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RESOURCE CONSERVATION POLICIES AND STRATEGIES FOR AGRICULTURE

THE CASE OF THE SYRIAN ARAB REPUBLIC

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EXECUTIVE SUMMARY

Introduction

On the threshold of the twenty-first century, the Syrian Arab Republic is confronted with three central challenges:

(a) Meeting the future food needs of the growing population (3.5% per year), which will reach around 17 million in the year 2000 and 20 million in the year 2011;

(b) Improving the standard of living of the poor;

(c) Preserving the natural resource base from degradation, for present and future generations.

Population pressures, combined at times with poverty, are forcing people to use land, water and natural vegetation (forest, range) to their limit and beyond. Indeed, much of the accelerated land degradation and desertification of the Syrian steppe, marginal lands and sloping areas in the different agro-ecological zones, including deforestation, cultivation of steep slopes, overgrazing of fragile rangelands, plowing the steppe for cereal cultivation and over-extraction of groundwater, arise from the need to produce more food for a rapidly growing population and to alleviate poverty. These trends seriously threaten the long-term sustainability of agriculture and the conservation of natural resources in the Syrian Arab Republic.

The present report is a policy action document which seeks to adjust and restructure strategies and policies for the sustainable use and conservation of renewable natural resources in the Syrian Arab Republic. The report seeks also to articulate strategies aiming at improving sustainability and management capability in the different sub sectors of agriculture: rain-fed agriculture, irrigated agriculture, forestry and steppe rangelands. A major objective of the report is to identify a coherent agriculture policy and strategy actions and programmes with a focus on improving Syrian agricultural productivity in the different sub sectors of agriculture, besides more specific policy actions for the preservation of land, water resources and biodiversity.

The document ends with a project idea/proposal as a possible vehicle to implement the proposed policies and strategies outlined in the report. The project proposal could be formulated at the request of the Government or possible donors.

A. RESOURCE DEGRADATION

Various studies and field observations in the Syrian Arab Republic confirm that the country's renewable natural resources (natural forest, rangelands in the steppe, agricultural land in rain-fed and irrigated areas and water resources) are being degraded at an accelerating rate owing to the misuse, mismanagement and overexploitation of resources for several technical, economic, social and environmental reasons. This section provides some facts on the extent of this problem in the Syrian Arab Republic.

Except for the 50,000 hectares of pine forests in the Baer-Bassit mountains of the coastal region, most of the forests in the Syrian Arab Republic (*Quercus calliprnos; Q. infectoria; Q. cerris* subsp. *pseudocerris*; *Abies cilicica*; *Cedrus libani*; *Juniperus excelsa*; *Cupressus sempervirens* and *Pistacia atlantica*) are in different stages of degradation, which is reflected by:

(a) The replacement of the original forest by shrubs, sub-shrubs and xerophilous thorny plant communities of low environmental and economic value, such as *Poterium spinosum*, *Genista acanthoclada* and *Calycotome villosa*;

(b) An acceleration of soil degradation accompanied by a decrease in forest soil productivity and wood production.

Rangeland degradation, owing to overgrazing, has resulted in the disappearance of perennial grasses, which in turn has extended the periods of pasture shortage. Annual grasses have increased and have replaced perennials partially or almost completely.

Soil, water and wind erosion are very common in the steppe owing to the overexploitation of natural vegetation. Zoght (1978) has calculated that 50 tons of soil per hectare (ha) per year are lost in the coastal zone on sloping marly terrain. In addition, 25% of the water is lost by surface run-off on the same terrain. The quantity of soil loss in the different ecozones of the Syrian Arab Republic is very high (FAO 1980) and is considered the most critical factor in land degradation and desertification in the country.

Askar (1991) calculated that 10 to 20 centimetre (cm) of soil are lost in 20 years by dust storms from land in certain areas of the steppe because of plowing for cereal cultivation. In some areas where wind erosion is very active, the parent material (gypsic horizon) has been exposed. The result of this accelerated wind erosion is the domination of sandy soil and the formation of sand dunes 50 to 60 cm in height.

The large-scale irrigation projects in the Euphrates basin, the Ghab valley and other places suffer severe degradation through salinization and waterlogging. This is a very serious type of soil degradation in areas of intensive agriculture, especially since the percentage of salt-affected and waterlogged soils amounts to 50% in the Euphrates valley, with a consequent reduction in yield, a restricted choice of crops and ultimately the loss of the land. Recent studies estimate the area of land affected by salinity in the Syrian Arab Republic to be approximately 600,000 ha. In the Euphrates basin, 30% of the land, amounting to 1.13 million ha, is either saline or affected by salinity. Syrian farming loses 3,000 to 5,000 ha of land annually.

Whatever water is available for agriculture in the Syrian Arab Republic is used liberally to irrigate crops. An International Center for Agriculture Research in Dry Areas (ICARDA) survey showed that the average supplemental irrigation given to rain-fed wheat by Syrian farmers was three times the optimum recommended by research. In addition, the overpumping of groundwater in many parts of the country has led to a lowering of the water-table, threatening the groundwater reserve in the country (approximately 1 metre per year in the area around Aleppo). In certain areas, groundwater has dried up, such as in Salamia, near Hama, because of overpumping for cotton cultivation in the 1950s; the area has now reverted to rain-fed farming.

The total area under supplemental irrigation from groundwater is estimated at 260,000 ha, or about 70% of the total supplemental irrigation area. The zone in which supplemental irrigation is practiced contains 70% of the country's water resources. The water resources that are available in the supplemental irrigation zone are already fully exploited, even overexploited, because of the overpumping of aquifers. According to Wakil (1993), the annual water deficit of the Khabour basin is estimated at 1,500 million m^3, and that of the Orontes basin (Asharneh aquifer) about 210 million m^3/yr. It has been observed that "temporary mining" is found in all the major aquifers, and that this could lead to permanent mining if aquifer water withdrawal remains the same. Therefore, no horizontal expansion in areas under supplemental irrigation, using new water resources, can be expected.

It should be emphasized that groundwater is biologically and chemically polluted in many regions of the country, particularly in the Damascus and Ghouta areas. Measures to control urban and industrial growth in Ghouta have been taken to protect and to permit further development of these productive irrigated lands and to conserve this exceptional and valuable agro-forestry system. Unfortunately, however, these measures have not been applied strictly, and this has led to a sizeable decrease in the best agricultural lands in Ghouta.

B. Past policies on natural resources conservation and sustainable agriculture

Past government policies and farmers' efforts have focused on increasing production, partly to meet the objective of achieving self-sufficiency in several strategic crops and partly to enhance exports of certain crops and livestock. During the period of growth, little if any attention was given to the rational use of natural resources, whose preservation forms the basis for sustainable growth. This has led to rapid depletion of groundwater in certain areas and to waterlogging and salinity, overgrazing of rangeland, degradation of natural pastures and silting of reservoirs owing to mismanaged watersheds. In many parts of the country, cultivation has already been extended to marginal lands.

The most important policies related to agricultural development which also directly or indirectly affected the natural resources (land and water) of the country pertain to price and trade policies, production planning, and input and output subsidies. Further, weak environmental protection institutions, inadequate legislation, lack of public awareness and policy distortions contributed to natural resource degradation.

Apart from other factors, policy distortions have resulted in underpricing the country's scarce natural resources, mainly water, forestry and rangeland. The analysis in the main report shows that water and feed for livestock are underpriced. The lack of well-defined property rights, and an effective regulatory framework, as well as permitting open access, resulted in the depletion of natural resources (groundwater and rangelands) for which the user does not pay the cost.

These distortions drive a wedge between private and social costs and therefore send wrong signals to the farmers concerning the real value of resource. As resources are cheap, farmers tend to overuse them, which is environmentally damaging to the natural resource capital of the country. The resulting development pattern in fact undermines the resource base on which its long-term growth depends and results in unsustainable agriculture.

1. *Policy effects*

Evidence is mounting that subsidies provided at the output and input levels are one of the factors contributing to land degradation and water depletion. In the past, wheat, barley and sugar beet production were heavily subsidized. The subsidies on inputs other than water have been gradually removed. These policies have resulted in negative externality, as most productive areas are being affected and land cultivation is encroaching on the marginal lands, as explained in the section on resource degradation.

In spite of the impressive progress of the agriculture sector in diversifying the production base and exporting sizeable quantities of horticultural produce and livestock (sheep), the overall performance, especially of cereals and cotton, is far from its potential. Any analysis should consider the sizeable investment in irrigated agriculture during the last two decades, the massive subsidy and the cost of natural resource degradation. It is now imperative that agricultural development strategy and agricultural policies aimed at enhancing growth and equity also take into consideration the need to conserve the natural resources of the country, particularly land and water.

Lack of water demand-management practices in the past also contributed to low efficiency in water use and to consequent waste. In addition, improvements in the availability of water stemming from the introduction of lumpy technology in the past diverted attention from demand management and reduced emphasis on low-cost alternatives such as improving efficiency, conserving resources and reducing waste through maintaining irrigation systems.

With regard to water pricing, the justification for increasing water charges stems from sound economic rationales; the present price levels and structures do not convey meaningful economic signals to the farmers because these charges constitute a very small percentage (6-9) of the overall cost of production and are not related to the production values. The current and proposed water charges to cover the operation and maintenance (O&M) cost are well below the returns imputed to irrigation water. The return on water (or its financial value) is more than six to ten times (depending on crop) the price the farmer is paying. Obviously these water rates are significantly lower than those rationalized under cost or marginal value criteria. In our view the proposal to double the price of water is well within the payment capacity of the farmers.

Another policy question is whether to invest in rehabilitating or improving the old system, which has an efficiency of less than 50%, or to develop a completely different but much more efficient system with very high returns in the long run. There would be many advantages to having a new irrigation system: they are easy to operate, reduce operational losses and provide a more reliable supply of water; new systems are often more versatile in adverse soil and water conditions; costs are lower; such systems use less labour and are suitable for areas where topography is difficult. However, these systems need continuous supplies of water and the high cost of this deters their widespread use.

As nearly all the suitable lands for rain-fed agriculture are already under cultivation, major policies have been oriented toward increasing the output of such lands through yield improvements by applying packages of new technologies and improved farm inputs. However, these packages have not been effective owing to inadequate research on the management of soil and water in rain-fed areas and lack of coordination among the many institutions in the country.

Past policies have also focused on using supplemental irrigation, in the summer, to improve crop yields in the rain-fed areas. Even in the higher rain-fed areas of the coastal region, the development of groundwater and surface-water sources can be useful as supplemental irrigation during the dry period of the year. However, overpumping of groundwater has led to depletion of this resource in many regions and will have a negative effect on agricultural production in the future.

Any expansion in supplemental irrigation can come only from a shift out of full irrigation. Such a shift could be dictated by the need to ease the depletion caused by temporary mining and to readjust the water balance of particular aquifers. Thus, increasing the proportion of supplementarily irrigated crops in the rotation has become an official long-term strategy in the Orontes basin, where the percentage of the irrigated winter crops has been officially increased from 55% to 80% (Mahmoud 1993). This has resulted in a saving of 75 million m^3/year, helping to reduce the water deficit of Asharneh aquifer. According to Wakil (1993), increasing the proportion of wheat in the rotation by 20% (from 60% to 80%) in the Khabour would result in a saving of 600 million m^3/yr.

It follows that what is needed at this stage is vertical expansion, through improving the existing supplemental irrigation system, particularly as this relates to improving water management at the farm level as well as the efficiency of water application. Such improvements would result in water savings and thus would provide the opportunity to increase the irrigated areas and consequently total production.

For nearly two decades, national policy in the allocation of fertilizer to different agro-ecological zones in the Syrian Arab Republic has favoured strategic crops in the high-rainfall and irrigated areas, and permitted none to low-rainfall barley areas. Results of research, however, have shown high returns to phosphate fertilizer on barley in the drier farming zone, indicating that gains could be made by reducing fertilizer allocation to the higher-rainfall crops and increasing those of rain-fed barley.

2. *Institutional effects*

Institutional failure in the area of resource conservation in the Syrian Arab Republic is due to the lack of well-defined property rights, regulatory frameworks, and tenurial arrangements and to the open-access system that encourages depletion of natural resources for which users do not pay the cost. The situation is further exacerbated due to the gap between the private and the social discount rates. A multiplicity of laws and regulations govern environmental and natural resource management in the Syrian Arab Republic. These laws are old and sector-specific and lack the wider scope that is compatible with modern environmental problems. Combating the problem of resource degradation will depend on the capacity of the Government to establish, implement and enforce laws and regulations, more importantly in the Badia and marginal lands to address the problems of common property access, soil erosion and the digging of wells.

The subdivision of the country into agricultural settlement zones based an average annual rainfall is the cornerstone of agricultural planning in the Syrian Arab Republic. Although useful as a first approximation for agricultural production, the present agricultural zoning ignores other highly important factors which determine success or failure of agriculture, such as soil type, soil depth, soil fertility, annual temperature regime, slope, elevation and wind. Such agricultural zoning does not permit the flexibility required in agriculture planning, particularly in a low-rainfall environment, and places a severe constraint on achieving the production potential of the country.

The Agrarian Reform Act of 1958 and legislative decree No. 31 of 1980, which put a ceiling on land-holdings of rain-fed and irrigated lands, created an ongoiong problem of small and fragmented farms, which can only worsen. The continuing fragmentation of land ownership, as an indicator of unsustainability, which is closely related to excessive population growth, may lead to disastrous consequences with regard to soil conservation and sound land management. The disaggregation of farm plots creates many difficulties concerning mechanization, water supply, drainage schemes, terrace construction and other agricultural practices which are not in line with sound environmental technologies.

While plowing in all areas receiving less than 200 mm of rainfall per year was declared illegal in 1970, with modification in 1973, plowing intensity in these areas is still high owing to lack of regulation and non-enforcement of the law.

Despite different measures and regulations devised by the Government to protect the steppe resources and restore the environmental balance in this fragile ecosystem, land degradation and desertification are accelerating at an alarming rate.

The first forestry law, of 1953, is a restrictive and repressive law. While focusing mainly on prohibitions, limitations and sanctions, it virtually ignores planning, management and development issues. It does not contain any specific provisions regarding forestry policy, forest administration, forest inventory, management plans, private forestry, research, training and extension, social forestry and public participation and involvement, or environment impact assessment. Because of the repressive character of this law, the forest areas in the Syrian Arab Republic have declined seriously during the past four decades, and many forests have been degraded and lost their socio-economic and environmental value.

The new forest law promulgated in 1994 represents a certain improvement over the previous law but still maintains the main weakness. Further improvement of the new forest law is needed, particularly in the areas of forest policy, social forestry and public participation and involvement, forestry planning, private forestry, research and extension, and environment impact assessment.

The recent law on environmental protection of 1994 will positively affect forestry in the Syrian Arab Republic. This law provides, in general terms, for the protection of flora, fauna, soil and natural resources. It empowers competent authorities to issue "standards, specifications and regulations for the protection of flora and fauna and of protected areas to ensure environmental balance and the conservation of living organisms."

3. *Environmental effects*

Finally, market failure refers to natural monopolies and other external costs placed on the agriculture and water sector. For example, in some cases small farmers in the mountain areas (zones 3 and 4) adopt practices with short-term benefits but which have large externalities or costs in the long run. Another case is the poor management of watersheds, which generates external costs to downstream users in terms of less water and poorer quality.

Although various economic and social factors were responsible of the degradation of the renewable natural resources in the country, policies and strategies in the past contributed to an overexploitation of the natural resource base on which agriculture—and indeed the economy of the country—depend in the long run. The fact that the dimension of sustainability was not incorporated into overall policies compromised the short-term goal of food security and the long-term objective of maintaining the stock of the renewable natural resources.

The policies and strategies regarding the sound and integrated management of soil and water have not been applied in the irrigated projects, and many serious environmental and socio-economic problems have arisen in the Euphrates valley, in particular: salinization, waterlogging, propagation of waterborne diseases, pollution of groundwater, and subsidence of irrigated gypsiferous soils. The continuous barley mono-cropping for animal feeds is rapidly eroding soil fertility. The situation is further exacerbated by converting rain-fed areas into irrigated land, or in extreme cases, expanding cultivation into marginal lands. The overgrazing of the country's pastures by sizeable increases in livestock population is an indication that resources are being used beyond their carrying capacity.

The high rate of land conversion from rain-fed to irrigated land is directly linked to high profitability and output and input subsidies for selected crops. The incentive policy induced farmers to expand cultivated areas by installing more than 20,000 wells during the last decade. This has resulted in declining groundwater levels and deterioration in water quality. In the south and south-east of the governorate it has deteriorated to the point that no new licenses are issued and summer crops are prohibited. There are signs in many parts of the country that such trends will prevent expansion into new areas, and in extreme cases the land irrigated with groundwater has reverted to rain-fed areas. In many regions the pumping depth has already exceeded or is fast approaching the economic limit for most crops, except some cash crops or crops that are heavily subsidized.

Market failure (treating irrigation water as a public good) continues to inhibit much-needed institutional reforms and the possibility of creating independent, private irrigation institutions. The sustainability and efficient use of water resources require that hidden gains or rents need to be transparent and traded. The system should be driven by supply and demand of water based on a clear relationship between water charges and the delivery of this commodity. Combining property rights with appropriate pricing of water—and if possible developing water markets—would provide a clear value of the resources being used in the Syrian Arab Republic.

In summary, among the top priorities, institutional and legislative reforms are important to promote water conservation and to control water pollution. Institutional and policy actions should include the

preparation of a coherent water strategy, and the identification and adoption of regulatory and economic instruments to conserve water and control pollution. The key to resource conservation depends on the capacity of the Government to establish and properly implement and enforce clear laws and regulations that promote the maintenance and rational use of natural resources. This requires changes in policies related to land tenure, land use and soil conservation. Further, credit policy should encourage access to institutional credit for conservation practices, which include the promotion of water-saving operations and technologies such as land levelling and the adoption of sprinklers and micro-irrigation.

C. Tentative prioritization of environmental issues in the agricultural sector

It is important for Syrian decision makers to prioritize the environmental issues in the different subsectors of agriculture in the country—irrigated agriculture, rain-fed agriculture, steppe rangelands, livestock production and forestry—in order to design new policies for the sound conservation and management of renewable natural resources and to improve the existing policies.

Tables 1 and 2 show prioritized environmental issues in the Syrian Arab Republic associated with agriculture in the five subsectors cited above. The following four criteria were used in the analysis:

(a) Human and animal health;
(b) Irreversibility of processes related to the issues;
(c) Rate of degradation of the environment;
(d) Geographic extent of the area where the impact of the issues is detected.

This exercise is based on available literature on the subject, gathered over a long period. The information represents a useful indication on the relative importance of the different environmental issues related to each of the five subsectors of agriculture in the Syrian Arab Republic. It can be improved in the future by using multi-objective analysis criteria often used to analyse an integrated approach to resource conservation.

Table 1. Prioritization of environmental issues for the agricultural sector in the Syrian Arab Republic

High priority	Medium priority	Low priority
- Deforestation - Steppe desertification - Soil salinization - Soil erosion - Soil degradation - Groundwater depletion	- Natural vegetation destruction - Surface-water degradation - Habitat destruction - Loss of biodiversity - Groundwater salinization - Loss of agricultural land	- Surface-water salinization - Reduction in the quality of agricultural products - Wetland destruction

TABLE 2. PRIORITIZATION OF ENVIRONMENTAL ISSUES IN THE FIVE SUBSECTORS OF AGRICULTURE IN THE SYRIAN ARAB REPUBLIC

Subsector	High priority	Medium priority	Low priority
Irrigated agriculture	- Soil salinization - Groundwater degradation - Groundwater salinization - Groundwater depletion - Soil degradation - Dissemination of waterborne diseases	- Surface-water salinization - Quality of produce - Habitat destruction - Subsidence of gypsiferous soils	- Natural vegetation destruction - Wetland destruction - Loss of agricultural land - Soil erosion
Rain-fed agriculture	- Desertification - Soil erosion - Soil degradation - Loss of agricultural land - Habitat destruction	- Groundwater depletion - Quality of produce - Deforestation - Loss of biodiversity	- Surface-water salinization - Groundwater salinization - Groundwater degradation
Steppe rangelands	- Desertification - Soil erosion - Soil degradation - Natural vegetation destruction - Loss of agricultural land - Groundwater depletion	- Groundwater salinization - Groundwater degradation - Habitat destruction - Loss of biodiversity	- Deforestation - Quality of products - Wetland destruction
Livestock	- Quality of products - Desertification - Soil erosion - Soil degradation - Natural vegetation destruction - Groundwater depletion	- Loss of agricultural land - Surface-water degradation	- Groundwater degradation - Groundwater salinization - Surface-water salinization
Forestry	- Deforestation - Soil erosion - Loss of biodiversity - Habitat destruction	- Natural vegetation destruction - Soil degradation - Loss of agricultural land - Groundwater depletion	- Groundwater salinization - Groundwater degradation

D. Proposed strategies and policies for sustainable natural resources and sustainable agricultural development

Sustainable agriculture can be defined as the successful management of resources for agriculture to satisfy changing human needs, while maintaining or enhancing the natural resource base and avoiding environmental degradation (definition adopted by the Technical Advisory Committee [TAC] of C.G.I.A.R. 1991).

According to this definition, and because of the degradation of the resource base (soil, water, vegetation) owing to the mismanagement of agricultural land, forests and rangelands, the conservation of agricultural resources has become an urgent task in the Syrian Arab Republic. In many parts of the country, cultivation has already been extended to marginal land, and soil, water resources, forests and rangelands have been overexploited.

The pressure placed on agricultural land from crop and livestock production can be partly relieved by increasing productivity, but short-sighted, short-term improvement in productivity can create different forms of ecological stress, such as the loss of genetic diversity in standing crops, soil erosion, salinization and waterlogging of irrigated lands, nitrate pollution of groundwater, and pesticide residues in food.

Future increases in agricultural production in the country should be based on the better-controlled application of water and agrochemicals as well as on the more extensive use of organic manures and non-chemical means of pest control, on the sound management of soil, forests and rangelands. These practices can be promoted only by strategies and policies based on ecological realities. In fact, agriculture production and food security in the country can only be sustained on a long-term basis if the land, water, forests and rangelands on which they are based are not degraded. The criteria that underlie the planning of these interventions should not be dominated by short-term considerations. These criteria should discourage environmentally unsound farm practices and should encourage farmers to maintain and improve their soil, plantation, water, forests and rangelands.

The concept of sustainable agriculture adopted in this report shows clearly the complexity and wide range of topics that are included within sustainable agriculture. These include:

(a) Sectoral activities, including agriculture, forestry, rangeland and livestock;

(b) Resource management issues dealing with soil, land, water and watersheds;

(c) Environmental problems, such as desertification, soil degradation, salinization and waterlogging under irrigation, and loss of biological and ecological diversity;

(d) Institution-building and human resources development;

(e) The roles of Government and the private sector;

(f) Agricultural research, extension and information management.

All these strongly indicate that sustainability in agricultural production and development impinges on various aspects of natural resources and environmental management and calls for a multidisciplinary approach requiring interaction among physical, biological, and socio-economic disciplines in planning, policy formulation, research, extension and development. It should be emphasized that sustainable agricultural development cannot be realistically pursued sectorally or in isolation. It must be an integral component of

an overall sustainable development strategy which gives priority to better management and conservation of resources so that their utilization to satisfy human needs minimizes damage to the environment. Consequently, sustainable agricultural development can most readily be achieved as a component of overall improved natural resources conservation, which would include the management, production, efficient processing and utilization of natural resources. It should be stressed that the Government should adopt both economic and non-economic instruments to internalize external costs owing to policy failure, institutional failure and market failure and at the same time modify the national income accounting system to reflect true economic losses from natural resource degradation and environmental deterioration.

This report proposes specific as well as sectoral strategies of renewable natural resources conservation for sustainable agriculture in the Syrian Arab Republic. Specific strategies are proposed in the following areas:

(a) Sustainable land management and soil conservation;
(b) Integrated watershed management;
(c) Water resources conservation;
(d) Biodiversity conservation;
(e) Institutional capacity-building in environmental conservation and the sustainability of agriculture;
(f) Institutionalization of environmental impact assessment within the agriculture sector;
(g) Orientation of agricultural research to the sustainable use of agricultural resources;
(h) Allocation of fertilizers.

Regarding sectoral strategies, the following are proposed:

(a) Sustainable use of water in irrigated agriculture;
(b) Sustainable development of rain-fed agriculture;
(c) Sustainable development of steppe rangeland;
(d) Sustainable development of forests.

