Views on Food Production: Towards a New Green Revolution

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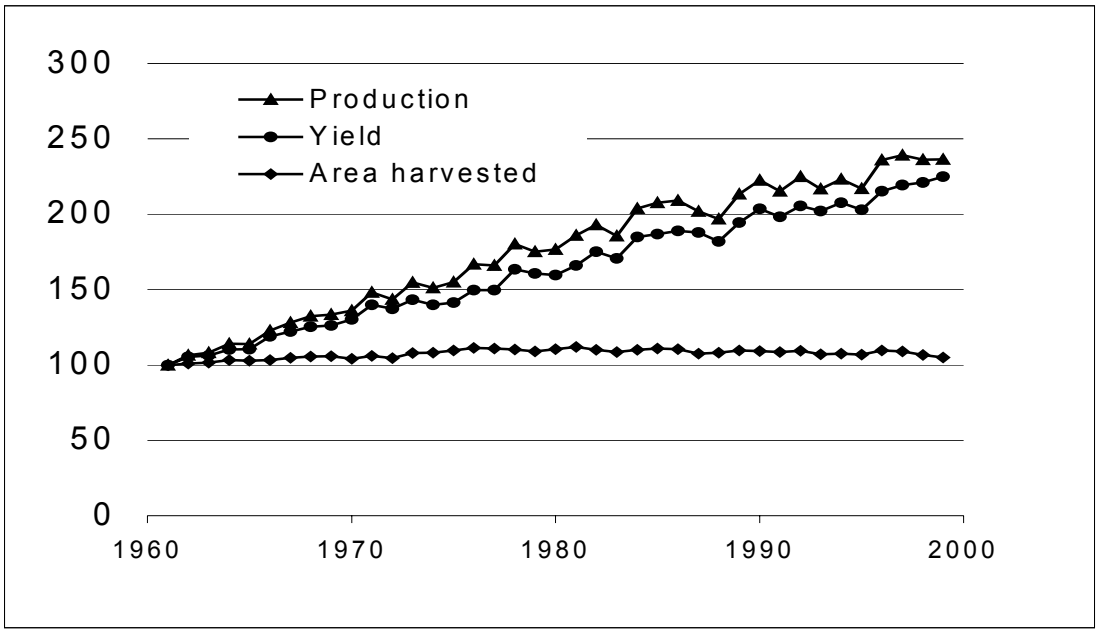
INTRODUCTION

History tells that human beings began relying on food produced from crop cultivation about 10,000 years ago. Since then food production has increased through the expansion of farming areas and productivity increases of crops and livestock. As long as human populations were small, increased demands for food could be met by clearing new land. The agricultural frontier, however, gradually disappeared as human population grew and in turn productivity growth came to a major source of production increase. This trend was accelerated in recent past especially during the last half a century. As seen in the figure 1, world agricultural land has expanded only by 10 % while its average cereal yields have more than twofold between 1961 and 1999. Productivity growth was the major force that enabled to improve average food intake per capita despite the growing world populations.

Behind these productivity increases is significant technological progress related to improved seed, farm inputs and irrigation. Application of technological packages as well as increased inputs have allowed the yield potential of major cereals to be realized more fully by farmers in developing countries. It is well represented by the so-called Green Revolution, which took place in the late 1960s and the 1970s mostly in Asia. The Green Revolution was very successful in raising cereal production and feeding the most populous region of the world. Resulting lower food prices relieved poor consumers and contributed to the economic growth.

Figure 1: World cereal production, yield and harvested area (index 1961=100)



Source: FAO (2000)

Initial enthusiasm, however, somewhat waned later with the growing awareness of its negative social and environmental impact. Some pointed out that the Green Revolution entailed more social inequity while others revealed that the input-driven Green Revolution caused environmental degradation in many places. It did not benefit the Africa region where hunger and poverty were more serious. In short, optimism based on the trust to the technological development and capital investment is being challenged.

The new millennium is seeing the world food and hunger problem to be more complex. Though being decelerated, human populations are still rising and pressures on existing agricultural land remain high. Concerns for the environment and food security including food safety are gaining momentum. Globalisation, economic growth and technological progress often skip the poor and sometimes make their living more difficult. The situation looks particularly serious in Sub-Sahara Africa and other poor countries. This short paper discusses major challenges for food security that we are facing in respect of food production on the basis of lessons learned from the Green Revolution.

