

Poverty, Food Security, and Agricultural Biotechnology: Challenges and Opportunities

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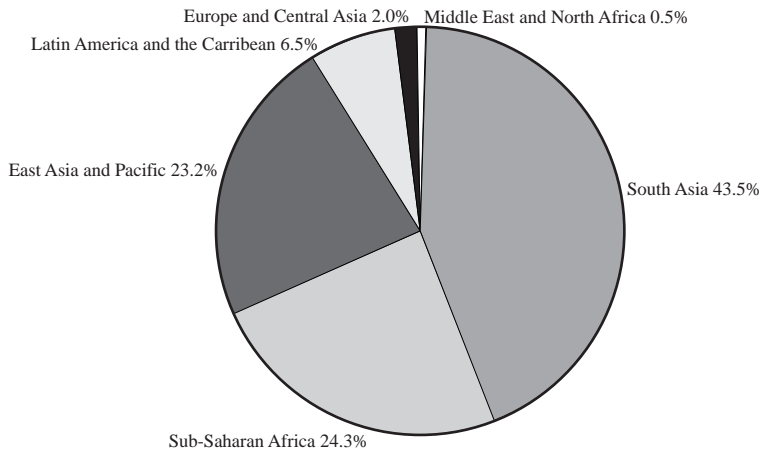
Poverty in an Unequal World

At the dawn of the twenty-first century the world is mired in poverty. Of the world's 6 billion people, 2.8 billion — almost half — live on less than \$2 a day, and 1.2 billion — a fifth — live on less than \$1 a day (World Bank, 2000). About 900 million or 68 per cent of the world's poor live in Asia; about 500 million in South Asia, 300 million in East Asia and 100 million in Southeast Asia and the Pacific (Figure 1).

About 526 million people are undernourished, including 160 million children (FAO, 1999). They lack not only sufficient money to buy food and other essentials, but also access to adequate schooling, housing and medical care. Those in rural areas are often short of water and fuel. Fertile land and water for farming are increasingly scarce. The urban poor lack money to buy enough food. What they can afford to buy may be deficient in proteins and essential vitamins and minerals.

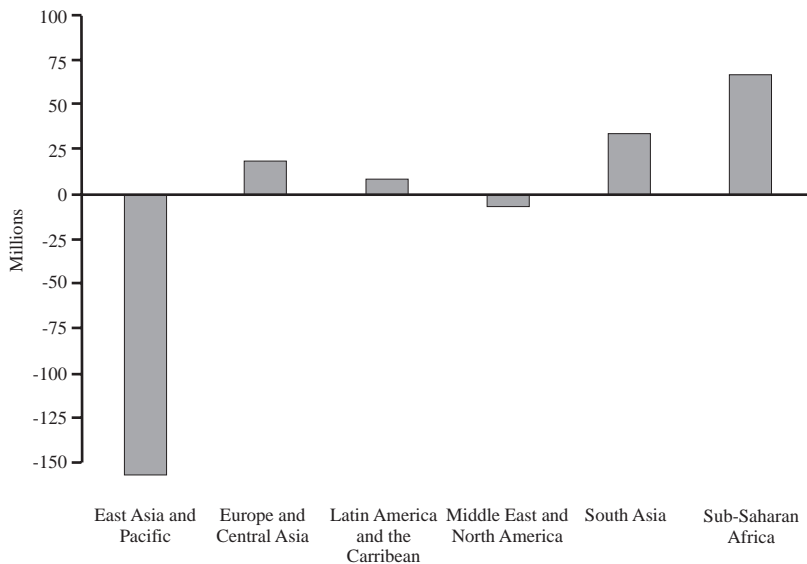
This widespread destitution persists even though human conditions have improved more in the past century than in the rest of history — global wealth, global connections and technological capabilities have never been greater. Yet the distribution of these global gains is extraordinarily unequal (Figure 2). In East Asia, the number of people living on less than \$1 a day fell from around 420 million to around 280 million between 1987 and 1998, but in South Asia, Sub-Saharan Africa and Latin America, the number of poor people has risen. In the countries of Central Asia and Europe in transition, poverty has increased more than twenty fold (World Bank, 2000). The average income in the richest 20 countries is 37 times the average in the poorest 20 — a gap that has doubled in the past 40 years. Although the absolute numbers of people living in poverty in Asia today are unacceptable, the situation could have been much worse without the success of the green revolution. In 1970, about 60 per cent of all Asians lived in poverty. That figure was cut by almost half by 2000. Countries such as Bangladesh, the People's Republic of China, and India have moved from periodic

Figure 1. Where the Developing World's Poor Live
 (Distribution of population of 1.2 billion living on less than \$1 a day, 1998)



Source: World Bank (2000).

