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Centre for Protection and Improvement of Environment (Berlin) of the Ministry of Environmental Protection and Water Management of the German Democratic Republic in cooperation with the Technical University Dresden

Subject I: International strategies for the solution of basic natural resource problems of developing countries

STUDY MATERIAL
elaborated by a team of authors under E. Seidel

Volume One

I.1. International activity in the environmental aspects of natural resource development
Round-table discussion

Volume Two

I.2. UNEP's role and priorities for the rational use and protection of natural resources

Volume Three

I.3. Environmental education and training
Workshop

Volume Four

I.4. Concerted action to improve the world food supply

Volume Five

I.5. Interactions between ecology and world food production; other global problems and strategies

I.5.1. Ecology and world food production with special reference to developing countries

I.5.2. Interrelationship between population development and utilization of natural resources; importance of stable eco-systems on a world scale, and in developing countries, to meet the growing need for food

Volume Six

I.5.3. The contribution of environmental protection to increased efficiency in national economies (through long-term safeguards for national economic production processes) and to improved living and working conditions; social aspects, sanitation and housing in developing countries

I.5.3.1. The contribution to increased efficiency in national economies

Volume Seven

I.5.3.2. The contribution to improved working and living conditions
Colloquium
Round-table discussion

Volume Four

		Page
I.4.	Concerted action to improve the world food supply	5
I.4.1.	UN strategy and results of the World Food Conference by S. MÖNCH and W. GRAEWE	5
I.4.2.	The role of FAO in implementing projects in developing countries with an introduction by E. Seidel	32
I.4.3.	Development trends in food supply for developing countries by the year 2000 with an introduction by E. Seidel	35
Annex I:	World Soil Charter	78
Annex II:	FAO/UNEP Food Loss Prevention in Perishable Crops	86
Annex III:	The state of natural resources and the human environment for food and agriculture	99

I.4. Concerted action to improve the world food supply

I.4.1. UN strategy and results of the World Food Conference

by S. MÖNCH, W. GRAEWE

In the document on the International strategy for the Third Development Decade[1] adopted by all UN member-countries, measures to create an efficient system of global food security are dealt with comprehensively. Basically, this refers to eliminating hunger and malnutrition as a problem that has to be settled as soon as possible but by the end of this century at any rate[2].

This orientation reflects a recognition of the situation in food supply that is not satisfactory for large parts of the world population in contrast to the declarations of intention already given at the World Food Conference 1974. This is especially evident in the following:

1. Measures that had been proposed at the World Food Conference to improve food security and stipulated in various documents could not be taken, although 43 countries and the EC had declared their readiness already by the end of June, 1975 to adopt the objectives, strategies and guidelines contained in the International commitment on world food security as recommended by the Conference[3].

2. Food security seen as the security or the right of the individual to have food as required in the Declaration on eradicating hunger and malnutrition of the World Food Conference[4] was not better at the beginning of the 1980s than during the first years of the 1970s characterized by an aggravation of the food crisis in developing countries.

In view of the speedily growing world population and the concentration of this growth on developing countries, the struggle against hunger and malnutrition is gaining in importance increasingly. Its international position and importance is

especially based on its complexity, its interlocking with other global problems, especially as to comprehensive progress in the process of détente and disarmament, and with establishing favourable external and internal conditions for the construction of national economies and for eliminating socio-economic obstacles impeding the efficient use and reproduction of natural resources in developing countries. In this context, the UN document mentioned above points out the necessity to achieve concrete progress in the direction of general and complete disarmament by which essential resources could become available for social and economic development especially to the benefit of developing countries[5].

The urgency of implementing political and institutional reforms to achieve perceptible economic and social progress in developing countries is given far more emphasis in the development strategy for the 1980s than in the respective document covering the preceding decade. This was also pointed out by the Executive Director of the World Food Council who designated the strategy for the Third Development Decade as an essential component of continuous efforts to establish the New International Economic Order aimed at achieving this objective and thus at creating full sovereignty of all states over their resources and economic activities. This requires the comprehensive participation of developing countries on an equal footing in the formulation and use of all activities aimed at far-reaching changes in the existing institutional system[6]. Special emphasis is attached to the political struggle of developing countries for a New International Economic Order by interlocking the tasks, objectives and measures of the Strategy with the necessity to reshape the international economic relations.

Progress made in implementing the conception of a New International Economic Order will show positive effects on improving the food supply in developing countries definitively. They promote and stimulate the development of domestic resources

for agricultural and food productions. In this context, the World Food Council requires political action at four different levels in order to overcome the crisis-like situation in the food supply sector in developing countries[7]:

1. To introduce national food strategies, food plans or systems and their implementation in the sense of appropriate food production and consumption;
2. To increase the contribution that international trade may provide to solve the food problem;
3. To establish a complex of measures in connection with world food security;
4. To increase development aid and investments both in technological and financial terms substantially to support the programmes of developing countries.

In all documents, specific importance is attached to the national activities of developing countries aimed at increasing food production and improving food supply. Domestic activities and responsibilities cannot be replaced by international measures to achieve food security. They are to be seen primarily as supporting measures to provide assistance to national development programmes or to overcome acute national or regional food supply crises.

Food security begins at the local level, and it is linked with the social problem whether peasants without land or with little land have access to land, the most important means of production and favourable production credits instead of being dependent economically and technologically on international monopolies cooperating with usurers, whether the mass of the rural population takes part in the implementation and determination of the production process, whether preconditions for stock-keeping are established at the local level and whether they succeed in putting an end to the process of the increasing involvement of important parts of agriculture in developing countries in the food supply complex of industrialized countries in the sense of ensuring food supply for the strongly expanding population in these countries primarily.

Food supply dependence in the sense of dependance on food imports from private international companies or trusts always brings about political and economic dependence. The way towards increased self-sufficiency in the field of food supply is also the way towards political and economic self-determination. This applies especially to countries with limited or unstable export revenues, that are subject to the manipulations by multinational corporations to an especially great extent. What matters is not the general reduction of agricultural export production; however, where this threatens the basis of domestic food security, this should be given further consideration.

The urgency of increasing the domestic food production in most of the developing countries becomes evident when the production development per capita in several countries is compared with the food supply situation in the same period. Table I.4.1. shows changes in the per capita production in the period from 1972/74 to 1980 and the food energy per capita available on the basis of latest comprehensive FAO calculations for the average of the years 1972/74. The demand on energetic food expresses the energy consumption in case of normal work; it is about 50 per cent higher than the 1,2fold basic energy consumption that may be designated as the critical threshold to acute hunger.

This means the satisfaction of the energy demand by less than 100 per cent - as shown in the Table for most of the countries - need not be linked with malnutrition when available food is distributed equally; however, this may exist only in a few countries.

Table I.4.1. does not provide concrete statements on the general availability of food in the countries concerned because foreign trade is not taken into account. However, it shows trends in connection with the fact whether and to which extent the development of domestic production contributed to

Table I.4.1. Availability of food energy in 1972/74 and growth rates in food production from 1972/74 to 1980 1)

Available food energy in 1972/1974 in per cent of demand	Growth rates in food production per capita from 1972/74 to 1980 in per cent					
	-1.1 and less	-1.1 to -0.1	0 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 and more
85 and more	Angola Mozambique Somalia Zaire Afghanistan	Tanzania AR Yemen PR Yemen Bolivia	Tchad Mauritania Upper Volta Bangladesh	Mali	El Salvador	Niger
86 to 90	Algeria Liberia Ethiopia Zambia Zimbabwe Haiti Jordan	Guinea Nigeria Sudan	Benin India	Botswana Philippines		Solomon Islands
91 to 95	Kenia Namibia Togo Uganda Honduras Nepal Kampuchea	Dominican Republic	Senegal Ecuador Pakistan Laos Indonesia	Guatemala Rwanda Swaziland	Colombia	Sri Lanka

contd./Table I.4.1.

Available food energy in 1972/1974 in per cent of demand	Growth rates in food production per capita from 1972/74 to 1980 in per cent					
	-1.1 and less	-1.1 to -0.1	0 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 and more
96 to 100	Zambia Ghana Iraq Peru Saudi Arabia	Sierra Leone Iran Papua Guinea	Venezuela	Gabun Tunesia Burma		
101 to 105	Congo Malawi Lesotho Lebanon Trinidad and Tobago	Burundi Madagascar Central African Republic Egypt Guadelope Guinea-Bissau Martinique	Guyana Panama	Cameroon	Thailand	Surinam Syria
106 to 110	Mauritus Morocco		Nicaragua		Brazil	
111 and more	Hong Kong	Jamaica	Cyprus Tonga Costa Rica Chile Mexico Uruguay	Ivory Coast Barbados Libya Turkey	Paraguay Reunion Malaysia Argentine Fiji	Malta Singapure

contd. Table I.4.1.

1) In case of a recession by ten points or more in the production indices of 1980 compared with the preceding two years, the average values for 1978/80 were used for 1980 (Guinea-Bissau, Mauritius, Senegal, Martinique, Nicaragua, Peru, Saudi Arabia)

Source: Calculated according to FAO Monthly Bulletin of Statistics July/August, 1981, p. 12/13 and FAO "The fourth world food survey", Rome 1977, p. 77-80.

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improving food security in various countries. Generally, a trend is reflected that was characteristic for the overall economic developments in developing countries in the last decade - increasing economic differentiation or the trend-like widening of the gap between the least developed countries and the so-called threshold countries or those in transitional stages.

The increase in domestic food production is of prime importance in those countries where prospects of a strongly increased demand on food imports occurred with maintaining long-term development trends in production. According to calculations made by the Research Institute of International Food Policy, one has to expect the following food deficits in 1990 (domestic food production compared with required consumption, expressed in grain equivalents): 44 to 46 per cent in the Sahel zone, 35 to 39 per cent in Nigeria, 30 to 35 per cent in Bangladesh, 32 per cent in Egypt, 26 to 28 per cent in Ethiopia, 11 to 13 per cent in the Philippines and 10 to 12 per cent in India that achieved self-sufficiency at the end of the 1970s. For India and Nigeria, this implies, for example, grain imports of 17 to 22 million tons respectively[8].

A characteristic feature of the development of food production in most of the developing countries are production fluctuations that are rather great in some cases. Due to the given food level, small regressions in production may bring about essential deteriorations in the food situation among the underprivileged strata of the population. This is an essential

reason why it is necessary to take measures on an international scale in order to improve food security. Great harvest fluctuations especially occur in countries or regions situated in semi-humid to arid tropical areas, if irrigation farming doesn't play the dominating role. In addition to climatically conditioned regressions in harvesting, however, economic factors like the drastic increase in prices for mineral fertilizer and plant protective agents in the middle of the 1970s, for example, may also bring about considerable regressions in production and in harvesting when developing countries, due to the lack of the domestic production of mineral fertilizer and plant protective agents, are dependent on their import from countries with free market economies.

In the second half of the 1970s, food production per capita decreased from one year to the other in several countries; examples are Algeria, Jordan, Saudi Arabia and Guinea-Bissau by more than 20 per cent, Gambia, Ghana, Botswana, Zambia, Peru and Iraq by 10 to 20 per cent, India, Bangladesh, Kenia, Egypt, Tchad, the People's Republic of Congo and many other countries by 5 to 10 per cent within a period of two years[9].

The International strategy contains necessary measures to be taken by developing countries with the powerful support by the international community in order to approach national self-sufficiency and collective self-reliance as quickly as possible[10].

The use of the term "collective self-reliance" in the UN document mentioned above is to be seen in the context with the programme of the same title, adopted by the representatives of the Group of 77 at their preparatory meeting for UNCTAD V in February 1979[11]. As to the food problem, this has to be seen as increased cooperation by countries in a region in the fields of food production, trade and food security. First attempts to organise such a cooperation have already been made in Africa, Asia and Latin America. The initiators of "col-

lective self-reliance" hold that this also covers an increased readiness to make investments by countries with a surplus in balance of payments to other developing countries.

As to necessary socio-economic changes, the UN document reads that the possibility of implementing agrarian land reforms is to be taken into due account as this is one of the most important means to stimulate agricultural production and rural development in harmony with priorities and plans of each developing country. Programmes are to be given priority that transform institutional structures in such a manner that the increased and equal access to soil and water resources as well as efficient farming ... is made possible in the interest of the country[12] because this is the only way to use natural resources efficiently and to ensure their protection with growing production because it is the proprietors who make the farming and who must think of future generations. This requires the cautious use of soil and water, the most important natural resources of farming.

According to information by the World Food Council, a great number of developing countries, international aid organisations and industrialized countries agree with the proposal of the WFC to involve all measures necessary for improving the food situation in a "food strategy" or "integrated national food planning". First meetings of representatives of African and Latin American countries with the aim of elaborating such food strategies took place in November 1980 and February 1981. Such a planning to be integrated into the overall complex of state development measures must specify, stipulate and control various political, economic and social tasks and decisions in the sense of short-term or long-term objectives. What matters in this context is not only to use existing investments available means and resources, to develop rural areas purposefully, to introduce new production procedures, to transform existing farming structures, to implement specific food programmes for especially threatened population groups

or to establish prices for agricultural products in line with domestic demands but also to overcome socio-economic structures and institutions impeding the development, to change tradition-conditioned ways of conduct in the process of education and training, and to create conditions that make it possible that a large number of peasants without land or with little land may assume responsibility in taking part in the processes of economic and social development.

Within food strategies, the harmony between production structures and consumption structures is to be given special attention. Growth rates of selected food cultures or food products in the 1970s may easily be used to show examples for regions of developing countries where the strong promotion of production fields did not improve domestic food supply but export expansion (see Table I.4.2.). This applies, for example, to enforced production increases in soybean (Brazil), palm oil and copra (Philippines, Malaysia) or sugar (various Asian countries) as well as the increased export of fruit, vegetable and meat from Latin America to the United States as an example of the increased involvement of important parts of Latin American agriculture in the US food system.

As to domestic food security, problems were created due to the completely insufficient development of the production of pulse in all regions as well as tuberous plants and root plants in Latin America and Africa or millet and also barley in Africa, the Middle East and Far East.

The strategy of the Third Development Decade points out that the 1980s will be a decade prone to crises and thus measures to establish an effective world food security have to be taken in addition to the prevailing development of food production in developing countries. Right from the beginning of the decade, urgent measures have to be taken in order to establish an efficient system of global food security[13]. The view of different UN bodies is that world food security can be im-

Table I.4.2. Annual growth rates of selected food cultures and food products in per cent from 1969/71 to 1980

	Africa	Latin America	Middle East	Far East
Grain	1,0	2.4	3.0	3.0
wheat	0.4	2.2	4.2	4.6
rice	2.5	4.3	0.0	3.1
maize	0.9	1.8	2.7	2.5
barley	1.7	0.1	3.7	-5.1
millet	0.6	3.0	0.4	1.8
tuberous plants and root plants	2.0	-0.6	5.8	4.1
pulse	0.8	0.7	1.5	-1.1
sugar	3.1	2.2	2.3	2.4
vegetable and melons	3.9	3.4	3.8	3.2
Vegetable and fruit	1.4	3.1	3.0	3.6
citrus fruit	1.8	6.5	4.6	3.7
bananas	1.4	1.5	2.0	5.2
vegetable oil and fat (in oil equivalents)	0.1	8.3	2.9	4.4
meat (total)	2.3	3.3	3.9	3.4
milk (total)	1.6	2.9	2.8	2.9
eggs	4.4	5.4	7.7	4.0

Calculated according to "FAO The state of food and agriculture in 1979, Rome 1980, p. A-25 to A-28
FAO "Monthly Bulletin of Statistics", July/August 1981, p. 22/23 and March 1981, p. 22 to 30.

proved only through a complex of international measures that must be efficient in their entity. Activities in the following eight fields are seen to be necessary[14]:

1. To conclude a new international grain (wheat resp.) agreement,
2. To speed up the establishment of a so-called food infrastructure in developing countries;
3. To create special possibilities for financing food imports within the framework of the International Monetary Fund;

4. To implement the Food Aid Convention in line with the fixed objective with the possible expansion of food aid;
5. To ensure annual food funds of 500,000 t;
6. To strengthen the world food programmes;
7. To conclude agreements on measures to be taken in case of unforeseen food crises;
8. To create reserves for unforeseen food crises.

The major point in this catalogue of measures is to ensure a sufficient and continuous grain supply independently from the international grain market because grain is of central importance for human nutrition in all developing countries with a few exceptions.

The grain trade of developing countries in the last ten years shows the rapidly increased importance of this group of countries as importers of grain (see Table I.4.3.). Table I.4.4. shows to which extent these countries are dependent on grain imports to maintain domestic food security. It doesn't show fluctuations, rather big ones in some cases, in the imported quantities of grain in relation to strong fluctuations of harvesting in several countries.

The importance of grain within the overall food system, growing dependence of many developing countries on grain imports and the concentration of exports to a small number of countries make grain a strategic food under the present conditions in the world, a commodity almost of the same importance as oil. Measures proposed by various UN bodies are to eliminate the misuse of grain trade for political and economic blackmailing against developing countries as far as possible, and to ensure, in times of increasing inbalances between offer and supply, minimum grain deliveries under acceptable conditions to countries threatened by hunger.

Table I.4.3. Grain trade of developing countries[1] in mill.t

	1966/67-1970/71	1974/75-1976/77	1977/78-1979/80	1980/81[2]	1981/82[3]
Wheat					
import	28.8	39.4	50.0	58.7	65.7
export	2.7	4.0	5.8	4.8	4.6
net import	26.1	35.4	44.2	53.9	61.1
Rice[4]					
import	5.1	7.9	9.8	9.9	10.2
export	3.4	5.2	8.0	7.4	8.0
net import	1.7	2.6	1.8	2.5	2.2
Other grain					
import	4.2	11.9	26.2	31.4	29.0
export	10.4	12.4	9.7	12.7	16.4
net import or export (+)	-6.2	+0.5	16.5	18.7	12.6
Total net grain import	21.6	37.5	65.5	75.1	75.9
Total grain import	38.1	59.2	86.0	100.0	104.9
Global grain import	102.0	142.8	173.7	208.2	220.3

1) including Asian socialist countries and Cuba

2) preliminary data

3) preliminary estimates

4) Trade data are based on calendar years, examples are 1966/67 - 1970/71 for the years 1966-1970 and 1981/82 for 1981.

Source: FAO Commodity Review and Outlook 1979/80, p. 46-54 and 1974/75, p. 59-73
FAO "Food outlook", No. 11/12, 1981, p. 27/28

Table I.4.4. Net grain imports of developing countries[1] in 1,000 t and as share of the total grain quantities available in 1977/1979

Net grain import in 1,000 t	Share of net grain import in grain quantities available in the country[2] in per cent					
	1 - 5	6 - 10	11 - 20	21 - 40	41 - 60	more than 60
up to 100	Afghanistan Tchad Mali Burundi Niger Rwanda Tanazania Upper Volta	Paraguay Laos Togo Central African Republic Guinea Sierra Leone	Benin Swaziland Costa Rica Nicaragua Panama	Botswana Gambia Guinea-Bissau Lesotho Liberia Belize	Comores West Sahara	Brunei Cape Verdes PR Congo Gabon Maledives Barbados
101 - 200	Ethiopia Sudan	Madagascar	Cameroon Zambia El Salvador Guatemala Honduras	Angola Somalia Haiti		Oman PR Yemen Malta Réunion Mauretania Mauritius
201 - 400	Pakistan			Bolivia Ecuador AR Yemen Ghana Zaire Ivory Coast	Dominican Republic	Cyprus Arab Emirates Jamaica Trinidad and Tobago

contd. Table I.4.4.

Net grain import in 1,000 t	Share of net grain import in grain quantities available in the country[2] in per cent					
	1 - 5	6 - 10	11 - 20	21 - 40	41 - 60	more than 60
400 - 1,000		Philippines	Colombia Syria	Chile Senegal	Tunesia	Hong Kong Jordan Lebanon Saudi Arabia Singapur Libya
1,000 - 2,000		Bangladesh	Nigeria	Sri Lanka Morocco	Peru Venezuela Iraq Malaysia	
more than 2,000		Indonesia	Brazil Mexico	Iran South Korea Egypt		Algeria

1) A number of smaller regions or territories with a high dependence on imports (examples are Oman, Macau, Seychelles) were not included.

2) Grain production ± export/import that is, stock changes were not taken into account.