E. PROPOSED ACTION FOR THE SUSTAINABLE DEVELOPMENT OF RENEWABLE NATURAL RESOURCES AND FOR SUSTAINABLE AGRICULTURE

1. *Short-term action*

(a) *Incorporating environmental concerns into national planning and policy formulation*

Incorporating environmental concerns into national planning and policy formulation would require the integration of these concerns at the administrative and procedural levels, as well as the use of economic and non-economic instruments. Administrative work required would involve streamlining responsibilities among the Ministry of Agriculture and Agrarian Reform, the Ministry of Irrigation and the Ministry of Environment concerning assigning the lead role and working out joint responsibilities. At the procedural level it would require changes in the policy formulation process, to focus on public participation in land and water use planning and on rigorous environmental impact assessment. The most important aspect is to integrate instruments that use economic and regulatory approaches. It is important to make progress toward the concept of full-cost pricing, which would require adopting a combination of economic and non-economic instruments to internalize external costs. A number of tools are available for implementing economic incentive policies to conserve natural resources and protect the environment. These instruments are often classified into the following seven categories: (1) property rights; (2) market creation; (3) fiscal instruments; (4) charge system; (5) financial instruments; (6) liability instruments; and (7) performance bonds and deposits

refund system. Detailed studies, as well as programmes of internal and external training, are required on the topics of natural resource management and environmental economics.

(b) *Institutionalization of environmental impact assessment*

Because of the lack of trained professionals in the country in the field of environmental impact assessment (EIA), it is recommended that the Supreme Council for the Safety of the Environment, together with the ministries concerned (Agriculture and Agrarian Reform, Irrigation, Health, Planning, Labour and Social Affairs, Higher Education), host two workshops on the definition and principles of EIA (two to three days for each workshop). The first workshop should be for upper- and mid-level managers in the ministries concerned and should aim at developing a shared understanding and definition of EIA. The second workshop should be attended by the same individuals who participated in the first, introductory workshop.

A third workshop should be hosted by the Ministry of Agriculture and Agrarian Reform for mid-level managers and key professional staff to specify mechanisms for incorporating EIA and other economic and non-economic tools into the decision-making process of the Ministry. The institutionalization of EIA as an environmental policy in the Syrian Arab Republic should have top priority.

A database for EIA should be created in the agricultural sector in order to provide relevant quantitative environmental data through the use of modern equipment and qualified staff. Such a database would be important in initializing EIAs in project design and in monitoring compliance with mitigation measures at later stages.

A department of environmental evaluation and monitoring should be established in the Ministry of Agriculture and Agrarian Reform, to be responsible for reviewing annual plans and project proposals with regard to compliance with EIA requirements. The head of the department and the staff should be trained in EIA and other environmental management tools. They should also participate in the three above-recommended workshops.

(c) *Raising public awareness*

The following should be done to raise public awareness on issues related to the conservation of natural resources:

(a) Preparation of television and radio programmes for the general public, and production of audiovisual materials and publications on the following topics related to the conservation of natural resources in the Syrian Arab Republic: forest fires, forest degradation, desertification, water depletion, salinity, urban encroachment, biodiversity conservation, and endangered plants and animals;

(b) Encouraging non-governmental voluntary organizations to expand their membership and activities on environmental problems at the local and national levels;

(c) Giving government and business staff the opportunity to acquire skills on natural resource conservation and on preserving the environment, in their respective professional disciplines.

(d) *Seminars*

A regional seminar and training courses on protected areas and biodiversity of the Near East countries should be organized, through a collaborative effort involving national, regional and international institutions and organizations.

(e) *Action for developing water resources*

The short-term emphasis regarding the development of water resources should be on demand management. A vertical expansion of water resources could be achieved by improving the existing supplemental irrigation system, in particular by improving water management at the farm level, including the timing of irrigation and the improved efficiency of water application. The achievement of these improvements would result in water saving and would make it possible to increase the irrigated areas.

Action to develop a national water policy should include defining water laws, rights and pricing. Immediate action should be taken to put controls on well-digging, and to institute water charges based on specific crop area rather than the current practice of calculating charges on the basis of a flat rate per ha.

(f) *Action for developing the steppe rangelands*

The laws of 1970 and 1973 related to the protection of the steppe, in particular the prohibition of plowing for cereal cultivation, should be enforced. In addition, the steppe rangelands should cease to be regarded as common property. The approach now being taken is the cause of the present degradation of the rangelands, which should be allocated to the hema cooperatives.

2. *Medium-term action*

(a) *Prioritization of environmental issues in the agricultural sector*

To help set better priorities regarding environmental issues for the agricultural sector as a whole and for each agricultural subsector included in the present report, a study should be conducted using multi-objective analysis. The analysis should look at the five following criteria: human and animal health, the irreversibility of processes related to the issue at hand, the rate of degradation, the geographic extent of the area where an impact of the given issue is detected, and socio-economic and cultural impacts.

(b) *Developing a framework for sustainable land management*

A framework for sustainable land management is urgently needed in the Syrian Arab Republic and could be developed through the following:

(a) Formulating an appropriate national policy and strategy for land use and soil conservation;

(b) Evaluating land capabilities in the country and producing land capability maps which would help in identifying the causes of land misuse and in removing or modifying them;

(c) Revising the land tenure policies in the steppe and marginal lands, and halting land fragmentation in order to establish a minimum farm size for each class of land use in each agro-ecological zone;

(d) Introducing reasonable pricing policies and incentives to promote production and conservation;

(e) Promoting the extension service in land management in the Ministry of Agriculture and Agrarian Reform;

(f) Setting up a general directorate for soil research;

(g) Promulgating a land and soil conservation law;

(h) Strengthening research in integrated land management and soil conservation;

(i) Promoting non-governmental organizations;

(j) Arresting urban and industrial encroachment.

(c) *Formulation of an appropriate national policy for the rational use of water resources*

There is an urgent need in the Syrian Arab Republic for the environmentally sound management and use of water resources, with special emphasis on making water use more efficient in the different sectors and on recycling wastewater. A coherent and updated national policy on water resources should be finalized under an overall natural resources conservation strategy, to solve the long-term land and water use problems of the country.

In the medium term, rehabilitation efforts should involve further diagnostic work on technical, social, economic and environmental aspects to evaluate the existing system, and to identify the need and justification for rehabilitating the system. Such analysis would require the long-term evaluation of production planning (cropping pattern), of market opportunities in the light of new regional and global economic developments, and of regional water balances and the marginal value of water within the sector in determining the rehabilitation of the irrigation system in the Syrian Arab Republic.

A graduated water tariff with few increments would be a rational and equitable policy. The water charges should cover the O&M costs of the irrigation infrastructure. Further, the policy should develop a blueprint for (1) water-metering, both for surface and groundwater use, (2) developing pilot projects to create public utilities that would provide water on commercial lines and (3) encouraging water markets for efficient and equitable allocation of water within and among sectors.

(d) *Encouraging the use of alternatives to chemical fertilizers and chemical pesticides*

A programme of action should be launched by the Ministry of Agriculture and Agrarian Reform to encourage the use of organic fertilizers to complement chemical fertilizers and to consolidate and promote the strategy applied in the Ministry to decrease the use of pesticides and increase the use of biological control and integrated pest management whenever possible.

3. *Long-term action*

(a) *Water resources development*

The sustainable development of water resources in the Syrian Arab Republic requires the following action:

(a) The implementation of a national water policy, along with institutional reforms;

(b) The adoption of efficient, water-saving technology. The advantages of new irrigation systems in the view of the authors are overwhelming: such systems are easy to operate, and they reduce operational losses, provide a more reliable supply of water, are often more versatile than traditional systems in adverse soil and water conditions, cost less to operate and maintain, use less labour and are suitable for areas where topography is difficult;

(c) Charging the full cost of water and developing water markets within and among sectors for the allocation of water. Water distribution on a commercial basis through public utilities should be fully explored. To ensure the financial viability of public utilities, prices have to be based on either MVP or on acceptable returns on investment as a fraction of net assets and working capital.

In the long run this would be the rational policy choice given the projected scarcity of water in coming years.

(b) *Developing protected areas and conserving biological diversity*

There is a general lack of awareness at the national level regarding the importance of establishing protected areas and the significance and importance of biological and ecological diversity in the country. Consequently, there is an urgent need to emphasize the importance of these activities among decision makers and the general public. The following action is proposed:

(a) Development of a national strategy for the conservation of biological and ecological diversity;

(b) Setting up of a national biodiversity entity in the Ministry of Environment composed of members of the ministries concerned, which would be responsible at the national level for issues concerning biological and ecological diversity;

(c) Calling for urgent action by economists, ecologists, and development specialists to employ a more meaningful valuation of the real, long-term economic losses associated with the irreversible extinction of ecosystems and species in the country;

(d) Undertaking a study on the disincentives that are leading to the depletion of biological and ecological diversity in the country, and on the various economic incentives that could be employed to replenish this diversity. Such a study should also focus attention on the indigenous culture, which possesses a great deal of knowledge, accumulated over the course of history, on the usefulness of the different natural species. This study could be enlarged to cover the Near East, as a regional project;

(e) Establishment of botanical gardens in Damascus, Aleppo, Homs, Lattakia, Hama, and Deir ez-Zor under the guidance of the various faculties of science and agriculture in the Syrian universities. These botanical gardens would contain plants that are rare or endangered, in order to protect them, and would be useful for research, teaching and ecotourism;

(f) Promotion of the protected area in Taleilah in the steppe devoted to the protection of the rangeland and the remaining wild animals and to the reintroduction of wild fauna that are rare or endangered;

(g) Further development of protected areas of endangered forest ecosystems such as the *Cedrus libani, Abies cilicica, Juniperus excelsa, Pistacia atlantica* and *Quercus pseudocerris* (in Froulok) forest ecosystems.

None of the different protected areas declared in the Syrian Arab Republic has actually been established and managed at the level of international standards required for a protected area, owing to the lack of financial resources to establish a park or a biosphere reserve, the absence of qualified rangers/staff to manage the resources and facilities, the lack of participation from the people living in the vicinity of the protected areas, and the absence of awareness on the part of the general public.

(c) *Agricultural research reorganization and reorientation*

(a) There is a strong and urgent need for immediate action to upgrade, consolidate, reorganize and reorient research topics with regard to integrated natural resource management and conservation and sustainable agricultural production systems. Sustained funding and provision of incentives are also required.

(b) A department of forestry and agro-forestry needs to be set up within the National Agricultural Research Center so as to integrate forests and forest-trees into the research dealing with the sound management of natural resources and sustainable production systems.

(c) Setting up an agricultural research council is highly needed for the coordination of agricultural research efforts in the country. The responsibilities of this council would be as follows:

(i) Reorientation of research topics to integrated and sustainable natural resources management and conservation;

(ii) Preparation of research priorities according to a national plan for agricultural development;

(iii) Promotion of multidisciplinary research according to national priorities;

(iv) Integration of environmental and socio-economic impact assessment into research projects;

(v) Strengthening cooperation between the national research system and regional and international centres.

(d) *Action with regard to the education system*

Curricula at the universities and at the secondary and primary schools should be strengthened in the field of the conservation of natural resources and biological and ecological diversity as developed in the chapter on proposed strategy.

(e) *Developing a comprehensive forest policy statement and improving the present forest legislation*

(a) Although present policy reflected in forest legislation provides the basis for the protection of forestland and trees, there is no well-defined or officially announced or adopted forest policy in the Syrian Arab Republic. Therefore, it is necessary for the Syrian Arab Republic to develop a comprehensive forest policy statement to avoid the steady loss of forestland. Consideration should also be given to the extension of forest cover, improvement of forest productivity, development of forestry institutions and the public administration of these, as well as the need for revenue-generating activities and general forestry education, research and extension;

(b) Based on a well-thought out and comprehensive forest policy, the Syrian Arab Republic should improve the present legislation to bring it into harmony with the sustainable development and administration of forestry resources.

(f) *Action to stop the accelerated degradation of the steppe*

(a) It is recommended that a sound management programme be applied as soon as possible in the steppe rangelands, using the "grazing management unit" approach, so as not to interrupt the progress made under the system of hema cooperatives but rather to facilitate further development;

(b) Emphasis should be placed on feed supply from sources other than rangelands, especially arable lands.

F. PROJECT PROPOSAL: ENVIRONMENTAL PROTECTION AND RESOURCE CONSERVATION POLICIES IN AGRICULTURE

1. *Project rationale*

The main areas of resource degradation in the Syrian Arab Republic are soil erosion, waterlogging and salinity, groundwater depletion, and degradation of range, forestland and watersheds. The proposed project could be the first phase in a long-term programme of international donor support to improve Syrian natural resource management.

The current state of natural resource degradation requires a policy and strategy shift for agricultural development based on producing crops and livestock that enjoy comparative advantage, are environmentally benign and preserve natural resources such as agricultural land, forestry, rangeland and water. In a country like the Syrian Arab Republic where rural income is low—and where poverty is increasingly a source and a result of environmental degradation and where natural resource exploitation is an engine of economic growth—environmental policy cannot be separated from economic policy and development strategy.

2. *Project components*

Based on the problems identified in the study, the project proposed herein can be divided into the following three components: technical assistance; institutional strengthening; and environmental and natural resource rehabilitation.

Under the first component, the project wold undertake a series of detailed policy studies in the area of water resource development, land use planning, range management, forestry development and biodiversity. The studies would culminate in the preparation of a comprehensive natural resource conservation strategy.

The second component would strengthen different ministries in terms of initiating environmental impact assessment for new investments, developing a framework to incorporate environmental concerns in policy formulation and planning, introducing environmental policy considerations into public and private investment decisions, raising policy makers' and the general public's awareness of the damage to the Syrian Arab Republic's environment and natural resources, and developing training in environmental planning and policy management.

The third component of the project would involve a series of sub-projects, to include operational work to rehabilitate the natural resources damaged in the past and to propose and test how efficiently new technologies use natural resources. These sub-projects would develop and/or rehabilitate watersheds, groundwater management and depletion, rangeland, forests and wildlife population. In the initial phase a pilot project would be undertaken. These projects would involve local communities in the design, preparation and implementation of the work. The projects would be consistent with the overall development strategy of the Syrian Government and in line with environmental and resource management policy.

3. *Project cost*

Expected cost: $5 million to $7 million.
Project duration: 3 to 4 years.
Financing: The United Nations Development Programme (UNDP) and possibly other donors.

PREFACE

The present report is a policy action document which seeks to adjust and restructure strategies and policies for the sustainable use and conservation of renewable natural resources in the Syrian Arab Republic. Past efforts both from policy makers and farmers focused on export-led growth in the agriculture sector. During this period little attention was given to the rational use of natural resources, whose preservation is the basis for sustainable development. The study evaluates how policy, institutional and market failures led to natural resource degradation and proposes short- and long-term strategies to correct the situation.

At the initiative of the former Joint ESCWA/FAO Agriculture Division, the study was undertaken in close collaboration with relevant ministries in the Syrian Arab Republic. The study was prepared by a team of three Syrian consultants—Mr. Ibrahim Nahal, team leader; Mr. Farouk Fares; and Mr. George Soumi—and a resource economist from the former Joint ESCWA/FAO Agriculture Division. The study is a joint publication of the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Economic and Social Commission for Western Asia (ESCWA).

It is hoped that the proposed policies and programme will be helpful to decision makers and senior officials engaged in environmental protection and formulation of resource conservation policy in the agriculture sector.

CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
CAB	Cooperative Agricultural Bank
DRC	domestic resource cost
EIA	environment impact assessment
EPC	effective protection coefficient
GDP	gross domestic product
ha	hectares
HAC	Higher Agriculture Council
ICARDA	International Center for Agriculture Research in the Dry Areas
km^2	square kilometres
LS	Syrian pounds
m	metres
m^3	cubic metres
mg/l	milligrams per litre
mg/kg	milligrams per kilogram
mm	millimetres
NPC	nominal protection coefficient
O&M	operation and maintenance
ppm	parts per million

Introduction

At the threshold of the twenty-first century, the Syrian Arab Republic is confronted by three central challenges:

(a) Meeting future food needs of the growing population (3.5% per year), which will reach around 17 million in the year 2000 and 20 million in the year 2011;

(b) Improving the standard of living of the poor;

(c) Preserving the natural resource base from degradation, for present and future generations.

Population pressures, combined at times with poverty, are forcing people to use land, water and natural vegetation (forest, range) to their limit and beyond. Indeed, much of the accelerated land degradation and desertification of the Syrian steppe, marginal lands and sloping areas in the different agro-ecological zones, including deforestation, forest fires, cultivation of steep slopes, overgrazing of fragile rangelands, land cultivation in the steppe for cereal production and over-extraction of groundwater, arise from the need to produce more food for the growing population and to alleviate poverty, but without taking into consideration the sustainable use of the natural resource base.

In response to the country's rising demand for food, especially livestock products, there is an increasing tendency to cultivate marginal and sloping lands and to overgraze natural pastures and steppes. These trends, all of which may increase productivity in the short term, also increase the variability in production levels and risks associated with production. Such a course of events will further intensify the pressure on land and water resources, at least in the medium term. In the longer term, this trend might be offset if peri-urban livestock production in higher potential areas were to grow fast enough through the substitution of fallow by a fodder crop to provide more animal feed. All these issues pose challenges for which policies and research are required to find answers.

These trends seriously threaten the long-term sustainability of agriculture and the conservation of renewable natural resources in the Syrian Arab Republic. In taking measures to curb imports and increase domestic production, new combinations of policy and technology must be found to increase land and labour productivity and improve efficiency in water use without damaging the environment. Solutions will come only from a commitment to improving economic incentives as well as the technical options to producers in addition to readapt research, extension and education on the sustainable use of natural resources. Economic instruments for sustainable agricultural development and environmental policy are a tool the Government can use to promote the internalization of environmental costs and also provide a way of building government capacity to deal with sustainable development issues in a cost-effective manner. Ways will have to be found to introduce resource conservation measures currently uneconomic for individual farmers. Education, institution-building, public awareness, training, research and extension have a crucial role in an integrated national policy for the sustainable conservation of renewable natural resources.

The Syrian Arab Republic should adopt a well-defined national policy and strategy on sustainable conservation and management of renewable natural resources which should be explicitly included in the planning and policy formulation process.

Managing Syrian natural resources sensibly will require a recognition of land and water fragility and scarcity, and at the same time a recognition of the significance of managing environmental problems; yields can be increased by careful and sustainable management of resources that are in use, making it easier to resist pressure to draw down extra resources—drawing groundwater supplies, clearing forests, encroaching on wildlife habitats, allowing accelerated urbanization to encroach on scarce agricultural lands, and degrading existing resources, including biodiversity.

The lack of a sustainability dimension in overall policies has compromised the short-term goal of food security and the long-term objective of maintaining the stock of renewable natural resources.

Meeting the future food needs of the growing population in the Syrian Arab Republic could be attempted in a sustained way if the policy and strategy for economic development, particularly the development of renewable natural resources (land, water, forest, range) are built on a sustainable base.

The present report is a policy action document which seeks to adjust and restructure strategies and policies for sustainable use and conservation of renewable natural resources in the Syrian Arab Republic. The report also seeks to articulate strategies aiming at improving sustainability and management stability in the different subsectors of agriculture: rain-fed agriculture, irrigated agriculture, forestry and steppe rangelands. A major objective of the report is to identify coherent agriculture policy and strategy actions and programmes with measures and interventions which would focus on Syrian agricultural policy in the different subsectors of agriculture, in addition to more specific policy actions for land, water resources and biodiversity.

The necessity of increasing agricultural production in the country to satisfy the increasing demand for food and other agricultural products in the long run, without damaging the resource base, will require effective programmes for education, agricultural research and extension services. Close cooperation between the national research system and the regional and international research centres established in the Syrian Arab Republic, such as the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) and the International Center for Agricultural Research in the Dry Areas (ICARDA) and other international organizations of the United Nations should be given high priority at this stage of formulating a national strategy and policy for the sustainable use of renewable natural resources in the country.

I. THE RESOURCE BASE

A. GEOGRAPHIC FEATURES

The Syrian Arab Republic lies in the Middle East between 32° 19' and 37° 20' N and between 35° and 45° 25' E. It has an area of some 185,000 km^2 and overlooks the Mediterranean in the west, the Taurus mountains in the north, and embraces part of the Arabian steppe/desert in the south-east.

The Syrian coast is sandy and narrow and runs more or less alongside a twin chain of mountains separated by a rift valley. Branches of the eastern chain of mountains are found in some inland areas.

Plains are located along mountain edges and near lowlands in the north-west, bordering the Euphrates and its tributaries in the north-central region, and extending to the Jezireh in the north-east. The steppe forms the south-eastern part of the country.

Elevations range from 0 to 200 m along the Mediterranean shore, part of the Ghab valley, along the Euphrates River and the foot of the Golan heights, covering some 5% to 6% of the total land area of the country, to more than 1,000 m in the mountains, composing about the same proportion of total land area. Separate mountains and high plateaus, including those in the south-west, with elevations ranging from 600 to 1,500 m cover about one third of the country. Land with elevations of 400-600 m cover about 60% of the total land area and includes much of the central and south-eastern sections of the country.

B. CLIMATE

The Syrian Arab Republic is characterized by a Mediterranean climate with rainfall concentrated in the cold or relatively cold seasons of the year, with the summer, the hottest season, being dry. The most striking aspect of this climate in terms of agricultural crops and natural vegetation is the dry summer coinciding with the period of maximum temperatures, which creates a period of severe drought.

The Syrian climate is also characterized by intense but infrequent rainfall; most rainfall occurs during the rainy seasons, which reduces its effectiveness for crops and groundwater, particularly on steep or bare lands. Figure I shows the bioclimatic zones in the Syrian Arab Republic.

1. *Precipitation*

The factors affecting precipitation in the Syrian Arab Republic are the general weather situation and the topography. The amount of precipitation received increases with the frequency of the passages of depressions and with elevation. Except for the windward side of mountainous areas, precipitation generally decreases from the west and north to the east and south-east. Breaks in the mountain chains allow for the penetration of relatively higher quantities of precipitation inland.

The rainy season begins in September over the coastal and north-eastern areas and spreads all over the country in October, reaching its peak in December and January. It ends in May, except for the coastal area, where it extends to June. Precipitation rarely occurs during July and August.

Average total yearly precipitation is 100 to 150 mm in the south-eastern part of the country, 150 to 200 mm in the band stretching from the south toward the centre and east central areas. In the plains and at the edges of the mountains along the western side of the country, average annual rainfall ranges from 300

to 600 mm, increasing in the mountains to 1,500 mm. Along the coast average annual precipitation is between 800 mm at the sea level and 1,600 mm in the western slopes of the coastal region.

There is a noticeable fluctuation in monthly and yearly rainfall from year to year. It increases in the arid and semi-arid zones and significantly affects agricultural production, water storage, groundwater, steppe vegetation and consequently livestock in the steppe. This fluctuation in rainfall should be taken into consideration in agricultural planning, land management, water management and agricultural research.

2. *Temperatures*

Air temperatures are affected by such factors as solar radiation, air masses, topography and type of earth surface; temperatures decrease with increasing elevation. With the exception of mountainous areas, the coastal area is milder in winter and cooler in summer than the rest of the country. The eastern and south-eastern parts of the Syrian Arab Republic are warmest in winter while the eastern and north-eastern parts are hottest in summer. January is the coldest month of the year; August is the hottest.

The continental influence causes greater differences in temperature between summer and winter in the interior of the country, where temperatures below zero are frequent almost every year.

The mean minimum temperatures of the coolest month (January) and the mean maximum temperatures of the warmest month (August) vary greatly from region to region according to proximity to the sea, altitude and exposure.

3. *Evaporation*

The potential evapotranspiration calculated according to the Blaney and Cridle formula varies in the Syrian Arab Republic from 1,400 mm/year in the first stability zone, to 2,200 mm/year in the fourth (marginal) and the fifth (the steppe) zone. Evaporation is around 1,600 mm/year in the first stability zone, 1,800 mm/year in the second zone and 2,000 mm/year in the third zone.

These rates of evapotranspiration are very high and should be taken into consideration in the irrigation of agricultural crops.