Figure 2. Where Poverty Has Fallen, Where it Has Not
 (Change in number of people living on less than \$1 day, 1987-98)



Source: World Bank (2000).

famines to near self-sufficiency in food production. As shown in Tables 1 and 2, the impressive gains in Asia over the past three decades are masked by considerable diversity of experience among countries. While some countries, particularly in Southeast Asia, have moved ahead from poverty to become middle-income countries within a mere three decades, others in South Asia have lagged behind².

Food insecurity associates closely with poverty. About 800 million people do not have access to sufficient food to lead healthy, productive lives. About 280 million of these food-insecure people live in South Asia, 240 million in East Asia, 180 million in Sub-Saharan Africa and the rest in Latin America, the Middle East and North Africa. Clearly, further efforts are needed to reduce poverty and food security. According to recent FAO projections, the World Food Summit (WFS) goal of halving the number of food-insecure people from 800 million in 1995 to 400 million by 2015 will not be achieved until 2030 (Figure 3).

Results from the International Food Policy Research Institute's (IFPRI) revised and updated global food model suggest that there will be similarly slow progress in reducing child malnutrition (Figure 4). Under the most likely scenarios, 132 million children under the age of six years — one out of every four — will be malnourished in 2020. This represents a decline of only 20 per cent from 166 million in 1997.

During the next two decades, the world's population is projected to increase by 24 per cent to reach 7.5 billion in 2020³ (Figure 5). Virtually all of the population increase will take place in developing countries, and much of it in urban areas.

With rising incomes and urbanisation, global demand for cereals is expected to increase by 35 per cent between 1997 and 2020 to 2 497 million tons and for meat by 57 per cent to 327 million tons. Almost all of the increase in demand will take place in developing countries (Figure 6).

How will increases in cereal demand of this magnitude be met? Primarily through increases in productivity, because the natural resources available for further expansion of farming have been virtually exhausted. The situation is particularly serious for Asia, where most good agricultural land is already farmed and the region as a whole may have passed the safe limits for agricultural expansion. FAO (1999) estimates that in South Asia, for example, with virtually no reserves of land with crop-production potential, land use per person will fall from 0.17 hectares in 1990 to 0.12 hectares in 2010. This pressure on the land will have three main effects. First, farming systems, traditionally in harmony with the environment as only low productivity was demanded of them, will become inappropriate. Second, increasing numbers of the rural population will be forced to farm marginal and unsuitable land, which becomes quickly degraded. Third, more people will move to urban areas, adding to congestion and pollution and removing yet more prime agricultural land from production. Agricultural land use increased by 13 per cent or 170 million hectares in the last 30 years, largely at the expense of lowland forests and their rich biodiversity (ADB, 2000).

Table 1. Indicators of Change in Asia, 1970 to 1995

	India	Other S. Asia ^a	People's Republic of China	Southeast Asia ^b	Developing Asia
Population (millions)					
1970	554.9	156.2	834.6	204.4	1 750.2
1995	929.0	293.9	1 226.3	343.7	2 792.9
% Change	67.4	88.2	46.9	68.2	59.6
Cereal Production (million metric tons)					
1970	92.8	25.4	161.1	33.8	313.2
1995	174.6	48.1	353.3	73.6	649.6
% Change	88.1	89.3	119.3	117.8	107.4
Per Capita Income (\$/Year)					
1970	241.0	187.0	91.0	351.0	177.0
1995	439.0	299.0	473.0	1027.0	512.0
% Change	82.2	60.0	419.8	192.6	189.3
Calorie Consumption (Kilocalories/person/day)					
1970	2 083	2 184	2 019	1 945	2 045
1995	2 388	2 274	2 697	2 596	2 537
% Change	14.6	4.1	33.5	33.5	24.1
Cereal Area Harvested (million hectares)					
1970	100.4	21.3	91.1	25.0	237.7
1995	100.2	26.0	88.2	32.9	247.3
% Change	-0.2	22.0	-3.2	31.6	4.0
Cereal Yield (t/ha)					
1970	0.925	1.197	1.769	1.352	1.317
1995	1.743	1.846	4.007	2.237	2.627
% Change	88.4	54.2	126.5	65.6	99.5

a. Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka

b. Cambodia, Indonesia, Lao People's Democratic Republic (PDR), Malaysia, Myanmar, Philippines, Thailand, and Viet Nam.

Source: *Rural Asia: Beyond the Green Revolution* (ADB, 2000).