Source: FAO Production Yearbook 1979
FAO Trade Yearbook 1979

Since the World Food Conference, the assumption has been made that essential problems of grain supply could be negotiated within the framework of a new international grain agreement and could be embodied in form of binding economic stipulations. The new agreement should consist of three independent parts - a grain trade convention, a fodder grain convention (which should function only in terms of information and consultation) and a food aid convention. Appropriate market and price stability in connection with grain should be achieved through establishing a price margin acceptable for exporters and importers, comprehensive stock keeping (including national grain reserves available on an international scale) and respective economic stipulations (financing, accumulation and release of stocks)[15]. The fact should be mentioned in this context that measures to stabilize the international rice market are not being discussed although rice is the basic food for about half of the world population, and the percentage share of rice trade in world production amounts to only 2 to three per cent; thus rice crop failures can scarcely be covered through trade. First attempts to establish a coordinated stock keeping of rice can be observed in some South Asian countries (Thailand, Indonesia, Philippines, Malaysia, Singapur).

The International Wheat Agreement, a multilateral contractual agreement, was concluded in 1949 for the first time, and it was renewed in the following years several times with slight changes in the economic stipulations and mechanisms of wheat trade; it was renewed in 1968 for the last time and remained in force by 1971, accompanied by an increase in the level of international grain prices. After the expiry of the agreement of 1968 in 1971, the International Wheat Council only agreed upon a wheat trade convention that did not contain any economic stipulations on wheat trade but was limited on the exchange of information essentially. This convention has been prolonged seven times since 1971 and will be valid by 30 June, 1985, the end of the economic grain year 1984/85.

The agreement renewed in 1968 consisted of two independent agreements for the first time - the agreement on wheat trade and the agreement on the supply of grain under special conditions to developing countries, the Food Aid Convention FAC. In this convention, the signatory states undertake to make generally favourable grain supplies to developing countries amounting to 4.2 million tons annually. This Food Aid Convention effective as an independent agreement was renewed in 1971 and also in the following years covering 4.2 million tons respectively. In the middle of the 1970s, in view of the bad food situation in many developing countries, the World Food Conference and the World Food Council called for increasing grain deliveries within the framework of the FAC to ten million tons at least, appealed to the selling countries to make firm promises on a long-term basis and supported the preferential supply to the MSA countries. In 1980, a new agreement was concluded stipulating deliveries amounting to 7.6 million tons totally. In the last few years, deliveries within the FAC framework show strong fluctuations in dependence on the respective situations in the free market economy.

Increased efforts have to be taken in all developing countries to develop grain production; this means:

- Increased yields by means of intensification, especially through improved soil fertility as the basis of stable agro-economic systems and efficient land use planning,
- Expansion of arable land through comprehensive land reclamation.

At present, the international grain trade is characterized to a large extent by bilateral agreements or informal arrangements between the big grain exporters and importers with a relatively stable import demand; examples are Japan, Great Britain, Mexico, Israel, Algeria, Brazil, Egypt, Lebanon, and also Poland, Soviet Union and the People's Republic of China. In contrast to multilateral agreements, these agreements stipulate fixed quantities but they don't contain price arrangements. In the large majority of developing countries, the grain import demand is changing

in dependence on their own harvesting considerably. Bilateral agreements would oblige them to import specific quantities even when they don't need these quantities directly, and this is even aggravated by the fact that these countries have no storage capacities or only small ones. Importers without bilateral agreements, however, are dependent on the so-called 'rest market' and experience made in sugar agreements, for example, shows that the instability of the 'rest market' increases with growing market shares. Thus the actual victims of the fact that there is no grain agreement are the least developed countries with fluctuations in their grain demands. That is the reason why the World Food Council and also the United Nations are insisting on concluding a new grain agreement as soon as possible through the International strategy for the third development decade so that, among other things, an internationally coordinated system of national food reserves is established.

As the FAO obviously expected a failure in the negotiations on a new grain agreement in November 1979, it presented a five-point plan for food security[18] containing the essential elements of the grain agreement as originally planned and the eight-point-WFC programme as presented before; these elements are grain stocks strategies, guidelines for the provision and release of stocks, the satisfaction of urgent import demands and emergency aid, aid measures for the establishment and maintenance of grain stocks in developing countries. The development strategy for the 1980s requires the implementation of this programme of action in a provisional form and on a voluntary basis[19] that is, eventual arrangements should be integrated into a new grain agreement.

The catalogue of WFC measures and the FAO programme of action are concentrated on two aspects - the expansion of stock-keeping including the mechanisms of their formation and use, and a catalogue of activities and decisions relating to food aid. In this context, the expansion of stock-keeping is not only to

bring about an increase in the nationally available reserves of the countries but for the first time, it is also to include national stocks that will be available internationally on the basis of stipulations to be elaborated. Such a grain agreement would involve the International Wheat Council, the institution that makes decisions on such stocks.

As to stock-keeping, two aspects have to be taken into account. First, the economic value of increased stocks is only given when it is correlated with annual consumption. With increasing overall grain consumption, this requires increased stock-keeping or arrangements on flexible stocks instead of quantitatively fixed ones in order to ensure the required security reserve. Estimates on world grain stocks from 1976 to 1982 (see Table I.4.5.) show that grain stocks totalling 250 million tons were planned for 1982 covering 16 per cent of world consumption while the stocks of 245 million tons in 1977 were 18 per cent of world consumption. The FAO holds 17 per cent would be necessary to counter strong price fluctuations and instabilities on the markets of the countries of free market economy.

Table I.4.5. World grain stocks in million tons - FAO calculations

	1976	1977	1978	1979	1980	1981[1]	1982[2]
Grain	187.4	245.3	237.1	273.9	252.6	225.3	250
- most important exporters	86.3	116.6	128.4	139.9	135.1	112.5	134
- other countries	101.1	128.7	108.7	134.0	117.5	112.8	116
wheat	76.7	115.0	97.3	116.6	101.6	93.3	93
rice	36.6	37.2	39.3	43.7	31.8	42.5	45
other cereals	74.0	93.0	100.5	113.5	109.3	89.5	112
Grain stocks in regions							
industrialized countries	100.8	146.6	146.3	177.2	156.2	131.7	152
- North America	49.0	79.9	93.6	94.6	92.3	74.1	95
- other countries[3]	51.8	66.7	52.7	82.6	63.9	57.6	57
developing countries	86.6	98.7	90.0	96.7	95.4	93.6	98
- Far East[4]	69.9	76.6	72.3	79.9	81.3	73.5	77
- Middle East	7.5	9.8	8.4	6.2	7.2	8.4	9
- Africa	2.5	3.8	4.0	3.5	2.3	2.7	4
- Latin America	6.6	8.5	6.2	7.0	5.7	7.2	9
World stocks in per cent of consumption	14	18	17	19	17	15	16

1) estimates 2) preliminary estimates 3) including FAO estimates on the Soviet Union
4) including FAO estimates on the PR of China

Source: FAO "Food Outlook", No. 11/23, 1981, p. 26

Second, the necessary quantity of national stocks including reserves for export or reserves possibly available on an international scale is determined by production fluctuations and the average growth rates in the countries concerned. The FAO calculated instability indices in grain production from 1952 to 1972 in almost all countries in addition to the average growth rates in the period mentioned above[20].

The instability indice is designated as the standard deviation of annual production changes from the trend rate. An indice of 4 means a fluctuation of four per cent above or below the trend. The respective indices are 9 for the United States (with an average growth rate of 2.6), 28 for Canada (1.6) and 43 for Australia (4.7). As to important developing countries, these indices are 8 for India (2.7), 9 for Pakistan (3.0), 32 for Tanzania (5.0), 44 for Iraq (1.8), 49 for Morocco (2.7), 51 for Algeria (-1.3) and 72 for Syria (0.2). To orientate national stock-keeping by given production fluctuations is of the same importance for exporting and importing countries.

According to the WFC, an internationally coordinated system of grain stock-keeping is to cover 20 to 30 million tons that is, 5 to 7 million tons as to developing countries and the remaining quantities as to industrialized countries taking part in the programme. Costs of stock-keeping of five million tons in developing countries amount to about one thousand million Dollar per year and additional 750 million Dollars for buying the respective grain quantities[21].

Although the necessity of comprehensive grain stock-keeping is uncontested, nationally maintained and internationally available reserve-keeping brings about basic problems. The complex of nationally maintained and internationally available grain stocks and the mechanisms used for the formation, release and accumulation bring about a variety of problems. This is not so relating to the necessity to improve food security in developing countries by implementing so-called grain stocks

strategies including the establishment of a food economy infrastructure in line with WFC recommendations. According to a WFC information, 60 developing countries with 57 per cent of the population living in this group of countries agreed to such a food stocks policy[23].

The most essential tasks are to make measures to store, conserve, transport and distribute food, to reduce generally high post-harvesting losses and to improve the stability of their markets in order to catch up with emergency situations[24]. They are to be integrated into the overall food strategies or planning of the countries concerned. An essential component of or even a prerequisite for the functioning of such systems is the establishment of an information system providing minimum information about food production, availability and demand on national and/or regional levels. In some cases, technical preconditions for low-loss stock-keeping must be created and it has to be ensured that stock-keeping policies don't have negative effects on domestic production developments but stimulate local production.

The implementation of a programme covering comprehensive stock-keeping will have to contain short-term and medium-term special programmes as well as long-term target programmes. The implementation will require international aid measures especially for the least developed countries where the annual food production does not suffice to satisfy most urgent demands. However, what matters is the collective self-reliance of developing countries and the use of their own potentials to improve economic cooperation. Although modern forms of grain stock-keeping in particular may be indispensable in many developing countries, the principle is valid here, too, saying that food security begins at the local level, in the households. In concrete terms, this means a programme of stock-keeping has to involve rural areas. In these regions, stock-keeping can be realized and controlled more cheaply owing to long experience made by the peasants and owing to regional re-

sources. This is an important aspect because, for example, the Post-Harvest-Technology (PHT) promises large profits for interested companies independently of the actual demands of developing countries[25]. Necessary aid measures taken by international organizations must be coordinated more strongly and brought into harmony with the national development plans. The efficiency of stock-keeping economy highly depends on natural local conditions, the infrastructure and the cultivation of natural resources in the crop formation (quality of products). Complex food aid and the satisfaction of most urgent import demands are to be ensured especially through food aid within the FAC framework (point 4 of the WFC programme), the establishment of international food emergency reserves (point 5), the expansion of the world food programme (point 6) and the establishment of a facility to finance urgently needed imports (point 3). In bourgeois technical literature, food aid is not an uncontested aspect; this is due to the fact that in the past, the volume and choice of products in connection with so-called food aid were determined by overproduction in capitalist countries more than by the demand of developing countries, that an increase in domestic production or agrarian reforms were impeded in many cases and/or did not contribute to satisfying demands. One has to proceed from the fact that there exists a genuine demand for food aid, and this demand must be satisfied on the basis of clear criteria and especially with involving domestic production and food programmes.

Various UN bodies are requested to achieve the objective determined by the World Food Conference in 1974 within the framework of the Food Aid Convention and amounting to ten million tons. The UN document on the Third Development Decade says that these ten million tons are the absolute minimum of available assistance. Efforts are made to establish new objectives as soon as possible on the basis of estimates saying that the volume of food aid in 1985 has to be between 17 and 18.5 million tons per year[26].

Article 92 of the document mentioned above says that the objective of 500,000 tons of food, grain predominantly, as planned for the International Emergency Food Reserve IEFR, has to be realized without delay. In 1980, the quantity of grain provided for this fund amounted to almost 400,000 tons that is, about 333,000 tons through the World Food Programme and the remaining quantities on a bilateral basis, with additional 1,000 t or so of pulses, vegetable oil, powdered skim milk etc.[27].

In this context, suggestions to increase the emergency reserves and to elaborate precise stipulations relating to the modalities of their use are being discussed as well as the transformation of the voluntary programme into legally binding arrangements; as to the last, however, many Western donor countries rose objections[28].

Another demand is relating to strengthening the World Food Programme financially. This programme, implemented by the UN and the FAO since 1962 jointly and institutionalized in 1966, works under the control of the intergovernmental Committee on Food Aid Policies and Programmes CFA; among other things, it provides the governments through the World Food Council with recommendations to improve their food aid policies and food aid programmes. Difficulties in providing the amount of one thousand million Dollar to be used for the two-year period 1981/82 caused the WFC and the United Nations to call for increased efforts in the document on the Third Development Decade. In this context, the Executive Director of the Programme said about 1.2 thousand million Dollar would be necessary for maintaining the existing performance level in 1983/84 due to inflationary monetary developments in the capitalist world.

The demand contained in Article 91 of the strategy can be said to be satisfied, formally at least; it covers the establishment of additional food facilities for food imports

within the framework of the International Monetary Fund. In May 1981, the IMF agreed to such a facility. Although all IWF member-countries are entitled to use this possibility of financing, it is to support income-weak countries in particular. It can be used in case of domestic production losses and sudden price increases for food imports. The repayment of this financial adjustment has to start three years after receiving the loans and is based on conditions more favourable than usual ones.

The UN bodies engaged in food problems and those engaged in the elaboration of the UN document on the Third Development Decase propose a complex catalogue of necessary activities and arrangements that could contribute to improving food security. However, the further institutionalization of food problems as well as the demand for more investments, technology, mineral fertilizer, plant protective agents or food aid alone cannot eliminate hunger and malnutrition. The food problem as a social phenomenon[29] as well as hunger and malnutrition as its concrete forms can be solved only by eliminating the respective socio-economic roots. When we succeed in making substantial progress in the establishment of a New International Economic Order in the 1980s - and as already mentioned, the strategy of the Third Development Decade is to be seen as an essential contribution in this field - it will be possible to diminish the existing system of the unequal division of labour among the countries. And when those socio-economic preconditions are created in developing countries, that provide the possibility of making material-technological and infrastructure-related measures fully effective in the sense of improving domestic food situations, it will be possible to advance in the direction of eliminating hunger and malnutrition.

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I.4.2. The role of FAO in implementing projects in developing countries

Introduction

The Food and Agriculture Organization of the United Nations FAO was established in Quebec in October 1945.

Its objectives are:
- To improve the food level and living standard,
- To ensure a higher efficiency in the production and distribution of all foodstuff and agricultural products produced by farms and enterprises of forestry and fishery,
- To create better conditions for the rural population and to take part in developing the world economy and ensuring the liberation of man from hunger.

Therefore, FAO activities are concentrated on the development of land and water resources - these are also two important tasks in the environmental programme -, increased production, the protection of plant and animal protection,
- to exchange technologies used in agriculture, forestry and fishery with developing countries,
- to develop agricultural research especially in developing countries,
- to promote the protection of plant gen resources,
- to efficiently use fertilizer and plant protective agents,
- to develop the epidemology of animal diseases,
- to promote the development and use of resources of the sea and inland waters,
- to support, by means of technical assistance, such fields like food supply, food economy including processing, land erosion control and irrigation technology,
- to elaborate strategies to develop agriculture and food production especially in developing countries by the year of 2,000,

- to permanently analyse the food situation and agricultural production in all regions with drawing conclusions in connection with measures to be taken in order to solve new problems.

This catalogue of tasks clearly shows that the FAO pays specific attention to solving one of the most important problems in developing countries, that is, to improve food supply in a planned and speedy manner in those countries where the population is expanding most strongly. At the end of the 1970s, there existed 1,500 projects in 132 developing countries.

In accordance with the increasingly complex character of the problems to be solved, the FAO is developing comprehensive cooperation with the UNESCO, for example, in the advanced training for experts in agricultural and food production to achieve high and stable yields in connection with profitable cost-use ratios and low harvest and stock losses by establishing stable agro-economic systems providing a stable basis. Close cooperation with UNEP is also maintained.

The FAO had also a decisive share in the preparation and organization of important conferences held in order to solve the economic and social problems of developing countries:
- World Conference of agrarian reform in Rome, 1966 (together with UNO and ILO)
- World Conference on agrarian reform and rural development (Rome, 1979) as a contribution to implementing the New International Economic Order on the redistribution of land to peasants without land or with little land,
  World Food Conference of the United Nations (Rome, 1974) with the establishment of the World Food Council (holding annual meetings),
- Support to the International Fund for Agricultural Development IFAD,
- Support to the World Food Programme WFP in cooperation with the UN.

The FAO plays an important and active role in solving a major problem of developing countries. Examples from the field of natural sciences and analysis are to demonstrate the work of FAO:

1. World Soil Charter; resolution 8/81 of the 21th session of the FAO conference (Annex I),
2. Recommendations for food loss prevention in perishable crops as a result of a comprehensive study (Annex II),
3. The state of natural resources and human environment for food and agriculture - The state of food and agriculture 1977, excerpts from documents of the 11th FAO Regional conference for Europe (Annex III).

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I.4.3. Development trends in food supply for developing countries to the year 2000

Introduction

Experience made so far proves that for solving the food problem in developing countries, attention should not be paid to population developments primarily but to the increase in the production of agricultural products to be used in direct consumption or for fodder in animal production and thus for the production of meat and milk.

This is to be achieved by two means:
(1) To increase yields on existing areas through intensification by increasing soil fertility by the use of improved fertilizer, irrigation, plant protective agents, crop rotation, measures relating to soil and cultivation, the election of species and by impeding wind and water erosion;
(2) To cultivate land not being used so far or only to an insufficient extent (the reclamation of fallow land or areas after mining) by land cultivation, the tillage and sowing of plants being appropriate mostly for the respective areas (ecosystems) in order to achieve high and stable yields.

Experience made in this field so far shows that this is not only a problem in terms of natural science and technology but it also brings about economic, social and cultural problems including permanent training and advanced training.

This is also shown in the report of the Secretary-General on social consequences of the green revolution to the Commission for social development of ECOSOC (Economic and Social Council) (E/CN 5/567/1979). In the summary of this report (pp. 89 - 108), it is said:

There is no simple answer to the many complexities which underlie the changes that are directly or indirectly associated with the introduction of the green revolution. Primary changes, when they occur significantly, produce various combinations of secondary consequences which affect the personal and institutional relations between persons and socio-economic categories, alter livelihoods and aspirations, change power structures, modify relations between classes and interact with political systems. The diversity in environmental, physical and institutional conditions, not only among countries but also among various parts of a particular country and even villages and farms, make it difficult to compare results and to generalize. Keeping this in mind as a caution, some general statements may be made.

The green revolution spread fast during the 1960's but has subsequently slowed down. As yet it covers a small percentage of the total area sown to wheat and rice in developing countries. It has only affected certain areas of the developing world and its adoption has been determined not only by natural and agronomic conditions but also, and what is more important, by social and economic factors. It is unlikely that the green revolution will spread widely and rapidly in areas where land structures are restrictive, access to credit is costly, where distribution organizations are unable to provide necessary inputs and a guaranteed market for millions of small agricultural producers and where training and information services are inadequate.

Though the new technology has brought about some increase in the output of food-grains in a number of countries, it has not yet succeeded in giving self-sufficiency even on the basis of current inadequate levels of consumption. In the period, 1966/77, for example, the average annual import of wheat by developing countries was 24.1 million tons, increasing to 32.9 million in 1973/74 and to almost 40 million tons in 1974/75. The import of rice for the same period of time in-

creased from 5.1 million tons to 6.0 million tons.[+] The increase that has taken place in production has not been evenly spread between different cereals, there being no significant impact on pulses, fibres, oil-seeds or other crops. It can be seen that although there has been an over-all increase in the proportion planted with high-yield varieties, there are large areas where they have not been used and even some areas which have reverted to local seeds. Present high-yield varieties are not suitable for all soils and for all climatic conditions and require inputs which for many farmers are not available or are unacceptable for various reasons.

Even in countries where there have been dramatic increases in wheat or rice production, a number of factors must be considered. Sometimes such increases have been at the expense of other crops and, what is most important, the new seeds have tended to concentrate on the best irrigated or natural soils. These areas are limited, but so far there has been little research with high-yield varieties for poor and dry soils. In short, present high-yield varieties require good land and expensive, sophisticated inputs, and in many cases, they do not always meet long-established tastes for grains with certain characteristics of flavour, colour and texture.[++]

There is clear evidence that recent technological break-throughs based on the alteration of the biological characteristics of wheat, rice and other minor grains with complementary inputs have not had widespread and equally beneficial effects in many rural areas.[+++] It appears that some farmers, usually large-scale ones, have rapidly profited from the green revolu-

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+ Food and Agricultural Organization of the United Nations, Commodity Review and Outlook, (Rome, 1975), pp. 58 and 72.

++ B. Dasgupta, Agrarian Change and the New Technology in India (United Nations Research Institute for Social Development, Report No. 77.2), p. 57.

