 kilocalories per person per day. In other words, in the aggregate, global food production and carryover stocks are adequate to provide everyone with the food they need if the food were distributed according to need. Breaking the figure down, availability exceeded the minimum in all regions except Sub-Saharan Africa (Figure 3.2), leaving the average African food insecure. Because food is not, in fact, distributed equitably in many places, many Africans consumed far less than their minimum requirements. IMPACT projections indicate that by 2020, food availability measured in terms of calorie availability per person will increase in all regions, despite substantial population growth and expected natural resource constraints on food production. Even in Africa, food availability will be more than adequate to provide everyone with their

minimum needs, although African food availability per person will continue to lag behind the levels of other regions (Rosegrant et al. 2001).

Figure 3.2 Daily Per Capita Calorie Consumption, by Region, 1997 and 2020



Source: IFPRI IMPACT projections (July 2001).

Turning to the question of ***access to food***, the picture is far less sanguine. Hundreds of millions of people are hungry today — and will remain hungry over the next two decades not because of inadequate food availability, but because even when food is available in the marketplace, they cannot afford to buy all the food they need and do not have access to the resources to produce it for themselves. For example, in early 2001, the Indian government debated whether to dump surplus wheat and rice at sea, in order to make room for government-acquired reserves from the new harvest. This discussion occurred at a time when 208 million Indians were suffering from chronic undernutrition, including 150 million affected by severe drought, and with a majority (53 percent) of the country's preschool children afflicted by malnutrition (Abdi 2001; FAO 2000b; UNDP 2000).

According to the World Bank (2001a), 1.2 billion people in developing countries (or about one in four) live on the equivalent of less than US$1 per day, and are too poor to meet their needs for food and the other necessities of life on a sustainable basis (Table 3.2). The patterns in the developing world with respect to poverty closely track food insecurity trends: poverty is heavily concentrated in South Asia and Sub-Saharan Africa, which are home to nearly 70 percent of poor people, while East and Southeast Asia have made substantial progress in reducing poverty.

Table 3.2 People Living on Less Than $1 per Day, 1990, 1998, and 2015

(millions of people and percent of population)

	1990		1998		2015 (optimistic)		2015 (pessimistic)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Developing world	1,300	29	1,200	23	777	13	1,000	16
Sub-Saharan Africa	242	48	302	48	361	40	462	47
East and Southeast Asia	452	28	267	15	65	3	101	5
South Asia	495	44	522	40	297	18	426	25
Latin America and the Caribbean	74	17	61	12	43	7	58	9
West Asia and North Africa	6	2	6	2	5	1	6	2

Source: World Bank (2001).
Note: The optimistic scenario for 2015 assumes moderate, broad-based economic growth worldwide, while the pessimistic scenario assumes slower growth and rising inequality.

The World Bank has projected poverty levels to 2015 under two scenarios: one of slow growth and increasing inequality, and one in which countries adopt policies and interventions that foster inclusion and broad-based growth. Overall poverty declines in both scenarios, but much more substantially in the latter, "optimistic" one. Poverty will likewise decline in South Asia under both scenarios, although many millions of South Asians will remain poor in either. Poverty will increase substantially in Africa under both scenarios, leaving the region with both the highest poverty rate and the largest number of poor people by 2015 (World Bank 2001a).

IMPACT projects income growth in all developing regions between 1997 and 2020 (Table 3.3). Growth rates will be highest in East and Southeast Asia, ranging between 3.5 and 6 percent annually. India will experience annual income growth of 5.8 percent if economic reforms continue to be implemented. Latin American incomes will grow at more moderate rates (3.6-4.5 percent per year), while growth will be slowest in Sub-Saharan Africa at 3.2-3.8 percent per annum (Rosegrant et al. 2001).

Table 3.3 IMPACT Population and Income Growth, 1997 and 2020

Region	Population 1997	Population 2020	GDP growth rates
	(millions)		(Percent/year/year)
Central Asia	54.9	69.5	3.0
Mexico	94.1	124.9	3.6
Brazil	163.2	209.3	3.6
Argentina	35.7	45.4	4.5
Colombia	37.2	52.6	3.8
Other Latin America	155.8	219.9	3.6
Nigeria	103.9	168.2	3.8
Northern Sub-Saharan Africa	142.7	253.0	3.3
Central and Western Sub-Saharan Africa	137.8	246.4	3.8
Southern Sub-Saharan Africa	83.5	135.9	3.2
Eastern Sub-Saharan Africa	93.0	155.0	3.5
Egypt	64.5	90.2	4.0
Turkey	62.9	83.6	4.5
Other West Asia and North Africa	211.4	331.2	3.5
India	960.1	1,266.0	5.8
Pakistan	144.1	244.3	4.5
Bangladesh	122.4	169.8	4.8
Other South Asia	61.9	100.2	4.5
Indonesia	203.2	262.3	4.5
Thailand	59.3	70.5	5.2
Malaysia	20.9	29.2	5.2
Philippines	70.7	101.6	5.0
Vietnam	76.1	102.5	5.8
Myanmar	46.2	58.8	4.0
Other Southeast Asia	15.9	23.7	4.0
China	1,249.0	1,461.4	6.0
South Korea	45.6	51.9	5.0
Other East Asia	25.8	32.3	3.5
World	5,820.6	7,456.3	

Source: Rosegrant et al. (2001).

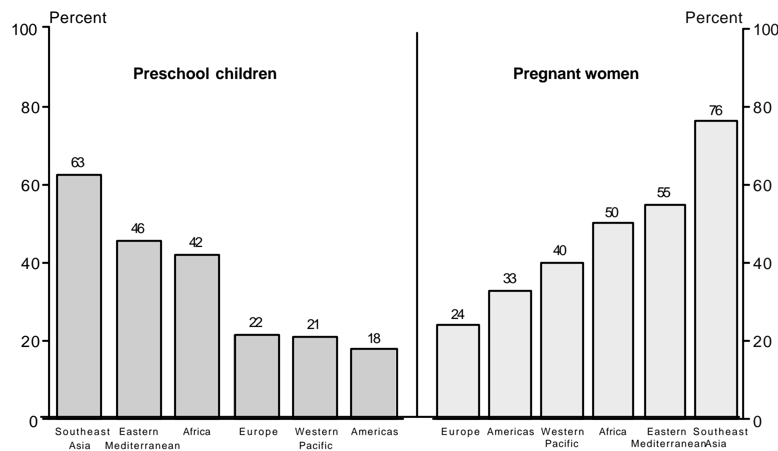
Growth alone will not improve access to food, though growth is one of the necessary conditions for achieving food security. Growth must be broad-based and occur in a policy context that stresses equity and poverty reduction (Drèze and Sen 1989). The World Bank has found that trends in inequality have been extremely diverse, both across countries and in single countries over time. Growth in areas where poor people live and sectors where they work benefit poor people. Changes in income inequality reflect changes in the distribution of assets. The design of economic liberalization programs can determine whether they will

reduce or worsen inequality (World Bank 2001a).

Regarding ***adequate utilization of food***, the figures presented thus far on general food insecurity and child malnutrition in developing countries tally those who consume less than the minimum number of calories needed for a healthy and active life. Nutritionists generally agree that if a person takes in enough calories, he or she is likely to consume the needed protein as well. However, adequate caloric intake does not guarantee that a person will also meet requirements for micronutrients — vitamins, minerals, and trace elements.

Iron deficiency is the world's most common nutritional disorder, and the World Health Organization (WHO) estimates that it affects 4 to 5 billion people, or between 66 and 80 percent of humanity, with severe public health consequences. About 2 billion people worldwide suffer from anemia, due mainly to iron deficient diets, including 48 percent of all pregnant women, 56 percent of pregnant women in developing countries, and 76 percent of pregnant women in South Asia (WHO 2001; ACC/SCN and IFPRI 2000). About 50 percent of all anemic women live in South Asia (Gillespie and Haddad 2000) (Figure 3.3). Anemic women's risk of maternal mortality is 23 percent higher than that of nonanemic mothers. Their babies are more likely to be premature, have low birth weights, and die as newborns. In Southeast Asia, 63 percent of school-aged children (five to 14 years) are anemic. Incidence is also high among South Asian infants and children (ACC/SCN and IFPRI 2000; Gillespie and Haddad 2000). Anemic preschoolers face impaired health and development and limited learning capacity. Anemia can impair immune systems of all age groups. Even when iron deficiency does not progress to anemia, it can reduce work performance. Meat and fish are the best sources of iron, but poor people often cannot afford them. Also, many people in developing countries avoid such foods for religious and cultural reasons. In South Asia, cognitive impairment and reduced work performance due to iron deficiency result in substantial annual economic losses: nearly 2 percent of gross domestic product in Bangladesh, over 1 percent in Pakistan, and nearly 1 percent in India, for a total of $5 billion per year in the subregion. Despite these devastating effects, high levels of iron deficiency anemia have persisted over the past two decades, and there are few high priority public health programs aimed at tackling the problem (ACC/SCN and IFPRI 2000; ACC/SCN 1997; Gillespie and Haddad 2000).

Figure 3.3 Prevalence of Anemia in Preschool Children and Pregnant Women by Region, 1999



Source: ACC-SCN and IFPRI (2000).

Iodine deficiency disorders affect 740 million people (WHO 2001). These include goitre (enlargement of the thyroid gland), brain damage, and severe mental retardation. However, efforts to iodize salt have proven an effective and affordable means to combat this scourge.

Vitamin A deficiency is the leading cause of preventable blindness in children and raises the risk of disease and death from severe infections. Between 100 and 140 million children are affected, mainly in Sub-Saharan Africa and South Asia. One-quarter to half a million go blind each year, and half of them die within 12 months of losing their sight. Although trends in the incidence of clinical eye disorders due to vitamin A deficiency are encouraging, inadequate vitamin A intake remains a serious public health problem in developing countries. Pregnant vitamin A-deficient women face night blindness and increased risk of mortality and mother-to-child Human Immunodeficieny Virus (HIV) transmission. Most of the 600,000 women who die from childbirth-related causes each year succumb to complications that could be reduced with better nutrition, including adequate vitamin A intake (WHO 2001; ACC/SCN and IFPRI 2000).

4 Causes of Food Insecurity

4.1 Poverty

Low-income people cannot afford to buy all of the food they need, even though poor households typically spend 50-70 percent of their income on food

(Deaton 1997). In addition, poor people frequently lack access to land and other productive resources, and so cannot produce food for themselves (International Fund for Agricultural Development (IFAD) 2001). The available data indicate that child malnutrition rates are significantly higher among low-income groups as compared to higher-income classes. In Brazil, China, Guyana, Morocco, Nicaragua, and Peru, the child malnutrition rate among the poorest 20 percent of households is three to four times the rate among the richest 20 percent. For another 11 developing countries, the poorest quintile had child malnutrition rates 1.3 to 2.2 times those of the wealthiest quintile. Only in Egypt among the countries studied were malnutrition rates equal (World Bank 2001a).

Despite rapid urbanization in developing countries, 75 percent of people living in poverty remain in rural areas, and the majority of poor people in developing countries will remain rural through at least 2035, although a majority of the overall population will be urban by 2020 (IFAD 2001; U.N. Population Division 2000). Women bear a disproportionate share of poverty (Marcoux 1998; Quisumbing, Haddad, and Peña 2001). Among rural people, farmers who practice rainfed agriculture, smallholder farmers, pastoralists, artisanal fishers, landless laborers, indigenous people, people in female-headed households, and displaced people are most affected by poverty.

Studies have shown that owners of even marginal landholdings tend to have higher incomes and to consume more than landless people. Landless rural people are more vulnerable to famine and have higher rates of infant mortality, which is a proxy indicator of food insecurity (IFAD 2001).

For poor urban dwellers, the needed resources may not be land so much as economic opportunities, such as secure employment at a wage adequate to meet basic needs or the chance to own a business, as well as access to social safety net programs. However, ownership of real property often remains important for urban poor people (Garrett and Ruel 2000).

4.2 Powerlessness

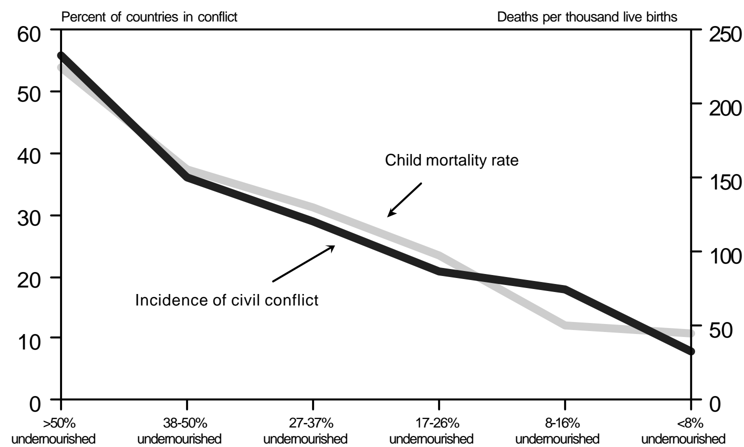
Poor and food insecure people frequently lack political voice and organizations that are accountable to them and capable of articulating their interests to policymakers and other power holders. As a result, policies tend to benefit people who are already well-off, and policymakers tend to give low priority to the needs of poor and hungry people or programs that would benefit them (Pinstrup-Andersen 1993; Cohen 1994). A World Bank report based on extensive

interviews of poor people in developing and transition countries found that they regard their situation as one where freedom and the power to control one's life are lacking. A poor Jamaican woman said that poverty is "like living in jail, living in bondage, waiting to be free" (World Bank 2000).

4.3 Violent Conflict

Since the end of the Cold War, internal conflicts have proliferated in developing and transition countries, particularly in Africa. Fourteen million refugees have fled these struggles, which have displaced another 20-30 million people within their own countries. At the end of 2000, nearly 24 million people were in need of food and other humanitarian assistance as a result of violent conflict; 78 percent of them were in Africa. Even after conflict ends, the costly burden of reconstruction may leave many people food insecure for years. Landmines continue to maim and keep land out of production long after fighting ends. Not only does violent conflict cause hunger (Figure 4.1), but hunger can contribute to conflict, especially when resources are scarce and perceptions of economic injustice are widespread, as in Rwanda in 1994 or Central America in the 1970s and 1980s (Messer, Cohen, and D'Costa 1998; Messer, Cohen, and Marchione 2001).

Figure 4.1 Food Security, Civil Conflicts, and Child Mortality, 1990-96



Source: FAO (1999).
Note: Countries grouped by prevalence of undernourishment.

4.4 Discrimination

Food insecure people tend to be disproportionately female and young or elderly. Cultural practices and official policies that marginalize people on the basis of gender, age, race, and ethnicity frequently contribute to food insecurity.

For example, in Sudan, where Arab Muslim-dominated government forces have engaged in a civil war for the past 20 years with African Christians and animists in the country's south, rates of malnutrition in the conflict zones are among the world's highest (Cohen 1994). In rural Guatemala, indigenous children are more likely to be malnourished than nonindigenous children (World Bank 2000). In India, tribal people and members of "scheduled castes" (once called "untouchables") have a higher risk of poverty than other Indians. Membership in more than one group subject to discrimination compounds the level of ill-being. Rural scheduled caste women have a literacy rate half the national female literacy rate (World Bank 2000).

In many parts of the developing world, gender discrimination has negative impacts on health, nutrition, and household income and assets. In Sub-Saharan Africa, women farmers have less access to education and to labor, fertilizer, and other inputs than men do, and often face limitations on their right to own or control land. In both Africa and Latin America, extension services and technical assistance focus primarily on male farmers. However, in Africa, women are responsible for about 75 percent of domestic food production, and play significant roles in both food and cash crop production in Africa, Asia, and Latin America. In Burkina Faso, men and children provide more labor to farm plots controlled by men than to women's plots, while women primarily contribute the labor on plots they control. Women's plots have 20-30 percent lower yields. Total household agricultural output would increase if there were more equitable allocation of labor and inputs. Women also face different rules from men relating to ownership and control of land in some African countries (Quisumbing et al. 1995; Meinzen-Dick et al. 1997; IFPRI 2000).

