# I INTRODUCTION

At the dawn of the twenty-first century, about 900 million or 68 percent of the world's poor people[1] live in Asia; about 500 million in South Asia, 300 million in East Asia, and 100 million in Southeast Asia and the Pacific (World Bank 1999). In addition, about 526 million people, including 160 million children, are undernourished[2] (FAO 1999c). Not only do they lack access to sufficient money to buy food and other essentials, but neither do they have access to sufficient schooling, adequate housing, nor medical care. Those in rural areas are often short of water and fuel. Fertile land and water for farming are increasingly scarce. Urban poor lack money to buy enough food. That which they can afford may be deficient in protein and essential vitamins and minerals.

Although the absolute numbers of people living in poverty in Asia today are unacceptable, the situation could be much worse. In 1970, 60 percent of all Asians lived in poverty. That figure has been cut by almost half, with about one third of all Asians living in poverty in 2000. Also, countries such as Bangladesh, the People's Republic of China (PRC), and India have moved from periodic famines to almost self-sufficiency in food production. However, further efforts are needed to reduce poverty by another 50 percent by 2015, as targeted by world leaders during the World Food Summit in 1997. The latter half of the twentieth century saw impressive advances in science and technology. We now have the capacity to apply this knowledge to reduce poverty and improve food security. This Working Paper discusses how biotechnology can be used to safely and effectively reduce poverty and improve food security in Asia.

## A. Past Successes in Reducing Poverty Through Agricultural Science

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 produc-

[1] The poor is defined as those people who survive on less than $1.00 day.
[2] Undernutrition is determined from data about people's weight, height, and age.

tion in Asia doubled, calorie availability per person increased by 24 percent, and real food prices halved (IFPRI 1997). Although the region's population grew by 1 billion people, overall food production more than kept pace with population 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 fertilizer and pesticide use, and greater availability of credit.

The scientific basis for the Green Revolution stemmed from national and international research programs that led to the development and distribution of new HYVs, particularly of rice and wheat. The first generation of these new varieties were based on the introduction of new genes for dwarfing that made the HYVs shorter, more responsive to fertilizers, and less prone to falling over or lodging when fertilized 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 from 1970-95 were government policies reflecting a belief that investments in increasing agricultural productivity were a prerequisite to economic development. These national policies were supported by political leaders in Asia and by both the public and private sectors of the international community. 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 over the past 30 years. Increased agricultural productivity, rapid industrial growth, and expansion of the nonfarm rural economy have all contributed to almost a tripling of per capita gross domestic product across Asia since 1970 (ADB 2000b, Pinstrup-Andersen and Cohen 2000).

## B. Present Problems

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 overfishing also threaten the sustainable use of natural resources.

Green Revolution technologies had little impact on the millions of smallholders living in rainfed 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 of Asia have been stagnant or declining for the past decade, while population continues to increase (Pingali et al. 1997). The key lessons learned from the Green Revolution are: (i) it has benefited farmers in irrigated areas much more than farmers in rainfed areas thus worsening the income disparity between the two groups, (ii) it overlooked the rights of women to also benefit from the technological advances, and (iii) it promoted an excessive of use of pesticides that are harmful to the environment.

As countries became self sufficient in food, government investments declined in the agricultural sector and in science and technology across the region. This reflects a worldwide trend toward declining public investments in the rural sector and in agricultural research and development (R&D), nationally and internationally.

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

## C. Future Challenges

The population of Asia is projected to increase from 3.0 billion to 4.5 billion in the next 25 years. During the same period, 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 member countries (DMCs) of ADB to increase food production. Food demand is influenced by population growth, urbanization, income, and associated changes in dietary preferences. Urbanization and income growth frequently lead to shifts from a diet based on root crops (cassava, yam, and sweetpotato), sorghum, millets, and maize to rice and wheat, which require less preparation time, and to more meat, milk, fruits, vegetables, and processed foods. This dietary transition has already happened in much of the region (ADB 2000b). Meeting the food needs of Asia's growing and increasingly urbanized population requires increases in agricultural productivity and matching these increases to dietary changes and rising incomes.

To meet this demand, cereal production will need to be increased by at least 40 percent from the present level of about 650 million tons annually, most of which will have to come from yield increases. In addition, meat demand will double during the period (Pinstrup-Andersen et al. 1999). Production increases will have to 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 DMCs themselves because on average 90 percent of the world's food is consumed in the country where it is produced. Food imports are not only expensive but discourage the creation of employment, which is badly needed in the rural areas.