+++ Progress in Land Reform: Sixth Report (United Nations publication, Sales No. E.76.IV.5), pp. 11 and 12.

tion, while others, particularly small farmers and tenants, having fewer resource endowments, have lagged behind. Cost considerations, especially in relation to fertilizer, the improvement of irrigation facilities and mechanization among other factors, have placed some new technology components out of reach of small farmers unless they are provided through public sector programmes. Lack of knowledge about technical use of modern inputs has meant lack of or inefficient adoption and use of these inputs. Co-operative activities necessary for efficient use of certain inputs have not been adequate. The result has been that the green revolution has not made any considerable impact on alleviating the disadvantaged position of small cultivators who form the bulk of the farming population in developing countries.

Given the current level of intensity and the extent of its application, the general impact of the new technology on rural employment is not sufficiently clear. It appears, that for a short period of time at the outset, it has had a slightly favourable effect on employment as substantial amounts of additional labour must be invested in applying fertilizer, weeding and the like. However, with their growing potential for multiple cropping, high-yield varieties place a premium on quick preparation of land and other agricultural operation. Farmers may no longer have several weeks to prepare the ground with plough and buffalo. They may have to use power-driven equipment to prepare land quickly and plant the next crop. Even in countries where the new technology is not yet in widespread use, the profitability of farm mechanization is being increasingly recognized. It is doubtful that with the expansion of mechanization the favourable effect of the green revolution on rural employment will be the same as at the beginning. It will undoubtedly lead to reduction of employment opportunities. Policies towards mechanization should be related to the socio-economic and labour situation in a particular country or region and labour-saving machinery should be avoided where labour is abundant.

Successful introduction of the green revolution requires the simultaneous adoption of new cultural practices and the use of modern inputs. The seasonal rhythm of rural activity, which, for example, in Asia was once determined largely by the monsoon, is changing as farmers begin to double-crop and introduce new combinations of crops. Where there has been a failure to make necessary reforms and to change institutional arrangements there has been a further concentration of control over productive resources, particularly land and capital. The central problem of increasing socio-economic differentiation rests on the difficulty of achieving economic efficiency of small land-holdings, especially of holdings below the self-provisioning size.

Large-scale introduction of the new technology makes the net return per unit of land higher.+ The consequences of this change are an increasing competition for land, rising land values, the renegotiation or imposition of new tenancy arrangements and a tendency towards concentration of land. In some areas tenants are being reduced to farm labourers. A process of the continuing high concentration of land ownership has been the feature of the over-all economic development.++ The green revolution has accompanied this process and tended to accentuate changes in agrarian structure in favour of larger landholders, capital-intensive farming, marginalization of small farmers and reduction on tenancies, and increasing the pace of population drift from countryside to cities with a resulting growth of unemployment in urban areas.

The obvious role of the new technology in rising agricultural productivity has had its psychological impact also. Poverty and unrewarded effort are beginning to be understood and considered as situations engendered by man and rooted in differen-

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+ M. H. Khan, The Economics of the Green Revolution in Pakistan (New York, Praeger, 1975), p. 115.

++ Progress in Land Reform, ..., p. 10.

tial access resources that are necessary for exploiting the opportunities created by the green revolution - opportunities that at first sight seem to be available to all people regardless of their position in a society. But in reality the new technology, if left to develop in its present viable settings without the necessary economic and social support systems for the less advantaged masses of rural population, may even lead to the pauperization of the small peasantry. There is no doubt that the possible social consequences of its adoption should be foreseen and taken into consideration along with economic advantages, if the green revolution technology is to contribute to increased well-being for the millions in rural areas.

There are strong physical and social obstacles to achieving the increased production offered by the green revolution in many parts of the developing world. These obstacles are fragmentation of landholdings, lack of institutions, low investment capacities, unskilled labour, shortages of credit, traditional attitudes of farmers and others. Critics of the green revolution also see other obstacles growing worse in the future. For example, they point to salinization and alkanization in many parts of irrigated lands.+ There are doubts as to how rapidly the investment funds can be obtained to extend irrigation or how oil-short nations will be able to finance the fuel required for their agricultural machinery. There is concern about long-term effects of uncontrolled well-digging on the total supply of ground water. Therefore, there is a reason to believe that the further spread of the new technology will not be as fast as early success might suggest.

This consideration of the possible consequences and problems associated with the large-scale application of the new techno-

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+ Report of the United Nations Water Conference (United Nations publication, Sales No. E.77.II.A.12), paras. 66-71.

logy demonstrates the close interrelations of the various factors that promote or impede economic development in general and rural development in particular. Of course, there are great variations among countries, and each country is experiencing a different set of these problems. But the complexity of these interrelations makes it all the more necessary that interdisciplinary research and co-operation should be undertaken, if the current problems are to be solved and future ones anticipated. More extensive and efficient adoption of the new technology will directly depend on the diagnosis and solution of these problems.

The indications are that the widespread utilization of the new technology, if left in its present form would lead to: (a) the further concentration of capital, land and wealth in the hands of larger farmers and service entrepreneurs, (b) the concentration of investments in improved technology and productivity in certain economically and socially favoured zones, (c) the further introduction of capital-intensive production and labour-saving machinery, (d) the dissolution of systems based on small land-ownership, ascribed communal rights, share-tenancies and village customary rights, and the consequent accelerated marginalization and proletarization of rural populations, (e) a risky reliance on expensive imported inputs, sophisticated research and the high world market prices for the daily food supplies of urban and rural populations.+ Whether or not these tendencies would be considered as positive or negative depends on the development policy followed by the Government of a particular nation.

As prerequisite for agricultural expansion and the use of the new technology, it is necessary to bring about social and institutional reforms. Social factors intervene strongly in the

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+ The Social and Economic Implications of Large-Scale Introduction of New Varieties of Foodgrain: Summary of Conclusions of a Global Research Project (United Nations Research Institute for Social Development, Report No. 74.1), p. 28.

application of a technology because of the nature of the small farm as a family enterprise. The institutions of developing countries need to be reformed or adapted in many cases to meet the special needs of small farmers in regard to land tenure, credit, co-operatives, marketing, social services, training and agricultural research. More attention needs to be given to employment-generating activities in rural areas, small-scale labour-intensive industry, livestock production and the nutritional problems of the rural population. The government services in the agricultural sector may have to be so designed and executed that they tend to slow down and prevent future concentration of capital and land and the marginalization of an increasing number of working farmers. On the other hand, significant structural changes must be made to provide access to the main productive resources by the various sectors of the rural population.

Since most people in developing countries are poor peasants, the satisfaction of their needs demands a national strategy for rural development based on employment generation in rural areas, and the production of inexpensive goods and services of the mass consumption variety rather than expensive luxuries required by the few. Such a strategy has important technological implications. It is necessary that the technology chosen be capital and energy saving rather than capital and energy intensive and labour saving; that it requires less skill or small modification in the skills of traditional craftsmen, rather than the expertise produced by training institutions; that is use local renewable materials and available sources of energy rather than non-renewable materials or materials that have to be imported from abroad or transported from distant parts of the country. Appropriate technology should be used for promoting mutually reinforcing development of both agricultural production and industry in rural areas.

There is a strong need to institute joint research among agricultural and social scientists in order to design more effective rural development programmes at the community and regional levels, particularly in linking social and cultural change with the introduction and better utilization of the new technology. Government efforts should be directed to providing necessary resources for education and training, including training of farmers, women and youth to bring about their active participation in agricultural production. Long-term goals in mobilizing peasants for the successful use of the new technology and the proper organization of agricultural production call not only for the diffusion of immediately useful information on the new technology but even more for the education of cultivators in the basics of the new agricultural methods by their participation in the operation and management of agricultural services. The success of each individual must be related to the success of the group in such a way that each individual strives to maximize the success of the group and the society as a whole.

There is a strong need for local institutions and organizations of working cultivators and labourers, which are necessary both to secure their participation in the control and organization of services and also to provide grass roots support for the programmes locally, as well as for the expressed policies of the Governments. Co-operative action is needed for land preparation, water management, pest control, energy recycling and post-harvest technology which confer both individual and collective benefits, thus allowing the fulfillment of the objective of increased production with social justice.

It should be emphasized that fundamental reforms are equally necessary for both economic and social reasons. Appropriate measures are needed to limit the transfer of land from small landowners to owners of medium-sized and large farms, which is still continuing in many developing countries.

Measures are also needed to protect the rights of tenants and strengthen their position in relations with landlords. It is equally important to encourage a larger flow of investment into farm production and to achieve a more equitable distribution of inputs and income to those who actually farm the land. Effective steps will have to be taken to prevent concentration of land in the hands of money-lenders, trading firms, banks and multinational corporations.

Special attention should be given to marginal farmers who have landholdings at below subsistence level and need to supplement their income from the small plots with income from other sources. The movement out of agriculture to cities cannot be considered a real alternative opportunity for large sectors of the rural population at the present time since job opportunities are so few in most developing countries that frequently even the natural increase in urban population cannot be absorbed. Therefore, on the one hand, steps will have to be taken to increase the productivity of their land by organizing the marginal farmers into production teams or groups for joint farming and providing assistance in obtaining credit and inputs. On the other hand, submarginal farmers should also be given opportunities to work outside their farm in the rural areas where they live through programmes of public works and the development of small-scale industries and service industries. At the same time the younger generation should be provided with opportunities to acquire new skills that would enable them to move into other occupations, which in turn would reduce the tendency towards further fragmentation of small farms.

It must be emphasized that land reform, whether it involves changes in the tenure system or redistribution of property rights, is basically a political issue in all regions of the world and would have to be treated in the political context. However, from a developmental point of view it should be re-

cognized that without modification of the land tenure structure, natural and human resources are employed at less than optimal economic efficiency in many parts of the world. In this respect land redistribution in the vast majority of cases is prerequisite for redistribution of rural income generated by the introduction of the green revolution technology.

The new technology alone is not a solution to all problems of rural development. What is needed is an integrated programme of rural development that would, within the framework of a national development strategy, improve the well-being of all sections of the rural population. This idea is prevalent now in the majority of the developing countries, where it is realized that non-agricultural development and expansion of social and cultural services in rural areas are as important as agricultural growth for solving problems of rural poverty and providing better living conditions. This means that integrated development of the natural and human resources in the rural areas with a programme encompassing agricultural, industrial and other activities can maximize production and employment in those areas. This is needed to ensure that in addition to changes concerned with production methods, changes will also take place in the social and economic structures. Policies to achieve such changes involve a comprehensive set of interlocking factors - social, political, economic and technical - all closely interrelated within an over-all institutional framework.

These findings had to be taken into account when elaborating the prognosis of developing foodstuff production in developing countries to the year 2000. With taking the objective of the New International Development Strategy into consideration, the FAO Conference adopted the following guide-lines for developing agriculture up to 2000 (excerpts from C 79/24 (1979)):

Overview: Policy issues in world agriculture

The challenges faced by world agriculture are examined in this report within a quantitative frame of growth which reflects the philosophy and objectives of a new international economic order.

The assessments of potentials and constraints are realistic provided that serious efforts are in fact made to improve the performance of the sector.

Certain policy issues which stand out are the focus of the final chapter of the report and are summarized in this Overview.

A. Abolishing hunger

It should be possible for the world to set a target to be taken seriously for abolishing hunger.

The World Food Conference target of mid-1985 was not only ambitious; in practice it has been ignored. This report does not propose targets but points out what needs to be done to abolish hunger within the span of time studied.

Action must take place both in accelerating production and in raising demand.

(i) Accelerating production

A sustained higher growth of production can come only by a modernization of the production process, i.e. purchased inputs must be increased and resources used more intensively in conjunction with an expansion of the land base.

The funds and the physical quantities involved are tremendous. The value of current inputs obtained from outside agriculture

for 90 developing countries is estimated to double from 1980 to 1990 and then almost to double again by the end of the century.

The agricultural sector must also raise investment substantially. Governments must therefore stop transferring significant funds out of agriculture; they must give full weight in budgets and in development plans to agriculture's need for increased funds for capital and current inputs; they must ensure that domestic industries do deliver the necessary inputs to agricultural production or that controlled allocations of foreign expenditure for agricultural requirements are actually made.

A substantial augmentation of material inputs to agriculture is needed to lift output. However, it is the extent and quality of the way they are used which will determine their effectiveness. The human factor is all-important in policies to raise production. The potential is there to be unlocked but the human factor is often neglected in planning, possibly because willingness to work, skill of management and readiness to learn and apply new technologies are not easily quantified in models and plans.

Producer prices must be judged remunerative by farmers. Agricultural education must be stepped up considerably even though the full benefit will not accrue for a long time ahead. Extension services must be expanded and tailored to the structure of agriculture and to the production requirements of the future. Education in agricultural disciplines must not be misused as a stepping stone to administrative work in offices. Whatever the kind of land-owning or land-use arrangements followed, they must give security and incentive to the producer. This will require many reforms. Rural people must participate more fully in decisions affecting their productive labour.

It is easy to list such requirements for the fuller use of human capital in an improved structure of agriculture. The policy issue arises because many countries have, in practice, for years treated agriculture as the Cinderella of the economy and they find it difficult to bring about changes to transform the sector.

The rapidly rising demands for agricultural products in the face of limited natural resources call for an increasing reliance on science and technology. The man/land ratio in developing countries is expected to fall from 0.9 ha in the mid-1970s to 0.5 ha of potential arable land by the year 2000 and water resources which are easy to develop and use are becoming scarce. Research must play a fundamental role in increasing agricultural production, basically by raising yields. The agriculture of the future in developing countries must become more science-based - in a broad sense - as has been the case with the agriculture of developed countries.

In the next decade, the adaptation of generalized findings to local conditions will call for the greatest effort. Crops other than cereals must now be given more attention. High priority should be given to research which tackles problems specific to small farmers with limited resources.

It is necessary to increase the resources devoted to research in or applicable to developing country agriculture, to ensure fruitful cooperation between national and international systems and to direct research to areas and subjects where the pay-off seems likely to be high.

The scientific effort must be buttressed by effective institutional systems to carry its results to potential users.

Finally, while the production objectives of AT 2000 can for the most part be met by applying knowledge which is already available, it would be short-sighted to neglect the scope for major breakthroughs.

(ii) Raising effective demand

Income growth without redistribution would raise effective demand. Assuming supplies were forthcoming, nutritional conditions would improve significantly. However, because of the uneven distribution of income, this improvement in nutrition would not abolish the hunger problem. Even if income grew in accordance with the normative scenario, numbers below the critical level of food intake would not fall below 240 million over the next two decades.

This would be unacceptable, particularly because the absolute size of the nutritional gap is small. The theoretical shortfall is projected to be only 28 million tons of cereal equivalent in 1990 and 20 million tons in 2000. In practice, the amount would be larger because of distributional problems but whatever the actual figure, it would remain small in relation to current levels of production (1978 forecast: world cereals production 1400 million tons (provisional)).

The policy issue is therefore clearly to redistribute purchasing power so as to enable the poorest people in developing countries to raise their food consumption in 1990 at least by an amount equivalent to around 2 per cent of current world cereal production. In the great majority of instances, national food production would be sufficient to bear the impact on demand of the necessary redistribution of income; in a few instances additional imports would be needed.

Governments have a choice of possible approaches - very direct redistribution of income-earning assets, fiscal means, direct measures of food redistribution, or a combination of these.

Governments naturally wish to pursue policies which hold down prices to consumers but keep them high enough to constitute effective incentives to producers.

However, because of the importance of incentives to producers and the need to improve income levels of an expanding agricultural population, the latter objective must receive priority. This implies a still greater need for measures which redistribute somewhat present patterns of purchasing power.

B. Restructuring for a New International Economic Order

A full contribution from agriculture is indispensable to the restructuring of the international economic order.

Trade

The major market for agricultural exports of developing countries will remain the developed countries whose markets for competing imports from developing (and other developed) exporters are heavily protected. At the same time, supply from developing countries has sometimes failed to materialize when the market opportunities did exist.

Developed countries should open their markets more fully for competing produce from developing countries while the latter should organize their production and trade to take consistent advantage of the greater market availability.

These are indeed amongst the most discussed trade and development issues of our day but the record shows only too well that they have generally not been solved.

In the past, the inter-dependence of the twin issues of better access and improved production have been recognized but then put to one side.

Policy guidance, investment, technical and marketing assistance must therefore now be directed to facilitating efforts of developing countries to expand specific export supplies for which access is being improved and adjustment assistance must

also be provided to farmers and processors in developed countries. Action on one side only is usually considered infeasible or too hazardous, so the necessary steps must be taken in concert.

Such arrangements should involve all developed countries. Even those countries most noted for agricultural exports are importers of some competing products, including processes products.

Both farmers and processors of agricultural products will need adjustment assistance to "move over" to provide more room for imports from developing countries. Such assistance is given to industry and there is no reason why it should not be given to agriculture, e.g. to high-cost producers of beet sugar.

At the heart of trade linkages is the question of self-sufficiency objectives. Every importing country or group of countries in the world seemingly wants to be more self-sufficient in basic foods but at the same time the potential benefits from taking advantage of varying resource endowments of countries are widely recognized.

The decision as to what degree of food self-sufficiency to aim for is - within moderately broad limits - made more on political than on economic grounds. Countries should, however, be aware of the implications of undie insuletion from international trade and competition. Imports of a larger share of competing products would undoubtedly be cheaper than domestic supply in some instances and, with the incentive to improved production coming from dependable market availability, could be a dependable source. Food and agricultural policies should benefit the consumer and not only the producer.

Countries should therefore reappraise their goals, implicit or explicit, for future degrees of food self-sufficiency. De-

veloped countries should give a lead to somewhat greater reliance on external sources, because their economic imperatives to boost domestic food production are lower.

As regards food, greater collective self-reliance on the part of developing countries is a goal needing carefull interpretation. There is a good deal of natural production complementarity between the temperate zone and relatively extensive agricultures of the developed countries and (frequently) tropical and labour-intensive agriculture of developing countries. Furthermore, larger agricultural import flows from developed countries could advantageously also be linked with expanded markets for manufactures from developing countries.

C. External assistance

The clear message of the quantitative analysis of AT 2000 is that a significant acceleration in agricultural output will not be achieved without a huge increase in the use of material inputs from outside the agricultural sector, both capital and current.

A large part of the foreign exchange component of these inputs will need to be provided by the developing countries themselves. This emphasizes the necessity for them to be given greater opportunities to earn that foreign exchange; in this context trade and investment are two sides of the same policy issue.

Part of the requirement must come, however, in the form of external assistance. The report estimates that annual requirements, as compared with the actual 1977 commitments of $ 4.3 billion, will rise to $ 12.7 billion in 1190 and $ 16.8 billion in 2000.

A clear priority is needed on the part of suppliers and recipients of assistance in the sectoral pattern of use of

funds. In turn, the priorities must be based on a definite strategy or model of development for some years ahead to provide the framework for the allocation of funds.

For at least most of the forthcoming decade and for the majority of developing countries, the investment needs of agriculture - and hence the allocation of external assistance for capital uses - should receive higher priority than in the past.

Suppliers of external assistance should, when helping to meet the foreign exchange component of agricultural investment, try to take as full account as possible of the comparative balance of payments prospects of recipient countries in relation to the acceleration aimed at in agricultural growth.

D. Agriculture and industrialization

The development of agriculture and industry is complementary in the long run and the attainment of the Lima target for industry will depend, to a significant extent, on a high rate of growth of agriculture.

The two most direct linkages are the manufacture of agricultural inputs and the processing of agricultural output. The rates of growth envisaged in the normative scenario give considerable scope for the expansion of both.

This long-term interdependence must be reflected in development planning and operational priorities. Appropriate balance should be sought in the allocation of public investment and flows of external capital assistance. Specific industries, particularly agricultural processing units, must be selected and sited in rural areas.

The issue is to bring agriculture and industry together in the cause of development.

E. Safeguarding the environment

The one-world concept underlying that of a new international economic order demands that the natural environment be protected. Pressures on it are increasing almost daily. Agriculture, forestry and fisheries as chief users of the land and the sea all have a primary responsibility for helping to safeguard the environment.

The first policy requirement is for countries to have long-term plans for land and water use - plans which are understood and accepted by the population at large and which are effectively implemented.

Secondly, the authorities must ensure that prices entering calculations of the use of natural resources take full account of all long-term costs.

Properly used, the economic calculus is the most effective policeman of all in the fight to preserve the natural environment.

It reads further:

Quantitative perspectives and production strategies

The core of AT 2000 is a detailed picture of the course that agriculture could take up to the year 2000 in 90 developing countries accounting for 98 per cent of total developing country population (excluding China). The full report presents some breakdown of the projections into the eighties and the nineties, but for brevity this summary does not generally do so.

