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## CHAPTER 5

### FOOD SECURITY: SUSTAINING THE POTENTIAL

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## CHAPTER 5

### FOOD SECURITY: SUSTAINING THE POTENTIAL

1. The world produces more food per head of population today than ever before in human history. In 1985 the global production of cereals and root crops, which are the primary sources of food, amounted to nearly 500 kg. per head.<sup>\*/</sup> Yet the cruel paradox is that, despite this, over 500 million people were chronically hungry and 13 to 18 million deaths resulted from hunger and hunger related diseases.<sup>\*/</sup> At the same time the accumulation of stocks led some countries to destroy the food that is so badly needed in other parts of the world.

2. Increases in production have not quelled the hunger of the many with very low incomes. The millions who suffer from starvation and malnutrition do so not because there is a shortage of food, but because they do not have the funds to buy their share. The problem facing the world community is not insufficient food supplies, nor is it one of global food production being outstripped by population. The problem is where and by whom the food is produced, and who has the resources to purchase it.

3. There is yet another contradiction in the present situation. The increase in production has often been obtained in a self-defeating manner that undermines the base for future growth. First, high yields in many food surplus countries are based on farm practices which threaten the ecological base, particularly soil fertility, vegetation and water. Second, the growing destruction of forests and the advance of deserts degrade land and water resources in developing countries. Third, within many developing countries, rising numbers of rural dwellers are forced into marginal areas and activities where, in order to survive, they are driven to damage the environment.

4. The agricultural resources and the technology needed to feed the growing number of people on earth are available. The economic and ecological crises that confront our agricultural systems are due, not to the lack of resources, but to the lack of policies which could ensure that the food is produced where it is needed and in a manner that ensures a sustainable livelihood base for the rural poor. This challenge can only be met if we resolve the economic and ecological crises which confront our agricultural systems and devise strategies for ensuring sustainable food and livelihood security.

#### I. ACHIEVEMENTS

5. Measured solely in terms of global increases in food production, the past generation has been one of historical progress in world agriculture. Between 1950 and 1985, cereal production outstripped population growth and increased from around 700 million tonnes to over 1800 million tonnes.<sup>\*/</sup> This increase helped to meet the rising demand for cereals because of population growth and income increases in developing countries and the growing requirement of grain

for animal feed in the developed countries.

6. This achievement hides large differences in performance between regions. At the global level food production has grown a little faster than population; but there are many regions where this is not the case (see Table 5.1). Where, like sub-Saharan Africa, they happen also to be areas of poverty, the people in these regions lack the means to purchase the surpluses available elsewhere. Moreover in these and in more prosperous regions there often is a food-population imbalance in poor households. Many such households in developing countries are subsistence farmers who are unable to feed adequately the rising numbers of family members from the limited resources at their command.

7. These regional imbalances in food production relative to demand growth have led to large changes in the pattern of world food trade which are most marked in the case of foodgrains. Fifty years ago Europe was the only deficit continent and it met its shortfall of about 20 million tonnes with grain from Canada and Argentina. The USSR, Asia and Africa were net exporters of cereals.<sup>\*/</sup> Today the situation is very different. Net exports from North America have increased from barely 5 million tonnes before the Second World War to nearly 120 million tonnes during the 1980s. The grain deficit of Europe is very much lower now and the bulk of North American exports are to the USSR, Asia and Africa. Three countries - China, Japan and the USSR - absorbed half the exports and much of the rest went to relatively wealthy developing countries like the oil exporters in West Asia. However several low-income developing countries became net importers of foodgrains, a phenomenon that is most obvious in sub-Saharan Africa at present. But it must be noted that the grain imports of sub-Saharan Africa accounted for less than 10 per cent of world grain trade in the 1980s.<sup>\*/</sup>

TABLE 5-1

Index of Per Capita Food Production			
	1961-64	1971-74	1981-84
<u>WORLD</u>	100	107	112
North America	100	106	121
Western Europe	100	116	131
Eastern Europe and USSR	100	124	128
Africa	100	97	88
Near East *	100	103	107
Far East **	100	101	116
Latin America	100	101	108
CPEs of Asia ***	100	111	135

\*An FAO grouping that includes West Asia plus Egypt, Libya and Sudan

\*\*An FAO grouping that covers South and South-East Asia excluding the centrally planned economies of Asia.

\*\*\*An FAO grouping of Centrally Planned Economies of Asia which covers China, Kampuchea, North Korea, Mongolia and Vietnam.

Source: Based on FAO data.



8. The food requirements of the poor are not the only, perhaps not even the primary, factor underlying the imbalances in world food production. If the population of developing countries had grown at say 1 per cent rather than at over 2 per cent between 1950 and 1985 there would have been 1250 million fewer people which, at the average consumption level prevailing in the developing countries, would have reduced cereal demand by less than 20 per cent. The rising demands of the more affluent are as important.

9. The growth in the demand for milk and meat is of particular importance. Animal protein is preferred to vegetable protein in many societies and accounts for a rising proportion of food consumption as incomes increase. The fulfilment of this demand has been a major feature of agricultural growth in the developed countries. In Europe for instance meat production increased more than three-fold between 1950 and 1984 and milk production nearly doubled.<sup>\*/</sup> There was also a substantial increase in meat production for exports particularly in the rangelands of Latin America and Africa. World meat exports have risen from around 2 million tonnes in 1950-52 to over 11 million tonnes in 1984.<sup>\*/</sup>

10. The production of milk and meat requires the maintenance of a large global livestock population which in 1984 amounted to about 1.4 billion cattle and buffaloes, 1.6 billion sheep and goats and 0.8 billion pigs, whose combined biomass is well in excess of the biomass of human beings.<sup>\*/</sup> The feed energy required to maintain this livestock was met largely from forage. However feedgrain requirements also increased, and led to a sharp increase in the production of cereals like corn, which in North America and Europe accounted for nearly two-thirds of the total increase in grain production between 1950 and 1985.

11. The growth in food production over the past few decades is unprecedented in human history. It has been secured both by an extension of the production base in the form of an increase in cropped area, number of livestock, number of fishing vessels, etc. But more than the extension, the growth is due to a phenomenal rise in yields per hectare of land or, in the case of meat and milk, per animal. The systematic application of genetics to plants and animals, the increase in fertilizer use, the expansion of irrigation and other technical improvements in crop and animal husbandry are the factors that account for this increase in yields

12. The expansion in the area under cultivation took place mainly in the developing countries of Asia, Africa and South America. In the case of foodgrains, this expansion has been a little over 50 per cent in the past three and a half decades.<sup>\*/</sup> However in per capita terms the area harvested under foodgrains has declined from about 0.19 hectares in 1950 to 0.15 hectares in 1985. With the growing scarcity of arable land the focus has been on increasing productivity by expanding irrigation, developing and disseminating new varieties and increasing the use of chemical fertilisers and pesticides.

13. New varieties of rice, wheat, and maize have figured prominently in the growth of output. Many of these varieties, have a high ratio of usable to total plant weight, shorter maturing time, while facilities multiple cropping, and higher disease resistance. But the effectiveness of the high-yielding varieties depends heavily on irrigation and on the use of market-purchased inputs such as fertilizers and pesticides.

14. At the global level the per capita application of fertilizers has risen five fold in 35 years, from about 5 kilograms in 1950 to 26 kilograms in 1985.<sup>\*/</sup> A growing proportion of this takes place in the developing countries,  
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particularly those where the green revolution is most widespread. According to FAO estimates fertilizer use was responsible for 55 per cent of the increase in yield in developing countries between 1965 and 1976.<sup>\*/</sup>

15. The use of chemicals to control insects, pests and weeds, showed an even sharper increase, rising 32-fold in 35 years.<sup>\*/</sup> Starting with industrial countries, pesticides soon found ready markets in developing countries, where governments encouraged their use through subsidies. They have contributed significantly to increased yields in several food and cash crops and enabled the expansion of cropland in many developing regions.

16. The third critical component in the new technology was the growth in irrigation. More than half the area irrigated at present came under irrigation in the past 35 years and this area is growing at an annual rate of 2.9 per cent compared to the rate of 0.7 per cent for non-irrigated land.<sup>\*/</sup> Irrigation has played an important role in stimulating agricultural growth in the developing countries, particularly in Asia. To give a few examples: the dramatic rise in Indian grain production in the late 1960s was due as much to irrigation as to improved seeds, while China's production increases recorded over the last five years are owed substantially to irrigation.