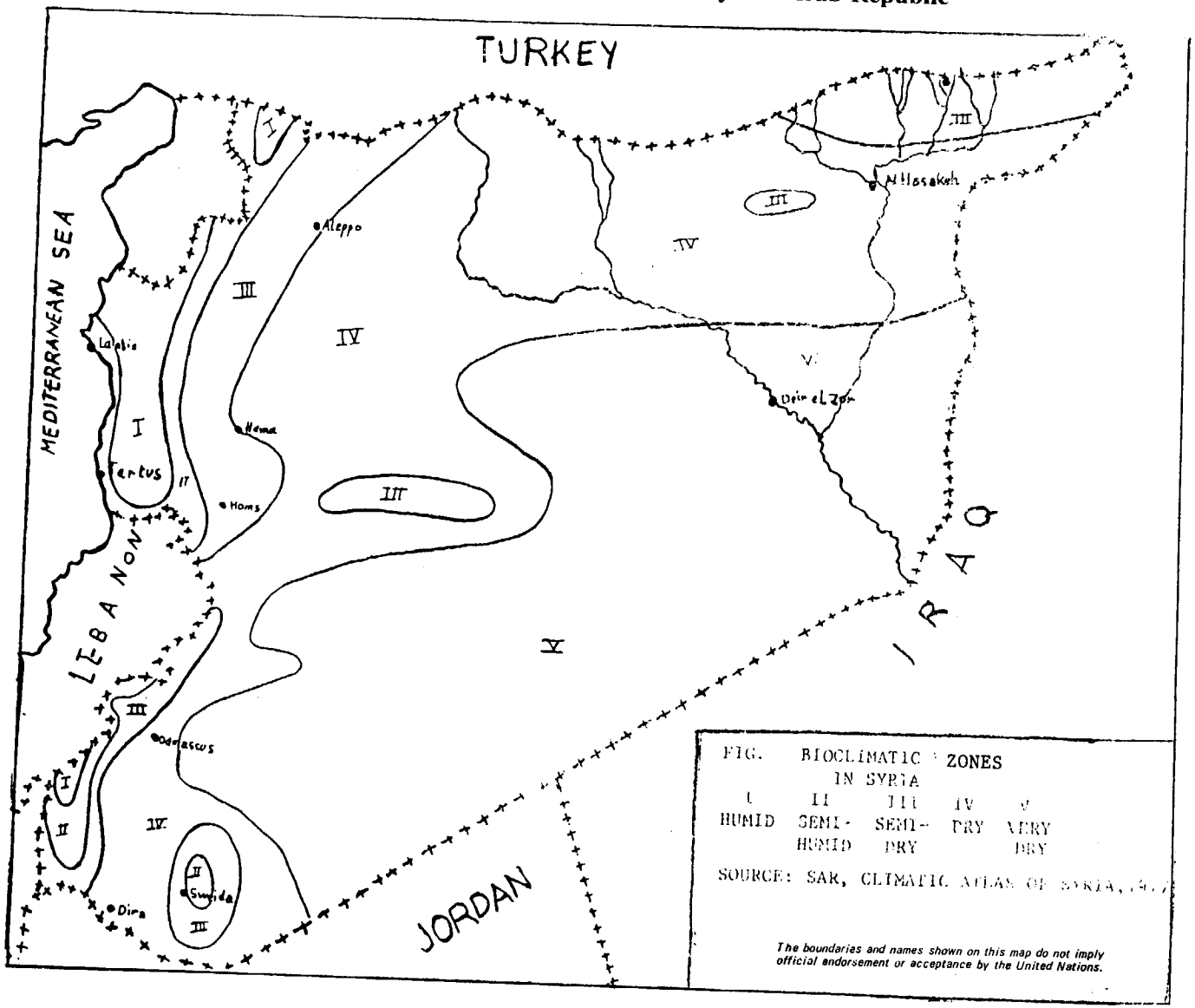
It is important to highlight that, regardless of the pattern of precipitation, and the variation in temperature, rain-fed crops in all environments in the Syrian Arab Republic enter the stage of maturity at the end of the humid period and are in danger of drought stress. The challenge to managers of cropping systems is to devise strategies to minimize the impact of these weather-induced stresses and year-to-year rainfall fluctuation on productivity.

C. SOIL RESOURCES: MAIN SOIL CATEGORIES

A general soil map of the Syrian Arab Republic (1:1,000,000) was prepared by ACSAD (1987) using the U.S.D.A. soil taxonomy (1975) as a classification system. The soils of the Syrian Arab Republic are represented by the following five orders (figure II):

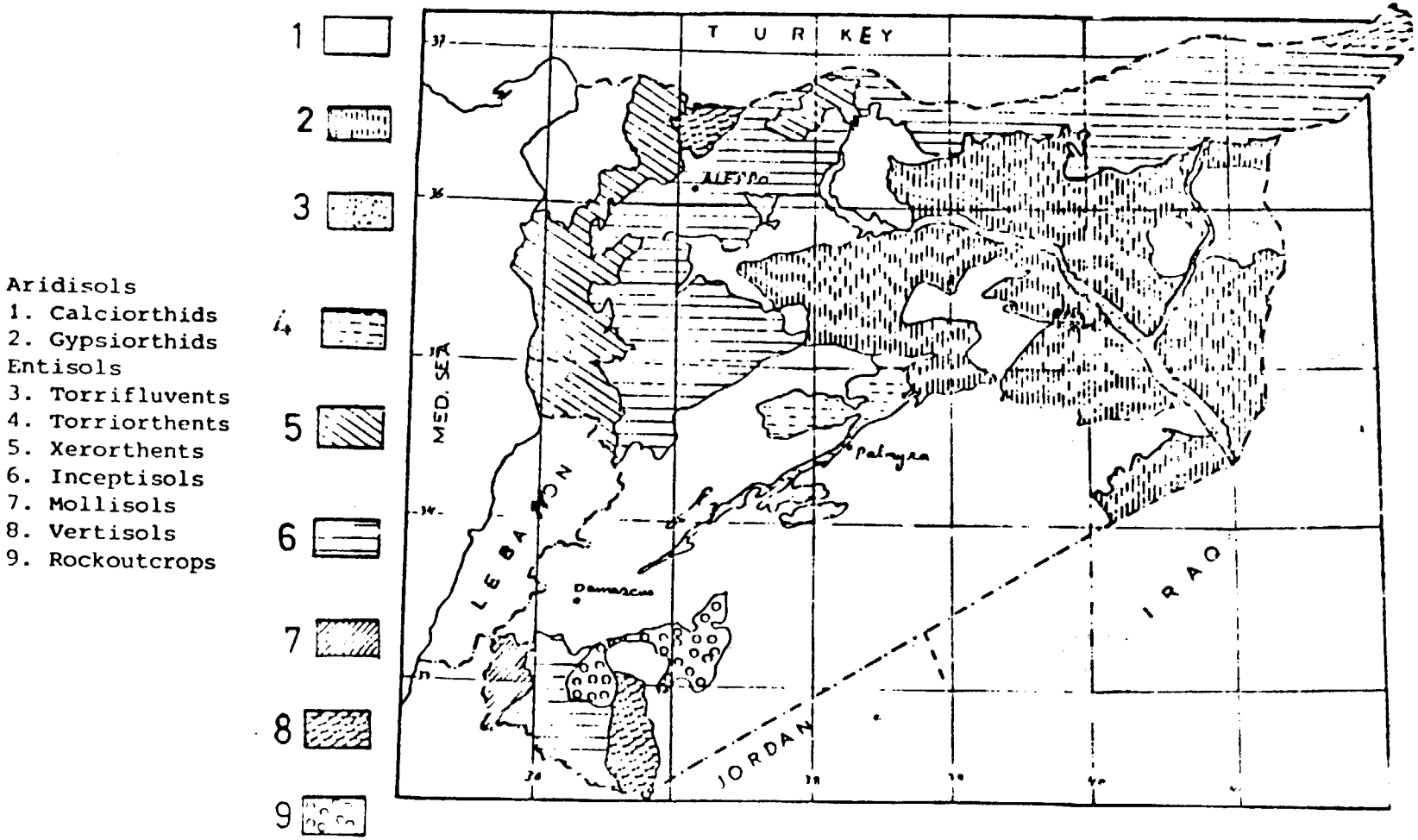
1. **Aridisols** are the most extensive soils in the Syrian Arab Republic, having an aridic moisture regime. They predominate in about 54% of the country (figure II):

Figure I. Bioclimatic zones in the Syrian Arab Republic



Source: Syrian Arab Republic, climatic areas of the Syrian Arab Republic, 1979.

Figure II. Soil map of the Syrian Arab Republic



The boundaries and names shown on this map do not imply official endorsement or acceptance by the United Nations.

Source: Simplified from ILAIWI, 1985.

(i) Calciorthids dominate the larger part of soils with an aridic moisture regime. They cover about 21% of the country, dominating about 30% of the total area. They are mainly spread in the south-eastern part of the Syrian Arab Republic including all the Syrian part of the Hamad plateau and most parts of the Syrian steppe (the badia). They are also the prevailing soils in some areas in the north-east, north-west and the largest part of the Bichri mountains;

(ii) Gypsiorthids are the most extensive soils in the north-eastern part of the country. About 21% of the soils are gypsiorthids of xeric soil moisture regime. They cover most of the Mesopotamian foredeep, all terraces of the Euphrates, Khabour and Balikh rivers and extend a considerable distance south of the meridional course of the Euphrates in the Syrian desert and al-Risafa steppe;

(iii) Camborthids cover only 3% of the country. They are mainly formed by colluvial and to a lesser extent by alluvial deposits of the Quaternary age;

(iv) Salorthids are mostly restricted to some steppe depressions with highly saline water-tables, near Palmyra and along the border with Iraq. Salinity has become a serious problem in the highly productive flood plains of the Euphrates River and to a lesser extent for the Khabour River. This is due to wrong irrigation practices. Salorthids were estimated to occupy 25% of the Euphrates flood plain. As a whole, they cover about 1% of the country.

2. **Inceptisols** of the Syrian Arab Republic, apart from a few volcanic ash soils, are entirely represented by Xerochrepts, which are the most extensive soils in the country. They cover about 24% of the total area. They are widespread along the northern border with Turkey and form the transition between the Xerothents of the coastal mountains on the west and the arid soils to the east. They cover the south-western part completely. The Xerochrepts of the Syrian Arab Republic are represented by six sub-groups of which Calcixerollic Xerochrepts has the largest extension.

3. **Vertisols** occupy 1% of the total area. As prevailing soils, they are found on the extreme north-east and north-west of the country. Where the annual rainfall exceeds 500 mm, they are also present as major and minor associations mainly with the Xerochrepts. In the landscape the Vertisols are always restricted to the lowered localities.

4. **Entisols** are represented by about 14% of the soils of the Syrian Arab Republic. Torriorthents and Xerorthents are the main soils within the order of Entisols. Torrifluvents and Xerofluvents have a lesser extension:

(i) Torriorthents are mainly represented by the lithic Torriorthents, which occupy about 7.5% of the country. They are mainly related to the Palmyrides chain;

(ii) The Xerorthents, mainly the lithic Xerorthents, only cover about 5.7% of the Syrian Arab Republic. Though they are chiefly related to the western mountains, smaller units are also found along the northern Euphrates valley and Jabal Abdul Aziz on the north-east;

(iii) Torrifluvents cover about 1.3% of the country. They are mainly related to the Euphrates and Khabour flood plains and to a lesser extent to some steppe Khabras;[1]

[1] Local arabic term to designate a pile of earth from torrential origin in the steppe.

(iv) Xerofluvents occupy small areas on the upper Khabour valley and along the course of the Orontes River on the west.

5. **Mollisols** dominate only 1% of the country. They are mainly found in the areas of the highest humidity in the Syrian Arab Republic and are chiefly represented by the Haploxerolls and to a very limited extension Calcixerolls. They prevail on the coastal plain where the annual rainfall exceeds 800 mm.

Non-soils: The non-soils surface in the Syrian Arab Republic is represented by rocky outcrops and to a lesser extent by bodies of water. The latter cover about 0.5% of the country, and while rocky outcrops dominate only about 1.1% of the south-west, they cover about 4% of the total area.

D. AGRICULTURAL SETTLEMENT ZONES

The Syrian Arab Republic has been divided into five agricultural zones, principally based on average annual rainfall received and the probability of receiving a certain amount of precipitation in a series of years. The subdivision of the country into agricultural (settlement) zones based upon rainfall is the cornerstone of agricultural planning (figure III).

These agricultural zones are useful in examining the crop mix, the potential yields, and the uncertainties of production as related to rainfall and the potential forage and field crop residues that could be made available for livestock grazing. At the same time, these zones have been identified to assist in land-use planning, and to serve as a guide in determining which lands should be cropped or be kept as forests and range.

1. *The first agricultural settlement zone*

This zone, with an average annual precipitation of 350 mm or more, has a total area of 2.7 million ha, or 14.6% of the total land area of the country, distributed as follows: 64.78% cultivable land, 18.76% uncultivable land, 11.46% forests and shrubs, and 5% rangeland and steppe.

This zone has been divided into the following two subzones:

(a) **Subzone 1,** with annual rainfall of over 650 mm, comprises the coastal and mountain regions, including parts of the forest areas in the Syrian Arab Republic. Non-irrigated crops could be successfully grown. The main cultivated fruit trees are citrus and olive. Vegetables are also grown in the open land under plastic houses;

(b) **Subzone 2,** with annual rainfall of 350-650 mm, and only two seasons out of three are secured. The main crops are wheat, legumes and summer crops.

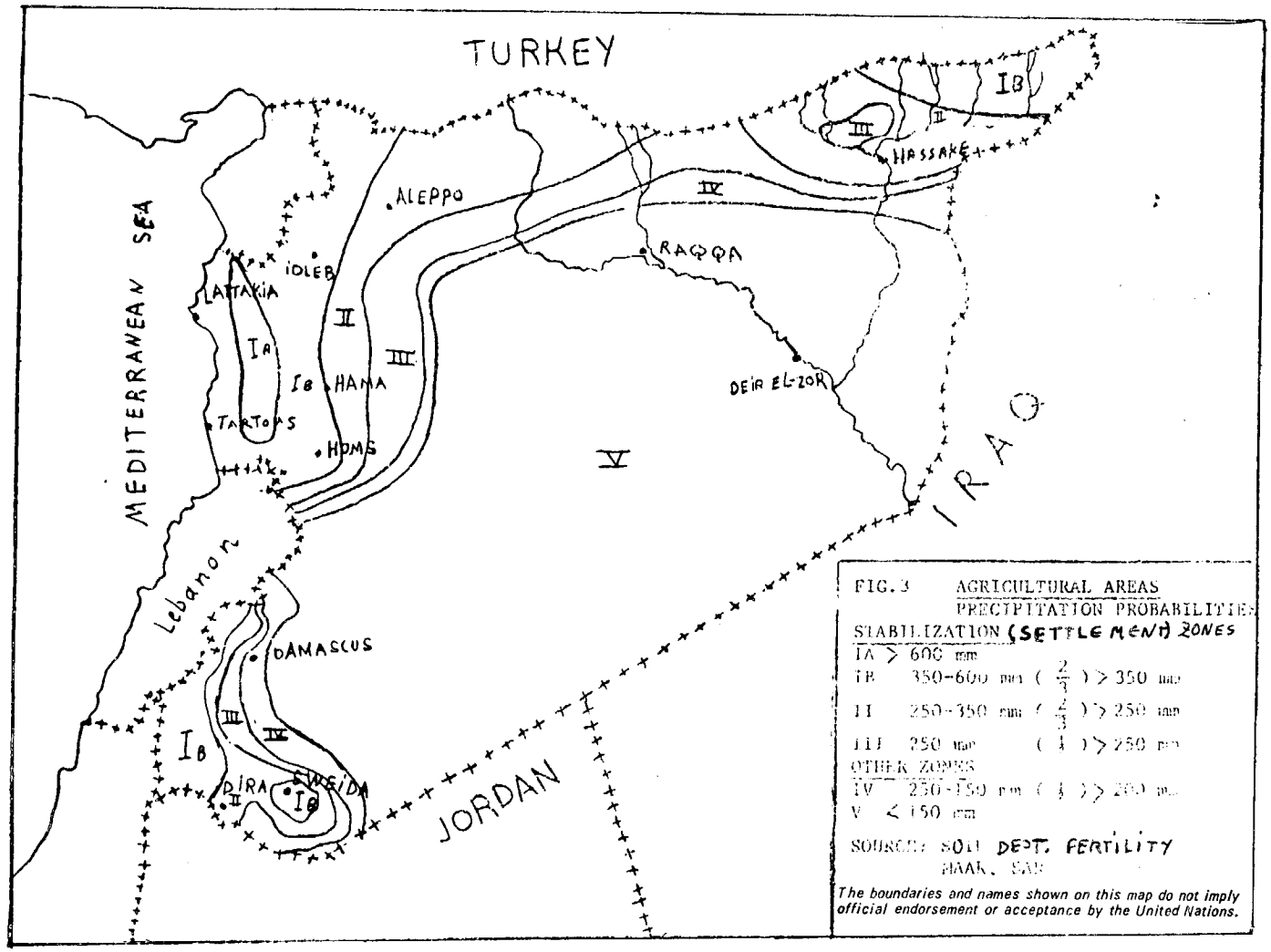
2. *The second settlement zone*

This zone has an average annual rainfall rate of 250-350 mm and more than 250 mm during two thirds of the related years; this zone could have two successful cropping seasons each three years. It constitutes 13.3% of the country's total area, which is approximately 2.44 million ha, distributed as follows: 74.45% cultivable land, 16.58% uncultivable land, 7.78% steppe and rangeland, and 1.19% forests.

The cultivable lands of this zone constitute 31% of the total cultivable lands of the country, and the irrigated areas constitute 27.52% of the total irrigated area.

Figure III. Agricultural areas/precipitation probabilities

Figure III. Agricultural areas/precipitation probabilities



Cultivated lands constitute 70.28% of the total area of this zone, with 11.29% of the cultivated area under irrigation. The soils of this zone are considered fertile. The main crops grown are wheat, barley and legumes, and the zone requires supplementary irrigation for the winter crops.

The zone lies to the east, south-east and south of the first settlement zone and is considered surface- and groundwater resources, as it is adjacent to rich basins, particularly on its northern and north-eastern part (the Khabour and Tigris basins) and the western and south-western part (parallel to the Orontes and Yarmouk basins).

3. *The third settlement zone*

The third settlement zone receives an average annual rainfall of over 250 mm. It is possible to have one or two crop seasons in each three-year period. The zone constitutes 7.1% of the country's total area, amounting approximately to 1.31 million ha distributed as follows: 63.53% cultivable land, 19.22% uncultivable land, 16.19% steppe and pastures, and 1.06% forests.

The cultivated land is 14% of the country's total cultivated land and 6.68% of the irrigated lands. The cultivated areas of this zone constitute 60.3% of its total area and the irrigated lands 5.18%. The main rain-fed crop is barley. Supplementary irrigation is applied to field crops in the areas adjacent to the second settlement zone.

Annual rainfall in this zone is estimated to be 3.3 billion m^3, and most of the area lies in the basins of the Khabour and Tigris and in the eastern part of the Orontes and Damascus basins as well as the southern and south-western part of the Yarmouk basin. Water resources of this zone are meagre, and thus any future extension of the irrigated areas would depend on water from the permanently flowing rivers.

4. *The fourth settlement zone (marginal)*

The annual rainfall in the fourth settlement zone ranges between 200 mm and 250 mm in more than 50% of the seasons. The zone constitutes 10% of the total area, amounting to approximately 1.83 million ha distributed as follows: 47.81% cultivable land, 13.77% uncultivable land, 32.74% steppe and pastures, and 5.68% forests.

The cultivated land of this zone constitutes 14.75% of the country's total cultivated land. The cultivated land constitutes 45.56% of its total area and the irrigated area, which depends mostly on river water, constitutes only 4.88%. The area is fit only for barley and pastures.

Water resources consist of rainfall of about 4.12 billion m^3 and the maximal evaporation rate is estimated to be 2,013 mm.

Most of the land of this zone lies in the basins of the Khabour and Euphrates, and other areas are distributed amongst the basins of Aleppo, the Orontes, the Yarmouk and partially the badia. This area is poor in groundwater resources and future extension of irrigated areas would have to be irrigated from the permanently flowing rivers which cross this zone.

5. *The fifth settlement zone (the steppe or badia)*

This zone is considered to be the main pastoral area for livestock and is not suitable for rain-fed agriculture, as annual rainfall is less than 200 mm. It constitutes approximately 55% of the country's total

area, that is, 10.2 million ha, distributed as follows: 6.31% cultivable land, 23.10% uncultivable land, 69.33% steppe and pastures, and 1.26% forests.

The cultivated land of this zone makes up 10.8% of the country's total cultivated land and 20.17% of total irrigated land. The exploited (cultivated) land of this zone is 5.9% of the total area and the irrigated area is 8%. Water resources from rainfall are estimated to be about 15.3 billion m^3, which is of an unstable and irregular nature, often falling at a high intensity and causing surface floods. In general, the badia is considered rich in catchments, which would allow the spreading of water for the development of plant cover (natural cover) and the storage and utilization of water for livestock. The annual maximal evaporation is about 2,200 mm/year.

6. *Water resources*

(a) The total annual water supply (taking into consideration that the average volume of rainfall amounts to 84.49 billion m^3 and that the current Syrian share of the Euphrates River is 6.62 billion m^3 per annum according to the temporary agreement with Turkey) amounts to 17.11 billion m^3 divided as follows:

Surface-water supply, 11.1 billion m^3 per annum or 64.85%
Groundwater supply, 2.322 billion m^3 per annum or 13.57%
Spring-water supply, 3.693 billion m^3 per annum or 21.58%.

This total annual supply increases to 22.515 billion m^3 if one takes into consideration that the Syrian share of the Euphrates is 12 billion m^3;

(b) The Syrian Arab Republic is divided into eight water basins classified according to a hydrographic network. The country's surface- and groundwater resources have been identified and mapped. Plans have also been drawn up for the development of these resources, as well as for the allocation for utilization by each sector of the economy;

(c) The area of the land irrigated by all water sources was estimated at 1,013,000 ha. This area was divided as follows:

(i) 610,000 ha irrigated by groundwater or 60.21%;
(ii) 403,000 ha irrigated by surface water or 39.89%;

(d) In most of the basins the annual extraction of groundwater has surpassed its recharge rate. This has brought on a drop in the water levels and a change in the quality of water, which in turn has had an effect on the discharges of the springs that feed the rivers;

(e) The share of groundwater in meeting total demand for water in 1993 was estimated at 8 billion m^3 on the assumption that the maximum water requirement is about 13,450 m^3/ha/annum with a cropping intensity of 125%;

(f) The unavailability of integrated monitoring networks for surface- and groundwater (excluding big rivers) makes quantifying the surface flows and groundwater extraction difficult. This in turn makes water-level monitoring difficult and hinders the establishment of a precise data and information base which could be crucial for designing and constructing water-development programmes and projects especially surface dams;

(g) International rivers, especially those that flow from Turkey (the Euphrates and the Tigris), are considered important water resources. However, these rivers are totally utilized to meet the needs of the different sectors of the economy. Drainage and irrigation networks have been established on these rivers. At present, the total water supply, including that of the Euphrates River at the Syrian-Turkish border, is estimated at 6.62 billion m^3 with a potential of 26 billion m^3.

E. NATURAL FORESTS

The total land area of the Syrian Arab Republic is 18,500,000 ha, of which about 3.8% is considered forest land (723,000 ha). An estimated 277,500 ha is normal-density pine and hardwood forest, of which only about 60,000 ha is currently productive. Another 155,000 ha is in open, shrubby stands of hardwoods. An estimated 270,000 ha is man-made plantations.

The main natural forests in the Syrian Arab Republic are the following:

1. *The coniferous forests*

Forests of *Pinus brutia*

These forests occupy about 145,000 ha and are concentrated particularly in the Baer-Bassit region of the coastal area. They are found in the humid, sub-humid and semi-arid bioclimatic zones. The stands are quite varied as to age, structure and condition. *Pinus brutia* is accompanied by many trees and shrubs, which vary according to local ecological conditions and which include *Quercus pseudocerris, Q. infectoria, Q. calliprinos, Pistacia palaestina, and Styrax officinalis.* These pine forests are very important in the Syrian Arab Republic for their economic, environmental, social and touristic value.