The projection of demands on the agricultural sector requires assumptions about the growth in population and income.

Basic growth assumptions - annual growth rates (per cent)

	Population		GDP[1]			GDP per caput		
	1963-1975	1980-2000	1963-1975	1980-2000		1963-1975	1980-2000	
				Trend	Norm.		Trend	Norm.
90 developing countries	2.6	2.3	6.0	6.6	7.7	3.2	4.1	5.2
Africa	2.6	3.0	4.8	5.9	6.9	2.1	2.9	3.8
Far East	2.5	2.0	4.7	5.6	6.8	2.1	3.5	4.7
Latin America	2.8	2.5	5.9	5.4	7.3	3.0	2.8	4.7
Near East	2.7	2.6	9.0	8.7	9.0	6.1	5.9	6.2
Low income countries	2.5	2.1	3.2	4.3	5.9	0.7	2.2	3.7
Developed countries	1.0	0.6	4.5	4.5	4.5	3.4	3.8	3.8
World	1.9	1.7	4.8	4.9	5.3	2.7	3.0	3.4

1) Gross Domestic Product (GDP)

Population growth is that of the UN medium variant, with adjustment made in the light of more recent information.

For developing countries two assumptions are made for growth in gross domestic product (GDP). The lower or trend one depicts the historical trend since the early 1960s, modified upwards to reflect expectations based on more recent performance. The high, or normative, rates reflect the assumption of an improved economic performance and take account of views generally accepted within the UN in mid-1978. For developed countries the trend assumption alone is used.

The period analysed goes from 1980 to 2000. Since the most up-to-date complete set of data is for 1974-76, (abbreviated to 1975) the period 1975 to 1980 is projected on the basis of recent trends.

Alternative paths of agricultural growth

Two possible paths of agricultural growth for the 90 developing countries are presented for both demand and production. First demand, which is based on the two sets of GDP assumptions described above.

	1980	2000	Growth rates 1963-1975	1980-2000
			per cent p. a.	
Food demand per caput:				
trend (calories per day)	2278	2489	0.3	0.4
normative (calories per day)	2278	2645		0.7
Total agricultural demand:				
trend ($ billion 1975)	286	537	2.9	3.2
normative ($ billion 1975)	286	595		3.7

The nutritional implications of trend demand growth are not encouraging. Although average energy consumption reaches average requirements by 2000, its unequal distribution leaves 390 million under-nourished at that time compared with 415 million in 1975. Under the normative assumptions the number is 240 million in 2000. Although an improvement on the trend, even this number is not acceptable and indicates the need for measures to redistribute income or purchasing power.

Two possible paths for production of crops and livestock are also explored. Trend output growth of 2.7 per cent is not

even enough to meet trend demand in developing countries. Their aggregate self-sufficiency ratio in terms of calories would decline from 92 per cent in 1980 to 80 per cent in 2000. Cereal imports by the cereal deficit developing countries would increase to almost 180 million tons in 2000, while the net meat deficit would be more than ten times higher at around 14 million tons. The overall consequence for the agricultural commodity trade balance would be disastrous, going from a surplus of over $ 6 billion in 1980 to a deficit of more than $ 36 billion by 2000 (1975 prices). These figures show the necessity for improving on past trends both in demand and in production.

The normative scenario embodies such improvements. In it the demand projections are the normative ones described above. The production estimates aim to meet that demand to the fullest extent considered feasible, country by country and commodity by commodity.

For imported basic foods this is equivalent to making each country's self-sufficiency ratio as high as possible, while exports are increased as far as is compatible with production possibilities and with the markets for them, markets which themselves are assumed to be greatly expanded by the reduction of trade barriers in the developed countries. The result is a path of agricultural production which grows at 3.8 per cent compared with a growth rate for domestic demand of 3.7 per cent.

The growth of production varies from country to country, but not significantly between regions. This means that the required acceleration in performance is greatest in Africa, whose historical rate has been less than that of the other regions. A significant acceleration is also projected for the low income countries.

Growth rates of gross agricultural production

	Normative scenario	
	1963-1975	1980-2000
	(per cent p. a.)	
90 developing countries	2.6	3.8
Africa	2.0	4.1
Far East	2.6	3.9
Latin America	2.8	4.1
Near East	3.1	4.0
Low income countries	2.1	3.8

Continuing a development already noticeable in the seventies, the output of livestock products grows somewhat faster, cereals less quickly than overall production growth, notwithstanding a great increase in feed demand.

Changes in the composition of gross output: 90 developing countries

	($ billion 1975 prices)			
	Percentage shares		Growth rate of production	
	1980	2000	1963-1975	1980-2000
			(per cent p. a.)	
Cereals	29	26	2.7	3.2
Other food crops	37	37	2.9	3.9
Non-food crops	13	13	1.2	3.7
Livestock	20	24	2.8	4.7

The implied rates of growth of non-agricultural GDP, though rapid, are not unattainably so, especially in the light of recent performance.

Countries classified by share of agric. in GDP in 1975	Share of total developing countries in 1975		Growth rates 1980-2000		
	GDP	Population	Total GDP	Agric. GDP	Non-agric. GDP
	(per cent)		(per cent p. a.)		
Above 30 %	23	57	6.2	3.5	7.4
15 - 30 %	27	28	7.4	3.3	8.1
Below 15 %	50	15	8.3	3.8	8.5

In spite of a growth in demand much higher than that of the past, the cereals self-sufficiency level of the 90 developing countries as a group remains at the mid-seventies level of 92 per cent until 1990 but then declines a little (to 90 per cent) by 2000.

A good part of the cereals deficit originates in the better-off developing countries, including oil or mineral exporters. However, a number of countries which are not so fortunately placed could experience severe payments problems if they had to meet their deficits entirely through commercial imports. But on the whole the poorest countries could succeed in increasing their self-sufficiency.

Approximately full self-sufficiency is maintained in most of the other major food commodities produced almost exclusively for the domestic market (roots and tubers, pulses, meat).

Inputs to production

The feasibility of attaining the production growth rates of the normative scenario depends most of all on the availability of the required capital and current inputs. For crops the analysis is based on a detailed picture of land and water use, crop by crop and country by country, together with an equally detailed specification of yield levels. Other input

requirements are derived from those yield levels - low yields require few inputs, high yields must be associated with more intensive cultivation methods.

Developing countries still have substantial under- or unutilized land resources and it is estimated that 205 million hectares of this land could be brought under cultivation by 2000, at which time, however, 62 per cent of the population of developing countries would live in countries where potential arable land was more or less fully utilized.

The area under soil and water conservation measures, drainage and flood control should increase to about 220 million hectares by 2000, so that land resources can be kept intact.

Production and key inputs - 90 developing countries
(ø 1975: Index (1975=100) unless otherwise stated)

	1980	2000	Growth rates 1963 1975	1980 2000
			(per cent p.a.)	
Gross value of agricultural production	115	244	2.6	3.8
Inputs from outside agriculture	126	436	n/a	6.4
Agricultural value-added	113	217	n/a	3.5
Gross value of crop production	114	232	2.6	3.6
Arable area (million ha.)	744	936	0.8	1.2
Yield	112	181	1.8	2.4
Irrigated area (million ha.)	104	152	2.0	1.9
Improved seed	120	292	n/a	4.6
Fertilizer (million tons)	19	94	11.8	8.2
Pesticide	114	279	n/a	4.6

Continued - Table, p. 60

	1980	2000	Growth rates 1963 1975	Growth rates 1980 2000
Tractors (thousands)	2327	9860	7.7	7.5
Labour (billion man-days)	63	105	n/a	2.6
Gross value of livestock production	115	288	2.9	4.7
Cereal feed (million tons)	57	190	5.4	6.2

As compared to the past, the contribution of arable land extension to growth in output declines and that from more intensive use of land through higher cropping intensities and through higher yields increases. The sources of additional crop production would be:

Area expansion	- 28 per cent
Yield increases and more intensive cropping	- 72 per cent

Yield increases require major programmes on a wide front; as inputs used individually are not as effective as those used in a carefully developed package of inputs and practices.

Water inputs from efficient use of precipitation through improved moisture management and through well managed irrigation schemes provide the major boost for crop yields. After land, water availability will be the most severe single constraint to production expansion in many developing countries. The area equipped for irrigation increases from 104 million hectares in 1980 to 152 million hectares in 2000; the proportion which is fully equipped rises from 60 per cent in 1980 to 77 per cent in 2000. Improvements will be required in the management of the systems, especially in the face of rising construction costs. This will call both for increased training for management personnel and irrigation farmers and also

for a major modernization and improvement of the institutions related to irrigation.

Even assuming more efficient use of organic sources of plant nutrients, chemical fertilizer use rises from 19 million tons (nutrient content) in 1980 to 94 million tons by 2000 (a growth rate of 8.3 per cent). Fertilizer use per hectare of arable land increases from 26 kg in 1980 to 100 kg NPK by 2000; on fully irrigated land it reaches about 320 kg. At this level of use, fertilizers account for 45 per cent of the value of all off-farm inputs.

To meet the increased demand for improved seeds, the seed produced by the seed industry in developing countries will have to rise about fourfold from its present level.

Although it is recognized that purely chemically based pest control leads to many problems of pest resistance and upsets ecological balances, a 4.6 per cent growth rate in pesticide use is projected, as part of a programme for developing locally suited systems of integrated pest control.

The demand for power rises at 2.4 per cent a year. An overwhelming share of this comes from hand labour (66 per cent in 1980) and while tractor mechanization grows rapidly (at 7.5 per cent between 1980 and 2000), the slow growth in numbers of work animals means that the share of hand labour in the total remains virtually unchanged.

For livestock production the acceleration required in output in response to demand and the biological constraints on bovine animal reproduction force a move towards a greater share of poultry and pigmeat (where acceptable in the diet) in total meat production. Because of increasing pressure on grazing land there will need to be a large increase in fodder production, from 132 million tons in 1980 to over 300 million tons

in 2000 (4.3 per cent). Concentrate feeding also rises rapidly; the feedgrain component alone rises at about 6 per cent a year.

Animal health services, particularly their preventative side, will need to be extended. There should be further development of the existing international and national programmes for the control of major livestock diseases. Animal health services in developing countries may cost as much as $ 2 billion a year by 2000.

In total, the value of current inputs for crop and livestock production grows at 5.6 per cent over the period 1980-2000, significantly faster than the growth rate of production (3.8 per cent). Within the total the inputs purchased from outside agriculture rise even faster at 6.4 per cent.

All inputs need energy in their manufacture, particularly fertilizer and power inputs. The postulated increases in these two inputs are almost 8 per cent p.a. between 1980 and 2000. Even at that rate the growth of energy consumption in agriculture will be lower than what other studies project for the rest of the economy, so it is unlikely that the 1975 share of 3 per cent of agriculture in total energy use will have changed significantly by 2000. Agriculture and forestry may also be able to make a bigger contribution to energy supplies.

Research and its application

A large part of the increased productivity aimed for in crop and livestock programmes must come from improvements in technology and its wider application. Much of the technology to be used is already known and available for use; the most important issues are adaptation and dissemination. Agricultural research can play a central role here together with improved extension services. Financial support for agricultural research is very low at the present (0.3 per cent of agricul-

tural GDP in 1975) and rapid agricultural growth cannot take place without a considerable increase in the research underlying production itself.

Investment in research and its application, however, is only effective if there is a well trained staff to undertake it. This emphasizes the need to improve training, both formal and in-service, to build up high quality cadres of research and applied scientists and technicians.

Major orientations for research should reflect the basic objectives for agricultural development. Considerations of income distribution place added emphasis on developing technologies to increase production and productivity of small farmers and less well-endowed regions. Research on particular crops should reflect expected returns; this may involve some shift from cereals to crops such as pulses, fruits and vegetables.

Investment requirements: 90 developing countries
($ billion 1975 prices)

	1990		2000	
	net	gross	net	gross
Land development and soil conservation	5.8	7.5	6.8	8.8
Irrigation and flood control	7.9	13.2	8.0	15.2
Tractors and equipment	5.5	12.8	9.1	22.6
Draught animals and equipment	0.4	6.3	0.4	6.6
Handtools	0.0	1.8	0.0	1.9
Working capital-annual inputs	2.9	2.9	4.6	4.6
Total crop investment	22.5	44.5	29.0	59.7
Livestock investment	6.6	6.7	10.8	10.8
Storage and marketing	4.1	5.9	5.3	7.9
Total investment - OECD "narrow"	33.3	57.1	45.0	78.3
Transport	6.2	6.2	7.9	7.9
Processing	6.9	15.0	8.8	20.5
Total	46.4	78.4	61.7	106.7

Fisheries

The rapid expansion of the world's fisheries of the fifties and sixties, growth in world catches in the seventies has been erratic and much reduced, as a consequence of over-fishing. Opportunities for increases in catch which remain however are mostly to be found off the coasts of developing countries. Aquaculture also offers growth possibilities but the more significant increases in catch could be achieved by better management, i.e. recovery of overexploited stocks.

Nonetheless, potential demand at constant relative prices is expected to outrun supply. Even with a drastic reduction of fish going into meal (not shown below but projected to be 23 million tons in 1980 for the world), and presuming that such fish could be made acceptable as food, some restriction of demand through price increases seems inevitable.

					Growth rates		
		1980	1990	2000	1963-1975	1980 1990	1990-2000
		million tons				per cent p.a.	
World	Production	75	85	92	3.6	1.2	1.0
	Food demand	60	79	97		2.7	2.4
Developing countries:							
	Production	37	46	53	3.4	2.0	1.7
	Food demand	29	43	57		3.8	3.4
Developed countries:							
	Production	38	39	41	3.7	0.3	0.3
	Food demand	31	36	40		1.6	1.3

Although some investment in new catching capacity will be needed, the main requirements for public action will be in the field of infrastructure to ensure better handling of fish (to reduce wastage) and to improve marketing opportunities.

The essential management problem remains that of limiting the annual harvest from a stock to its productive capacity, but the institutional arrangements for such action are in transition as a result of the widespread adoption of 200 mile exclusive economic zones. Such regimes pose new problems for scientific research, for surveillance and for enforcement, particularly where shared stocks are concerned.

Forestry

The forest sector too will face increasing difficulties in meeting demand. Particular problems are foreseen in the supply of fuelwood (an overall growth rate of only 0.7 per cent) particularly in some wood-poor developing countries. Firewood could be used much more efficiently, but even so extensive planting programmes at the village level are needed to create new sources of supply.

For industrial wood too it is thought unlikely that the constant price projections of demand can be met.

Industrial wood removals (billion m^3)

	1975	2000 Normative	Growth rate (% p.a.)	2000 trend	Growth rate (%p.a.)	2000 adjusted[1]	Growth rate (% p.a.)
World	1.32	2.90	3.3	2.60	2.9	2.10	1.9
Developing countries (incl. Asian CPE)	0.24	0.85	5.2	0.55	3.4	0.47	2.6
Developed countries	1.08	2.05	2.6	2.05	2.6	1.63	1.6

1) The result of industry judgement on likely supply availability.

Developing countries' forests, largely tropical, are currently under-utilized, but are being rapidly cut over for selected species. Moreover, by 2000 about 150 million hectares (12 per cent) will be lost through clearance. There is great need to avoid environmental damage from indiscriminate agricultural clearing and fuelwood cutting.

In developing countries, production and consumption growth of industrial wood products are projected to grow at 2.6 per cent and 2.8 per cent p.a. respectively. Exports of developing countries are expected to continue their upward trend, with processed products accounting for a larger share of the total, but their imports too, particularly of paper, will rise strongly, thus checking the growth in their net export earnings.

Investment requirements for logging and primary transportation will be of the order of $ 1 billion annually, and about ten times that amount will be needed to replace wood stocks.

Other domestic policy issues in the developing world

Employment

It is estimated that in 1980 the agricultural population of developing countries will account for 60 per cent of the total. That proportion will decline over the next 20 years but by just how much is difficult to estimate. Nonetheless, agriculture will be a major source of employment and income for a large proportion of developing country population well beyond the end of the century.

Provisional estimates suggest a growth of labour demand for crop production of 2.6 per cent p.a. Assuming an increase of the average days worked per person in direct crop producing activities by 25 per cent, this growth of labour demand

would require the labour force in agriculture to increase by 156 million persons, or at a rate of 1.4 per cent per annum (the comparable growth rate was 1.2 per cent per annum for 1963-1975). Over the period 1980-2000 the total labour force is projected to increase by 475 million. It is not certain what share of the latter increase will be retained in agriculture.

In the normative scenario a higher rate (as compared with past performance) of labour absorption in agriculture is arrived at by assuming a modest pace of substitution of machinery for labour. Realization of the potential for increased labour absorption, however, would require selective policy interventions, a major one being an attempt to bring about more favourable terms of trade of agriculture so as to check the increasing gap in per caput income levels between the agricultural and non-agricultural sectors.

Nutrition

In 1974-1976 about 415 million people in developing countries were seriously undernourished (22 per cent of total population). Economic growth combined with increased food production will provide the major basis for substantial improvement in the nutritional situation even without changes in the income distribution within countries.

But, normative growth of GDP at 7.7 per cent a year would still leave in 2000 some 240 million people (7 per cent of total population) in the developing countries below the critical food intake level. The absolute amount by which food intake theoretically falls short of meeting requirements is not dramatically large - only 20 million tons in 2000 compared with the projected demands of the normative scenario.

Consumption: Food energy per caput (normative GDP growth)

	Calories (number)			Growth rates 1975 to 2000 (per cent p.a.)	Projected demand as per cent of national average requirements		
	1975	1990	2000		1975	1980	2000
90 developing countries	2207	2452	2645	0.7	96	107	115
Africa	2197	2308	2520	0.5	94	98	107
Far East	2054	2322	2504	0.8	92	104	112
Latin America	2543	2856	3080	0.8	106	120	129
Near East	2614	2755	2890	0.4	106	112	117

Although the causes of under-nourishment are even now not fully understood, there seems no doubt that the most effective means of eliminating the hard core of the under-nourished is to increase their incomes faster than for the average through some form of income redistribution.

According to estimates from FAO study of 14 developing countries an increase of around 50 per cent in the growth rate of expenditure of the lowest two income deciles resulting from income redistribution would practically eliminate under-nourishment by 2000; if total income remained at its normative level, expenditure of the top two deciles could continue to rise but a little more slowly.

Marketing and processing

Significant factors for the marketing sector are the rapid growth of the non-agricultural population and a likely shift, at least in relative terms, from subsistence to monetized farming systems. The growth in the quantity of food that has to pass through the market is, at about 5 per cent per

annum for the period 1980 to 2000, markedly higher than the growth of production or consumption. The other two main components of marketed products also grow rapidly, exports at 4.7 per cent and non-agricultural inputs at 6.4 per cent. As well as growing fast the system must also become more efficient; the smaller the margin between producer and consumer prices the better.

The over-riding need is to bring the small semi-subsistence farmer more into the market, both as a supplier of food and agricultural raw materials and as a user of inputs such as fertilizer.

First stage processing of agricultural goods is projected to increase at about the same rate as production; the total extent of agricultural processing in developing countries is an important issue both as regards the future linking of development of agriculture and industry and in relation to potential expansions of exports of processed products.

Price policies

The contribution that price policies can make in providing incentives for farmers to adopt the more modern, input-intensive cultivation techniques needed for a rapid growth of production is examined. Agricultural price policies in developing countries have often had the effect of turning the domestic terms of trade against agriculture. Such policies have probably done more long-run harm than good. Accordingly, it will be necessary to improve input-output price ratios for agriculture in most developing countries by such means as minimum price support programmes, selective input subsidization and an overall reduction of undue protection of other sectors, although where market prices are moving in line with policy objectives, they may both be left alone. The consequent short-run effects of higher food prices should be mitigated by well-directed public distribution schemes.

Income redistribution will offset the impact of higher food prices on the welfare of poorer consumers. In the long run, advances in agricultural productivity should moderate food price rises.

Institutional changes

Far-reaching changes will be needed in institutional arrangements. Among these the most fundamental concern land holding and tenure. Great improvements are also needed in education and extension services. A target of one extension agent per 500 farm families would require about 1 million such agents by 2000. These agents should themselves be better educated, better informed and more highly motivated; they are an essential component in any strategy to increase farm productivity.

Also of vital importance is the role of the overall administrative framework of development. Greater decentralization and delegation of authority and responsibility, at the lowest levels of the organization, at the point of communication with farmers, needs to be more flexible and effective. The increased participation of rural people in the making of decisions which affect them is a vital element in future institutional developments.