17. A global view tends to mask regional differences which are quite substantial (see Box 5-1 on "Regional Perspectives"). The impact of the new agricultural technology was uneven and, in certain respects the gap in agricultural technology has widened. For instance, the average level of foodgrain productivity in Africa in relation to European productivity declined from roughly one-half to about one-fifth over the past three and a half decades.<sup>\*/</sup> Even in Asia, where the new technology spread particularly rapidly, productivity in relation to European

levels declined. Similar "technology-gaps" have emerged within countries.

18. In a broad sense the developments of the past few decades have seen the emergence of three types of food production systems. The first is industrial agriculture, which is capital- and input-intensive and usually large-scale. It is dominant in North America, Europe, Australasia, the East European non-market economies, and in some enclaves in developing countries. The second is Green Revolution agriculture which is found in uniform, resource-rich, often flat, and irrigated condition in the agricultural heartland areas in developing countries. It is more widely spread in Asia but is also found in parts of Latin America and North Africa. The third type is resource-poor agriculture in developing countries, usually in rainfed and often ecologically complex and vulnerable regions. This predominates over most of sub-Saharan Africa and in remoter areas of Asia and Latin America. Here, per capita production has been declining and the lack of access to food is a critical problem. Today all these systems display signs of crises that endanger the possibilities of future growth.

BOX 5-1

Regional Perspectives on Agricultural Development

Sub-Saharan Africa

- \* following increased agricultural productivity during the 1950s and 1960s, a drop in per capita food output of about 1 per cent a year since the beginning of the 1970s
- \* a growing dependence on imported food, fostered by inadequate production of staples and increasing urban preferences for non-traditional foods
- \* a focus on cash crops and degradation of the agricultural resource base due to unfavourable and unequal terms of trade on the international market
- \* enormous hidden potential in both physical and human resources, with less than 25 per cent of the arable land cultivated, with irrigation extended to less than 16 per cent of the area it could be developed on, and with low levels of fertilizer use

North Africa and West Asia

- \* limited arable land and considerable amounts of desert, making food self-sufficiency a challenge
- \* recently improved and controlled irrigation, leading to higher productivity following the cultivation of high-yielding varieties
- of many migrants and emphasized the fragility of import-dominated food security
- \* a growing food poverty experienced by many landless people with access to neither land nor irrigation systems

(Box 5-1 continued)

South and East Asia

- \* little unused land, and extensive, unabated deforestation
- \* government commitments to be self-reliant in food, leading to national research centres, development of high-yielding seeds, the spread of irrigation, and the fostering of location-specific technologies
- \* increased production, with some countries registering grain surpluses today, due to a vertical growth in productivity rather than an increase in area cultivated
- \* growing numbers of rural landless
- \* high potential for improved use of water through better management of existing large and medium-sized irrigation projects and through extension of efficient irrigation to small projects

Latin America and the Caribbean

- \* a huge land resource and high productivity potential, though most of the potentially arable land is in the remote, lightly populated Amazon basin, where perhaps only 20 per cent of the land is suitable for sustainable agriculture
- \* declining food imports since 1980, as food production kept pace with population growth over the last decade
- \* degradation of the agricultural resource base fueled by high national debts and by inequitable distribution of land
- \* government support for agricultural productivity in the form of research centres to develop high-yielding seeds and other technologies and to support irrigation measures

(Box 5-1 continued)

Eastern Europe and the Soviet Union

- \* increased government investment in agriculture accompanied by eased farm distribution and organization to meet desires for food self-reliance, leading to production increases in meat and root crops
- \* food deficits met through imports, with the Soviet Union being the world's largest grain importer
- \* pressures on agricultural resources through acidification, salinization, alkalization, and the ground and surface water contamination

North America, Western Europe, and Australasia

- \* the world's leading source of surplus foodgrain, though the rate of increase in output per hectare and in total productivity in North America slowed following the 1973 oil price rise
- \* subsidies for production that are ecologically and economically expensive, leading to surpluses that reduce the bargaining power of local producers and to production methods that strain the resource base
- \* limited land for future agricultural expansion in Europe, and frontier areas in the United States and Australia that can be intensively farmed only at high cost
- \* a resource base increasingly degraded through erosion and acidification, with the possibility of needing to retire large areas from production in the future

## II. SIGNS OF CRISIS

19. The preoccupation of agricultural policy in practically all countries has been output growth. Despite this, it has proved far more difficult to raise world agricultural output by a consistent 3 per cent a year in the mid-1980s than it was in the mid1950s. Moreover record achievements in production have been offset by the appearance of an interlinked set of economic and ecological crises. The symptoms can be seen in the growing difficulty in managing the surplus food production potential in many developed countries, the erosion of the livelihood base of millions of poor producers in the developing countries and in the deterioration in the resource base for agriculture in virtually all countries.

### 1. Impact of Subsidies

20. The food surpluses in the developed market economies are largely the result of subsidies and other incentives that stimulate production even in the absence of demand. While the systems vary greatly, virtually the entire food cycle now attracts direct or indirect subsidies. These incentives systems have become extremely expensive. In the United States the cost of farming support has grown from \$ 2.7 billion in 1980 to \$ 25.8 billion in 1986. In the EEC the cost of farm support has gone up to \$21.5 billion in 1986 compared to \$ 6.2 billion ten years earlier.<sup>\*/</sup>

21. With the growth in food surpluses it has become politically more attractive, and often cheaper, to ship surpluses than to store them. Food aid, too, because it is assumed to combine morality with political necessity, has acquired great appeal as a means of reducing surpluses.



Indeed, there are some who have seen it as their duty to Third World countries to create surpluses for export. Yet, these heavily subsidized surpluses have depressed prices of commodities such as sugar in international markets and created severe problems for several developing countries in which agriculture is the mainstay of the economy. An equally serious consequence is the impact of food aid and low-priced imports on prices and agricultural policies in developing countries. And still the pressure to export grows to such an extent that exports have now come to attract subsidies, raising the prospect of a destabilizing trade war in agricultural products.

22. The environmental consequences of a heavily subsidized production system are also becoming evident. They vary from region to region, but they include lower productivity on previously good-quality soils, stemming from intensive production practices and over-use of chemicals, fertilizers and pesticides. They include the destruction of the countryside, clearing hedgerows, parkbelts and other protective cover, levelling, occupation and cultivation of marginal land and watershed protection areas. Moreover, the nitrate pollution of ground-water aquifers has become a serious problem in many areas due to the over-use of nitrate fertilizers, which often qualify for subsidies.

23. The financial, economic and environmental effects of the current incentive systems are beginning to be questioned by many governments and groups, including farm organizations themselves. While they may not be removed for the time being, it is clearly in the interests of all concerned, in particular the agricultural industry itself, that they be changed. Their financial and economic burden has to be reduced. The negative impact of unwanted surpluses on the economic and resource base of Third World agriculture has to be eliminated. Most important to those ends, their ecological contradictions have to be removed.

## 2. Neglect of the Small Producer

24. The new seed-fertilizer technology which underlies the increase in agricultural productivity, developed in response to the specific compulsions of agriculture in the developed countries and was focussed as much at economizing on labour as on improving land productivity. Its successful application required a base of scientific and technological skills, a developed system for technology extension and other services for farmers and a high degree of commercial orientation in farm management.

25. In the developing world the new technology worked where these pre-conditions could be created; but this could not be done everywhere. Inequalities emerged as ecologically disadvantaged areas and land poor rural masses could not benefit from these advances, and governments in most developing countries were unwilling or unable to correct this through redistributive measures. As a consequence, despite rising food production, hunger and malnutrition continued and, in some parts, even increased.

26. In recent years, the worsening economic situation in many developing countries hit poor peasants and other rural people with particular force, especially subsistence farmers and pastoralists. Subsistence farmers or poor peasants have always been at the bottom of the national ladder in terms of support. Unable to increase production because of lack of inputs, they meet their food needs through sale of labour, often seasonally. With the rural work force growing more rapidly than employment opportunities, the economic position of many of these house-holds has deteriorated.

27. Subsistence farmers have been pushed into more marginal and fragile lands as financially more powerful urban and rural households bought up better quality land.

Pastoralists have faced similar problems as crop agriculture gained prominence, especially as a source of foreign exchange. They have been pushed off their lands and their grazing areas turned into croplands. The new comers who purchase these lands often lack the experience to manage them in an ecologically sound manner.

28. Women play a critical role in food production: in cultivation, seed selection, storage; in some regions they are the basis for successful afforestation efforts; they provide the main labour on the minifundia in Latin America; in Latin America, the Caribbean and Asia they form a large agricultural labour force. In sub-Saharan Africa, they provide the main labour force in food production. In some countries, their contribution to food production is as high as 73 per cent.<sup>\*/</sup> Despite this women farmers suffer the most from unequal access to the means and factors of production.