Forest of *Abies cilicica*

These forests are confined to the cool perhumid bioclimatic zone and occupy a small area in the higher elevations (1,300 m to 1,500 m) of the coastal mountains, particularly in the western slope of Nabi Matta region. They are very degraded and need urgent protection. They represent an important special type of forest ecosystem from the floristic and environmental points of view, despite the very small area they occupy. *Abies cilicica* is accompanied by many other trees and shrubs such as *Quercus cerris, Q. infectoria, Q. libani, Carpinus orientalis, Ostrya carpinifolia, Acer hermonerum, Sorbus torminalis, S. flabellifolia, Ulmus montana, Cerasus mahaleb and Fraxinus ornus.*

Forests of *Cedrus libani*

These forests are confined to the cool humid bioclimatic zone on the eastern slope of the coastal mountains at an elevation of 1,100 m to 1,300 m in the Nabi Matta region. *Cedrus libani* is accompanied by many shrubs and trees such as *Quercus cerris, Q. infectoria, Sorbus torminalis, S. flabellifolia, Fraxinus ornus, Carpinus orientalis, Ostrya carpinifolia , Juniperus drupacea and Acer hermoneum.*

The cedar forests are degraded and need urgently to be protected. They represent an important special type of forest ecosystem from the floristic and environmental points of view, despite the very limited area they occupy.

Forests of *Juniperus excelsa*

These forests are remnants of the large forests which used to cover the Anti-Lebanon mountains. They have disappeared from many areas, and the remnant patches of forests are very degraded. *Juniperus excelsa* is not regenerating, for example, in Issal al-Ward region. *Juniperus excelsa* is accompanied in its natural range by *Berberis libanotica, Prunus prostrata, Crataegus azarolus, Amygdalus korschinkü, Rhamnus palestina and Prunus tortousa.* These remnant forests need urgent protection.

Forests of *Cupressus sempervirens*

These occupy scattered small areas in Massiaf, Qadmous and Jaoubet Berghal, in comparison with the large areas they occupied in the past. *Cupressus sempervirens* is accompanied by *Quercus calliprinos, Pistacia palestina and Styrax officinalis*. The forests are very degraded and need protection.

Forests of *Pinus halepensis*

These are represented by scattered stands such as those in Qadmous and Safita. There, stands are very degraded and Aleppo pine is accompanied by many species of the maquis; they need to be protected.

2. *The broadleaf forests*

Forests of *Quercus calliprinos*

These occupy a large area in comparison with the other natural forests in the Syrian Arab Republic and exist in the lower humid, sub-humid and semi-arid bioclimatic zones. They are in the form of maquis and are in different phases of degradation. *Quercus calliprinos* is accompanied by many woody species such as *Pistacia palaestina, Phillyrea latifolia, Arbutus andrachne, Styrax officinalis and Rhus cotinus.*

These forests are shrinking due to illegal deforestation by rural people who are replacing them with orchards.

Forests of *Quercus cerris* sp. *pseudocerris*

These forests occupy the lower perhumid, sub-humid and higher sub-humid bioclimatic zones, in the coastal and Akrad mountains. They constitute beautiful stands in Froulok (Baer-Bassit) and Slenfeh (Jebel Alawite). The Froulok forest represents a special type of humid forest at an altitude of about 500 m, as a unique forest ecosystem which requires urgent protection. This forest is under high pressure because of the great volume of tourists passing through. *Quercus cerris* is accompanied by many woody species such *Quercus infectoria, Carpinus orientalis, Ostrya carpinifolia, Cercis siliquastrum and Fraxinus ormus.*

Forests of *Quercus infectoria*

These formerly covered a large area in the medium altitude of the coastal mountains (700-1,000 m) in particular, corresponding to the humid bioclimatic zone. The remnant stands are scattered and are in the form of maquis, more or less degraded. These forests have been replaced by orchards (cherry trees, apple trees) in the majority of their natural range. *Quercus infectoria* is accompanied by a number of woody species such as *Quercus calliprinos, Pistacia palaestina, Styrax officinalis, Rhus cotinus and Juniperus oxycedrus.*

Forest of *Castanea sativa*

This is found in the Syrian Arab Republic in Wadi an-Nassara, on basaltic soils and in the sub-humid bioclimatic zone and is accompanied by *Corylus avellana*. This forest covers only a few hectares, where *Castanea* is regenerating naturally. *Castanea sativa* is an important agroforestry tree in the sub-humid zone and on basaltic soils.

Forests of *Pistacia atlantica*

These forests formerly covered a large part of the steppe mountains (Abdul Aziz, Balaas, al-Abiad, Palmyra), in the arid and semi-arid bioclimatic zone.

These forests no longer exist in the majority of their natural range in the country, because of deforestation, overcutting, plowing, overgrazing and the uprooting of shrubs for fuel. *Pistacia atlantica* is accompanied by *Pistacia khinjuk, Crataegus azarolus, Amygdalus orientalis, Rhamnus* sp., *Artemisia herba-alba* and *Haloxylon articulatum*. The remnant stands of *Pistacia* should be protected as representative of forest ecosystems adapted to arid conditions.

3. *The riverside forests*

These forests occupy a narrow strip along the rivers in the coastal and interior zones and consist of the following trees: *Platanus orientalis, Alnus orientalis, Salix alba, Tamarix* sp. (in the coastal zone) and *Populus euphratica* and *Tamarix* (along the Euphrates). These forests are shrinking, in particular those of *Populus euphratica,* and have lost their environmental and economic value. They should be rehabilitated.

F. RANGELANDS

Rangelands in the steppe represent around 45% of the total land area of the Syrian Arab Republic, occupying essentially the very dry region where average annual precipitation is only 200 mm or less, with the lowest precipitation being around 100 mm in the south-central part of the country. Steppe plant communities dominate in these rangelands including shrubs, grasses, legumes and grasslike plants, such as the following:

Artemisia herba-alba
Haloxylon articulatum
Ephedra alata
Achillea fragrantissima
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Astragalus sp.
Leontodon hispidulus
Micropus longifolius
Hypecum pendulum
Helianthemum aegyptiacum
Silene coniflora
Salsola sp.
Senecio desfontainci
Plantago notata
Chameleon auriculatum
Erodium puverulentum
Gymnarrhena micrantha
Arnebia decumbens
Malcolmia torulosa
Scbiosa aucheri
Koelpinia linearis
Trigonolla radiata
Carrichtera annua
Halophile chenopodiaceae
Peganum harmala
Noaea mucronata
Poa sp.
Salvia sp.
Anthemis sp.
Evax contracta
Malva aegyptiaca
Stipa sp.
Schismus arabicus
Filago spathula
Atriplex sp.
Juncus maritimus
Tamarix sp.

The more valuable grasses, shrubs and legumes for grazing (Draz 1978) include *Poa sinaica, P. bulbosa, Stipa barbata, S. lagascae, Haloxylon articulatum, Salsola vermiculata, S. lancifolia, Astragalus* sp. and *Onobrychis* sp. As a result of overgrazing, these plants have been replaced by less palatable plants such as *Noaea mucronata, Peganum harmala and Carex stenophylla.*

Sheep-raising is the primary livestock enterprise, although lambs may graze here for a short period before slaughter or being fattened in feedlots near the larger cities outside the steppe. A major product is milk, which is processed into cheese, yogurt, butter or ghee. Wool also is an important product. Some flocks are kept in the region by Bedouin who live there, while other flocks are moved there from the west.

A few camels are grazed in this region. They belong to Bedouins, who tend to have few if any sheep. The camels are kept for milk and meat and are sometimes used for transport of crops in the region to the west.

Three main types of grazing systems are generally used in the steppe:

(a) Continuous grazing by nomads living in the steppe;

(b) Easterly and westerly movement; practised by nomads who live in villages and towns near the steppe;

(c) Temporary system of eastern movement into the steppe; practised by semi-nomads living in villages and other village people who own large flocks.

The rangelands in the steppe have deteriorated due to overuse and in particular to overgrazing, ploughing for cereal cultivation and shrub uprooting.

II. AGRICULTURAL SECTOR POLICIES AND STRATEGIES

A. AGRICULTURAL DEVELOPMENT OBJECTIVES

The importance of agriculture and the conservation of the natural resource base to national development has been always emphasized in the stated objectives of different Five-Year Plans, in particular the fourth, fifth, sixth and seventh as well as in the different resolutions adopted by Ba'ath Party conferences in various national agricultural seminars, and in the addresses of the President of the Republic and the Prime Minister to the parliament.

As stated officially, the agriculture sector forms an integral part of the economy, providing the key basis for national development. Not only is the agricultural sector expected to contribute through increased production of food supplies and employment, it also contributes through foreign exchange earnings from exports, and through forward and backward linkages with other sectors of the economy involving purchases of production inputs and providing raw materials for processing.

Since the sixth Plan (1986-1990), agriculture and irrigation have received more emphasis, and the seventh Plan (1991-1995) gave it top priority, with self-sufficiency in staple foods a declared government policy objective.

The structure and performance of the agricultural sector in the Syrian Arab Republic, and consequently the conservation of the agricultural resource base, have been influenced by a package of legislation and public policies chosen to develop and conserve natural resources in the country and improve agricultural production. They have also been influenced by the extent to which the legislation and policies and their related programmes and measures have been implemented and coordinated.

However, it has been recognized that several political, economic, financial and human factors have hindered the development of these potentials and have slowed the pace of achieving stated growth objectives. These factors relate to high population growth, land fragmentation, absence of appropriate production planning and trade policies, input and output subsidies, the absence of appropriate and sustainable production systems, the limited financial resources available, and the need for more basic infrastructure, such as dams, agricultural machinery and fertilizer factories. The situation is further aggravated by a limited tradition of collective effort among farmers, misuse and mismanagement of soil and water in rain-fed and irrigated areas, and mismanagement and overuse of forest lands and rangelands, and lack by of agricultural research and extension in the field of integrated soil and water management and sustainable production systems.

In order to achieve the agricultural sector's goal of increased production, major policies have been carried out that emphasize both extensive and intensive development of the nation's natural resource base. Extensive (horizental) development of agriculture primarily involves increasing the land area that is allocated to agriculture for crop and livestock production. There are also corollary policies to guide water resource development in the various ecological zones, as well as policies designed to protect and conserve the existing natural resource base. Policies aimed at intensive development of land and water resources seek to expand agricultural production through increased yields (increased output per unit of output).

B. THE ECONOMY

The past policies pursued by the Syrian Government were dominated by the public sector, were inward looking and stressed social welfare. The Government strictly controlled prices, credit, international trade, the exchange rate and major investments. The economy being fairly controlled, agriculture and small-scale trade

have progressed in relatively free economic environments. Agriculture and oil were the main propellants of the economy.

During the 1970s the Syrian economy experienced a rapid growth, of 10% owing to large investments in the industrial sector and in irrigation infrastructure. The economic growth was fueled by the surge in oil prices and the flow of grants from oil- producing countries. The favourable foreign exchange situation enabled the Government to improve its current account deficit and maintain a low level of external debt. Growth was sustained well in the first two years of the 1980s, when GDP growth was close to two digits.

The rest of the 1980s marked a slow-down in the economy, as growth in GDP fell to 3.2% in 1982 and showed negative growth of -0.4% in 1983. The slow-down in the economy reached its nadir in 1989 when GDP registered a negative growth of 9% and external debt stood at $16.9 billions. Poor performance of the agriculture sector, and a slow-down in the trade and services sectors coupled with a slow-down in remittances contributed to the downturn. The fall in oil prices and reduction in the flow of external grants exacerbated the situation. Inflation which was running at 7% in the first half of the 1980s, soared to 25% per annum. In the wake of these economic imbalances, the Government devalued its principal exchange rate, from 3.92 Syrian pounds (LS) to the dollar in 1987 to 11.22 to the dollar in 1988 (table 1). The devaluation resulted in a surge exports and a contraction in imports.

TABLE 1. ECONOMIC INDICATORS

	1987	1988	1989	1990	1991	1992	1993
Interest rate (percentage)	5	5	5	5	5	5	5
Exchange rate (LS to $1.00)	3.925	11.225	11.225	11.225	11.225	11.225	11.225
Wholesale price index numbers, 1990=100	49	72	82	100	114	123	..
Consumer prices (1990=100)	55.9	75.2	83.8	100	107.7	117.9	131.8
Volume of exports (1990=100)	46	51	78	100	104	105	..
Volume of imports (1990=100)	114	98	92	100	163	143	..
Unit value of export (1990=100)	65	62	77	100	98	68	..
Unit value of imports (1990=100)	83	102	99	100	101	98	..
Population (millions)	10.97	11.34	11.72	12.12	12.53	12.96	13.31
GDP (billions)	127.71	186.05	208.9	316.2	316.2	371	..

Source: IMF, International Financial Statistics, January 1995.
Note: Two dots (..) indicate that data are not available.

The 1990s have been characterized by stable growth of the economy, primarily owing to market liberalization, the greater role of the private sector and an outward-looking trade regime. GDP continued to grow at 5.6 to 6% after record growth of 11.6% in 1992. Agriculture remained the main driving force of the

economy, which continues to perform well, along with construction sector. Further, incentive policies for mobilizing investment (Investment Law of 1991 and 1994 No. 10) are paying dividends in the form of an increase in domestic investment and inflows of remittance and foreign investments.

Notwithstanding the impressive growth, the economy still has certain macro imbalances that would hinder growth on a sustained basis, among them. The existence of multiple exchange rates, a high rate of inflation (20% in 1994), a widening trade deficit, a reduction in the current account deficit and a high rate of unemployment. The Government also needs to reform the absolute monopoly of the State-owned bank and increase the pace of the reform programmes.

C. AGRICULTURE PERFORMANCE

The agricultural sector in the Syrian Arab Republic has abundant natural resources, especially in regard to water, arable land and labour. The sector is a major source of income, foreign exchange, and jobs in the Syrian Arab Republic. Agriculture employs around 30% of the labour force, accounts for nearly 20% of GDP, and contributes over 60% of non-oil exports. Agro-industries account for around 25% of the country's output and for an estimated 50% of the jobs in the manufacturing sector. The irrigated areas produce over 50% of the total value of agricultural production on about 15% of the cultivated land. Cotton, sugar beets, and considerable amounts of wheat are produced in the irrigated areas.

The value of plant production was the highest in 1988 (about LS 20.5 billion) but then dropped to LS 13.2 billion in 1989, owing to the fall in cereals production, from LS 7.3 billion in 1988 to about LS 1.4 billion in 1989. It afterwards recovered to reach LS 20.1 billion in 1992.

The production of the livestock sector increased slowly, from LS 7.5 billion in 1988 to LS 12.7 billion in 1992. Milk production was the leading subsector, since it produced about LS 5.9 billion in 1992. Within the livestock subsector (about LS 4.9 billion), animal production increased sharply, especially in the steppe areas. The value added by the livestock sector is quite important in terms of expected potential, given the fact that very low expenditure was made by the Government to generate this value. For the last decade, the livestock sector has been the key to the overall good performance of the agriculture sector and represents one of the most valuable resource assets in the Syrian economy.

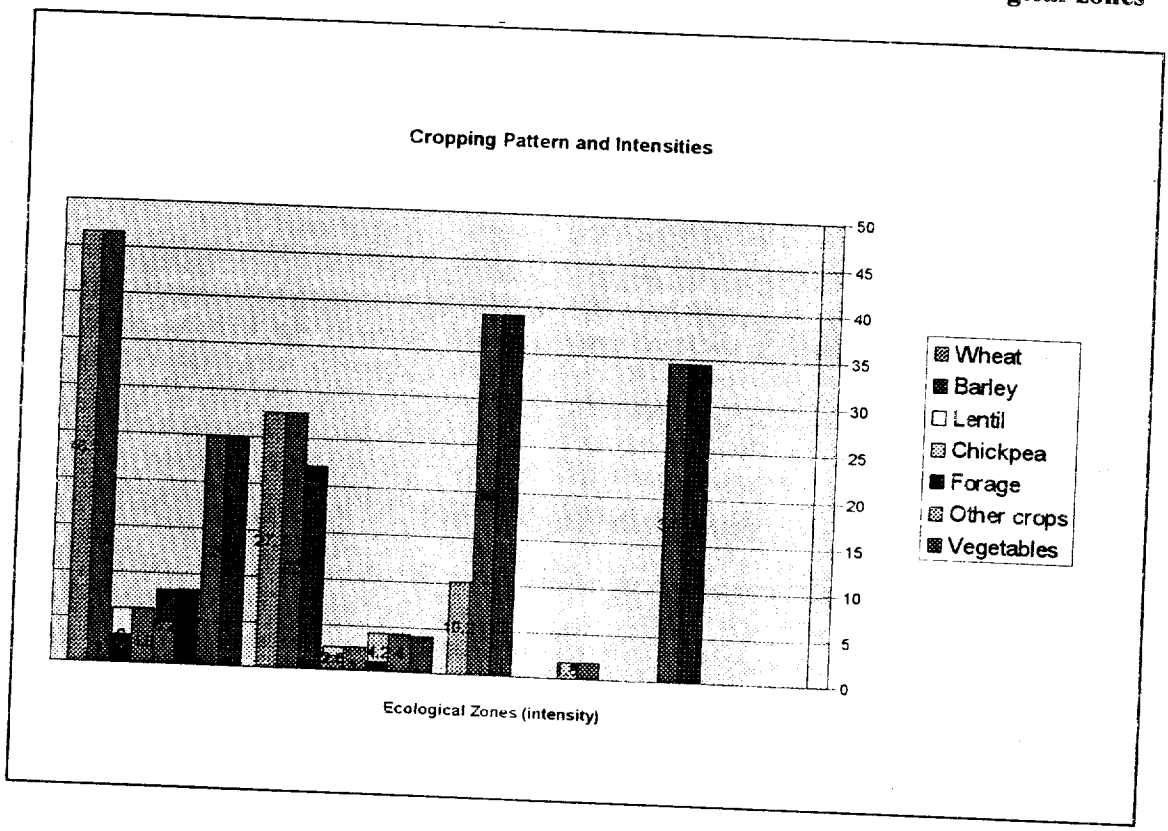
In addition to its contribution to GDP the agricultural sector, is important for the major contribution it makes in providing food to the increasing population and in providing inputs for agro-business enterprises. It also contributes to the balance of payments through growing trade in agricultural products. The agricultural export share in total exports was about 15% in 1989, increasing to 16.4% in 1990 and then to 18% in both 1991 and 1992.

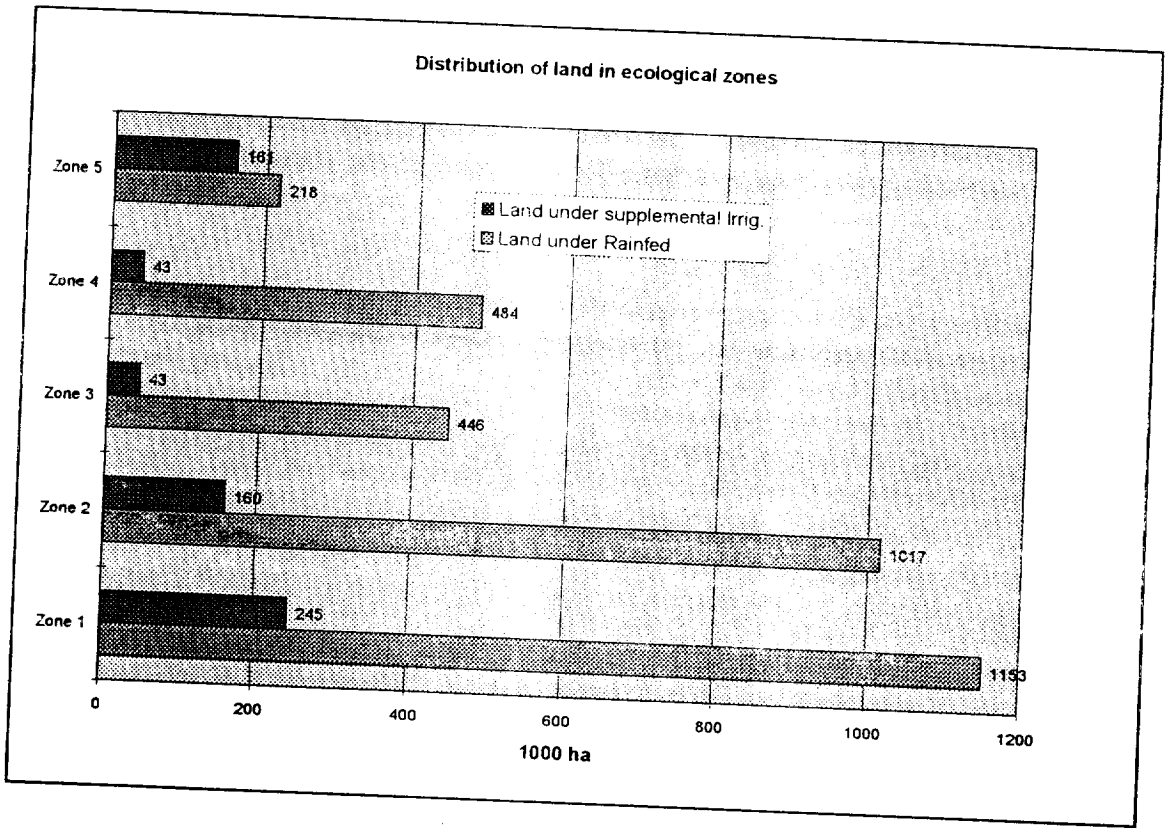
D. CROPPING PATTERNS AND CROP ROTATION

There is a wide variation in cropping patterns in the irrigated region owing to variation in water resources and agro-climatical zones (figure IV). Strategic crops such as wheat and cotton are concentrated in the north and the east of the country. More than 50% of the wheat and cotton production comes from Hasakah governorate. However, winter-vegetable production is centered in the coastal region, while summer vegetables are produced mainly in the internal plains, especially in the middle and southern regions. Irrigated fruit trees such as citrus are mainly produced in the coastal region. Rain-fed fruit trees are centered in the highlands, especially in the first and the second agro-climatical zones.

In 1993, the total irrigated area was 1,013,000 ha of which 124,000 ha were planted with fruit trees, the other 889,000 ha being planted with field crops and vegetables. Production intensity in field crops reaches

Figure IV. Cropping pattern and intensities; distribution of land in ecological zones





to 120%, out of 1,066,000 ha, 676,000 ha are planted with winter field crops and vegetables and 390,000 ha are planted with summer field crops and vegetables.

In the rain-fed region, in 1991, the total area devoted to fruit trees and field crops amounted to 3,925,000 ha in the five agro-climatical zones. The actual cropped cultivated area in the first zone was 98% of the total arable area, of which 73% was devoted to field crops and 25% to fruit trees. The actual cropped areas of the total cultivated lands in the second, third, fourth and fifth zones reached 88.5%, 81%, 70% and 52% respectively. Wheat and barley are the dominant crops in the rain-fed regions.

For each settlement zone, the ideal crops and cropping patterns are determined centrally after extensive consultation with local civil authorities and with the concerned bodies in the farming community. The selection is based not only on strict agro-climatic factors but also in accordance with national objectives, such as achieving self-sufficiency in major staple foods and providing adequate supplies or raw materials to existing agro-processing plants.

E. Food security issues

Among the stated objectives for agriculture development, the most prominent are to achieve self-sufficiency in selected crops in order to reduce import dependence, and to earn foreign exchange by encouraging agricultural exports. Past policies have clearly favoured a production plan that increased the domestic production of import substitutes and of commodities with export potential. The two (often competing) objectives of food security and export expansion led to a mix of interventionist policies which in some cases resulted in inefficient resource use and higher levels of food imports. The regulatory regime included policies for: (a) subsidizing producer prices, especially for wheat, barley, cotton, chick-peas and lentils; (b) low water prices in government-owned projects and springs; (c) subsidizing agricultural credit; (d) regulating cropping patterns in the irrigated and non-irrigated areas; and (e) dominant role for Government in marketing and distributing farm inputs.

In spite of the impressive progress of the agriculture sector in diversifying the production base and exporting sizeable quantities of horticultural output and livestock (sheep), the overall performance, especially of cereal and cotton is far from reaching its potential. Any analysis of this sector should take into account the sizeable investments made in irrigated agriculture during the last two decades, the massive subsidies and the cost of natural resource degradation.

The self-sufficiency ratio could at best achieve the 1970s level (table 2). If these numbers are any guide, the past pricing and other subsidy policies had only a marginal impact on wheat.

TABLE 2. SELF-SUFFICIENCY RATIOS IN THE MAJOR COMMODITIES IN THE 1970S, 1980S AND 1990S

Commodity	1970-1972	1983-1985	1991-1993
Wheat	72	59	77.8
Barley	107	84	110
Maize	82	19	83.8
Red meat	103	99	99.1
White meat and eggs	100	100	100.4

Source: Calculated from FAO, Statistical Agricultural Database (AGROSTAT).