International dimensions of agricultural development

International trade in agriculture

One element of the normative scenario for developing countries is a rapid increase in their exportable supplies of most agricultural products. Their share of world agricultural exports could rise to 50 per cent by 2000, provided the projected export availabilities materialize as actual trade.

Moreover, with the concomitant slowdown in the rate of growth of their food imports, particularly in the 1980s when there

will be great scope for import-saving increases in production, their positive balance in agricultural trade with the rest of the world would be substantially enhanced - to nearly $ 30 billion in 2000 for the products covered, compared with $ 12 billion in 1975.

As a result, forecasts speak about the following yields (ton/ha) up to 2000: (see Table "Yield levels at selected annual crops").

Agricultural trade in 90 developing countries[1]

	1975	1990	2000	Growth rates 1963-1975	1975-1990	1980-2000
				per cent p.a.		
Gross imports ($ billion)	18	29	49	4.6	3.2	3.6
Gross exports ($ billion)	30	48	78	1.7	3.2	4.7
Net trade balance ($ billion)	12	19	29			
SSR (per cent)	105	105	105	not applicable		
Exports as per cent of domestic demand	13	12	13			

1) Gross exports include exports from countries which are net importers and gross imports include imports by countries which are net exporters. Forest and fishery products are not included.

These objectives pose large challenges for trade policies: they imply above all else that market conditions will be favourable for investment in production for export. This means not only assurance of stable and remunerative prices, but notably, improved conditions of market access for the agricultural export products of the developing countries.

While the normative scenario also points to increasing emphasis on trade cooperation among the developing countries them-

selves, the main scope for raising their agricultural exports rests on opportunities to find expanding markets in the developed countries, which will not occur if current trends in developed countries continue.

Hence there is an urgent need to accelerate positive action to liberalize restrictive import regimes, to moderate or halt the growth of high-cost production in developed countries and to make much faster progress than is evident so far in implementing measures for restructuring international trade as set out in the *Programme of Action on a New International Economic Order* and in the *UNCTAD Integrated Programme for Commodities*. In parallel with this, steps need to be taken in developing countries to ensure that an adequate and assured supply would actually be forthcoming to satisfy additional market demand arising from policy measures taken by importing countries.

Food aid

Food aid requirements assesses for the future. In view of the considerable uncertainties inherent in quantifying food aid requirements as far ahead as 2000, the quantitative analysis focusses on 1990.

In general, a continuing need for food aid can be foreseen, both to meet emergencies and to ease balance of payments constraints on low income food importing countries. Estimates are made on two bases, each applying aid shares to projected cereal imports of food deficit countries. For the trend basis, the aid share is the relatively high one of 1969-71, for the normative the lower current share. The latter estimate also includes a component related to estimates of the nutritional gap.

The alternative estimates of 1990 cereal food aid requirements are therefore:

	Trend basis	Normative basis
	million tons	
57 most vulnerable countries[1]	26	10
Other developing	6	4
Nutritional supplement	-	-
Total	32	20

1) Low income countries, MSA, least developed, land-locked and island countries.

/These estimates may be modified in the light of the study of the food aid needs of the 1980s currently under way in FAO for the Committee on Food Aid./

By 2000, although the need for food aid would persist, it is likely that its nature and purpose would be significantly different with greater emphasis being placed on project aid to help overcome the problem of the under-nourished. Agrarian reform and income redistribution could also add temporarily to food aid needs. Generally food aid should be provided on a more assured basis, while recipients should continue to guard against adverse effects on domestic production and on consumption habits.

Yield levels of selected annual crops

(ton/ha of harvested land)

	Year	Developing countries	Africa	Far East	Latin America	Near East
1. Wheat	1975	1.28	0.85	1.33	1.37	1.30
	1990	1.82	1.24	2.05	1.73	1.77
	2000	2.27	1.53	2.65	2.05	2.11
2. Rice, paddy	1975	1.98	1.33	1.99	1.86	4.19
	1990	2.68	1.76	2.76	2.11	4.61
	2000	3.10	2.13	3.23	2.32	5.05
3. Maize	1975	1.39	1.02	1.29	1.56	2.44
	1990	1.76	1.33	1.77	1.86	3.47
	2000	2.11	1.61	2.23	2.15	4.13
4. Barley	1975	1.14	0.88	1.34	1.20	1.19
	1990	1.46	1.16	1.62	1.44	1.56
	2000	1.76	1.36	1.82	1.68	1.93
5. Other cereals	1975	0.74	0.63	0.58	2.01	0.89
	1990	0.99	0.79	0.80	2.54	1.09
	2000	1.21	0.94	0.98	3.01	1.31
6. Sugar cane	1975	50.11	51.42	47.12	51.93	84.06
	1990	61.08	65.28	60.23	60.25	90.94
	2000	69.21	79.55	68.28	67.11	105.22
7. Pulses	1975	0.50	0.41	0.48	0.59	0.97
	1990	0.65	0.51	0.68	0.64	1.34
	2000	0.78	0.61	0.82	0.71	1.56
8. Soya beans	1975	1.50	0.40	0.82	1.71	1.26
	1990	1.70	0.48	1.01	1.85	1.45
	2000	1.94	0.61	1.18	2.08	1.74

	Year	Developing countries	Africa	Far East	Latin America	Near East
9. Groundnuts	1975	0.91	0.78	0.94	1.18	1.09
	1990	1.08	0.90	1.16	1.29	1.33
	2000	1.23	1.02	1.36	1.43	1.62
10. Sunflower	1975	0.77	0.56	0.24	0.91	1.05
	1990	0.87	0.79	0.39	1.02	1.26
	2000	1.01	1.01	0.50	1.10	1.64
11. Sesame	1975	0.29	0.34	0.23	0.53	0.33
	1990	0.40	0.39	0.32	0.64	0.46
	2000	0.49	0.45	0.40	0.73	0.61
12. Tobacco	1975	0.94	0.87	0.87	1.15	0.84
	1990	1.12	0.94	1.11	1.30	1.00
	2000	1.32	1.04	1.38	1.44	1.18
13. Seed cotton	1975	0.82	0.48	0.55	1.20	1.61
	1990	1.05	0.65	0.91	1.24	1.80
	2000	1.23	0.78	1.20	1.35	1.95
14. Jute and other fibres	1975	1.09	0.67	1.15	1.19	0.99
	1990	1.30	0.73	1.40	1.24	1.08
	2000	1.48	0.83	1.63	1.26	1.18

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Annex I

World Soil Charter

Resolution 8/81 of the
21st Session of the Conference of the
Food and Agriculture Organization of the United Nations

Rome, November 1981

W/P6453

World Soil Charter

The Conference,

Recalling Resolution VI of the World Food Conference (Rome, 1974), by which the Food and Agriculture Organization was urged to establish a World Soil Charter as a basis for an international cooperation towards the most rational use of the world's soil resources,

Realizing that land resources are limited and that of the total land area of the world only a small percentage is currently used to feed the world population which is likely to reach six billion by the end of the century,

Recalling further the Programme of Action as adopted by the World Conference on Agrarian Reform and Rural Development (Rome, 1979), which called for "an efficient use of land ... with due regard for ecological balance and environmental protection", and the Plan of Action of the U.N. Conference on Desertification (Nairobi, 1977) to combat land degradation and desertification,

Concurring that the food requirements of mankind including the eradication of malnutrition can be met by:

- the intensification of food crop production including multiple cropping, wherever this can be safely accomplished,
- the bringing into cultivation of new lands, wherever conditions for sustained cropping prevail, with a view to meeting food production requirements,
- the establishment and better utilization of grasslands and forests.

Sharing the concern caused by the dangers of soil degradation resulting from misuse of land and inappropriate measures for intensifying production, particularly in areas which are exposed to water and wind erosion, or salinity and alkalinity,

Noting the research carried out by FAO in conjunction with Unesco, UNEP, WMO, and other competent international organizations, and in consultation with Governments concerned, with a view to assessing the lands that can still be brought into cultivation, taking proper account of permanent vegetation cover for the protection of catchment areas and of land required for forestry, grazing and other uses, with particular reference to hazards of irreversible soil degradation as well as the order of magnitude of costs and inputs required,

Recognizing that decisive progress towards intensified assistance in the improvement of productivity and conservation of soils can be achieved by the adoption and implementation of appropriate principles and guidelines for action at the national and international levels,

Having noted the conclusions and recommendations adopted by the Committee on Agriculture at its Sixth Session and by the Council at its Seventy-ninth Session,

1. Hereby adopts the World Soil Charter;

2. Recommends to the United Nations and international organizations concerned to give effect, within their respective spheres of competence, to the Principles and Guidelines set forth below.

Principles

1. Among the major resources available to man is land, comprising soil, water and associated plants and animals: the use of these resources should not cause their degradation or destruction because man's existence depends on their continued productivity.

2. Recognizing the paramount importance of land resources for the survival and welfare of people and economic independence of countries, and also the rapidly increasing need for more food production, it is imperative to give high priority to promoting optimum land use, to maintaining and improving soil

productivity and to conserving soil resources.

3. Soil degradation means partial or total loss of productivity from the soil, either quantitatively, qualitatively, or both, as a result of such processes as soil erosion by water or wind, salinization, waterlogging, depletion of plant nutrients, deterioration of soil structure, desertification and pollution. In addition, significant areas of soil are lost daily to non-agricultural uses. These developments are alarming in the light of the urgent need for increasing production of food, fibres and wood.

4. Soil degradation directly affects agriculture and forestry by diminishing yields and upsetting water regimes, but other sectors of the economy and the environment as a whole, including industry and commerce, are often seriously affected as well, through, for example, floods, or the silting up of rivers, dams and ports.

5. It is a major responsibility of governments that land use programmes include measures towards the best possible use of the land, ensuring long-term maintenance and improvement of its productivity, and avoiding losses of productive soil. The land users themselves should be involved, thereby ensuring that all resources available are utilized in the most rational way.

6. The provision of proper incentives at farm level and a sound technical, institutional and legal framework are basic conditions to achieve good land use.

7. Assistance given to farmers and other land users should be of a practical service-oriented nature and should encourage the adoption of measures of good land husbandry.

8. Certain land tenure structures may constitute an obstacle to the adoption of sound soil management and conservation measures on farms. Ways and means should be pursued to over-

come such obstacles with respect to the rights, duties and responsibilities of land owners, tenants and land users alike, in accordance with the recommendations of the World Conference on Agrarian Reform and Rural Development (Rome, 1979).

9. Land users and the broad public should be well informed of the need and the means of improving soil productivity and conservation. Particular emphasis should be placed on education and extension programmes and training of agricultural staff at all levels.

10. In order to ensure optimum land use it is important that a country's land resources be assessed in terms of their suitability at different levels of inputs for different types of land use, including agriculture, grazing and forestry.

11. Land having the potential for a wide range of uses should be kept in flexible forms of use so that future options for other potential uses are not denied for a long period of time or forever. The use of land for non-agricultural purposes should be organized in such a way as to avoid, as much as possible, the occupation or permanent degradation of good quality soils.

12. Decisions about the use and management of land and its resources should favour the long-term advantage rather than the short-term expedience that may lead to exploitation, degradation and possible destruction of soil resources.

13. Land conservation measures should be included in land development at the planning stage and the costs included in development planning budgets.

Guidelines for action

Acceptance of these Principles would require the following action:

By Governments

i. Develop a policy for wise land use according to land suitability for different types of utilization and the needs of the country.

ii. Incorporate principles of rational land use and management and conservation of soil resources into appropriate resource legislation.

iii. Develop an institutional framework for monitoring and supervising soil management and soil conservation, and for coordination between organizations involved in the use of the countries' land resources in order to ensure the most rational choice among possible alternatives.

iv. Assess both new lands and the lands already being used for their suitability for different uses and the likely hazards of degradation. Provide decision makers with alternative land uses which both satisfy communities' aspirations and use the land according to its capabilities.

v. Implement education, training and extension programmes at all levels in soil management and conservation.

vi. Disseminate as widely as possible, information and knowledge about soil erosion and methods of controlling it both at the farm level and at the scale of entire watersheds stressing the importance of soil resources for the benefit of people and development.

vii. Establish links between local government administrations and land users for the implementation of the soils policy and emphasize the need to put proven soil conservation techniques into practice, and to integrate appropriate measures in forestry and agriculture for the protection of the environment.

viii. Strive to create socio-economic and institutional conditions favourable to rational land resource management and conservation. These conditions will include providing security of land tenure and adequate financial incentives (e.g. subsidies, taxation relief, credit) to the land user. Give encouragement particularly to groups willing to work in cooperation with each other and with their government to achieve appropriate land use, soil conservation and improvement.

ix. Conduct research programmes which will provide sound scientific backing to practical soil improvements and soil conservation work in the field, and which give due consideration to prevailing socio-economic conditions.

By International Organizations

i. Continue and intensify efforts to create awareness and encourage cooperation among all sectors of the international community, by assisting where required to mount publicity campaigns, conduct seminars and conferences and to provide suitable technical publications.

ii. Assist governments, especially of developing countries, on request, to establish appropriate legislation, institutions and procedures to enable them to mount, implement and monitor appropriate land use and soil conservation programmes.

iii. Promote cooperation between governments in adopting sound land use practices, particularly in the large international watersheds.

iv. Pay particular attention to the needs of agricultural development projects which include the conservation and improvement of soil resources, the provision of inputs and incentives at the level of the farm and of the watershed, and the establishment of the necessary institutional structures as the major components.

v. Support research programmes relevant to soil conservation, not only of a technical nature but also research into social and economic issues which are linked to the whole question of soil conservation and land resource management.

vi. Ensure the storage, compilation and dissemination of experience and information related to soil conservation programmes and of the results obtained in different agro-ecological regions of the world.

Annex II

Food and Agriculture Organization
of the United Nations

United Nations
Environment Programme

Food Loss Prevention in Perishable Crops

based on an expert consultation
jointly organized by the

Food and Agriculture Organization of the United Nations

and the

United Nations Environment Programme

Food and Agriculture Organization of the United Nations
Rome 1981

Summary

Forecasts as to the extent to which the increased demand for food in the world can be fulfilled over the next decades range from very cautious to optimistic. More concrete is the expectation that the necessary food supplies will have to be derived increasingly from the intensification of agricultural production rather than from additional land use. This will require a more judicious use of limited production inputs and may have repercussions on costs.

The reduction of post-harvest food losses is a complementary means for increasing food production. This draws its importance not only from a moral obligation to avoid waste, but also because the cost of preventing food losses in general is less than producing a similar additional amount of food of the same quality. Therefore, the concept of food loss prevention, to which attention was drawn by the World Food Conference in 1974, will afford mankind increasingly significant opportunities to meet its food requirements. The programmes that have been initiated so far at the international level, amongst which is FAO's Food Loss Prevention Programme, have focused mainly on the durable food grains because of their prominence in the daily diet. The perishable crops, because of their high moisture content, are inherently more liable to deteriorate, especially under tropical conditions. Fruits and vegetables provide basic food and nutritionally essential vitamins and trace elements and, moreover, have an important role in improving food flavour and acceptability.

This study, therefore, is concentrated on the perishables of plant origin and endeavours have been made to review the magnitude of losses, the places where they occur and the measures that can be taken to reduce them in the developing countries.

The findings and course of action to improve the situation are reflected in the Recommendations proposed by the Expert Consultation on Food Loss Prevention in Perishable Crops, held at FAO, Rome, in May 1980, and are listed below.

Recommendations

1. An international action programme of post-harvest food loss prevention in perishables of plant origin should be initiated. A proper balance should be maintained between post-harvest scientists and economists, engineers and food technologists in project formulation and implementation.

2. All projects designed to increase food production or improve food marketing should give consideration to the post-harvest implications of the project including both project development and project monitoring phases.

3. All post-harvest food loss reduction activities should consider the environmental impact of that activity. Environmental and health issues should be part of the documentation of project proposals and the planning process.

4. Each country should attempt to identify the principal problem areas affecting losses in perishables of plant origin occurring in its own post-harvest system with a view to establishing appropriate priority areas for action. Since the value of the product may be doubled in the post-harvest period, these value changes need to be assessed for specific crops. The scale of priorities should be compiled on the basis of the magnitude of the losses, their economic and nutritional importance and the feasibility of applying effective remedial action that is operationally and economically reasonable. A systems approach should be used in this process taking into account biological, physical, economic and social factors with reference to the various economic groups including the rural poor. There should be full participation of the expected beneficiaries in the planning of food loss reduction activities. Traditional technologies should not be ignored.

5. The use of proper temperature management procedures should be promoted. This includes simple cooling systems such as shading from direct sunlight and use of evaporative cooling.

Where appropriate, more cool stores and better utilization of existing cool stores should be promoted. The International Institute of Refrigeration should co-operate with national and international organizations to organize training in refrigeration management, design, operation and maintenance suitable for conditions experienced in developing countries.

6. The search for low cost cooling systems should beintensified. This should include the application of solar energy and other renewable sources of energy to power cooling systems. Practical research programmes should be drawn up by national and international agencies and institutes to adapt refrigeration techniques to the needs of developing countries.

7. There should be development and promotion of gentle handling of horticultural produce at all steps in the harvesting and marketing system when it is technically feasible and economically viable. This includes the development and use of improved market and field containers that are used to harvest, transport and store horticultural produce. All training manuals should emphasize that mechanical damage is the major factor in providing pathways for infection of produce by microorganisms. The avoidance of mechanical injury should be an essential criterion in the design of harvesting and handling machinery. The importance of efficient marketing systems as a factor in the prevention of post-harvest losses particularly the less durable fruits and vegetables has also to be recognized and such systems adapted to suit the requirements of efficient perishables' marketing.

8. There should be active encouragement of rigid sanitation and public health procedures of all produce handling and operation areas, sanitary operation of equipment, containers and stores, and sorting out and proper disposal of diseased and damaged units from the produce.

9. The relevant International Agricultural Research centres of the Consultative Group for International Agricultural Re-

search in collaboration with national and other international institutes should be encouraged to initiate or expand a co-ordinated programme of research to resove outstanding problems related to post-harvest factors and storage behaviour of horticultural crops, e.g., root crops. Plant breeders in these institutions should consider long inherent storage life as an important criterion of selection in the breeding of fruits, vegetables, roots and tubers.

10. Research to develop small scale drying technology or other suitable appropriate technologies for transforming horticultural crops should be promoted. The use of these technologies should be promoted where their benefits have been clearly demonstrated.

11. Every country should be cautioned against the use of hazardous protective agricultural chemicals until the following actions have been accomplished:

a) analytical laboratories and inspection services have been established to monitor the proper use of pre- and post-harvest agricultural chemicals;
b) guidelines have been developed and are being applied to educate farmers and food handlers in the proper and safe use of hazardous compounds and safe disposal of empty containers;

Information should be available in each country as to which national and regional laboratories have the facilities to identify decay organisms.

12. A variety of types of training programmes in prevention of losses in horticultural crops should be initiated. These should be designed to suit the differing needs of the people in different parts of the harvesting and marketing chain. While most training should be provided within their own country exchanges with other countries may be beneficial in some cases. The transfer of existing good storage technology from

national and international institutes to potential users should receive priority in the programmes of these institutions.

13. The following publications should be prepared:

a) technical loss prevention manuals for commodities or groups of commodities;
b) a world-wide directory of institutions and training programmes involved with prevention of losses in perishable crops;
c) guidelines for loss assessment.

14. An international information network on food losses in horticultural crops should be established making as much use as possible of existing national and international programmes to facilitate technical co-operation between similarly oriented institutions. The information to be collated in a World Directory (13 b) should form the basis for establishing International and Regional co-operation in improvement of training at all levels.

I. Rationale and Directions for Reducing Food Losses in Perishable Crops

Securing an adequate food supply has been the fundamental concern of mankind over the millenia, and even in today's modern world of great scientific and technological achievements, diets are inadequate for about five hundred million people. In the community of nations concern is increasingly focused on fulfilling the basic needs of all people, and the need for food is a dominant one. Without ensuring satisfactory diets, people cannot lead healthy and productive lives.

Agriculture, including fisheries, is the main if not the sole provider of food and the crucial question can be raised if and how far agriculture can respond to the rising demand for food in the coming decennia.