29. The rising number of the landless and the unemployed in the rural areas of the Third World is the root of the rural poverty problem. The survival strategies that these dispossessed households have to resort to leads to unsustainable pressures on land, water and forests. An ecologically oriented agricultural policy cannot work unless it provides a sustainable and adequate livelihood to these households.

### 3. Erosion of the Resource Base

30. The consequences of short sighted policies can be seen in the erosion of the resource base for agriculture which is deteriorating on almost every continent at varying rates: erosion in North America, soil acidification in Europe, deforestation and desertification in Asia, Africa and Latin America; and pollution and leaching of the water frontier almost everywhere. Within 40 to 70 years, climatic change

may begin to deplete the resource base of coastal areas. Some of these effects arise from trends in energy use and industrial production. Some arise from the pressure of population on limited resources. But agricultural policies have contributed greatly to this deterioration by emphasising production growth at the expense of environmental considerations.

### 3.1 Degradation of Soil Resources

31. The increase in cropped area in recent decades has often meant the extension of cultivation to marginal lands prone to erosion. During the great export boom of the 1960s and 1970s, prices soared and the advice from government officials and agricultural experts in countries like Canada and the US as in Western Europe, reinforced policies that encouraged farmers to bring more land into production. The landscape was transformed. Several million hectares of marginal land were brought under the plough, encouraged by measures such as tax relief for land development, crop support loans and cash subsidies.

32. The impact of this extension of cropland onto marginal lands can be seen in several countries. By the late seventies soil erosion exceeded soil formation on about a third of US cropland much of it in the midwestern agricultural heartland.<sup>\*/</sup> In Canada soil degradation is costing farmers one billion dollars a year.<sup>\*/</sup> In the USSR the extension of cultivation to the Virgin Lands was a major plank of agriculture policy; but now it is beleived that much of this land is marginal.<sup>\*/</sup> In India soil erosion affects 25-30 per cent of the total land area and the area under cultivation.<sup>\*/</sup> An FAO study estimates that, in the absence of conservation measures, the total area of rainfed cropland in the developing countries of Asia, Africa and Latin America would shrink by 544 million hectares because of soil erosion and degradation.<sup>\*/</sup>

33. Erosion damages the soil in a variety of ways. It changes the water retention capacity of the soil, depletes it of nutrients and reduces the depth available for the roots to take hold. The consequence is a decline in the productivity of the land. The top soil that is eroded is carried to rivers, lakes and reservoirs where it can lead to a decline in fish population, the siltation of ports and waterways, the loss of valuable storage capacity in reservoirs and increased risks of floods.

34. Other soil degradation problems can be traced to the considerable growth in irrigation since mid-century. Poorly designed and implemented irrigation systems have led to waterlogging, secondary salinization, and alkalization of soils. FAO and UNESCO estimate that as much as half the world's irrigation schemes are in some degree subject to these three problems.<sup>\*/</sup> These estimates indicate a global abandonment of some 10 million hectares of irrigated land annually.

35. Soil degradation erodes the resource base for agriculture in a most direct sense. The loss of croplands increases the pressure to use the remaining land more intensively and to extend cultivation to forests and rangelands. A sustainable agriculture cannot be based on methods that mine and deplete the soil. Hence the reversal of current trends in soil erosion and soil degradation should be one of the most important objectives of agricultural policy.

### 3.2 Impact of Chemicals

36. The use of chemical fertilizers and pesticides, has been stimulated by commercial pressures and government subsidies. They have contributed significantly to increased production since World War II; but clear warnings have been raised against over-reliance on chemical inputs. Over

application of fertilizers and pesticides has contributed to environmental degradation in regions where industrial agriculture has been dominant.

37. Water resources are particularly sensitive to the run-off of nitrogen and phosphates from excess use of fertilizers. Eutrophication of large and small lakes, irrigation channels, reservoirs, canals and other water bodies has become a universal problem; it ruins major sources of water for drinking and other purposes, and it destroys fisheries. The feared death of many lakes in North America and Europe brought the overall question of water quality to the international agenda in the mid-1960s; although the process has since been reversed in a few areas, the problem continues to spread. The percolation of nitrogen into underground water sources can impose heavy costs on a community or region as aquifers have to be abandoned in favour of more expensive alternatives.

38. The use of chemical-control agents for insects, pests, weeds, fungi etc. enhances productivity; but its impact on other species has been quite dramatic. Commercial fisheries have been affected, bird species endangered, and predatory insects wiped out. Disrupting nature's equilibrium by indiscriminate pesticides use has increased the resistance of the target pests, while at the same time destroying natural predators. The number of pesticide-resistant insect species worldwide jumped from 25 in 1974 to 432 in 1980.<sup>\*/</sup> Many resist even the newest chemicals. The variety and severity of pest infestations multiply, threatening the productivity of agriculture in the areas concerned. Chronic exposure to pesticide and chemical residues in food, water, and even in the air is hazardous, particularly to children. The contamination is not limited to the area where pesticides are used but travels through the food chain to either areas.

39. At present pesticide use is concentrated in the developed countries, but its use is also growing at a rapid rate in developing countries. Given the larger populations exposed there, the greater institutional and educational barriers to safe use, and the higher rates of spill-overs between farms, the problems of pollution and contamination could reach or exceed those of developed countries. A 1983 study estimated that approximately 10,000 people died each year in developing countries from pesticide poisoning and about 400,000 suffered acutely.<sup>\*/</sup> Most victims are farm workers. Accidental poisoning from food contamination is common.

40. The use of chemical fertilisers, pesticides and other chemicals in agricultural production is not, in itself, inconsistent with sustainability. In fact the use of these chemicals is still quite low in many regions of the world and in these areas response rates and the capacity to cope with residues is large enough to justify increasing levels of application. However the growth in chemical use tends to be concentrated precisely in the areas where these conditions do not hold. Hence agricultural policy will have to aim simultaneously at the promotion of more benign alternatives in some areas and of higher levels of chemical use in others.

### 3.3 Pressure on Forests

41. Forests and their ecosystems are crucial for maintaining and improving the productivity of agricultural land. Yet the processes of agricultural expansion and other factors have led to severe pressures on forest cover. Although this destruction has been taking place in an unprecedented manner throughout the world, today the greatest challenge to forests and woodlands is in developing countries, particularly in rain forests. This century has seen a reduction of such forests by almost half; every year 11.3 million hectares are destroyed.<sup>\*/</sup> (See Chapter 9)

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42. The opening up of forests for agricultural production and for ranching is especially important in Latin America (although it occurs elsewhere also) where big landowners lock up vast extents of forests. In Central America it has been the major cause of forest depletion. Government policies to encourage the conversion of forests to pastures for ranching and large scale resettlement schemes have contributed to these pressures. There is nothing inherently wrong with extending agriculture in this way. In point of fact, future food security in the developing countries will depend to a large extent on bringing additional arable land under cultivation. But are these the best lands? Has the capacity of the forest soils to sustain agricultural production been assessed?

43. The growth in population and the growing lack of arable land lead many poor farmers in the developing countries to seek new lands in the forests to grow more food. Indeed, in some parts of Africa deforestation caused by shifting cultivation is 40 times higher than that caused from forest exploitation for fuelwood. And in Latin America, shifting cultivation accounts for 33 per cent of annual deforestation.<sup>\*/</sup> Other small local farmers and landless squatters add to forest denudation.

44. Agricultural expansion is by no means the only source of pressure on forests. Many countries endowed with large forest resources have come to regard their forests as sources of foreign exchange. There is, of course, nothing intrinsically wrong with a policy that seeks to utilize a resource to contribute to general development. In practice, when account is taken of the damage caused to the general forests through the selective logging of mixed tropical hardwoods, the returns to developing countries are, in most cases, negative. Yet another factor at work is the growing demand for wood fuels which is discussed later in Chapter 7.

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45. Disruptions to the ecosystem due to deforestation are more acutely felt in upland-watersheds. The uplands play a very important role in the hydrological cycle: they influence the precipitation of moisture in the form of snow or rain and provide the energy for the maintenance of flows in streams and rivers in the plains. Since the stability of the water flow is largely a function of the state of the soil-vegetation-system, floods and droughts everywhere have been linked to deforestation and the consequent destabilization of these upland watersheds.

