

# **The Future of World, National and Household Food Security<sup>1</sup>**

## **1. Introduction**

The coming decades will pose daunting challenges for policy makers and the international agricultural science community mandated to solve the complex problem of providing adequate food for everyone. Between 70 and 80 million people, just about the population of Germany, will be added to the world's population every year between now and 2020, increasing the world's current population of six billion by a third to reach almost eight billion.

Roughly speaking we are living today in a 1:4:1 world, i.e., one billion people enjoying the amenities of life and living well without any concern about food insecurity, four billion from quite well to just breaking even, and one billion people living in poverty not being able to secure the food they need for a healthy and productive life.

In which of these three groups will the two billion additional people, almost all of them expected to be born in the developing world, end up? It depends on the decisions taken today whether the world will move to a 1:4:3 hotpot, full of tension, war and inhumanity or whether it will become a better world with substantially less than one billion people being in the last, the poverty category.

To produce and provide the food needed for those additional two billion people is possible but difficult. We know that it cannot come from expanding cultivated area; the lion's share of future food production growth will have to come from productivity increases. IFPRI and FAO estimate this share to be between 75 % and 80 % (Pinstrup-Andersen, Pandya-Lorch and Rosegrant, 1999 and de Haen and Wolter, 1999). Without any doubt, this is the more complex, the more difficult way of increasing food production. It requires generating a steady flow of technological innovations and adapting them to local ecological, institutional and socio-economic conditions; it requires educating people, changing their behaviour, modifying institutions, formulating and implementing policies often against well entrenched interests and political power structures. This is the science intensive path to productivity growth under the constraint of preserving the natural resource base. Agricultural research is called upon to carry the ball, indeed a daunting challenge!

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## 2. World Food Prospects

There is general consensus that the overall production potential is adequate to provide the food demanded for the growing world population, provided that technological innovations will continue to be generated and applied in a way that preserves the natural resource base. In fact, actual food prices have declined during the last decades (with a temporary interruption in the mid-1990s) and are projected to remain steady or fall slightly in the next two decades. However, declining food prices are an inadequate indicator of food security. Markets and prices reflect that part of food needed that commands the purchasing power necessary to enter the market. The food needs of the poor and hungry without income to enter the market are not reflected in market prices. Still, it is noteworthy that the decline in food prices seems to slow and perhaps has come to a halt due to the observed continuing slowdown in crop yield growth.

### 2.1 Demand

Population growth, income increases and changing consumption patterns are the driving forces behind food demand increases. World population growth, of which 98 % is occurring in the developing countries, continued at unabated rates until the mid-1990s. Around 1995 the population curve seems to have reached the turning point and growth rates have started to decline.

**Table 1 - World population, 1995 and 2020**

Region	Population level		Population increase,		Share of increase
	1995	2020 <sup>a</sup>	1995-2020	(per cent)	
	(millions)		(millions)	(per cent)	(per cent)
Latin America and the Caribbean	480	665	185	38.5	10.1
Africa	697	1,187	490	70.3	26.7
Asia, excluding Japan	3,311	4,421	1,110	33.5	60.5
China	1,221	1,454	233	19.1	12.7
India	934	1,272	338	36.2	18.4
Developed countries	1,172	1,217	45	3.8	2.5
Developing countries	4,495	6,285	1,790	39.8	97.5
World	5,666	7,502	1,836	32.4	100.0

Source: United Nations, World Population Prospects: The 1998 Revision (New York: UN, 1999).

In: Pinstrup-Andersen, Pandya-Lorch and Rosegrant, 1999.

<sup>a</sup> Medium-variant population projections.

While Asia will have the largest absolute increase in population, growth rates will be highest in Africa, despite HIV/AIDS with its devastating effects on African economies and societies. Developing countries' growing population will continue to be an important driving force behind increasing food demand, although less so than in the past. Food demand driven by population growth is projected to grow at 1.8 % p.a. as compared with 2.3 % p.a. in the 1980s (de Haen and Wolter, 1999).