A recent study (FAO) referring to 90 developing countries representing 98 per cent of the population in the developing world (excluding China) reveals that the most striking share of increases in food demand will be caused by expanding world population. By the year 2000 fifty per cent more food will have to be available to meet present intake levels; yet additional food supplies will be needed by the end of the century to conquer famine and malnutrition. With respect to the material production inputs, which include land, water, minerals, organic substances, and energy, to meet these production targets, the availability of land will be the most limiting factor. Consequently, between 1980 and 2000 only twenty-eight per cent of the required additional crop production will be derived from area expansion and seventy-two will have to come from yield increases and more intensive cropping. This, in turn, will put more than proportional demands on water, fertilizer, pesticides, energy and managerial skills.

These figures and trends may illustrate that the case to reduce post-harvest losses, or preserving what has been produced with increasing efforts and costs, has become much stronger and will become more so in the future.

Attention to the concept of post-harvest food loss reduction as a significant means to increase food availability was drawn by the World Food Conference held in Rome in 1974. The 7th Special Session of the U.N. General Assembly in 1975 passed a Resolution calling for a 50 per cent reduction of post-harvest losses by 1985. This recognition of the potential value of post-harvest loss reduction has found practical expression in the continuing debate among a number of International Organizations and Institutions. As a result several initiatives at the international level have been taken with the special aim of making a concerted effort to reduce unnecessary losses at all the post-harvest stages of the food production process. In FAO, after consultation with its Governing bodies, food loss prevention became a priority area and an Action Programme became operational in early 1978. The

United Nations Environment Programme supports and promotes ecologically sound and sustainable development. Food loss reduction is an important activity in which UNEP has an interest, because this will increase the resource base as well as enhance the environment.

The FAO Action Programme so far has focused only on staple foods with particular emphasis on food grains, in order to make the greatest possible impact with limited resources. This should, however, not detract from other important foods where losses are known to exist in the post-harvest system. It was felt that a stage had been reached where a second large group of commodities, the perishable crops, which for reasons of their importance to human nutrition, their magnitude of production and their vulnerability to spoilage, have common characteristics and problems, should be investigated further.

To this end the United Nations Environment Programme and FAO organized an Expert Consultation on the subject. Preceding this meeting three Consultants with different background and geographical expertise visited major Centres of activities in this field and prepared three working documents.

For the Consultation itself another 15 Specialists from the various post-harvest disciplines and with a broad geographical coverage were invited. The 4-day meeting took place in May 1980 at FAO Headquarters in Rome. The complete list of people attending, or having assisted in the preparation of this Consultation, is given on Pages xvii-xix. The major task of the Meeting was to discuss and complement the information prepared by the Consultants on the present status of the post-harvest food losses occurring in perishable crops and the opportunities and means to reduce these losses.

The conclusions reached by the meeting were:

1. Post-harvest loss in perishable crops constitutes an important issue that needs increased and continuing attention at national, regional and international levels by FAO, Governments and other concerned organizations because it requires fewer resources and applies less pressure to the environment in maintaining the quantity and quality of food than through increased production to offset post-harvest losses.

2. Traditional effective methods for preventing and reducing post-harvest losses need to be identified and exploited; this includes maintenance of continuous supply, storage for restricted periods, and transformation to durable products.

Some valuable traditional technologies for food preservation are in danger of becoming lost because they are being superseded by more sophisticated methods of doubtful long-term value. Modern and technology-intensive methods should be applied appropriately according to prevailing conditions including cultural factors. Efficient and proper management of such technologies is as important as the types of equipment and facilities selected.

3. The entire food production and supply system needs to be addressed as a whole, because of the interrelationship between and amongst the different components of the system. A substantial amount of post-harvest losses have their origin in the pre-harvest stage, for example, genetic factors, infections, pest infestations, environmental factors and cultural practices during the production stage.

4. Most post-harvest losses in horticultural produce result from infection by fungi and bacteria (pre- or post-harvest), and from inherent physiological activity although insects, rodents, nematodes, and occasionally birds may cause significant losses under certain conditions. Insects can disseminate some plant pathogens and also provide wounds as points of entry for microorganisms. In general, pre-harvest applica-

tion of fungicides is more important in the control of post-harvest problems of fruit and vegetable crops than in root crops. Infections established prior to harvest are extremely difficult to control after harvest. Sanitation in all post-harvest operations is a key factor in eliminating sources of infection and reducing levels of contamination.

5. A distinction needs to be made between post-harvest losses incurred as a result of inadequate production planning (surpluses), speculation or excessive quality grading (mostly occurring in developed countries) and losses incurred due to lack of know-how, technology, or infrastructure (mostly occurring in developing countries) because the reduction of the different types of losses requires different approaches.

6. All food losses occur within a particular socio-cultural and economic environment. Techniques to reduce food losses require cultural and economic adaptations. While physical aspects are clearly most important, the subject must be considered within the wider framework of an approach whereby human as well as physical factors are taken into account.

7. Since losses are commodity and location specific, there is a need for specific activities, e.g., workshops, pilot projects, training courses, marketing studies, etc., in each country or region to address the priority problems of that area. Particular attention needs to be given to locally important commodities in each area. International assistance to developing countries in the field of post-harvest loss prevention needs to be geared to improve capability of the developing country to handle these programmes.

8. There is a need for an international information network to promote exchange of information on prevention of losses in perishable crops. Links between existing national and international institutions need to be strengthened. There is a need for a periodically annotated bibliography covering studies on post-harvest food losses in perishable commodities

and for a world-wide directory of post-harvest technology centres and personnel.

9. There is a need to establish exchange programmes (technical co-operation between developing countries) between countries of similar needs and interests but which have an apparent difference in advancement in post-harvest handling systems.

10. Proper management of temperature and humidity of root crops and certain other perishables in the initial post-harvest period is essential to good curing which improves wound healing and minimizes infection by microorganisms.

11. Refrigeration is an important tool in the temperature management of perishables. It is desirable to remouve field heat as soon as possible after harvest and to store at that temperature which will give the longest shelf-life. However, refrigeration technology should not be adopted as a panaces for all problems connected with deterioration associated with high temperature. Its introduction needs careful study, due consideration of its appropriateness and of the supporting infrastructure available within the post-harvest system, as well as the relation of refrigerated storage capacity to the collection, pre-cooling, transportation, marketing and distribution system. Special care may be needed when a complete "cold chain" cannot be maintained within this system, and where refrigerated storage would form an additional operation in post-harvest handling.

12. A key factor influencing the magnitude of post-harvest losses is the severity of mechanical damage to the crop during harvest and subsequent handling because it provides pathways for invasion by fungi and bacteria.

13. Intervention activities need to be particularly directed to those individuals involved in handling the commodity

throughout the post-harvest system and consideration needs to be given to their level of understanding.

Any innovation to reduce post-harvest losses introduced to the private sector should be accompanied by a clear financial incentive.

In exploring new technologies, due attention needs to be paid to ensuring their acceptance by producers and market operatives, particularly if the adoption of a new technology would mean the displacement of labour or a particular class of labour (e.g., women).

14. In view of the very short post-harvest storage life of cassava, research work on fresh cassava should continue but priority should be placed on research related to its transformation into stable products. Gari and cassava flour are examples of such transformed products.

In the case of yam, parallel work is necessary on the fresh product as well as on the transformed forms but with major emphasis on storage of the fresh product.

Processing or transformation of perishable crops could form a rural agro-industrial operation and assist in retaining the added value of processing in rural areas.

15. Additional research effort is needed in some areas where basic knowledge is inadequate, for example, chilling damage to tropical fruits and vegetables, the causes of deterioration of cassava, dormancy of yams, post-harvest physiology and pathology of roots and tubers, genetic improvement techniques, biological pest control, the effect on storability of chemicals and cultural practices used during the growing period. This will require the training and employment of specialized post-harvest technologists concerned with perishable crops.

16. Based on presently available information, the use of post-harvest chemicals has not shown toxicological problems. But when they are used there is need to ensure that the dosages and residues conform with internationally recommended maximum levels, e.g., of the FAO/WHO Codex Alimentarius Commission.

17. The preparation of outlines on when, where and why losses occur in selected perishable food crops is desirable but it is recognized that preparing a full methodology for loss assessment on perishables of plant origin is a complicated and time-consuming task. Diagnostic studies using an interdisciplinary approach are needed to properly identify the area where losses occur within the post-harvest system of perishable food crops.

18. There are some important issues that lie outside the immediate scope of this Export Consultation that warrant further attention, for example, preventing the possible carry-over of excessive field pesticides into the post-harvest system, agricultural chemicals that have been banned in the country of origin but nevertheless still exported, grades and quality standards for horticultural products, reduction of losses in household food preparation, and increased consideration of environmental aspects in post-harvest intervention activities related to cereals and other foods.

Annex III

The state of natural resources and the human environment for food and agriculture

Introduction

Man's demands on the natural resources that sustain his existence have increased enormously with the unprecedented rise in his numbers that has occurred in modern times. Two centuries ago the world population was probably still less than 1,000 million, and by the beginning of the present century it was only a little more than 1,500 million. But it rose to 2,500 million in 1950 and 4,000 million in 1975. Although the population is generally expected to stabilize some time towards the end of the next century, further large increases are inevitable in the meantime. Looking only as far ahead as the end of this century, the latest United Nations projections indicate a world population somewhere between 5,800 and 6,600 million, with the most probable figure around 6,300 million.[1]

The past population growth has already placed considerable pressure on natural resources, and has in many cases led to their degradation and depletion. In the future this pressure will become even greater. Merely to sustain the likely population of 6,300 million in the year 2000 at current levels of consumption would entail a further increase of almost 60 per cent in agricultural, fisheries and forestry production in the quarter of a century from 1975. Allowing for the expected rise in incomes and effective demand might raise this figure to at least 80 per cent.[2]

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1 United Nations, World Population Prospects as Assessed in 1973, Population Studies, No. 60, New York, 1977, p. 14.

2 FAO's projections of the future demand for food and agricultural products are at present being revised and updated to cover the 1990s in the longer-term perspective of the whole period up to the end of the century. A global perspective study, entitled Agriculture: Towards 2000, is now

But the demands on natural resources are likely to rise ever more rapidly than is indicated by such figures. More than 90 per cent of the population increase that is expected by the year 2000 would be in the developing countries, so that they would by then account for almost 80 per cent of the world total.[3] A very large number of people in these countries still live in abject poverty and are unable to obtain their nutritional and other basic needs. If their basic needs are to be met by means of income redistribution and other measures, and if the income gap between the developed and developing countries is to be reduced in the spirit of the Declaration and Programme of Action on the Establishment of a New International Economic Order, agricultural production in the developing countries will have to be increased at an unprecedented rate.

Even the effective demand for food in the market in these countries is rising by as much as 3.6 per cent a year[4]. Meeting the basic needs of their poorest people by the end of the century would entail a still faster increase in their production. The International Development Strategy adopted for the Second United Nations Development Decade, covering the 1970s, set the target of a 4 per cent average annual increase in the agricultural production of the developing countries. This target was reaffirmed, in respect of food production, by the World Food Conference in November 1974. Even this rate of growth would probably not suffice to meet the basic needs of the poor by the end of the century, but it would already imply that the food production of the developing countries should be doubled in the next 18 years, in comparison with the period

contd. Footnote 2
in preparation. In the meantime, the latest FAO projections of the world demand for food from 1969-71 to 1985 indicate an average annual increase of 2.4 per cent (United Nations World Food Conference Assessment of the World Food Situation, Present and Future, E/CONF.65/3, Rome, 1974, p. 79).

3 United Nations, op. cit., p. 15.

4 United Nations World Food Conference, op. cit., p. 15.

of slightly less than 25 years taken for the last doubling.

The past damage to natural resources and the greatly increased pressure on them that is to be expected in the future, especially in the developing countries, make it urgent to carry out an assessment of these resources. The productive capacities of most of the natural resources that are used for agricultural production depend on delicate physical and biological balances that man does not yet fully understand and cannot fully control. The ecological equilibrium appears to be less stable in the tropics, where most of the developing countries are to be found, than in the temperate zone. Man's capability of disturbing this equilibrium has vastly increased and, whenever a resource is used beyond its productive capacity, this results in degradation and depletion, often beyond the possibility of recovery for many generations to come. At the same time, modern agriculture is developing approaches and methods that make production possible on a sustained basis, through a better understanding of the productive capacity of natural resources under various ecosystems. It is therefore necessary to identify these approaches and methods more clearly, and to adapt them to the different socio-economic conditions of local environments.

The Seventeenth Session of the FAO Conference discussed these problems, and concluded that "the major environmental problems facing agriculture, forestry and fisheries were not only the avoidance of environmental pollution but the ensuring, in the development process, of the maintenance of the productive capacity of the basic natural resources for food and agriculture through rational management and conservation measures". It recognized that "agricultural development and world food security depended on the careful husbandry of living resources, on their biological laws and ecological balances as well as on the adjustments of production, supply and reserves to demands". It therefore endorsed the Director-General's proposal "to make periodic assessment of 'the State of Natural Resources

and Environment' as an essential complement to the existing yearly report on the State of Food and Agriculture in the field of production and economics."[5]

This chapter has been prepared as the first such assessment. It is a preliminary benchmark survey of the state of the natural resources of principal importance for agricultural production and development, and of some of the more critical problems that have arisen from man's use of these resources. Since it is aimed at a wide audience, it attempts to highlight the crucial issues, without going into too much detail on technical and management aspects. Its preparation has been made difficult by the lack of adequate basic data. For many countries data on the natural resources for food and agriculture are either completely lacking or, at best, incomplete and heterogeneous. This first global assessment therefore cannot pretend to be exhaustive, and will have to be revised and updated as improved data become available.

The main objectives of the chapter are threefold: first, to provide a broad overview of the complexity, vastness and importance of the problems of natural resource management and conservation in relation to food and agricultural production; second, to draw attention to the possibilities and limitations of the productive capacity of certain key natural resources, in relation to other resources and to the environment, for the satisfaction of man's present and future requirements on a sustained basis; and, third, to identify critical environmental issues deriving from the pressure put on natural resources, particularly in developing countries, in order to satisfy the rapidly increasing demand for food and agricultural products.

The first and main part of the chapter consists of a global overview of the state of the principal natural resources for food and agricultural production, and of related environmental

5 FAO, Report of the Conference of FAO, Seventeenth Session, Rome, 10-29 November 1973, C 73/REP, Rome, 1973, p. 57.

issues. The remainder of the chapter is necessarily much more selective. Four specific problems of the environmental impact of the intensification of agricultural production are briefly discussed: those arising from fertilizer use, pest control, pollution by forest industries, and the contamination of food and feed. Some environmental problems are to a great extent specific to certain ecological zones, and of these three are selected for discussion: shifting cultivation in the sub-humid and humid tropical zones, desertification, and land utilization problems in highland areas. After a brief review of some of the legislative aspects of environmental problems, the chapter attempts to draw some general conclusions on the state of natural resources, the different environmental problems of developed and developing countries, and some of the requirements for the better assessment and management of natural resources.

The state of natural resources

The following global overview of the state of natural resources covers soil, water, grazing land and forage, forests, wildlife, fisheries, and genetic resources. Although atmospheric resources such as air and climate are also of major importance for agriculture, they are not dealt with separately here in view of the lack of knowledge of man's influence on them. Energy resources and their use in agriculture were examined in the 1976 issue of The State of Food and Agriculture.[6]

Each of the main natural resources is of necessity treated separately, although the interrelations between the different resources are brought out as far as possible. In each case an account is given of the principal problems arising from man's activities in using the resource.

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6 FAO, The State of Food and Agriculture 1976, Rome, 1977, p. 79-111.

Soil resources

The appraisal of soil resources as a global basis has been attempted from the beginning of the century, and various estimates have been made of the extent and distribution of the world's potentially arable soils. A recent study noted that the world's arable land area could be increased from 1,400 to 3,200 million hectares, and that over 50 per cent of the unused potential was in tropical areas.[7]

Estimates of this kind have been handicapped by inadequate data for some regions and by the lack of a uniform approach, which has made it difficult to compare data from different parts of the world. Furthermore, overall estimates of "arable land" which do not specify the type of land use envisaged provide only a very rough indication of the potential of land resources. A unified approach for obtaining a more accurate inventory and appraisal of the world's soil resources has recently been developed in the framework of the FAO/UNESCO Soil Map of the World[8]. By interpreting this information in terms of major limitations for agricultural use, a general indication can be given of the distribution of soil resources and their potential for food and agricultural production.[9]

FAO is now compiling data on the extent of the land variously suited to the rain-fed production of twelve major crops at two levels of inputs (approximating to subsistence and commercial farming). The study takes into account both climatic and soil

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7 C. E. Kellogg and A. C. Orvedal, Potentially Arable Soils of the World and Critical Measures for their Use, United States Department of Agriculture, 1977.

8 FAO/UNESCO, Soil Map of the World, Vol. 1, Paris, 1964.

9 R. Dudal, Inventory of major soils of the world with special reference to mineral stress, Proceedings of Workshop on Adaptations of Plants to Mineral Stress in Problem Soils, ARS, Cornell University, AID, Washington, D.C., 1976.

conditions, and the results are to be presented by agro-ecological zones. In this way the food production potential of different regions will be determined. In the assessment, the principles of the FAO Framework for Land Evaluation are being applied, including the concept that suitability refers to use on a sustained basis and without risk of environmental degradation. Any comprehensive land use planning through land suitability assessment must take full account of the interrelations between the desired technical and socio-economic goals and the physical and biological components of the environment.

On a global basis, the main limitations to the use of the word's soil resources for agricultural production are drought, mineral stress, shallow depth, water excess, and permafrost (Table 3-1). Only about 11 per cent of the world's soils offer no serious limitations to agriculture. Europe, Central America and North America have the highest proportion of soils with no serious limitations. North and Central Asia, South America and Australasia have the lowest proportions. Drought is the dominant limitation not only on a world basis but also in Central America, Africa, South Asia, and Australasia.

The uneven geographic distribution of soil resources does not correspond to the equally uneven distribution of population. There is thus an imbalance between land potential and food and agricultural requirements in various regions of the world. The uneven distribution of soil resources may be illustrated by comparing the endowments of South America and Africa.

The dominant feature in South America is the high proportion of soils with low fertility status. Almost 50 per cent of the continent, centred on the Amazon basin and the central uplands, is occupied by such soils. Soils under semi-arid climates occupy approximately 17 per cent of the continent, covering large parts of the western and southern uplands, the low-lands and mountain deserts along the west coast, and the Andean Altiplano.

Steep lands, with limited agricultural potential, make up about 11 per cent of the continent.

In Africa, 44 per cent of the area is occupied by deserts or soils under arid and semi-arid climates. Soils with low fertility status occupy a further 18 per cent of the area. The soils of the savanna zones suffer from unfavourable physical properties and can be subject to severe erosion. Large areas with iron-stone crusts occurring at various depths in the soil are particularly threatened by erosion, since the removal of surface layers irreversibly lessens rooting depth.

Table 3-1. World soil resources and their major limitations for agriculture

	Drought	Mineral stress[1]	Shallow depth	Water excess	Permafrost	No serious limitations
	..... % of total land area					
North America	20	22	10	10	16	22
Central America	32	16	17	10	-	25
South America	17	47	11	10	-	15
Europe	8	33	12	8	3	36
Africa	44	18	13	9	-	16
South Asia	43	5	23	11	-	18
North and Central Asia	17	9	38	13	13	10
Southeast Asia	2	59	6	19	-	14
Australasia	55	6	8	16	-	15
World	28	23	22	10	6	11

Source: Data compiled from FAO/UNESCO Soil Map of the World, Paris, 1964-74.

1 Nutritional deficiencies or toxicities related to chemical composition or mode of origin.

The available evidence indicates that globally soil resources are sufficient to meet a large expansion in the current world demand for food and agricultural products. The major constraint resides in the uneven geographic distribution of these resources with respect to population density and the level of technology applied in their use. This creates imbalances between the land available for agriculture and the food requirements of a country or region, with the result that in certain areas the expansion of arable land into marginal areas may cause severe degradation and even loss of soil resources.

Soil degradation problems

Soil degradation refers to the deterioration or total loss of the productive capacity of the soil for present and future use. It has many causes, but those of most immediate concern are erosion, salinization and waterlogging, and chemical degradation.

Erosion is the washing or blowing away of surface soil. This phenomenon may take place without man's influence, but it is often accelerated when his activities cause the disappearance of the protective cover of natural vegation. Soil may be washed or blown away faster than it can regenerate, resulting in a net soil loss. The degree to which erosion takes place is influenced by a combination of factors, the most important being climate, the slope of the land, vegetation cover, the nature of the soil, and cultivation practices. Erosion hazards severely limit the range of uses to which the land may be put.