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

(i) Water will become the most important limiting factor in agricultural production because the quality and quantity of water will decline as a result of pollution, forest degradation, and increased agricultural, domestic, and industrial use (ADB 2001).
(ii) Urbanization will mean the loss of agricultural land to residential and industrial development, and a decline in the number of farm workers.
(iii) Most farmers are poor with small landholdings.
(iv) Farming systems are commonly heterogeneous with mixes of food crops, livestock, and trees.
(v) About 70 percent of the cultivated land is rainfed 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 labor, water, and cultivated land. This can be done 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 adequately and sustainably feed the growing population in Asia. Thus, developments in modern biotechnology could make extremely important contributions to future agricultural growth, food security, and poverty reduction. Increasing smallholder agriculture productivity will not only increase food supplies, but will reduce poverty and malnutrition, increase food access, and, improve living standards of the poor (McCalla and Brown 2000).

## D. Rationale for ADB's Involvement in Biotechnology

Biotechnology has the potential to (i) increase crop and animal productivity; (ii) improve nutritional quality; (iii) broaden tolerance of crops for drought, salinity, and other abiotic stresses; and (iv) increase resistance of crops to pests and diseases. These potential benefits will have significant impact in increasing food production and reducing poverty in DMCs if they can be applied to problems of the poor farmers in the tropics. As with any technology, biotechnology brings with it potential risks. To maximize the benefits and minimize the risks, the introduction and use of biotechnology in DMCs or elsewhere must be thoughtfully managed by the public and private sectors. The key risks that relate to the application of new developments in biotechnology for the public good are food and environmental safety, economic concentration, and intellectual property (IP) management.

To explore the opportunities and risks of biotechnology, ADB has decided to undertake a comprehensive study on the use of biotechnology to reduce poverty and achieve food security in cooperation with the Australian Centre for International Agricultural Research (ACIAR)/ Australian Agency for Agricultural Development (AusAID). There are many reasons to support this initiative:

(i) As a premiere development institution, ADB should be well informed on the development of biotechnology and the issues surrounding modern biotechnology.

(ii) Biotechnology has been identified by the Rural Asia Study as one of the emerging challenges in Asia (ADB 2000b).

(iii) Biotechnology has been identified by the Consultative Group on International Agricultural Research (CGIAR) as a powerful tool to fight poverty when used in conjunction with other agricultural research (Persley and Lantin 2000).

(iv) ADB is responsible for assisting the DMCs in dealing with potential risks of biotechnology and providing information on various biotechnology issues.

(v) ADB's Policy on Agriculture and Natural Resources Research recommends that ADB support research to increase farm productivity through modern biotechnology approaches, while giving appropriate consideration to indigenous and traditional knowledge (ADB 1995).

## E. ADB's Poverty Reduction Strategy

While the need for further intensification of agricultural production in Asia is clear, intensification strategies must change to avoid adverse environmental impact and to reverse the effects of earlier practices. Enhanced, but inefficient use of irrigation and mineral fertilizers over the past three decades has had negative side effects such as soil salinity and nutrient leaching. With crop intensification, incidences of pests and diseases also increased (Pinstrup-Andersen and Cohen 2000).

The following strategies are needed to meet the food demand in Asia over the next 25 years.

(i) Sustainable productivity increases in food, feed, and fiber crops.
(ii) Reducing chemical inputs of fertilizers and pesticides and replacing these with biologically based products.
(iii) Integrating soil, water, and nutrient management.
(iv) Improving the nutrition and productivity of livestock and controlling livestock diseases.
(v) Sustainable increases in livestock, fisheries, and aquaculture production.
(vi) Increasing trade and competitiveness in global markets.

As rural poverty persists in Asia, agriculture will play a prominent role in achieving equitable and sustainable rural growth in the twenty-first century. Even when rural people do not work directly in agriculture, they rely on nonfarm employment and income closely related to agriculture. Where there are large numbers of rural poor, agricultural growth is a catalyst for broad-based economic growth and development. Agriculture's linkages to the nonfarm economy generate employment, income, and growth in the rest of the economy. A healthy agricultural economy also offers incentives for natural resource conservation (Pinstrup-Andersen and Cohen 2000).

The ADB Poverty Reduction Strategy (ADB 1999) sees three factors, pro-poor, sustainable economic growth; good governance; and social development as key elements for reducing poverty. Biotechnology may contribute toward achieving the poverty reduction goals in several components of the strategy:

(i) Increasing priority for agriculture and rural development.
(ii) Addressing environmental considerations.
(iii) Increasing the public and private sector roles in poverty reduction.
(iv) Encouraging regional and subregional cooperation.
(v) Coordinating efforts of funding agencies.

The challenge is how to use new scientific developments such as biotechnology, together with information and communications technology, to make the complex agricultural systems of Asia more productive and sustainable. Good governance is also crucial to ensure that new agricultural biotechnology reaches the poor.

## F. Key Questions

It is in the context of this complex and evolving situation, that this report will address three key issues:

(i) What are the potential benefits and risks of agricultural biotechnology on human health, the environment, and agriculture; how can we minimize the risks and enhance the benefits?
(ii) How can we use biotechnology to reduce poverty and achieve food security in Asia?
(iii) What policies and strategies should be considered by funding agencies, including ADB, to support biotechnology for the benefits of small farmers in Asia?