As people in poor countries tend to spend a high share of their additional income on food, income growth is a second important determinant of food demand, and poverty is the key factor in explaining food insecurity. Prospects for overall economic growth in developing countries look favourable, although regionally very different. IFPRI's global food model (version July 1999) assumes total income in the developing world to increase at an average rate of 4.3 % p.a. between 1995 and 2020. Far behind the other regions is Sub-Sahara Africa, whose per capita income is projected to increase during this period from US\$ 280 to US\$ 359. This means that Sub-Saharan Africa's per capita income on average will still be below the poverty line with one dollar a day (see Table 2). Thus, food security in many parts of Africa will remain extremely fragile.

Urbanization is changing food demand patterns in an important way. While most of the poor and food insecure still live in rural areas, urbanization is progressing rapidly. Urban population growth is expected to be much higher resulting in cities to overtake rural areas in absolute numbers around 2015. Urban people tend to have more diversified diets, substitute rice and wheat for coarse grains and eat more fruits, vegetables and meat products. Rapid urbanization with its effects on lifestyle, work organization, food preferences and hence food demand will require significant adjustments in food production and marketing and food security policy.

**Table 2 - Income levels and growth, 1995 - 2020**

Region	Annual income growth rate, 1995-2020	<u>Per capita income level</u>	
		1995	2020
	(per cent)	(1995 US\$ per person)	
Sub-Saharan Africa <sup>a</sup>	3.40	280	359
Latin America and the Caribbean	3.59	3,590	6,266
West Asia and North Africa	3.83	1,691	2,783
Southeast Asia	4.44	1,225	2,675
South Asia	5.01	350	830
East Asia	5.12	984	2,873
Developed countries	2.18	17,390	28,256
Developing countries	4.32	1,080	2,217
World	2.64	4,807	6,969

Source: IFPRI IMPACT simulations, July 1999.

In: Pinstrup-Andersen, Pandya-Lorch and Rosegrant, 1999.

<sup>a</sup> Excluding South Africa.

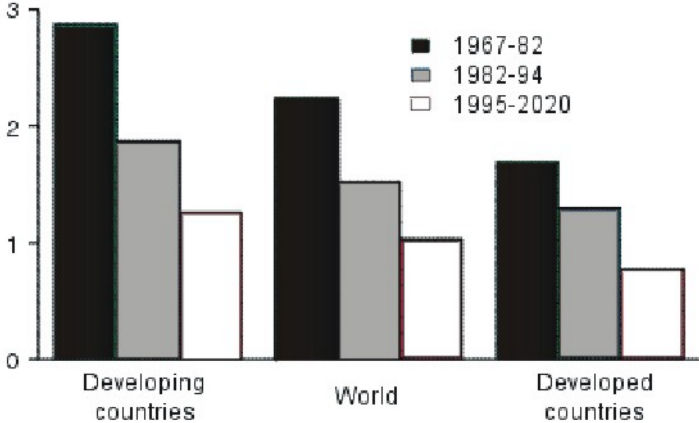
Like urbanization, also rising incomes will encourage people to shift to more diverse diets. A particularly rapid growth of demand is foreseen for livestock products. On the basis of past trends IFPRI projects meat consumption to grow at 2.8 % p.a. in the next two decades, compared with 1.8 % p.a. for cereals. In response to the rapid expansion of developing countries' meat consumption, demand for feed grains is expected to grow more than twice as fast as demand for cereals for direct human consumption. These changes will also require adaptation of agricultural research priorities.

## **2.2 Supply of Food**

### **2.2.1 Food Production**

Future supply of food is likely to be based overwhelmingly on productivity increase and this is innovation-driven. Decisive is how successful agricultural research will be in raising yields. Yield increases for cereals have slowed down, both in developed as well as in developing countries, as shown in Figure 1 (see also Alexandratos, 1995).

**Figure 1 - Annual growth in cereal yields, in per cent per year, 1967 - 82, 1982 - 94, and 1995 - 2020**



Source: 1967-82 and 1982-94; Food and Agriculture Organization of the United Nations, FAOSTAT database <<http://faostat.fao.org>>, accessed May 2000; 1995-2020: IFPRI IMPACT simulations, July 1999. In: Pinstrip-Andersen, Pandya-Lorch and Rosegrant, 1999.