Table 2. Poverty Changes in Asia, 1975 to 1990s

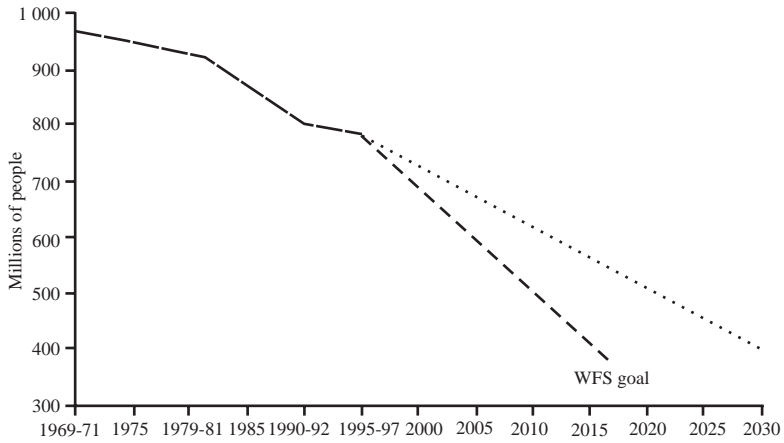
	South Asia ^a	People's Republic of China	Southeast ^b Asia	Developing Asia
Poverty (millions)				
1975	472.2	568.9	108.1	1 149.2
1990s	514.7	269.3	40.2	824.2
Poverty (per cent)				
1975	59.1	59.5	52.9	58.7
1990s	43.1	22.2	11.5	29.9

a. India, Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka

b. Cambodia, Indonesia, Lao People's Democratic Republic (PDR), Malaysia, Myanmar, Philippines, Thailand and Viet Nam.

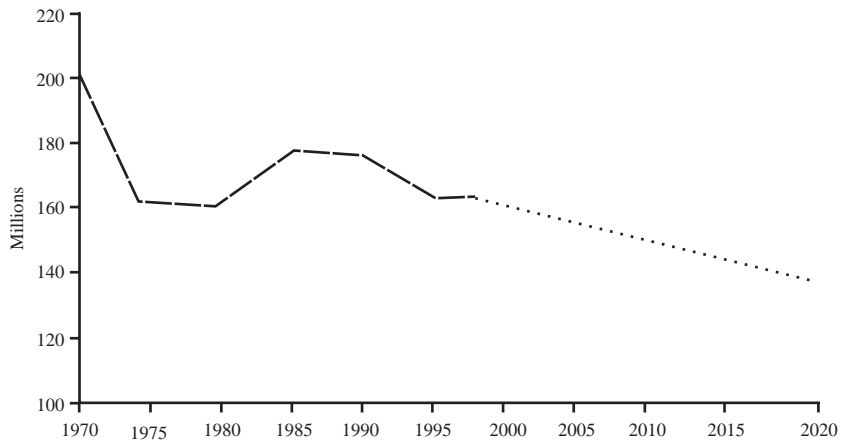
Source: *Rural Asia: Beyond the Green Revolution* (ADB, 2000)

Figure 3. Food Insecurity in the Developing World, 1969-2030



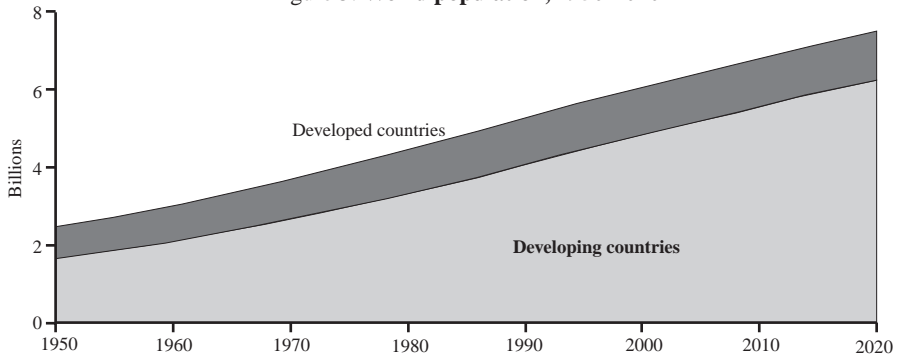
Source: FAO (2001).