46. The economic and ecological consequences of deforestation are far-reaching:

- \* indigenous forest dwellers and forest-based economies are often displaced;
- \* a valuable development and renewable resource capable of assisting in the process of industrialization, in absorbing labours and in earning foreign exchange is destroyed;
- \* soils are degraded;
- \* more solar heat is reflected back into space, which could alter air circulation patterns and change the climate;
- \* water regimes are upset;
- \* many wildlife species lose their habitat and centres of genetic diversity are destroyed before their potential contribution to animal and crop resources has been investigated.

### 3.4 Advancing Deserts

47. Some 29 per cent of the earth's land area is subjected to slight, moderate, or severe desertification and an additional 6 per cent is classified as extremely severe.<sup>\*/</sup> The large populations supported on these lands

indicate the significance of the problem. In 1984, some 850 million people were reported to be living in drylands, of whom, 230 million people were on lands affected by severe desertification.\*/

48. The process of desertification affects every region of the globe, but it is most worrying in the drylands of South America, Asia, and Africa, where 18.5 per cent (870 million hectares) of productive lands are severely desertified and completely denuded of vegetation.\*/ The most extensive desertification occurs in the rangelands, where 82 per cent of the land surface is moderately to severely desertified.\*/ Of the drylands in the developing countries, the Sahelian-Sudano zones of Africa and, to a lesser extent, the countries to their south suffer the most. In their arid and semi-arid lands are to be found 80 per cent of the moderately affected and 85 per cent of the severely hit people \*/

49. In 1983, annual losses in production due to desertification were estimated at US\$26 billion. Land no longer producing as a result of desertification or degraded to desert-like conditions continues to grow at an annual rate of 6 million hectares.\*/ Each year, 21 million additional hectares provide no economic return because of the spread of desertification.\*/ These trends are expected to continue although there will be local improvements.

50. Deserts are the results of natural processes which have been accelerated by the rapid growth of both the human and animal populations, detrimental land-use practices (especially deforestation), adverse terms of trade and civil strife. Thus a preference for cash crops has led to the utilization of unsuitable rangelands for this purpose and has forced herdsmen to rear their cattle on marginal lands. The unfavourable international terms of trade for primary

products and the policies of aid donors have reinforced government-engineered pressure for increasing cash-crop production at any cost.

51. A Plan of Action drawn up at the 1977 United Nations Conference on Desertification has led to some slight, mainly local gains.<sup>\*/</sup> On the whole, realization of its goals is hampered by lack of financial support from the international community; inadequacies of the regional organizations established to respond to the local nature of the problem; and the lack of involvement of local, grassroots communities. The root of the problem lies in the fact that the plan of action does not extend to the causes and deals largely with effects.

### III. THE CHALLENGE

52. The challenge facing governments today is to meet the increase in food demand in a manner that alleviates poverty and protects the resource base. This will require measures to reduce the unwanted surpluses of the developed market economies, to shift the focus of production to enable food-deficit countries, regions, and households to produce much more, and to improve opportunities for economic access to food.

53. The projected growth in food demand has two main sources: population increase and changing consumption patterns. In the remaining years of this century, about 1.4 billion people will be added to the human family (see Chapter 4). Rising incomes may account for 30 to 40 per cent of the increased demand for food in developing countries and about 10 per cent in developed countries.<sup>\*/</sup> In many cases these income increases are accompanied by wasteful consumption patterns amongst the economically

better-off. This unprecedented pressure means that over the next few decades, the global food system must be managed to secure 3 to 4 per cent annual increases in production.

54. A focus on global production is not enough. The food security problem arises from the growing imbalance between the geographical patterns of food production on the one hand and population and income growth on the other. Global food security depends on shifting the focus of production to those continents and countries where it is most needed. Many of these countries possess the largest remaining reservoir of untapped agricultural resources. Latin America and the sub-Sahara are especially well endowed with land resources, although aggregate figures mask the high variability of land quality between the land-abundant and land-short countries and the quality and vulnerability of the unexploited arable lands.<sup>\*/</sup> The Soviet Union and parts of North America have some significant amounts of frontier land left that is suitable for agriculture; only Asia and Europe are truly land-starved regions.

55. Global food security also depends on ensuring access to food by all, even the poorest of the poor. While on the world scale this challenge would require a re-appraisal of global food distribution, the task weighs more immediately and heavily on national governments. Inequitable distribution of production assets and lack of access to income-earning activities by the poor are at the heart of the problem of hunger in many countries.

56. Rapid agricultural development is crucial both to generate the livelihoods necessary to purchase food and to increase its availability. In view of this, when countries with untapped agricultural resources respond to rising food demands by increasing food imports, effectively they import unemployment. They add to marginalization and to destructive pressures on the resource base. Shifting production to

food-deficit countries and to the resource-poor farmers within those countries is a way of meeting the challenge of sustainable livelihood security.

57. Conservation of the agricultural resource base and security of sustainable livelihoods through resource entitlements for the poor, are interlocked and can be mutually supportive in three ways. First, secure resources and adequate livelihoods lead to good husbandry and sustainable management. Second, it eases rural-to-urban migration, stimulates agricultural production from resources which otherwise would be underutilized and reduces the need for food to be produced elsewhere. Third, by combating poverty, it contributes to the stabilization of population.

58. Shifting the focus of production to food-deficit continents and countries will also reduce pressure on agricultural resources in the industrialized market economies and enable a transition to more sustainable agricultural practices there too. Incentive structures can be changed so that they encourage farm practices that sustain and even enhance the soil and water base for agriculture. At the same time, the budget burden of subsidies for the storage and export of surplus products can be reduced, if not eliminated.

59. The shift in agricultural production to food-deficit countries, regions and households will be sustainable only if the resource base is secure. As indicated in the previous section this is far from the case today. If global food security is to be achieved, it is essential that the resource base for food production be generally sustained and enhanced and, where it has been diminished or destroyed, restored. This will require a steady reorientation of the global and of national food systems, bringing ecological and social considerations to the centre of decision making on economic, trade, agricultural, and food policy generally.

#### IV. STRATEGIES FOR SUSTAINABLE FOOD SECURITY

60. If the food security challenge is to be met through the year 2000 and beyond it will be necessary to marshal and utilize the human and natural resource potential in the most effective and efficient way possible. The experience of the past several decades demonstrates clearly that this requires more than "good" programmes which can be, and usually are, overridden and undermined by inappropriate agricultural, economic, trade and other policies. These policies are now "ecologically blind" in their conception, funding and implementation. They must be given "ecological eyes". A strategy for sustainable food security must go beyond the narrow matter of adding an environmental component to projects and programmes. It must be based on a broader perspective that takes into account all the policies that bear upon the threefold challenge of shifting production to food-deficit countries, regions and households, ensuring livelihood security for the rural poor and conserving the resource base.

##### 1. Promote a Global Perspective

61. Strengthening the environment and development foundations of food security from a global point of view, requires a series of steps that would, among other things, reduce incentives that force over-production and non-competitive production in the developed market economies, and would do the opposite in developing countries. This will require a difficult shift to thinking globally about a sector that is deeply intermeshed with the world economy.

62. Trade in agricultural products tripled between 1950 and 1970; and it has doubled since then. Yet, when it comes to farming, countries are at their most conservative,

continuing to think in strictly local or, at best, national terms and concerned, above all, to protect their own farmers at the expense of competitors. The recognition of a common interest in orderly trading patterns, always weak, has now almost disappeared under the pressure of contradictory policies.

63. The incentive driven surpluses in the developed market economies have led to increased pressures to export these surpluses at subsidised prices or as food aid. Food aid is undoubtedly essential in an emergency situation. It does little, however, to prevent starvation after the emergency has ended. Coupled with low-priced imports, food aid depresses prices paid to local farmers, and makes it easier for governments to relax in their efforts to develop agricultural infrastructures. Donor and receiving countries should consider the impact of aid and use it for long-term objectives by, for example, channelling some of it to food-for-work programmes to restore degraded lands. It can also be used to purchase surpluses from small-scale producers and stimulate their increased production.

64. In many developing countries trade policies are skewed against food security. In fact, these countries are net food exporters in the wide sense. Certain items such as beef and fish go to feed the very people in developed countries on whom they depend for their grain. Third World countries and regions must reappraise their policies on international food trade and address the contradictions they create. It may well be sensible for some countries to export some forms of food and import others, provided that in this process they are able to protect the interests of poor producers and consumers.

65. A shift in food production towards food deficit countries will require a major shift in trading patterns. However the search for more rational production and trade

patterns is overshadowed by forces that would maintain the momentum of existing processes. Countries must move towards more open trade policies, recognizing that all parties lose through protectionist policies, which reduce trade in food products representing genuine comparative advantage. And they must begin by redesigning their trade, tax and incentive systems against criteria that include ecological as well as economic sustainability and genuine international comparative advantage.