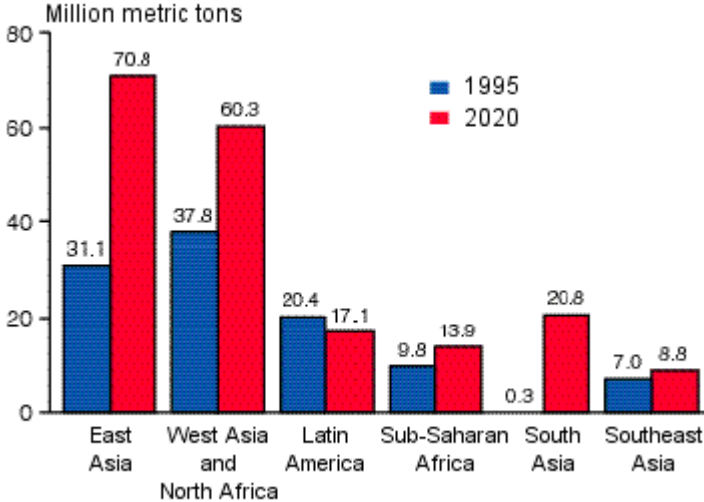
The yield decline reflects partly declining real prices for cereals. Also institutional constraints in input supply, rural credit and infrastructure have become increasingly constraining on fertilizer use. Investments in agricultural research have been insufficient to produce a continuous flow of yield increasing technologies (Pinstrip-Andersen, Pandya-Lorch and Rosegrant, 1999). The controversial and often emotional debates about and actions against genetically modified foods have certainly hampered investments in innovation generation in these areas. To keep a steady flow of productivity increasing innovations running both public and private sector agricultural research need to be directed towards increasing agricultural and particularly food production while preserving natural resources. Substantial and increased levels of investment in research of innovation generation and acceptance processes are necessary to avoid the continuing decline in yield levels and to turn the trend around.

**2.2.2 Food Trade**

In food security international trade will play a key role. Most of the additional food will be needed in developing countries, and it is there where production is projected to increase much faster. IFPRI’s impact model shows between 1995 and 2020 cereal production in developing countries to grow by 51 %, as compared to 24 % in developed countries (Pinstrip-Andersen, Pandya-Lorch and Rosegrant, 1999). Many developing countries will be moving away from food self-sufficiency in the foreseeable future; they are shown in need of filling an increasing

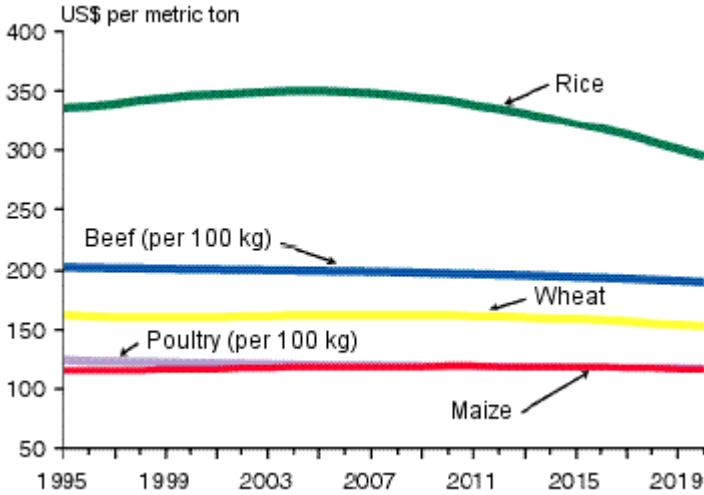
gap between food production and demand by rapidly rising imports.<sup>2</sup> Particularly East Asia with fast rising incomes as well as South and West Asia with expected declining growth rates in yields are driving the rising import demand (Figure 2).

**Figure 2 - Net cereal imports of major developing regions, 1995 and 2020**



Source: IFPRI IMPACT simulations, July 1999. In: Pinstруп-Andersen, Pandya-Lorch and Rosegrant, 1999.

**Figure 3 - World prices of major commodities, 1995 - 2020**



Source: IFPRI IMPACT simulations, July 1999. In: Pinstруп-Andersen, Pandya-Lorch and Rosegrant, 1999.

<sup>2</sup> It should be emphasized that there is no need for being self-sufficient in food as long as a trade surplus in other products allows to cover deficits in food. Also, trade mobilizes resources via exploiting comparative advantages.