IMPROVING FOOD SECURITY FOR THE POOR

Food security concept has evolved over the last half a century. Up until the 1970s, ample food supply had been the synonym of food security for the majority of the world population. In the poor populous world, threat of famine was a stark reality particularly when natural calamity devastated nation's crop harvests. However, economic growth, increased food production and better international cooperation in the last few decades began to make many developing countries more resilient against food shortages. Studies on famine revealed that starvations occur for more complex reasons than simple crop failures or even when food supply exists. It has become evident that increased physical food supply alone does not necessarily assure food security of poorer populations.

Nowadays food security is more broadly defined. The World Food summit 1996 prescribed that *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.* This definition suggests that access to sufficient food is key to food security. Needless to say, “sufficient food” is assured by ample supply but it is only a condition. “Access to food” should be guaranteed. It can be derived either by producing food by oneself or by having sufficient purchasing power to buy food. It is also notable that food safety, nutrition and even food preference are regarded as important elements. The definition also embraces stability and equity elements by referring to "all people" and "all times".

FAO estimates that about 826 million people of the world were undernourished, a state of chronicle food insecurity, in 1996-98. Of which 792 million live in developing countries. Asia and pacific region accounts for two third of them. India alone has more undernourished population (208 million) than total Sub-Sahara region (186 million). However, degree of food deprivation is far more serious in Sub-Sahara region. Eighteen of 23 countries classified as "high prevalence and high depth of undernourishment” are in this region. In fact, Sub-Sahara is the only region whose number of hungry population has shot-up since 1970. Not surprisingly, most of them are resource poor, low income and conflict suffering countries.

Wherever they live, a common feature of food-insecure people is that they neither consistently produce enough food for themselves nor have the capacity to earn sufficient income to buy food. In other words, they are poor in income and assets. They are more likely rural than urban residents as the three quarter of the world poor still live in rural areas. They include small farmers, pastoralists, landless labourers, indigenous people, female-headed households and displaced people in developing countries who are often deprived of capital assets or higher education and income opportunities (see table 1).

Table 1: Who are the poor? By region

Region	Rainfed farmers	Smallholder farmers	Pastoralists	Artisanal fishermen	Wage Labourers/ landless	Indigenous people: Scheduled Castes/tribes	Female-Headed households	Displaced people
WCA		✓						
ESA		✓		✓	✓			
AP		✓	✓	✓	✓	✓	✓	✓
LAC	✓	✓	✓	✓	✓	✓	✓	✓
NENA	✓		✓	✓	✓	✓	✓	✓

WCA: West and Central Africa; ESA: East and Southern Africa; AP: Asia and the Pacific; LAC: Latin-America aand the Caribbean; NENA: Near East and North Africa

Source: IFAD (2001)

A direct policy implication drawn from these observations is to accelerate economic growth. Economic growth offers increased demand for agricultural produce, job opportunities and better public services including education. Indeed, the recent experience of East Asian "tigers" proved that high economic growth successfully reduced poverty and hunger. Market incentives and export-oriented labour-intensive industrialization have been highlighted. Growth in world trade would allow food-deficit poor countries to produce and export industrial goods and services that should enable them to purchase significant quantities of food. It was considered that the Earth still has considerable potentials to produce food if environment and economic conditions allow. For these reasons, recent international development assistance was centred on activities aiming at market reform and human capital formation. Priorities were given to privatisation, export-oriented industrialization or increased rural non-farm employment.

Investments in agricultural sector especially for production enhancement were largely neglected in the 1990s.

We now know that this strategy was insufficient for attacking poverty and hunger reduction. Various market policy reforms, though in some cases helped rural sectors by rectifying overvalued currencies, did not provide much positive impact on the poorest segment of the society including small or landless farmers. Dividends of these reforms and industrialization did not trickle down to the powerless lowest tier of the society. Recent Asian financial crisis indicated that excessive reliance on market mechanism and external capitals often put the socio-economy of developing countries at risk and agonized the socially weakest people most.

International organizations and development agencies are now recommending more sensible strategies to reduce poverty and hunger. Although market-oriented economic growth remains as a priority, equity and security problems are gaining more attentions. Education, training and job creation for the poor and socially-handicapped people including women are the main target of development assistance. Measures to strengthen social security net as well as good governance are receiving full attention.

