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THE ENVIRONMENTAL ASPECTS OF NATURAL RESOURCE
MANAGEMENT AGRICULTURE AND SOILS
(UN Conference on the Human Environment,
Stockholm, 1972)

Paper prepared by FAO, a UN inter-agency focal
point with contributions from WMO, UNESCO, WHO,
IAEA and IUCN and with the collaboration of
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Stockholm, 1972

THE ENVIRONMENTAL ASPECTS OF NATURAL RESOURCE MANAGEMENT

AGRICULTURE AND SOILS *

Agenda Item II (a) (1)

* This basic paper was prepared by FAO as UN inter-agency focal point with contributions from WMO, UNESCO, WHO, IAEA and IUCH and with the collaboration of Dr. R.J. Penn, Consulta

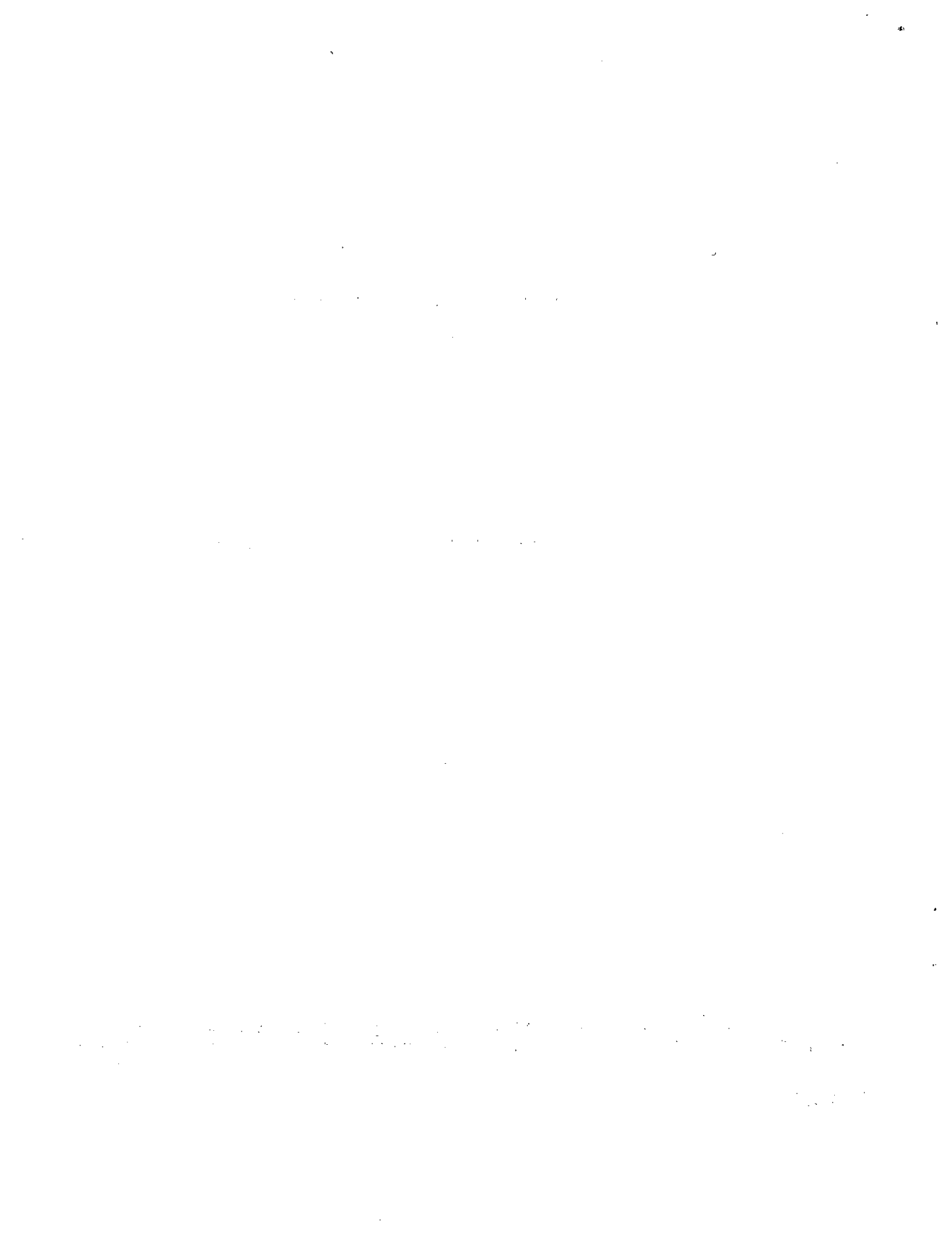


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THE ENVIRONMENTAL ASPECTS OF NATURAL RESOURCES MANAGEMENT

AGRICULTURE* AND SOILS

SUMMARY

1. PRESENT SITUATION AND PROBLEMS

Over half of the world's population are farmers, living and working on small farms, who own, use or manage most of the land and other resources in rural areas. Most of these farmers understand the need to maintain natural resources because they make their living from using them. However, increasing population and higher expectations lead to demand for more food and force the farmers to a greater use of natural resources and modern technology. This situation tends to add to the difficulty of ensuring the maintenance of natural resources because:

- (i) New lands are brought into crop production from pasture and range and new areas for livestock production are taken from forest lands. These are usually lands of marginal value and/or lands on which problems are unknown. Consequently these lands are particularly liable to multiple forms of deterioration such as accelerated erosion, depletion of productive capacity, and the introduction and spreading of diseases. This also often leads to alterations of the climate and the hydrological cycle.
- (ii) Intensification of crop and livestock production per unit area by the introduction of high-yielding varieties and additional inputs such as agro-chemicals also creates increased problems of maintenance of both land and plant and animal genetic resources. Agrochemicals may increase problems of pollution and waste disposal.
- (iii) Concentration of agricultural processing and agricultural service industries puts additional pressure on land resources by encouraging monocultures and intensification of land use. These industries also increase problems of pollution by effluents and wastes. But, at the same time, such concentration may make pollution control easier by the ready identification of pollution sources.
- (iv) Agricultural lands are often wasted by non-agricultural activities: the discharge of wastes from urban areas and industries and the encroachment of urban and industrial areas and transport infrastructures on agricultural lands.

2. ASSESSMENT OF PRESENT MEASURES

Present programmes of agricultural development are rarely preceded in developing countries by an appropriate evaluation of resources and their use, and the gathering of statistics and other information. Moreover, the data from different types of surveys and sectoral studies are generally insufficiently integrated at the planning and project formulation stage. Comprehensive land use planning is often lacking and where it does exist, does not generally involve the local communities.

* The term "agriculture" here does not cover activities of forestry, fisheries, wildlife management, which are dealt with in other papers.

Land use legislation, agrarian laws, zoning ordinances, licensing and other regulations are playing an important role but are often insufficient to prevent misuse of agricultural lands. Such legislation is specifically use-oriented and not resource-oriented. It is not supported by comprehensive land use plans and taxation policies.

Moreover, education, training, research, technical assistance and extension programmes are not adequate to meet the requirements of environmental protection arising from the technological changes in agriculture. Credit availability and credit use, and existing structures of tenure and taxation often limit the small farmers' ability to ensure the maintenance of the land resource and avoid deterioration of the environment.

However, when compared with other human activities, a well managed agriculture still plays in general a positive role in the maintenance and conservation of natural resources. It also contributes to a better balance in the environment and to recycling wastes.

3. POLICY GUIDELINES AND RECOMMENDATIONS

3.1 REDUCING THE KNOWLEDGE GAP

Because the demands of the expanding population and the desire for higher standards of living will probably continue to force adoption of technology at a rate faster than it can be tested and taught, and because there will be a need for higher standards of knowledge and technology, major recommendations are made in the areas of research, surveys, monitoring, education and training.

- (i) Basic multidisciplinary research should be continued for a better understanding of the effects of environmental factors and technological inputs on the physical and biological productivity of agricultural ecosystems. More emphasis should, however, be placed on making use of the findings of these investigations to increase agricultural production with minimum damage to the environment, and on understanding the human and social factors in the stability of the ecosystems.
- (ii) Adaptive research and experimentation in new technologies under local ecological and social conditions should be directed not only towards maximizing agricultural production but also towards a better conservation of the resources and a better control and recycling of wastes.
- (iii) Methods of determining the costs of pollution and other forms of environmental damage to agricultural lands should be developed as part of the environmental criteria in evaluation of projects and programmes of agricultural development in farm management, and in preparing new legislative and institutional arrangements for environmental protection.
- (iv) Surveys and inventories of basic natural resources for agriculture should continue with a view to promoting a safer transfer of technologies between areas with similar ecological conditions. The collection of basic data on natural resources should, therefore, be associated with the gathering of information on the possible utilizations of these resources. International agencies concerned should play an increasing role in promoting the collection and exchange of such practical information and data. Much of these data, of course, will have to be collected by ground surveys and assembled and used locally.

- (iii) The costs of environmental damage and benefits from maintaining and improving the quality of the rural environment should also be taken into better account in the planning.
- (iv) The importance of good management of land and arrangements for the training of people in this skill should be part of any land use planning programme.

3.3 IMPROVING LAND MANAGEMENT

Land management programmes have a direct effect on the lives of people and on the environment. Generally, however, they are specific to an area or a region, so a listing of recommendations must necessarily be illustrative.

- (i) When based upon a sound and comprehensive land use planning policy, appropriate institutions, land use legislation, licensing and regulations can be most effective in implementing land management programmes which can prevent deterioration of the rural environment. As considerable progress is still required in this respect, exchange of national experiences and harmonization of national institutions and legislation with the assistance of the international organizations concerned should play an increasing role in improving on a global scale the management of agricultural lands and consequently the rural environment. An integral part of this process must be the organizational arrangements for integration of efforts for environmental improvement.
- (ii) In most countries, farmers, and especially the small farmers of developing countries, will require technical guidance and extension, and assistance in the form of credit, and better marketing facilities and sometimes also more land so that they may safely and profitably use modern technologies. With such help, farmers will be able to introduce improvements of the rural environment, adopt better land management and conservation practices and undertake improvement work on their farms. Modern mass media of information and communication should be increasingly used in extension work to reach the greatest number of farmers when trying to introduce improved practices of land resource management.
- (iii) These actions should be supplemented by regulatory legal and institutional arrangements (such as taxation, liability for damage, special assessments, etc.) in order to allocate the costs of environmental deterioration to those responsible for or benefiting from the deterioration and to enforce the legislative provisions for the protection of natural resources.
- (iv) As it is increasingly recognized that many side benefits are derived from the maintenance of natural resources (production of food in sufficient quantity and of satisfactory quality, recreation, buffer zones between urban concentrations, employment, etc.), the role of agriculture in maintaining the quality and attractiveness of rural areas will therefore become more and more recognized as an activity of general public interest. This may lead the governments and international organizations concerned to increase technical and financial assistance to help the farmers to fulfil their responsibilities in protecting and maintaining the quality of the global environment.