66. International trade in agricultural inputs and technology transfer also needs to be subjected to sustainability criteria particularly in the case of products and technologies harmful to humans, animals, or plants. Each country should apply suitable controls and safeguards on the export of agricultural inputs and technologies which are banned or restricted in use within its territory. Beyond this, a measure of international regulations is also necessary when the harmful consequences spill over national boundaries.

## 2. Reorient Government Intervention

67. Government intervention in agriculture is the rule in both developed and developing countries and it is here to stay. Public investment in agricultural infrastructure is universal. The existence of this infrastructure, along with agricultural research and extension, assisted farm credit and marketing services and a range of other support systems can take much of the credit for the successes of the last half century. The weakness of agriculture in much of Africa, Latin America and some other developing countries stems in large part from the weakness of these systems.

68. Intervention has taken other forms as well. The management of virtually the entire food cycle -- inputs and outputs, domestic sales, exports, public procurement,



storage and distribution, price controls and subsidies -- has been common in most countries. So have various forms of regulation of land use, acreage, crop variety, etc. Some of these interventions are part of a long-term strategy to build up the productive base of agriculture. Others, particularly those involving tax relief, direct subsidies and price controls, are the cumulative result of annual responses to short-term pressures. In recent years, in many developed countries, these systems have lost whatever coherence they may have had. They are now studded with contradictions that encourage the degradation of the agricultural resource base and, in the longer run, cause more harm than help to the agricultural industry.

69. In the centrally planned economies, while the subsidy incentive to individual farmers is absent, fertilizer consumption, as that of other chemicals, has been increasing at a higher rate than in the market economy countries. The disastrous effects to the soils and ground-water aquifers are as alarming, while damage to surface water is threatening the water-based ecosystems. Clearly, planners would have to evolve policies which, while moving nearer to the goals of food self-reliance, do not damage the agricultural resource base or the health of the human resource.

70. In developing countries, the resource base is under sustained attack, but the causes are different. Subsistence requirements often compel foodgrain production even when it is not optimal. Small farm size results in many "externalities," from farm practices that induce erosion and from the use of pesticides. Major gaps in infrastructure and support systems make it difficult for farmers to switch to more optimal cropping patterns, while unsolved problems of land tenure and land distribution lead to the marginalization of small holders and to improper land use.

71. Market interventions in developing countries are often ineffective for lack of an organizational structure for procurement and distribution. Farmers are exposed to a high degree of uncertainty, and price support systems have often favoured the urban dweller or are limited to a few commercially oriented crops, leading to distortions of cropping patterns that add to destructive pressures on the resource base.

72. From the point of view of sustainability these patterns of government intervention suffer from three principal defects. First the criteria which underlie the planning of infrastructure, research and extension, incentive schemes, etc. lack an ecological orientation and are often dominated by short term considerations. Accepting that agricultural policy must serve a range of interdependent political, economic and, in the future, ecological goals, these criteria must be modified. They should be augmented by some new sustainability criteria designed both to discourage farm practices that reduce the quality of the environment and encourage practices that at least maintain and preferably enhance the quality of the land and its associated forests and waters.

73. The second defect in the current approach is that agricultural policy tends to operate within a national framework with uniform prices and subsidies, standardized norms for the provision of support services, indiscriminate financing of infrastructure investments, etc. A measure of spatial differentiation in agricultural policy to ensure that it encourages farmers to adopt practices that are ecologically sustainable in the region. Thus priorities for research and extension and policies governing the location and financing of land development and irrigation schemes, of agro-processing facilities, of colonization schemes and the establishment of marketing networks need to be given an ecological dimension.

74. The third defect is the tendency in many developing countries to neglect the special requirements of small farmers, particularly women, and the needs of ecologically disadvantaged regions where poverty is concentrated. In the pursuit of rapid production growth infrastructure investments and support systems are directed largely towards large farmers and well-endowed areas. This neglect of the majority of rural households has to be corrected...Hence the Government intervention must also involve measures to provide greatly increased access to land and other assets such as water, credit, and new technology by small and resource-poor farmers.

75. The reorientation of policy must be accompanied by a change in the criteria used to evaluate policy and monitor performance. At present these criteria focus attention largely on production and input use. They need to be widened to cover the impact on the agricultural resource base. In order to do this each nation should strengthen its capability for monitoring the use of basic agricultural assets like land and water at the national, sub-national and local level. The eco-system concept should be built into the methodology and hierarchical structure of such a monitoring system.

### 3. Sustain and Enhance the Resource Base

76. Agricultural production can only be sustained on a long-term basis if the resources of land, water and forests on which it is based are not degraded. The reorientation of public intervention suggested in the previous section will provide a framework for this purpose. However more specific policies are required to protect the resource base for agriculture so as to maintain and even enhance agricultural productivity and the livelihood base of all rural dwellers.

### 3.1 Promote the Best Use of Land

77. The initial task in enhancing the resource base will be to delineate broad land categories. Enhancement and restoration areas are the two major categories, but equally important are prevention areas. Enhancement areas may include land capable of sustaining intensive cropping, and higher population and consumption levels, but with a potential for increased productivity and yields. Restoration areas (discussed later in this chapter) consist of land which has been stripped of vegetative cover and whose productivity has either been totally lost or drastically reduced. Prevention areas are those that by common consent should not be developed for intensive agriculture or where developed, should be converted to other uses (see Chapter 9).

78. Land can be identified according to notions of "best use" only when the required information is available. Most industrial countries possess detailed inventories of their lands, forests, and waters describing surface and subsurface characteristics, soil quality, and relationships to the watershed in which they are located. Most developing countries do not yet have such detailed inventories, but they can and should be put in place rapidly. Indeed, improving the data base for agricultural planning at national, regional, and local levels is one of the priority areas for action. Satellite monitoring and other rapidly evolving techniques should both reduce the time and cost of such programmes and greatly increase their usefulness. (See Chapter 10)

79. The politics of selection, ranging from farm unit to watershed, could be facilitated by making it the special responsibility of a select board or commission involving outstanding representatives of the interests involved, especially, in the case of developing countries, the poor

and more marginalized segments of the population. The entire process must be essentially public in character with publicly agreed criteria. In particular, the criteria must combine the best use approach with the level of development required to sustain livelihood.

80. The classification of land according to best use should form the basis for regional and even local variations in infrastructure provision, support services, promotional measures, regulatory restrictions, fiscal subsidies and other incentives and disincentives. For example

- \* In areas that are potentially subject to wind and water erosion, public intervention through subsidies and other measures should encourage farmers to adopt practices that conserve soil and water
- \* For land that is located over recharge areas for underground aquifers that are subject to nitrate pollution, incentives might be introduced to induce farmers to adopt ecologically acceptable forms of maintaining soil fertility and increasing productivity.
- \* In areas where pest resistance to chemicals has become, or will become a problem, measures should be introduced to encourage the development and adoption of community-wide systems of integrated pest management.

81. The promotion of an appropriate cropping pattern is crucial for ensuring the best use of land. In many developing countries the drive to increase agriculture's contribution to national economies, particularly as a source of foreign exchange, has intensified the production of cash-crops, often without considering the soil's capacity to support the crops or the crops' ability to contribute to soil's sustainability. Moreover, survival dictates on the

part of farmers have led to the need to concentrate on the most profitable cash-crop year after year, whereas rotation with a food crop or green manure could be of longer-term advantage. In some cases, government-sponsored projects have fallen into this trap themselves. Governments and farmers need to work together to insist on growing crops suitable to the given soil's capacity and sustainability.

82. Lands identified as prevention areas through participatory processes should be denied all forms of support and subsidy that would encourage their development for intensive agriculture, whether through bringing grasslands under the plough, felling upland forests or clearing designated wetlands and estuaries. Such areas, on the other hand, might well support certain forms of use on an ecologically and economically sustainable basis: for example, grazing, fuelwood plantations, fruit farming, forestry etc. Agricultural policy is seldom designed to encourage this since it focuses attention on only a few crops. In redesigning systems, attention should be focused on a broader range of crops, including those that enhance grazing, soil and water conservation, etc. This could help to convert hundreds of millions of the most erodable hectares to ecologically and economically appropriate uses more effectively and efficiently than any number of soil and water conservation plans.

### 3.2 Restore Destroyed Lands

83. There are vast areas today where land-use practices have reduced productivity to a point too low even to sustain farmers at the subsistence level. They include land from which the vegetative cover has been removed to such an extent that they are subject to degrees of accelerated erosion and water run-off. Not only are these lands unproductive but they also reduce production on adjacent and downstream areas through, for example, the creation of flash

floods and the siltation of rivers and reservoirs, and "desertification creep".