These are all welcoming changes for the battles against world poverty and hunger but still one key element seems to be missing - the role of agricultural growth in the early stage of economic development and poverty reduction. Lessons from the Green Revolution in Asia suggest that increased staple food production enhanced food security to both farmers and consumers alike, activated rural processing industry, contributed social stabilities and made economic transformation less painful. For the poor economies that are predominantly agriculture based, economic growth and poverty reduction should come from agriculture itself.

LESSONS FROM THE GREEN REVOLUTION

Technological progress in modern agriculture builds on the experience gained from scientific endeavours. A recent dramatic improvement in major cereal yields forms an

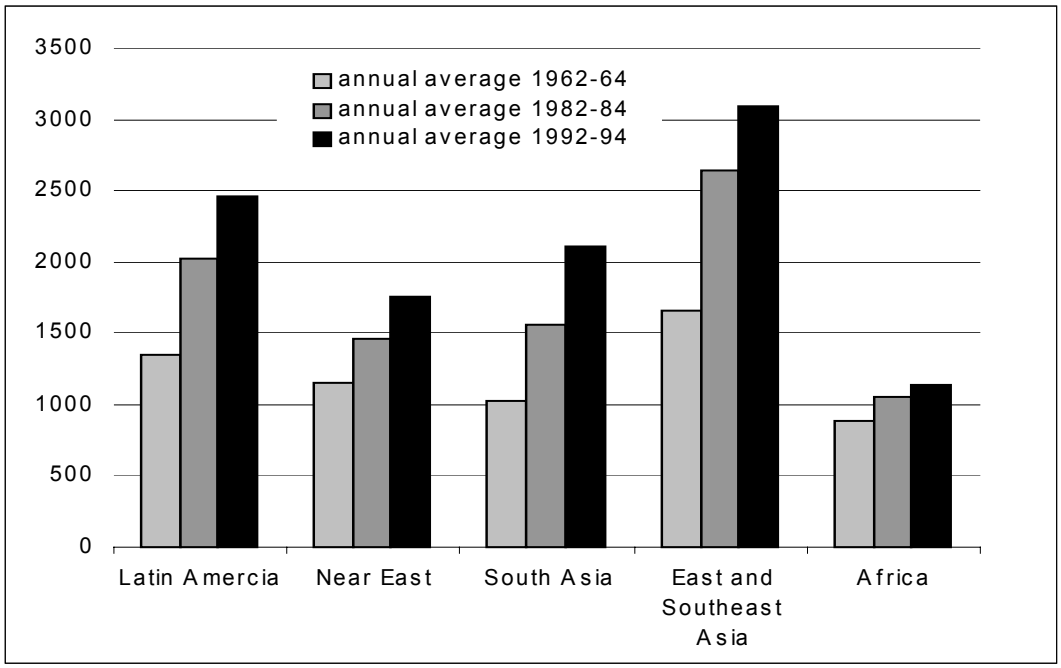
integral part of this development. The foundation is a science-based technological ability to modify the environment so as to create more optimal conditions for crops and livestock than nature alone can offer. Yield increases in the farming systems can be interpreted as the implementation of this paradigm. The Green Revolution of the 1960s and 1970s was squarely based on it, where the improved varieties of rice and wheat could benefit from the use of external inputs (including water) that provided good growing conditions for realizing the genetic potential of the new varieties. The creation of favourable socio-economic environments that opened up for the use of these inputs and created markets for the sale of the produce was an integral part of this change.

The Green Revolution was a technology package comprising material components of improved high-yielding varieties (HYVs) of major staple cereals (rice and wheat), irrigation or controlled water supply and improved moisture utilization, fertilizers and pesticides and associated management skills. The utilization of this technology package on suitable land in suitable socio-economic environments resulted in greatly increased yields and incomes for many farmers in Asia and in some developing countries elsewhere. It did not require large initial investment by farmers nor sophisticated techniques and knowledge to use. Many of these farmers were well versed in irrigated farming systems already. Statistics indicate that yields of these two cereals, and of maize, approximately doubled between the 1960s and the 1990s.

During the period 1963-1983 (important Green Revolution years) total production in developing countries of paddy rice and wheat rose by 3.1 and 5.1 percent per year. Yields per hectare rose less steeply for the same three crops during 1963-1983: 2.1 and 3.6 percent. In Asia the trends were similar. The average yields of rice and wheat rose ? and ? percent between 1963-1983 respectively. The increasing trend lasted even after this period though the gradual expansion of localization technologies. This remarkable performance shows a sharp contrast with a modest achievement in Sub-Sahara Africa. It should be reminded that the absolute level of cereal yields in Sub-Sahara Africa are far below, almost half of the other regions (see figure 2). This is the reason why it is often called that the Green Revolution did not reach Africa.