The goal of achieving food security should be pursued keeping both the short-and long-term perspectives and potentials in mind. Price liberalization in line with the principal of comparative advantage will impose efficient resource use and enhanced production on a sustainable basis. The domestic resource coefficient (DRC) for irrigated wheat is high, and wheat could therefore be replaced by a more profitable crop (ESCWA 1994b). The contribution of rain-fed wheat, however, is more attractive in terms of returns on domestic factors. A relatively free price regime contributed to a rapid growth in the production of fruits and vegetables, to the extent that the Syrian Arab Republic was able to meet domestic requirements and export the surplus. However, subsidies for barley encouraged its use as feed for livestock and resulted in an increased population of goats and sheep, which often exceeded the carrying capacity of rangeland.

Food security policy in the Syrian Arab Republic needs broad-based reform to bring out efficiency, equity and sustainability in the economy and the agriculture sector. Further, under changing global environments (GATT and the European Union) the Syrian Arab Republic needs a sound domestic policy environment which promotes trade, channels investment flows and at the same time protects its natural resource capital. A major focus of policy reform in agriculture should shift from food self-sufficiency to food security by establishing a market-oriented and competitive sector based on principles of the sustainability of natural resources (especially water and rangelands) and protection of the environment. It is believed that correcting the relative agricultural commodity prices and owing for greater private-sector involvement would contribute to improving rural incomes and to the sustainable development of the sector in the long run.

F. Pricing policies

Pricing policy in the Syrian Arab Republic plays a significant role in development strategy. The core purpose, of the agricultural pricing policy is to achieve self-sufficiency in the production of main foodstuffs and commodities. The policy also ensures the domestic industry of the availability of agricultural raw materials for the production of the required quantities of manufactured goods, and for the promotion of export crops.

A permanent central committee consisting of representatives from the Ministry of Agriculture and Agrarian Reform, the National Farmers Bureau, the Ministry of Supply and Internal Trade, the Farmers Union, the Agricultural Engineering Association and the Cooperative Agricultural Bank (CAB) prepares cost-of-production estimates by specifying the standard needs of inputs for each crop in physical and monetary units.

The following three different ways are used to determine prices: (a) The Higher Agricultural Council sets the prices of the main products that are handled by the government agencies. These products are wheat, barley, cotton, sugar beets, and tobacco; (b) The products planned centrally by the Government but handled by other agencies are priced according to the cost of production but are freely traded. The government agencies are obliged to buy any quantities of this group of products, paying only 10% more than the cost of production for them. These products include potato, onion, garlic, peas, tomatoes and grapes (all of these for processing), as well as apples, milk, eggs and broilers; and (c) The prices for the rest of the agricultural products are set three times weekly by secondary committees in the Governorate on the market basis.

The Higher Agricultural Council (HAC) set wholesale prices by adding high profit margins for the main products (34%-76%) according to the policy for each product as stated in table (3). The table clearly indicates that wheat and barley enjoy the highest cost/price margin. In 1987 the margin for wheat and barley amounted to 37% and 15% respectively, and it increased to 73% and 44%.

The current price and exchange rate regime entails significant producer subsidies for wheat, barley and sugar beets. Water is highly subsidized and to some extend credit and fuel prices also contribute to input

subsidy. This clearly underpins the government policy of import substitution. The policy is not inconsistent as long as the commodities in question enjoy a comparative advantage and the policy does not lead to resource degradation. The central theme of resource conservation strategy is that past pricing and other policies have contributed to resource degradation (land and water); in other words an attempt is being made to link ecology and economics. This subject is relatively new, but has lately drawn considerable attention due to global environmental awareness. However, very little empirical work has been done as yet.

TABLE 3. COST OF PRODUCTION AND PROFIT MARGINS FOR MAIN AGRICULTURAL PRODUCTS, 1987-1992
(Syrian pounds (LS) per kilogram)

Crop		Year					
		1987	1988	1989	1990	1991	1992
Wheat (high-yielding)	Cost	1.82	2.43	2.85	4.19	4.55	4.92
	Price	2.50	3.60	5.10	7.5	8.00	8.50
	Margin (%)	37	48	79	79	76	73
Wheat (rain-fed)	Cost	1.89	2.50	2.96	4.69	5.68	5.68
	Price	2.65	3.75	5.75	8.50	9.00	9.50
	Margin (%)	40	50	49	81	58	67
Barley	Cost	1.74	2.14	2.47	3.79	4.48	4.50
	Price	2.00	2.80	3.50	5.50	6.25	6.50
	Margin (%)	15	31	42	45	40	44
Chick-peas	Cost	4.95	6.26	7.06	9.76	9.78	10.60
	Price	7.00	9.00	10.00	13.50	15.00	16.00
	Margin (%)	41	44	42	38	53	51
Lentils	Cost	4.88	6.90	7.81	10.51	10.57	11.50
	Price	6.00	8.00	9.00	12.00	13.25	14.00
	Margin (%)	23	16	15	14	16	22
Maize	Cost	2.44	3.39	3.76	5.26	5.26	5.50
	Price	3.00	4.00	5.50	7.00	7.00	7.00
	Margin (%)	23	18	47	33	33	27
Cotton	Cost	4.96	7.32	8.43	11.67	12.50	13.50
	Price	6.65	10.00	14.00	19.00	20.00	2.00
	Margin (%)	31	37	66	63	44	48
Sugar beets	Cost	0.38	0.44	0.67	0.91	1.25	1.30
	Price	0.40	0.55	0.85	1.25	1.90	1.90
	Margin (%)	25	27	37	52	68	46
Sunflower	Cost	..	8.10	8.19	11.94	11.94	..
	Price	..	14.00	14.00	16.00	16.00	..
	Margin (%)	..	73	52	34	34	..

Source: Syrian Arab Republic, Ministry of Agriculture and Agrarian Reform.

Note: Two dots (..) indicate that data are not available.

G. Land and water use policies

1. *Land use*

Changes in land use are reported from 1985 to 1992 as shown in table 4.

TABLE 4. CHANGES IN LAND USE

Land use	1985	1989	1992
Irrigated	652	670	906
Rain-fed	3 318	4 727	4 215
Fallow	1 653	106	433
Steppe	8 328	5 503	5 554
Forests	516	718	655
Uncultivated	3 547	3 782	3 759

Source: Syrian Arab Republic, Ministry of Agriculture and Agrarian Reform.

Cultivable land is classified as irrigated, rain-fed or fallow. Whereas during the period 1985 to 1992 the irrigated and non-irrigated area increased, the fallow area fell sharply and the steppe area fell moderately. Traditionally, barley is grown as barley/fallow rotation, but increasingly this has been replaced by continuous cropping of barley, thus depleting the soil nutrients and affecting productivity. The largest area (45%) is steppe and pasture land. Forests make up only 7% of total land. Uncultivable land is mainly used for buildings, services and desertification.

2. *Water supply and demand*

(a) *Resource availability*

The total estimated water supply in the Syrian Arab Republic is estimated at 10,490 million m^3. Quantity of surface water available is estimated at 44,76 million m^3. Annual water supply based on average annual rainfall (considering that the average volume of rainfall amounts to 48.49 billion m^3) is constrained by the annual flow of water supply including that of the Euphrates River at the Syrian-Turkish border. Based on different water flows from Turkey, the following water availability scenarios were developed.

The first scenario involves an annual water supply including that of the Euphrates River at the Syrian-Turkish border, is estimated at 26 billion m^3. Rain feeds surface and groundwater resources to yield a total of about 36.5 billion m^3 distributed as follows:

- Surface supply of 30.746 billion m^3 per annum (83.5%)
- Renewable groundwater supply of 2.322 billion m^3 per annum (6.36%)
- Spring-water supply of 3.693% billion m^3 per annum (10.12%)

In the second scenario, the total annual water supply (taking into consideration that the Syrian Arab Republic share of the Euphrates River is 12 billion m^3 per annum) amounts to 22,515 billion m^3 divided as follows:

- Surface-water supply: 16.5 billion m^3 per annum (73.28%)
- Groundwater supply: 2.322 billion m^3 per annum (10.31%)
- Spring-water supply: 3.693 billion m^3 per annum (16.4%)

In the third scenario, the total annual water supply (taking into consideration that the current Syrian share of the Euphrates River is 6.62 billion m^3 per annum according to temporary agreement) amounts to 17.11 billion m^3 divided as such:

- Surface-water supply: 11.1 billion m^3 per annum (64.85%)
- Groundwater supply: 2.322 billion m^3 per annum (13.57%)
- Spring-water supply: 3.693 billion m^3 per annum (21.58%)

(b) *Water demands*

The total water demand for irrigation is estimated at 13 billion m^3 on the assumption that the maximum requirement is about 13,000 m^3/hectare/annum with irrigation efficiency of 50% and cropping intensity of 125%. The sectoral shares are as follows: 83% for agriculture, 7% for domestic supply, and 10% for industry. The area of land irrigated by all water sources was estimated at 1,013,300 ha during 1993 with an increase of 428,600 ha over the base year for the period 1976 to 1980, or an absolute increase of 189.5%. This area was divided as follows:

- An area of 610,000 hectares, or 60.21% irrigated by groundwater.
- An area of 403.000 hectares, or 39.89% irrigated by surface water.

On the demand side, the major concern is the continuous increase in demand not only from agriculture but also from the domestic and industrial sectors. The share of groundwater in meeting total demand for water in 1993 was estimated at 8 billion m^3 with the assumption that the maximum water requirement is about 13,450 m^3/ha/annum given a crop intensity of 125%. Comparing the demand with an estimated safe supply of 2.33 billion m^3 shows the extent of overpumping taking place. In many regions the pumping depth has already exceeded or is fast approaching the economic limit for most crops, except for some cash crops or crops supported with high subsidy.

H. STRATEGIES FOR RENEWABLE NATURAL RESOURCES DEVELOPMENT

1. *Land resources*

The general objectives and strategy of development for the land resources mapped out by the different Five-Years Plans are the following:

(a) Extension of irrigated lands, to increase the stability of agricultural production;

(b) Intensification of use of agricultural land to the utmost possible extent, to approximately 160% for irrigated land, and 100% for the land in the first zone of settlement, and reduction of the uncultivated land of the second zone;

(c) Increase in the area of the exploited irrigated and rain-fed lands;

(d) Conservation of agricultural soil against degradation and erosion;

(e) Conservation of natural pastures against degradation and increase of the plant cover.

In the area of land resources development, the following policies and strategies were carried out in each successive Five-Year Plan:

(a) The policies and strategies provided in the fourth Five-Year Plan highlighted the necessity of completing agricultural lands classification and adopting this as a basis for agricultural planning, in order to increase productivity. In subsequent plans, this aspect was advanced by setting up policies that would require the development of a mechanism technical soil classification by a producing large-scale maps that would facilitate planning at the level of the productive unit and individual village;

(b) Great importance was attached to adopting soil classification as a base for agricultural rotation as well as to establishing crop patterns according to technical and economic indicators and also to replenishing the soils nutritional elements, through the use of fertilizers that are appropriate with both regard to quality and quantity;

(c) Conservation of soil against erosion and desertification was an important aspect of the framework of policies and procedures in successive Plans, particularly the sixth one, which advocated the necessity of the increase and development of the plant cover, particularly for the natural pasture areas (that is, the steppe land), a large portion of which deteriorated from the action of erosion caused by water and wind, from overgrazing and from plantation of crops in the more fertile areas, in addition to the forest cutting process. Therefore, the policies described in the sixth Five-Year Plan called for setting up an integrated plan to cover both the medium term and the long term for the development of the Syrian steppe.

2. *Water resources*

The general objectives of the development strategy are the following:

(a) Full use of groundwater resources;

(b) Optimal use of water and extending land reclamation, and gradually and continuously transforming the rain-fed land into irrigated land;

(c) Increasing the number of dams and water reservoirs, as well as extending the utilization of river water, and concentrating on winter irrigation;

(d) Conservating water resources and protecting them against pollution and severe overpumping of groundwater;

(e) Spreading the use of appropriate modern techniques of irrigation.

A review of the general objectives of the agricultural development strategy, particularly what is related to the use of agricultural resources—land and water—reveals the following:

(a) The general objectives of the agricultural development strategy have been achieved by increasing the total agricultural product to meet the domestic demand for agricultural commodities and to provide the raw materials for local industries, hence paving the way for an export surplus and an improvement in the nutritional standard;

(b) In contrast to previous plans the Sixth Five-Year Plan has a limited orientation towards the vertical development of resources and their use, and more emphasis is placed on resource conservation and

protection against pollution, degradation and attrition. The following areas are highlighted: conservation of soil and natural pastures against desertification and degradation; increasing the volume of stored water by increasing the number of dams, together with a specific change in the use of water, including greater efficiency in winter irrigation; conservation of water resources against pollution and severe overpumping of groundwater; extending the use of improved irrigation technologies for more efficient water use; and conservation and development of forests;

(c) There has been an increase in agricultural production in regard to the major commodities. An export surplus has been realized, but this was achieved at the expense of over pumping of ground water and extending barley production in the steppe areas, which are not sustainable practices. Moreover, the available advanced technologies to conserve water have not been introduced. Further, the percentages of agricultural intensification achieved have not met the targets set up in the plans, and this is mainly attributed to the insufficient use of mechanization.

3. *Legislation of water resources conservation*

Prior to 1982, the Syrian water sector was managed by different governmental directories and administrations. Responsibility and authority in this sector overlapped among a number of ministries, including the Ministry of Public Works and Water Resources, the Ministry of the Euphrates Dam, the Organization of Major Projects, the Ministry of Municipalities and Rural Affairs, the Ministry of Agriculture and Agrarian Reform, and the Government Planning Authority. In fact, prior to 1982 the water sector lacked the features of a strong central planning and managing body.

In 1982, however, considering the importance of the water sector for economic and social development, Law no. 16 was promulgated, under which the Ministry of Irrigation was founded. The Ministry's task was to manage the water sector, and to guide and coordinate the various uses of water to be utilized for the purpose of promoting public welfare.

In 1982, resolution No. 320 was issued concerning public water conservation; the resolution provided for licensing water utilization, and for making misuse of water resources punishable by fine.

In 1958, Law No. 165 was promulgated, defining the organization of investment for pumping surface and groundwater. This law also instituted licensing requirements for public water utilization by pumping and for well-digging.

The law entitled the Ministry of Public Works and Water Resources to assign ceilings for the quantity of water licensed for utilization in each basin. The Ministry was also entrusted with assigning the area to be irrigated, putting restrictions on the methods of groundwater drawing and imposing requirements for protecting those resources. The law also required all institutions digging for groundwater to submit geological and hydro-geological maps of the locations to the Ministry of Public Works and Water Resources.

In the light of the importance of storing flood water for use in dry seasons, Law no. 3 of 1973 was issued. It dealt with different aspects of dam construction (design, construction, management and finance), with the aim of making possible the storage of flood water in order to provide drinking water for people and animals, helping develop rangelands and creating oases in the steppe. The stored water would also help in the expansion of irrigated cultivation.

Law No. 46 of 1972 discusses the beneficiaries of governmental irrigation projects. It also includes water utilization rates and restrictions on the size of irrigated areas.

Law No. 30 of 1964 gave a legislative dimension to the increasingly important issue of preventing water pollution. This law, concerned with marine life, prohibited dumping of industrial waste and chemicals from vessels for the purpose of protecting water resources from pollution.

Adding to the above Law No. 393 of 1980 issued by the Ministry outlined restrictions for the agricultural, industrial and construction sectors when located in spring areas. The restrictions were imposed to prevent wells from pollution.

The Ministry of Environment also has been concerned with water environment and conservation. Jointly with the Ministry of Irrigation it has issued decrees requiring the treatment of discharged water by factories and oil refineries to ensure it meets certain standards before it is discharged into rivers.

Although the government policy is to protect and safeguard water resources from pollution, it has been noted that in some water basins pollution has intensified. Al-Asi basin, has been the worse polluted. Fertilizer factories near Homs as well as the sewage and agricultural drainage water of Homs have contributed to the aggravation of waste in the river. This situation is hazardous to health especially since Al-Asi water is used to irrigate vegetables that are eaten raw.

In the Damascus basin, the Barada river is very polluted, especially in summer. This river is important for the agriculture around Damascus. Unremittingly high levels of pollution caused by factory and others waste jeopardizes the river and means that its water cannot continue to be utilized for the purposes to which it is currently put.

In the Aleppo basin, Aleppo city suffers as much from pollution as Damascus. The irrigated area around the city is irrigated by sewerage water, especially after the diverting of the river Qweik that flows from Turkey.

4. *Steppe rangelands*

The general objectives for the development of the steppe rangelands were the following:

(a) Conserving this important national natural resource from degradation;

(b) Improving the productivity of the rangelands to allow increased production of livestock and livestock products;

(c) Combating desertification, which is progressing in the steppe area at an alarming pace;

(d) Improving the range livestock;

(e) Increasing the standard of living of the inhabitants through education, better nutrition and better health care.

The following national programme for range and steppe development was developed by the Syrian authorities, as part of a livestock development plan to achieve the following objectives:

(a) Natural regeneration and improvement of range based on the establishment of Hema range cooperatives to cover 20% of the steppe with in a five-year period (1971-1975), which was amended to cover 50% of the steppe by 1980 carried out with World Food Programme (WFP) assistance and a government hema range and sheep production centre in each governorate;

(b) Encouraging sheep fattening operations through the establishment of fattening cooperatives, so as to keep sheep from grazing the range (WFP-assisted project);

(c) Prohibiting cereal cultivation in the steppe in areas receiving less than 200 mm/year of rainfall by the law of 1970 with modification in 1973;

(d) Developing water resources in the steppe through the construction and improvement of dams and wells;

(e) Encouraging plantations of forage shrubs such as Atriplex halimus, Atriplex nummularia and Salsola vermiculata;

(f) Establishing protected areas in the steppe;

(g) Integrating animal production into the agricultural systems by introducing forage legumes in rotation with wheat in areas receiving more than 350 mm to replace the traditional wheat/fallow rotation and to expand irrigated forage crop production in newly developed land (WFP-assisted project);

(h) Strengthening research and training in range development, with cooperation among the Ministry of Agriculture and Agrarian Reform, universities (particularly Aleppo University) and ICARDA.

It should be mentioned that the above overall strategy for the development of the steppe rangelands has not been completely applied, in particularly in regard to the following:

(a) The prohibition of cereal cultivation has not been strictly followed;

(b) The establishment of protected areas has not been pursued in the different parts of the rangeland steppe;

(c) Research and extension on nutrition and management have received lower priority than they deserve in the country, often coming in third place behind veterinary services and efforts genetically improve livestock, which have been expensive and ineffective. Livestock nutrition and management remain traditional, because there is a general belief that farmers are well-informed and have a traditional and ancestral knowledge about nutrition and management.

(d) Training in range management did not receive the priority expected or the efforts needed for such a large programme for steppe range lands development.

5. *Forest resources*

The different five-year plans have given a great deal of attention to protecting natural forests and improving their productivity, to increasing the afforested land in the different agro-ecological zones in the country (as a measure to enhance soil and water conservation), enhancing the productivity of degraded forestlands, fixing moving sand dunes in the coastal and interior areas where necessary for the protection of agricultural land, orchards, villages, roads, railways and to fourth, protecting of orchards and agricultural fields in general from the wind by establishing wind-breaks, and beautifying the landscapes and improving the local environment.

The following aimed to achieve the above objectives:

(a) Establishment of a management plan for the forests of *Pinus brutia* and the forests of *Quercus cerris* ssp. *pseudocerris* of the coastal region, in the north of Lattakia, particularly in the Baer-Bassit zone;

(b) Protection of the pine forests from fire by all means mechanical and biological, particularly in regard to establishing fire lines, opening forest roads, etc;

(c) Delimitation of the forest areas in order to arrest agricultural encroachment;

(d) Increasing the number of the forest nurseries for the production of seedlings for the afforestation projects executed by the forestry department in degraded forest lands;

(e) Distribution of forest trees to farmers at a nominal price for the establishment of wind-breaks;

(f) Training more technicians in forestry in the Institute of Forestry and Range of the League of Arab States in Bouka, Lattakia;

(g) Establishment of a specialized department of forestry and ecology in the four faculties of agriculture in order to enhance teaching and research in forestry and ecology and train highly qualified technicians at the engineer level, which are highly needed in the country.

It should be mentioned that the above strategy for forest development has not been completely followed, in particularly in regard to the following:

(a) The incomplete application of the management plan prepared in 1956/1957 for the development and exploitation of the pine forests in the Baer-Bassit region;

(b) The delimitation of the forestlands, which has progressed very slowly;

(c) The encroachment of agricultural lands, which has not been stopped completely.

The main thrust of forest development and protection was by the following:

(a) Extension of forest plantations (afforestation) and setting up the necessary plans for forests, and also identifying hand crafts in the forested areas that would utilize raw materials from the forest;

(b) Protection of forests against aggression and fire and taking the necessary precautions and establishing the necessary control systems including constructing forest roads which would make it easier to protect them;

(c) Economical exploitation of natural forests through service development and thinning;

(d) Expanding of the production of forest seedlings focussing on the production of species that would be of economically meaningful output and environmentally suitable;

(e) Continuing of afforestation in the appropriate sites and environments by establishing new woodlands.

III. IMPACT OF PAST POLICIES AND STRATEGIES ON NATURAL RESOURCES CONSERVATION

A. General overview

In the Syrian Arab Republic, the legal and regulatory framework governing resources management is generally weak. Most of the existing legislation was drafted in the past for sector-specific activities and did not take an integrated environmental approach. With its focus on compliance rather than problem-solving, especially in cases where there were socio-economic reasons for non-compliance, the legislation has often contributed to environmental degradation such as overgrazing of rangelands, deforestation, encroachment of urbanization on suitable agricultural land, and overpumping of groundwater.

Most of the resource conservation measures in the country have been implemented on a piecemeal basis, without a well-conceived development strategy taking into account the institutional and regulatory framework needed for support. A frequent problem in the past has been a preoccupation with construction projects, with the prime objective of increasing agricultural production and with little emphasis on management-oriented efficiency increases, which is highly needed for a sustainable use of renewable natural resources and for sustainable agricultural production systems adapted to the different agro-ecological zones in the country.

In the past, the de facto land policy in the Syrian Arab Republic was geared towards agrarian reform, complemented by land reclamation. At the same time, water policies, were synonymous with the expansion of the irrigated area, irrigation investment and construction of drainage systems. Water development projects included the construction of dams, reservoirs, well fields, canal of pipe networks. In the last 10 years the Syrian Arab Republic has devoted 60%-70% of the entire agricultural budget to irrigation. Eighty per cent of the new land since 1987 has been irrigated through digging groundwater wells supported by subsidies on fuel for the operation of pumps by the Government.

Initial increases in the water supply for irrigation contributed immensely to bringing more irrigated area under cultivation and increasing agricultural production. However, in the past, land and water policies, together with economic and financial policies, depleted land and water resources at a rate that would not have been sustainable in the long run. Although it was difficult to predict the long-term environmental impact of policy measures, the concept of natural resource valuation was not incorporated into conventional economic analysis, since natural resources were perceived to be abundant and free. For example, land reforms for improving the distribution of land resources could not adequately anticipate the adverse impact of fragmentation, over-exploitation and soil degradation at the time of inception. Irrigation projects focused on expanding the irrigated area without being accountable for the associated rise in the water-table, in waterlogging and salinity, and in gypsum problems.

The problem of gypsum in the middle and lower Euphrates terraces is a clear illustration of soil degradation and declining yield because of neglecting environmental considerations. In fact, the soils in these terraces and adjoining area are more than 70% gypsum (FAO 1993). Although an expansion in the network of canals and watercourses contributed to a rapid rise in agricultural production and yields initially, insufficient maintenance led to leakages and a gradual rise in the water-table which in turn adversely affected yields in the long run. The increase of gypsum from "low" to "high" levels has reduced the yield of cotton from 3.9 tons/ha to 1.6 tons/ha and in the case of wheat from 4.0 tons/ha to 1.6 tons/ha in the Raqqa area.

Poor demand management in the past also contributed to inefficiency in water use and consequent waste. In addition, improvements in the availability of water owing to the introduction of sophisticated

technology in the past diverted attention from demand management and reduced emphasis on low-cost alternatives such as improving efficiency, conserving water and reducing waste by maintaining the irrigation infrastructure.

In addition, water charges in the agricultural sector have been kept low in a bid to offset the controls on the price of agricultural produce. However, the price of water is so low that it does not cover operation and maintenance costs. With increasing water scarcity leading to rising marginal costs, such a policy is not sustainable in the long run.