A rough idea of the degree and distribution of soil erosion in the world may be obtained from estimates of the suspended sediment loads of major rivers.[10] It appears that the most susceptible areas are the lands receiving medium to high rainfall

10 F. Fournier, Climat et érosion: la relation entre l'érosion du sol par l'eau et les précipitations atmosphériques, Paris, 1960.

with latitudes approximately between 42° north and 42° south. In tropical areas the danger of soil erosion from run-off and rain is negligible wherever dense evergreen forest is present but, as soon as it is removed, especially on slopes, serious erosion may take place. The hazard of soil erosion decreases in the temperate regions at higher latitudes where rainfall is gentler and more evenly spread throughout the year.

Table 3-2 lists the world's major rivers in terms of their mean annual yield of suspended sediment. Erosion intensity can be assessed by comparing the area of the basin with the total sediment load. The International Commission on Erosion and Sedimentation is compiling a world map on the basis of such data.

Whilst heavier sediment loads are associated with humid tropical zones, there is also a positive correlation with the relative proximity of mountains to the sea. This is especially so in Southeast Asia, Europe, South America, and generally at latitudes around 20° north.

A major problem associated with erosion and sedimentation is that of siltation, which can result in the silting up of reservoirs and streams and in the frequent clogging of irrigation channels. It is estimated that more than 1,000 million m^3 of sediment are deposited each year in the major reservoirs of the United States alone.[11] The cost of sediment removal, the dredging of steams, the purification of water supplies and the reconstitution of irrigation systems is enourmous.

Wind erosion can be a problem in all dry and semi-arid areas, as well as in areas of sloping or flat lands with seasonal rainfall. The conditions which favour wind erosion are dry loose soil with little or no vegetative cover, a relatively smooth surface, and a wind of sufficient velocity. In the

11 N. Holeman, The sediment yield of major rivers of the world, Water Resources Research, 4, 1968, p. 737-747.

semi-arid and sub-humid regions the expansion of livestock numbers and overgrazing lead to the breakdown of the traditional pastoral systems, with the result that soils are stripped of their vegetative cover and become subject to severe blowing.

Table 3-2. Major rivers of the world ranked by sediment yield

River	Drainage basin	Average annual suspended load	
	thousand km^2	million metric tons	metric tons/km^2
Yellow	673	1,887	2,804
Ganges	956	1,451	1,518
Brahmaputra	666	726	1,090
Yangtze	1,942	499	257
Indus	969	435	449
Ching	57	408	7,158
Amazon	5,776	363	63
Mississippi	3,222	312	97
Irrawaddy	430	299	695
Missouri	1,370	218	159
Lo	26	190	7,308
Kosi	62	172	2,774
Mekong	795	170	214
Colorado	637	135	212
Red	119	130	1,092
Nile	2,978	111	37

Source: N. Holeman, The sediment yield of major rivers of the world, Water Resources Research, 4, 1968, p. 737-747.

Salinization is the accumulation of salts to the extent that they have a deleterious effect on soil productivity and crop yields. Alkalinization refers to a high saturation of the

soil with sodium. The main factors affecting salinization are the aridity of the climate, geomorphology, topography, hydrology, the physical properties of the soil, and agricultural management practices.

Salt affected soils are found in every continent (Table 3-3), and it is estimated that they total close to 7 per cent of the land area of the world. In Europe only about 51 million hectares of saline soils are reported, but the potentially salt affected areas are considerably larger. The problem is very extensive in Australasia, with 357 million hectares affected, and also in the USSR, with close to 200 million hectares. Salinization is also a major problem in the Near East, although its extent in quantitative terms is not known in all the countries of the region.

Chemical degradation may occur if the nutrients in the soil are not replenished to maintain soil fertility. Particularly in the humid tropics, the climate is very conducive to the leaching and depletion of soil nutrients. As was shown in Table 3-1, while 23 per cent of the world's soils suffer from mineral stress, the proportion is as high as 59 per cent in Southeast Asia and 47 per cent in South America.

The traditional practice of shifting cultivation, aiming at the replenishment of soil fertility through long fallows (10 to 25 years, depending on the nature of the soil), has for a long time been the land use best adapted to the conditions prevailing in the humid tropics. When population growth necessitates more intensive land use, however, a reduction in the length of the fallows may result in rapid chemical degradation, and a drop in yields. Shifting cultivation is discussed in more detail in a later part of this chapter.

Table 3-3. World distribution of salt affected soils

Region	Area	
	thousand ha	% of total land area
North America	15,755	0.9
Central America	1,965	0.7
South America	129,163	7.6
Europe	50,804	4.6
Africa	98,521	3.5
South Asia	85,108	7.9
North and Central Asia	211,686	7.2
Southeast Asia	19,983	5.9
Australasia	357,330	42.3

Source: Data compiled from FAO/UNESCO, Soil Map of the World, op. cit.

While the problem of soil degradation is of great magnitude, no comprehensive appraisal has yet been made. A global assessment of both actual and potential soil degradation is now being undertaken by FAO, with the support of the United Nations Environment Programme UNEP).

Environmental impact of intensification of agriculture

The above survey of the state of natural resources for food and agricultural production has drawn attention to the many ways in which the intensification of production has led to the degradation and depletion of these resources. In addition, some aspects of the intensification of agriculture and of related forest and agro-industries may create specific pollution problems in the environment. The problems arising from the use of fertilizers and pesticides and from forest industries are briefly reviewed below. There is also a brief discussion of the contamination of food and feed from various sources.

Another problem arises from the use of agricultural and agro-industrial wastes and residues. A recent UNEP/FAO seminar which reviewed the global availability of such materials for recycling concluded that it was difficult to identify the extent of pollution or environmental problems deriving from them.[12] A review of this subject must therefore await the analysis of the data that are at present being collected, although some mention is made below of the problems involved in the use of these and other organic materials as fertilizer.

Fertilizer use

Especially in view of the very rapid increase in the use of mineral fertilizers, concern has been expressed about the possible side-effects of intensive fertilizer use on the environment. Because of the crucial importance of effective fertilizer use for the expansion of food production,[13] it is essential to examine the grounds for these fears.

The world consumption of mineral fertilizers has quadrupled during the last two decades, increasing from about 22 million tons of plant nutrients (N, P_2O_5 and K_2O) in the early 1950s to 89 million tons in 1975/76. However, although there is intensive use in developed countries, consumption remains low in the developing world. The total consumption in all of the developing countries taken together (including China and the other Asian centrally planned economies) is approximately equal to that in North America alone.

In a recent study of the effects of intensive fertilizer use on the environment in countries where consumption is steadily

12 UNEP/FAO Seminar on Utilization and Management of Agricultural and Agro-Industrial Wastes, Rome, 18-21 January 1977.

13 It will be recalled that Table 3-1 indicated that about 23 per cent of world soil resources suffer from mineral stress, with proportions as high as 59 per cent in southeast Asia, 47 per cent in South America, and 33 per cent in Africa.

rising,[14] it was concluded that, when fertilizers are properly applied, their contribution to the loading of surface and groundwater in nitrogen, phosphorus and potassium is smaller than that coming from other sources. Where detrimental effects were observed, they were related to excessive use, and could be corrected by the careful adjustment of applications to the requirements of soils and plants. On the other hand, the efficient use of fertilizers can also benefit the environment indirectly in that, by increasing the yield per hectare of good land, it allows the withdrawal from cultivation of land of low inherent quality that otherwise would be prone to such hazards as erosion.

Since not all the nutrients applied are taken up by the crop, the fate of fertilizer residues must be given due consideration. They can remain in the soil, be removed in drainage water, or be lost to the atmosphere by volatilization. The three major crop nutrients behave quite differently under intensive use in soils.

Only a negligible proportion of fertilizer phosphorus is leached from soils into drainage water, since it is very immobile in most soils. It can, however, be carried into rivers, mainly through soil erosion, having first been absorbed on soil particles. Similarly, only a small proportion of fertilizer potassium can be lost by leaching, because most soils hold most of the added potassium sufficiently strongly for only very little to enter the soil drainage water.

Nitrogen is the most likely fertilizer element to be leached out of the soil, but there is very limited evidence that this has had an appreciable effect on the composition of groundwater or streams. Researchers recognize, however, that it is technically difficult to interpret specific changes in water com-

14 FAO/SIDA, Effects of Intensive Fertilizer Use on the Human Environment, FAO Soils Bulletin No. 16, Rome, 1972.

position, since the whole process is complicated by related biological activities and the release of various other industrial, urban and rural effluents in the drainage system. Run-off and soil erosion can be a main factor in the enrichment of surface waters in plant nutrients, especially where steeply sloping lands are cultivated. The intensive use of fertilizers should therefore be combined with proper soil conservation practices.

Recent research results indicate that nitrogen oxide (N_2O) released into the atmosphere through a number of man's activities can be carried by air motions in the stratosphere, and contribute to the depletion of the ozone layer. The denitrification of nitrogenous fertilizers used for intensive cultivation is often mentioned as one of the causes. A recent UNEP expert meeting, however, came to the conclusion that more research is needed to identify those human activities contributing most to the release of N_2O in the atmosphere.[15]

Possibly undesirable effects on the environment will be minimized if fertilizers are used with maximum efficiency. The correct choice of fertilizers and their application at the correct time and in optimum quantity for crop yields are all important considerations. In most developing countries, the threshold at which fertilizer applications would be in excess of actual requirements is far from being reached. At present only 15 per cent of the total world consumption of mineral fertilizers is used in developing countries, although they have 70 per cent of the world population. There is still plenty of room for the further intensification of fertilizer use in these countries.

The constraints on the increased use of fertilizers in the developing countries are well known. They include the lack of fertilizer supplies at national or village level, lack of

15 UNEP, Meeting of Experts Designated by Governments, Inter-Governmental and Non-Governmental Organizations on the Ozone Layer, Washington, D.C., 1 - 9 March 1977.

knowledge among small farmers, low prices for farm products, high fertilizer prices, and the shortage of credit facilities. Under these circumstances, any fear of a negative impact of fertilizers in these countries is premature.

Organic fertilizers

Organic materials represent a rich and underexploited source of fertilizer, especially in the developing countries. It is estimated in Table 3-4 that about 113 million tons of plant nutrients were potentially avilable in these countries in 1971 in the form of organic residues. This is about eight times the 13.5 million tons of mineral fertilizer used in the same countries in 1970/71. This enormous potential supply of organic plant nutrients in the developing countries also considerably exceeds the present total world supply from mineral fertilizers. In combination with the limited amount of mineral fertilizer available to the developing countries, it could contribute substantially to increasing their agricultural production. Its greater use would be especially beneficial in tropical areas, where organic matter is an essential component of soil fertility and stability.

The storage and disposal of organic waste products are not without problems, and hygienic and pollution hazards need to be taken into account. Drainage or run-off water leaving the farm may pollute sources of drinking water, and may carry with it considerable amounts of phosphate and nitrogen from manure heaps. Special care therefore needs to be taken to prevent soluble organic compounds from getting into drainage ditches and surface water. The amounts of manure or slurry spread on the land must be determined on the basis of the absorptive capacity of the soils and the nutrient requirements of the crops to be grown. With the use of sewage sludge, attention must also be paid to the content of heavy metals, which may in the long run accumulate in the soil at toxic levels.

Table 3-4. Availability of plant nutrients in organic residues in developing countries[1], 1971

Source	N	P_2O_5	K_2O	Total
	..... million metric tons			
Human	12.3	2.9	2.6	17.8
Cattle	11.4	3.1	9.0	23.5
Farm compost	9.5	3.3	9.5	22.3
Urban compost	0.5	0.4	0.6	1.5
Urban sewage	1.4	0.3	0.9	2.6
Other[2]	6.6	4.5	11.4	22.5
Total	41.7	14.5	34.0	90.2

1 Excluding central America and developing countries in Oceania, but including Asian centrally planned economies.

2 Bone meal, poultry, sheep and goat litter, bagasse, oil cake, press mud.

The use of manures, compost and night soil as a plant nutrient can be combined with the production of biogas (methane).[16] The process reduced the loss of organic matter through decomposition and stops nitrogen losses. At the same time, it provides gas for cooking and reduces the requirements for fuelwood, the collection of which is, as already noted, a serious threat to forest resources in some parts of the developing world.

Symbiotic nitrogen fixation

In the context of the possible pollution of the environment as a result of excessive applications of fertilizers, it is necessary to consider the possibilities of economizing in their use. One way of doing this is by making fuller use of the fixation of atmospheric nitrogen by nodulated legumes through their symbiosis with the Rhizobium bacteria. This is an important source of soil nitrogen, which in some cases may increase the nitrogen

16 For a fuller discussion, see: FAO, The State of Food and Agriculture 1976, op. cit., p. 88, 92.

available for subsequent crops. It should in fact be considered as a significant component of the natural resources for food and agricultural production. Its more effective use gains even greater relevance in the light of the high price of mineral fertilizers in relation to the purchasing power of small farmers in developing countries, and the present dependence of the manufacture of nitrogen fertilizers on feedstocks deriving from fossil fuels.

Results obtained in certain countries have shown that the potential of tropical legumes for fixing nitrogen is as high, or almost as high as that of temperate ones.[17] In the temperate zones, pastures of white clover and ryegrass can fix the equivalent of 250 to 400 kg/ha of nitrogen per year. In the tropics, several legume and grass mixtures are known to fix 200 to 250 kg/ha per year, and some much higher figures have also been obtained. An indication of the potential is the wide variety of pulse crops grown in the developing countries, especially in Asia, as a major source of protein. The total harvested area of such crops in the developing countries (including the Asian centrally planned economies) is estimated as about 60 million ha in 1976.[18]

The greater and more effective use of symbiotic nitrogen fixation in developing countries is now being given increased attention. In cooperation with UNEP, FAO has made an assessment of the potential in several countries of Africa and Latin America.[19]

Inoculation with Rhizobium bacteria can be used to improve the nodulation of traditionally grown crops, or when a new crop is

17 Shaw and Bryan (eds.), Tropical Pasture Research, Commonwealth Agricultural Bureau Bulletin, 1976.

18 FAO Production Yearbook 1976, op. cit., p. 116.

19 FAO/UNEP, Development of a Programme Promoting the Use of Organic Materials as Fertilizers, Rome, 1976.

introduced into an area where the specific Rhizobium is not present. Lotononis, Desmodium and Centrosema are examples of forage legumes which require a specific strain, in the absence of which they will obtain their nitrogen from the soil. Soybeans are a similar example among crops of major economic significance. They are indigenous to the Far East, and when they are grown in other parts of the world it is essential to inoculate them with their specific Rhizobium strain. It is estimated that the fixation of atmospheric nitrogen by well-nodulated soybeans can reach from 25 per cent to more than 50 per cent of the total needs of the crop.[20] The persistence of the specific Rhizobium in old fields is limited, so that it is necessary to inoculate soybeans at sowing. This can be carried out at low cost, and is now a common practice.

Field studies have also shown that, within certain Rhizobium strains, there are some which are more efficient than others. By the use of plant breeding, it is therefore possible to obtain a more efficient symbiosis. In general, however, there is still insufficient knowledge and practical experience of how to make better use of symbiotic nitrogen fixation. For example, in some countries 150 kg/ha of nitrogen fertilizer is used to grow lucerne, while in others with similar ecological conditions none is required. Nevertheless, it is essential to consider the inoculation of legumes with their appropriate Rhizobium strain as one of the inputs required for higher production.

The possibility of extending nitrogen fixation to non-legume crops is also promising.[21] Some cowpea strains of Rhizobium can form abundant nitrogen-fixing nodules on the small non-legume bush Trema cannabina. Casuarina trees, which are very useful in semi-arid areas as shelter belts to prevent soil ero-

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20 J. R. Jardini - Freize, in FAO/UNEP Report on Biological Nitrogen Fixation (in the press).

21 P. J. Dart, Recent Development in the Field of Biological Nitrogen Fixation, CGIAR, TAC, 14th Meeting, Hyderabad, 14 - 18 October 1976.

sion, have been found to have nitrogen fixing non-legume nodules formed by actinomycetes. In Senegal, casuarina trees can fix up to 60 kg/ha of nitrogen per year.

The role of blue-green algae in biological nitrogen fixation is also hopeful. It is estimated that algae associated with a water fern (Azolla) in rice paddies contribute more fixed nitrogen than the root system of the plant, which fixes around 0,05 kg/ha per day.[22] Nitrogen balance studies at the International Rice Research Institute (IRRI) and elsewhere indicate that an average of 60 kg/ha of nitrogen can be taken up by a rice crop, other than that from fertilizers.

Pesticide use

Pests[23] represent one of the major constraints on agricultural production. Until effective means of control, in the form of synthetic organic pesticides, became generally available, cultural controls such as crop rotation and field clearing were almost the only means of reducing their impact. Some of the changes associated with the intensification of production, such as greater reliance on monoculture, increased fertilizer use, improved water management, multiple cropping, the use of a smaller number of crop varieties, and reduced tillage, in fact create conditions which can increase the danger of pest attack. For example, in the United States, notwithstanding the considerable increase in the use of plant protection measures, the total losses from pests appear to have increased in the last 30 years both in absolute terms and as a proportion of the value of the crop.

Various attempts have been made to estimate the magnitude of the losses caused by pests, but the results are still far from

22 Idem, Biological Nitrogen Fixation, CGIAR, TAC, 8th Meeting, Washington, D.C. 24 July - 2 August 1974.

23 Including weeds, insects, mites, rodents, birds, nematodes, bacteria, fungi, viruses, and other plant pathogens.

satisfactory. FAO has recently established a programme to collect further information. In general, the losses due to pest attack are put at between 20 and 40 per cent on a worldwide basis. In developing countries, where pesticides are only lightly used and other methods of control as yet poorly developed, the losses are probably still higher.

Chemical pest control

Over the past three decades, pesticides have made very substantial contributions to the great expansion in agricultural production and productivity. Particularly in developing countries, where their use is so far quite small, requirements are likely to continue to increase for many years to come. Replies from 38 developing countries to a questionnaire sent out by FAO indicated a total 1973 consumption of 162,000 metric tons.[24] This represented an increase of 23 per cent a year since 1971, while the future increases in these countries were estimated at about 10 per cent a year, this lower figure resulting mainly from increased costs. In many developing countries herbicides are barely used at present, and their use is expected to increase more rapidly than for any other class of pesticide. Moreover, only a very small part of the estimated 20 per cent of total world consumption of pesticides that is accounted for by the developing countries is used for food crops.

Nothwithstanding the considerable efforts being made to optimize pesticide use through integration with biological and cultural controls, the continued need for an expanding use of pesticides must be recognized. This was the conclusion of the FAO Ad Hoc Government Consultation on Pesticides in Agriculture and Public Health, held in 1975. It specifically

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24 Pesticide Requirements in Developing Countries, Summary of Replies to 1975 FAO Questionnaire, Ad Hoc Government Consultation on Pesticides in Agriculture and Public Health, Doc. AGP:PEST/PH/75/B44, 1975.

recommended that further attention should be paid to raising efficiency in methods of distribution and use, to providing training and generally raising competence in monitoring the presence of residues, and to monitoring and evaluating the importance of environmental impacts of uses in developing countries.[25]

Efforts are being made to implement these recommendations through various components of the FAO Pesticides Programme. A number of countries are being assisted in the establishment and administration of schemes for the registration and official control of the introduction and use of pesticides. Training courses in safe and efficient use are organized. Official laboratories are being assisted to raise their competence in the detection and measurement of residues in food and other substrates. The statutory groups of experts that provide advice on official control of pesticides, on the occurrence of residues in foods, on impacts on the environment, and on the development of resistance of pests to pesticides have recently been reconstituted.

It must be recognized that over-dependence on pesticides, particularly in some developed countries with intensive agricultural systems, has led to considerable problems, including the development of pest strains resistant to the chemicals used for their control, the destruction of natural enemies of pest species, the expansion of populations of species not previously regarded as pests, the occurrence of unwanted residues, and other undesirable environmental effects. But the knowledge that has become available from studies of these effects now provides a much sounder basis for planning for the future.

The experience of the last 30 years has led to the re-shaping of concepts of pest control. Greater emphasis is now being

25 FAO, Report of the Ad Hoc Government Consultation on Pesticides in Agriculture and Public Health, 7 - 11 April 1975, Doc. AGP:1975/M/3, Rome, 1975.

placed on the study of the complex made up by the crop, the pest, and the natural enemies of the pest, and on crop management strategies that minimize dependence on chemicals, using them to supplement cultural and biological methods rather than to supplant them. There is also greater emphasis on the introduction of pest resistant crop strains, and on possible new departures such as the use of attractants, repellents and hormones as pest control agents. This broad multidisciplinary approach to practical pest control has come to be referred to as integrated pest management.