Figure 4. Child Malnutrition in the Developing World, 1970-2020
(children <6 years)



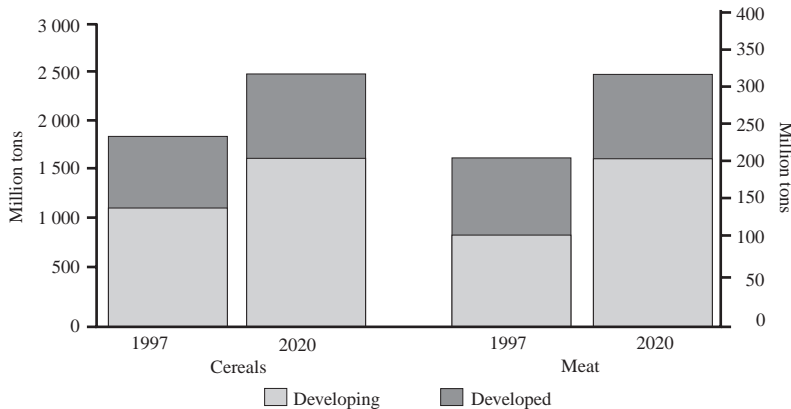
Source: 1970-95 data from Smith and Haddad (2000),
1997-2025 projections from IFPRI IMPACT simulations (October 2000).

Figure 5. World population, 1950-2020



Note: Medium-variant projections for 2000-2020.
Source: United Nations (1999).

Figure 6. Total Demand for Cereals and Meat Products, 1997-2020



Source: IFPRI IMPACT simulations (October 2000).

Agricultural Science and Poverty Reduction

Science and technology underpinned the economic and social gains in Asia over the past 30 years. In agriculture these gains came to be known as the Green Revolution. Between 1970 and 1995, cereal production in Asia doubled, calorie availability per person increased by 24 per cent and real food prices halved (IFPRI, 1997) (Table 1). Although the region's population grew by one billion, overall food production more than kept pace with this growth (McCalla, 1998). These food production increases were achieved largely by the cultivation of high-yielding varieties (HYVs) of rice and wheat, accompanied by expansion of irrigated areas, increases in fertiliser and pesticide use and greater availability of credit. Clearly, productivity improvement rather than area expansion was responsible for the phenomenal increase in production.

The scientific basis for the Green Revolution stemmed from national and international research programmes that led to the development and distribution of new HYVs, particularly of rice and wheat. The first generations of these new varieties were based on the introduction of new genes for dwarfing that made the HYVs shorter, more responsive to fertilisers and less prone to lodging when fertilised and irrigated. Subsequent varieties also carried genes that gave increased pest and disease resistance and improved taste and grain quality.

The key elements in improving food security in Asia in 1970–95 were government policies reflecting a belief that investments in increasing agricultural productivity were a prerequisite to economic development. Political leaders in Asia and both the public and private sectors of the international community supported these national policies. This mix of supportive public policies, scientific discoveries and public and private investments in rural Asia, particularly in irrigation, credit and inputs, led to substantial reductions in poverty and improved food security throughout Asia. Increased agricultural productivity, rapid industrial growth and expansion of the non-farm rural economy have all contributed to almost a tripling of per capita gross domestic product across Asia since 1970 (ADB, 2000; Pinstrup-Andersen and Cohen, 2000).

Despite these successes, problems remain. The intensification of agriculture and the reliance on irrigation and chemical inputs has led to environmental degradation, increased salinity and pesticide misuse. Deforestation, overgrazing and over-fishing also threaten the sustainable use of natural resources.

Green-revolution technologies had little impact on the millions of smallholders living in rain-fed and marginal areas, where poverty is concentrated. Furthermore, the Green Revolution has already run its course in much of Asia. Wheat and rice yields in the major growing areas have been stagnant or declining for the past decade, while population continues to increase (Pingali *et al.*, 1997). Three key lessons were learned from the Green Revolution. First, it has benefited farmers in irrigated areas much more than those in rain-fed areas, thus worsening the income disparity between the two groups. Second, it overlooked the rights of women to benefit from technological advances. Third, it promoted an excessive use of pesticides and in some situations indiscriminate use of fertilisers harmful to the environment.