In South Asia, because families of daughters must pay bridegrooms a dowry, girls tend to receive less care and food than boys. As a result, girls have higher mortality rates, and are "missing": there are only 950-970 females for every 1,000 males (IFPRI 2000).

4.5 Demographic Factors

World population will increase by more than 25 percent between 2000 and 2020, from 6 billion to more than 7.6 billion people. On average, 77 million people, equivalent to the population of Vietnam, will be added each year, virtually all in developing countries. Six countries, all of which already have populations in excess of 100 million people, will account for fully half of this population increase — India, China, Pakistan, Nigeria, Bangladesh, and Indonesia. India

and China alone, which already have populations in excess of 1 billion people each, will account for one-third of the increase (U.N. Population Division 2001). Between 1997 and 2020, Sub-Saharan Africa will have the highest annual rate of population growth of any region, 2.4 percent. Global population growth will stimulate substantial increases in food demand (Rosegrant et al. 2001).

Urban population in developing countries is expected to double between 1997 and 2020, when the majority of the developing world's population will live in urban areas (U.N. Population Division 2000). Ninety percent of the population increase between 2000 and 2020 will occur in the rapidly expanding cities and towns. When people move to cities, their lifestyles change, becoming more sedentary, and women experience higher opportunity costs on their time. As a result, urban dwellers tend to shift consumption to foods that require less preparation time (e.g., from sorghum, millet, maize, and root crops to rice and wheat), and to more meat, milk, fruit, vegetables, and processed foods (Garrett and Ruel 2000).

Growth in urban poverty, food insecurity, and malnutrition and a shift in their concentration from rural to urban areas will accompany urbanization, although globally, poverty and food insecurity appear to be urbanizing more slowly than the overall population of developing countries. Despite the growing consequences to urban well-being, policymakers do not yet have solutions that adequately reflect and respond to these challenges, which have long been conceptualized as rural problems. Urban dwellers are more dependent on money income, may have fewer opportunities to grow their own food, and require access to child care in order to pursue income earning opportunities (Garrett and Ruel 2000).

4.6 Unsustainable Natural Resource Management

In many developing countries, poverty, low agricultural productivity, and environmental degradation interact in a vicious downward spiral. This is especially pronounced in resource-poor areas that are experiencing high rates of population growth and are home to hundreds of millions of food-insecure people, particularly in South Asia and Sub-Saharan Africa, the key food insecurity hot spots, as well as on the hillsides of Central America and Southeast Asia. Agricultural growth, poverty alleviation, and environmental sustainability are not necessarily complementary, and achieving all three simultaneously cannot be taken for granted. Much depends on specific social, economic, and agroecological circumstances (Hazell 1999; Pender and Hazell 2000).

In addition, the social status and degree of empowerment of women has a direct bearing on the sustainability of natural resource management. To the extent that rural women enjoy ownership or control over land, the more likely they are to undertake natural resource conserving measures. Yet, even where women bear the major responsibility for food production, as in many African countries, land is generally owned or controlled by men. Poor rural women also often expend much time and effort in fetching fuel, usually in the form of wood, for cooking, lighting, and agricultural processing activities. Affordable technologies that reduce the time and effort women need to spend searching for fuel allow them to spend more time on other tasks, e.g., child care, which is essential for good child nutrition. At the same time, the development of affordable alternatives to wood as an energy source can reduce deforestation. In a similar "win-win" approach, integrated pest management technologies can help protect natural resources while also reducing the time women and children must spend weeding crops (Quisumbing and Meinzen-Dick 2001).

Less-favored areas may be "less-favored" by nature or by humans. They include lands that have low agricultural potential because of limited and uncertain rainfall, poor soils, steep slopes, or other biophysical constraints, as well as areas that may have high agricultural potential but have limited access to infrastructure and markets, low population density, or other socioeconomic constraints. Nearly two-thirds of the rural population of developing countries, or 1.8 billion people, live in these areas, including marginal agricultural areas, forests and woodlands, and arid zones. Most poor rural people in the developing world live in these areas. Low agricultural productivity and land degradation are severe, cereal yields are exceedingly low, and deforestation, overgrazing, soil erosion, and soil nutrient depletion are widespread. The threat of famine is severe, and resource degradation seems to be contributing to this threat (Pender and Hazell 2000).

Some natural resource degradation in agricultural areas has been caused by the misuse of modern farming inputs (especially pesticides, fertilizers, and irrigation water in high-potential areas). But a lot of environmental degradation, particularly soil degradation and deforestation, is concentrated in resource poor areas that have not adopted modern technology. In these cases the problem is typically insufficient agricultural intensification, with yield growth failing to keep up with population growth. Poor rural people in developing countries tend to depend on annual crops (which generally degrade soils more than perennial crops) and common property lands (which generally suffer greater degradation than

privately managed land). They often cannot afford to invest in land improvements. Degradation and lack of access to high-quality land frequently push poor people into clearing forests and pastures for cultivation at the expense of wildlife habitat, contributing to further degradation. Land degradation includes soil erosion from wind and water, chemical degradation (loss of nutrients, soil salinization, urban industrial pollution, and acidification), and physical degradation (compaction, waterlogging, and subsidence of organic soils). Chemical degradation accounts for 40 percent of agricultural land degradation. Degradation between 1945 and 1990 caused cumulative crop productivity losses of 5 percent, with mean reductions for Sub-Saharan Africa of 6.2 percent (Rosegrant et al. 2001; Rosegrant and Hazell 2000; Pender and Hazell 2000; Scherr 1999).

IFPRI and the World Resources Institute have found that depletion of soil organic matter in developing countries is widespread, leading to significant economic losses and reduced fertility, crop productivity, moisture retention, and soil workability. Degradation also leads to increased carbon dioxide emissions from agricultural land, contributing to global warming. Agriculture accounts for about 20 percent of the "greenhouse gasses" that lead to warming. Farming practices have led to soil degradation, aquifer depletion (as irrigation uses water more rapidly than it can be replenished trough rainfall), water pollution from farm chemical runoff, and reduced plant and animal biodiversity. Twenty to 30 percent of forest land has been converted to agricultural uses, resulting in loss of species and wildlife habitat. Agriculture is also encroaching on park land and protected areas (Wilson 2001; Wood, Sebastian, and Scherr 2001).

Preharvest losses to pests (insects, animals, weeds, and plant diseases) reduce the potential value of farm output by 40 percent, while postharvest losses cost another 10 percent. In developing countries, losses greatly exceed agricultural aid received. Developing countries' share of the global pesticide market is expected to increase significantly during the early 21st century. Insecticides now used in developing countries are often older and acutely toxic, and are generally banned in developed countries except for export (Yudelman, Ratta, and Nygaard 1998).

Unless properly managed, fresh water may well emerge as the key constraint to global food production. This is most likely to be true in Central and Western Asia, North Africa, and much of Sub-Saharan Africa, where population growth is expected to continue to be high and exploitable per capita water resources are quite low. Water is important for food production not only because of direct effects on yields and cultivated area, but also because reliable water supplies

induce farmers to invest in other crop inputs. While water supplies are adequate in the aggregate to meet demand for the foreseeable future, water is poorly distributed across countries, within countries, between seasons, and among multiple uses. Irrigation currently accounts for 72 percent of global water withdrawals and 90 percent of withdrawals in low-income developing countries. Irrigated agriculture supplies about 40 percent of world food production from 17 percent of total cultivated land. In India, irrigated land accounts for 60 percent of domestic food production. Irrigation expanded rapidly from the 1950s until the late 1970s, but new development has slowed since then due to rising costs for dams and other infrastructure, low and declining prices of staple cereals, declining quality of land available for new irrigation, and concern about the environmental and social impact of large-scale irrigation projects (Rosegrant et al. 2001).

Demand for water will continue to grow rapidly, and IMPACT projects that withdrawals in 2020 will exceed 1995 levels by 35 percent, accounting for half the accessible runoff. In developed countries, most of the increased demand will be for industrial use. Developing countries are projected to increase their withdrawals by 43 percent, with the share of domestic and industrial uses in total water demand doubling at the expense of agriculture. Growth in irrigated area is expected to slow significantly. Although Africa's irrigated area is projected to increase by 50 percent, it will remain very low (Rosegrant et al. 2001; Rosegrant and Ringler 2000; Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1999).

5 Emerging and Reemerging Trends Will Impinge on Future Food Security

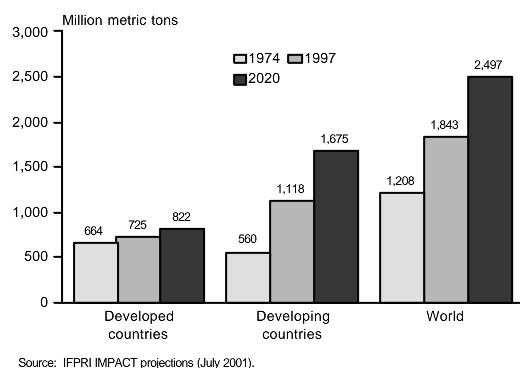
A number of global factors will affect food security over the next two decades, for good and ill. These include projected rises in food demand, globalization, falling aid, debt, technology, global climate change, and health issues.

5.1 Demand Growth

Largely as a result of projected growth in income, population, and urbanization, IMPACT projects an increase in cereal demand in developing countries of 49 percent between 1997 and 2020 (Figure 5.1). Asia will account for 62 percent of the increase in cereal demand, with China alone accounting for 31 percent and India for another 14 percent (Figure 5.2). In absolute terms, Sub-Saharan Africa will exhibit the largest regional increase in cereal demand, 89

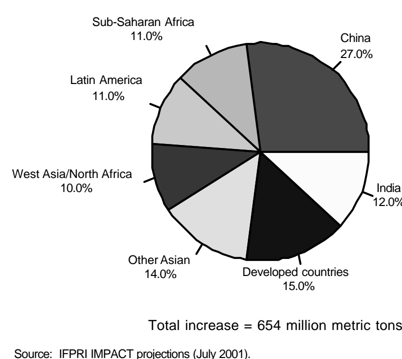
percent. Maize will overtake rice and wheat in accounting for 30 percent of total cereal demand in 2020, compared to 26 percent in 1997 (Figure 5.3). Most of the increasing demand for maize, especially in Asia, will be feed demand driven by rising meat demand, which will increase 57 percent globally and 92 percent in developing countries, led by China (Figure 5.4). In 1997, feed accounted for 21 percent of global cereal demand, but feed will account for 35 percent of the cereal demand increase between 1997 and 2020 (Figure 5.5). Cereal production will grow 1.3 percent annually over 1997-2020, but production increases in developing countries will be insufficient to meeting rising demand (Figure 5.6). The United States and European Union will boost their exports to fill in the gap. Expansion of cultivated area will account for just 15 percent of increased cereal production in developing countries, with yield gains responsible for 85 percent (Figure 5.7). But yields will grow a bit less than 1 percent per year globally, resulting in a 25 percent increase in cereal yields over the 1997-2020 period (Figure 5.8). Only Sub-Saharan Africa will experience improving yield growth rates during the period. Slowing rates of yield growth will result from increasing input requirements in order to sustain yield gains in Asia, as well as slowed public investment in agricultural research and irrigation infrastructure (Rosegrant et al. 2001).

Figure 5.1 Total Cereal Demand by Region, 1974, 1997, and 2020



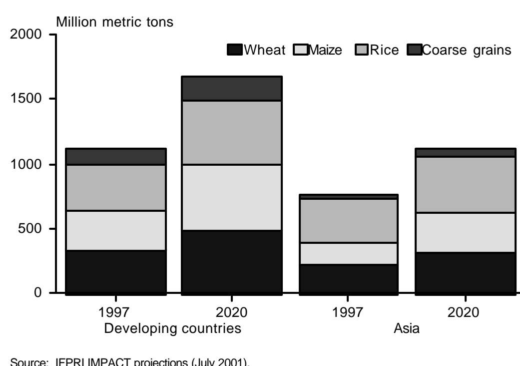
Source: IFPRI IMPACT projections (July 2001).

Figure 5.2 Share of Various Regions in Cereal Demand Increase, 1997 to 2020



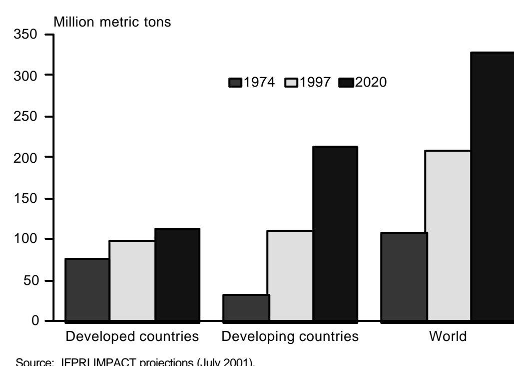
Source: IFPRI IMPACT projections (July 2001).

Figure 5.3 Cereal Demand Composition by Crop and Region, 1997 and 2020



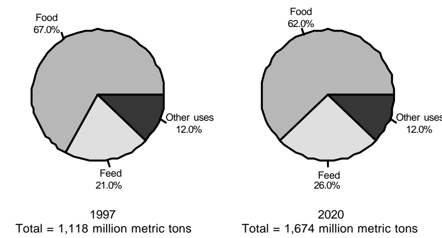
Source: IFPRI IMPACT projections (July 2001).

Figure 5.4 Total Meat Demand by Region, 1974, 1997, and 2020



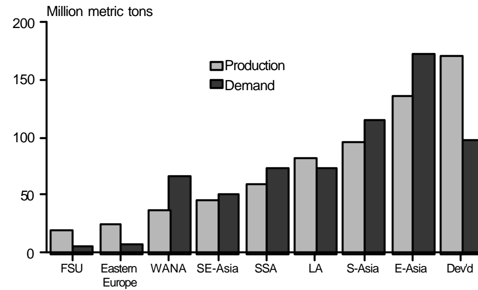
Source: IFPRI IMPACT projections (July 2001).

Figure 5.5 Share of Food, Feed, and Other Uses in Total Cereal Demand of Developing Countries in 1997 and 2020



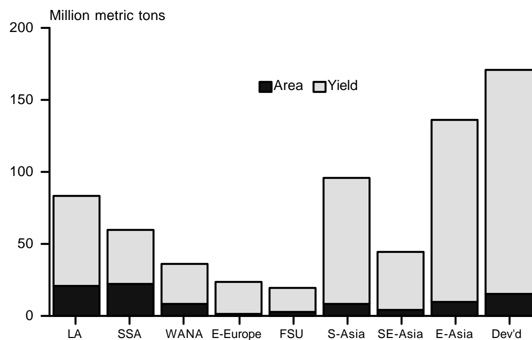
Source: IFPRI IMPACT projections (July 2001).

Figure 5.6 Cereal Production and Demand Increase by Region, 1997 to 2020



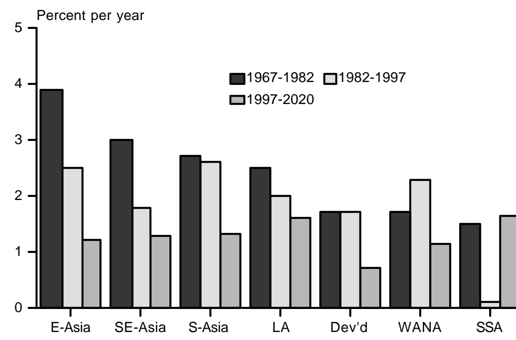
Source: IFPRI IMPACT projections (July 2001).

Figure 5.7 Share of Area and Yield Changes in Regional Cereal Production Growth 1997 to 2020



Source: IFPRI IMPACT projections (July 2001).