84. The type of treatment for areas to be restored would, of course, vary with the site. Three generic methods, or combinations of these, are generally employed:

- i) protection of the area in order to permit the natural regeneration of the vegetation;
- ii) the establishment of vegetation (trees, shrubs, grasses etc.) through planting; seeding etc.; and
- iii) the construction of bunds, terraces, etc.

85. Protection measures are often difficult to implement in areas in which there are large herds of animals or large numbers of people. In these areas the agreement and participation of the local people are of the highest importance. The State could declare such areas national reserves and use its normal machinery to ensure that they remain protected. In such instances they would be treated as if they were forest reserves. Where these areas are privately held, the State might wish either to purchase the land from the owners or to provide incentives to them for its non-use. Similar measures may be adopted in those restoration areas on which vegetation is to be planted, terraces to be constructed, etc.

86. In all categories of restoration areas, including deserts, Governments should give priority to establishing a national policy and multi-disciplinary programmes and to creating or strengthening institutions for implementing such programmes. Where these already exist, they should be better co-ordinated and better designed. The current UN Plan of Action to Combat Desertification is a strategy already in place that requires more concerted and committed

support, particularly financial. People's participation should be encouraged so that the programmes formulated are able to attract the support and self-restraint of those most directly affected.

### 3.3 Improve Water Management

87. Along with land, water is the most basic of agricultural resources. Improvements in water management are essential not merely to raise agricultural productivity but to reduce land and water degradation. The two critical issues here are the design of irrigation projects and the efficiency of water use in the field.

88. Many countries now realize that big dams perhaps pose more problems than they solve. Where irrigation systems have not been developed, such as in much of Africa, emphasis must shift away from major reservoir-based irrigation toward small scale irrigation. This has the added advantage of involving local people in planning, design, construction, and direction. Chances of disease are also minimized. Thus, the socio-economic interests of people, the supposed beneficiaries, would be assured on a more sustainable basis.

89. The broad objective of irrigation projects must be to maximise the productivity per unit of land in areas where water is not scarce and the productivity per unit of water where it is. However these broad objectives have to be pursued in the context of local topography and soil conditions which will define the amount of water that can be used without endangering soil quality. Salinization, alkalization, and waterlogging can be avoided with careful attention in the planning and execution stages of the scheme to measuring the amount of soluble salt in the soil at the beginning and at the end of the project, the rate of leaking, and the rate of salt accumulation in the soil. The

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risks of excessive water use can be reduced by a more careful approach to the fixation of cropping patterns, regulating the quantity of water supplied and more rational water charges.

90. A major problem of water use in some areas is the excessive draught on groundwater supplies leading to a lowering of the water table. This is a case where private benefits are realised at a cost to society. In areas where the demand for water could well exceed the recharge capacity of local aquifers a measure of regulatory or fiscal control becomes essential. The conjunctive use of groundwater and surface water can also help to improve the timing of water availability and the draught on scarce supplies.

#### 3.4 Develop Alternatives to Chemicals

91. The indiscriminate use of chemicals is a major source of environmental degradation and hazard to human health in many parts of the world. In many cases the responsiveness to chemical inputs has also reached a plateau. In these areas alternatives to chemicals need to be developed and extended. However there are many other parts where this is not the case and where chemical fertilisers and pesticides need to be promoted in order to enhance yields. In the short to medium-term, chemical fertilizers may be seen as a basis for increased yields, particularly in developing countries. But in the medium to the long-term, agricultural systems worldwide should see organic and inorganic sources of plant nutrients used increasingly to complement one another, with gradual and greater shifts to organic sources.

92. Chemical fertiliser and pesticide use attracts subsidies in many countries. In practice subsidies end up promoting chemical use precisely in the more commercially oriented agricultural areas where chemical use may already be excessive in relation to environmental capacity. Hence  
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the first step must be to reorient policies which regulate and promote chemical use and ensure that they are regionally differentiated

93. The legislative and institutional framework for controlling and regulating agro-chemicals must be greatly strengthened. In developed countries, where such systems are already in place, they must be provided with structural autonomy, ensuring that they are not subordinate to ministers and senior officials whose overriding aim is to increase next year's yield. Developing countries must possess the basic legislative and institutional instruments to manage the agricultural use of chemicals within their countries.

94. Alternative strategies (see Box 5-2) require a higher priority and, most of all, a change of public policies that now encourage the spread of pesticides and fertilizer. In order to do this, the legislative, policy, and research capacity for advancing non-chemical strategies must be established and sustained.

BOX 5-2

Natural Systems of Nutrient Supply and Pest Control

- \* Crop residues commonly burnt in fields and farmyard manure are potentially significant sources of soil nutrients.
- \* Organic wastes reduce run-off, increase the take-up of other nutrients, and improve soil's water-holding and erosion-resistance capacity.
- \* Properly managed organic food production can produce up to 90 per cent of the yield per acre of agriculture with chemical inputs, but at 66 per cent of the energy cost.
- \* Developing countries can register lower production costs when the manure of cattle, pigs, or chickens is used, especially in conjunction with intercropping and crop rotation.

(Box 5-2 continued)

- \* Overall systems efficiency is enhanced if manure or vegetable biomass is anaerobically digested in biogas plants, yielding energy to run pumps, motors, or electric generators.
- \* A comprehensive composting or biogas programme throughout developing countries could provide 50 - 100 million new jobs.
- \* Integrated pest management (IPM) reduces the need for inorganic fertilizers, improves a country's balance of payments, releases foreign exchange for other development projects, and creates jobs where they are most needed.
- \* IPM requires detailed information about individual pests and their natural enemies, seed varieties tailored to pests in different areas, integrated cropping patterns, and farmers who are fully support the approach and are willing to modify farm practices to interrupt pests' life cycles.

Sources: \_\_\_\_\_.

### 3.5 Integrate Forestry and Agriculture

95. Forests can be used to provide, at one and the same time, a multiplicity of goods and services. The broader issues of forest policy are dealt with later in this report. (See Chapter 9). From the point of view of agriculture forest policy should be based on an analysis of the inherent capacity of the land under forests to perform various functions. Scientific land capacity classification would reveal which land would need to be under forest cover and which could be used for various other types of economic activity. On the basis of the land capability classification, the integrated management of forests might provide: a portion of land for annual crops under intensive cultivation, a portion for permanent crops, a portion for livestock, low-quality land for agro-forestry and, where necessary, areas devoted exclusively to the provision of such forest services as water regulation.

96. Agro forestry can significantly reduce deforestation: It reduces the need to convert forest into agricultural land and pastures, and provides farmers with the means to produce their own firewood, timber, fertilizer, fodder, building poles, and other forest products. Agro forestry systems are well suited for the production of food and fuel by small-scale and resource-poor farmers. One or more tree crops are combined with one or more food crops or animal farming on the same land, though sometimes at different times. Well chosen crops reinforce each other and yield more food and fuel than under separate systems. Agro-forestry has been practised by traditional farmers everywhere. The challenge today is to revive the old methods and adapt them to the new conditions, in addition to developing some new ones.

97. International forestry research organizations should be established as soon as possible, in various tropical countries in selected ecosystems, along the lines now followed by the Consultative Group in Agricultural Research (CGAR) and where they exist, such as ICRAF, be strengthened and included in CGAR networks. These research organizations should specifically undertake work in agro-forestry and should attempt to develop models that would more precisely foretell what would be the effect on water and soil loss, for example, of removing portions of forest cover in specific locations. The interrelationships of forests and agriculture should also be examined in these organizations, and forestry's role in increasing agricultural production should be given greater emphasis in research.

98. Genetic improvements have raised agricultural yields throughout the world. This growing understanding of the usefulness of genetic resources has created concern about the wanton destruction of habitats through deforestation.

Clearly, campaigns now in progress to conserve the biota in biosphere reserves and national parks are a matter of priority for national governments (see Chapter 9). In addition, efforts to preserve germ plasm in gene banks must be extended as a matter of urgency for the future of sustainable agriculture. Advances in molecular biology will promote this development of an integrated genetic conservations strategy. The technology is being developed should be shared with all governments, particularly research centres in developing countries.

### 3.6 Promote Aquaculture

99. Fisheries and aquaculture are critical to food security because they are a source of both protein and employment. Of the food production projected by the turn of the century, 10 to 15 per cent is expected to come from marine and inland fisheries.<sup>\*/</sup> (See Chapter 10) In addition, export of fishery products generates valuable foreign exchange.