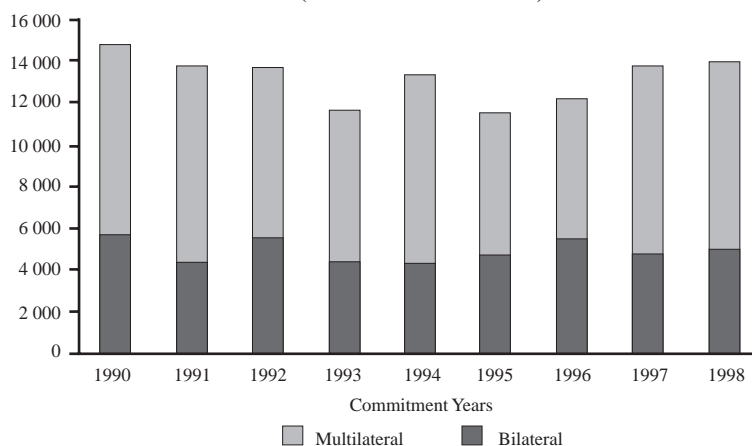
As countries have become self sufficient in food, government investments have declined in the agricultural sector and in science and technology across the region. This reflects a worldwide trend toward declining public investment in the rural sector and in agricultural research and development (R&D), nationally and internationally. These factors have been responsible for the decline in annual agricultural growth rates from an average of 3.3 per cent during 1977–1986 to about 1.5 per cent during 1987–1996. As Table 3 and Figure 7 show, government expenditures and external assistance to agriculture have virtually stagnated over the past decade.

Table 3. Share of Government Expenditure for Agriculture in Total Expenditure by Developing Region (1990-98)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Latin America & Caribbean	3.2	4.6	3.9	4.2	3.9	3.4	2.7	3.3	1.9
Near East & North Africa	4.1	3.6	3.7	3.6	3.3	3.7	3.5	3.5	1.1
Africa South of Sahara	6.2	5.8	6.6	5.3	5.5	5.0	5.6	4.7	3.9
East & South East Asia	6.9	6.5	5.9	6.1	7.0	7.5	7.4	7.1	5.2
South Asia	8.4	10.0	10.4	10.5	11.2	11.2	8.8	6.3	5.4

Source: FAO (2001).

Figure 7. Total Commitments of Funds for Agriculture by Main Bilateral and Multilateral Donors (millions of 1995 dollars)



Source: FAO (2001).

In Asia, private investments in the rural sector and related R&D have concentrated on export commodities. The downward trends in public investment by governments and development agencies in smallholder agriculture over the past decade have not been matched by a concomitant rise in private investment. Similarly, there is little private R&D (and few incentives for it) on the food crops, livestock, fisheries and aquaculture systems important for food security and poverty reduction in rural Asia.

The challenge for the future is how to keep ahead in the food–population race with diminished resources. Asia’s population is projected to increase from 3.0 billion to 4.5 billion in the next 25 years. The urban population will nearly double from 1.2 billion to 2.0 billion, as rural people move to the cities in search of employment. These increases will place massive pressure on developing countries to increase food production. Food demand is influenced by population growth, urbanisation, income

and associated changes in dietary preferences. Urbanisation and income growth frequently lead to shifts from diets based on root crops and cereals to more meat, milk, fruits, vegetables and processed foods. This dietary transition has already happened in much of the region (ADB, 2000). Meeting the food needs of Asia's growing and increasingly urbanised population requires increases in agricultural productivity.

To meet this demand, cereal production will need to increase by at least 40 per cent from the present level of about 650 million tons annually. Most of the increase will have to come from yield increases. In addition, meat demand will double during the period (Pinstrup-Andersen *et al.*, 1999). Production increases must be achieved by increasing yields in a sustainable way, to conserve diminishing and degraded natural resources. Nearly all of these production increases will need to take place in developing countries because on average 90 per cent of the world's food is consumed in the country where it is produced. Food imports not only are expensive but also discourage the creation of employment, which is badly needed in the rural areas of Asia.

In this millennium, we face a food, feed and fibre production challenge in highly complex farming systems, for several reasons:

- Water will become the most important limiting factor in agricultural production because its quality and quantity will decline as a result of pollution, forest degradation and increased agricultural, domestic, and industrial use (ADB, 2001a).
- Urbanisation will mean the loss of agricultural land to residential and industrial development and a decline in the number of farm workers.
- Most farmers are poor with small landholdings.
- Farming systems are commonly heterogeneous with mixes of food crops, livestock, and trees.
- About 70 per cent of the cultivated land is rain-fed, with unreliable distribution and intensity of rainfall.
- Thus, the increase in food production during the next 25 years will have to be achieved using less labour, water, and cultivated land. This can occur only if scientists can develop new crop varieties with high yield potential and high water-use efficiency. New understanding of plant and animal genes may offer ways to increase crop yields to the levels required to feed the growing population in Asia adequately and sustainably. Increasing smallholder agriculture productivity will not only increase food supplies, but also reduce poverty and malnutrition, increase food access and improve living standards of the poor (McCalla and Brown, 2000).

Strategies to meet the required increases in food supply in Asia include:

- Sustainable productivity increases in food, fuel and fibre crops;
- Reducing chemical inputs of fertilisers and pesticides and replacing them with biologically based products;