While trade data show that world trade in food products is increasing, especially for pulses, and that developing countries are increasingly participating in world food trade, the major sources for these cereal imports are likely to remain North America, the EU and Australia. An unknown variable in this picture is the future development in Eastern Europe and the countries of the former Soviet Union, particularly whether they will be entering to a significant extent the cereal export market. Also the future of WTO negotiations will play a role for world cereal markets.

As a result of these projected developments, IFPRI's impact model projects world prices of major cereals to remain constant or slightly declining until 2020 (Figure 3).

### **3. National and Household Food Security: A Complex Issue**

Behind these overall developments are enormous differences between and within regions, calling for a more differentiated look at food security. In fact, world food security does not guarantee national food security; and national food security does not ensure that all households are food secure. Even within households distorted intra-household distribution may leave some members deficient of food although the household overall may have adequate access to food (Alderman et al., 1995).

While the world in total is able to produce the additional food required to ensure food security for everyone, undernutrition is likely to persist in large regions of the developing world. The highest number of people suffering under hunger today are counted in countries of South and East Asia; during the coming two decades per capita food availability is expected to significantly increase in East Asia and moderately in South Asia. The highest incidence of undernutrition is found in Subsaharan Africa, also the region where progress is expected to be slowest and where hunger is likely to persist. Food insecurity in the other developing regions is less severe, more localized and expected to be easier to handle.

A differentiated picture presents itself in looking at household food security which in large parts of the world remains critically inadequate. Household food security is conditioned by a complex set of factors that go far beyond the food production and trade domain. Household food security is not just a matter of producing sufficient food ensuring its availability in adequate quantities and quality, it also requires creating the possibility for households to acquire the needed food and to access the knowledge necessary to use food properly. Thus, a house-

hold's food security is directly linked to poverty and a household's possibility to get access to the food needed. Also, knowledge about adequate food diets, about hygiene and health and the interlinkages between them are an important component of an expanded concept of food and nutrition security (von Braun, Bellin-Sesay, Feldbrügge and Heidhues, 1998).

### **3.1 Poverty and Household Food Security: Causes and Linkages**

Any policy targeting household food security has to be aware of and take into account not only the natural resource and infrastructure environment but also the economic, political, socio-cultural and institutional setting. Poverty and household food security and their relationship to the conditioning environment are interacting in different ways and have therefore to be analysed in a location- and time-specific setting (von Braun, Teklu and Webb, 1999).

The key factors determining household food security in an interacting way may be grouped into five categories:

- natural resources
- innovation generation and dissemination
- population growth
- infrastructural, socio-cultural and institutional setting, economic and policy framework
- natural disasters, wars