B. Causes of renewable natural resources degradation

1. *Land tenure*

In the Syrian Arab Republic, the agrarian reform of 1958 fixed the maximum size of ownership, which was reduced further in 1980. The article of this law limited the ceiling of the land holding for rain-fed and irrigated land according to the region and the method of irrigation. Notwithstanding the progress in reducing the size of parcel, defining property rights and providing ownership rights to former tenants, the land reform policy has created a continuous problem of small, uneconomic units and land fragmentation.

Fragmentation of land emerged as a serious constraint to modern agriculture. In the Syrian Arab Republic, the total number of agricultural holdings in 1970 was 396,282, comprising 1.8 million plots of land. Reductions in land holdings per capita served to reduce household income and consumption. An offshoot of low farm incomes was a lack of investment in and management of land, especially soil conservation and the overall sustainability of the agriculture sector.

The large number of farmers with small and fragmented holdings are also bringing about further decline in groundwater. An average farm consist of four plots, with even a 1-ha holding averaging three separate plots. Because farmers need timely and secure supplies of water, they dig wells at each parcel, leading to unnecessary withdrawal of water (FAO 1994).

2. *Population growth*

The population of the Syrian Arab Republic increased from 4 million in 1956 to 7.3 million in 1975 to 13.76 in 1993. The growth rate of 3.5% is one of the highest in the world. The challenge of the future is to feed the growing population with minimal damage to the resource base. Fulfilling the minimum needs of the population has an impact on the environment. For instance, each person needs 2,350 food calories daily to stay healthy and productive. The rapidly increasing number of people forced crop farming into grazing areas, and resulted in the removal of vegetation for wood, often leading to desertification.

As population density increases, more pressure is exerted on the land to grow food, produce wood for fuel and meet other needs. The farmers give up traditional farming practices of sustainable land use and crop rotation. In the face of rapid increase in population, survival for many farmers depends on encroaching on marginal lands and intensively exploiting existing parcels. In addition, migration from rural to urban areas has shifted fertile arable land to commercial use.

In the Syrian Arab Republic the minimum area required to support a family is 1 hectare in areas with more than 1,000 mm/year of rainfall. The necessary size of holding rapidly increases as the average rainfall decreases and the importance of livestock becomes prominent. In areas with rainfall of less than 100 mm, the population growth is very modest. The required farm size increases to 5 ha in regions where rainfall is 400 mm per year and to 20 ha in rainfall of 600 mm per year. The worst effect of population growth is more

visible in areas where rainfall is 100-400 mm per year. Here, serious competition to exploit relatively scarce resources often leads to overgrazing, crop rotation without fallow and encroachment on marginal lands.

Further, population pressures force people to migrate to cities, often taxing the basic services (public health, welfare transfers, and education) available and polluting the environment with industrial and sewerage effluent. Rapid population and heavy rural urban migration have seriously strained on living conditions in Damascus as rural emigrants have sought shelter by building temporary houses on land which is often valuable for agriculture. Many studies have shown that population density is strongly correlated with deforestation, soil degradation and watershed mismanagement.

3. *Production planning policy*

The implementation of this policy is carried out by means of a licensing process administered by the Farmers Union and the Ministry of Agriculture and Agrarian Reform, as well as other agencies. All of the main agricultural crops produced in the Syrian Arab Republic are licensed. This includes cereals, cotton, vegetables, tobacco and sugar beets. All other commodities are licensed if the farmer desires a loan from the Cooperative Agricultural Bank (CAB). For some commodities, such as tobacco and sugar beets, licenses are handled on an allotment or contract basis in cooperation with the specific organizations or establishments responsible for those commodities.

It is also generally known that despite regulations relating to the use of inputs obtained through the licensing process, some farmers may shift usage of them to other, more profitable crops such as vegetables. Besides this, subsidizing and allocating inputs may cause inefficient applications, which may increase the salinity of land.

In view of emerging global and regional changes, the government policies should encourage farmers to move progressively towards the production of high-value crops that have a better chance of competing in the international market, especially under the growing challenges posed by the General Agreement on Tariffs and Trade (GATT) and other regional groupings. Flexibility in the planning system is needed to allow farmers to respond to relative prices.

Farmers cannot fully react to favourable market signals under planning arrangements. The area planning system with price levels derived from the average cost of production induces farmers to adopt a cropping pattern under inappropriate conditions. A good example is the extension of barley cultivation in zones the fourth and fifth, which can destroy the delicate structure of the soils, once the native vegetation cover is removed for barely cultivation. However, distorted price structures do encourage farmers to adopt efficient technology. Past subsidies on inputs and outputs often discouraged farmers from adopting a demand management strategy for the rational use of natural resources.

4. *Trade policies*

As the economy becomes monetized and, outward-looking, resources are exploited commercially. Resources which were formerly exploited on a sustainable basis tend to be overexploited. There are many examples involving the cutting of forest land, extraction of groundwater and rangeland exploitation. Commerce-oriented policies put pressure on land and water resources.

The relevance of trade policies can be traced through comparative advantage enjoyed by the country in producing strategic crops. Tables 5 and 6 provide estimates of returns on land and comparative advantage for selected crops in rain-fed and irrigated areas. In the rain-fed areas returns on land are highest for wheat in the first Zone 1 barley in the second, third and fourth zones. The returns to land in the irrigated areas

depend on the irrigation system and the relative price structure. Agriculture using relatively low-cost water from government projects and the river supply is more profitable than that utilizing a water from shallow or deep wells. Sugar beets and tomatoes bring the highest return in all irrigation systems, followed by cotton and wheat. The results confirm the massive price supports provided to wheat and sugar beets.

The price support for sugar beet is questionable, since the domestic resource coefficient (DRC) indicates inefficiency in production. The cultivation of maize is likewise unproductive in economic terms. The crop is grown after wheat as a second crop. Low yields are the main cause of negative productivity and of a DRC of less than 1. In other words, the returns on domestic factors (land, water and capital) are not enough to justify its cultivation.

In the last decades two important changes have taken place in the production pattern of the agriculture sector in the Syrian Arab Republic. First, there is a growing shift towards those cash crops primarily directed towards export markets. Trade reforms included new export policies which allow private exporters to retain 100% of foreign exchange, which could be used to import agricultural inputs and a few other food items. After devaluation, exports increased tremendously, from 1988 onwards. Exports of sheep surpassed cotton, and fruit exports rose sharply. The country was earning foreign exchange by over exploiting natural resources, in this case water and rangeland. A good case can be made that past trade liberalization policies in the Syrian Arab Republic are beginning to have an effect in terms of environmental degradation. It is generally argued that protection of the environment is incompatible with trade liberalization.

TABLE 5. RETURNS TO LAND AND DOMESTIC RESOURCE COEFFICIENT (DRC) IN RAIN-FED AREAS, 1993

(Gross margin per ha)

	Wheat	Barley	Lentils	Chick-peas
Zone 1	9 568	6 290	106	107
(DRC)	(.17)	(.37)	(.32)	(.37)
Zone 2	704	6 260	91	153
(DRC)	(.19)	(.24)	(.32)	(.33)
Zone 3	2 271	2 348	80	
(DRC)	(.33)	(.38)	(.45)	—
Zone 4		300		
(DRC)	—	(.76)	—	—

Source: ESCWA Evaluation of Agricultural Policies in the Syrian Arab Republic (Policy Analysis Matrix Approach) E/ESCWA/AGR/1994/5.

Note: An em dash (—) indicates that the amount is nil or negligible.

The link between trade liberalization and environment degradation has long-term economic and welfare implications which have been ignored in the past and which are likely to be counter-productive not only to the environment but also to the well-being of future generations. The Syrian Arab Republic should pursue policies such that the benefits of trade liberalization accrue through the development of comparative advantage based on an environmentally appropriate pattern of production. The present analysis indicates that to some extent the first aspect of policy prescription has been adopted, but that the second part has been by and large ignored.

TABLE 6. RETURNS TO LAND AND DOMESTIC RESOURCE COEFFICIENT (DRC) IN IRRIGATED AREAS, 1993

(Gross margin per ha)

	Wheat	Maize	Sugar beet	Cotton	Sunflower	Tomatoes	Citrus
Deep-well zones	9 831	-11 455	28 821	15 703	6 130	27 135	15 691
(DRC)	(1.00)	(1.16)	(1.32)	(0.59)	(0.85)		
Shallow wells	1 683.1	-3 455	38 821	25 703	14 130	37 135	15 631
(DRC)	(0.90)	(1.04)	(1.20)	(0.52)	(0.73)		
Rivers	19 331	-455	42 321	29 703	17 130	40 635	15 683
(DRC)	(0.86)	(0.99)	(1.15)	(0.49)	(0.68)		
Government	23 331	6 044	49 321	38 203	23 630	47635	15 571
projects (DRC)	(0.82)	(0.94)	(1.10)	(0.46)	(0.63)		

Source: Evaluation of Agriculture Policies in the Syrian Arab Republic (Policy Analysis Matrix Approach) (E/ESCWA/AGR/1994/5).

Note: The returns on citrus are according to the type of land:
Row 1 = Flat land and stone-free land
Row 2 = Flat with stone land
Row 3 = Rough and stone-free land
Row 4 = Rough with stone land

5. *Output subsidy*

Intervention in output prices (taxes or subsidies) changes the relative prices and shifts crop acreage from one crop at the expense of substitute crops. The impact on resource use or on the environment can be positive or negative depending on whether the commodity in question is environmentally damaging or benign. In the case of the Syrian Arab Republic, facts are beginning to surface supporting the notion that past output (and to large extent input) subsidies on water are one of main causes of groundwater depletion, salinity and other types of resource degradation.

First, the nature and extent of subsidies are examined. A recent study (ESCWA/FAO 1994a) on agricultural pricing policy in the Syrian Arab Republic reveals that wheat and barley are the two most protected cereal crops. The nominal protection coefficient (NPC) (1.20) and the effective protection coefficient (EPC) (1.41) indicate the extent of subsidy at the output and input levels for wheat. Similarly, the prices facing barley producers in terms of output are close to international prices (NPC 1.04), while input prices are subsidized (EPC 1.67). The findings further support the high private profitability of producing wheat under irrigation in the different governorates and wheat and barley under rain-fed conditions in the four eco-zones.

Lentils and chick-peas are the two legumes produced widely in the rain-fed zones of the Syrian Arab Republic. Lentils are produced in rain-fed zones one and two, while chick-peas ares produced in zones one and two. The NPCs for lentils indicates a disincentive. The NPCs for chick-peas are higher than 1 demonstrating that regulated prices are 11% percent higher than world prices. The DRCs for both crops indicate that the country has a comparative advantage in producing those two crops in the rain-fed areas. The social profits from lentils are higher than those from wheat.

The pricing policy for cotton, a major export crop, is neutral, meaning that private prices are not significantly different from social prices. The NPCs and EPCs are very close to 1 indicating that the current prices do not provide a real incentive to farmers, but the comparative advantage coefficients are below 1 for cotton produced in Aleppo, Hasakah, and Hama. Social profits are also much higher than private profits, indicating the high potential of this crop to provide the Syrian Arab Republic with hard currency.

Substantial subsidies are offered for producers of sugar beets. These subsidies are reflected by the high values of NPCs and EPCs, and by the differences between private and social profits. Yet the DRC coefficient suggests that the Syrian Arab Republic does not have a comparative advantage in producing sugar beets. The country could allocate resources more efficiently to produce a commodity with attractive social returns.

6. *Possible impact*

In the Syrian Arab Republic high rate of land conversion from rain-fed to irrigated land is directly linked to the high profitability of cash crops such as cotton, sugar beets and other food and horticulture crops. The net results of past policies have started to show signs of stagnation or decline in the overall production of the agricultural sector. It is argued that the long-term productivity of agriculture cannot be sustained under the land and water degradation taking place in the Syrian Arab Republic.

The Governorate of Hasakah produces more than 50% of the country's cotton, wheat, barley, lentils and chick-peas, primarily owing to favourable output prices (wheat, cotton and barley) in the past resulting in an expansion of the cultivated area with the installation of 20,000 wells. This has resulted in declining groundwater levels and deterioration in the quality of groundwater. In the south and south-east of the Governorate, it has deteriorated to the point that no new licenses are issued, and summer crops are prohibited. The focus has shifted to demand management by encouraging water-efficient sprinkler irrigation. There are signs in many parts of the country that such trends will prevent expansion into further areas, and in extreme cases the land irrigated with groundwater has to revert to a rain-fed area. The other option would be to encourage supplementary irrigation, meeting water needs according to rainfall frequency.

Another case from rain-fed areas is illustrated to provide an ecology/economic policy link for sustainable agricultural development in the fifth zone. The high subsidy provided to barley (SPC 1.41) encourages farmer to grow barley, which competes with wheat in the second zone, dominates the cropping pattern in the third zone and is the only crop grown in the fourth zone. Recently the cultivation of barley extended to the fifth zone. In the absence of regulations and because of lack of enforcement to protect resource degradation, the current incentive policy provides farmers an opportunity to seek maximum rents. Such policy results in further degradation by erosion and removal of native vegetative cover and upsets the delicate ecological balance once the native vegetation is removed.

7. *Input subsidy*

Four sources of water are used for irrigation in the different governorates. These water sources include deep tube wells, shallow tube wells, pumping from rivers, and government projects. Irrigation rates for surface irrigation in the government projects per hectare are nominal; they do not cover costs and do not help rationalize the use of agricultural water. It is estimated that a price increase to LS 5,000 per ha would cover the operation and maintenance (O&M) costs. At the same time, low water rates do not encourage the utilization of modern irrigation methods that economize on water use and contribute to increasing agricultural productivity.

In view of increasing water scarcity, the high cost of financing new investments, and negligible O&M revenues compared with expenditures, the Government has started changing for irrigation. In 1993, the

irrigation costs per hectare were estimated at between LS 1,718 and LS 3,562). However, rates were set at LS 2,500. It is estimated that water rates of LS 5,000 per ha would cover the O&M costs. At the same time, the high costs associated with land reclamation compelled the Government to charge land reclamation fees of LS 100,000 to be paid in 25 years.

Private cost of water varies from one source to another. Pumping water from deep and shallow wells costs LS 1.45 and LS 0.89 per cubic metre respectively. Water pumped from the river costs only LS 0.54 per cubic metre. On average wheat requires 4,500-6,000 m^3/ha. This translates into a cost of LS 6,525 to 8,700 per ha to raise wheat under deep-well irrigation. This cost or price represents the opportunity cost of water. In other words this is the minimum that farmers are willing to pay for an extra unit of water. This can be used as a proxy to price water being provided by government projects.

It is estimated that on average the water requirement for seasonal crop is about 13,000 m3/ha. The rate for water for irrigation in the past was LS 1,250 per ha. The per cubic metre cost works out to be LS. 0.096 under the old tariff, LS 0.192 under the existing tariff and LS 0.384 in the future to cover O&M costs. The imputed returns on one cubic metre of water used for wheat and produced from deep tube wells, shallow tube wells, pumping from rivers, and government projects are LS 2.45, LS 4.19, LS 4.81, and LS 5.81 respectively. These numbers give an idea of the massive subsidy on water enjoyed by farmers. On the one hand these subsidies are a fiscal drain on the public sector and on the other hand generate enormous economic rent as calculated above. Further, since water charges are based on area rather than volume, any additional water the farmer applies has zero marginal cost. In other words, the current tariff rates do not provide any incentive to conserve water. This is one of the major causes of overpumping, depletion of groundwater and decrease in the overall productivity of agriculture and sustainable agriculture development in the Syrian Arab Republic.

C. Impact of specific policies and strategies

Land and water policies, in the past, contributed to the trend in decreasing food security, increasing water scarcity, and natural resource degradation. The pressure of population, growing at an average of about 3.5% increased the vulnerability of the agricultural production base and the conservation of natural resources. The lack of incorporation the sustainability dimension in overall policies compromised the short term goals of food security and of maintaining the stock of natural resources in the long run.

Food self-sufficiency ration which relate domestic food staples production to domestic consumption fell between 1965-1967 to 1986-1988, from 100 to 84. Per capita food production in 1986-1988 was less than its level in 1979-1981 (per capita food production index was 93 in 1986-1988 compared to 100 in 1979-1981). These points out to inefficiencies in land use and to fragmentation and reduction in arable land per capita of agricultural population, which has decreased from 2.28 million in 1965 to 1.68 million in 1988.

Although past water policies served to increase the cultivated area under irrigation, the long term result of rapid increase in water use led to water scarcity. Ground water resources are being depleted at alarming rate. The policies have contributed to a lowering of the water table beyond the minimum sustainable level. In many cases it has even made further pumping uneconomic. The free access to ground water and the low price of water has resulted in inefficient use of resources. An appropriate pricing policy is needed for sustainable use of water in the country.

It is calculated (Van Tuijl 1993) that per capita renewable water resources in the Syrian Arab Republic will decline from 438 cubic metre in 1990 to 308 in the year 2000 and to 151 by 2025, a reduction of 35% from the 1990 level. This is a substantial decline, requiring supplementary water from other sources.

Despite initial increases in land and water availability for agricultural production, policies were not conducive to the sustainable development of natural resources and led to soil erosion, waterlogging and salinization and to desertification in the arid and semi-arid areas.

1. *Analysis of land use strategy and agricultural policies*

(a) It was previously shown that 60.5% of the total cultivable lands of the Syrian Arab Republic are concentrated in the first and second zones of settlement. These are the main areas of rain-fed agriculture and strategic crops such as wheat and food legumes. These zones have fertile soils, and water resources there (rainfall) is estimated to be about 21 billion m^3, which is approximately 50% of the total rainfall and to have an evaporation rate of 1,600 mm;

(b) The uncultivable area amounted to about 914,000 ha in both the first and second settlement zones, 518,000 ha of which were classified as rocky and sandy land. It is believed, however, that the criterion adopted for such determination has changed in view of the available machinery and mechanical potentialities at present, for it has become easy to transform them in whole or part to cultivable land, due to quantities of rainfall that would be appropriate for crops, fruits and forest-trees;

(c) In the fifth zone of settlement (the badia), rainfall is characterized by high intensity and short time duration, ideal for the establishment of water-harvesting projects, since intense rainfall leads to the formation of surface floods and soil erosion. The rainwater source in this zone is estimated to be 15 billion m^3 as a result of only few rain storms;

(d) Land in the Syrian Arab Republic was classified into five types of soil which differ with regard to fertility and physical properties and which were formed under different climatic and pedogenetic conditions. They are considered to be generally low in organic matter and phosphorous. A large proportion contains a high percentage of Ca CO_3 and gypsum. Other groups have by large quantities of gypsum, and carbonates, poor fertility and low to high degrees of salinity. The gypsiferous soils, particularly in the Euphrates basin, are subject to subsidence, creating serious problems in very short-term irrigated cultivation;

(e) The changes that occurred to the areas of the cultivated lands were very slight during the study period (1976 to 1993) ranging only between 32.05 and 32.07%;

(f) There was a sizeable decrease in fallow lands, from 30.65% of the total exploited area for the average of the period 1976-1980 to 7.97% in 1993. In spite of this important development, 125,000 ha in the first and second zones of settlement were kept as fallow land in 1993;

(g) The percentage of the actually cultivated land increased from 69.35% of the total exploited area during the period 1976-1980 to 91% in 1993, at a rate of 1,068,000 ha. The cultivated rain-fed areas increased by about 589,000 ha and the irrigated area by about 479,000 ha;

(h) There was a decrease in the percentage of the exploited rain fed area from 86.2% of total cultivated areas during the period 1976-1980 to 79.5% in 1993, as a result of putting rain fed areas under irrigation, which areas increased from 13% to 20.5% of total exploited area during the same period;

(i) There was an increase in the area of public utilities buildings which amounted to about 292,000 ha during the period of 1976-1980 through 1993. A large portion of this extension did take place on fertile agricultural land;

(j) There was an increase in the percentage of cereals in the cropping system which constituted, 77.3% in the irrigated lands, and 52% in the first settlement (on account of food legumes) and 81.2% in the second and third, 61% in the fourth, and 47.6% in the fifth zone;

(k) The percentage of wheat cropped area in the irrigated and rain-fed areas, increased by about 37.2% during the period 1986 to 1993 because of the State pricing policy;

(l) The agricultural rotations are established on the basis "planned" or "desired" production targets, irrespective of the suitability of the rotation and its effect on soil conservation and fertility that would conserve.

2. *Impact of land use planning policy and crop rotation and agricultural intensification*

Planning for the use of rain-fed and irrigated lands is undertaken according to the State's strategy and priorities. Agricultural rotation and cropping patterns are established according to rainfall, taking into account soils properties and then suitabilities crops. However, within the framework of the annual agricultural production plan, crop rotation and intensification are established for the irrigated as well as rain-fed land. These were as follows for the years 1986, 1990 and 1993:

(a) The cropping intensity in the irrigated lands was: 125%, 134% and 127% during the years 1986, 1990 and 1993 respectively. This change in the cropping intensity mainly reflects the quantities of the available water during the year and changes in the groundwater and surface-water resources;

(b) A large increase of the wheat area in the agricultural cropping pattern passing from 42.7% in 1986 to 58.6% in 1993 of the total irrigated cropped area or an overall increase of 137.2%, owing to the increasing demand of this strategic commodity and the State policy of self-sufficiency in regard to wheat;

(c) There was a tangible decrease in the area of forage legumes from 5.5% in 1986 to 0.53% in 1993. A similar decline was also noted for winter vegetables. These areas were used for wheat and sugar beets to meet the annual demand on these commodities;

(d) There was also a decrease in the percentage of summer crops from 43% in 1986 to 33% in 1993. This was due to the decline of water resources, and to the decline of the profit margin, particularly from cotton as compared with irrigated wheat;

(e) Land use planning of rain-fed land is based on the agricultural settlement zones and annual rainfall. In general, wheat, food legumes and forage legumes are planted in the first settlement zone followed by the second, but barley is mainly planted mainly in the third settlement zone and in other settlement zones depending on the planned cropping intensity.

The cropping intensities in the different settlement zones were as follows:

* **First Zone:** The percentage of cropping intensity was 100% during all years with a great increase of the wheat percentage from 46.5% in 1986 to 54.8% and 56% during 1990 and 1993 respectively, an increasing percentage of food legumes from 10.6% to 20.6% and 25% during 1986, 1990 and 1993 respectively, and a decrease of the percentage of the feed legumes and other crops in favour of wheat and food legumes and other crops in favour of wheat and food legumes.

* **Second Zone:** The cropping intensity increased from 63% during 1986 to 100% during 1990-1993. This increase came mainly from wheat and barley.

The percentage of wheat area in the total cropped area varied from 27.7%, 43.6%, 37.5% and barley from 22%, 44.5%, 43.7% during 1986, 1990 and 1993 respectively.

* **Third Zone:** A general trend toward an increase in the cropping intensity was observed. The wheat and barley constituted 49.5%, 97.1%, 80.2% during 1986, 1990 and 1993 respectively.

* **Fourth Zone:** The cropping intensity varied from 34.4% to 98.6% during the period 1986-1990 and barley from 34.4% in 1986 to 59% in 1993 respectively.

* **Fifth Zone:** The cropping intensity changed from 73.1% to 47.6% in 1993 with a decrease of wheat from 33.7% to 2.3% and an increase of barley percentage from 23.3% to 45.3% while it is to be pointed out that the cultivated areas of both fourth and fifth zones of settlement were topographically courses of floods and water catchments areas.

The following can be concluded:

(a) The cropping intensity in the irrigated lands depends on the quantity of water available, particularly for intensive cultivation;

(b) The crop rotations and percentages of cropped areas are determined in the production objectives, particularly the strategic ones such as wheat, without due consideration to rotations that conserve soil fertility;

(c) The abidance of farmers by agricultural rotations already planned is related to two main factors:

(i) The price of the commodity and the extent to which mechanization is used in planting and harvesting the crop, since both factors provide farmers with necessary incentives for planting the planned crops, such as in the case of wheat and in further expansion on the account of other crops particularly food and feed legumes;

(ii) The agricultural rotation in the irrigated land leaves the areas allocated for cotton unexploited for four months of the year during which these areas could be used for planting forage crops for producing grain, green fodder or using as green fertilizer, particularly if the farmer does not use organic fertilizers.

D. Impact of sectoral policies and strategies

1. *Impact on irrigated agriculture*

Policies related to the extension of irrigated land by maximum use of water have been emphasized order to increase the volume and stability of production.

In addition, policies established to guide the development of irrigated agriculture have given the primary emphasis to large-scale programmes, most notably the Euphrates Dam and the Euphrates basin, and also the Ghab valley. Additional policy statements have stressed the urgency of constructing dams and irrigation networks in various other areas of the country, such as the Khabour, Jughjugh, Naher el-Kabir and Rouge rivers.