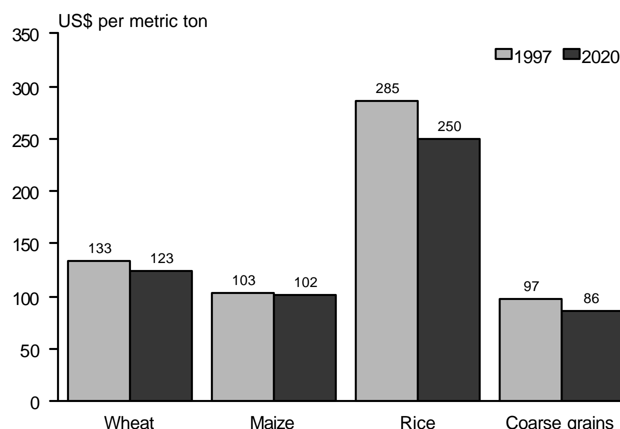
Figure 5.8 Yield Growth Rates by Region, All Cereals, 1967-1982, 1982-1997, and Projected 1997-2020



Source: IFPRI IMPACT projections (July 1997).

IMPACT projects declining international cereal prices over 1997-2020, but at a slower rate than in the 1980s and 1990s. Wheat prices will decline 8 percent, rice prices 13 percent, and maize prices will remain flat, due to strong feed demand. Between 1982 and 1997, real world wheat prices declined by 28 percent, rice prices by 29 percent, and maize prices by 30 percent (Figure 5.9). Moreover, prices will only begin to decline significantly after 2010, with increases of 3 percent for wheat and constant prices for maize and rice over 1997-2010.

Figure 5.9 Cereal Prices by Crop, 1997 and 2020



Source: IFPRI IMPACT projections (July 2001).

5.2 Globalization

Globalization offers significant new opportunities for economic growth in most developing countries, but it may also carry significant risks. These include: the inability of many developing-country domestic industries to compete in the short term; the potential destabilizing effects of uncontrolled short-term capital flows; increased exposure to price risk; and worsening inequality as many poor people and backward regions may get left behind. Managing these risks while exploiting growth opportunities will be a key challenge for developing countries in the years ahead.

In response to the 1994 Uruguay Round global trade agreement and structural adjustment programs enacted with the strong encouragement of aid donors, many developing countries have liberalized foreign trade in food and agricultural commodities. The developed countries have not matched this with reciprocal liberalization efforts, instead maintaining barriers to high value imports from developing countries such as beef, sugar, peanuts, dairy products, and processed goods. Losses due to these trade barriers are not offset by developed countries' preferential trade schemes for specified quantities of certain developing-country exports. There is a major incoherence between the wealthy countries' development cooperation policies on the one hand, and their trade policies on the other. In their aid donor roles, the developed countries have encouraged developing countries to undertake structural adjustment programs that emphasize production of the same high-value agricultural commodities for export that are subject to trade barriers in industrialized country markets. Some developed countries also continue to subsidize their agricultural exports, and occasionally impose export embargoes. The asymmetry in trade liberalization reduces benefits to developing countries and may make continued market liberalization under these conditions unviable for them. In addition, many developing countries lack administrative, technical, and infrastructural capacity to comply with global trade rules (Diaz-Bonilla and Robinson 1999; Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1999 and 1997).

Africa's share of world agricultural trade continues to decline rapidly (Figure 5.10). The effect of current trade agreements is likely to be adverse for most African countries (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1999).

Figure 5.10 African Share of World Agricultural Trade, 1961-1997

Source: Mukherjee and Harris (1999).

When they signed the Uruguay Round agreement in Marrakech, Morocco in 1994, the member countries of the new World Trade Organization (WTO) agreed to the "Decision on Measures Concerning the Possible Negative Effects of the Reform Program on Least-Developed and Net Food-Importing Developing Countries." This Marrakech Decision commits developed countries to provide compensation to poor food importing countries experiencing short-term negative consequences as a result of agricultural trade liberalization. It specifies such measures as increased food aid, access to export credits, and increased financial and technical assistance to agriculture in the affected countries. However, the Marrakech Decision does not make any institution responsible for determining whether trade liberalization has caused harm to the poor countries, and there has been much inconclusive debate ever since (Diaz-Bonilla and Robinson 1999; Marlin-Bennett 1997).

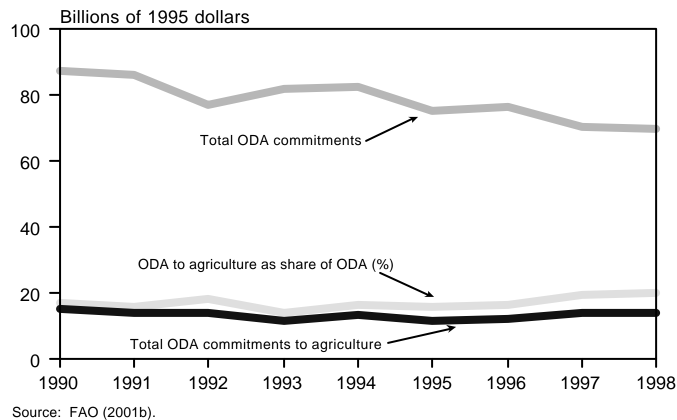
Fortunately, studies indicate that the Uruguay Round agreement will have a very limited impact on international food and agricultural prices. The agreement will increase grain and livestock prices by between 2 and 5 percent between 1995 and 2005 (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997).

5.3 Plummeting Aid

With the end of the Cold War, official development assistance (ODA) has become a much lower priority for industrialized-country governments. Aid from the principal donors countries fell nearly 22 percent in real terms from 1991 to 1997. Since then, aid has risen slightly, but total ODA remained below the level provided in the early 1990s (Figure 5.11). Aid to Sub-Saharan Africa declined 35 percent over 1995-99, from $18.4 billion to $12 billion in nominal terms. The share of ODA to Africa in all ODA dropped from 31 to 23 percent. Aid to South

and Central Asia also fell, though only by 8 percent, from $6.4 billion to $5.9 billion, and the share of ODA provided remained at 11 percent. During the same period, aid provided to low-income developing countries fell from $31.8 billion to $24.5 billion, and from 53 percent of all ODA to 48 percent. Higher income countries and countries in Eastern Europe, East Asia, and West Asia/North Africa saw their aid allocations increase (OECD 2000).

Figure 5.11 Total ODA and ODA to Agriculture and Rural Development, 1990-98



Source: FAO (2001b).

Japan has consistently been the largest donor of ODA since 1993, and, following substantial reductions in aid levels in 1996 and 1997, increased the level provided in 1998 and 1999, reaching a record level of $15.3 billion in the latter year due to special loans provided in response to the Asian economic crisis. Though the figure fell back to $13.1 billion in 2000, Japan retained its place as the largest donor. Japanese ODA remains well below the U.N. target level of 0.7 percent of GNP. On this measure, Japan ranked tied for 12th among the 22 major donors in 2000, and seventh in 1999. Looking at the five largest donors (Japan, the United States, France, Germany, and the United Kingdom), which provided 69 percent of the total ODA from members of the Organisation for Economic Co-operation and Development's Development Assistance Committee in 1999 and 2000, Japanese ODA as a percent of GNP ranked behind France and the United Kingdom in 2000 and behind only France in 1999. In light of Japan's current economic circumstances, it may be difficult to sustain such levels of assistance, but because Japan so far has provided high levels of ODA during difficult economic times, it is well poised to encourage other donors to increase their aid (Randel and German 2001; Berkman 2001; OECD 2000 and 2002).

Between 1986 and 1997, aid to agriculture and rural development from all donors shrunk by almost half, while the share of total aid going to agriculture

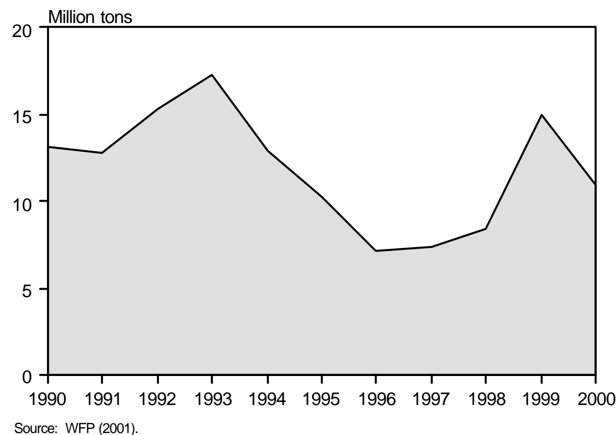
dropped from 25 to 20 percent. Although aid to agriculture increased somewhat in 1996-98, in real terms, the resources provided were 8 percent below ODA to agriculture in 1990. The increase was provided entirely through multilateral channels, primarily the World Bank, as bilateral assistance actually declined in 1997 and 1998. The share of global aid to agriculture going to Africa declined from 30 percent in 1990 to 21 percent in 1998. Some donors have taken steps to refocus ODA on agriculture, however. Denmark increased the share of its aid going to agriculture from 6 to 20 percent over five years at a time when overall ODA was increasing. Japan has been the leading bilateral donor of aid to agriculture in recent years, providing assistance to 60 countries, with an emphasis on improving productivity of staple food crops (FAO 2000c; FAO 2001b; Berkman 2001). **We recommend that Japan, and JBIC in particular, continue to take a leadership role in this area.**

IFPRI research has demonstrated that reducing ODA to agriculture is short-sighted on the part of the donors that have done this. Aid to developing-country agriculture not only is effective in promoting sustainable development and poverty alleviation, but it leads to increased export opportunities for developed countries as well, including increased agricultural exports, as agricultural growth spurs more general economic growth and demand for food products (Pinstrup-Andersen and Cohen 1998).

Donors have also scrimped on aid to education. Since 1990, aid to education has consistently accounted for 10 percent of ODA, even as aid levels have fallen, meaning considerable reductions in the available resources. Only five of the 21 main bilateral donors (Denmark, Finland, Germany, the Netherlands, and Sweden) provide more than two percent of their aid to basic education. Japan's ODA to education is currently heavily oriented toward university-level training, with just 0.3 percent of aid going to basic education. The international community has failed to deliver on the commitment made at the 1990 World Conference on Education for All in Jomtien, Thailand, to universal primary education, for girls and boys alike, by no later than 2000. Presently, only 55 percent of school-aged boys and 46 percent of girls are enrolled. In South Asia, the figures are 65 percent for boys and 50 percent for girls, meaning higher enrollment rates for both boys and girls but a larger gender gap. Girls account for 60 percent of the 130 million children aged six to 11 years who are not in school. At the current rate of progress, it will be nearly impossible to meet the revised goal of universal primary education by 2015 (Randel and German 2001; Watkins 2001; UNICEF 2000).

Food aid levels have fluctuated considerably since the mid-1990s (Figure 5.12). Late in the decade, the United States, which remains the largest donor (accounting for 50-65 percent of global tonnage in recent years), expanded food aid substantially, following major reductions in 1994-96. The sharp peaks and valleys stemmed far less from developing country needs for either humanitarian or trade liberalization adjustment assistance than from U.S. domestic market conditions, as the United States continues to tie its food aid to U.S. farm products and use food aid for surplus disposal (WFP 2001; Clay and Stokke 2000; Cohen 2000).

Figure 5.12 Global Food Aid Deliveries, 1990-2000



Source: WFP (2001).

5.4 Debt

Forty-five of the poorest countries, 30 of which are in Africa, owe $235 billion to external creditors, mainly other governments and international financial institutions. Debt per capita exceeds these countries' income per capita. Most of these highly indebted poor countries cannot afford to make payments on this debt, due in large part to deteriorating terms of trade for their primary product exports. According to debt relief advocates, both international creditors and debtors have engaged in irresponsible practices over the past 25 years (Catholic Relief Services 2001; Pettifor 2000). Many of the highly indebted poor countries suffer from high levels of food insecurity (FAO 2001b). In order to repay their debts, poor country governments delay investments in schools, clinics, and roads. They also seek ways to boost exports that will earn the hard currency in which they must make their debt payments, and so they may end up encouraging production of flowers for export to developed countries instead of staple food crops consumed by their own people. In Africa, governments spend four times as much on debt service as they do on education, health, and nutrition (Catholic Relief Services 2001; Pettifor 2000).

5.5 Technology

Technological advances developed through agricultural research and development made substantial contributions to the spectacular increases in food production witnessed during the twentieth century. But rapid changes are taking place in the financing, management, and organization of agricultural research, the proprietary nature of the agricultural sciences, and the nature of the biological sciences themselves. These changes are placing an increasing share of agricultural research and the ownership of new technologies in the private domain, raising concerns about the extent to which agricultural R&D will help eliminate hunger for the world's poor people in the decades to come (Alston, Pardey, and Taylor 2001). Likewise, the privatization of the International Marine Satellite Organization and the planned privatization of the International Telecommunications Satellite Organization raise serious concerns about whether the "digital divide" in access to information and communications technology will widen (Thussu 2001). At the same time, biotechnology, modern information and communication technologies, and energy technologies offer new opportunities that could benefit poor people, their food security, and natural resource management, if policies are in place to assure that poor people can reap these benefits (Thussu 2001; Pinstrup-Andersen and Cohen 2001; Mohan 2000; Obasanjo 1995).

5.6 Global Climate Change

Global climate change is leading to higher average temperatures and sea levels and to less stable weather patterns, including more frequent and severe droughts and flooding. These changes will have profound and often negative impacts on developing countries, with many of the poorest countries being most vulnerable (Wilson 2001). There remains great controversy within the scientific and policy communities over the extent of, and future trends with regard to, this phenomenon (Shapiro 2001). Nevertheless, the United Nations-sponsored Intergovernmental Panel on Climate Change recently reported that anticipated increases in temperatures mean that in the tropics, where some crops are near their maximum temperature tolerance and where dryland agriculture predominates, yields would decrease generally with even minimal increases in temperature. Where there is a large decrease in rainfall, crop yields would be even more adversely affected. Drier soils and heat could also reduce crop production in some parts of the North American "breadbasket." In addition, some scientists believe that the increase in the number and intensity of natural disasters, such as the floods and hurricanes of 1998, are due to increased global warming as a result of human activity, such as burning fossil fuels. However,

increased levels of carbon dioxide, which contribute to global warming, also lead to improvements in plant growth (Wilson 2001; Agence France Presse 2001; Annan 1999).

5.7 Health

Hungry and undernourished children are likely to miss more school days due to illness, and diet-related chronic diseases — perhaps linked to undernutrition *in utero* — take individuals out of the workforce and absorb resources from primary health services. Compounding the difficulties of malnutrition is the relentless burden of disease. The interaction of inadequate dietary intake and disease leads to malnutrition, disability, and death. Insufficient access to food, inappropriate caring practices, a poor environment, inadequate health services, low women's status, and poverty play catalytic roles (Flores and Gillespie 2001).

The tragic pandemic of HIV/ Acquired Immune Deficiency Syndrbme (AIDS), the emergence of obesity as a serious health risk in many developing countries (often alongside undernutrition), and the on-going threats from malaria, tuberculosis (TB), and other health problems are all compromising food and nutrition security in developing countries. The result is a global health crisis that appears to infect poor and undernourished people while impoverishing the affected. About 36 million people are currently living with HIV/AIDS, two-thirds of them in Sub-Saharan Africa, most of whom will be dead by 2020, along with the 14 million Africans who have already succumbed. The disease is spreading dramatically in Asia. It has contributed to rising health care costs, labor shortages, a declining asset base, breakdown of social bonds, loss of livestock, and reliance on crops that are easier to produce but less nutritious and economically valuable. Tuberculosis and HIV/AIDS often conjoin to destroy lives. TB kills 30 percent of AIDS victims in Africa and Asia, and HIV accelerates the progression to active TB by up to one hundredfold. African children under the age of five account for 90 percent of the 1.5 to 2.7 million people who die of malaria annually. Because malaria often strikes during harvest time, it can threaten food security and agricultural production (Flores and Gillespie 2001).