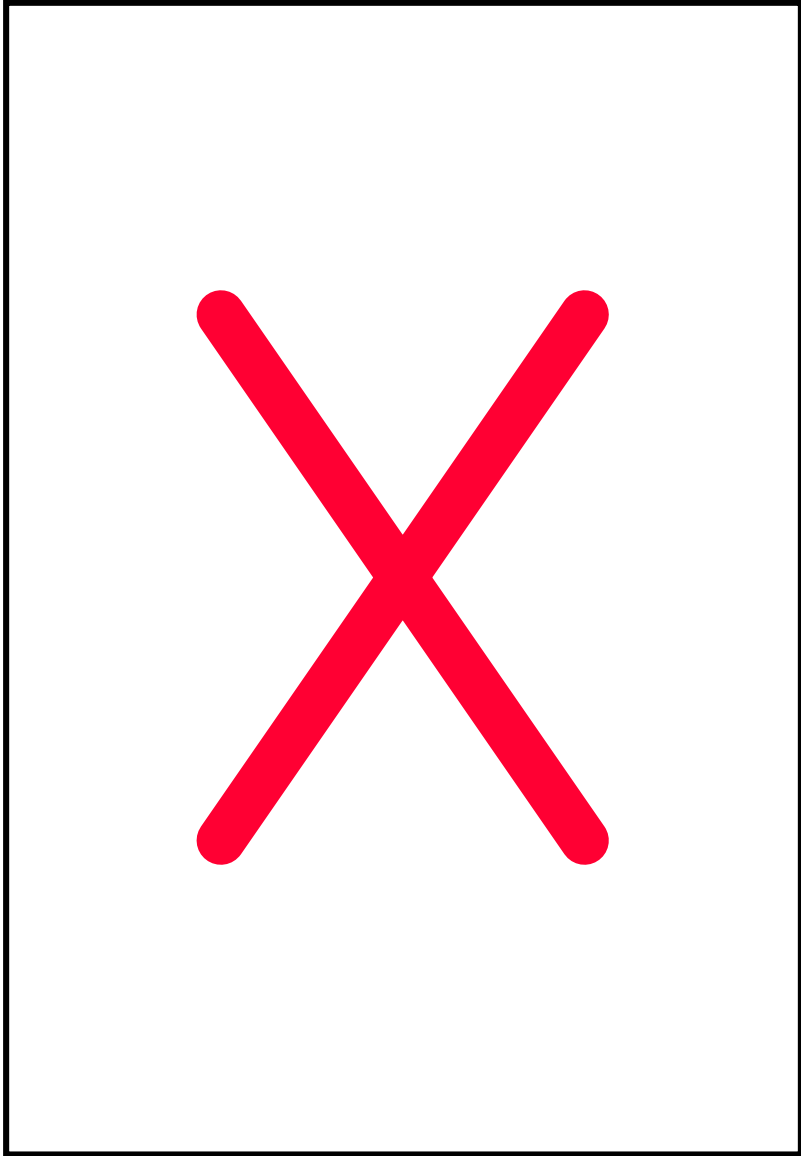
Figure 4 highlights the major interrelationships. Actions to influence the factors and their impact on food security can be directed at any of the boxes in Figure 4. Much of this conference will focus on natural resource conservation and innovation generation and dissemination processes in the natural resource/agricultural productivity domain with the objective of raising the carrying capacity of natural resources. These are vitally important areas of action. Without any doubt the best of science available in these areas has to be mobilized for food security if the World Food Summit challenge of reducing hunger by half by 2015 is to be met. One can hardly overemphasize the priority that research in these areas deserves.

While enormous progress in these areas is necessary, it is not sufficient to ensure food security for the poor. A major focus in research and policy action needs to be placed on the socio-cultural, institutional, economic and policy factors and their relevance for poverty and food security. Identifying these factors, understanding their relevance and mutual interactions is a precondition for designing measures and policies that are effective in improving food security. Thus, research of socio-cultural, economic and institutional complexities are important and need to complement natural science research work. It hardly needs to be elaborated that lack



of water is a binding constraint for irrigation. What is often less understood is that an institutional failure or an economic constraint, such as an insecure land tenure situation or lack of access to credit, can be just as limiting for innovation acceptance as a lack of water is for irrigation.

**Figure 4 - Food security in context: causes and interrelationships**



From the factors shown in Figure 4 different levels of policy actions, apart from the intra-household actions, may be derived. The top group represents basic structural conditions: natural resources and population growth. The boxes in the mid-range denote important areas of action; on the left in agricultural research and innovation dissemination and on the right hand side on economic development. They are interacting with each other as well as with the action areas shown in the bottom part of Figure 4: policy, institutional, market and governance failures; they again are closely interdependent and decisively influence basic structural condi-

tions. Both groups of factors, individually and in their interaction, together with the political framework determine a household's food security.

Natural disasters and wars, often perceived as exogenous factors or even 'force majeure', may well be seen as endogenous results of scarcities, failures in policies and flawed institutional set-ups (von Braun, Bellin-Sesay, Feldbrügge and Heidhues, 1998). They often are only the outburst of a simmering fragile ecological and economic situation by a small and in itself unimportant external shock.