Integrated pest management

It has become evident that nature can play a much more important role in the control of pests than was previously thought. Even with pests causing regular damage to crops, parasites and predators can cause considerable mortality. Such a situation should be fully exploited, and should not be disturbed, for example by the indiscriminate use of pesticides.

In the developing world, where food crops are almost entirely produced on a small farm basis, there are good opportunities to promote the principles of integrated pest management from the beginning. These principles include the application of pesticides only when needed and in a way which avoids killing natural enemies (ecological selectivity); the development and introduction of pest-resistant crop varieties; the adoption of suitable agricultural practices; biological control, such as the use in China and various Latin American countries of artificially multiplied parasites to control certain caterpillars; and the correct forecasting of pest development.

Integrated pest management has been successfully introduced, for example, in certain cotton-growing areas, including Nicaragua, Peru and the United States. This experience has de-

monstrated that the amount of pesticides needed to control cotton pests effectively may be reduced by more than 50 per cent.[26] In Central America the sole reliance on pesticides, with up to 40 applications per season, created serious environmental contamination, including the development of pesticide-resistant plant pests and vectors of malaria, and the elimination of natural predators.

A Panel of Experts on Integrated Pest Control was established by FAO in 1966, and the FAO/UNEP Cooperative Global Programme for the Development and Application of Integrated Pest Control in Agriculture was initiated in 1975. This programme provides for the setting up of inter-country programmes on major crops, including demonstration and training, applied research, and assistance in the implementation of knowledge at the farm level.

New regulations adopted in many countries will already reduce, to a large extent, the shortcomings of pesticides use as they were revealed in the past. Moreover, the gradual adoption of integrated pest management practices will further optimize the use of pesticides. It must, however, be recognized that it will still need considerable efforts to permit the full effective use of these new approaches.

Because of their effectiveness and easy use, pesticides will remain essential elements in crop protection programmes for the foreseeable future. Continued efforts must be made to ensure that they supplement rather than supplant good crop and pest management practices, and that they are distributed and used with maximum efficiency and safety to man and the environment.

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26 L. A. Carruth and L. Moore, Cotton scouting and pesticide use in eastern Arizona, Journal of Economic Entomology, 66, 1973, p. 187 - 190.

Pollution problems of forest industries

The pulp and paper industry has had a bad reputation in public opinion as a gross polluter, especially of rivers and lakes into which untreated effluent was discharged. In recent years, the environmental issue has become widely recognized and the industry has been under heavy pressure by environmentalists and legislators to reduce the harmful effects of both liquid effluent and atomospheric discharges. In some countries very strict laws have been passed and are rigidly enforced. In developing countries, the tendency is to undertake some form of environmental impact assessment and to plan control measures case by case.

The processes used to reduce liquid effluent pollutants include the settling of solid matters as a first step, followed by biological treatment and, as a last step in some cases, colour removal. Internal measures, such as the reduction of water consumption through its efficient recirculation and the recovery of pulp and liquor spills, are very effective means of reducing effluent pollution, and this methods is employed by most new mills. New bleaching processes also reduce the worst source of pollution. Atmospheric pollutants, particulate matters and obnoxious gases are treated by scrubbing devices, chemical treatment, and burning.

As a result of all these measures, pollution from the pulp and paper industry has been drastically reduced. After the completion of the abatement programmes now being carried out in at least the main producing countries, the point will soon be reached where the pulp and paper industry is no longer a major hazard to the environment. However, this will not be achieved without considerable cost. The installation of pollution abatement systems is a heavy financial burden for the industry, and cannot be accomplished without affecting product prices. In some cases it has not been financially possible to eliminate effluent discharge from old mills, and this has caused the closure

of the operation and consequently unemployment. It must therefore be understood that there is a price to pay for a clean environment.

Among the mechanical forest industries, fibreboard manufacturing is technologically the closest to the pulp and paper industry. If adequate purification facilities are not installed, wet process fibreboard mills are often a source of considerable water pollution. Good progress is reported from various parts of the world in the implementation of the most efficient and economical ways of water pollution abatement in fibreboard industries. In addition, during the last few years several mills have achieved the complete closure of the 'white water' system. This requires additional expenditure on investment and operation, and also affects certain characteristics of the final products. It has, however, paid off handsomely in densely populated areas with scarce water resources, where fibreboard mills were faced with the possibility of closing down if they continued to pollute.

Another means adopted by fibreboard industries for coping with water pollution has been the application of the dry method of manufacture, which does not require water for the forming of the fibre mat and therefore causes no water pollution problems. There are, however, disadvantages in using this system. Synthetic adhesives are needed as an additive in the manufacturing process, and there is considerable air pollution.

Other mechanical wood product industries (sawmilling, and plywood and particle board manufacture) do not produce substantial amounts of toxic wastes, but their disposal of organic waste (bark and wood particles) can create pollution problems in waterways, due to oxygen depletion. However, these problems can be alleviated by the use of the organic wastes. Residues from sawmilling can be used for pulp and board manufacture, or as fuel.

Food and feed contamination

In recent years the intensification of production, the increased use of storage, and the centralized processing, distribution and handling of food and feed have created greater potential hazards of chemical or biological contamination. Chemical contamination is more characteristic of the present industrial era. Biological contamination is mainly due to underdevelopment and poverty, and can often become endemic.

Chemical contamination of food and feed may originate from industrial activity, industrial wastes, chemicals and pesticides used in agriculture which find their way into the food chain, and toxic metals such as lead, cadmium or mercury arising also from pressing, packaging, seed dressings or accumulations. Biological contamination is caused by pathogenic micro-organisms such as salmonella, enterotoxin producing bacteria, and various parasites and fungi.

Greater awareness of the problems of food and feed contamination and its contribution to health hazards and economic losses has emerged during recent years. Spectacular and tragic accidents, like Minamata and Niigate in Japan, resulting in aquatic pollution with mercury and its resultant uptake and accumulation by edible fish, have helped to highlight these problems. Other examples have included the findings that "itai-itai" disease in Japan was the result of environmental contamination provoking high levels of cadmium in food over long periods of time; the accidental use of mercury treated seed wheat as human and animal feed in Iraq; and the accidental admixture of polybrominated biphenols with cattlefeed and the consequent loss of thousand of coew and over 1 ½ million chickens, pigs and sheep in the United States. It is estimated that 71 per cent of the outbreaks of food-borne diseases in the United States in 1969 resulted from contamina-

tion of food by pathogenic micro-organisms.[27] Food is a good indicator of the quality of the environment in which it is produced, and has often been the trigger which has set natural resources protection measures in motion.

As a result of a series of such mishaps, added to a more general awareness of the problems of the environment and of the need for the protection of food, systematic food contamination monitoring now exists in many industrialized countries. The results of such monitoring have already proved useful, for example in the United Kingdom with lead in infant foods, in Sweden with mercury in fish, and in Canada, the United States and a number of European countries with pesticide control.

In the developing countries the main problems of food contamination are found in the sub-humid and humid tropical zones, where they arise mainly from contaminants of biological origin, such as parasitic infections in livestock, enterotoxin producing staphylococci, coliform bacteria, and the group of enterobacteriaceae. The lack of scientific knowledge and of an appropriate infrastructure for food control has also been responsible for several large-scale accidents of food poisoning in these zones. A major problem that has been increasingly recognized during the past two decades is that temperature and atmospheric humidity favour the development of fungi and the production of toxic metabolites (mycotoxins).

The classic example of the effects of a mycotoxin is the ergot poisoning that, during the Middle Ages and sporadically since that time, has resulted from the consumption of cereal grains infected with the parasitic fungus Claviceps purpurea. In 1942-47 there were numerous deaths in certain communities in the USSR associated with the fungi present in overwintered

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27 W. H. Booker Jr. et al., Food-borne disease surveillance, Washington State, American Journal of Public Health, 64(7), 1974, p. 854 - 859.

mould grain. Nevertheless, the hazards from these and other moulds continued to be largely ignored. Then, in the early 1960s, over 100,000 turkeys died after eating groundnut cake contaminated with the mould Aspergillus flavus. Epidemiological data support the hypothesis of a causal role for aflatoxin, the toxic metabolite of this mould, in the aetiology of primary liver cancer in Africa and southeast Asia, where the disease is common. Toxicity data are scarce for man, but a recent report from India indicated that in 1976 over 100 people died after consuming mouldy maize for a period of about two months, with an average daily consumption of aflatoxin of about 6 mg[28]. Although the mycotoxin problem is more acute in the tropical and subtropical countries, it is not confined to those areas. Other mycotoxins such as ochratoxin, zearalenone and the trichothecene toxins have been demonstrated to be responsible for adverse effects in animals and man on a worldwide basis. Outbreaks of mycotoxicoses in farm animals have been reported in many countries of the temperate zone.

In the developing countries the economic losses caused by the contamination of food and feed can often be of great significance. The introduction of tolerance limits for aflatoxin by many importing countries has led to reduced export earnings for crops such as groundnuts, and sometimes the total loss of the import market. Millions of tons of food and feed are lost every year because they are not sufficiently protected against insects, rodents, and microbiological and man-made chemical pollutants. These losses are especially important in developing countries, because they add to the extent of malnutrition.

Problems relating to fish and fishery products cover a large number of natural and artificial contaminants. Chemical con-

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28 K.A.V.R. Krishnamachari, R. V. Bhat, V. Nagarajan and T.S.B. Tilak, Investigations into an outbreak of hepatitis in parts of western India, Indian Journal of Medical Research, 63, 1975, p. 1036-1049.

tamination has affected some fisheries, where accumulation through the food chain has caused levels in certain products to exceed the standards adopted by some countries. Trace metals may also be a problem.

Measures for the control of food contamination through environmental pollution consist of monitoring and surveillance, and the strengthening of food control activities. Several developing countries are seeking to start such programmes. The FAO/WHO Codex Alimentarius Commission has been developing international food standards both to protect the consumer and to facilitate trade, and these standards contain provisions for maximum levels or residues of certain important contaminants. FAO, WHO and UNEP are also developing a Joint International Food and Animal Feed Contamination Monitoring Programme. The major objectives of this programme are to determine global trends of food contamination; population groups that may be at high ris; the geographical spread of certain specific highly toxic contaminants; the total intake of such substances via food; the total exposure to a contaminant through air, water and food; the extent and trends in the contamination of food by biological agents; and to provide information to those responsible for the development of international food standards containing a contaminant component.

A significant trend in both national and international lawmaking in this field has been the broadening scope of legal rules, from a use-oriented to a resource-oriented perspective. Some countries have attempted the comprehensive cofidication of all rules relating to renewable natural resources and environment protection, in a single natural resources or environment code. Others, while retaining separate legal instruments for different categories of resources, have introduced substantive reforms, with a change in emphasis from the police functions to the management functions of the law, and to new incentives for compliance; from classical nature protection to natural resources conservation; from water and air pollu-

tion controls to general anti-pollution acts; from provisions for specific dangerous chemicals, such as pesticides, to the regulation of all potentially harmful substances; and from laws protecting particular species of animals and plants, to trade controls over the primary and secondary products derived from them.

At the same time, besides re-allocating administrative competence between existing and new institutions, a growing number of countries have enacted framework legislation laying down general policies and procedures for environmental management, including citizen participation in decision-making. The regulatory systems developed for this purpose usually require either special licences or environmental impact statements for all activities involving potential environmental risks. At the international level, a combination of legal restrictions with compulsory licencing and joint technical measures has been developed, for example for the control of waste dumping in ocean and inland waters. There is also a tendency to establish (by law, and in some cases by international agreements) functional administrative units for ecological areas which are either particularly suitable for resource management (e.g., self-governing water basin authorities) or particularly endangered (e.g., nature reserves and parks).

There now are more than 40 multilateral conventions dealing with natural resource management and conservation. These have especially concerned the marine environment. While a number of these treaties are global in scope (possibly culminating in a future convention on the law of the sea), the main advances in recent years have been made at the regional level. In particular, a number of new legal instruments have been created (and existing agreements revised) for the joint management of inland water resources and ocean fisheries, and for environmental protection in special marine regions such as the Baltic, the Mediterranean and the Red Sea. Together with bilateral agreements on shared resources and trans-fron-

tier pollution, and witht-the related declarations, recommendations and standard-setting activities of several international and regional organizations, these instruments may be considered as part of the growing body of international environmental law. Besides serving as secretariat for several of the institutions concerned, FAO has contributed to the development of new methodological approaches in this field by way of information exchange, legal drafting assistance, and the organization of expert meetings and intergovernmental conferences.

Conclusions

This preliminary survey of the state of natural resources and the human environment for food and agriculture brings out the wide variations that exist in the use and conservation of these resources. At the global level, the world's natural resources appear to be adequate for mankind's likely needs. However, they are unevenly distributed in relation to the population and its demands on them, and their utilization thus creates environmental problems in particular areas. These problems frequently differ in both nature and degree as between the developed and developing countries.

In the developed countries the unprecedented rise in levels of living has brought very heavy demands on natural resources from both the industrial and agricultural sectors. It has stimulated the development of highly industrialized, energy-intensive agricultural systems, in order to maximize the productivity of natural resources. This has created problems such as waste disposal, which have necessitated technical and legal measures and comprehensive planning to reduce the adverse environmental impact. Moreover, agricultural processing and service industries, like other industrial activities, have caused the pollution of land, water and air, and the contamination of food and feed.

In the developing countries, on the other hand, the major environmental concern is not so much the pollution of natural resources as their degradation or depletion. The rapid increase in the population of these countries has placed great pressure on natural resources. The consequent drive to intensify production has caused the dislocation of traditional agricultural systems, and has led to sometimes over-hasty attempts to replace them by modern agricultural systems and technologies that are not compatible with the prevailing ecological and socio-economic conditions. Many of these changes are taking place in tropical ecosystems that are more fragile than those of the temperate zone. Full scientific knowledge of the productive capacity of the natural resources in these ecosystems is still lacking.

Althoug the environmental problems of the developed and developing countries are thus different, their experience in overcoming them could be mutually beneficial, especially in the light of the energy crisis. There are a number of main types of action that are required at the national and regional levels, particularly in the developing countries, for the assessment of natural resources and for their national management so that the demands on them can be met on a sustained basis.

It is necessary to reduce the knowledge gaps in the assessment of natural resources, by means of adaptive research on the introduction of new technologies in traditional agricultural systems. Multidisciplinary research is particularly required on the effects of environmental factors and technological inputs on the physical and biological productivity of tropical agricultural systems. More emphasis should be placed on the application of research findings at the field level under specific local socio-economic conditions.

A further requirement for the improved assessment of natural resources is the development of coherent networks of data on

these resources. Sectoral surveys and inventories are essential, but they should increasingly be part of and compatible with a broader scheme for the full assessment of the relationships between man's activities and the state of natural resources. Local ad hoc monitoring should be undertaken whenever there is a major change in the use of a resource, and the data collected should be used to assess the environmental impact.

As regards the more rational management of natural resources, a major need is for integrated land use planning. Such planning should be comprehensive enough to link both physical and socio-economic requirements, and should aim to guide rural development programmes towards the rational management of natural resources for increased productivity. It should be dynamic and flexible, so that plans can be continuously adapted to development requirements, keeping in view not only the immediate goals but also the productive capacity of natural resources on a sustained basis. Plans should also be adapted to new technologies, and revised according to the findings of new research and surveys. A large part of the planning should be carried out at the local level, involving local communities and taking into account the diversity of the rural environment.

In view of the heavy pressure that is indiscriminately put on land resources, especially in developing countries, to meet the increasing demand for food and agricultural products, it is important to concentrate the intensification of agricultural production as far as possible in the most suitable areas. This will reduce the pressure on marginal lands which are ecologically fragile and subject to rapid degradation if they are exploited beyond their productive capacity. The more suitable areas should be developed through sound soil and water conservation and land use practices, taking account of the ecological limitations and the demands of the local population for socio-economic development.

A further requirement for more rational management is the promotion of well-adapted systems of production that integrate modern technology with the traditional systems of resource management. In many areas there is a move away from traditional uses of natural resources in agriculture. During the transition stage, many valuable components of the old systems (which usually take account of the need for the balanced use of resources) are discarded. More attention has been paid in recent years to the integration of the modern technologies required for the intensification of production with traditional production systems. It is necessary, however, to promotoe the exchange of information on promising new approaches based on traditional systems, and to guide and assist small farmers to a better understanding and utilization both of natural resources and human skills. Farming systems that closely associate crop and animal husbandry, and agri-silviculture and aquaculture are particularly appropriate. The aim should be to help small farmers adopt self-reliant systems which make full use of local traditional knowledge, experience and custom.

In conjunction with the application of improved technologies, it will be necessary to develop adequate rural institutions and infrastructures, including extension, credit and marketing services that are adapted to the needs of small farmers. It must be recognized that it is particularly difficult for extension and other services to train small farmers in developing countries in appropriate agricultural practices and in the safe use of new technologies. This is mainly because of the large number of people and production units involved, and the scarcity of production means and of trained personnel, but another less frequently recognized factor is the rapidity with which changes are occurring in the rural areas of the developing countries. This has a strong bearing on the degradation of natural resources. In order to prevent millions of farmers from damaging the productive capacity of the resources at their disposal, it is urgently necessary to disseminate and apply the

information and experience already available, and to provide them with the means for achieving increased productivity on a sustained basis.

At the same time, it is necessary to develop a legal system to define the rights and duties of individuals or groups in relation to the utilization of natural resources in the light of their ecological limitations. The legal framework for this purpose has to be flexible enough to take account of the traditional system of regulatory power, as well as changes in the pattern of resource use. A mechanism is also required for the rational planning, implementation and monitoring of the use of natural resources from national to village level.

Education on the better management and conservation of the natural resources used in agriculture is another requirement. It should aim to make the general public aware of the ecological limitations on the potential of natural resources, of the need to utilize these resources in a rational manner, and of the rapid degradation which may occur through reckless management.

At the more technical level, education for improved resource use should provide administrators, decision-makers, extension officers and small farmers with a sound knowledge of all the operational aspects of good resource management. This should include not only the technical aspects, but also their relationship to the socio-economic environment in which they must be applied.

In addition to these general requirements for action in such fields as research, data collection and monitoring, planning, institutions and services, legal systems, and education and training, it is possible to identify a number of specific major problems on which a concerted attack is urgently required. The priority areas mentioned below are divided into measures for the more rational management of natural resources, and measures to combat the existing degradation and loss of these

resources. In all cases, appropriate solutions are already available, but they have to be further developed and promoted.

In the former category concerning more rational management, mention has already been made of the need to concentrate the intensification of production on the most suitable land. More generally, the improvement of soil fertility should be pursued through the judicious combination of the efficient use of mineral fertilizers with the recycling of organic materials and the wider use of nitrogen fixing organisms. Improved genetic materials should be developed by making full use of the existing genetic variability and gene combinations in locally adapted strains. Techniques of integrated pest management should be promoted. Wherever feasible, crop and animal husbandry should be integrated, and agri-silviculture developed. High priority should be given to the rational management of grasslands in arid and semi-arid areas and of tropical forests.

With respect to the existing degradation and loss of natural resources, the highest priority attaches to the control of soil erosion, soil salinity and desertification and the conservation of fish stocks and of genetic resources. Soil erosion must be controlled and eroded land reclaimed on a watershed basis, through appropriate practices for the management and conservation of soil and water resources. Salinization should be controlled and saline soils reclaimed through proper irrigation practices and drainage systems. Desertification control requires the management of vegetation according to ecological principles, including massive programmes of reforestation. The pressure on marine fish stocks can be reduced not only by agreed international measures but also by the development and promotion of aquaculture. A further major priority is for the conservation of endangered genetic resources.

Progress in the various areas outlined above requires action at many levels, from government action at the national and international levels to action at the level of the village and the individual producer. But in the final analysis, it is only through the values held and the action taken by the producers who are actually responsible for the day-to-day use of the world's natural resources that it will be possible to use these resources in a way that is conducive to increasing production on a sustained basis.

The vast majority of the world's population, and even more of its agricultural and rural population, is concentrated in the developing countries. The concept of agricultural development in these countries is now being widened to a concept of rural development that will take account of all of the needs of their populations. This concept has to be widened still further, so as to include the rational use and conservation of natural resources so that they provide not only for the present but also for future generations.

S. 140

(204) Ag 652/024/83