With hindsight it is easy to see the profound and often unforeseen impacts that the Green Revolution technologies had in many farming communities beyond the actual production sectors. In this sense, the Green Revolution shares the pros and cons of many of the technological advances that have changed and built modern global societies. There have been both winners and losers. The Green Revolution clearly averted a major food crisis in Asia, it became the foundation for startling economic growth in China, Southeast Asia and South Asia. It inspired the subsequent development of more environmentally benign methods of, for example, pest control in rice. Wheat and rice prices have continued to decline in the world market, offering cheaper food for all, not least for the huge numbers of urban poor in the developing countries.

Figure 2: Cereal yield crop by region (Kg/Ha)



Source: FAOSTAT

The greatest beneficiaries of the Green Revolution may be the consumers. Real food prices in Asia, indeed throughout the world, have steadily declined over the past 30 years through the application of yield-increasing, cost-reducing technologies. Low real food prices benefit the poor relatively more than the rich, since the poor spend a larger proportion of the available income on food. Table 2 below may illustrate to what extent

the reduced prices of cereals have had positive impact on the household expenditures of developing countries. Expenditures for the staple food accounted 30-40 percent of the total household expenditures in may low income countries. It should be noted that even for Korea Republic it was close to 40 % in the early stage of economic development. Increased production enabled the prices of staples to stay low and gave great relief to the poorer household. Reduced burden of staple expenditures would allow the household to divert their income more to other uses including the spending for industrial products, education or savings and thus greatly contribute to boosting the economic growth as a whole.

Table 2: Share of cereals in household expenditure

Country	Year	Share of cereals (%)		
			Urban	Rural
Korea	1964	37.7		
	1995	2.8		
Indonesia	1969/70	31.1		
	1998	15.5		
Bangladesh	1973/74	43.5	33.1	44.5
	1988/89	32.9	41.7	35.5
India	1972/73		22.4	44.5
	1985/86		14.2	26.7
Egypt	1981/82		7.3	13.1
Morocco	1970/71	13.7		
Central Africa	1992	2.8 (23.4)		
Kenya	1977	21.1		
Tanzania	1969			21.5 (27.2)
	1982/83			17.6 (24.8)
Sierra Leone	1989/90	23.1		30
Tanzania	1969			21.5 (27.2)
	1982/83			17.6 (24.8)
Haiti	1986/87	11.8		

The Green Revolution has also led to increased rural incomes through multiplier effects. Positive effect accrued in food marketing and processing industries while increased demand for farm inputs benefited local industries and domestic manufacturers. It is certain that the same magnitude of positive multiplier effects can not be expected from

imported staples. It may not be coincidence that most remarkable economic growth was recorded in the region where the Green Revolution was also most successful. The causal linkage should be studied further but at least the two incidences of success underwent in parallel being interlinked each other.

The Green Revolution technologies, however, were not without their problems: the need for a significant use of agrochemical-based pest and weed control in some crops has raised environmental concerns as well as concern about human health; as irrigation areas expanded, water management required skills that were not always there; gender roles were shifted; and there were new scientific challenges to be tackled. The move to a higher-input environment naturally favoured those farmers who had access to capital and skills. They strengthened their roles in society, sometimes at the expense of less well-endowed groups. Many studies have also claimed gender biases in the development of the Green Revolution.

Experiences with the Green Revolution on social impact are varied. A review (Freebairn, 1995) of more than 300 academic studies on the Green Revolution during the period 1970-1989 revealed that over 80 percent of the studies indicated greater inequities as a result of the Green Revolution. However, it also pointed out that Western authors tended to attribute the increased income inequalities to the Green Revolution whereas authors of Asian origin did not.

While the productivity gains in rice and wheat in Asia have been significant, farmers growing other crops and those in other parts of the developing world have had modest productivity increases. These increases have not, with the possible exception of maize, been based on the large-scale application of Green Revolution technologies. It is clear that limited research efforts have been devoted to globally less important crops than rice and wheat. This may explain why productivity gains have been smaller in many minor African crops.