100. The greater part of world fish supply comes from marine fisheries' which yielded 74.6 million tons in 1983, half of which was concentrated in the Northeast Atlantic and Northwest Pacific.<sup>\*/</sup> Landings have increased by 1 million tons per year over the past few years; by the end of the century, a catch of around 100 million metric tons should be possible.<sup>\*/</sup> However this is well short of the projected demand of 140 million tonnes and alternative resources in inland fisheries need to be developed.

101. With regard to fresh-water fisheries, there are indications that most of the fish stocks in man-made African lakes are fully exploited, except certain swamp areas in Botswana and Sudan. Overfishing, particularly with commercial trawlers, has caused serious damage in several large lakes. In Asia, although reservoir development has

increased fresh-water catches, some losses in production have been recorded mainly due to more intensive husbandry and increasing use of pesticides. Over enrichment and pollution have remained the principal causes of damage to European fresh water fisheries.

102. A substantial potential for meeting future needs lies in aquaculture, which differs from conventional fishing in that fish are deliberately reared in controlled water bodies. Yields from aquaculture have doubled during the last decade and now represent about 10 per cent of world production of fishery products.<sup>\*/</sup> A 5- to 10-fold increase is projected by the year 2000 provided the necessary scientific, financial, and organizational supports are available.<sup>\*/</sup> Aquaculture can be undertaken in paddy fields, abandoned mining excavations, small ponds, etc. It can be carried out at all levels of commercial scale - individual, family, co-operative, or corporate. The expansion of aquaculture should be given a high priority in developing countries and elsewhere.

#### 4. Increase Productivity and Yields

103. The conservation and enhancement of the resource base for agriculture will lead to substantial gains by way of higher production and productivity. However more specific measures are required to increase the effectiveness of input use in agriculture. The crucial task here is to strengthen the technological and human resource base for agriculture in the developing countries and improve the effectiveness of input use.

##### 4.1 Strengthen the Technological Base

104. A unique opportunity now exists for meeting basic human needs in nutrition and employment on a sustainable basis through a blend of traditional and modern technologies. Biotechnology including tissue culture

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techniques, technologies for preparing value-added products from biomass, micro-electronics, computer sciences, satellite imagery and communication technology are all aspects of frontier technologies that can enrich rural professions.

105. The potential opportunities offered by the new technologies can be made effective only if based upon strong and explicit national research priorities which should emphasize the generation of new knowledge and the adaptation of existing knowledge directed specifically to the amelioration and sustainability of agricultural production in the poor farmer sector. This would imply major changes in current research priorities in many Third World countries by addressing a gap unlikely to be covered by the current directions of global technological change.

106. Sustainable livelihoods for resource-poor farmers present a special challenge for agricultural research. Green revolution technologies, as applied at present, are better suited to stable, uniform, resource-rich conditions with good water supplies and soils such as the alluvial plains and deltas in much of Asia, parts of Latin America and small portions of Africa. Yet, new technologies for production and sustainable livelihoods are most urgently needed in sub-Saharan Africa, and the remoter areas of Asia and Latin America, which typically have less reliable rainfall, uneven topography and poorer soils.

107. In order to serve these areas and the needs of resource-poor farmers, agricultural research has to be more differentiated and sensitive to farmers' conditions and priorities. This needs decentralization and new roles for scientists that will enable resource-poor farmers to articulate their priorities for research. Researchers must learn from workshops of farmer innovators. The key lies in adaptive research on the farm, using research stations for

referral, with eventual evaluation by the farmers. The new challenge is the joint development and adaptation of technology by farmers and scientists together.

108. There is a big gap between knowledge and its utilization because the worlds of the 'giver' and the 'receiver' are apart. Knowledge must reach the poor in a form and a language that is related to the experience of the world they live in. This implies an understanding of the context in which knowledge can be used and applied. Special attention needs to be paid to make knowledge usable, and for this purpose two-way "laboratory to land" and "land to laboratory" programmes are needed.

109. The framework for agricultural research and extension has to be provided by essentially public institutions. Many academic and research institutions in developing regions are underfunded. The problem is most acute in the low income countries where expenditure on agricultural research and extension amounts to 0.9 per cent of total agricultural income as against 1.5 per cent in the middle income countries.<sup>\*/</sup> It is essential that the research and extension effort be greatly expanded, particularly in institutions which deal with ecological problem areas.

110. Commercial enterprises can play an important role in specific areas of technology development and diffusion. However the basic objective of ensuring access must not be forgotten. An important case relates to the patenting of new seed varieties. At present 55 per cent of plant genetic resources are controlled by institutions in developed countries, 31 per cent by institutions in developing countries and 14 per cent by International Agricultural Research Centres.<sup>\*/</sup> This genetic material is drawn to a large extent from the developing countries. Commercial interests seek proprietary rights to improved seed varieties without recognising the rights of the countries from which the original seeds were obtained. This could lead to a



decline in the exchange of genetic material and reduce the options available for seed development both in developed and developing countries. Moreover the gap in genetic research capabilities is so wide that agriculture in the developing countries could become excessively dependent on private gene banks and seed companies in the developed countries. In view of these considerations international cooperation and a clear understanding on the sharing of gains is vital in critical areas of agricultural technology like the development of new seed varieties.

#### 4.2 Build up human resources

111. The technological transformation of traditional agriculture will be difficult without a matching effort at human resource development (see Chapter 4). One aspect of this strategy entails reforming educational systems so they will produce scientists more attuned to the needs of rural peoples and agriculture. Educational programmes can also provide a vital link between researchers and producers by helping young people to act as agents of change.

112. Illiteracy is still widespread among the rural poor. Hence, along with efforts to promote formal literacy, technical literacy in relation to land use, water and trees should be imparted. Non-formal education centres, indigenous dramatic forms and the modern mass media should all be used in the spread of this knowledge, essential to promoting harmony in the human environment.

113. In the rural schools, the core of the curriculum must reflect the knowledge the child must acquire for better understanding and management of his local resources and for survival. If knowledge is to be relevant, the curriculum must include information about local soils, water and its conservation problems, deforestation and the role of the community and individual intervention in its destruction or

revival. The teachers must be trained in required knowledge and the curriculum developed with field needs to link school education with the agricultural balance sheet of the area. Children should learn the "assets" and "liabilities" aspects of the agricultural balance sheet of their village/region so that, from early childhood, they become aware of the need to improve their natural assets and minimize the liabilities.

114. Women play a critical role in agricultural production. Yet their access to education and their representation in research, extension and other support services for agriculture is woefully inadequate. Women should be given as many educational opportunities as men. There should be more female extension workers; and women should participate in field visits. Women's organizations should be promoted in decision-making regarding agricultural and forestry programmes.

115. Human resource development for food security must also involve efforts to keep workers in rural areas, where producers suffer from a shortage of labour. As labour-substituting technologies are far from widely available, human labour remains critical to a strategy of increasing agricultural production. Both wages and prices for agricultural products must therefore be maintained at levels where they will stimulate production and ensure workers' access to food supplies.

#### 4.3 Increase Input Productivity

116. In traditional agriculture energy, nutrient supply and pest control needs were met from local organic sources. With the growth of high-input agriculture these needs are increasingly met by electricity, petroleum products, chemical fertilisers and pesticides. The cost of these inputs forms a growing proportion of agricultural costs and wasteful use leads to harmful economic and ecological consequences.

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117. Agriculture is usually the least energy-consuming sector in national economies. Globally, it accounts for about 3.5 per cent of commercial energy use in the industrial countries and 4.5 per cent in developing countries.<sup>\*/</sup> Agriculture yields the highest economic and social returns for each extra unit of energy input. By increasing yields, or by intensifying and extending the use of farmland, energy inputs also greatly increase employment, especially for the landless and other segments of rural populations who need work. Hence the provision of energy for agricultural operations should have a high priority in energy development plans.

118. One of the most important energy-related needs, mechanical power for irrigation pumping is generally provided by electricity or petroleum products. There is a large potential for improving the efficiency of pumpmsets, particularly through small design changes to take local conditions into account. Energy for irrigation pumpsets can also be provided by windmills or by conventional internal combustion engines running on biogas produced from local biomass wastes or on producer gas from the gasification of wood or charcoal. These non-conventional organic sources should be promoted, particularly in areas which, otherwise, would be starved of energy.

119. Post-harvest operations such as processing, storage, and transporting also require energy. One of the major problems developing countries face relates to collection and storage of food, which can involve enormous wastages. In many countries harvesting coincides or is shortly followed by the clearest and hottest periods of the year. Development of solar dryers and solar coolers and refrigerators would go a long way to saving a lot of agricultural products. These systems are relatively cheap and can be developed at the local, and even household, level.