Noting the severe problems with gypsum and salinity in the Euphrates valley, and considering the situation with regard to technical, financial and human resources, it was recommended that land reclamation

in the Euphrates valley be introduced gradually with various schemes being developed in stages, in order to avoid potential problems related to gypsum and salinity that might arise from proceeding too quickly while major technical (engineering and agricultural) and socio-economic problems were still unsolved. In addition the gradual approach should be based on a regional integrated development plan taking into consideration technical, economic, social and environmental factors, and should be integrated into the national plan for development.

Owing to the engineering and agricultural problems encountered with gypsiferous soils in the Euphrates valley, the policy was to postpone or cancel development plans in areas with gypsum problems, and to develop the irrigation potential in other areas of the country where technically and economically feasible. Higher priority was also given to the construction of irrigation networks at dams already completed.

What is urgently needed in the Syrian Arab Republic for the present time and in the future are policies and strategies for integrated, and sound management of soil and water in the irrigated areas, in order to increase agricultural production to meet the needs of the growing population, while maintaining and improving the productivity of the land and protecting the environment.

It should be mentioned here that expanding the irrigated area through the development of groundwater resources, received much less attention in the beginning than surface water. However various policy recommendations made on many occasions directed attention to the development of groundwater resources, particularly in Talal-Ala, al-Asharney and the Ghab, to study changes in groundwater and surface-water balances, and to explore the Damascus, Orontes, Aleppo, Coastal, Yarmouk and steppe hydrological basins.

Attempts have been made to protect irrigated agricultural land, particularly in the Damascus Ghouta, from growing urban and industrial encroachment. Measures to guide urban and industrial growth in the Ghouta have been taken in order to protect and to conserve this exceptional and valuable agro-forestry system from the ecological and socio-economic points of view. Unfortunately, these measures have not been applied strictly, and this has led to a large decrease in the area of the best agricultural lands in the Ghouta, which have been urbanized.

Policies on the development of land under irrigation have been complemented by a policy on increasing productivity through increased yields irrigated crops and rain-fed crops. This policy has been given increasing attention, as it is becoming the major means available for achieving the goal of expanded agricultural production. Nearly all the land suitable for rain-fed agriculture is already under cultivation, and so yield increases are the only means to greater output. In order to implement this policy, emphasis has been directed toward measures and programmes related to the introduction of modern agricultural technologies and the use of improved agricultural practices and farm inputs which should be introduced as a package.

2. *Impacts on rain-fed agriculture*

Since nearly all the lands suitable for rain-fed agriculture is already under cultivation, major policies on natural resources development have been oriented towards increasing the output of such land through improvement in yields, by delivering a package of modern agricultural technologies and improved farm inputs. However, this package of services has not been efficient owing to inadequate research outputs on the management of soil and water in rain-fed areas and the lack of coordination among the numerous institutions in the country, responsible for providing these services.

Recent policy has highlighted the importance of using supplemental irrigation in the summer in order to improve crop yields in rain-fed areas. Even in the higher rain-fed areas of the coastal region, the use of

groundwater and surface-water for supplemental irrigation could be useful during the dry period of the year. However, overpumping of groundwater has led to the depletion of aquifers in many regions and will have a negative impact on agricultural production in the near future. In addition, knowledge on sound management of land in rain-fed areas, particularly in sub-humid and semi-arid zones, are still incomplete. More research is still needed in this domains to increase yields while preserving and improving the productivity of the land and protecting the natural resource base from degradation.

For nearly two decades, national policies in the allocation of fertilizers to different agro-ecological zones in the Syrian Arab Republic have favoured strategic crops in the high-rainfall and irrigated areas. No allocations were made for barley production in the dryland areas.

Collaborative research between the Ministry of Agriculture and Agrarian Reform and ICARDA demonstrated high returns to phosphate fertilizer on barley in the drier farming zone. (Jones 1991). Other studies showed reduced responses to phosphate in higher rainfall areas. Recently there has been a change in the policy to reallocate fertilizers from higher to lower rainfall areas.

3. *Impact on steppe rangelands*

Development policies for the steppe rangelands are primarily oriented intended to increase the productivity of this very arid region, which is ecologically and economically unsuitable for crop production without irrigation. The major development activity in the steppe involves developing grazing land resources for increased production of livestock and livestock products. The protection of the steppe rangelands from deterioration and desertification is also seen as a major target in the development of this natural resource. However degradation of the steppe owing to overgrazing, the uprooting of shrubs and, particularly, plowing of land for cereal cultivation is continuing, and desertification is progressing.

While plowing in areas receiving less than 200 mm of annual rainfall was declared illegal by legislative decree No. 140 in 1970, with a modification in 1973 in the form of Law No. 13, the plowing intensity in these areas is still high, owing to the inadequate enforcement of the law.

Successive Governments have reaffirmed their commitment to give a higher priority for steppe development, and policy recommendations have been made to improve grazing and livestock resources through cooperatives established for the production and marketing of sheep and to the development of water resources in the steppe for use by livestock through the construction of water storage dams in the steppe area. It has also been recommended and reaffirmed on several occasions that, where available, any additional water supply would be used for irrigating crops, pastures and trees near the dams.

Feed subsidies, loans for sheep-fattening cooperatives, feed delivery and storage in the rangelands, and the renovation of Roman cisterns to stock water in these areas have been organized, but unfortunately such assistance has contributed to the overstocking of the rangelands, because of the lack of integrated management of the steppe rangelands.

The Government started an extensive programme (in the mid-1980s) of range rehabilitation using exotic and local species of shrubs, mostly *Salsola vermiculata, Atriplex halimus, Atriplex nummularia* (D 1978). The total area to date of shrub plantations in government reserves is 61,900 ha. This has met with mitigated interest from the agro-pastoralist community, who were required to establish fodder shrubs on their private or communal land in that part of the steppe receiving less than 200 mm/year of rainfall. Although shrub plantations in the country have not been put to systematic use by livestock, except in experimental plots, the main result has been an impressive vegetation cover on a highly degraded area in a 150 mm/year zone, with enough seed production to allow further re-vegetation.

Various measures and regulations were also taken to protect the steppe resources of plants, wild animals, soils and water, including prohibiting crop cultivation and forbidding the hunting of wild birds and wild animals in order to restore environmental balance in this fragile ecosystem. However, all these measures and regulations together were not enough to stop the accelerated deterioration of the steppe.

4. *Impact on forestry*

In the absence of reliable data on forest resources in the Syrian Arab Republic, the importance and role of forestry in the national economy and development are not well understood and are even underestimated, in terms either of forest products or ecological advantages.

No policy has yet been, officially adopted by the Government to prescribe long-term objectives in the forestry subsector. Hence, there is no structured, detailed national strategy formally laid down for the development and conservation of the country's forest. The forestry programme consists of no more than targets to be achieved and budgets to carry them out.

However, there is a general policy direction, which consists of preserving existing natural forests and creating a core of forest plantations to cover around 15% of the country's area. The primary function assigned to forest vegetation is therefore more oriented to protection than production.

The first forestry law, enacted by legislative decree No. 66 of 21 September 1953, was the basic enactment governing forestry in the Syrian Arab Republic. A second one, much more limited in scope, was the forest policy law enacted by legislative decree No. 86 of 30 September 1953 (amended in 1962, 1969 and 1970). The forest law was complemented by three other statutes, namely: (a) legislative decree No. 128 of 23 August 1958 on the protection of trees and plantations and damage caused by goats, (b) legislative decree No. 65 of 20 September 1966 on the prohibition of grazing of certain animals in certain lands, and (c) legislative decree No. 169 of 30 June 1959 on the distribution of arid lands in the forested regions of the Syrian Arab Republic.

The law of 1953 was a strictly regulatory law, and it is restrictive and repressive. While focusing mainly on prohibitions, limitations and sanctions, it virtually ignores planning, management and development issues. It does not contain any specific provisions regarding forestry policy, forest administration, forest inventory, management plans, private forestry research, training and extension, social (community) forestry and public participation and involvement, or environmental impact assessments.

Through the repressive character of this law, the forest areas in the Syrian Arab Republic have declined seriously during the four past decades, and many forests have been degraded and have lost their socio-economic and environmental value.

A new forest law was promulgated in 1994, replacing the old one of 1953. It represents a certain improvement over the old law, but, it retains the main weakness of the 1953 forest law detailed previously. Further improvement of the 1994 forest law is needed, particularly in forestry policy, social forestry and public participation and involvement, forestry planning, private forestry, research and extension (see details in the chapter on policy action). It should also be mentioned that the recent law on environmental protection of 1994 will affect forestry in the Syrian Arab Republic in a positive way. This law provides in general terms for the protection of flora, fauna, soil and natural resources. It empowers competent authorities to issue standards, specifications and regulations for the protection of flora and fauna and for the sites of protected areas in order to ensure environmental balance and the conservation of living organisms.

The High Commission for tree planting established by Presidential decree No. 108 of 1977 is a forestry body having a specific mandate for tree planting in the country and for the promotion of plantations of both forest and fruit trees, with a view to afforest progressively 15% of the country's area.

There are two other bodies dealing with environment which are also concerned with forestry. One is the General Commission for Environmental Affairs, created in 1991, but which only recently became operative. It is specially charged with preparing of environmental plans and law, assessing environmental problems, preventing and controlling ecologically harmful activities, and promoting environmental public awareness.

The second body is the Supreme Council for Environmental Safety established in 1991. It is a prominent decision-making organ which has the power to adopt environmental policies, regulations and standards, as well as to prohibit any environmentally damaging activities.

E. Impact of the multiplicity of ministries and authorities concerned with the use of land resources

Many public services are involved or deal with one or another aspect of the use of the land resources of the country, although there are weak links and lack of coordination among them. The principal reason for the weak liaison among ministries and authorities is that no group or directorate within the government services can be recognized as a prime source of information on land, regarding the quality and the constraints on the various forms of its use. At present, no ministry is charged with acquiring this information and with making it available. Decisions on land use are therefore made with imperfect information.

Poor coordination between, for example, the Euphrates Irrigation Authority and MAAR have contributed to some of the land use problems in the area of irrigation. The use, distribution and allocation of water, as related to crop requirements is one example. Lack of continuous and effective contact has, in this case, been a contributing factor to the creation of salinity, waterlogging and drainage problems. The problem exists also in the other irrigated areas, such as the Khabour basin and the Ghab valley.

Weak coordination among and even within ministries, has led to the development of legislation and regulations with conflicting aims, so that the objectives of sustainable land conservation are completely ignored.

In planning for food self-sufficiency and addressing future changes, an enhanced programme of high quality data acquisition to provide a sound information base on present systems and processes (soil qualities and biophysical, technical and socio-economic data) is highly recommended to facilitate the evaluation of the sustainability of alternative land use systems.

F. Impact of farm fragmentation

The agrarian reform act of 1958 and legislative decree No. 31 of 1980 comprise the act of agricultural property. The articles of the decree put ceilings on land holdings of rain-fed and irrigated land, according to the region and the method of obtaining irrigation water. This legislation, which made land available to farmers, who were formerly the tenants of large proprietorship, has been highly successful. However, tenure changes and inheritance provisions have created a problem of small and fragmented farms, which can only worsen.

The continuous fragmentation of land, which is closely related to excessive population growth, is an indicator of unsustainability, and may have disastrous consequences for soil conservation.

In the absence of action to slow down population growth, there is a high risk that successful implementation of the adopted strategies will postpone but not prevent the collapse of the ecosystem.

The disaggregation of farm units creates many difficulties concerning mechanization, water supply and drainage schemes and results in many agricultural practices that do not fit with environmentally sound technology.

In the long-term interests of sustainable land management, the Syrian authorities, should continue to address the question of minimum farm size in each agro-ecological zone of the country.

IV. RENEWABLE NATURAL RESOURCES DEGRADATION

A. INTRODUCTION

The different studies on and field observations of the Syrian Arab Republic confirm that the major cause for degradation of the country's renewable natural resources (natural forest, natural rangelands in the steppe, agricultural lands in rain-fed and irrigated areas, and water resources) is the misuse, the mismanagement and overexploitation of resources, owing to technical, economic, social and environmental reasons.

This section will cover the following environmental issues associated with the exploitation of renewable natural resources in the Syrian Arab Republic, based upon local observations and experience and as cited in the relevant scientific and technical publications.

(a) *Natural vegetation*

Natural forest degradation
Degradation of steppe rangeland
Degradation of wildlife habitat
Loss of biodiversity

(b) *Soils*

Soil salinization
Soil degradation (other than salinization)
Soil waterlogging
Soil erosion by water and wind
Loss of agricultural lands
Subsidence of gypsiferous soils in irrigated areas

(c) *Water*

Groundwater depletion
Groundwater salinization
Groundwater degradation (other than salinization and depletion)
Surface-water salinization
Surface-water degradation (other than salinization)
Destruction of wetlands

(d) *Agricultural produce*

Change in the quantity and quality of agricultural production

(e) *Desertification*

B. Natural forest degradation

Deforestation, overgrazing, overcutting, and man-made forest fires are the major causes of natural forest degradation. Forests are shrinking at an accelerated rate, particularly in the highly populated areas, such as the coastal mountains, where they are being felled for agricultural land.

With the exception of the 50,000 ha of pine forests in the Baer-Bassit mountains of the coastal region, the majority of the forests in the Syrian Arab Republic (*Quercus calliprinos, Q. infectoria, Q. cerris* subsp. *pseudocerris, Abies cilicica, Cedrus libani, Juniperus excelsa, Cupressus sempervirens, Pistacia atlantica*) are in different stages of degradation which is reflected by:

(a) The replacement of the original forest by shrubs, subshrubs and xerophilous thorny plant communities of low environmental and economic value such as *Poterium spinosum, Genista acanthoclada and Calycotome villosa;*

(b) An acceleration of soil degradation accompanied by a decrease in forest soil productivity and wood production.

Certain forests such as the forest of *Quercus infectoria* in the humid zone and the forest of *Pistacia atlantica* and of *Juniperus excelsa* in the arid and semi-arid zones are remnants of large areas that they covered in the near past. In addition, these remnant forests are degraded, and the trees *Pistacia atlantica* and *Juniperus excelsa* are not regenerating. The forests of *Juniperus excelsa* in the Anti-lebanon mountains are now degraded and have disappeared from large areas formerly covered by them. Aerial photographics have shown that in the Issal Al-Ward area, the forests previously covered a large area and that 4,909 ha disappeared between 1941 and 1982 due to overcutting. The remnant forests are also degraded and are not regenerating. A very important type of forest *Juniperus excelsa*, which played an important role in the life of the ancient civilizations in the Syrian Arab Republic will disappear completely if urgent measures are not taken to protect the remnant stands. The forests of Pistacia atlantica are in the same situation. These forests reportedly covered large areas of the mountains in the steppe in 1912. They are in a very critical situation and the remnant should be saved from disappearing.

The riverside forests of *Populus euphratica* along the Euphrates River are also degraded and are reduced to patches along the rivers and standing on islands in the river.

The natural forests in the Syrian Arab Republic are in a critical situation, losing their environmental, economic and recreational value at an accelerated rate.

C. Natural rangeland degradation in the steppe

Overgrazing, the uprooting of woody species for use as fuel, plowing land for cereal production in areas of low rainfall and mismanagement of water resources are the major causes of natural rangeland degradation in the steppe area in the Syrian Arab Republic and in many places where desertification is observed in the country.

As a result of rangeland degradation, in particular grazing which exceeds the carrying capacity of the range and which results in the trampling of the land by sheep, perennial grasses have disappeared, which in turn has intensified the periods of pasture shortage. Perennials remain green and nutritious for a much longer time than do annual grasses, which have increased and which have partially to almost completely replaced perennials.

As a result of overgrazing and in the absence of control measures, the more palatable shrubs, perennial grasses and legumes such as *Salsola vermiculata, S. lancifolia , Dactylis glomerata, Oryzopsis holciformis, Stipa barbata, Astragalus* sp., and others formerly common in the Syrian steppe have been replaced by less palatable plants such as *Noaea mucronata, Peganum harmala* and several spiny shrubs of very low forage value. Where *Poa sinaica* was the dominant species, overgrazing has brought about an increase in *Carex stenophylla*, a less productive species.

On salty soils, another widespread type of rangeland deterioration of the steppe flora is the development of certain inedible annual or perennial Chenopodiaceae species such as *Haloxylon articulatum, Anabasis haussknechtii, Noaea mucronata* and others. Certain species can also invade very sandy soils or the grey soil of the *Artimisia herba-alba* steppe.

Plowing of the steppe has completely destroyed a number of plant associations such as *Poa sinaica, Poa bulbosa, Stipa barbata and S. lagaseae*, and these have been replaced by less productive annuals such as *Hordeum murinum* and *Stipa carpensis*, which are not reliable during drought years or dry seasons (DRAZ 1978). Under the ecological conditions of the Syrian steppe, the re-establishment of the natural vegetative cover after successive plowing is a very slow process.

While plowing in all areas receiving less than 200 mm/year of rainfall was declared illegal in 1970 with modification in 1973, plowing is still practiced because of weak enforcement of regulations.

The loss of rangeland vegetation continues to contribute to wind and water soil erosion in the steppe and it is also by itself a degradation of natura resources. With increasing overgrazing, palatable species die out and unpalatable species become dominant. Where the now unproductive land is plowed for barley, the whole ecosystem, previously sustainably productive at a low level of output, is irretrievably destroyed. This is desertification, which is observed in many areas of the steppe rangelands in the Syrian Arab Republic. The continuous degradation of the rangelands will lead to a continuous desertification of the steppe and a definitive loss of natural resources.

D. Soil erosion

The mismanagement of forest land, rangeland and agricultural lands has activated the process of water erosion and wind erosion in the different ecozones in the country, which has resulted in tremendous loss of soil, particularly on the sloping terrain (from water erosion) and in the semi-arid and arid zones (from wind erosion).

1. *Water erosion*

Soil erosion occurs in many areas in the steppe due to the overexploitation of vegetation. Steeper slopes with thin rocky soils denuded of vegetation have suffered sheet erosion, while among deeper and heavier soils in the sloping plains, gully erosion is active in some areas. Considerable run-off of water and soil occurs with the occasionally heavy rains, and the force of water is sufficient to destroy rather large earth dams. The amount of soil loss can readily be seen by examining the basins of dried-up reservoirs. In the sub-humid and humid zones, the mismanagement of the sloping cultivated lands and the absence of soil conservation measures have activated soil erosion and depletion of plant nutrients leading to loss of soil productivity. In many places, arable soil has disappeared, exposing the parent material.

It should be mentioned that water erosion occurs in humid as well as in arid areas in the Syrian Arab Republic. The immediate causes vary, but everywhere it represents inattention to long-term consequences in the urgency of responding to current need. In wetter areas, steep slopes are cleared for planting orchards

of olive, apricot, fig and vine. The clean-cultivated land with widely spaced trees afford little resistance to erosion, and often, the stones and rocks that could have been used to built simple terraces are cleared into useless heaps. Whether under orchard or animal crop production land is filled without regard to the contour, usually up and down the slope. Indeed, this is almost unavoidable where land ownership, is constituted of long and narrow individual holdings running up the slope as a result of laws of inheritance.

Zoght (1978) calculated that 50 tons of soil per hectare per year are lost in the coastal zone on sloping marly terrain. In addition, 25% of the water is lost by surface run-off on the same terrain. The quantity of soil loss in the different ecozones of the Syrian Arab Republic is very high (FAO 1980) and is considered the most critical factor in land degradation and desertification in the country (tables 7 and 8).

TABLE 7. PRESENT SOIL LOSS BY WATER EROSION IN THE DIFFERENT ECOZONES OF THE SYRIAN ARAB REPUBLIC (FAO 1980)

Ecozones	Soil loss (tons/ha/year) according to the intensity of degradation of the natural vegetation
Coastal mountains	50 - 200
Djebel Al Akrad	10 - 50
Baer-Bassit mountains	10 - 50
Kalamoun and Antilebanon mountains	10 - 50
The mountains in the steppe	10 - 50

Source: FAO.

TABLE 8. HUMAN-INDUCED OIL DEGRADATION IN THE SYRIAN ARAB REPUBLIC

Type	Degree		
	Slight	Moderate	Severe
Water erosion loss of top soil	902	127	29
Wind erosion loss of top soil	1 210	380	30
Wind erosion overflowing	11	267	130
Salinization	15	20	90
Total	2 138	794	279

Source: M. Ilaiwi, "The impact of the present agricultural practices and rural development on the environment", UNEP, ACSAD.

2. *Wind erosion*

In rain-fed farming systems, following the widespread introduction of mechanization over the last 40 years, shallow tillage has been replaced in many areas by disc and moldboard ploughs, to a depth of 20-30 cm. Not only is deep tillage itself costly in fuel use, but it necessitate another cultivation to prepare the seed-

bed. Furthermore, it tends to destroy soil structure and activate soil erosion by wind, prejudicing the long-term maintenance of the soil itself.

Wind erosion also occurs where natural vegetation has been removed and not replaced by any other form of soil protection, a situation exacerbated by a deteriorating soil structure, which is frequent in rain-fed areas and in the steppe due to cereal cultivation.

In drier arable lands, large tracts of land are cultivated without any wind breaks, and stand empty and vulnerable to wind erosion through the dry, windy summer. Stubble and other plant residues, which may provide some physical protection and contributes indirectly to the maintenance of the soil structure, are removed or grazed, and the frequent trampling of animals across the land increases the susceptibility of the surface soil to wind action. The situation is similar in much of the steppe rangelands; the perennial vegetation has been totally destroyed by overgrazing and firewood collection, leaving the soil exposed. And the ever-decreasing biomass available for grazing encourages land users to plow and grow barley, thereby destroying the last vestiges of any dry-season soil protection.

M. Askar (1991) has calculated that 10 cm to 20 cm of soil are lost in 20 years by dust storms from land in certain areas of the steppe, because of plowing for cereal cultivation. In some areas where wind erosion is very active, the parent material (gypsic horizon) has been exposed. The result of this accelerated wind erosion is the domination of sandy soil and the formation of moving sand dunes 50 to 60 cm in height.

It should be noted that owing to the severe deterioration of the plant cover and the accelerated soil degradation, the frequency and intensity of dust storms have increased in the steppe. In 1987, there were 39 dust storms, compared to 11 major dust storms in 1987, each of which lasted over one hour. With increasing drought duration during the period 1989 - 1991, dust storms lasted more than 24 hours. Measurement of soil losses caused by wind erosion (ICARDA 1991) have shown that, from one field at TelHadya (Aleppo) where the soil structure had been destroyed, an estimated 17 tons of soils were lost per hectare during the summer of 1991.

It should be highlighted that soil genesis is extremely low under the ecological conditions in the Syrian Arab Republic, particularly in the arid and semi-arid zones, and that the reconstitution of the soil lost by erosion, will take thousands of years. Therefore, soil conservation and sustainable land management should be declared a strategic option by the Syrian Government for food security and national security, and for the present and future generations.

E. GROUNDWATER DEPLETION AND POLLUTION

Whatever water is available for agriculture in the Syrian Arab Republic, it is freely used to irrigate crops. Many farmers believe "the more water, the more production" almost without limit. An ICARDA survey showed that the average amount of supplemental irrigation given to rain-fed wheat by Syrian farmers was three times the research optimum, although the yield was nearly 20% lower. In addition, the overpumping of groundwater in many parts of the country has led to the lowering of the water-table, thus threatening the groundwater reserve in the country (approximately one meter per year in the area around Aleppo). In certain areas, groundwater has dried up, such as in Salamia, near Hama, because of overpumping for cotton cultivation in the 1950s. The area is now under rain-fed farming.

The expansion of agriculture into the drier areas has been greatly facilitated by the widespread existence of underground water resources. But few aquifers, can sustain the current rates of extraction for long.

In the coastal zone overpumping has led to groundwater salinization by sea water intrusion, thus affecting the quality of the water for domestic use and for irrigation. Groundwater depletion is reaching a critical point in the supplemental irrigation zone. Under the agroclimatic conditions of the Syrian Arab Republic, the zone that can be considered as potentially suitable for supplemental irrigation lies between the 250 mm isohyet (considered as the minimum required rainfall for rain-fed farming) and 600 mm, which represents the full wheat-crop water requirement. This zone is spread over five hydrological watersheds: the Khabour, Euphrates, Aleppo, Orontes (Al Assi) and Yarmuk Basins, with a total area of about 4.5 million ha (25% of the Syrian Arab Republic), of which 80% is considered cultivable (3,550,000 ha) (ICARDA and Ministry of Agriculture 1993). In 1991, owing to the limited water resources, only 450,000 ha of this zone was under irrigation (full and supplemental) while 2.5 million ha was rain-fed.