- (v) Multipurpose assessment of land capabilities for use should be based on comprehensive and integrated surveys of land resources (soil, vegetation, climate, livestock, wildlife, etc.) including social and institutional surveys, and on findings of research and other information indicated above. This should lead to identification of major land use problem areas (environmental in particular) and serve as a guide for more intensive research for land use planning and land management programmes.
- (vi) Local ad hoc monitoring activities should be established whenever there is a major change in land use. A series of periodic "on the spot" surveys should be made not only to record pollution and other forms of land degradation, but also to review the data previously collected and to assess the environmental impact of changes such as in living conditions, farm organization, distribution of income, credit availability, markets and taxes. These activities should be closely associated with the monitoring of the performances of farmers and the effectiveness of agricultural statistics.
- (vii) Taking into account the diversity of local agricultural conditions, national and global monitoring of the rural environment should be confined to those aspects which can usefully be considered at the national and international level: the climate, the balance of natural resources used for agriculture with the amount and nature of agricultural inputs, the quantity and quality of agricultural products available and the agricultural wastes. These national and international monitoring activities should be first established on a pilot and sectoral basis before considering their integration into more comprehensive systems. Full use should be made of existing institutions at national and international level in establishing these monitoring activities (for example, agricultural research and experimental stations existing in developed and developing countries).
- (viii) Teaching of basic ecological principles in agricultural education should be given more emphasis and specialists in the field of agriculture should receive a more multidisciplinary education and training.
- (ix) The education of the public is an essential aspect in maintenance and improvement of the environment. People must be taught to appreciate the seriousness of the situation and to accept and support the regulations prepared to control infringements.

3.2 IMPROVING LAND USE PLANNING

Rural land use planning can be a most effective device for guiding the development and management of natural resources so as to give greatest protection to the environment.

- (i) Rural land use planning should be a dynamic and flexible process by which plans can be continuously adapted to economic and social development requirements and new technologies and revised on the basis of the findings from the research, surveys and monitoring indicated above.
- (ii) Although land use planning is primarily a national responsibility, an important part of the rural planning process should be carried out at the local level involving local communities and taking into account the diversity of the rural environment. Moreover, due to environmental considerations (air pollution, water use, etc.) border lands will increasingly require joint planning by neighbouring countries. Appropriate methodologies should be developed for this purpose.

PART I

PROBLEMS AND MAJOR ISSUES

1. INTRODUCTION

Clearly there is international concern about the condition of the world's natural resources, with man's relation to them and with man's relation to man in the process of using natural resources and changing the environment. Agriculture is a major part of that concern since rural people control nearly all the world's land resources and since they represent more than half of the world's population.

Increasing population and increased expectations means need for more agricultural production. New areas are being brought into production and new technologies are being used both by the agricultural and non-agricultural sectors. The improper use of technology is polluting the environment and presenting the need for costly improvements.

Urban development has been taking up some of the best agricultural land. Forest areas in many cases are being depleted to make room for new crop land. DDT used on farms and for malaria control has found its way to fish in the ocean.

This paper deals only with the environmental effects of the use of technology in agriculture and to the place of agriculture and soils in natural resource management.

1.1 DEFINITION OF THE HUMAN ENVIRONMENT

Environment usually is considered to be the earth's physical and natural resources. When the subject is expanded to Human Environment it includes not only all of the natural resources (land, water, air and all those living organisms thereon) but also the relationships between men as they go about using these natural resources. Man is the one animal able to generate change in the environment for better or for worse. Hence, this paper includes men's relationship with each other as they manage agriculture and soils.

1.2 AGRICULTURE AND THE HUMAN ENVIRONMENT

Over half the people of the world live and work on small farms, and in some countries nearly all the inhabitants do. Farmers are the owners and custodians for most of the world's natural resources. They know the land, the water, the plants. Most of them know the main pitfalls in farming such as, for example, that improper irrigation systems create saline soils and erosion results from insufficient crop cover. But the introduction of new technology makes some of their knowledge and experience obsolete and creates problems that cannot be solved without technical assistance and changes in institutions. New technology has been used by agriculture to meet the growing demands for food and fiber. In adopting the new technology, agriculture must make sure that the environment does not suffer.

1.3 POPULATION GROWTH

Population has been increasing rapidly around the world, independent of resources and the capacity of the environment to support it. This is creating great problems in some parts of the world, especially in the developing countries where the need is greatest to raise food intake and living standards.

Many question whether enough food will be produced to feed the people. Although substantial gains have recently been made in food production, there are still millions of undernourished people. In addition to meeting food needs, most nations encourage production of goods for export to earn foreign exchange to finance industrial development.

Extensive use of fertilizers and pesticides in many countries has had its impact on food production and some effects on the environment. Large scale feeding operations have concentrated animal waste for disposal, thus preventing recycling. Processing of agricultural products involves agriculture in pollution problems similar to those of other industries.

1.4 LACK OF KNOWLEDGE

In formulating policies for action on environmental problems, the lack of knowledge about present conditions and the implications of contemplated programmes is a major restraining factor. Data on the extent and degree of deterioration in the environment are in most cases lacking. Similarly, the effects of various technologies on the eco-systems are often inadequately understood. Thus action has often been taken without consideration of possible risks in introducing new technology, nor has the joint effect of various technological measures been adequately considered. Conversely, measures to protect the environment may themselves have consequences which are not known.

In agriculture, institutions and legislation have evolved over a long time but with the more rapid introduction of new technology they may no longer be suitable. The development of a new institutional and legal framework usually lags far behind the change in circumstances and conditions. Information about the impact of new technologies is usually insufficient or lacking and that available even to decision makers is usually confined to particular aspects and does not cover the complex of problems arising from introduction of new technologies or new approaches.

1.5 LEVELS AT WHICH ENVIRONMENTAL PROBLEMS ARE MET

Environmental problems are, of course, met at the family unit level (health and sanitation, nutrition, heating, etc.), at the local level (village, district and municipality) and at the national, regional and international levels. Action for solution of environmental problems has to be taken at each of these. This requires information, education, improvements in legislation and institutions, national policies and regional and international agreements.

1.6 OBJECTIVES OF THE PAPER

The objectives of this paper are:

- (i) to look at the demands made on agriculture by an increasing population and by desires to improve living standards, and to examine the methods by which these demands have been met in the past and may be met in the future;
- (ii) to identify the problems and to analyze alternative solutions;
- (iii) to suggest programmes for action.

2. ENVIRONMENTAL PROBLEMS CAUSED BY THE USE OF MORE LAND

Arable crop and irrigated land, permanent pasture, and forestry are given by regions in Table 1. While it is evident that substantial areas of land in the world are not being used by farmers, the food demand of the increasing population is resulting in efforts to increase the amount of land used for crops and livestock. There is danger that moving agriculture into marginal areas will damage the natural resources.

2.1 CROP LANDS

Growing pressure on land resources has led to the extension of crop farming into areas which, for reasons of limited rainfall, climate, topography or soil quality, are not suitable for such production. Typical instances are the plowing up of pasture lands for dryland farming and the extension of farming to hillsides. Introduction of mechanization has in many instances accelerated this process, such as in the case of dryland cereal farming in marginal areas which is characterized by a high degree of instability with recurrent crop failures. The major problems caused by this extension into marginal areas are depletion of plant cover, wind and water erosion and deforestation. The eventual effect can be a permanent lowering of land capabilities for agriculture. Uncontrolled crop farming in the watersheds leads to changes in the hydrological cycle by increasing run off, reducing the water retaining capacity of the soils and increasing the silt load in rivers and streams. The increased silt load may greatly reduce the potential value of reservoir sites already developed or required for the future. Extension of irrigation to some types of marginal lands causes problems of waterlogging and increasing salinity not only in the areas under irrigation but often in adjacent areas.

Cutting down forests to make additional crop land (which will be dealt with in another paper) is mentioned here only because of the major transformation of resources that takes place. Thus, cutting down rain forests to make a place for crops may have several harmful effects on the environment. First, not much is known about the use of tropical forests and cutting may waste a resource of considerable future value. Soil erosion and water run off may develop as problems. Moreover, many tropical soils tend to deteriorate rapidly when their natural forest cover is removed.

Shifting cultivation has been a traditional practice in many parts of the world. When population was limited, harmful effects from such cultivation were of minor importance but the growing number of people practising shifting cultivation forces a reduction in the periods for regeneration of the vegetation. The results are: lowering of soil fertility and crop yields, destruction of natural vegetation, reduced moisture infiltration and retention, and accelerated erosion and silting of river beds. In areas subject to typhoons (hurricanes), elimination of natural windbreaks through intensified shifting cultivation presents a serious problem both to human life and to agricultural production.

2.2 EXTENSION OF GRAZING AND ANIMAL HUSBANDRY TO MARGINAL LANDS AND TO FOREST LANDS

Extension of uncontrolled grazing and animal husbandry to marginal lands in arid and semi-arid zones often creates severe problems. In such lands the ecological balance is often precarious and overgrazing can have major deleterious effects on the environment. With overgrazing, perennial grasses and palatable plants are the first to be damaged and eventually are replaced by less valuable species. Encroachment of low value brush often occurs. Eventually, such severe depletion of vegetation may occur that its value for grazing becomes negligible while soil erosion, changes in the hydrological cycle and sedimentation of river beds may become major problems. In areas bordering deserts, extension of the desert may

occur. Thus, it is estimated (Riney, 1967) that the extension of the desert along the southern edge of the Sahara has been taking place at a rate of one or more miles annually over the last 50 years.

In cases when grazing is extended to forests, constant degradation through fire and trampling, as well as overgrazing, inhibits natural regeneration on the one hand, and reduces the forests' quality and size on the other. In areas where forests are on the border of their critical range, such practices produce irreversible damage and loss to the environment.

Nomadism is a common feature of man's utilization of marginal lands and has evolved because of an unfavorable climate, particularly the limited and erratic rainfall, and the relatively poor soils. These factors make for low forage production varying greatly from season to season and from place to place, hence the evolution of a system of free-range grazing following migratory routes. Thus, nomadic people have adjusted their operation to the ecological conditions under which they live. In fact, if it were not for the nomads, many marginal lands would not be used by man (Riney, 1970). However, any former balance between grazing animals and feed resources has been upset by the expanding livestock numbers associated with the growth of human populations. Encroachment of the plough in the extension of farming to unsuitable sites continues to reduce the natural area for grazing. Increasing development of water points without coordinated resource management has led to localized range land destruction in many areas of the arid and semi-arid zones. In addition, control of animal diseases without provision for improving feed supplies has resulted in increasing grazing pressures upon a naturally fragile environment. All of these factors accentuate grazing pressures with severe damage to the vegetation, leading to the consequent degradation of the lands.

2.3 LIVESTOCK PRODUCTION IN NEW AREAS

One of the large areas where livestock could be expanded once the tsetse fly has been brought under control is Africa. The control of the tsetse is a prerequisite for livestock use of the forests or savannah wood land, an area of about 4.5 million sq-miles of Africa south of the Sahara. Tsetse flies of several species occur and transmit trypanosomes from wild animals to livestock. The trypanosomes cause a fatal disease in livestock. In view of the growing demand to open up more land for livestock production, large scale tsetse eradication campaigns are needed. These may involve 1) the partial or complete clearing of vegetation, 2) the removal, i.e. destruction, of all potential wild hosts with a view to starving the tsetse prior to the introduction of cattle, or 3) the extensive application of insecticides, from the ground or by aircraft, or by a combination of these methods. The aim of the first two methods is to alter the tsetse habitat in such a way that these highly adapted insects cease to occur in the controlled area. This implies profound influences on the ecology of the areas to be developed. The third method has similarly grave ecological side-effects in that all other insect life, and some animal life such as that of the bird and the bat, is severely and indiscriminately affected.