Although only limited data are available on obesity in developing countries, obesity seems to be rising in Latin America, in the Middle East, and in urban areas. At present, it is still rare in South Asia and Saharan Africa. In Mexico, it is emerging as a marker of poverty, rather than affluence. In China, obesity in men tripled to 14.1 percent between 1989 and 1997, and the rate doubled for women to 20.7 percent. This fits with studies of the shifts in dietary behavior

that have shown a marked increase in the consumption of pork, oil, and other sources of fat. Thirty-three to 39 percent of the adult women and 30-35 percent of adult men are projected to be overweight by 2020. In India, 20 percent of women and 16 percent of men are expected to be overweight by 2020. Overweight is associated with an increased prevalence of cardiovascular risk factors, gallstones, and osteoarthritis. Overweight and the risk of certain cancers rise in direct proportion. Some researchers believe that poor nutrition during fetal and infant development with later periods of positive energy balance are risk factors for overweight. Some countries with high levels of obesity still report significant rates of child malnutrition. Given limited resources, it is difficult for governments of poor countries to address the dual nutrition agenda of obesity and undernutrition (Flores and Gillespie 2001; Gillespie and Haddad 2000).

A strong relationship exists among health, nutrition, and economic productivity. The benefits of good health and nutrition for economic growth cannot be overstated. Progress against hunger and poverty depends on a response to these emerging and reemerging health and nutrition concerns (Flores and Gillespie 2001).

6 Policies and Programs to Achieve Food Security: The Role of ODA

Critics of varying political persuasions have criticized ODA for failing to alleviate poverty, propping up favored governments without benefitting people in need, and providing too many benefits to firms and consultants in the donor country (Lappé, Collins, and Rosset 1998; Johnson and Sheehy 1995). There is some truth to these criticisms. However, development assistance has been successful in advancing sustainable development and human well-being. It has helped boost immunization rates among children in developing countries, thereby reducing child deaths. Aid has provided significant support for dramatic gains in life expectancy and educational achievement in many developing countries. Humanitarian assistance has made a life-and-death difference for people affected by natural disasters and armed conflicts (Cohen 1996).

ODA has provided funding for microcredit, small loans that allow poor people to start or expand small businesses. Such loans have had very high repayment rates, and have successfully boosted incomes for poor households, contributing to improved food security and nutrition (Zeller and Sharma 1998). ODA has supported the work of international agricultural research centers and national

agricultural research systems in developing countries. As a direct result, global food production increased by 80 percent between 1971 and 2000, per capita calorie consumption in developing countries rose by 26 percent, and the incidence of chronic undernutrition in developing countries fell from 37 percent to 18 percent. Yield gains attributable to agricultural research and development have permitted the preservation of over 426 million hectares, or more than all the farmland of the United States, Canada, and Brazil combined. This conserved forests and wildlife habitat that otherwise would have been cultivated, thereby preserving biodiversity. This, in turn, meant that less carbon was released into the atmosphere. The Future Harvest international agricultural research centers hold over 600,000 accessions of more than 3,000 plant species in their gene banks, and this collection, too, is absolutely critical to the preservation of biodiversity (Cohen and Pinstrup-Andersen 2001; CGIAR 2001; McNeely and Scherr 2001).

Solutions to the problem of food insecurity must and will come primarily from the affected countries themselves. Food insecure people themselves hold the key to food security, and when given the opportunity, are eager to engage in income generating activities, to produce food for their own consumption, and to participate in making the decisions that affect their lives. Governments of developing countries are likewise essential. They can enact and enforce policies that assure that opportunities and resources are available to poor people, that no one interferes with the efforts people undertake to feed themselves, and that safety nets are available to vulnerable groups.

Financial and technical assistance from wealthy countries can play a vital catalytic role in assuring that the appropriate policies and programs are in place. For poor countries, external assistance is especially important. Private foreign direct investment flows from North to South jumped 130 percent between 1990 and 1999, but virtually all of the funds went to higher-income developing countries in Latin America and Asia. In countries with high levels of food insecurity, ODA accounts for over 50 percent of government expenditures and 86 percent of gross domestic investment (FAO 2001b). If ODA is to be effective, donors must reverse the decline in overall aid resources. In addition, they must better target resources on the basis of need. **We recommend that a larger proportion of ODA from JBIC and other donors go to the most food-insecure countries, i.e. to low-income countries in Sub-Saharan Africa and South Asia, and that a larger share of aid go to support policies and programs that can have a substantial food security impact; these are identified below.** Resources to support this can come both from an overall expansion of ODA budgets, and from reducing aid to higher income recipients. In

the case of some donors, reducing military aid and export subsidies would also free up resources.

7 Broad-Based Agricultural and Rural Development is Key to Food Security

It may seem paradoxical, since food insecurity results more from problems of access to food than from lack of food availability, but broad-based agricultural and rural development must be at the center of any strategy to achieve food security in the developing world. This is because the center of gravity of poverty — and therefore hunger — will remain rural for the next 35 years. Even when rural poor people are neither farmers nor farm workers, their livelihoods depend on nonfarm activities that are closely related to agriculture (IFAD 2001). Low agricultural productivity in developing countries results in high unit costs of food, poverty, food insecurity, poor nutrition, low farmer and farm worker incomes, little demand for goods and services produced by poor nonagricultural rural households, and urban unemployment and underemployment. IFPRI research has shown that for every new dollar of farm income earned in developing countries, income in the economy as a whole rises by about $2.50, as growing farm demand generates employment, income, and growth economy-wide (Delgado, Hopkins, and Kelly 1998). As incomes rise in the farming sector, farm households demand more goods from the nonfarm sector. Small- and medium-sized farm households, on average, devote a higher share of their budgets to nonfarm consumption goods than larger farms do. As agricultural production increases, it generates demand for inputs such as seeds, water, and fertilizer and for farm implements produced by the nonfarm sector. The need to process food and agricultural raw materials also stimulates rural nonfarm activities (Islam 1997). Rural industries that support agricultural production and process farm output offer employment, management, and entrepreneurial opportunities for rural poor people. Rural industries and trade can facilitate women's empowerment by increasing rural women's economic options.

Broad-based agricultural and rural development supports sustainable food security in other ways as well. Agricultural growth also helps meet rising food demand stemming from population and income growth and urbanization. A healthy agricultural economy offers farmers incentives for conserving the natural resource base upon which future agricultural production depends. Also, productivity gains on existing land make farmers less likely to clear wild, marginal, or forest land (Rosegrant et al. 2001; World Bank 1997).

Small farmers in developing countries face many problems. Low soil fertility and lack of access to plant nutrients, along with variable weather and acid, salinated, and waterlogged soils contribute to low yields, production risks, and natural resource degradation. Inadequate infrastructure, land tenure biased against poor people, poorly functioning and poorly integrated markets, and lack of access to credit and technical assistance add impediments.

Sound public policies are needed to guarantee that agricultural and rural development is indeed broad-based, creating opportunities for small farmers and other poor people on an equitable basis. **We recommend that JBIC and other donor agencies target ODA to poor countries, as aid resources are critical to assuring the implementation of appropriate policies and that appropriate public investments are carried out.**

The development of well-functioning and well-integrated markets for agricultural inputs, commodities, and processed goods, along with the supporting institutions and infrastructure, such as roads and storage, especially in rural areas, will contribute enormously to poverty alleviation, food security, and the overall quality of life in developing countries. Market performance improves and marketing costs fall when the government no longer monopolizes trade and a competitive private sector emerges. Yet even as the government reduces its role, competent public administration will remain essential to assure that:

- contracts are enforced;
- grading and quality control standards are enacted and implemented (especially for export crops);
- market conduct and investment are appropriately and fairly regulated;
- safety net programs are provided for vulnerable groups;
- public health and safety are maintained;
- infrastructure is created;
- agricultural research and extension services are available; and
- credible and sustainable macroeconomic policies are implemented and provide a favorable environment for savings and investment and accurate and transparent incentives for consumers and producers alike (Kherallah et al. 2000).

As important as effective and efficient markets are, by themselves, markets cannot, and should not, be expected to assure equity. Key public policies and investments must assure that agricultural growth truly is broad-based:

- Poor farmers must have access to yield increasing crop varieties — including drought- and salt-tolerant and pest-resistant varieties — improved livestock, and other yield-increasing and environment-friendly technology;
- Poor farmers must likewise have access to productive resources, including land, water, tools, fertilizer, and pest management;
- Smallholders need opportunities to participate in production of export crops, as this will have spillover effects on input use and food crop productivity, increase access to markets, and have a beneficial impact on income and food security;
- Institutional barriers to the creation and expansion of small-scale rural credit and savings institutions need to be removed, and credit must be accessible to small-scale farmers, traders, transporters, and processing enterprises;
- Strong extension services and technical assistance to communicate timely information and developments in technology and sustainable resource management to farmers and to relay farmer concerns to researchers must reach small- and medium-sized farmers; and
- Primary education, health care, clean water, safe sanitation, and good nutrition must be available for all.

IFPRI research in India has examined the mix of public investments in rural areas that would be most likely to result in agricultural growth and/or poverty reduction. Government spending on productivity-enhancing investments (especially agricultural research and extension), roads, and education all contribute to reductions in rural poverty, while investment in agricultural research and extension and in roads significantly boost agricultural productivity. In contrast, investments in irrigation or electrification have less impact on productivity and none on poverty. In China, IFPRI research has found that investments in agricultural research, roads, education, and rural telephones have substantial impacts on both poverty and agricultural productivity, especially in less-favored areas (Fan, Hazell, and Thorat 1999; Fan and Hazell 2000). **While these results may not be widely generalizable beyond India and China, given the large number of rural poor people in those countries, we recommend that policymakers in the two countries and aid donors use these results as guidance in setting public investment priorities**.

To succeed, programs aimed at fostering broad-based agricultural and rural development must be implemented within an appropriate policy context. This includes good governance — the rule of law, transparency, sound public

administration, democratic and inclusive decision making, and respect for human rights. Democratic governments are more likely to be responsive to the needs of all their citizens, to make food security a high priority, and to welcome community participation (Smith and Haddad 2000). In addition, trade, macroeconomic, and sectoral policies must not discriminate against agriculture and must be favorable to poverty reduction and food security (Tweeten and McClelland 1997; Drèze and Sen 1989).

Agricultural and rural development policies, programs, and projects must engage low-income people as active participants, not passive recipients. To assure responsive policies, poor people need accountable organizations that articulate their interests. In both Chile and the Indian state of Kerala, an extensive array of government health, nutrition, and education programs are maintained in part because community organizations, labor unions, women's groups, and farmer associations have pressed for such policies (Drèze and Sen 1989). The Zimbabwean national non-governmental Organization of Rural Associations for Progress (ORAP) works with village organizations, extended family groups, and community associations established during the independence struggle on rural development projects. ORAP provides technical assistance to further the local groups' own initiatives, and also lobbies the national government for supportive policies, such as access to land and other resources (Cohen 1994). Farmer organizations, such as credit unions, cooperatives, and farmers' associations, can help assure that small farmers have access to inputs, credit, markets, and opportunities to engage in more diversified, higher value crop production (Kherallah et al. 2000; Delgado 1997).

Poor people can often gain empowerment effectively by making alliances with groups of nonpoor people. For example, in Brazil, the 3 million-member Citizens Action anti-poverty movement includes professionals, business people, and trade union members, as well as poor people themselves. It works through 3,500 local committees to improve nutrition, health care, employment, housing, and sanitation, and has pressed the national government to make food security a high policy priority (Cohen 1996).

7.1 Boosting Public Investment

Despite the critical role of agricultural and rural development in poverty alleviation and economic growth, developing countries are currently underinvesting in this sector. Many developing-country governments have concluded that agriculture is a declining sector, and have put resources instead into industry and

urban development, which tend to have more politically potent constituencies. Long-term declines in real food prices have contributed to a sense of complacency about agriculture among both donor and developing-country governments. Also, in the 1980s and 1990s, there was a tendency in development circles to stress natural resource management, gender equity, and democratization without linking programs to the agricultural context that remains central to the livelihoods of most poor people (World Bank 1997).

New data from FAO (2001b) indicate that Sub-Saharan African governments devoted just 4.7 percent of their expenditures to agriculture in 1996-98. For South Asian governments, the figure was 6.8 percent. For the countries with the highest incidence of food insecurity, the share was under 6 percent. These allocations are below expected levels in view of the importance of agriculture in the overall economy of most poor countries, and in view of the sector's potential to contribute to poverty reduction. As already noted, for some poor countries, high levels of debt service place a severe constraint on public investment. Moreover, military spending during the same period generally exceeded public expenditure on agriculture: it accounted for 15.6 percent of government expenditures in South Asia and 7.8 percent in Sub-Saharan Africa. For all low-income countries, the figure was 13.3 percent (World Bank 2001b). Given the high levels of child malnutrition and poverty in South Asia, ending the arms race in that region would free up critical resources for investment in agriculture, education, nutrition, and food security.

ODA donors, too, need to change their policies. They should encourage increased public investment in broad-based agricultural and rural development, and should provide technical and financial assistance to make this possible. The decline in the absolute value of ODA to agriculture must be reversed. JBIC and other Japanese government agencies involved in development cooperation, together with the World Bank and the Danish aid agency, have set an example as leading sources of ODA to agriculture. **We recommend that JBIC encourage other donors to increase their resources so as to boost the poverty reducing, natural resource sustaining impact of their assistance. In addition, we recommend that all donors rethink their 20-year emphasis on reducing government's economic role. This has contributed substantially to developing countries' public underinvestment in agriculture** (FAO 1996c). As already noted, greater reliance on market forces in agriculture continues to require a substantial and effective government role.

8 Agricultural Research: A Global Public Good

Public investment in agricultural research that can improve small farmers' productivity in developing countries is especially important for food security. Continued low productivity in agriculture not only contributes to gaps between food production and demand in poor countries, but it also prevents attainment of the broad-based income growth and lower unit costs in food production needed to help fill the gap and improve food security. Efforts to improve longer-term productivity on small-scale farms, with an emphasis on staple food crops, livestock, fisheries, and agroforestry (the integration of farming and tree cultivation), as well as high-value cash crops, must be accelerated. Crop research should focus on crops relevant to small farmers and poor consumers in developing countries: bananas, cassava, yams, sweet potatoes, rice, maize, wheat, sorghum, and millet. IFPRI research shows that even minor increases in agricultural research for developing countries can significantly accelerate food supplies while relatively small cuts could have very serious negative effects (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997; 1999).

The indirect impacts of agricultural research on poverty and food insecurity may be even more important than the direct benefits (or losses) from on-farm technological adoption and changes in agricultural employment. As a result of widespread adoption in Asia of high-yielding cereal varieties, developed at International Agricultural Research Centers (IARCs) and national agricultural research institutions (the Green Revolution), output increased dramatically. This in turn led to lower food prices, and, over time, increased nonfarm employment opportunities, to the great benefit of poor people. Lower food prices were not only beneficial to nonfarm poor consumers, but they helped many poor farmers who were net purchasers of food. Farmers who produced as much or more than they sold gained even though prices declined, because technical advances allowed them to reduce costs of production (Kerr and Kolavalli 1999).

Research and technology alone will not drive agricultural growth. Policies must expand and guide research and technology development to solve problems of importance to poor people. The full and beneficial effects of agricultural research and technological change will materialize only if government policies are conducive to and supportive of poverty alleviation and sustainable management of natural resources.

The private sector is unlikely to undertake much research needed by small farmers in developing countries because expected profits from disseminating the fruits of this research are unlikely to cover the cost of investment. However, gains to society and to poor people are high. Social rates of return to agricultural research investment exceed 20 percent per year, compared to long run real interest rates of 3-5 percent for government borrowing, but these returns can only be obtained through public investment (Alston et al. 2000).