### **3.2 Policy Actions and Programmes for Household Food Security**

The effectiveness and success of food security policy and programme interventions depend on the basic conditions, institutions and actors that determine food security. Food security policy is of a crosscutting nature. Isolated programme interventions may bring some relief but are likely to fail in promoting long-term food security. Sustainable food security policy can only be successful if it integrates long-term population policies, economic development and productivity enhancing strategies and natural resource conserving programmes with short-term actions to remove market distortions, to correct institutional failures, to design more effective policies and to move towards good governance. Thus, access to input, output and factor markets affects innovation acceptance and agricultural productivity. Better employment opportunities in less distorted labour markets can effectively enhance income and purchasing power of the poor and thus their food security. Access to financial markets can be instrumental in adopting innovations. Moreover, it has also been shown to be an effective way for poor households to bridge periods of temporary food stress; poor households with access to financial markets feel less need to sell their productive assets (such as animals or tools) and have been found to recover more quickly after periods of stress than households without access to the financial market; also their nutritional well-being suffered less (Zeller, Schrieder, von Braun, Heidhues, 1997). Programmes of physical and social infrastructure improvements (education, health, social and communication services) have an impact on labour productivity, employment and income; and on mortality, fertility and migration which in turn affect population growth and a household's food situation (FAO-WFS, 1996). Thus, it is important to recognize that there is not one set of policies that is optimal for achieving food security; depending on the location- and time-specific framework conditions and characteristics of the food security problem, there is a wide range of options from which the most effective ones are to be chosen. They are grouped and discussed here under the headings 'Governance, De-

velopment Strategy and Macroeconomic Policy’; ‘The Agriculture and Food Security Link’; and ‘Food Aid and Specific Food Security/Nutrition Programmes’.

### **3.2.1 Governance, Development Strategy and Macroeconomic Policy**

#### **a) Governance**

As Figure 4 tries to highlight, poverty and food insecurity is a multi-dimensional problem. One of the most important contributions of the development discussion during the 1990s is the recognition that poverty is not just defined by material well-being, but also by the choices an individual has and the freedom of developing individual capabilities. Amartya Sen in his ground-breaking work ‘Development as Freedom’ (1999) has shown that freedom and democracy are constituent elements of development. There is increasing evidence indicating that poverty, ignorance and disease are highly correlated not only with low labour productivity but also with the poor’s absence of freedom of choice and action (Dethier, 1999). The poor are often unable to control their own lives and have no way of influencing local or national decisions affecting them. Voicelessness and powerlessness are generally perceived by the poor as a major constraint on their life and, not seldom, as a cause of their material poverty (Narayan et al., 1999).

Governments have a central role to play in creating a framework that gives everyone the freedom to develop one’s own capabilities, i.e. to guarantee basic personal protection and security, to ensure fair and enforceable access to due legal process and to promote equity between different economic, social and ethnic groups in society. Governments and state institutions in many developing (and transition) countries fail often on all three tasks. Corruption, rent seeking and capture of the state by interest groups has been shown to perpetuate poverty and inequality. Transparency and participation of people, particularly of the poor, in decision making, and accountability of officials in the provision of public goods are key requirements of better governance that is essential for reducing poverty and food insecurity.

#### **b) Development Strategies and Macroeconomic Policy**

Historical evidence and development experience have shown the striking relevance of the chosen development strategy for growth and poverty reduction. Big push strategies emphasizing industrialization not only failed in generating growth and employment, they tended to polarize societies in a few rich and a majority of poor. Re-emphasizing the rural sector in the rural development paradigm and recognizing the complexity of the development problem and

the multiplicity of actors in the process in the comprehensive development framework have been big steps in the direction of poverty reduction, but much remains to be done. Again, not a general strategy can address the multifaceted issues of poverty in all countries; a country- and often region-specific approach geared to address the specific characteristics of the poverty situation is called for.

Structural problems and adjustment policies in the 1980s have amply demonstrated the important effects of macroeconomic policies on the poor and their food security (Pinstrup-Andersen, 1990). Macroeconomic stability, a liberal and competitive market and trade environment and efficiency promoting infrastructure and public sector policies have proved to be vitally important for integrating the poor in the development process. Still, there is a need to complement these policies with special support measures for the extreme poor, particularly for those that cannot participate in the labour market (see 3.2.3 below).

Fluctuations in agricultural production, markets and trade are inherently linked to agriculture and can aggravate food insecurity. Rising food prices have been shown to bear particularly hard upon the poor (Teklu, von Braun and Zaki, 1991). Storage and food-trade policies require renewed emphasis, given the volatility of food markets, the uncertainties of international trade and the amplified risks of international financial markets (Haug, 1999). It is against this background that governments often feel that a certain amount of storage under public control is essential for food security.