2.4 SPREAD OF DISEASES AND PARASITIC ORGANISMS INTO NON-INFECTED AREAS

The process of expanding livestock production into tropical forest and savannah lands hitherto unutilized for agriculture may lead to the introduction with imported stock of parasitic microflora and fauna different from those native to the area. Depending on the prevailing environmental conditions, the introduced organisms may establish themselves or perish. Establishment in their new environment may involve adaptation to indigenous vectors or reservoir animals which may then become a dangerous source of infection for domestic livestock. Moreover, because of the susceptibility of wild animals to introduced infections, epizootics

TABLE 1 - DISTRIBUTION OF LAND USE BY REGIONS

(Zone C Study Countries by Countries)

Region	Total land area (mil. ha)		Total arable mil. ha %		Irrigated area mil. ha % of total arable		Permanent pastures ml.ha %		Forestry ml.ha %		Not used for agriculture ml.ha %	
		(%)										
Africa S. of Sahara	1,520	(29%)	152	10	1.1	0.7	517	34	380	25	471	31
Asia and Far East	541	(10%)	211	39	44.1	20.9	16	3	141	26	173	32
Latin America	1,857	(36%)	130	7	10.5	8.1	371	20	743	40	613	33
Near East & N.W. Africa	1,167	(22%)	70	6	16.7	23.9	152	13	128	11	817	70
error	157	(3%)	-	-	-	-	50	(5)	55	(4)	52	(2)
Total	5,242		563	11	72.4	12.9	1,106	21	1,447	28	2,126	40

Sources: Provisional Indicative World Plan for Agricultural Development, Volume 1

- 1) p. 42, table 1 - Distribution of land by major classes in the Zone C Study Countries
- 2) p. 43, table 2 - Distribution of land use by regions
- 3) p. 44, table 3 - Cropping intensities (1961 - 1963)
- 4) p. 46, table 5 - Importance of irrigation according to regions (1961 - 1963)

of large and adverse economic impact may result from the introduction of domestic livestock. The first rinderpest panzootic in Africa, which swept through the whole continent killing hundred of thousands of game animals, thus causing major ecological changes, provides an example of such a happening. And, of course, wildlife itself is a source of disease of many kinds.

The use of mercurial fungicides in the treatment of seed makes some, if only small, contribution to the distribution of mercury in nature. The grains are picked up from the fields by small birds in which the mercury compounds have accumulated. The small birds are eaten by their enemies, with adverse effects on the predators. In certain areas as, for example, in Scandinavia, legal measures have been taken to reduce the use of mercury compounds for the treatment of seeds.

It should be noted, however, that a much heavier contamination of the natural resources by mercury compounds arises from the leakage into streams of mercury from industrial plants. Leakage has resulted in the occurrence of mercury in fish at levels that are dangerous for human consumption.

3. INTENSIFICATION OF LAND USE

3.1 INCREASING COMMERCIAL AGRICULTURE

Formerly in developed countries, as now in developing countries, agriculture was the primary base for development. Today it must furnish food for the increasing urban population, as well as provide capital, in the form of raw materials, savings or foreign exchange, for investment in industrial development. In the developing countries, the vast rural population is the main source of supply of labour. The type of agriculture not only has an impact on the environment but agricultural use of natural resources largely determines the nature of the human environment.

To contribute to development, agriculture must produce a surplus to its own needs, therefore, modern production technology is needed. Business organization or farm management must introduce this technology at low unit cost for a profit.

Many developing countries have developed, or are attempting to develop, substantial export production. Examples are rubber and palm oil in Malaysia, tea and cotton in Malawi, India and Ceylon, sugar and cotton in Peru, livestock products in Colombia and Panama. International lending agencies encourage this type of production because the foreign exchange earned makes the loan repayment easier and contributes to the balance of payments. Developing countries, in addition, may be interested in large agricultural projects since they generally are visible evidence of development.

There are, however, difficulties to be faced in such trade. For example, countries selling agricultural products on the international market have to minimize their unit cost to compete. Products so marketed are subject to fluctuating world prices. Poor terms of trade generally exist for the seller of raw materials unless an international commodity agreement can be put into operation, including the costumers.

There is also the fact that shifting raw materials and natural resources from one nation to another may be wasteful and ultimately costly to the seller. This appears to be more significant in fuels, minerals and forestry products than in agricultural products. Nevertheless "in the current stage of this immense and continuing process (trade of natural resources between countries) the disparities in the rate and

depth of change remain such that one third of the world's population extracts several times as much beneficial use per person from the environment as the other two-thirds".*

Much emphasis has been placed recently of programmes to increase food production for domestic use. Lately important advances have been made through plant breeding whereby high yielding varieties of wheat and rice have been developed. The advances have been achieved through use of seed capable of producing high yields with application of increased inputs such as fertilizers and water and better management practices. Because of the high yields and high cash inputs the need for seed treatment and plant protection against diseases and pests is becoming more urgent.

A large part of the credit should go to research. Rockefeller Foundation, in cooperation with Mexico, initiated the maize and wheat breeding programme in 1943 (at what is now called International Maize and Wheat Improvement Center - CIMMYT). As a result mainly of the work done there, dwarfed wheat varieties became available in 1961, which made possible greater applications of fertilizer without lodging. Wheat yields in Mexico increased from 750 kg/ha in 1945 to 1417 kg/ha in 1960 and to 2790 kg/ha in 1967. Mexico became self-sufficient in wheat whereas in 1953, 55% of its total consumption (275,000 tons costing 100,000,000 pesos) was imported.

Maize production in Mexico increased from 3.5 million tons in a good rainfall year in the late 1940's to 9 million tons in a good year like 1968 (250%). Average yields per ha doubled. Sorghum production increased from 30,000 tons to 2 million tons in two decades. **

Mexican seed varieties and production techniques have been adapted for use in India, West Pakistan, Afghanistan and Turkey. Pakistan raised its total wheat production from 4.6 million tons to 8.4 million tons (83%) in five years. India increased its wheat production from 12 million tons in 1965 to 20 million tons in 1970. India is now nearing self-sufficiency in wheat.

Rice production is following the same course as wheat. The International Rice Research Institute at Los Baños in the Philippines has developed new rice varieties and improved production practices. The semi-dwarf IR8 variety has been used in many parts of South East Asia. The Philippines has achieved self-sufficiency in rice. Ceylon has increased production by 50% and Malaysia is approaching self-sufficiency.

The success of the high yielding varieties needs to be viewed in the light of the effects this development has had and may have on the human environment. The possible dangers to the physical environment are primarily loss of genetic resources, pollution of water resources from chemical fertilizers, weedicides and pesticides, contamination from chemical treatment of seed and overexploitation of ground water resources encouraged by the potential high yields in high returns.

Moreover, the use of the same varieties over extensive areas increases the hazards of crop damage by the spreading of pests and diseases. This is particularly important owing to the fact that these varieties have been introduced in areas without sufficient crossing and breeding with local, better adapted varieties which often have built in resistance to local pests and diseases.

* Proceedings, Man's Impact on Global Environment - Assessment and Recommendations for Action. MIT Press 1970 p. 249

** Wellhausen, E.J. Director of CIMMYT - The Urgency of Accelerating Production on Small Farms, Conference on Strategies for Increasing Agricultural Production on Small Holdings, Pueblo, Mexico, Aug. 70, p. 5-6.

An important economic and sociological fact is that the increase in production has been chiefly on large farms or in more favourable areas, but most of the people live on small farms and many on lands with less favourable conditions. The Revolution has widened the income gap between the large and the small farmers. This and other factors point to the need for a national price stabilisation policy and for commodity management programmes when production of a food crop equals or exceeds the demand of the domestic market.

3.2 INCREASING PRODUCTION ON SMALL HOLDINGS

It has been estimated that over half the people of the world live on and work subsistence farms. Globally, they farm as much as 40% of the land and in some countries as much as 70% but their farm lands cannot provide profitable employment for the increasing population.

The small urban and industrial sector of developing countries can hardly furnish employment for its own increase in population. Hence there is no work opportunity for the unemployed and underemployed rural population. So the important issue in development is not to see how large agricultural production can be with the fewest inputs of labour and capital but to help rural people to farm better the land they are now on and to train them for other work, especially for rural-based industry.

Social scientists have largely neglected this area of investigation. Dorner and Kanel have done some of the best theoretical work on the relationship between employment and development.*

If food production can be increased by the subsistence farmers, they may not only eat better but will have something to sell. This development could lead to a demand for industrial goods and services and ultimately to investments and to improvement generally in the rural levels of living. With this in mind, Mexico started what has come to be known as the "Puebla" project. It is a regional project in the area of Puebla which aims at increasing corn yields on 50,000 small rainfed farms.

The project was conceived in 1962 by Leobardo Jimenez Sanchez, its general coordinator. The project is closely integrated with the corn research programme in Mexico, which includes production practices as well as yields. Staff are trained to give farmers

* Dorner, Peter and Kanel, Don, The economic case for land reform, employment, income distribution and productivity. Prepared for AID Spring Review of Land Reform, Washington DC., June 1970, p.2.

"Our conception of agricultural development includes more than growth in output per capita. Development cannot be measured by changes in any particular statistical series or along a uni-dimensional scale. We view agricultural development as widening the economic opportunities for the mass of people in the agricultural sector, improving their skills and capacities needed to exploit these opportunities, reducing mass poverty, and elevating the conditions of life among the rural population."

technical assistance on the farm as well as help in organizing credit and market facilities. According to Jimenez, the project has been growing and he considers it successful.*

The cost of the Puebla project appears favourable. Cane and Myren developed a cost benefit analysis measuring the quantifiable items. In 1968 costs were \$113,202 and benefits only \$5,962 or a cost-benefit of .05. In 1969, the second year, the benefits were \$268,550 and the costs \$161,911 or a cost-benefit ratio of 1.66. The 1970-75 projected cost-benefit ratio (1967 dollars and 12% interest) is 7.8. **

If such work with small farms can be successful, considerable agricultural investments of this type could be made in most of the developing countries. The Puebla project aims primarily at production. To achieve this, it has been necessary to change many institutions while seed, fertilizers, pesticides and other inputs had to be made available. Technically trained people had to work with the farmers. Credit facilities had to be changed and loans made to small farmers. Markets for the maize had to be made available.

But more than production programmes are required by the small holder in developing countries. He needs assurance of rights to the land and this may require a major change in land tenure institutions.

Improvement programmes which include the family and the community are also necessary if they are to raise their level of living. Better education in the community or greater participation in local programmes, such as the cooperative, provide means toward this end.

3.3 SINGLE CROPPING

As is now known, some plant diseases spread more rapidly in a specialized farm than in a diversified farm. For instance, the specialized farm may have more severe insect infestation and a faster rate of depletion of particular soil elements. Some monocropping also increases the problem of waste disposal.

On the economic side, a crop failure is extremely serious for the community. Many single crops do not require continuous use of labour and mechanization may replace labour which in countries with unemployment reduces the national value of such a crop.

* Jimenez Sanchez Leobardo, International Conference on Strategies for Increasing Agricultural Production on Small Holdings, Puebla, Mexico, Aug. 70. p. 15-16.

"The number of participating farmers has grown rapidly. Agricultural research was initiated in 1967 with 30 small farmers. The results were extended to 103 farmers with small but commercial scale planting in 1968. This number increased to 2,561 in 1969 and 4,833 in 1970."

"The land area devoted to high yielding planting grew from 76 hectares in 1968 to 5,838 hectares in 1969 to 12,496 in 1970. The response of farmers has exceeded all expectations considering the relatively short period of years and the damage from severe drought in 1969 and again early in 1970."

** Ibid Cano, Jairo and Myren, Delbert p. 60-61.

3.4 ABANDONED MARGINAL CROP LANDS

One of the consequences of intensified farming on good agricultural lands is that farming on marginal lands becomes less competitive and they tend to be abandoned. This often happens because the younger farmers leave the land for better opportunities. Problems created by idle lands include erosion, changing the hydrological cycle and the use of the lands for uncontrolled discharge of waste. There is also an increased fire hazard, growth of weeds and spreading of disease. Of course, it should be noted that abandoned land may naturally recover vegetation - and may be helped in this if the owner finds it worthwhile.