The Green Revolution technology is characterized as a yield enhancing technology package with higher inputs of labour and fertilizer or chemicals. It is a labour intensive technology that suits best the conditions of scarce land and surplus labour. However, in

Africa and Latin America, increased food production has mostly been based on expanding the cropping area, often into more marginal lands with a lower yield potential. Until recently, incentives for the intensification of production have often been absent in many African countries. With little access to either appropriate technologies, capital or skills to implement new farming systems, farmers have extended their proven farming practices on to new land.

Lesson from the Green Revolution taught that scientific advances alone can not solve the food security problems of developing countries. Policies must create suitable socio-economic and institutional enabling environments, while access to credit and markets should play a key role in improving productivity. Greater equity does not necessarily arise from greater food production. The environmental consequences of high-input/high-output agriculture were taking shape in terms of water pollution or soil problems.

CHALLENGES IN PRODUCTIVITY OBJECTIVES

World populations will continue to grow further mostly in developing countries and few hundred millions will remain food-insecure in their poorest regions for foreseeable future. Though globalisation and economic growth should pave the way for diverse food security opportunities to the poorest countries too, economic reality will allow them neither to rely on continual food aid or imports nor to achieve quick industrialization. Past experiences suggest that boosting their food production through a Green Revolution type technology package greatly help those countries to get out of the vicious circle of poverty and underdevelopment. The new technology package, however, should be applicable in less favourable conditions, environmentally more friendly and targeted at poor populations. The new Green Revolution is possible if all the people including policy makers, researchers, international communities work together with those farmers.

Yield-enhancing technologies and dissemination

Some critics argue that recent deceleration in yield growth indicates that agricultural science is running out of fresh ideas on how to increase productivity. However, it is increasingly clear that research institutions still achieve sizeable yield increases with conventional tools, that new scientific tools are becoming available and that many crops and livestock breeds have not been subject to much improvement. Recent advances in biotechnology, not available at the time of the Green Revolution, have huge potential to produce new high yielding stress-resilient varieties and breeds. Adding useful genetic traits such as heat and drought tolerance to local varieties would help boost production in tropical marginal areas. These technologies, which have been largely focused on major cereals, will be extended to other crops too. Improved dissemination systems including extension services and seeds multiplication are the key to bringing the benefits to small-scale farmers.

Provided that precautionary principles are adhered to, particularly efforts should be made to build genetic resistance to pests and diseases into useful crops and animal breeds. Linking the use of genetic resistance to methods of integrated pest management (IPM) holds a lot of promise, as demonstrated in rice cultivation in Southeast Asia. It is fundamental that these and other advances in biotechnology do not bypass food-insecure farmers.

Other important challenge is to narrow the yield gap between experimental station and farmer's field. In past, researchers have found and proved thousands of promising technologies and species. Problem is the productivity gap with farmers. Typically, dryland farmers obtain only between one-tenth and two-thirds of research station yields each year, and most farmers normally reach less than one-half. This suggests that changes in the socio-economic enabling environments for farmers, including access to additional knowledge, credit or market, have the potential to create large yield increases in farmers' fields for a wide variety of crops. The narrowing yield gaps in rice in some Asian countries demonstrate that research and extension can work in favourable socio-economic enabling environments.

Sustainable development

At the heydays of the Green Revolution in Asia, few people addressed the issue of sustainable agriculture and rural development. We now know that it has a paramount importance. The genetically homogeneous monocultures increased the potential for massive pest and disease attacks on rice and maize, triggering in its turn the large-scale application of standard pesticides. Lessons learned from the Green Revolution have yielded innovative approaches to a more integrated pest management (IPM). A wide variety of techniques, including biological control, are replacing heavy applications of agrochemicals. Another advance has been the development of the concept of integrated cropping system management, which includes both IPM and integrated nutrient management (INM).

A greater understanding of soil-plant relationships has created new platforms for nutrient cycling, thereby reducing the need for heavy fertilizer applications so commonly associated with the Green Revolution. Development of INM will be more crucial for countries where fertilizer use is already high such as China. To prevent soil degradation, research is providing new options for sustainable land use including low-cost techniques of terracing, use of vegetative borders and agroforestry techniques. Similarly, conservation tillage can play a major role in controlling soil erosion, improving moisture and building up organic matter. These alternative approaches are less labour-intensive than earlier techniques

With growing scarcity of water resources, good water management is another key to productivity gains in many tropical and subtropical farming systems. The disappointing performances of many large-scale irrigation schemes pointed to the need for more manageable and sustainable irrigation systems that can encourage farmers' participation in operation and maintenance and appropriate water pricing policies.