Economists use the term "public goods" to refer to commodities or services that, if supplied to one person, can be made available to others at no extra cost. In contrast to private goods, public goods are "non-rival" because one person's consumption does not reduce anyone else's opportunity to consume. Also, public goods are "non-excludable," because once the good is provided, the producer cannot prevent anyone from consuming it. As a consequence, private markets for the good do not function, since no one would be willing to pay for it. Public goods are therefore generally provided by the government, or through private channels with public funding. Some examples are national defense, streetlights, education, public health, and environmental protection (Dalrymple 2001; Schuh 2001; Pinstrup-Andersen 2000; Pearce 1986).

In recent years, there has been considerable interest in what are called "global public goods." These are transnational in nature and their production depends upon collective action and a multilateral approach. Examples include the development of vaccines against infectious diseases, control of transboundary pollution, and certain kinds of agricultural research. **We recommend that JBIC and other aid agencies provide the resources that are essential to assure that developing countries have access to such knowledge and technology. ODA can play an especially important role in forging public-private partnerships to assure that pressing problems are addressed. In the absence of a public and multilateral response, the private sector is unlikely to address many transnational problems facing poor people, such as food insecurity, disease, and natural resource degradation** (Berkman 2001; World Bank 2000; Kaul, Grunberg, and Stern 1999).

Knowledge derived from research — whether in the natural sciences, the social sciences, or the humanities is clearly non-rival. One person's acquisition of knowledge does not detract from anyone else's ability to obtain the same knowledge. Those who create and distribute knowledge, e.g. research institutes on the one hand or scientific journals on the other, my try to limit access to knowledge by charging a fee, so knowledge may be excludable, although the Internet may be making this more difficult. Also, because knowledge is non-rival, even if access is limited

through fees, once someone has paid the fee, it is likely that the knowledge may spread from the purchaser, because consumption does not use it up.

Knowledge of agricultural practices is a good example; it can be reused. Some knowledge is primarily of local or national interest, e.g. the optimal planting time for teff in various parts of Ethiopia. Other knowledge is of interest and benefit globally, such as knowledge about international economic trends and certain health, food, and agricultural knowledge, including knowledge derived from some kinds of agricultural research. The development of high-yielding varieties of widely planted staple food crops, such as wheat, rice, maize, millet, sorghum, and cassava, would be examples.

The transnational nature of the benefits of this research are substantial. As already noted, agricultural research has helped boost agricultural productivity and food consumption (thereby reducing poverty), while preserving biodiversity and conserving natural resources in developing countries. In addition, every dollar invested in agricultural research in developing countries boosts their imports of goods and services by $4, including $1 in agricultural imports. Investments in international agricultural research directly and handsomely benefit consumers and farmers in the donor countries, not only because of higher exports and related income and employment, but also because crop varieties bred for use in developing countries may prove beneficial in industrialized countries as well. For example, every dollar invested in international wheat research by the United States has meant $190 in benefits for U.S. consumers and farmers; investments in rice research have had a $17 return per dollar invested, as U.S. farmers have joined their counterparts in Asia and Latin America in widely planting IARC-bred varieties (Pinstrup-Andersen and Cohen 1998; Pardey et al. 1996).

A World Bank study examined ODA funding for five categories of global public goods: knowledge, health, environment, peace and security, and financial stability. In the late 1990s, about 18 percent of global ODA was allocated to global public goods. However, funding grew mainly for health, the environment, and peace keeping, while funding for knowledge, particularly agricultural research, stagnated (World Bank forthcoming). Between 1990 and 2000, donors' support for international agricultural research centers declined about 10 percent in real terms. Funding stabilized in the mid-1990s, but there have not been significant increases (Cohen and Pinstrup-Andersen 2001).

Knowledge may be embodied in physical technology such as computer chips or improved seeds. If the technology is subject to clear and enforceable intellectual

property rights, then it ceases to be a public good. In the case of seeds, such rights are much more difficult to enforce, because seeds tend to multiply. Hybrid seeds, however, generally lose their improved traits after first use, unlike open pollinated seed, and so are much more likely to be commercialized. The private sector generally has a greater incentive to carry out research on hybrid seeds because farmers need to buy new seed every season to maintain hybrid vigor. But private-sector agricultural research has limitations. Consumers as well as farmers may benefit from improved seed, but the seed company does not have the right to tax consumers. Hence, the benefits derived by the farmers will set limits on the gains a company can capture. From a social point of view, a private company is likely to underinvest in agricultural research.

Basic research — in agriculture or other fields — is a public good and likely to be carried out by the public sector unless the results can be patented. Private-sector agricultural research has typically involved applied research leading to knowledge and technology of direct utility for farmers. Public universities and government agencies have traditionally carried out basic research, while the private sector has adapted the results. More recent partnerships between public universities and private companies demonstrate that the private sector recognizes the importance of basic science, even if private firms have to cover some of the cost and even if they may not capture exclusive rights to the resulting knowledge (Pinstrup-Andersen 2000).

Developing countries severely underinvest in agricultural research. The average share of farm production invested in agricultural research in low-income developing countries is 0.5 percent, as compared to 2 percent in higher income countries. Average annual growth rates of public agricultural research expenditures in developing countries in the 1980s and 1990s were below those of the 1970s (Table 8.1) (Rosegrant et al. 2001; Alston, Pardey, and Taylor 2001; Alston et al. 2000; Pardey and Alston 1996).

Table 8.1 Public Agricultural Research Expenditures in Developed and Developing Countries, 1971-91 (average annual growth rates)

	1971-81	1981-91	1971-91
		(percent)	
Developing countries	6.4	3.9	5.1
Sub-Saharan Africa	2.5	0.8	1.6
China	7.7	4.7	6.3
Asia and Pacific (excluding China)	8.7	6.2	7.3
Latin America and the Caribbean	7.0	-0.5	2.7
West Asia and North Africa	4.3	4.1	4.8
Developed countries	2.7	1.7	2.3
World	4.3	2.9	3.6

Source: Alston, Pardey, Taylor (2001).

Low priorities for agricultural development and improved food security among many developing-country governments, along with lack of knowledge about how powerful agricultural research can be to achieve economic growth and reduced poverty and many governments' short planning horizon relative to the time lag between the investment in agricultural research and the resulting benefits, are the main reasons for the serious underinvestment of public funds. Failure by the public sector to expand investment in agricultural research will result in lost opportunities for increased economic growth and reduced poverty and food insecurity (Pinstrup-Andersen 2000). **We recommend that JBIC play a leadership role in the development cooperation community in assuring that adequate ODA resources go to pro-poor agricultural research.**

Private-sector research relevant to small farmers in developing countries is very limited even in the larger middle-income countries. It is almost non-existent in the poorer developing countries, including most African countries. The public goods nature of the technology needed by small farmers in developing countries along with lack of rural infrastructure, lack of access to credit among farmers and traders, and poorly functioning markets for seed, fertilizers, and agricultural output account for the limited private investment. Although early adopters of the technology may gain, most of the economic benefits will go to consumers through price decreases resulting from productivity gains and expanded supplies. Agricultural research may generate other social benefits besides more plentiful food

and lower prices, such as improved management of natural resources. But the private sector generally cannot capture these social benefits.

Trade policies have a significant bearing on who benefits from agricultural productivity increases. In an economy that is closed to international trade, the domestic price declines resulting from productivity gains are dramatic. As countries liberalize trade, price decreases may be less and farmers may capture a larger share of the benefits. In the case of small countries producing for export, almost all of the benefits may be captured by farmers. In such cases, producer groups may be willing to pay for agricultural research and the private sector may be able to obtain sufficient gains to warrant its carrying out the research. This is the case for much of Australia's agricultural research, and for coffee research in Colombia, where most of the crop is grown by small farmers (Pinstrup-Andersen 2000). Furthermore, as trade liberalizes, the benefits from productivity increasing technology applied to maize farming in Uganda, for example, might go to consumers outside Uganda. This justifies a sharing of research costs internationally.

Given the unattractiveness to the private sector of carrying out agricultural research to benefit poor farmers and consumers in developing countries (who are often one and the same) in most instances, and the high social benefits, publicly funded agricultural research is needed. Strong national agricultural research systems focused on solving problems facing poor farmers and consumers are likely to make major contributions to both efficiency and equity goals. These contributions would be significantly enhanced if national research agencies in developing countries have access to results from international research aimed at the creation of knowledge and technology relevant to many countries, i.e. global public goods, such as those currently produced at the Future Harvest IARCs sponsored by the Consultative Group on International Agricultural Research (CGIAR). Developing-country agricultural research agencies can also enhance their impact through partnerships with the private sector in which patented processes and traits are transferred for restricted use in research to adapt the technology for ecoregions and commodities of little or no commercial interest to the patent holder. The latter would reap good public relations, something in which the multinational life science companies are keenly interested in light of controversies over pesticides and genetically modified foods. Over time, as small farmers prosper, the companies might also find new customers. The CGIAR might be an appropriate broker and participant in such research partnerships.

The public sector can expand private-sector research for poor people by converting some of the social benefits to private gains, e.g. by offering to buy

exclusive rights to newly developed technology and make it available either for free or for a nominal charge to small farmers. The private research agency would bear the risks of failure or of a competitor capturing the benefits, as it does when developing technology for the market. This arrangement is similar to that proposed by Harvard economist Jeffrey Sachs for developing a malaria vaccine for use in Africa (Anonymous 1999).

8.1 Pro-Poor Agricultural Research: Integrating Science and Indigenous Knowledge

Pro-poor agricultural research must join all appropriate scientific tools and methods — including agroecology, conventional research methods, and genetic engineering with better utilization of indigenous knowledge. It is important that poor farmers have access to insights into agricultural development from the full range of approaches to tackling their problems. Research should focus on sustainable productivity gains and reduced risk on small farms, emphasizing staple food crops and livestock.

An example of the integration of various kinds of knowledge comes from the Andhra Pradesh Tribal Development Project in India, supported by the International Fund for Agricultural Development. Working with tribal people in a mountainous part of India, the project emphasized production of horticultural and tree crops such as mangoes, nuts, pineapple, coffee, and pepper, both to boost the impoverished communities' incomes and to improve conservation of severely degraded soils long subjected to shifting cultivation. At the same time, the project stressed the use of soil and water conservation techniques long employed by the tribal highlanders themselves, such as stone and bench terraces, grade bunds, and rock fill dams. The villagers designed and built these conservation works (Hazell, Jagger, and Knox 2000).

As this successful project demonstrates, agricultural research and development must put farmers in decision making roles. They must be fully informed about their options for improving productivity, reducing risks, and increasing the well-being of their families. It is also important for agricultural researchers to recognize that farmers themselves have carried out experimentation, adaptation, and breeding at the farm level for thousands of years, and welcome active partnership with scientists (Rhoades 1987).

Researchers working on the Indonesian island of Bali have found that villagers there have developed highly sophisticated approaches to the timing and sharing of irrigation water resources. Before planting season, farmers gather at

water temples located at forks in rivers and negotiate these issues. They have arrived at patterns of efficient water management, equitable allocation to households, cooperative social relationships, less pest infestation, and less variation in harvests (Fountain 2000).

8.2 Agroecology

Although high-yielding Green Revolution technologies have been responsible for enormous productivity increases among small-scale farmers in Asia, many farmers in the region's less-favored areas have been bypassed. The desire to find ways of assisting these farmers, combined with concerns about excessive dependence on external inputs such as fertilizers, pesticides, and irrigation water embodied in the first generation of Green Revolution technologies, has stimulated interest in alternative or complementary approaches, including the so-called "agroecological approach" (Pretty 2001; Altieri, Rosset, and Thrupp 1998).

This approach aims to reduce the amount of external inputs that farmers have to use. Instead, it relies heavily on available farm labor and organic material, as well as on improved knowledge and farm management. Use of locally available materials such as crop residues, farm manure, and compost to improve soil fertility is an important part of the agroecological approach, as is Integrated Pest Management (IPM).

One of the great strengths of the agroecological approach is that it promotes sustainable management of natural resources and active participation by farmers in identifying problems as well as designing and implementing appropriate solutions at the farm and community levels. Such participatory technology development can be extremely effective in finding the most appropriate solutions to production problems.

We recommend that JBIC and other donor agencies recognize that efforts to assist small farmers reject the notion that various approaches represent either/or choices. Combining the best of agroecological approaches and use of external inputs, including improved seeds containing characteristics such as drought tolerance and resistance to certain pests, is likely to be the most appropriate way to assist most small-scale farmers.

8.3 The Potential of Modern Agricultural Biotechnology for Food Security[2]

It is possible that the introduction of agricultural biotechnology into developing countries can contribute to increased productivity, lower unit costs and prices for food, preservation of forests and fragile land, poverty reduction, and improved nutrition. This depends on whether the research is relevant to poor people, on the economic and social policy environment, and on the nature of the intellectual property rights arrangements governing the technology. By raising productivity in food production, agricultural biotechnology could reduce the need to cultivate new lands and help conserve biodiversity. Strong opposition to Genetically Modified (GM) food in the European Union and Japan is driven in part by perceived lack of consumer benefits, uncertainty about possible negative health and environmental effects, and widespread perception that a few large corporations will be the primary beneficiaries.

Consumers' own risk/benefit calculation is likely to vary according to how they earn their income and how much of their income they spend on food. Consumers outnumber farmers substantially in industrialized countries, can afford to pay more for food, and can increase subsidies to agriculture. In contrast, in developing countries, poor consumers depend heavily on agriculture for their livelihoods and spend the bulk of their income on food. Thus, productivity gains and lower unit costs and prices are a life-and-death matter.

Modern agricultural biotechnology offers many potential benefits to developing countries. It may help achieve the productivity gains needed to feed a growing global population, introduce resistance to pests and diseases without high cost purchased inputs, heighten crops' tolerance to adverse weather and soil conditions, improve the nutritional value of some foods, and enhance the durability of products during harvesting or shipping. Biotechnology research could aid the development of drought-tolerant and pest-resistant crops, to the benefit of small farmers and poor consumers. The development of cereal plants capable of capturing nitrogen from the air could contribute greatly to plant nutrition, helping poor farmers who often cannot afford fertilizers. Biotechnology may offer cost-effective solutions to vitamin and mineral deficiencies, such as vitamin A-rich rice, and be used to develop protein-enhanced crops or edible vaccines. By raising productivity in food production, agricultural biotechnology could reduce the need to cultivate new lands and help conserve biodiversity.

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[2] This section is drawn from Pinstrup-Andersen and Cohen (2001).

Bioengineered products may reduce reliance on pesticides, thereby reducing farmers' crop protection costs and benefitting both the environment and public health. Cotton farmers in China who have adopted insect-resistant cotton have reduced their use of highly toxic insecticides that have been responsible for many deaths (Smith 2000).

Except for limited work on rice and cassava, little transgenic crop research currently focuses on the productivity and nutrition of poor people. In 2000, North America accounted for 75 percent of GM crop plantings, with the United States alone accounting for 68 percent (James 2000). There is tissue culture and other non-transgenic agricultural biotechnology research underway in some developing countries. Additional public and philanthropic resources are needed in support of the appropriate research. The Future Harvest centers have an essential role to play.

Successful adaptation of GM crop technology for the benefit of poor farmers and consumers in developing countries will require the establishment of appropriate institutions to assess and manage public health and environmental risks. In addition, developing countries will need to have appropriate policies in place with respect to industrial competitiveness, international trade, and intellectual property if they want to use this technology to help advance food security. The development of global standards and a public global regulatory capacity in many of these areas has lagged far behind the pace of economic globalization.

We recommend that JBIC join with other donors to provide the ODA that is critical for assuring that developing countries can enact and enforce effective national biosafety regulations. Thorough testing is necessary to ensure the safety of new crop varieties developed through biotechnology. Testing of genetically modified crops needs to increase in developing countries; at present, about 90 percent of the testing occurs in developed countries.