4. INTENSIFICATION OF LIVESTOCK PRODUCTION

4.1 INTENSIFICATION, BENEFITS AND PROBLEMS

The intensification of animal production is inevitable in any attempt to improve the supply of animal protein for man. Intensification is sometimes attacked as though its sole merit were financial. It is true that the more intensive methods of animal production often do reduce costs in relation to output. It should not be overlooked, however, that the intensive systems also increase the efficiency with which foodstuffs are used by animals, simplify systems of management and provide improved controls of the nutrient balance in the diets of the animals; and they are also usually much less demanding in terms of land area occupied than are traditional methods.

High concentration of intensive animal production units in certain developed countries have produced a new series of problems such as the disposal of excreta from animal houses and feedlots and of the effluents from silos. These problems call for caution in setting up such units, e.g. large intensive units should not be sited in the vicinity of towns and care must be exercised to avoid siting silos and dung pits near streams or on areas where ground water can easily be contaminated by percolation and seepage. The problems are also likely to become serious near major urban centers. The new method of spreading slurry, particularly from pig farms, on fields in the neighbourhood of urban areas, which produce air pollution, is an example. There is also the problem that concentration of herds and flocks further lead to a concentration of disease agents and parasites. Such problems, however, should not be an impediment to the development of new intensive methods of animal production, provided reasonable precautions are taken.

4.2 SETTLEMENT OF NOMADIC HERDS AND FLOCKS

Environmental problems brought about by the settlement of nomadic herds and flocks such as congestion, competition for available resources and impact on sanitation facilities and services, will be avoided if preference is given to a policy of partial settlement. With partial settlement and development of other sources of feed, transhumance becomes possible in some areas. In transhumance, herds and flocks are taken at certain times of year to defined grazing areas. This policy makes possible the improvement of pastures and of stock and has many social advantages over nomadism. But the problem of settlement of nomadic herds and flocks needs fuller study so that management systems can be evolved which are compatible with the social and environmental context.

4.3 INTENSIFIED ANIMAL HEALTH CONTROL; INDISCRIMINATE USE OF DRUGS AND PESTICIDES; ECOLOGICAL EFFECTS OF VECTOR AND DISEASE RESERVOIR CONTROL

As intensification of animal production implies concentration of livestock and their parasites, any such intensification must be accompanied by greatly intensified health control measures. In tropical and subtropical environments, routine control of ticks becomes essential. This is often done in such countries by driving cattle into plunge dip baths. The concentration of large numbers of cattle around dip tanks may lead, however, to destruction of vegetation and serious erosion problems may arise. To avoid such environmental damage, mobile spray units have been used in many areas. Care must be exercised in the disposal of chemicals used for this purpose.

Routine prophylactic treatment in intensified health control often leads to the development of resistant strains of micro-organisms which in turn may cause grave changes in the natural equilibrium between plants, animals and environment.

Another aspect concerns the control of certain mammal species which constitute disease reservoirs, e.g. foxes in Europe. Considering the food chains inherent in the eco-system, control practices may have an ecological impact which may not be detected for a long time with the result that, in the absence of predators, other mammal species, e.g. rodents in Europe or dassies in Africa, may multiply into destructive populations. Implementation of control of this nature deserves, therefore, careful ecological consideration.

4.4 ANIMAL GENETIC RESOURCES

Over the last century, a number of highly productive animal breeds and strains have been developed in the industrialized countries. These breeds are now being gradually introduced into the developing countries. When given proper management and feeding, several of these animal strains have been shown to do well also in rather hot climates. Intensive forms of production, such as milk and pig production, are likely to be based to an increasing extent on European-type breeds in the developing countries. On the other hand, beef and mutton will be produced largely under extensive grazing systems utilizing the vast range areas of Africa, Asia and the Americas. As the animals have to cope with adverse conditions, the animal material will probably be based on indigenous populations which however might, through crossing, derive from some genes from the more rapidly growing strains now in existence in the more developed areas of the world. The changes in the genetic composition of the livestock breeds will have a rather limited influence on the human environment. As the use of more productive types of livestock will also require a more efficient management and utilization of the land resources (improved pastures, production of fodder crops, etc.) the introduction of high yielding cattle strains for milk production is likely to improve the human environment rather than to have any detrimental effects. The same will probably be the case when improved beef cattle and sheep breeds become more widely used. The introduction of European-type livestock will naturally decrease the present genetic variation within the world's livestock population. However, the change will be gradual and if anything were to go wrong, corrective methods might be undertaken by crossing provided some genetic material from indigenous stock be kept either as reserves or in the form of deep-frozen semen.

5. AGRICULTURAL BASED INDUSTRY

5.1 WASTE DISPOSAL

Industries that have been processing agricultural products are not, of course, all new. Slaughter houses and tanning and dairy plants are illustrations of agricultural processing industries that have been with us for a long time. The disposal of the wastes of such industry was an early concern, as is evidenced by the laws passed to prevent the establishment of slaughter houses and tanning factories within city limits. In British law several processing industries were identified as nuisances in this respect. More recently dairy plants in some countries have been required to run their waste water through sewerage systems.

An important aspects of this problem, however, is the fact that with the development of processing techniques, many of the waste products are now converted to useful purposes. Thus less is being discharged to pollute the environment. An illustration of this is the large amount of the animal carcass that is now made into useful products. Again, whey from dairy plants is now dried and used for food instead of being discharged by the roadside.

Another beneficial aspect of agro-industry is the use of natural, degradable fibers (binder twine, for instance) and bags, which after having served their useful life, are quickly absorbed in nature's cycle. This in contrast to the synthetic fibers and bags, which not only are unsightly when left in the country side, but are a hazard to livestock when the refuse is inadvertently eaten.

With recent modernization of agriculture increased processing of its products is being done away from the farm. Processing of fruits and of vegetables now often requires large industrial establishments, thus creating new problems of waste disposal.

But it is the supply of new agricultural inputs for farming that has led to new threats of pollution. For example, commercial fertilizer plants pollute the air. The use of pesticides, herbicides, feeds, drugs and antibiotics by the farmer contributes to the dangers of environmental pollution as some of the wastes and by-products are discharged into streams and lakes. Transportation facilities, trucks, railroads and ships sometimes contribute to pollution in moving supplies to agriculture.

In the change from a subsistence to a marketing economy, the establishment and extension of agricultural-based industry and business in the developing countries form an intrinsic part of the development pattern. The people running such enterprises are becoming more and more aware that protection of natural resources and environment and improvement of rural life are essential for long term, sustained production. Consequently large scale activities now include strong and well-organized assistance and extension schemes to the farmers.

The initial local processing of such export oriented crops as cocoa, peanuts, coffee, soya beans, etc., is becoming more significant. In the markets of the developing countries, due to the socio-economic changes taking place, the demand for canned and preserved foods (fish, tomato, fruit, meat, etc.) is increasing. There is no doubt that the establishment of processing facilities plays a vital role in the improvement of the production and distribution of agricultural produce. It can also be expected that the demand for fertilizers, pesticides, herbicides, feeds, drugs and antibiotics will activate, where feasible, their local production. An inevitable consequence of these increased activities in the agro-industrial field is the danger of introducing pollution problems, such as the ones which

have so clearly surfaced during the last 20 years in the developed countries. The well-known adverse effects on environment by contamination of the air from by-products and incomplete fuel combustion, water and land pollution from discarded wastes and disposal problems of non-returnable and non degradable packaging materials, will result if the industrial expansion is left to develop uncontrolled.

The ration between contaminants of the environment and the natural capacity of absorbing and eliminating them is still unknown but appears more favourable in rural areas. In developing countries, the present size of the industrial units is comparatively small. This may, however, change and Governments should in their long range forecasting, prepare themselves to use controls to prevent the possible ill-effects of industrialization.

5.2 AGRO-INDUSTRY AND THE HUMAN ENVIRONMENT

We have not mentioned the large numbers of service businesses which are a part of the agro-industry complex because, generally, such businesses as brokers, bankers, or centres for artificial insemination, do not much affect the environment.

However, agro business activities have been identified recently by the environment-alist as harmful to the environment. Whether right or wrong, the business has been considered as vertically integrated operation with power to make the important decisions. And the argument continues that those concerned can make decisions about location of agricultural production and what to produce, where, what techniques to use, etc. And some are powerful enough to bypass local or national regulations protecting the environment against their type of operations.

While most of the argument is not well founded, it is true that some forms of agro-business enterprises are associated with the type of modern agriculture which has contributed to environmental problems. Such business also often leads to mono-cropping or uniform cropping patterns regardless of land capabilities. This can create degradation of land resources and depletion of groundwater resources. It must be stressed, however, that these observations do not support a negative attitude towards modern agriculture and its associated industries but point to the need to ensure proper use of the new technology and modern agricultural practices.

6. IDENTIFICATION AND EVALUATION OF PRESENT INSTITUTIONAL POLICIES AND MEASURES TAKEN WITH RESPECT TO ENVIRONMENTAL PROBLEMS RELATED TO AGRICULTURE AND AGRICULTURAL DEVELOPMENT

6.1 APPRAISAL OF LAND CAPABILITIES

Sound understanding of the nature and distribution of lands of differing potential, limitations and hazards is a prerequisite for reliable planning of agricultural development. Interpretative land classifications, in which such understanding finds expression, should represent an integration of data obtained by fact-finding surveys. Systematic surveys of the soil, climate, vegetation, hydrology and topography are a first requirement, for these provide a basis for comparing conditions in different places and thus ensure that the potential of individual land units can be interpreted in relation to a variety of alternative uses or management approaches which appear feasible and which deserve consideration by the planner. Furthermore, basic survey data can be reinterpreted to meet the demands of changed social and economic circumstances. In the absence of soundly interpreted, reliable data on land resources, there can be no certainty that land is put to its best use. An unsuitable choice of land or land-use can lead not only to disappointment or disaster in terms of production failure, but also to irreversible destruction of soil resources.

Although considerable progress has been made in the methodology of integrated surveys, an integrated approach to the assessment of the multiple use capabilities of land resources is still not widely used. Moreover, further advances are necessary in the methodologies of integrated surveys to ensure a better association of sectoral surveys, e.g. soil surveys and climatic studies, soil surveys and vegetation surveys and, especially, natural resources inventories and socio-economic surveys. Land classifications are often developed for one type of land use only and are mostly based upon judgement rather than on quantitative data. The recent technological advances on land use, the results from adaptative research and experiments, and the social factors, are often insufficiently taken into account in land classifications.

However, when properly used, land classification provides an excellent tool to prevent at the planning stage and at the management stage decisions which could lead to the deterioration of land resources. Unfortunately, land classifications are often only required by planning authorities for some types of major development projects (mostly irrigation and drainage) but rarely for regional planning, for urban and industrial planning, for small-scale agricultural projects and for programmes of agricultural improvements, land reforms, for extension work and monitoring the rural environment.

6.2 LAND USE PLANNING AND ZONING LEGISLATION

Zoning ordinances or land use planning laws are often considered to be the same as land use plans. They are, however, simply legal instruments by which government uses its power to regulate what an individual may do with his land resources. Such a rule or law may be enacted by any unit of government that has authority to use power to regulate an individual's use of land.

6.2.1 Zoning ordinances

Generally the ordinance classifies land into land use districts or zones, with the boundaries of each zone clearly described - either by map or legal descriptions or both. The text of the ordinance also contains specific land use regulations applicable to each zone or district - for instance, it is necessary to spell out in the law a prohibition of industrial or commercial uses in an agricultural zone or of automobile disposal areas along a scenic highway or of grazing in a forestry zone.

A very important aim of zoning is, of course, to protect values and eliminate waste in settlement and development of land. It can help guide long range land use development by providing the criteria for resolving the day to day handling of conflicts in land use.