Storage needs are dependent upon country specific parameters, such as cropping pattern, climate risks, sectoral diversification, infrastructure and ease of access to international markets. In determining food storage needs and in designing policies it is important to take account of the administrative capacities and to weigh the benefits of stabilized prices against the costs of the resources tied up in storage. In this context it is worth emphasizing that food insecurity and undernutrition, apart from their ethical and human dimension, in purely economic terms, are enormously costly and ‘the largest world-wide waste of potential economic resources’ (FAO-WFS, 1996). A benefit-cost comparison has to properly value the higher productivity of people now and in the future as a result of better nutrition and a more secure food supply against the momentary fiscal costs of stabilization expenses.

### **3.2.2 The Agriculture and Food Security Link**

In formulating specific agricultural and food security policies different types of linkages can play a role.

#### a) Dietary Link

Agriculture is obviously important as it produces virtually all the food. A healthy diet requires a diversified supply of food from fruits, vegetables and staples to high protein products. This has important implications for agricultural science. For the urban population the market intermediates between producer and consumer. The variety of supply and market access determines the possibility of acquiring a diversified diet. Thus, infrastructure, market and trade policies need to take into account not only an adequate supply of staple foods but also the needs for diversified diets. In subsistence agriculture households' diets are more directly linked to farmers' cropping pattern; they can hardly be modified by varying market supply. Production and technology promotion policies need to be designed in support of diverse cropping patterns and multiple dietary needs. Also plant-breeding research directed at raising nutritional value and micro-nutrient content can have favourable effects on diet quality (Bouis, 1995).

#### b) Growth-Employment Link

Placing highest priority on agricultural development and promoting agricultural production and productivity can benefit food security, if it directly or indirectly increases income and food consumption of the poor. These policies may affect the poor via two channels: higher incomes and lower food prices. Boosting agricultural production not only increases employment and income in agriculture, it also spreads to other sectors via income and consumption increases and multiplier-accelerator effects (Hazell and Ramasamy, 1991). The larger the share of agriculture in the economy, the more important the role of agriculture as an engine of overall growth and poverty-oriented economic development becomes. Lower food prices play a key role in securing food for the poor who spend the overwhelming part of their income on food. Lower food prices are mainly driven by innovations and, therefore, agricultural research plays a most vital role. The development promoting effect of agricultural growth deserves emphasis as too often it is overlooked, particularly in analytical approaches based on partial equilibrium models. At the policy level, development institutions and governments need to re-recognize the key importance of agriculture for overall growth and development and for poverty reduction in particular. Fighting poverty and food insecurity without proper attention to agricultural growth is like trying to sweep water uphill.

#### c) The Agricultural Productivity-Environment-Health Link

Agricultural productivity increase is often linked to increased irrigation and extended use of fertilizers, pesticides and other chemicals. Irrigation may spread water-borne diseases if proper measures are not taken; increased health problems reduce work capacity and labour productivity. Overuse of chemicals is of concern in technologies that rely on irrigation and high intensity packages of pesticides and fertilizers. Reduced water quality downstream may limit its use for household consumption and pose serious health risks with subsequent effects on labour productivity and mortality.

#### d) The Technology – Soil Degradation Link

Many mountainous regions in low-income countries are exposed to rapidly rising population pressure, pushing agriculture into hillside cultivation with often heavy soil degradation processes set in motion. While farmers recognize the erosion danger, they often underestimate the damage done to soil fertility as the simultaneous introduction of higher yielding varieties often combined with increased fertilizer use tends, at least initially, to over-compensate the erosion-caused fertility decline; despite heavy erosion, yields are still increasing, making it difficult to raise awareness of the longer term consequences of such agricultural practices. Extension and technology policies are challenged to turn farmers attention to the long-term consequences.

### **3.2.3 Food Aid and Specific Food Security/Nutrition Programmes**

Food security can be enhanced not only by policies oriented towards the development of agriculture, economic growth and employment but also by food aid and food-related income transfers. Food aid has played a critical role for some countries, both as a recurrent resource transfer and as a bridging measure in times of emergency. However, it is not a reliable source of food for poor countries. When world market prices for food rise, the supply of food aid from donors tends to decline. Thus, it has been observed in the mid-1990s, when international cereal prices increased by 30 % to 40 %, that food aid supplies dropped to about half of their early 1990s' level (FAO, 1998; FAO-WFP, 2000). Also, liberalization of agricultural markets in the main grain exporting regions set in motion under the Uruguay trade agreement have resulted in lower surpluses and food stocks. Food aid to individuals at critical times in their life cycle or at stress periods during the year can have a significant positive impact on de-

veloping their physical and mental potential and thus on their long-term food security. In situations of natural disasters and wars survival may hinge on access to food aid.