Both food safety and biosafety regulations should reflect international agreements and a given society's acceptable risk levels, including the risks associated with not using biotechnology to achieve desired goals. Poor people should be included directly in the debate and decision making about technological change.

Effective legislation is also required to balance seed companies' intellectual property rights with farmers' rights to save, reuse, and exchange seed. This would

balance provisions in WTO agreements, the Convention on Biological Diversity (CBD), and the International Undertaking on Plant Genetic Resources. Relevant to this, genetic use restriction technology (the "terminator" gene) is the first patented component of a technological approach to intellectual property protection. Seeds containing this gene produce plants with sterile seeds. This technology is not appropriate for small farmers in developing countries because existing infrastructure and production processes may not be able to keep fertile and infertile seeds apart. Small farmers could face severe consequences if they inadvertently planted infertile seeds.

The CGIAR has rejected the use of "any genetic system designed to prevent seed germination," such as the terminator. In its 1998 statement on this matter, the CGIAR cited concerns about the spread of this trait through pollen, the possibility of the sale or exchange of non-viable seed for planting, the importance of saving seed for poor farmers, potential negative impacts on genetic diversity, and the importance of farmer selection and breeding for sustainable agriculture (CGIAR 1998).

Unless developing countries have policies in place to assure that small farmers have access to extension services, productive resources, markets, and infrastructure, there is considerable risk that the introduction of agricultural biotechnology could lead to increased inequality of income and wealth, because larger farmers may capture most of the benefits through early adoption of the technology, expanded production, and reduced unit costs.

The outcome of the new global agricultural trade negotiations could also bear upon developing countries' social and economic risks related to biotechnology. If the European Union's "precautionary principle" is accepted as the basis for new agreements on sanitary and phytosanitary standards and technical barriers to trade, then the EU and Japan could discriminate against any potential exporters of GM food or feed without having any scientific evidence of harm. The CBD's Protocol on Biosafety, signed in January 2000, permits heightened scrutiny of GM imports, including labeling and segregation of GM and non-GM imports, but not outright bans.

The dilemma is not just a potential one for developing-country agricultural exporters: the EU has warned Thailand that it will reject imports of Thai rice containing GM organisms. This could undermine Thailand's rice biotechnology research, which seeks inter alia to develop disease-resistant varieties. In addition, Saudi Arabia has banned imports of Thai tuna because it is usually packed in soy

oil, which may be made from GM beans from the United States. Soy oil derived from biotechnology is indistinguishable from oil from non-GM beans. Fearing bans in other Middle Eastern countries, Europe, and Japan, Thai canneries have switched to sunflower oil (Paarlberg 2000; Anonymous 2000).

Low-income developing countries that wish to use an agricultural export-led growth strategy will be faced with the choice between adopting modern biotechnology in agriculture or maintaining the possibility of a GM-free food export to the EU and Japan. They could choose to differentiate and label GM foods and non-GM foods, and to the extent that they can manage such a differentiated system, they would be able to capture the benefits from modern agricultural biotechnology for domestic consumption while maintaining an export market for GM-free foods. Developing countries may also decide to label GM foods and GM-free foods in the domestic market to provide the choice to domestic consumers. In view of the tremendous importance of productivity increases in agriculture in low-income developing countries for poor people in both urban and rural areas, it is hard to believe that any low-income developing country would refrain from utilizing appropriate modern biotechnology in agriculture once reasonable biosafety regulations have been established.

A large share of the food imported by developing countries originates in the United States and these importing countries must take a position on not only biosafety and food safety, but also whether they wish to insist on product differentiation and labeling in the case of imported food. Rejection of GM crops in Europe and Japan may make such crops cheaper for developing Asian importers that are willing to purchase them.

Modern agricultural biotechnology, including genetic engineering, can play a role in achieving food security in developing countries as part of a comprehensive sustainable poverty alleviation strategy focused on broad based agricultural growth. Biotechnology is not a “magic bullet” solution for hunger, but neither is it, as some critics have charged, “a solution looking for a problem.” The problems are genuine and momentous. Increased public sector research is essential for assuring that molecular biology-based science serves the needs of poor farmers and consumers, as is increased public-private cooperation.

The biggest risk is that technological development will bypass poor people in a form of “scientific apartheid” (Serageldin 1999: 389), focusing exclusively on industrialized countries and large-scale farming. If opposition in developed countries leads to moratoria or outright bans on agricultural biotechnology research,

most developing countries will be unlikely to receive scientific or financial support for their research. This would seriously limit opportunities to reduce poverty, food insecurity, child malnutrition, and natural resource degradation. Therefore, **we recommend that JBIC support agricultural biotechnology research focused on the problems of poor farmers and consumers in developing countries.**

9 Policies for Sustainable Management of Natural Resources: The Role of Property Rights and Collective Action

A high degree of complementarity amongst agricultural development, poverty reduction, and environmental sustainability is more likely to be achieved when agricultural development is broadly-based and inclusive of small- and medium-sized farms, market-driven, participatory and decentralized, and driven by technological change that enhances productivity but does not degrade the natural resource base. In order to achieve this, policymakers must understand the ways in which property rights and collective action issues influence whether farmers are willing to adopt natural resource management practices and technologies. In addition, agricultural research must pay greater attention to sustainability features of technology, to broader aspects of natural resource management at the watershed and landscape levels, and to problems of resource-poor areas. Polluters or degraders should be subject to taxation or regulation. The performance of public institutions that manage and regulate natural resources must improve (Hazell 1999; Knox McCulloch, Meinzen-Dick, and Hazell 1998). **We recommend that JBIC resources support the implementation of appropriate policies and programs for sustainable management of natural resources, with needed attention to property rights and collective action issues, as outlined below.**

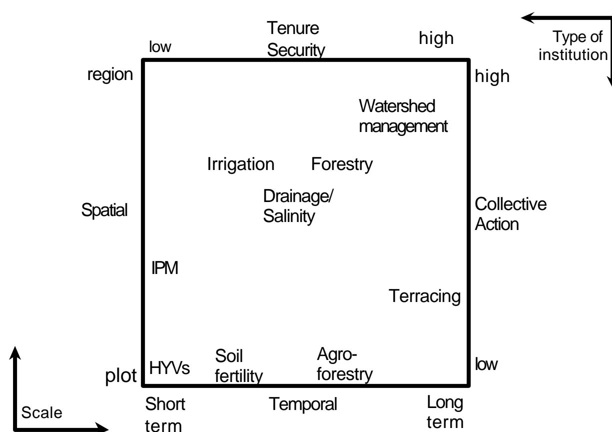
9.1 Property Rights and Collective Action[3]

Many natural resource management technologies take years to give full returns. If farmers lack secure rights to natural resources, they have no incentive to adopt these technologies. Some technologies also need to be adopted over a wide area to be effective, so farmers who wish to adopt them must cooperate with their neighbors in collective action. IPM offers rapid returns but requires collective action over a wide area. By contrast, terracing may be very localized yet investment is continuous and long-term. Watershed management, irrigation

[3] This section is drawn from McCulloch, Meinzen-Dick, and Hazell (1998).

systems, and salinity control require both long time horizons and coordination among farmers. River basin management involves such a vast spatial scale that it even extends beyond the realm of strictly local collective action. Intervention by national governments or co-management arrangements involving national and local institutions may offer the best solution. When water resources must be shared across national boundaries, intergovernmental arrangements may be necessary. Technologies operating on a landscape scale may be more appropriate where traditions of cooperation are strong, while those that require an extended duration to produce benefits may realize greater success where tenures are long-term and reasonably secure (Figure 9.1).

Figure 9.1 Property Rights, Collective Action, and Sustainable Agriculture/NRM Practices



Source: Knox-McCulloch, Meinzen-Dick, and Hazell (1998).
Note: Location of specific technologies is approximate, for illustrative purposes.

Within agroforestry, community nurseries require high degrees of collective action, whereas, given the short time needed to derive benefits, property rights are less important. In contrast, agroforestry aimed at producing fuelwood or poles requires an extended duration for production but little, if any, coordination beyond the household level, so property rights are essential.

Property rights and collective action are also important in determining who benefits from productivity increases, both directly by determining who can reap the benefits of improvements and indirectly through their effects on land markets, access to credit, etc.

Property rights include not only ownership of resources as defined by laws, but also a variety of rights from customary law and local practice. For tenure security, the rights should provide:

- excludability, to allow those with rights to exclude others from using a particular resource;
- duration, to provide a sufficient time frame to reap the benefits of investments;
- assurance that rights are enforceable; and
- robustness, the number and strength of the bundle of rights an individual possesses.

Policy prescriptions for Africa and other developing countries have often argued for the need to replace community-based land tenure institutions with freehold tenure backed by formal titles. Yet much empirical evidence shows that establishing titles and privatizing land ownership is unlikely to increase adoption of technologies because it does not enhance tenure security, and may even weaken it. This is due to the strength and effectiveness of indigenous property rights institutions that still exist in much of Africa. These often supercede national land laws in the eyes of local people. For example, research in Benin found that even though plots may not be formally registered, when farmers acquire land through inheritance, purchases, or gifts, they perceive that this provides enough long-term security to encourage the adoption of soil-improving technology. Elsewhere in Africa, indigenous property rights institutions have often proved effective in recognizing and enforcing secure property rights for community members, and where these institutions persist, a title does little to strengthen land rights. Where indigenous systems have broken down, either because of internal factors or externals threats, such as outsiders attempting to claim land, registration or land titling may be needed. This may also be true where commercialization has advanced to the point where efficient credit and land markets are needed.

Collective action for natural resource management can include joint investment in buying, constructing, or maintaining local infrastructure and technologies; setting and implementing rules to exploit a resource; representing the group to outsiders; and sharing information. As important as collective action is, it cannot be assumed to exist. Research shows that greater social cohesion is likely if the number of users is fairly small, if they are alike in terms of shared values and dependence on the resource, and if the net benefits from group membership are substantial and equitably distributed. However, collective action does not guarantee equity. Women, for instance, may have little voice in the decision making process while still being accountable for labor contributions. Where there are sufficient incentives but governance mechanisms are lacking, local leadership or external community organizers can facilitate collective action. To be sustainable, governance needs to be institutionalized, however. Linkages between collective

action and property rights are especially strong in the management of common property resources. Tenure security for users of such resources requires:

- an effective local institution to manage an regulate the use of the resource, to assure members that if they abide by the rules, others will also;
- secure group or community ownership rights over the collectively managed resource; and
- secure membership in the group to assure continued use rights to the resource.

Many common properties are under pressure from population expansion, increased competition for resources, and breakdowns in management institutions arising from market forces, policy interventions, and challenges to the rights of the community by outsiders. Policies to recognize community rights and local organizations can help natural resource management in such situations.

Other factors besides property rights and collective action keep farmers from adopting technologies for natural resource management. However, even many of these factors interact with property rights or collective action. For example, the distribution of technologies and information is linked to property rights. Extension services often favor landowners, which gives men and wealthier members of a community greater access to information. Collective action can strengthen the bargaining power of disadvantaged groups. For example, establishing a community managed seed bank may facilitate individual tree planting and provide a forum for information sharing on the technology.

The ability to manage risk can also be affected by prevailing property rights and collective action institutions. Locating plots of a single farm in different microclimates reduces the possibility that a farmer's full range of crops will be lost to pest or weather problems. Common property resources frequently function as a buffer against risk. Pastoral and agropastoral populations occupying arid and semi-arid regions rely on mobility on communal rangelands to mitigate their risk to exposure. By serving as a risk-sharing device, collective action can alleviate food insecurity and other survival risks and lower constraints on technology adoption. In Bangladesh and Pakistan, groups of small-scale farmers, including landless people and women, obtain rights to groundwater by collectively purchasing and managing wells and pumps.

The many examples of informal financial institutions undertaking successful group lending schemes may be seen as substituting collective action for conventional property rights as a form of collateral. Credit groups may even enhance opportunities for collective action in natural resource management. If groups are already formed around a common purpose and share a common set of norms and values, this reduces the information and coordination costs of their organizing around another purpose.

Collective action and reciprocity arrangements may be employed to overcome household labor shortages, particularly in cash-scarce economies, thereby facilitating the use of more labor-intensive technologies. Within households, property rights often fail to correspond closely to labor responsibilities. In some cultures, women may need to contribute labor to their husbands' plots in order to access plots for their own production. The introduction of a new technology, such as irrigation, can shift these labor demands and responsibilities. In Western Ghana, the spread of cocoa as a commercial crop has led to men demanding a greater share of women's labor to farm cocoa crops that the men own. In some cases, men have given women a stronger claim over land as compensation, a shift that is expected to result in greater technology adoption by women.

Community rules, norms, and ideas can act to expand or constrain technology choices. In Mexico, farmers' adoption of conservation tillage practices is partially attributed to state agricultural policies, including a law prohibiting the burning of crop residues. In South Asia, cultural norms forbid women to use plows, restricting their productivity and reinforcing their dependence on men. Property rights institutions frequently shape and reinforce other rules. For example, property rights vested in the state allow for laws that forbid the cutting of trees. In patrilineal societies in Africa, wives often move to their husband's community and acquire secondary use rights to land without retaining rights to land in their birth community. Polygamy requires periodic redistribution of land. Altering the principles and property regimes that facilitate a cohesive community may increase exposure to environmental risk and diminish social security for women, at least in the short term.

The choice of natural resource management technologies will shape property rights and collective action institutions. Technologies that have a large spillover effect, such as irrigation, are likely to cause farmers to demand common property regimes and collective action, given the gains to be realized from coordinated efforts. Technologies with temporal implications may call for enhanced tenure security. Planting trees may establish a claim on land. Technologies that increase the value

of a resource may induce privatization and the exclusion of some customary uses. Household income and reliance on common property resources for subsistence purposes are negatively correlated. Women especially depend on resources from common property to provide for their family's needs or for their own security where private property does not guarantee them access in the case of widowhood or divorce.

Tenure security may elicit higher productivity and more efficient outcomes by ensuring that only those who invest reap the benefits from doing so and that the right to do so is guaranteed for a long enough period in the eyes of the producer. Tenure security can also provide incentives for producers to conserve resources by assuring them future benefits. Wealth, power, and status influence one's tenure security and thus shape environmental and equity outcomes.

Many customary tenure regimes permit different users to exploit different "niches." Pastoralists and cultivators may use the same land; irrigation, fishing, and domestic water users draw on the same resources; other producers exploit forests for timber, firewood, and minor forest products. Technologies that increase the production of one good at the expense of others do not necessarily improve efficiency. For example, introducing new tree species or forest management practices may maximize log production but sacrifice kindling and minor forest products critical to local livelihoods.

Privatization of common property and lands under communal tenure tends to lead to loss of multiple user rights in favor of more concentrated resource holding by a less diverse set of interests. Conversion to freehold tenure may mean loss of access to land and other resources by smallholders and large-scale land acquisitions by wealthy producers, government officials, and speculators, without any gains in efficiency. If purchasers seek short-term profits and have little stake in the long-term productivity of the land, soil fertility and other natural resources may be depleted.

Incorporating transaction costs and risk considerations in efficiency calculations shows the rationality of livelihood strategies employed by poor households. They may be risk averse in order to maximize stability of earnings. Introducing technologies that are unsuitable for small-scale farmers or those with less secure tenure exacerbates inequalities. High-yielding crop varieties are scale neutral and offer short-term benefits, so farm size and tenancy and not constraining. Tubewells or tractors require a longer time horizon and a larger service area to be profitable, and so are more likely to be purchased by larger farmers or groups of

small farmers with long-term rights to resources. Scale-neutral technologies may require investment in large-scale technologies such as irrigation to be effective, and this can undermine the adoption of otherwise equity-enhancing innovations. Common property regimes do not assure equitable outcomes, but they accommodate multiple users beyond the household level and so are better equipped than private property to spread benefits more evenly. Common property regimes and collective action often fail to embody impartial sharing rules and equal distribution of power. Even when users have equal rights to a resource, the ability to exploit it may depend on access to private means of production.