Zoning started in urban areas of the more developed countries. It was used to do such things as to keep slaughter houses and brickyards out of residential areas. Some ordinances protect agricultural and forestry areas against encroachment. They have prevented settlement and development on the flood plains of lakes and streams and they have required aesthetic development along waterways and highways. Zoning ordinances can be used for water use regulation and even for air regulations. Water use zones may be established which limit the use of surface or ground water or for using the water to carry off pollution. Air use zones might well be established, particularly around cities and industrial areas. Certainly it is not necessary to have the same kind of air and water use rules in all areas. Zoning ordinances have mostly been used in urban areas. Unfortunately, they have often been based upon insufficient information about natural resources.

Because a land use zoning ordinance requires the establishment of land use zones and a description of the types of land use permitted in each zone, it must be preceded by some comprehensive land use planning. Hence, land use zoning has often been considered the same as land use planning.

6.2.2 Land use planning legislation

Land use planning legislation can be used for a variety of objectives:* to prevent farm land from being used for non-agricultural purposes, to restore land to agricultural use, to reallocate or consolidate agricultural land for optimal development, to encourage reforestation, to establish natural reserves or recreation areas, or to assign land to other preferred uses based on environmental considerations.

While public ownership of land may be considered as the most effective way to maintain control of land use, experience in many countries indicates that more expropriation of land (subject to compensation in accordance with national constitutional principles) is not sufficient and will have to be followed by effective reallocation and regulation of use.

Legislation for land use planning requires close coordination with land tax legislation, since both are ultimately based on an assessment of land capability, and both can be used to encourage or discourage specific land use practices. In particular, legislation can prescribe soil and water conservation measures for designated areas, e.g., to prevent cultivation on steep slopes or plowing of grass land too dry to cultivate, to limit the intensity of grazing, or to allocate and regulate water use. It can regulate or restrain the use of pesticides and fertilizers or the introduction of new technology which is harmful to the environment.

Regulation may consist in the setting and implementation of specific standards for land use, which can periodically be adjusted by an appropriate institution to fit changing circumstances, changing objectives or changing technologies.

Other procedures that have been used in some states and could be used in others are licensing requirements for the building of structures on land or for establishing a specific use. Registries of such licenses can become a record of changing uses and a restraint against undesirable new uses.

In spite of the very considerable function that zoning ordinances and land use planning laws have in guiding land use, they are only two of a number of group decisions concerning land use - they are tools. However, the basic plan is more important than the tool. The plan and the tool are separate things although we often think of them as one.

* E.G., see "Legislation on Land Use Planning in Europe", FAO (Rome, May 1967); and Supplement 1966-1968.

6.3 COMPREHENSIVE LAND USE PLANNING - INTEGRATED RURAL PLANNING

A comprehensive land use plan must be built on as much physical and economic data as are available. Data are needed on topography, climate, drainage, and types of soil as well as land ownership, and the land use experience and the hopes and aspirations of those people now on the land. Some forecast is needed as to the direction of the whole economy. Land use plans are generally specific to land areas but should recognize the relationship of the use of one area to another.

A land use plan can be used for many purposes. For instance, it can be the basis of a modern land tax structure. Chile, with a low cost classification of its land done largely with aerial photography, has successfully introduced a modern land tax.

The plan should help guide settlement and development in new areas and make easier the decisions on where to make greater investments in production and guide expansions of credit. It should make easier an appraisal of the impact of agricultural pollution through concentration of animal feeding operations or location of agricultural processing industries. However, most of the present land use plans do not meet these requirements.

Recently Europe has recognized the importance of "regional planning" which is land based and is similar to land use planning. In 1958 the Conference of Local Authorities asked the Assembly of the Council of Europe to study the problems of regional planning. The study was to include the improvement of less developed regions, the economic integration of natural regions divided by frontiers, and the balance between rural and urban land uses. In 1961, the Assembly adopted resolution 210 on European regional policy and local authorities which says that European regional planning was one of the essential political tasks facing European institutions.*

In 1964 the Assembly of the Council of Europe decided to make a through study and in 1968 passed recommendation number 525 establishing the Conference of Ministers responsible for regional planning.

Since 1968 the Conference of Ministers of the Council of Europe has encouraged many activities under its broad charter of regional planning. The Conference on Conservation met in Strasburg 9-12 February 1970 and adopted a "Declaration on the management of the natural environment in Europe", laying down guiding principles as regards natural environment and setting policy guidelines ranging from the international to the individual level. Here are some of the principles included in that declaration: *ibid* page 21.

- "to define and allocate responsibility for strategic planning of the environment ..."
- "to enact laws to insure the effective planning, management and conservation of the environment and establish inter-disciplinary teams of professionals and scientists to implement them ..."
- "to draw up long term plans for rational use and management of land".

* European Conference of Ministers responsible for Regional Planning, Council of Europe CMAT (70) 9, Bonn 9-11 September 1970, page 19.

Another group, an ad hoc conference on planning of rural areas, has been meeting on integrated rural planning. It is made up of the European Commission on Agriculture, European Forestry Commission and FAO. At the Berne, Switzerland, meeting 25-30 August 1969, Prof. Wibberley explained the need in the future for the future for integrated rural planning - Wibberley G.P. Integrated Rural Planning Ad Hoc Conference on the Planning of rural areas, Conference Report, FAO, Rome, January 1970, page 425: "So much of the experience of rural planning in the countries of Europe which have a strong industrial or urban base has either been of a character which is essentially the defense of rural areas against urban growth and urban influences or else it is involved in just the development of one rural resource or activity; in the latter case, the concern has mainly been the development of agriculture, but it has sometimes been just forestry or the development of secondary or rural industries or, of late years, the development and control of tourism and recreational activities. Attempts at integrated rural planning have been seen only in a few countries ...".

The Federal Republic of Germany and the Kingdom of Belgium have entered into an agreement to establish a joint regional planning commission and cooperate on regional planning matters. This was in response to a suggestion of the First European Conference of Ministers responsible for regional planning. As a result, this international planning commission proposed creating a park as a joint use of land along the boundary of the two countries. This has been made into a treaty.*

Comprehensive land use planning has been difficult to achieve in developing countries. In an informal way, of course, the successful political leader knows the families of his area, the kinds of land there, how it is used and the kinds of issues faced by the decision makers and the importance of the participation of local people. But this is not enough for thorough and reliable land use planning. Unfortunately, however, most developing countries have few trained personnel. Even those who have established planning groups in the central government find they do not have the required information for comprehensive land use planning. As a result, contracts are often granted to groups from other countries to make development plans for specific areas or projects.

Agricultural institutions, policies and programmes will have an impact on the environment in relationship to the goals of the families, the communities and the nations. The goal can be to increase the market value of agricultural products, to feed the population with the least use of labour, or to feed the population with maximum employment in agriculture.

Programmes and policies to accomplish these objectives in developed as well as developing countries have usually centered around production technology and farm organization and management. Too often overlooked is how the individual and the family gain access to the land resources. So the land tenure institution needs to be treated first.

6.4 INCREASING ATTRACTIVENESS OF RURAL LIVING

In many countries insufficient emphasis has been placed on maintaining and increasing the attractiveness of the rural environment both to improve farm living and to improve recreational possibilities.

* Council of Europe, Strasbourg 29 March 1971, DELA/Inf (71) 1, 2, 3

6.5 LAND TENURE

Changes in ownership, land reforms, changes of the land managers, and changes in the size of land holdings may create environmental problems as the experience accumulated in managing land under certain conditions might be lost or become inapplicable. This may result in misuse of the resources. Land consolidation projects may have similar effects and such things as, for instance, the removal of existing tree fences may have major influence on climate and other environmental factors.

As land became scarce, communities and nations worked out systems of rules to allocate the rights to use land and to improve it, and rights to the produce from it. The one receiving the rights had responsibilities to the community in the way he used the land. This is too often overlooked in developed countries. The community also had responsibilities to the land users. These working rules enforced by the community and the nations are to be considered in matters of land tenure.

Obviously, the system of land tenure rules varies in complexity with each country. Some countries have customary land tenure systems in which an individual's rights to use land are based entirely on customary usage. Other countries have formal systems to record the individual's rights to land. Of these, the Torrens system of recording land titles guaranteed by the State is probably the most formal. Some countries maintain the ownership of land in the State and develop other procedures to give to individuals use rights. Many countries have all of these systems of land tenure currently in use, hence they fail to look at the real issue which is how an individual's rights to land are allocated, how are they enforced, and how do they affect investment in the land and returns from it.

Whatever the system, an individual needs some "security of expectation" with respect to continued use of land and the returns from its use. Such security is essential if the individual is to make investments to improve current production and also to improve the land in the future. When the issue is environment it is most important that the individual expects to use the land in the future. If all he can expect is to be on his land for one or two years, he will try to get the greatest return in that time even if it means cutting down all the trees, complete destruction by gully erosion or having the soil saturated with non-degradable pesticides.

Another important aspect in land tenure with impact on the current environmental situation is the treatment of water and air.

In most of the developed countries, the rights to use water and air are traditionally associated with the rights to use land. A person had the right to use water and air that could be reached from his land. This is not the situation today. Where water became scarce, systems of water rights for irrigation developed, which controlled the use of land more than the land rights did. Water rights, too, were designed to give the user security. However, since water cannot be reduced to possession and the only rights were to use the water available in the future, the rights were frequently priority allocations. The first user had the first right to future water.

As water carries much pollution from both rural and urban areas, the rights to pollute water are in the process of substantial change. And water pollution and ground water levels now involve not only the individuals but also groups of nations and international agencies.

Air has been almost a free resource until the last decade or so. Any rights to its use in any way, were usually associated with the rights to use land.

Air pollution has become an international issue almost over-night. Rights to the use of air, water, and to some extent land, are now matters for international consideration. The issue is not what kind of government but rather how international government can place restraints on individual users while at the same time giving the user some reasonable expectation of future use.

6.6 RESEARCH, PUBLIC AWARENESS AND TECHNICAL ASSISTANCE

6.6.1 Research

Considerable progress has been made as a result of research but research activities have not come fully to bear on environmental problems to help resolve them. This is due to over-specialization in most research programmes and their tendency to be restricted to sectoral techniques and analyses. Furthermore, research has been mainly focused on improving economic returns of the individual and the nations, with too little attention paid to environment and to the institutions through which natural resources are used.

There is now an urgent need to pay attention to the efficiency and long term stability of modern agricultural and silvicultural systems as eco-systems, particularly in relation to the exhaustion of resources and deterioration of the environment. In this field and in the areas of physical and biological productivity of eco-systems, and on social organization, research should be continued.

Because of the pressing need for ever-increasing food production, new technologies are being adopted before the consequences are known and cultural practices are being transferred before there is time to test them fully and before people have time to understand their use. With respect to the environmental questions, even developed countries have inadequate research.

Research has not paid sufficient attention to the problems met in agriculture and there has not been sufficient emphasis on the use of research findings.

6.6.2 Public awareness

The question of who is to make the decisions on what is to be communicated to the public and how it is to be weighted is important in environmental matters. A damage to a resource may be rated much greater by one person or one group than by another. It is desirable that the determination as to what is detrimental to the environment should be made public and that the public should be involved. This is not always the case at present.

Sociologists have found that the most effective way to induce changes is by person-to-person contact. Most of this research has been done in developed countries. Since trained personnel is too scarce for person-to-person contact even in developed countries, communications specialists have been exploring ways of not only getting information to large numbers of people but of obtaining a return flow of experience and ideas useful in formulating new programmes. In a Latin American country, it was found that information on improved production practices sent through the mail was kept, understood and used even though the receiving person himself could not read.*

* Brown, Marion, PhD thesis, University of Wisconsin, 1968

"Some communications people now feel that the most effective procedure is to locate a communication specialist at the research base and as part of the team. He can modify the communication technique in accordance with the practice to be demonstrated. He can feed experience of local people into the research team's analysis."