Specific efforts for Africa

One of the lessons from the Green Revolution is that labour-intensive, inputs-driven technologies could not easily settle in Sub-Sahara Africa. With the current magnitude of

its poverty and hunger situation, all efforts should be directed to increasing their food production. A new type of Green Revolution that fits African mould should develop. First is to develop new crop varieties requiring minimum labor and chemical inputs . Modern biotechnologies or traditional breeding technologies should be mobilized to produce new rice, maize, sorghum or root crop varieties which assure decent yields under the stress of low soil fertility, drought, heat, weed, micro nutrient deficiency, salinization, pests etc.

For African staple food crops, applications of less than 5 kg/ha of fertilizer are common. Improving both the access to and the wise use of fertilizer are important components of the new Green Revolution. There is no escape from severe phosphate deficiencies in many African soils and the amelioration of highly acid soils is crucial to obtain significant yield increases. Use of phosphate rocks with crop residues are being studied.

Modest increases in irrigated areas, often in the form of low-cost high-intensity schemes will form an important element of new Green Revolution efforts in Africa. It will also be important to ensure that there is equitable sharing of water and land resources for communities practising different farming systems, for example, between pastoralists and irrigators. Linked to the expansion of irrigation should be a new and better understanding of the role that water can have in the spread of human diseases, and of how proper management.

Livestock has a specific importance for African farming households. Cattle, small ruminants, pigs, poultry and fish are main source of animal protein. Large animals work as buffer stocks or insurance at a time of emergency. Manure and wastes are used as fertiliser and fuel. Research and extension on livestock greatly help food security of rural households.

Last but foremost is to renew efforts to provide enabling environment, i.e. political stability, better infrastructure, undistorted market, improved public service system etc. Any good technology package will not spread without these basic conditions.

CONLUSION

At the entrance of the new Millennium, we still have serious problems of hunger and poverty in one part of the world. It is increasingly known that they are more complex than expected and centred on specific regions and peoples who are trapped in vicious circle of poverty and underdevelopment. Globalisation and technological progress do not seem to offer quick solution. Rather, they may make the catch-up by the poorest more difficult.

Asian experience suggests that the Green Revolution can offer a possible solution. It not only increases food production but also offers great relief to poor consumers and encourages other domestic sectors. If well managed, a win-win situation between food security and economic growth may be geared.

The Green Revolution is a technology package comprising improved high-yielding varieties, irrigation, fertilizers and associated management skills. It was a labour intensive input-driven technology. Utilization of this package resulted in greatly increased yields and incomes for many farmers in Asia where large population live in limited land areas.

Lessons from the Green Revolution taught that scientific advances alone can not solve the food security problems of developing countries. Policies must create suitable socio-economic and institutional enabling environments, while access to credit and markets should play a key role in improving productivity. The environmental consequences of high-input/high-output agriculture should be kept in mind.

Considering its gravity of poverty and hunger in Africa, a new green revolution should be introduced in its mould. However, it should be tailored for the conditions that the region faces. Among otheres are the development and dissemination of varieties resilient against specific stress, improved access to fertilizer and its effective use, careful irrigation management and provision of enabling environment including political stabilities. It is possible and international community can assist them.

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ABSTRACT

At the entrance of the new Millennium, we still have serious hunger and poverty in one part of the world. It is now known that they are more complex than expected and centred on specific regions and peoples. Globalisation and technological progress do not seem to offer quick solution. Rather, they may make the catch-up by the poorest more difficult.

Asian experience suggests that the Green Revolution can offer a possible solution. It not only increases food production but also offers great relief to poor consumers and encourages other domestic sectors. If well managed, a win-win situation between food security and economic growth may be geared. The Green Revolution is a technology package comprising high-yielding varieties, irrigation, fertilizers and associated skills. It was a labour intensive input-driven technology. Utilization of this package resulted in greatly increased yields and incomes for many farmers in Asia. Lessons from the Green Revolution taught that scientific advances alone can not solve the food security problems of developing countries. Policies must create suitable socio-economic and institutional enabling environments. The environmental consequences of high-input agriculture should be kept in mind. Considering its gravity of poverty and hunger in Africa, a new green revolution should be introduced in its mould. However, it should be tailored for the conditions that the region faces. Development of new technological pakage and provision of enabling environment including political stabilities would be indispensable . A new Green Revolution is possible and international community can assist them.

AUTHORS' REMARKS

This paper is the update of FAO documents prepared for the world Food Summit 1996.