120. Sustainable agriculture will also require greater economy and care in the use of pesticides and chemical fertilisers. In the short term, food production increases of 3 to 4 per cent a year cannot be achieved without an increase in both. As mentioned earlier, many developing countries, particularly in Africa, still have reasonable tolerance ratios and can therefore increase their application without a threat to the resource base. However, a substantial part of the nutrient is lost when fertilisers are improperly applied. Often they leach away with the flow of water in a field and degrade local water supplies. Similar problems of waste occur in the use of pesticides. Hence extension systems and chemical manufacturers should undertake programmes to promote careful and economical use of these expensive and toxic materials.

### 5. Ensure Equity

121. The challenge of sustainable agriculture is not to raise just average productivity and incomes but the productivity and incomes of the resource poor. This compulsion is sharpened by projected population increases in many countries and regions which mean that in future, larger numbers will have to find their living in rural areas. To meet the challenge requires giving higher priority to special programmes of resource redistribution: land, livestock and tree reforms; preference for smallholders, including and especially women, in new land and irrigation development and in technology utilization; reinforcement of the rights of ownership and use of the poor; and the generation of better livelihoods for landless agricultural workers.

#### 5.1 Accelerate Land Reforms

122. In many developing countries, broad-based land reform leading to equity and new rural power structures is essential to sustainable increases in productivity and

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yields. The vast variety in land ownership, land use, farming systems, institutional structures, and ecological conditions throughout the world means that no universal approach to improved access to productive assets is possible. Because this would reduce the need for food imports, land reform would also have a favourable impact on a nation's balance of payments and debt, releasing capital for other development priorities.

123. Redistribution of land is basic. Without it, institutional and policy changes introduced to protect the resource base can actually worsen distribution, by serving the interests of a minority of large farmers who are better able to obtain the limited supplies of credit and other available services. In thus leaving hundreds of millions without options, such changes would have the opposite of their intended effect, ensuring the continued violation of ecological imperatives and the collapse of the development process.

124. Given existing patterns of land distribution, the number of smallholders and landless households would increase by about 50 million, to nearly 220 million by the year 2000.<sup>\*/</sup> Together, these groups represent three-quarters of the agricultural households in developing countries.<sup>\*/</sup> The required increases in food production need measures to ensure improved distribution of inputs and services to these groups.

125. Despite their importance for ecological and agricultural rehabilitation and enduring food security, in many countries women do not have direct rights in land and their access is curtailed by titles being provided to men only. In the interests of food security, land reforms should recognize women's crucial role in this sector. They should be given direct rights in land, especially where women are heads of households.

126. Small farmers are, in the main, not part of the power structures. Their experience and views on resource management and exploitation are not taken into consideration. The wealth of their knowledge and the critical role they will play in food security dictate that their participation be actively sought. Developing countries need to foster the concept of people's participation in decision making as a component of agricultural policy. Associations and clubs linked to central seats of power through local governments could be a means of achieving this.

## 5.2 Protect Subsistence Farmers and Pastoralists

127. Although subsistence farming is not a part of the commercial economy, it is a source of livelihood for many. Pastoralism is also an important activity in many developing countries, especially in sub-Saharan Africa. Many rural families depend on it for their livelihoods - as a direct source of food and as a source of income with which to purchase other foodstuffs, particularly grain.

128. Agricultural support systems seldom take into account the special circumstances of these groups. Subsistence farmers cannot afford a high cash outlay on modern inputs. In many cases they are shifting cultivators and often they do not have a clear title to the land that they use. Their choice of crops reflects their consumption requirements rather than the capacity of the land at their disposal. Thus they may plant a variety of crops on a single plot which makes it difficult for them to use methods developed for large scale mono-culture.

129. Pastoralists are, in the nature of things, more commercially oriented. However they are nomads and difficult to reach with the usual static systems for extension and input provision. They, like subsistence

farmers, are dependent on certain traditional rights which are threatened by commercial developments. Their herds are based on traditional breeds which are hardy but not necessarily highly productive.

130. Subsistence farmers are often seen as threats to the environment. This may sometimes be the case. However the aim of public policy must be to address the threat at its root by providing a sustainable livelihood for these groups.

131. In the first instance the traditional rights of subsistence farmers, particularly shifting cultivators, and pastoralists must be protected from encroachments. When their traditional practices lead to unsustainable pressures on the resource base, the rights could be curtailed but only when alternatives have been provided. In the long run most of these groups must be helped to enter the market economy on equal terms.

132. Support systems must reflect a phased programme of development for these groups. In the early stages the research system must pay specific attention to the varietal requirements of mixed farming which is typical in subsistence agriculture. Extension and input supply systems must become mobile and reach shifting cultivators and nomads where they happen to be at the moment. The cash income required by these households must be provided through employment programmes and some cash crop production. Public investment must be used to improve the cropland, grazing areas and water sources used by them.

#### 6. Provide Financial and Institutional Support

133. Regionally differentiated, ecologically oriented agricultural policies may constrain short-term and medium-term income potential in some areas and generate high earnings in others. The basic approach should be to compensate those whose earnings are constrained in the

interest of sustainability, and to raise the funds for this by cutting back on unnecessary subsidies to those who are not so constrained. This will require a redirection of existing programmes. But in developing countries major investments will be required, and sufficient financing will not come from such readjustments.

134. Only national governments and local people can take the fundamental actions needed to reverse the steady deterioration of the agricultural base. No outside assistance, however massive, can possibly substitute for these essential national actions. Nevertheless, the success of any strategy to put agriculture on an ecologically and economically sustainable footing in developing countries will continue to require external finance. Assistance is needed to invest in the agricultural development of raw lands in Africa and Latin America and in sustainable means of increasing yields and productivity; finance infrastructural needs, research institutes, extension services, and human-resource development; arrest current trends in erosion, desertification, deforestation, and degradation of the resource base; and promote understanding of approaches that do the most to ensure sustainable livelihoods.

135. Donor agencies and international institutions must place higher priority on projects that promote these objectives in their aid policies and programmes. Donor countries must take care that their support does not distort national and regional priorities. At the same time, agencies must co-ordinate their efforts in the interest of effectiveness and efficiency. Receiving governments and communities are now often stretched to the limits of their capacity in coping with the many well-intentioned helpers and projects.

136. The prevailing narrow view and objectives of both agricultural and environmental policy have been reflected in



the structure and the mandates of public and private institutions relevant to agriculture, especially in most developed countries. Often, the Ministry of Agriculture or Forestry has formal responsibility for soil and water conservation, forest protection, and watershed management. Since the late 1960s, some countries have created a Ministry of Environment with the responsibility for the conservation of nature, parts, and wildlife. In a few countries, the latter is a sub-agency of the former.

137. The institutional changes required must begin with recognizing ecological security as a priority goal of agricultural policy in all its manifestations. Reaching this goal will involve broadening and reinforcing the mandates of the economic, finance, planning, trade, and other central agencies of government, making them individually and collectively responsible for ensuring that policies enhance the ecological basis for food security in the short, medium, and long term.

138. The technical support and the information base required for an ecologically oriented agricultural policy will have to be provided on a regional basis, particularly when ecological causes and effects spill across national boundaries. This is very often the case and regional organizations should be strengthened by member governments with the help of donor countries where necessary. These organizations can monitor ecological and environmental development and problems on a regional basis and stimulate regional co-operation.

139. The goal of institutional change for enduring food security is to recognize ecological security as primary in agricultural policy in all its manifestations. This goal should be reflected in a strengthening of the agricultural, trade, and other relevant mandates of all appropriate international agencies.

## V. FOOD FOR THE FUTURE

140. The next few decades present a greater challenge to the world's food systems than they may ever face again. The effort needed to increase production in pace with an unprecedented increase in demand, while retaining the essential ecological integrity of food systems, is colossal both in its magnitude and complexity.

141. Today we have the knowledge that we need to conserve our land and water resources. New technologies provide opportunities for enhancing productivity and reducing the pressures on these resources. A new generation of farmers combine experience with education. With the resources at our command we can meet the needs of the human family. What stands in the way is the narrow focus of agricultural planning and policies.

142. The agricultural systems that have been built up over the past few decades have contributed greatly to the alleviation of hunger and the raising of living standards. They have served their purpose; but now they are riddled with contradictions. Today we need agricultural systems that focus as much attention on people as they do on technology, on resources as they do on production, on the long-term as they do on the short-term. If we can do this then we will be able to meet the challenge of the future.