In many countries the technical specialist is attempting to broaden his contacts by giving special short courses to local farmers and farm women, depending on these to contact the local people. In this respect, it should be emphasized that it is most desirable to use non-formal educational channels to spread information to the rural masses.

Extension services have been established in many developing countries. Unfortunately, they have mostly been patterned on the extension organization in developed countries and often staffed by people from another country.

Staffing of the education and public awareness programmes with nationals should be done as soon as possible.

6.6.3 Technical assistance

Regarding technical assistance, there is the major problem of the transfer of experience and technology from developed to developing countries in different ecological zones. Another problem arises because, in many cases, requests for technical assistance are confined to specific, narrow fields and, consequently, highly specialized experts are provided whereas people with broader experience would be much more useful. Moreover, when multi-disciplinary projects are implemented, the governments and international agencies concerned tend to give priority to actions which can provide immediate returns, and development projects bringing slow but long-term improvement, perhaps to marginal agricultural areas, are often given second priority. This seems to indicate a need for more selective sifting and screening of priorities.

7. MAJOR ENVIRONMENTAL ISSUES

7.1 UNDERSTANDING THE HYPOTHESIS AND GOALS OF THE ENVIRONMENTALIST

A major part of the world's natural resources is, and has been, used and controlled by rural people. Although not a basic issue, an understanding of the theory, literature and primary concerns of the environmentalist is desirable.

Although the environment is now receiving major attention around the world, it has concerned many civilizations in the past. For example, most people in agriculture have long been aware that salty soils due to irrigation, soil erosion, overgrazing and rapid cutting of trees result in environmental damage. The recent concern about the environment grows out of the rapidly increasing rate of technological change in both the agricultural and the non-agricultural sectors and the impact of the rapid increase in the world's population and higher expectations.

It was Aldo Leopold, however, who developed the theoretical ideas on which a large part of the current concern is based. His ideas can best be presented by quoting from his Sand County Almanac*:

"There is as yet no ethic dealing with man's relation to land and to animals and plants which grow upon it ...

"The extension of ethics to this third element in human environment is, if I read the evidence correctly, an evolutionary possibility and an ecological necessity ...

* Leopold, Aldo, A Sand County Almanac, Oxford University Press, 1949, pages 203-219.

Individual thinkers since the days of Ezekeil and Isaiah have asserted that the despoliation of land is not only inexpedient but morally wrong. Society, however, has not yet affirmed their belief. I regard the present conservation movement as the embryo of such an affirmation ...

"All ethics so far evolved rest upon a single premise: that the individual is a member of a community of independent parts. His instincts prompt him to compete for a place in that community, but his ethics prompt him to cooperate (perhaps in order that there may be a place to compete for) ...

"The land ethic simply enlarges the boundaries of the community to include soils, waters, plants and animals or collectively: the land ...

"An ethic to supplement and guide the economic relation of land presupposes the existence of some mental image of land as a biotic mechanism ...

"The image commonly employed in conservation education is 'the balance of nature' ... this figure of speech fails to describe accurately what little we know about the land mechanism. A much truer image is the one employed in ecology: the biotic pyramid ...

"Plants absorb energy from the sun. This energy flows through the circuit called the biota, which may be represented by a pyramid consisting of layers. The bottom layer is the soil. The plant layer rests on the soil, an insect layer on plants, a bird and rodent layer on insects and so on up through various animal groups to the apex layer which consists of the larger carnivores ...

"The species of a layer are alike not in where they come from, or in what they look like, but rather in what they eat. Each successive layer depends on those below it for food and often for other services, and each in turn furnishes food and services to those above ... man shares an intermediate layer with bears, rocoons and squirrels which eat both meat and vegetables ...

"The lines of dependency for food and other services are called food chains ... The pyramid is a tangle of food chains so complex as to seem disorderly, yet the stability of the system proves to be a highly organized structure. Its functioning depends on the cooperation and competition of its diverse parts ...

"Land then is not merely soil: it is a fountain of energy flowing through the circuit of soils, plants and animals. Food chains are the living channels that conduct energy upwards; death and decay return it to the soil ...

"When change occurs in one part of the circuit, many other parts must adjust themselves to it ... Evolutionary changes ... are usually slow and local. Man's invention of tools has enabled him to make changes of unprecedented violence, rapidity and scope ..."

Building on Leopold's model, the current environmentalists are concerned about the rapid adoption of new technology within the ecological system.* Dubos points out the alarming technological pollution of the environment by saying that man is rapidly losing control of his environment. ** Professor Van Potter, a distinguished

* Carson, Rachel, *Silent Spring* Faurett Publishing, 1970

** Dubos Rensules, Man and His Environment, US Department of Agriculture, Graduate School, 1966, p.6

cancer researcher for 30 years, has taken Leopold's model into the very structure of man. He pleads for inter-disciplinary investigation and asks for a bio-ethic if man is to survive. * Commoner and others make a strong argument that although increased population means increased use of food and shelter, therefore pollution, the greater pollution danger is from the technologies. His rough estimates of increase in pollution levels in the US range from 200 to 1000 percent between 1946 and 1968. Population increased about 43 percent during the same period.**

Agriculture's first priority has been to grow food for the population. Since it has generally been necessary to accommodate agricultural production with the environment, the goal of increasing food production has seldom been questioned. Agricultural colleges, departments of agriculture, and the Food and Agriculture Organization of the United Nations have all been encouraged to promote improved techniques of agricultural production. While increased production remains essential, the environmental factor has now become a matter of priority and must be given a place of importance.

7.2 WHAT EFFECT WILL ANTICIPATED CHANGES HAVE ON THE ENVIRONMENT ?

Population increase is one of the dominant factors encouraging all types of new technologies affecting the environment. Future projections indicate that, in spite of recent food increases, food production will not long keep up with population needs. The increased use of products requiring greater amounts of natural resources increases the demand on the environment at a greater rate than that of population increase.

A slow-down of population growth to, or near to, zero is a critical necessity if our environment is to be maintained. In many countries this is contrary to national policy.

7.3 SEPARATION OF BENEFITS AND COSTS

When the one who benefits from exploiting natural resources is not the one who must pay the cost, there is no incentive to caution and wise use. For instance, the farmer with relatively level land on top of a hill finds it to his advantage to concentrate the surface water run off in one place. This concentration may result in serious soil erosion on his neighbour's farm in the valley. It is not easy to get the farmer on the high ground to pay the cost of erosion below him.

The tenant farmer who, because of the rent he pays and the cost of the credit advance, gets no more rice for his family, will be reluctant to pay the cost of improved production techniques.

The dairy plant that discharges its waste into the river which destroys fishing downstream has no incentive to stop polluting the stream. The water it gets from its wells is not affected by its discharge. But its wells may lower the ground water enough to affect the wells of nearby farmers.

* Potter, Van R. Bioethics - Bridge to the Future, Prentice Hall, 1971

** Commoner, Barry; Carr, Michael and Stamler, Paul j. Environment Vol. 13 (3), April 1971

As rural people are the major users of the natural resources they should therefore be fully consulted in the management of these resources. Thus, the questions of resource management and family planning are closely connected and cannot be separated in programme planning. All programmes should encompass the farm family and educational opportunities must be extended to the entire family, particularly the women who are all too often neglected in agricultural programmes. This will enhance the status of women and their role in the improvement of the quality of the environment.

The family is also important from another aspect. Human welfare can be enhanced not only by increasing income but also by improving general living conditions through better sanitation, better food habits, better housing and other amenities. Since more than fifty percent of the people in many countries are living in rural areas, improvement of the human's environment in rural living is of great importance. In such improvements the rural family - and in particular the woman - is the key factor.

One of the key issues in improving the use of natural resources is to devise ways in which those who benefit pay the cost. Unfortunately, in many countries the benefits have been capitalized into the economic system and the costs simply represent a price to be paid by depletion of natural resources.

7.4 TRANSFER OF NATURAL RESOURCES BETWEEN NATIONS

Related to the cost-benefit issue is the matter of transfer of natural resources between nations. Developing countries use much of their natural resources for export to the developed countries. This situation is significant in the case of minerals and fossil fuels. But it is also true of crops, such as cotton, rubber, sugar, coffee, coca, palm oil, lumber, bananas, etc... The terms of trade are generally less favourable to the exporter. This trade seems to have been built into the general economy of the nations.

The long-term disadvantages of this arrangement for the developing countries are seen in an example of an operation in a South East Asian country. In the short run, it appears desirable for all concerned. The country receives an international loan to develop agriculture. Virgin timber is cut down. Of the several hundred species of timber, only two are used and, of those two, only the 30 inch tops. The logs or lumber are sent to a developed country at a relatively low delivery cost. The remainder of the timber is cut and used locally for fuel. The land is planted to rubber and oil palm and settlers are sold these plantations on credit. The world market for rubber is not particularly good but for palm oil it is very good. However, since so much oil palm is being planted, the world market is expected to drop substantially by the time the plantations come into production. Thus the operation becomes a waste of a natural resource.

Developing countries should therefore carefully evaluate proposals for projects which earn a profit in the short run, but in the long-term deplete the natural resources.

7.5 MEASURING THE LEVEL OF LIVING

Too often the level of living of a nation is measured by the Gross National Product per capita - a composite of available numbers, including quantitative price values of goods produced and services rendered, with the total divided by the population. This, of course, gives no importance to the distribution of income. Neither does it

measure in any way what may be happening to a nation's natural resources. It does not even give an adequate measure of level of living. It includes in the total many goods and services that are needed to some extent because of environmental pollution. For example, included are costs of hospitals and medical services which are necessary in part to repair human damage from pollution, expenditure for sanitation services, and expenditure for transportation.

7.6 DECISION MAKING

At issue in nearly every country in the world is the question: who makes the agricultural decisions? Who, and with what authority, and for how long, determines how agriculture uses, protects, and conserves natural resources? Generally speaking, ownership, institutions or working rules of the community or nation give the authority for decision making.

7.6.1 Ownership of land

Ownership generally gives decision making authority over the use of land. In some areas, as in some parts of Latin America, the large land owner does not use his land to capacity. When he does, it is to his profit to use the most modern technology available, including labour saving machinery. In either case, the tenants and the farm labourers have, because of the land owner's decision, little opportunity for increased employment in agriculture. Where land ownership controls also the people on it, the landowner is the one who has the credit and controls the marketing channels. He decides the public investment in aqueducts and schools; he appoints the police and the judge and runs the local government. There is no land tax because the landowner pays the cost of all the investment. The issue in this case is to give the individual farm family some access to land either by individual landownership or through community or cooperative farms or state farms.

Many countries have laws which prevent corporations - major private firms - from owning farms. This is because the farmers fear that farming decisions will be made by large integrated corporations in a better competitive position than the family farmer to get credit, sell their produce and cope with taxes. The farmer also fears, among other things, that if the decisions are made by the corporation, all the soil conservation practices he has installed, like terraces, stripcropping, grass waterways and good crop rotations, will be removed in the drive to exploit the land for the greatest short-term profit.

7.6.2 Credit and Decision Making

In many parts of the world, the small farmer finds credit hard to get. It is usually tied to availability of food, seed, fertilizer, pesticides and other inputs on the one side and to the market on the other. The creditor often provides for the family food until harvest and the agricultural inputs, and sometimes owns the land. He then makes most of the decisions on what to plant and how much. When the crop is harvested, he takes it to repay the loan. Prices and interest rates are fixed by the creditor. The issue here is to give some of the decision making power back to the farmer. Many nations are establishing agencies that will make credit available to farmers. This often means that some form of production assistance is necessary and that some market alternatives must be made available.