The importance of food aid has increased as the number and complexity of emergencies has risen (FAO-WFS, 1996), and it may well increase further in the future. The expected rising need and declining resources available point out the need for food aid programmes to become more effective and efficient in the future. Also criticisms that some programmes in the past have been wasteful, inefficient and counterproductive to long-term food security call for better management and coordination of food aid programmes and their integration into general development policy.

Specific food security/nutrition programmes including food-price subsidies and food stamps are widely used instruments. In order to control costs and limit access to those in need, food-price subsidy policies are often combined with rationing and targeting efforts. It has proven difficult to achieve household food security for all through rationed food subsidization programmes. Often corruption, rent seeking and the appropriation of programmes by powerful interest groups have undermined their effectiveness. Self-targeting by using commodities predominantly of interest by the poor and geographical delineation of programmes to poor regions or neighbourhoods are attempts to control costs and limit their scope to those in real need of food.

Specific nutrition interventions are often integrated into more comprehensive nutrition-education-health programmes. This approach seems logical given the multifaceted nature of nutrition problems. It has also proven to be an effective and efficient way of addressing complex nutrition problems.

#### **4. Conclusion for International Agricultural Research**

What then is needed to face future food security challenges and to develop solutions to these complex and multifaceted problems:

- (1) Building strengthened and adequately funded national and international research systems with the proper balance between specialized and interdisciplinary research and effectively interlinked internationally is a top priority. Public and private sector research need to be brought together complementing each other according to their specific roles and comparative advantages. Private sector research typically serves its enterprise's objectives of pro-

fitability, competitiveness and market share. Where public goods are at stake, and eliminating hunger and poverty is primarily a public sector good, public sector research has a leading role to play. Modern communication and transport systems allow to bring together specialists of different disciplines world-wide to address multifaceted issues of food security and nutrition in an integrated way.

- (2) Food needs are continuing to increase. Given the limited possibilities of expanding cultivated area, raising natural resource productivity is of utmost importance. The trend of declining rates of yield increases is a matter of concern. The big potential that modern science offers needs to be mobilized for food research. In plant breeding, molecular biology promises new advances in yields and resistance characteristics. Also research for improving production technologies and natural resource management offers considerable potential. Research needs to take the public's concern about the impact of biotechnology on health and the environment seriously. It needs to address these concerns to build up trust, without public confidence in these technologies it will be hard to mobilize public support for them.
- (3) Given that poverty is mostly found in marginal areas, research must include in its agenda crop improvement for marginal areas. There is ample evidence that redistribution of food from richer to poorer regions is conditioned by many constraints. Marginal areas must be directly the subject of research if it is to address poverty and reduce food insecurity. A particular emphasis is to be placed on mountainous regions. They are of key importance for the global ecosystem, and more than 10 % of the world's population depend directly on these regions for their livelihood.
- (4) Research has to take into account farmers' problems and their priorities. Therefore, farmers need to be brought into the research process. The Global Forum of Agricultural Research has called for a research agenda where priorities are set with a focus on farmers' perspectives (GFAR, 2000). Research design and dissemination should involve the intended users and beneficiaries, particularly farmers. Besides this call for farmers' participation in agricultural research, participation itself is a research issue. At what stage in the research, innovation and dissemination process farmers' participation is appropriate and what are the constraints, benefits and costs, needs to be carefully assessed, if participation is to become a widely accepted and effective approach in agricultural research.



- (5) Research results have to be proven to be economical. That is a necessary precondition of acceptance, but not sufficient. The above discussion has highlighted the complexity of the food security issue. Many of these issues originate in cultural, social and political constraints. These are not simple issues to deal with. Causes and interlinkages need to be understood if effective measures and policies are to be formulated. This requires research. International agricultural research must include these issues in its mandate.
- (6) Removing food insecurity is also a matter of political will. How to generate political commitment and how to translate it into effective policy actions is also a research issue. Too little attention has been given to these questions, where political science and law need to be brought into the research process for food security.

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