Greater control over resources tends to enhance one's capacity to influence community power structures and exert political leverage with government officials and others responsible for technology distribution, infrastructure, and market development. Collective action can reshape policies and political outcomes, and can enable marginalized groups to challenge property rights institutions, political and cultural institutions, and technology adoption. Artisanal fishers in the Indian state of Kerala, acting collectively, were able to regain lost coastal common property rights, state government financial assistance, and a seasonal ban on trawling by commercial fishers. Fishers' organizations in the Philippines prevent the use of beach seine nets, dynamite, and poisons for fishing. In both places, local groups constructed artificial reefs to lure more fish, increase their food supply, and enhance the productivity and environmental sustainability of coastal resources.

Where indigenous property systems have broken down so that members no longer are assured of benefits from investments or long-term management practices, individualization of resources can facilitate more sustainable resource management practices. Efficiency, equity, and environmental objectives may also involve tradeoffs. Privatization of rangelands and fisheries has been advocated as a measure to control stocking rates and improve resource management to enhance profitability. Yet failure to account for fragility and environmental variability has resulted in overgrazing, soil erosion, and other forms of degradation on many privatized ranches. However, the tradeoffs may be overstated. In the case of agroforestry, environmental degradation can raise the perceived value of products, leading to investment in technologies that conserve the resource base. When transaction costs and risk considerations are incorporated into efficiency calculations, livelihood strategies of poor people can be seen as economically rational. When productivity measures include the value of nontraded goods and services that poor households (especially women) obtain for their livelihood and security, an equitable distribution of resources or technologies that favors the disadvantaged may be seen as highly productive.

Because of the many interrelationships, and the number of site-specific factors involved, it is not straightforward to prescribe a certain type of property regime as "most appropriate" for a particular technology or resource management practice. Even if it were, simply passing laws specifying the rights and responsibilities of individuals, groups, or government agencies is not enough. Effective institutions are needed to monitor and enforce the specified rights. Collective action cannot be dictated from outside, although governments, academic institutions, and nongovernmental organizations can play a catalytic role in encouraging local participation in collective action. Neither individuals nor communities can be expected to adopt long-term practices if they lack long-term rights to the resource. Yet many governments have been unwilling to transfer rights to water, irrigation infrastructure, rangelands, or forests when they devolve management responsibility to user groups. The issues of community rights and ways of creating new common property resources in place of government ownership are emerging as critical issues in devolution programs.

9.2 Promoting Sustainable Development in Less-Favored Areas[4]

The conventional wisdom in policy circles is that developing countries should emphasize public investments in favored areas. It is argued that increased food production and rapid economic growth in these areas will ensure food security and allow people to migrate out of less-favored areas, reducing poverty and pressure on resources. Despite large investments in the favored areas and rapid urbanization in most developing countries, population continues to grow rapidly in less-favored areas. Even though productivity is lower in these areas than in favored areas, they usually have a comparative advantage in some type of agricultural production or in nonfarm activities. With investment in infrastructure and institutions, less-favored areas can exploit these advantages. There is evidence that investment in these areas can yield relatively high rates of economic return and substantial reductions in poverty in some countries. Whether resource and environmental degradation can be reduced at the same time is unclear, though anecdotal evidence suggests that it can be. **We recommend that JBIC support developing countries' investments in less-favored areas, along the lines specified below.**

Research shows that public investment in lower-potential areas of China and India results in high returns, and in some instances these are higher than returns to investment in favored areas, in terms of both economic growth and poverty reduction. Investments in agricultural research and development, education,

[4] This section is drawn from Pender and Hazell (2000).

roads, and irrigation have greater incremental impact in less-favored areas in these countries, in part because the opportunities for investment in these areas have been neglected. Relative rates of return depend to a large extent on past investment patterns. China and India have invested so heavily in high-potential areas that additional investments now exhibit diminishing returns. In Africa, where overall public investment in agriculture is low, additional investment in both high-potential and less-favored areas remains critical.

Given the variety of situations in less-favored areas, no one strategy is likely to succeed everywhere. Agricultural potential, access to markets and infrastructure, and population density are key factors determining comparative advantage. In areas having high agricultural potential but poor market access, such as much of humid West Africa, parts of the East African highlands, and the Southeast Asian uplands, high-value nonperishable perennial crops such as coffee, cocoa, or oil palm often have a comparative advantage. Areas with low crop production potential are likely to have comparative advantage in extensive livestock production, particularly if they are far from markets and not densely populated, as in much of semiarid West Africa and the Altiplano of the southern Andes. In remote, densely populated areas, mixed-crop livestock production is more important, even where crop production potential is low, as in parts of the East African highlands. Areas with low crop production potential but good access to markets, as in periurban areas of semi-arid India and other low-potential areas, are likely to have a greater comparative advantage in forestry, intensive livestock production, or nonfarm activities.

Strategies for developing and disseminating technologies must take into account the special characteristics and demands of less-favored areas. These include a high degree of diversity in biophysical and socioeconomic conditions; susceptibility to droughts, pests, diseases, temperature extremes, and other risks; the fragility of land and other resources; remoteness from markets and services; and the subsistence orientation of farmers. Strategies must be participatory and demand-driven, stimulating and building on local innovation, and adapting to local circumstances. Technologies that help reduce risks and conserve and improve resources may be more effective than those that simply promote high yields. Technologies are needed to conserve and efficiently use scarce water, control erosion, restore soil fertility, and increase the supply of useful biomass. Labor- and land-saving technologies such as improved fallows during a short rainy season or agroforestry may have potential. In areas with limited rainfall, scarcity of biomass and high demands for alternative uses of biomass, for example for fuel and fodder, limit the potential of many organic approaches to land management. Low-

external-input technologies are typically labor intensive, and this can be an important constraint. Fallows and green manures also keep land out of crop production, and composting and manuring compete for household energy use and are difficult for many small farms.

Agricultural research can have significant productivity impacts and reduce poverty in some types of less-favored areas. Many such areas have adequate sunshine and rainfall to sustain good crop yields but lack adequate soil nutrients and the means to capture and store the available rain until it is most needed. Rainfed grain yields in West Africa could be doubled or tripled if plant nutrients, especially phosphate, were adequate and seasonal soil moisture constraints were overcome. Experimental trials based on increasing key plant nutrients, such as combining rock phosphate applications with improved fallows planted to leguminous trees or cover crops and water catchment at the landscape levels suggest that land productivity can likewise be doubled or tripled in some less-favored environments. Plant-breeding for greater tolerance to such stresses as drought, salt, and acidity may boost yields even under existing plant nutrient and soil moisture conditions. In Brazil, liming and no-till farming has made poor and acidic soils highly productive.

Strategies will be most effective if they are linked to development pathways that have comparative advantage in particular circumstances. Small-scale irrigation development is likely to yield the highest returns in areas with good market access and otherwise suitable soil conditions, since this can enable high-value crop production and intensified food production. Road development is likely to have the highest returns in densely populated areas with good agricultural potential but limited market access, by enabling marketing of high value commodities and the needed inputs. Improved management institutions for common property resources such as community grazing lands or woodlots are critical in many less-favored areas, particularly low-potential areas with limited opportunity to increase crop productivity. Investments in education and training are also important, particularly in low-potential areas with limited market access, where emigration is likely to be an important element of people's livelihood strategies. All effective strategies will require investments in physical, human, natural, or social capital. Responsive and effective institutions are needed to mobilize such investments and to ensure accountability, efficient management, and equitable distribution of the benefits. **We recommend that JBIC and other donor agencies provide the resources that are essential to carrying out these strategies.**

9.3 Soil Fertility Management

Low soil fertility and lack of access to reasonably priced fertilizers, along with past and current failures to replenish soil nutrients in many countries, must be rectified through efficient and timely use of organic and inorganic fertilizers and improved soil management. Policies should support an integrated nutrient management approach that seeks to both increase agricultural production and safeguard the environment for future generations. Chemical fertilizer use should be reduced where heavy application is causing environmental harm. Fertilizer subsidies that encourage excessive use should be removed. However, it may still be necessary to subsidize fertilizer in backward regions where current use is low and soil fertility is being mined. In such areas, increased use of fertilizer will help boost production and reduce land degradation. Policies should raise the value of forests and pastures, offer incentives for sound management, such as secure property rights for small farmers, and help create nonfarm employment opportunities (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997, 1999; Hazell 1999; Scherr 1999). **We recommend that JBIC and other ODA agencies provide both financial and technical support to such efforts.**

9.4 Integrated Pest Management

Until recently, developing-country governments and aid donors encouraged use of chemical pesticides. Now, consensus is emerging on the need for IPM, emphasizing more judicious use of synthetic chemicals (e.g., applying minimally adequate quantities at the right time), and greater reliance on alternative means of pest control. These alternatives include safeguarding natural predators of pests and relying on them more for pest control, use of biological pesticides, and cultural practices, such as crop rotations and planting pest resistant crop varieties. The latter may be developed through either conventional or biotechnological means. **We recommend that JBIC support IPM research, program implementation, and efforts to scale up successful small-scale projects.**

Projects in Bangladesh, Ecuador, and Mali aimed at reducing the use of synthetic chemicals also achieved yield gains or higher incomes for farmers. There are, however, concerns about whether small-scale projects can scale up to become larger programs. Indonesia has had a successful national-level IPM program, implemented after excessive use of chemicals led to the development of resistance in target pests and heavy crop losses. The program reached about 500,000 farmers by the late 1990s, and emphasized farmer participation in planning, implementation, and training new participants, with government extension agents

working as facilitators rather than administrators (Yudelman, Ratta, and Nygaard 1998).

Future Harvest centers have been involved in IPM, both through breeding pest resistant crop varieties and in developing biological control programs. Centers in Africa and Latin America collaborated with other research institutions on identifying parasitic wasps that would control the cassava mealy bug, which caused losses of up to 80 percent in an important African food crop, and predator mites that would combat the cassava green spider mite. Research on biological control of the mealy bug cost $15 million and is estimated to have saved $2.2 billion, making it a phenomenally cost-effective investment (Gabre-Madhin and Haggblade 2001; Schiøler 1998).

The West African Rice Development Association, a Future Harvest research center in Côte d'Ivoire, recently developed a weed-resistant rice crossbred from Asian and African varieties. It is very hardy, and its broad leaves deny weeds light, controlling them biologically. The center worked closely with farmers on breeding and field trials, including Kone Figue (see page 8). By reducing the time poor women farmers like Ms. Figue need to spend weeding their plots by hand, this new rice allows them to spend time on other tasks, such as providing their children the care that is essential for good nutrition (Schiøler 1998).

9.5 Water Policy Reform [5]

A large share of the water needed to meet increased demand through 2020 must come from saving water that is currently used. Comprehensive water policy reform can help save water, improve use efficiency, and boost crop output per unit of water, while reducing the risk of armed conflict between countries sharing surface or ground water sources. Such reforms will be difficult to carry out, due to long-standing practices and cultural norms in many places that treat water as a free good. Also, vested interests benefit from current arrangements. Specific reforms will vary from country to country, depending on the level of economic development, institutional capability, degree of water scarcity, and the intensity of agricultural production.

Key elements of needed reforms include providing secure water rights for individual users or groups of users. In some countries and regions, these rights

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[5] This section is drawn from Rosegrant and Ringler (2000); Pinstrup-Andersen, Pandya-Lorch, and Rosegrant (1997, 1999); and Rosegrant (1997).

should be tradable, thereby increasing incentives for efficient water use. Such a reform can empower users, provide investment incentives, improve water use efficiency, reduce incentives to degrade the environment, and increase flexibility in resource allocation. In addition, devolving irrigation infrastructure and management to water user associations, combined with secure access to water, will provide incentives for efficient use, for bargaining with government water agencies, and for improved operations and management.

Reducing or eliminating general water subsidies can also improve efficiency of use. Privatization and regulation of urban water services can help make water resources available for agriculture. In the industrial sector, increased water prices can encourage investment in water recycling and conservation technology. Funds freed up by eliminating general subsidies will make it possible to provide targeted subsidies to poor urban dwellers and farmers.

Increased water prices or establishment of tradable water rights can encourage farmers to take account of the costs their water use imposes on other farmers, reducing pressure to degrade resources. A farmer at the head of a canal who overuses water may waterlog other farmers' land through excess return flows, seepage, and percolation. If the first farmer could trade the excess water, that would encourage conservation.

As incentives are introduced for water conservation, the availability of appropriate technology will be essential. This might include drip irrigation, computerized water control systems, small-scale water harvesting techniques, or sprinklers. Enhanced environmental protection policies, for example to prevent overexploitation of aquifers, are also needed. **We recommend that JBIC support developing-country efforts to carry out such policies.**

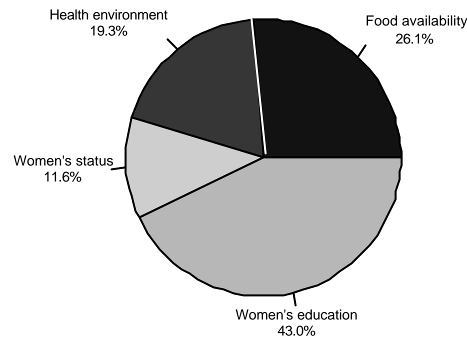
10 Other Needed Policies

10.1 Tackling Child Malnutrition

IFPRI has found four critical reasons why child nutrition improved in the developing world between 1970 and 1995. Improvements in women's education accounted for 43 percent of the total reduction in child malnutrition during this period. Together, improvements in women's education and improvements in per capita food availability accounted for nearly 70 percent of the reduction. Improvements in women's social status relative to that of men, as measured by

gains in female life expectancy relative to that of males, accounted for another 12 percent of the reduction, while improvements in the health environment contributed the remaining 19 percent (Figure 10.1) (Smith and Haddad 2000).

Figure 10.1 Estimated Contribution of Major Determinants to Reductions in Child Malnutrition, 1970-95



Source: Smith and Haddad (2000).
Note: Malnourished children refers to underweight children.

Yet in addition to low public investment in agriculture, developing-country governments often drastically under-spend on education. Sub-Saharan African governments spend $32 per capita on education, and in South Asia, the figure is $14, compared to $1,211 in developed countries and $156 in Latin America. In addition, many poor countries underinvest in primary education, as opposed to higher levels. India devotes only 46 percent of its education budget to primary education, while Zambia devotes 135 times the level of resources primary school students receive to university students. However, Malawi and Uganda have allocated two-thirds of education spending to primary schools. If India and Pakistan were to make similar allocations, this would boost overall enrollments and could help redress gender imbalances. The extra $1.3 billion provided to India's defense budget in 1998, at a time of high tension with Pakistan, would have been sufficient for construction of the additional schools and hiring the additional teachers needed to achieve universal primary education by 2005. Sudan and Angola spend four times as much on the military as on education, while Rwanda and Burundi spend twice as much (Watkins 2001).

Given the importance of female education to improved child nutrition, agricultural productivity, household income, and smaller family size, it is essential that developing-country governments boost spending on education, with an emphasis on primary education for all school-aged girls as well as boys. We recommend that JBIC and other ODA agencies support these efforts with substantial increases in aid to education, given the declines of the past decade.