7.6.3 Community Organizations

Community organizations have a large part in determining who makes agricultural decisions. Generally, they are not considered a part of the local government organization and sometimes are not even thought to exist except as some kind of a protest group. But they do exist and play an important role in management of the rural environment, as the following examples illustrate.

In one country in East Africa, an entire land settlement project was jeopardised. Goats ate the fruit trees because the owner who had received and planted the trees was not the same person as the local organization recognised as the owner. In a country in South East Asia, the owners of land in one district in the official records were different from the owners in the eyes of the rural community. Many tenants who were supposedly renting small tracts of paddy land were, in fact, being given this land by the community or family for their subsistence - a sort of welfare programme of the local organization. In a Latin American country, a small community group bought large farms and sub-divided them for their sons. They processed their own coffee and built their own schools.

Much more attention should be given to the rules and practices of local organizations which should be integrated with those of the formal government. When individuals have a part in the farming decisions and in their government, farming has a better chance of being of benefit to the environment.

7.7 TRANSFER OF TECHNOLOGY

After the second World War, nations and international agencies started to transfer technologies in a large way from one part of the world to another. The organization or technology which was transplanted arrived almost unchanged. This practice had some success when the physical conditions were similar and the cultural and educational levels of the people were about the same. As could have been expected, difficult problems of adjustments were encountered when the move was made from the temperate regions to the tropics or to arid areas, and from the culture of the western industrial nations to that of some of the developing countries.

7.7.1 Technical Assistance

In the early days of technical assistance programmes great emphasis was put on increasing production through agricultural extension services. But it was often found that the experience of the temperate developed world could not be applied in the tropics or in arid and semi-arid zones. There is now a realization that research and testing are required to determine what crops and livestock are suitable in different areas and for good management of water resources, and a number of research centres have been established to provide knowledge applicable to the problems of developing nations.

7.7.2 Supervised credit

Supervised credit has been tried in many countries as a way for the government to help the small farmer free himself from the creditor. Much of this credit has found its way no further than to one or two persons in the community. The supervisors' knowledge of the needs and problems has not generally been adequate. Supervision by commodity organizations or cooperatives has often been more successful.

7.7.3 Transplanting new food production technology

As already pointed out, the "Green Revolution" is a good example of transplanted technology. The idea behind the "Revolution" is that of a total production package - seed, fertilizer, pesticide, credit, technical assistance and marketing at good prices. But here again are some problems. The large farmers on the best irrigated lands are the ones that first increase their production, followed by their medium-sized neighbours and any others able to do so. But the smaller farmers on poorer marginal lands cannot duplicate the increase. The widening of the gap in incomes and the decline in employment opportunities are increasing social unrest. On the technical side, there is the danger that when one variety takes over such a large part of the planting area, the varieties developed specifically for the area may be lost.

Research and knowledge of the local methods of operation are therefore important when transferring a technology from one area to another.

PART II

POLICY GUIDELINES AND MAJOR ACTION PROPOSALS

8. INTRODUCTION

In Part I the focus was on the impact of agriculture on the human environment, an evaluation of the present activities, and what are the basic issues concerning the environment and their causes. In Part II we come to the recommendations and priorities for action. First, suggestions on measures to fill the data and information gaps that now exist, then recommendations on how to improve and incorporate environmental matters into land use planning and, finally, major recommendations on the management of natural resources by agriculture. In each section an attempt will be made to suggest actions or roles that might be appropriate for UN agencies. It should be clear by now that the problems of the natural resources and the environment must be of concern to people. The problems are almost always inter-disciplinary and are closely interrelated with the non-agricultural sectors. For example, agriculture in its use of pesticides may create damage mostly to the urban community while programmes of urban solid or liquid waste disposal may affect agricultural land use.

It should also be clear that action taken to improve agriculture's management of natural resources may involve only the farm family or it may call for community, national and international action. Recent environmental problems have tended to call for action at higher levels. A river does not stop being polluted when it crosses a national boundary or when it flows into the international waters of the ocean. Air pollution is no longer just one city's problem when it begins to affect the climate of another nation. Such problems require international action and the cost-benefit arrangements must be worked out by international agreement.

9. MEASURES FOR FILLING KNOWLEDGE GAPS AND DATA COLLECTION

Surveys and inventories and adaptative agricultural research take long to carry out, consequently, individual farmers and local and national authorities are often obliged to take decisions to use new technological means and to expand or intensify the use of natural resources for agriculture without having full knowledge of the possible environmental consequences. It is therefore necessary in the implementation of any agricultural development programme to provide for controls and further adjustments of the decisions by monitoring. In many cases, the risks taken can be considerably reduced if all data and information already collected in similar ecological conditions or/and similar action programmes have been made available and fully utilized. These four main lines of action supplement each other and should therefore be fully associated.

9.1 MONITORING

One of the suggestions to the Stockholm Conference should be to increase the agricultural use of local, national and global monitoring. Climatic data are important in determining what crops to plant and when, when and where rainfall can supply irrigation water, where droughts are serious, when and where frosts can be expected and the kind of shelter needed for livestock. Agricultural use can in fact change the climate and be related to soil erosion.

While global data can be important, monitoring should be done locally on a pilot scale in consultation with agricultural technicians in order to make sure that the data can be used in land use planning, programme formulation and management at the local level. Primary emphasis in this paper is given to land use planning at the local level with participation by local people, and to monitoring

locally the results of major land use changes that could not be tested prior to adoption. Global monitoring should demonstrate that data from it can be of assistance also to local farmers before there is wholesale gathering of such data that may not be used.

9.2 KNOWLEDGE ABOUT LAND RESOURCES

Essential to land use planning (discussed in the next section) is a knowledge of land resources. Most developing nations do not have enough well trained personnel to make the needed surveys of the soils, the vegetative and forest cover, climatic conditions, present land use and agricultural statistics.

International agencies should help train nationals and otherwise assist in preparing such surveys.

The extent and nature of the surveys, of course, depend on the facilities available. The surveys should be flexible and tailored to the use that is to be made of them. For instance, the soil survey for an intensive cropping area is not needed for potential range lands or isolated forest areas. Agricultural statistics about crop production, which are in fact about a natural resource, are a necessary input into land use planning. Judgement will be required to put together information from a world data bank, if one is developed, with the ground survey information.

When there is a major change in land use, tests should be continued to determine the decomposition rate of pesticides or the amount of soil erosion or the flow of plant nutrient through the soil, etc. Also studies should be made about the farm organizations that use the new technology, the effect on credit needs, and the markets. Community and government may have to provide special assistance to small farmers and this requirement should be evaluated.

Current information and statistics with respect to land use developments need to be expanded and oriented towards problem solving.

9.3 COSTS AND BENEFITS

Available quantitative data and any that can be generated should be used to determine the costs and benefits of land use programmes and development projects. The costs and benefits should be continued in physical terms as long as possible before giving them a monetary value. An experimental effort should be made to calculate with some precision the environmental costs and benefits. For instance, what is being taken away from the store of natural resources (in physical terms) and what is being added, what is the amount of pollution, who benefits and who pays the costs? Perhaps it would be desirable for each project to have a natural resource cost benefit account. One of the big issues in the use of natural resources is getting a better relationship between the benefit from using the resource and the cost of repair or distribution. Hence, the natural resources account should, if possible, keep the ownership records.

10. MEASURES TO IMPROVE LAND USE PLANNING

10.1 IMPORTANCE OF LAND USE PLANNING

Land use planning and land use plans are the best guidelines to wise use of natural resources. They indicate under the present state of technology and population the optimum use of natural resources and include from present land use. Land use plans are valuable, of course, in urban areas to guide development. But land use planning is particularly valuable in agriculture where most of the natural resources are. It can be a guide to protection of the best farm land against urban sprawl and, generally, to the wise use of land resources by providing the answers to a host of questions such as: What is the grazing capacity of range land in different areas? Is there enough water to build a dam at this point and maintain the water flow down the river? Is there land that can be irrigated without resulting in salinity? What lands should remain for forestry? Which land can be cleared for crop use without the danger of soil erosion? What crops can be expected to yield most? Where do the people live and how do they want to farm? What kind of services and markets will be required?

10.2 METHOD OF LAND USE PLANNING

Planning the use of the land is planning the environment. Whenever a new project, such as an irrigation dam, range management procedures, or a high yielding crop package is considered, it must be judged in terms of the land use plan. When projects are adopted, the land use plan must be reconsidered. In fact, it is more important to develop the continuous process of land use planning than to develop the fixed plan.

The first step towards a plan is to get as much information as possible about the area to be considered. It should include physical data such as soil surveys, land capability, topography and slope, drainage, altitude, hydrology and water supplies, climate, including monthly rainfall and temperature, crop cover, types of crops grown, production records, etc. and the following:

- data on how people farm, size of farm, field systems, livestock and range land use, power if any, types of crops, double cropping, irrigation water availability and use;
- data on who owns the farm, what are the taxes, the value of land, is it rented, for how much, from whom, is it used free, is credit available, from whom, at what price, what products are marketed, to whom, at what price;
- some information is needed on the family and family income, how many in the family, what are its goals, its level of living, its interest in schools and other community activities, how much income from the farm or from off-farm employment;
- information on infrastructure is needed, including roads and local government.

Some of the developing countries have made considerable progress in placing physical data on electronic equipment. For instance, Sabah, the Malaysian state of North Borneo, has detailed information, physical and written, on each recorded deed (Torrens system). They are experimenting with recording physical data, such as topography and cover.

The next step in land use planning is to identify the major land use problems by regions and subregions etc., and to relate each area to the large river basin or land use area to which they belong. Is there enough water or grass to supply the entire area? Are there areas which, because of better soil or for other reasons, are more promising for development or less liable to environmental damage? Would development in one area cause environmental problems in another? What would be the overall salt and water balance? These are the types of questions which would be answered at this stage.

The third step is to rank the problems and the areas by priorities, taking into account the policies and major objectives of the national government. On doing this, the following alternatives should always be considered: 1) improving the lands by major capital investment and/or change in land use, and 2) improving the existing management.

A very important part in the planning procedure is to involve the people at the local level and at the other decision levels at every step. The knowledge of the local land users is of valuable assistance in collecting the basic data and in identifying problems associated with changing land use. If people have a part in making a plan, it is theirs, they know about it and the difficulties of putting the plan into operation will be minimized.

10.3 LAND USE PLANNING AS A CONTINUOUS PROCESS

Any proposed major change in natural resource use, such as a new irrigation project, adoption of new high yielding varieties, controlled grazing, developing a new settlement or an oil palm unit from the forest, dividing up land or helping tenants, etc. should be considered in the same way as in developing a land use plan. Planning is a continuous process, or should be, by which technicians, people concerned, government representatives and administrators review changes in land use.

In land use planning, the socio-economic factors are integrated with environmental factors. Not only do people consider the use impact on natural resources, but they consider rules for the relationship with other persons who may use natural resources.

The process considers the distribution of the benefits from the use of resources. It is here that techniques need to be worked out to balance costs and benefits.

10.4 INSTITUTIONS AND LEGISLATION

The need to change institutions, tax programmes, income sharing programmes and other legislation is important in plan formulation and decision making.