IFPRI recently completed an evaluation of a particularly innovative effort to improve household food supplies and education for poor families in Bangladesh. Since 1993, Bangladesh has provided a free monthly ration to low-income families that send a child to school. The families are free to consume or sell the ration as they choose. The program covers 27 percent of the country's primary schools and 2 million households, accounting for 40 percent of the 5.2 million students in those schools. IFPRI found that the program has been successful in boosting enrollment, attendance, and retention of primary students. Female enrollments increased by 44 percent, male by 28 percent. The program effectively targets poor households, though targeting could be improved. It significantly increases calorie and protein consumption in beneficiary households, although it does not target the most vulnerable members of the households (IFPRI 2001). This program may be replicable in other developing countries. To the extent that such food for education programs make use of locally produced food, they will be more sustainable than if they rely on external food aid. Also, reliance on local food might have additional impacts in terms of promoting agricultural and rural development. **We recommend that JBIC support similar programs in developing countries.**

10.2 Fighting Micronutrient Deficiencies

Despite the huge numbers of affected people and the severe impact of micronutrient malnutrition ("hidden hunger"), inexpensive public health interventions could significantly reduce these problems if governments have the will to implement such programs. Food fortification with both iron and vitamin A is one cost-effective approach. Providing pregnant women with iron sulfate tablets can greatly reduce the incidence of anemia. Many health programs for poor children in developing countries provide vitamin A tablets. Whereas promotion of dietary diversity does not seem an effective way to attack iodine deficiency, it has great promise for improving iron and vitamin A intakes. Development of iron- and vitamin A-rich staple crops through both conventional plant breeding and biotechnology is another potentially effective approach, and may be more sustainable than supplementation or fortification. All of these strategies should be viewed as complementary, not either-or choices (Bouis 2000; WHO 2001). **We recommend that JBIC and other donors provide urgently needed increased support to efforts to reduce micronutrient malnutrition, given the huge human and economic costs.**

10.3 Preventing and Resolving Conflicts

Where armed conflicts and civil strife are occurring, governments and the international community must give priority to conflict resolution and prevention. We recommend that JBIC and other international development institutions, in partnership with governments and communities, expand and strengthen early warning systems and response mechanisms for food and political crises. It is essential to include conflict prevention in food security and development efforts, and to link food security and long-term sustainable development to humanitarian assistance programs. Savings from conflict avoidance should be calculated as returns to aid and development spending. Humanitarian assistance must include agricultural and rural development components that lead to secure livelihoods and build sustainable social and agricultural systems. **We recommend that national governments and international development agencies such as JBIC incorporate conflict prevention into program and project planning by identifying areas where the potential for conflict is high and defusing them by delivering aid in a manner that avoids competition and fosters or demands cooperation among groups or communities; that directs resources to those areas that might be conflict-prone; by finding and promoting "engines of growth" to overcome perceived scarcities and to move people beyond scarcities; and by providing opportunities for men and women from conflict-affected areas to participate in project planning, implementation, and evaluation** (Messer, Cohen, and D'Costa 1998; Messer, Cohen, and Marchione 2001).

10.4 Reversing Gender Discrimination[6]

IFPRI research confirms the central role women play as producers of food, managers of natural resources, income earners, and caretakers of household food and nutrition security. Agricultural productivity increases dramatically when women get the same amount of inputs as men. When female African farmers obtain the same levels of education, experience, access to services such as extension, and farm inputs that currently benefit male farmers, they increase their yields for maize, beans, and cowpeas (all crops consumed by poor people) by 22 percent. In Kenya, a year of primary education provided to all women farmers would boost maize yields by 24 percent. In Burkina Faso, total household agricultural output could increase by 10-20 percent if currently used inputs were reallocated from men's to women's plots. Likewise, assuring women long-term access to land offers them incentives to preserve and regenerate it.

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[6] This section is drawn from IFPRI (2000) and Quisumbing and Meinzen-Dick (2001).

Technical training is essential if efforts to empower women farmers are to succeed. This is especially true for knowledge-intensive activities, such as animal husbandry, integrated pest management, and the application of yield-enhancing crop technologies. Presently, most extension agents in developing countries, and particularly those dealing with livestock, are men and target their expertise to male farmers. This problem can be addressed by recruiting new female extension agents, by retraining currently employed female extension agents whose primary focus is home economics in other disciplines, and by providing employment-related incentives to male agents to work with female farmers.

The Women in Rice Farming Systems Network, based at the International Rice Research Institute in the Philippines, has tested and evaluated technologies, including improved germplasm and machinery, in specific rice-farming environments in Southeast Asia. The Network uses gender analysis as an integral part of such assessments. This research found that affordable rice processing machinery could have particular benefits for women farmers and empower them individually and as a group, since women carry out most of the postharvest processing in the region. Hulling and milling machinery can save women farmers time, reduce drudgery, and increase the volume of rice processed, thereby boosting their incomes.

Strong evidence shows that enhancing women's control of resources directly contributes to improvements in household and child well-being. For this reason, social welfare transfer programs are increasingly targeted to women. For example, in Mexico, the PROGRESA program (the Education, Health and Nutirition Program) provides cash transfers to poor rural women, provided that they enroll their children in school and that all family members regularly visit health clinics. The program has been shown to contribute to improved adult and child health, and has increased the food expenditures of beneficiary households, primarily because women control the additional resources. In South Africa, old age pensions for poor rural women have been shown to contribute to improved child health and nutrition; pensions for men do have the same effect.

Studies in Egypt and Mozambique have shown that mothers' education is crucial to poverty reduction. In Egypt, assuring that mothers complete primary school reduces the proportion of the population below the poverty line by 34 percent, while in Mozambique, increasing the number of adult females who have completed primary school in each household by one leads to a 23 percent decrease in the proportion of the population below the poverty line. In both studies, female

education had a much larger impact on poverty than other factors, including male education.

Research in Bangladesh, Ethiopia, and South Africa has shown that assets in the hands of women increase the share that households spend on education. Even in patriarchal societies such as Bangladesh, women's assets increase expenditures on children's clothing and education and reduce the rate of illness among girls.

The provision of care to children by mothers has a large and positive impact on children's nutrition status. Almost 75 percent of mothers surveyed in Accra, Ghana had less than a secondary education. Within this group, improved care practices equalized poor children's nutritional status with that of children from wealthier and better educated families. Training poor mothers in good child feeding practices and the use of preventive health care services can greatly improve the nutrition of poor children.

Development programs need to enable women to use and benefit from their own resources and capabilities. Such programs should include organizations that provide women with opportunities to develop social networks and undertake collective action (i.e., social capital) or substitute for their lack of physical and financial assets. The organization of female borrowing groups through microcredit programs in Bangladesh and elsewhere has contributed to women's empowerment at the household and community level, while also increasing household incomes and well-being, particularly of children.

Legal, social, and cultural institutions must be changed to create an environment in which women can realize their full potential. Specific areas where change is needed include divorce laws, social entitlement and transfer programs that benefit women, and property rights laws that allow women to hold individual or joint title to land. Monitoring these and other changes, including those in government outlays for men and women, can help reinforce the reform process and raise the consciousness of policymakers and constituents. We recommend that JBIC support such efforts.

Targeted programs to reduce poverty should improve women's roles as gatekeepers of food security. Mexico's PROGRESA program, for example, provides an integrated package of health, nutrition, and educational services to poor families and directs monetary transfers directly to women. More generally, development projects should enhance the productivity and earnings of women alongside those of men. When projects address the needs of both men and women, their

sustainability increases by 16 percent. Project planners and policymakers need to shift their attention from the important question of how to help women to the central question of how to help men and women. More effective projects can be formulated only through a better understanding of the totality of local gender asymmetries and relations. **We recommend that JBIC and other donors encourage such new thinking among policymakers and support appropriate projects.**

10.5 Responding to Demographic Forces

Policies that allow poor people to achieve economic security are the best way to assure that birth rates will decline (McNicoll 1997). It is also critical to facilitate women's access to reproductive health services, consistent with individual values and consciences. The international community agreed at the International Conference on Population and Development, held in Beijing, China in 1994, that all couples have the right "to decide freely and responsibly the number and spacing of their children, and to have the information, education, and means to do so." Achieving reproductive and sexual health requires access to information, education, and family planning services including contraceptives, prenatal care, and prevention of sexually transmitted diseases such as HIV/AIDS (UNFPA 2001). **Given the more restrictive policies enacted by some donors, we recommend that JBIC provide support in this area.**

As food insecurity urbanizes along with the general population, we recommend that governments, with support from JBIC and other donors, improve livelihoods and employment among urban poor people, support environmentally sound urban agriculture, promote healthy physical environments and adequate caring and feeding practices, and design more participatory urban programs and strategies (Garrett and Ruel 2000).

10.6 Making Globalization Work for Poor People

Developing countries must be encouraged to participate effectively in the current round of global agricultural trade negotiations, pursuing better access to industrialized countries' markets. Coalitions with certain groups of higher income countries may help improve their bargaining position. The Cairns Group, which includes both developing and developed country non-subsidizing agricultural exporters, is an example of such a coalition. There are also some common interests between Japan and the Republic of Korea on the one hand and many developing countries on the other in pursuing "food security" as a non-trade concern within the negotiations, although there may be some differences over what is meant by food

security (Diaz-Bonilla et al. 2000; Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1999; Diaz-Bonilla and Robinson 1999). **Nevertheless, given this area of potential common ground, we recommend that JBIC provide aid to developing countries for capacity strengthening in the area of trade negotiations.**

Without appropriate domestic economic and agricultural policies, however, developing countries in general and poor people in particular will not capture fully potential benefits from trade liberalization. The distribution of benefits will be determined largely by the distribution of productive assets. Low-income countries must try to strengthen their bargaining position and pursue changes in both domestic policies and international trade arrangements if they are to capture fully potential benefits from trade liberalization (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997 and 1999; Diaz-Bonilla and Robinson 1999). Again, JBIC should provide assistance as appropriate:

- Developing countries should enact domestic policy reforms that remove biases against small farmers and poor people while facilitating access to benefits from more open trade;
- Developing countries, with technical and financial support from industrialized countries, must develop strong animal and plant health standards, in order to be able to produce for developed country markets;
- Developed countries must be persuaded to eliminate export subsidies, taxes, and controls on a greatly accelerated basis; and
- Food aid donors should provide adequate levels of food aid, on a multi-year basis as appropriate, targeted to poor groups in ways that do not displace domestic production, to those low-income countries adversely affected by trade liberalization.

10.7 Debt Relief

Given the constraint imposed on many low-income developing countries by debt service burdens, we recommend that JBIC enact a policy of "debt for food security swaps." Under this policy, those governments that receive ODA loans for food security-related programs outlined in this paper would receive either loan forgiveness or more favorable loan terms in exchange for meeting mutually agreed-upon food security goals and timetables.

10.8 Global Warming

Climate change poses a threat to the livelihoods of small farmers, and agriculture contributes to climate change. **We recommend that JBIC support agricultural strategies to reduce global warming.** Small farmers have an important role to play in mitigating global warming by sequestering carbon in their agricultural systems through cropland, forest, and pasture management strategies that result in improved soil organic matter; improving nitrogen-use efficiency; reducing nitrous oxide emissions; and improving water-use efficiency. Avoiding deforestation and tree planting both offer potential carbon gains. Improved livestock feeds can reduce methane emissions from livestock while enhancing meat and milk production, although production of the improved feed may require increased fertilizer use. Crops, livestock, tree species, and their husbandry can become more efficient in response to changing climatic conditions. Other coping strategies include germplasm improvement for higher yield and better resistance to abiotic and biotic stresses, and enhanced protection of biodiversity on the farm (Wood, Sebastian, and Scherr 2001; CGIAR 2001; Wilson 2001).

Low and reduced tillage practices in wheat-rice rotations can maximize yields, conserve soil and water, and contribute to the slowing of global warming. The Indo-Gangetic plains include the most intensely cropped agricultural land in the world, and are a source of food and livelihood for nearly 1 billion people, many of them extremely poor. Reduced tilling could save irrigation water and diesel fuel, and reduce pesticide use significantly. Reduced fuel use could eliminate 1.3 million tons of carbon emissions annually. Another 17 million tons could be eliminated by minimizing the burning of crop residues. These gains represent win-win-win solutions that protect the environment, promote economic growth, and reduce poverty (CGIAR 2001).

Conversion of unproductive croplands and grasslands to agroforestry has the highest potential to soak up maximum amounts of atmospheric carbon, at rates on the order of 3 tons of carbon per hectare per year. This conversion occurs in the process of replenishing the soil fertility of smallholder farms in Sub-Saharan Africa, and in implementing tree-based alternatives to slash-and-burn agriculture at the margins of the humid tropical forests worldwide. The potential contribution of converting degraded croplands and grasslands into agroforestry systems is predicted to be 390 million metric tons of carbon per year by 2010 (CGIAR 2001).

10.9 Meeting Health Challenges

We recommend that governments and international agencies address health risks that compromise food and nutrition security as a key part of any comprehensive effort to achieve food security and poverty reduction. We recommend that JBIC and other ODA donors invest in health and food security synergies, such as promoting good health and nutrition as a means to foster rural development, and recognizing that efforts to boost rural incomes are likely to improve access to better health and nutrition. We further recommend that development cooperation policies overcome past tendencies to make tradeoffs between food security and health. When problems interact and coexist among certain populations, integrated solutions can achieve multiple benefits and be more cost-effective. Food supplements for nutritionally vulnerable pregnant women may be linked to community-based prenatal care programs, thereby benefitting both mother and child and reducing the incidence of low birth weight. Similarly, there is evidence to justify multiple micronutrient supplementation as a means to reduce micronutrient malnutrition and low birth weight, and to prevent malaria. Food-based approaches to micronutrient malnutrition should be integrated into agricultural development and extension programs (Flores and Gillespie 2001).

Malaria, tuberculosis, and HIV/AIDS are currently the subjects of major campaigns backed by international organizations. In contrast, the dual agendas for undernutrition (preventing low birth weights and reducing micronutrient deficiencies) and overnutrition (obesity and related chronic disease), where these two problems coexist, have been given little attention, although there are some signs of positive developments. **We recommend that JBIC and other donors provide resources to such efforts**. People must be made more aware of the need to maintain a healthy diet, use preventive health services, increase physical activity, and adopt safe sexual practices. The availability and affordability of effective drugs for malaria, TB, HIV/AIDS, and adult chronic disease must be a priority. The care of adolescent girls and pregnant women must be emphasized, to protect their own health and that of their future children. Nutrition interventions in particular must adopt a life-cycle approach to targeting. Care for the elderly also will become increasingly important.

Given the devastating impact of HIV/AIDS on agriculture, nutrition, and food security, we recommend that JBIC provide assistance to preventing the spread of the pandemic. As labor becomes depleted, new cultivation technologies and varieties need to be developed that do not rely so much on labor, yet allow crops to remain drought resistant and nutritious, especially with respect to micronutrients

that support the immune system. Innovations such as farmer field schools can facilitate the transfer of community-specific and organization-specific knowledge within and between generations. Making institutions, including agricultural research centers, more client-focused can help natural resource management remain effective in the presence of weakened social capital and property rights. For example, where there are large numbers of women widowed by AIDS, gender-equitable land ownership rights are ever more important. Also pressing is the need to care for Africa's hundreds of thousands of "double orphans" — children who have lost both parents to AIDS. Nutritional support can help postpone HIV/AIDS related illnesses and prolong life. Research is needed to confirm the evidence that exclusive breast-feeding prevents mother-to-child transmission of HIV (Haddad and Gillespie 2001; Flores and Gillespie 2001).

11 Conclusion

Appropriate national and international policies are essential for achieving food security. By mustering the political will to make food security a higher priority, national governments and the international community can do much to hasten progress toward food security for all. **We recommend that ODA agencies such as JBIC act as catalysts for appropriate action.**

There is nothing inevitable about the rather pessimistic outlook for food security. It is possible to meet and even exceed the World Food Summit's goal. Doing this will require concerted and committed action by governments, citizen groups, and the international community to empower poor people; mobilize new technological developments to benefit poor and hungry people in developing countries; invest in the factors essential for agricultural growth, including agricultural research and human resource development; and harness the political will to adopt sound anti-poverty, food security, and natural resource management policies. Failing to take these steps will mean continued low economic growth and rapidly increasing food insecurity and malnutrition in many low-income developing countries, environmental deterioration, forgone trading opportunities, widespread conflict, and an unstable world for all.

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