The area boundaries of jurisdictional units with authority to plan are often not the same boundaries to be considered in making a land use plan. It was suggested in one South-east African country that the land use development plan should consider not one specific project but rather several projects in one section of the country. This would have made it possible to place a set of priorities on the specific projects in terms of employment as well as production. It would have made it possible to invest in a general programme of training and technical assistance to all farmers in the area whether or not they lived within the boundaries of a specific project. But this would have required a revision of government administrative machinery and budgeting process, if not legislation.

Different units of government may have administrative jurisdiction for individual matters in the same area. For instance, in one South-east Asian country, the land ownership, tax system, land alienation and the recording system were all in the jurisdiction of the state governments. For the national government to acquire land for development, legislation was required and then a specific contract between the State and National Government. As the State government's only income is from land rent, it requires some alternative source of revenue before it can release ownership.

Legal and institutional arrangements, such as general taxation, indemnities, special assessments, etc. should be developed to allocate the costs of environmental deterioration to those benefiting from or responsible for the deterioration.

It should always be remembered that for most of the rural world, a change in land use means a change in natural resources and affects "human environment".

10.5 TECHNICAL ASSISTANCE IN LAND USE PLANNING

The primary thrust of land use planning must be at the community, provincial and national level. However, most countries, particularly the developing ones, need and would like considerable assistance in land use planning from international agencies.

Basic, of course, are the surveys of soil, forestry, fish and wildlife. To this should be added surveys of farm organizations and community activities, while agricultural and other natural resources and trade statistics need to be continued and developed.

Technicians who can look outside their discipline to the wider aspects of a land use problem should be mobilized from the international agencies and made available to the associated governments. These technicians should help train nationals since nearly all final land use planning decisions will be made by nationals. The international technicians should, of course, be used by governments in evaluating land use and development plans.

Land use planning requires skillful coordination. It is recommended that when the land use planning effort begins in a country, the appropriate personnel from the several national and international agencies concerned be called in to participate in formulating the planning needs and procedures.

Since most of the technicians needed in rural land use planning will be in agriculture, it is recommended that FAO take the lead in establishing a task force for this purpose. Other U.N. agencies should participate.

TO SUM UP THE IMPROVEMENT OF THE PLANNING PROCESS TO PREVENT ENVIRONMENTAL PROBLEMS SHOULD COVER THE FOLLOWING:

- (a) At the national level: it is recommended that planning activities be strengthened and broadened so as to take into account not only socio-economic aspects but also the actual use capabilities and limitations of natural resources and the inter-dependence of natural resources and sectoral activities in the environment; "environment impact surveys" and pilot trials should be made prior to the implementation of major projects and programmes; the processes of planning and adjustment of plans should be continuous and carried out in close connection with environmental monitoring and research activities; local communities should be involved in land use planning, and zoning ordinances and comprehensive licensing control on the basis of these plans should be developed.

- (b) At the international level, the UN specialized agencies concerned should strengthen their regular programme activities in the field of planning (especially rural land and water use planning in FAO), provide assistance to Governments for more comprehensive planning and introduce environmental considerations in the formulation of development projects and programmes.

11. MANAGEMENT OF NATURAL RESOURCES IN AGRICULTURE

11.1 PLANNING THE USE AND DEVELOPMENT OF NATURAL RESOURCES

Planning is, of course, one of the highest forms of management and land use planning is, in effect, the blue print for programmes and projects in this field. One continuing difficulty is to arouse sufficient interest among all those concerned - the Government and state and local authorities, the scientists and technicians, the owner of land, the farmer and his workmen, the villagers and the rural community and the population generally - in land use planning. The most direct way is to incite the interest of those directly concerned in a situation, such as that of farmers who find that a city "dump" is to be established adjacent to their land. The farmers concerned can be quickly aroused as to the adverse effects on their condition and will actively support measures to control such dumping as, for example, demanding a zoning ordinance. And because such an ordinance requires first a land use plan, the farmers will support the introduction of such a plan.

A land use plan cannot, of course, emerge as the result of a series of ad hoc situations such as the one mentioned above. Such situations should be used to promote the idea of the overall need of a land use plan which should, basically, be a national plan, developed in accordance with the national interest and regional and local requirements. For example, major irrigation and drainage systems can be of national importance and of special significance regionally and locally and these various interests should be reconciled in the overall land use plan and given their specific values in the regional and local plans. So, in the case, for example, of a major water system, such a plan should take into account not only the consequences of the development and use of hydro-electric power which may influence the lives of millions of people over hundreds of thousands of square miles, but all the subsidiary effects such as the containment of water in reservoirs, the control of rivers and streams and floods, the development of irrigation systems from such controlled waters, the effects of such changes on the countryside, agriculture, the life of the human population and of all the eco-systems involved. At any level - national, regional or local - such a plan is of the highest importance and governments need to accord such planning the top priority not only for the benevolent guidance of their countries' development but also for the protection of the environment.

It can be asserted that a concept of land use planning as outlined in the previous chapter is not yet common even among those governments most aware of the need to seek orderly development and to protect the environment. In many of the technically advanced countries the lack of such a concept and such a plan has already resulted in a multitude of problems arising from misuse of land in all sorts of ways, extensive and largely uncontrolled urban and industrial development and the staggering burden and difficulties of wastes and pollution of various kinds. Much work is still to be done to arrive to a detailed concept of land use planning aiming at an optimal use of resources in the short run and an optimal development of resources in the long run, basing on data collection and analysis and leading to the formulation of a plan, the selection of means for the implementation and the actual implementation.

11.2 SPECIFIC PROBLEMS OF RAPID CHANGES

While the critical problems of air, land, sea and fresh water pollution grow in intensity in the technically advanced countries, the problems are daily increasing in the developing countries. The technically advanced countries, because of their wealth and technical expertise, do have a chance - now that they are awaking to the perils of pollution - of meeting the challenge if they devote sufficient resources to this purpose. But the developing countries are especially vulnerable in this respect because they are, in the main, concentrating all their limited resources on development - the introduction of modern agriculture, bringing with it the use of improved seeds, artificial fertilisers, pesticides, machinery and general mechanisation, more irrigation, new crop rotations, new marketing and distribution systems, road development, mechanised transport, use of electricity, changed standards of living and so on, the development of industry of all kinds, the rapid and vast expansion of cities and other urban concentrations with all the multitudes of difficulties and problems they entail. As anyone who has been in the developing countries has seen, the rapid developments taking place are causing all sorts of pollution of the environment and degradation of the natural resources.

The fast increasing population itself is a cause of pressure on those resources. For example, the demand for increased supplies of food has led to the exploitation of land regardless of the long-term consequences, so forests have been felled and land overgrazed. At the same time, good agricultural land has been taken over for urban and industrial expansion. Erosion, alkalinity and salinity, and other results of misuse are causing increasing concern in a great many of the developing countries where 70 percent or more of the population still live - or exist - in the rural areas. Unfortunately, even in those rural areas where production has increased and standards of living have risen - such as where the introduction of the improved varieties of wheat and rice and other cereals and of some cash crops has been successful - the increase in pollution is deplorable.

The crowding of millions into cities without adequate housing, water, sanitation, food, clothing and employment is not only an example of the degradation of human life but a source of infectious disease and contamination. Apart from the pollution of the land and water in their neighbourhood, the disposal of the wastes from these millions adds to the urban problems. Even in the smaller towns and the villages, where the possibility of effective disposal of wastes could be greater, there is little evidence of awareness of the problem. And with any "improved" standard of living the volume of wastes in these communities will increase. Pollution problems in rivers, lakes, streams, wells and any other source of water are increasing inevitably with the growing population and increasing industrialisation and urbanisation.

11.3 ENVIRONMENTAL EDUCATION

It is obvious that, if there is to be any effective control by man over his environment, the mass of mankind will have to be awakened to the perils of the situation. Again, in the technically advanced countries where the population is largely literate there are more readily useable ways and means of communicating with the population than there are in those countries where the great majority of the populace is illiterate. As most of the people of the world are to be found in the developing countries, the problem of communication is most acute there and this is one to which the governments concerned need to give the highest priority because without the understanding and cooperation of the mass of the people any action to prevent pollution of the environment and degradation of the natural resources will be doomed to failure. This is equally true of developed as of developing countries. Environmental education in all its forms and in its fullest sense is therefore a matter of the highest priority for all governments.

In any discussion of education in respect of pollution and the environment and the conservation of natural resources there is a tendency on the part of "educated" people - perhaps especially the scientists and technicians and the bureaucrats of the governments - to think that the mass of people are the only ones in need of such "education". Unfortunately, there is little evidence to support this conceit. The bald truth is that vast numbers of scientists and technicians and bureaucrats and other "educated" people are so immersed in their own field of specialisation that they have given little or no real thought to such a multi-disciplinary subject as "the environment". Therefore they, just as much as the farmer and the extension worker, the farm labourer and the factory worker, the villager and the townsman, the lawyer and the teacher, the "man in the street" and his wife and children, are in need of information, instruction, advice and guidance about "the environment" and what must be done to control and decrease, if possible, its pollution and the degradation of the earth's natural resources. Education and training at all levels, therefore, are required, with special stress on the education of those most able to influence man's activities which affect the environment - the scientists, the technicians, the engineers, the bureaucrats, the extension workers and farmers and, particularly, the governments at all levels, international, national, regional and local. There should, of course, also be a sustained effort made in each country to educate the public in this matter. The subject should be part of the syllabus of every school from the elementary to the most advanced. In addition, use should be made of every channel of non-formal education to reach all of the adult population, urban or rural, literate or illiterate.

11.4 IMPROVING RESOURCE MANAGEMENT PRACTICES

A sensitization of the people should be coupled with a concerted public effort to try to reduce the present level of pollution resulting from excessive use of fertilizers, pesticides and measures violating the balance of existing eco-systems. Practices which exploit the use of natural resources and affect their future quality and/or usefulness in productive processes should be avoided. In general, the introduction of better management practices should be encouraged. Basic land improvement works such as drainage, levelling and soil conservation work, i.e. terracing, gully control, wind brakes and recovery of grazing lands should be promoted. In many cases governments should facilitate such action by making adequate financial resources and other services available. It would always be beneficial to secure the active participation and joint action of local people (where feasible in the form of a specialized local organization for self-help).

Improved management practices which can be applied on the farm unit level include:-

- diversification of cropping patterns
- use of adapted varieties (breeding with local varieties)
- improvement of soil management practices (soil and water conservation practices and salinity control)
- more efficient use of fertilizers, avoiding waste by percolation (nitrogen) and run off
- integrated techniques of pest control
- selecting and using suitable machinery and equipment
- using and recycling agricultural waste
- rotation grazing and adjustment to grazing capacities

Improvement of management practices requires readily available short and medium term credit, improvement of tenure conditions (land reform), adequate storage and marketing facilities and related price policies.

11.5 THE ROLE OF FAO

Throughout this paper there has been reference to the many ways in which agriculture and the use or misuse of land affect the environment, protecting and conserving it or adding to its degradation. Obviously, in much of the field so surveyed FAO has played a part. While this Organization must continue to operate in all these fields, perhaps one of the most significant actions it could take is to give much needed leadership for the coordinated approach to the environmental problem. This could be done not only in the organization of FAO's general and technical work in these fields but in focussing attention on the need for the multi-disciplinary approach and in holding global and regional meetings to promote this approach.

The overall need in every country is land use planning, which is essential for efficient programming and management. A major obstacle to such planning and programming and management is the lack of trained personnel at all levels. Here, again, is a field in which FAO could give strong leadership, assisted by other UN organizations and member governments and the appropriate national bodies. Training courses at the various levels required could be prepared for governments to organise, assisted by FAO. Similarly, FAO could organise training courses at the regional level.

In support of all the work to be done on environmental control and conservation within the Organization's field of competence, FAO could develop a literature on the subject through special studies and reports and a summary of current publications and other information.

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