The large increase in the supplemental irrigation area in recent years, that is, from 130,000 ha in 1980 to 360,000 ha in 1990, was based on groundwater. This rapid expansion was mainly a result of the following two factors:

(a) Official policy aimed at to enhancing national cereal production to counteract the cover local consumption. In this regard, two incentives were made in the form of a price increase of cereals and the provision of loans for drilling of wells and installation of pumping units;

(b) Farmers' observation of the drastic increase in yield and yield stability arising from supplemental irrigation.

The main expansion took place in areas depending on groundwater for irrigation, especially in the Khabour basin, where the area irrigated from groundwater is estimated at about 240,000 ha, of which about 60% is under supplemental irrigation. This represents 40% of the Syrian Arab Republic's total area under supplemental irrigation. The Orontes provides for another 30% (110,000 ha).

The total area under supplemental irrigation from ground-water is estimated at about 260,000 ha, or about 70% of the total supplemental irrigation area. *The supplemental irrigation zone contains 70% of the country's water resources*[1], including the largest rivers, of Khabour, Euphrates, Afrine, Orontes and Yarmuk. The total water resources in this zone is estimated at about 6.0 billion m^3/yr (not including the flow of the Euphrates River), 23% of which (1,350 million m^3/yr) is groundwater. The most important aquifers are in the Khabour, Orontes and Aleppo basins.

The main crop grown is wheat (around 75% in 1991-1992) in rotation with food legumes, beans and forage crops. Crop rotation and cropping intensity depend largely on water availability and water quality, particularly, water salinity.

Cropping intensity in the Euphrates and the Aleppo basins, varies between 80 and 100% depending on water availability. In some places, wells dry up in summer, and only winter crops are grown, mainly wheat. The same pattern is observed in areas depending on limited water resources, such as springs, non-perennial rivers (Koweik, Jagh Jagh), or small earth dams in wadis for the storage of run-off water from rainfall.

The available water resources in the supplemental irrigation zone are already over exploited because of the overpumping from the aquifers. According to Wakil (1993), the annual water deficit of the Khabur

[1] According to the Syrian Ministry of Irrigation.

Basin is estimated at about 1500 million m3, and of the Orontes basin (Asharneh aquifer) at about 210 million m^3/yr. "Temporary mining" is found in all the major aquifers, however, that this could lead to "permanent mining" if aquifer water withdrawal remains the same (Mahmoud 1993). Therefore, no horizontal expansion of supplemental irrigation utilizing new water resources can be expected. Any expansion can come only from a shift away from full to supplemental irrigation. Such a shift could be dictated by the need to ease the temporary mining and to readjust the water balance of particular aquifers. Thus, increasing the proportion of supplementary irrigated crops in the rotation has become an official long-term strategy in the Orontes basin, where the percentage of the irrigated winter crops has been officially increased from 55% to 80% (Mahmoud 1993). This has resulted in a saving of 75 million m^3/year, thus helping to reduce the water deficit of Asharneh aquifer. According to Wakil (1993), increasing the proportion of wheat in the rotation by 20% (from 60% to 80%) in the Khabour basin would result in a saving of 600 million m^3/yr. It follows that what is needed at this stage is vertical expansion in particular, which would be achieved by improving the existing supplemental irrigation system, particularly, by improving water management at the farm level. This should include an adequate flow and amount of water used, appropriate timing of irrigation and improved efficiency of water application. Such improvements would result in water saving and provide the opportunity to increase the irrigated areas and total production as well.

With regard to groundwater quality, it should be mentioned here that groundwater is biologically and chemically polluted in the different regions of the country, particularly in the Damascus and Ghouta areas and should be treated adequately before use.

The lakes of Qattineh and Rastan have been adversely affected by biological and chemical pollution, with negative impact on fish production. The groundwater in certain wells around Aleppo city is highly polluted by nitrate, and which can reach 186 mg/l in the sulphur water (Ramadan and Sabbagh 1993) as a result of use of fertilizers.

F. SURFACE-WATER DEGRADATION

Deterioration of surface-water quality in the Syrian Arab Republic is the result of various activities. The underlying reasons include the natural scarcity of watercourses and the high concentration of industrial, urban and agricultural activities in the surrounding areas.

Although surface water is degradation is noted throughout the Syrian Arab Republic, the causes of the degradation are different from one area to the other. Agriculture adds nitrates and phosphates and biocides to the surface water through the use of fertilizers, particularly in areas with intensive agriculture. In addition, nitrate and phosphate in surface waters increase algae activities, leading to eutrophication processes and deteriorating of water quality. Surface-water degradation caused by activities other than agriculture in the Syrian Arab Republic is very common. Biological pollution is one of the main type of degradation of surface water which is becoming very serious, particularly, around the large cities and agglomerations. The Orontes (Al Assi), Barada and Queik rivers are seriously polluted by organic wastes, yet they are used for irrigating crops around the cities of Homs, Damascus and Aleppo. They are responsible for the transmission of many water-borne diseases such as cholera, typhoid, dysentery and others.

The chemical pollution of surface water is also increasing as a result of industrial development, particularly in the main rivers such as the Barada (Al Atrach 1974) and Al-Assi (Abdul Rahim and Khoudray 1974; Hajjar 1984). Studies of the Queik river in Aleppo (Ramadan and Mandil 1990) have shown that many of the water samples analyzed contained a large amount of dissolved organic matter, suspended material, dry extracts and toxic substances (Fe, Cd, Pb, Ni and As). This reflects a high degree of pollution of the river water, particularly in certain places near the discharge of polluted industrial effluent and domestic sewage to the river. Certain water samples near Ramousseh and the Public Garden contained 46.2 mg/l of organic

matter. Other samples were very polluted and contained a high percentage of toxic minerals, especially during summer and autumn; these include iron (1.2 mg/l), manganese (51.38 mg/l), nickel (0.42 mg/l), cadmium (0.065 mg/l), arsenic (0.13 mg/l), and lead (0.42 mg/l).

G. SOIL AND WATER DEGRADATION IN IRRIGATED LAND

The large-scale irrigation projects in the Euphrates basin, in the Ghab valley and in other places suffer severe degradation through salinization and waterlogging. This type of land degradation occurs where drainage, whether natural or artificial, is inadequate, and where there is an absence of sound, integrated management of the land under irrigation poor management practices, degradation of irrigation water quality, use of saline soils, limited soil leaching, high evaporation, poor on-farm water management, particularly poor drainage, and over-fertilization in some areas. Salinization and water logging is a very serious type of soil degradation in areas of intensive agriculture in the country, and the percentage of salt-affected and waterlogged soils amount to 50% in the Euphrates valley with a consequent reduction in yield, a restricted choice of crops to be grown and, ultimately, the loss of land.

Recent studies estimate the area of land affected by salinity in the Syrian Arab Republic at about 600,000 ha. In the Euphrates basin, 30% of the land, amounting to 1.13 million ha, is either saline or affected by salinity. Syrian agriculture loses annually 3,000 to 5,000 ha because of salinity.

In Wadi al-Fayd, irrigation alone appeared to be responsible for a rise in the water-table of 0.30 m per year. The critical depth of the water-table to avoid concentrations of salts harmful to plants is unlikely to be less than 2 m, and it is essential therefore to maintain the water-table below this level. In 1976 hydrological and drainage investigations emphasized the various effects of leakage from Wadi al-Fayd's main canal on the water-table and the costly additional drainage that must be undertaken unless leakage is halted.

In the Ghab project, the area of the saline lands and those affected by salinity is estimated at about 15,000 ha, that is over 20% of the area of the Ghab plain, which amounts to 71,000 ha. This problem is attributed to insufficient drainage and to the high concentration of salts in the groundwater adjacent to the surface and to unsound land management in particular.

In addition to the mismanagement of water and wastes, the environmental disturbance owing to irrigation in these arid and semi-arid areas has provided conditions for the establishment of the vectors of malaria, schistosomiasis and leshamania and for the overgrowth of many hydrophilous plants in the irrigation canals. The gypsiferous soils, particularly in the Euphrates valley, near Rakka, are subject to subsidence creating serious problems for long-term irrigated production. These soils should have not been put under irrigation, but rather kept under natural vegetation to be used as rangelands.

Because of the scarcity of water resources in the Syrian Arab Republic, *brackish groundwater* is more and more used by farmers for irrigation. Thus, around 25% of the Khabour plains is irrigated with brackish water. Brackish groundwater is also used for irrigation in the Euphrates, Aleppo and Orontes basins. None of the irrigated areas using groundwater in these basins is provided with drainage networks, and therefore salt tends to accumulate rapidly in the soil. Research results from ICARDA (1993) indicated that salt starts to accumulate in the first year of irrigation. Owing to the high rate of evaporation and the low average rainfall in the supplemental irrigation zone (around 300 mm annually), salt continues to accumulate progressively in the soil with repeated applications of irrigation water. Thus a saline soil media develops in the upper soil layer which affects plant growth and reduces crop productivity. An average wheat yield decline of 50% was recorded after five years of using irrigation water with an electrical conductivity (EC) of 3-4 millimho per centimetre (mmho/cm) in the Khabour basin.

The proportion of irrigated wheat in the crop rotation increases as the groundwater becomes more saline. This was widely observed in the Khabour basin, where the farmers opt for monocropping of wheat, because of the sensitivity of winter legumes to salinity. In Salamieh, traditionally a legume-growing area, farmers, in areas using saline aquifers, grow only wheat. Winter legumes failed completely after three years of using water with an EC of 1.85 mmho/cm.

Combating soil salinization can only be ensured by enforcing measures to improve irrigation and drainage system and resource management practices. These measures include selecting crops with low water demand, improving soil drainage, excluding soil with high indigenous salt content from the production system, following a sound crop rotation, proper use of fertilizers, preventing return flow from reaching cultivated lands, improving the quality of wastewater treatment, increasing groundwater recharge and controlling overpumping.

Another type of soil degradation in irrigated areas is the accumulation of toxins and the development of pathogens in the soils owing to the increasing use of wastewater in irrigation, (for example soils irrigated by wastewater around Aleppo), the intensive use of pesticides and fertilizers, and the concentration of soluble organic material which reaches the water bodies by run-off. If materials are absorbed by plants and accumulate in the leaves, fruits or tubers, they can pose serious health hazards to both animals and humans. The sources of pathogens are usually inadequately treated wastewater, untreated wastewater, solid waste disposal from urban areas in waterways, and undercomposed manure. Such hazards occur in irrigated areas close to urban centres (Damascus, Aleppo, Homs).

H. Change in the quantity and quality of production

The degradation of the forests, rangelands and agricultural lands in rain-fed and irrigated agriculture has resulted in a reduction in the yield of wood, forages and agricultural products. The quality of agricultural products has also been adversely affected by irrigating crops, particularly vegetables, produce in areas where wastewater that is inadequately treated or not treated is used in production. The repeated use, or the increasing proportion of the use of this water in irrigation, will eventually lead to the accumulation of organic and inorganic substances (particularly arsenic, copper and nitrates) to harmful levels in soils and consequently in vegetables produced.

Research (Ramadan and Mandil 1988) on production of vegetables on polluted soils by arsenic, copper and nitrates in the irrigated plains around Aleppo have shown that the amount of arsenic in certain irrigated soils using wastewater from the Kweik river is becoming high and could reach in certain soils as high as 12.9 mg/kg. The amount of arsenic in vegetables growing on these polluted soils varies from 1.47 to 2.27 mg/kg in the leaves, 2.56 to 2.68 mg/kg in the fruits, 2.12 to 2.25 mg/kg in the flowers, 1.03 to 1.60 mg/kg in the roots and 1.52 mg/kg in the oingons. These polluted vegetables are not suitable for human or animal consumption, the acceptable international standard of arsenic in vegetables for consumption being 1 mg/kg. Research on tomato irrigated by wastewater from the Kweik river has also shown that some tomato paste produced from these tomatoes was seriously polluted by copper, which could reach 21.6 ppm; the international standard for the maximum amount of copper is 5.00 ppm.

Ramadan and Sabbagh (1994) have shown that the nitrate amount in vegetables grown on soils overfertilized with nitrate around Aleppo was very high and reached 2,511 mg/kg in radishes and 394 mg/kg in squash. In addition, the concentration of industry close to waterways plays a significant role in increasing the level of toxic substances in irrigation water. It has been reported that animal products such as dairy and meat products has been adversely affected by the concentration of chemicals in the animals' surroundings.

The production of poultry substantially multiplied over the last few decades in the Syrian Arab Republic. The use of feed concentrates and chemicals to provide better hygienic conditions has adversely affected the quality of the products. Sooner or later, such materials reach the surrounding soil and water. Waste produced from the poultry sector is used in irrigated farming, while waste from slaughterhouses is dumped with municipal waste. Because of its organic nature, it represents a potential source of disease if not properly disposed of.

I. Loss of agricultural land

The loss of agricultural land refers in this report to the natural or artificial conversion of productive agricultural land into other uses. Urbanization, land fragmentation and erosion of arable land are a major threat to land resources in the Syrian Arab Republic. The encroachment of urban and industrial centres contributes to a serious loss of fertile agricultural lands, particularly in the vicinity of large cities such as Damascus, Aleppo, Homs and Lattakia. Urban and industrial centres, for example, have invaded the scarce fertile soils of the Ghouta around Damascus where the most productive soils for agricultural production are found and are threatening this vital and complex traditional agroforestry system. They have also invaded the fertile and very narrow coastal plain and the fertile Ghab valley.

The conversion of agricultural land to other uses has great impact on the whole ecosystem because it destroys the ecological equilibrium and accelerates wind and water erosion within and around urban areas, thus contributing to desertification, particularly in semi-arid and arid environments. It should be highlighted that housing and industrial development and other non-agricultural uses should be directed towards land of little productive potential. The principal cause of this uncontrolled spread and divesting urban expansion is the lack of effective regional and town planning in the country.

J. Loss of biodiversity and degradation of natural habitat

The present situation of biodiversity in the Syrian Arab Republic is very critical. It is reflected by the disappearance or the degradation of certain natural ecosystems and the disappearance of certain wild plant or animal species due to deforestation, overexploitation and mismanagement of these ecosystems, such as overcutting of trees, overgrazing, ploughing of the natural rangelands in the steppe, forest fires, drying up of wetlands which happened during the past, but are still happening these days, but in an accelerated way. The following section gives examples of the most important endangered natural ecosystems and plant and animal species in the Syrian Arab Republic (Nahal 1989):

1. *Natural forest ecosystems*

The following natural forests are endangered as natural ecosystem entities: *Abies cilicica* forest, *Cedrus libani* forest, *Juniperus excelsa* forest, *Pistacia atlantica* forest, *Populus euphratica* riverside forest, *Ceratonia siliqua* and *Pistacia lentiscus* forest.

It should be noted that these forest ecosystems are becoming more simplified genetically through habitat degradation. Many species composing these ecosystems are losing entire populations, which reduces their genetic variability and thus their ability to adapt to climatic change and other forms of environmental adversity, particularly drought, frost and heat. Certain species are impoverished genetically by the loss of ecotypes, races and varieties. In these cases, there is loss of gene reservoir, even if the species itself is not extinct.

2. *Endangered plant species*

The following plant species are becoming very rare and are considered endangered because of having lost their genetic variability (Nahal 1989): *Ceratonia siliqua, Olea europaea, Cerasus mahaleb, Juniperus excelsa, Pistacia atlantica, Fraxinus syriaca, Digitalis ferruginea, Paeonia mascula, Circea lutetiana, Iris damascena, Iris pseudasorus, Iris sofarana* forma *westii, Iris nussairensis, Vicia dionysiensis, Vicia tigridis, Lathyrus gleosperma, Lathyrus chrysanthus, Pancratium martitimum, Viola alba* ssp. *thessala, Tulipa aleppensis, Thypha australis, Typha latifolia*, many *Orchis* species, *Osmunda regalis* and *Adiantum capillus-veneris*.

Many of the wild animal species appearing in the historical records of the Syrian Arab Republic are now extinct or threatened. The main factor that led to this situation is natural habitat degradation owing to deforestation, deterioration of natural vegetation and urbanization.

The period during the First World War witnessed the most destruction in wildlife habitat in the Syrian Arab Republic owing to the construction of railroads, which resulted in the overcutting of trees to be used as train fuel. During the Second World War and after, the human population increased dramatically, which meant increases in the numbers of rifles and vehicles; the rate of animal depletion accelerated almost to the point of extinction. Some species left their natural habitat and moved to other, unsuitable areas which had weak environmental and biological capacity to absorb additional numbers of the same species. In addition, the use of pesticides in fruit orchards, most of them established close to or amidst forest areas, particularly in the western zone, has caused a severe reduction in vegetation intensity and biodiversity of wild plants. Urbanization, the drying up of wetlands, a reduction of in the number and discharge of springs due to overpumping of groundwater, and surface-water depletion have also contributed to the degradation of wild animal habitats. The spring system in the mountainous areas in the Syrian Arab Republic played a significant role in supporting wild animals and sedentary or migratory birds in these areas by providing drinking water, food and shelter, as in the Ghab valley and in the western mountains.

3. *Extinct, rare and endangered wild animal species*

The following lists extinct and endangered wild animal species in the Syrian Arab Republic:

(a) *Extinct species*: The following species disappeared from the Syrian Arab Republic over history (Montreal 1969): *Felis leo, Cervus capreolus, Cervus mesopotamicus, Elephas syriacus, Oryx leucoryx* and *Addax nasomaculata*;

(b) *Rare and endangered species*, as classified by the International Union for Conservation of Nature and Natural Resources (IUCN) in 1977, include the following:

(i) Mammals: *Ursus syriacus* (very rare), *Monachus, Gazella arabica, Canis lupus, Panthera pardus tueliana, Rhinolophus ferrumequinum, Capra syriaca* (same as *C. aegagrus*);

(ii) Birds: *Pelecanus onocrotalus, Egretta alba, Platalea leucoradia, Phoenicopterus ruber, Anas angustirostris, Aquila heliaca, Falco peregrinus, Porphyrio porphyrio, Vanellus spinosus, Larus genei, Gelochelidon nilotica;*

(iii) Amphibians: *Mauremys caspica rivulata* (the turtle).

4. *Tentative prioritization of environmental issues in the agricultural sector*

It is of high importance for the Syrian decision makers to know the prioritization of environmental issues in the different subsectors of agriculture in the country: irrigated agriculture, rain-fed agriculture, steppe rangelands, livestock production and forestry, in order to elaborate adequate new policies for the sound conservation and management of renewable natural resources and to improve the existing ones. This study attempted to priorities the environmental issues in the Syrian Arab Republic associated with agriculture in the five subsectors cited above. Four objectives or criteria were used in the analysis:

Human and animal health
Irreversibility of processes related to the issues
Rate of degradation of the environment
Geographic extent of the area where an impact of the relevant issues is detected

This exercise is based on the experience of the writers and on publications and reports from the concerned ministries and from researchers. Even if it is not complete or fully objective, this exercise, represents a useful indication of the relative importance of the different environmental issues related to each of the five subsectors of agriculture in the Syrian Arab Republic. It should be improved in the near future using a process known as multi-objective analysis. Tables 9 and 10 show the prioritization of environmental issues for the agricultural sector and the prioritization of environmental issues in each of the five agricultural subsectors in the Syrian Arab Republic.

TABLE 9. PRIORITIZATION OF ENVIRONMENTAL ISSUES FOR THE AGRICULTURAL SECTOR IN THE SYRIAN ARAB REPUBLIC

High priority	Medium priority	Low priority
- Deforestation - Steppe desertification - Soil salinization - Soil erosion - Soil degradation - Groundwater depletion	- Natural vegetation destruction - Surface-water degradation - Habitat destruction - Loss of biodiversity - Groundwater salinization - Loss of agricultural land	- Surface-water salinization - Reduction in the quality of agricultural products - Wetlands destruction

TABLE 10: PRIORITIZATION OF ENVIRONMENTAL ISSUES IN THE FIVE SUBSECTORS OF AGRICULTURE IN THE SYRIAN ARAB REPUBLIC

Subsector	High priority	Medium priority	Low priority
Irrigated agriculture	- Soil salinization - Groundwater degradation - Groundwater salinization - Groundwater depletion - Soil degradation - Dissemination of waterborne diseases.	- Surface-water salinization - Quality of product - Habitat destruction - Subsidence of gypsiferous soils	- Natural vegetation destruction - Wetland destruction - Loss of agricultural lands - Soil erosion
Rain-fed agriculture	- Desertification - Soil erosion - Soil degradation - Loss of agricultural lands - Habitat destruction	- Groundwater depletion - Quality of product - Deforestation - Loss of biodiversity	- Surface-water salinization - Groundwater salinization - Groundwater degradation
Steppe rangelands	- Desertification - Soil erosion - Soil degradation - Natural vegetation destruction - Loss of agricultural land - Groundwater depletion	- Groundwater salinization - Groundwater degradation - Habitat destruction - Loss of biodiversity	- Deforestation - Quality of products - Wetland destruction
Livestock	- Quality of products - Desertification - Soil erosion - Soil degradation - Natural vegetation destruction - Groundwater depletion	- Loss of agricultural land - Surface-water degradation	- Groundwater degradation - Groundwater salinization - Surface-water salinization
Forestry	- Deforestation - Soil erosion - Loss of biodiversity - Habitat destruction	- Natural vegetation destruction - Soil degradation - Loss of agricultural lands - Groundwater depletion	- Groundwater salinization - Groundwater degradation

V. PROPOSED STRATEGIES AND POLICIES FOR SUSTAINABLE DEVELOPMENT OF RENEWABLE NATURAL RESOURCES AND SUSTAINABLE AGRICULTURE

A. THE CONCEPT OF SUSTAINABLE DEVELOPMENT

According to the World Commission on Environment and Development, *sustainable development* is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

At a minimum, sustainable development must not endanger the natural systems that support life: the atmosphere, the water, the soil and living beings.

In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investment, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.

This requires the design of strategies that allows the country to move from its present, often unsound, processes of growth and development and renewable natural resources exploitation onto sustainable development paths. It also requires also policy and strategy changes for sound management and exploitation of renewable natural resources such as soil, water, forests and rangelands.

It should be mentioned here that the conservation of renewable natural resources is not limited to the sphere of development goals; it should be a part of the collective moral obligation to other living beings and future generations.

B. THE CONCEPT OF SUSTAINABLE AGRICULTURAL DEVELOPMENT

Sustainable agriculture can be defined as the successful management of resources for agriculture to satisfy changing human needs, while maintaining or enhancing the natural resource base and avoiding environmental degradation (definition adopted by the Technical Advisory Committee [TAC] of the C.G.I.A.R. 1991).

According to this definition and because of the degradation of the resource base (soil, water, vegetation) owing to the mismanagement of agricultural lands, forests and rangelands, the conservation of agricultural resources becomes an urgent task in the Syrian Arab Republic. In many parts of the country, cultivation has already been extended to marginal lands; soil, water resources, forests and rangelands have been overexploited.

These resources must be conserved and enhanced to meet the needs of the rapidly growing population of the country. Land use in agriculture, forestry and range lands should be based on a scientific assessment of land capacity.

The pressures on agricultural land for crop and livestock production can be partly relieved by increasing productivity. But short-sighted, short-term improvement in productivity can create different forms of ecological stress, such as the loss of genetic diversity in crops, soil erosion, salinization and waterlogging of irrigated lands, nitrate pollution of groundwater, and pesticide residues in food.

Ecologically, more benign alternatives are available. In fact, future increase in agricultural production in the country should be based on the better-controlled application of water and agrochemicals as well as on more extensive use of organic manures and of nonchemical means of pest control, and on the sound management of soils, forests and rangelands. These practices can be promoted only by strategies and policies based on ecological realities. A reorientation of public intervention is needed to provide a framework for a sustainable agriculture production (legislation, education, investment in research and extension services, and credit and marketing services). The criteria that underlie the planning of these interventions should not be dominated by short-term considerations. They should discourage environmentally unsound farming practices and encourage farmers to maintain and improve their natural resource base of soils, water, forests and rangelands.

All these points strongly indicate that sustainability in agricultural production and development impinges on various aspects of natural resources management and calls for a multi-disciplinary approach, requiring interaction among physical, biological and socio-economic disciplines in planning, policy formulation, research, extension and development. It should be emphasized that sustainable agricultural development, cannot be realistically pursued sectorally and in isolation. It must be an integral component of an overall strategy for sustainable livelihood and development, strategy, which gives priority to better management and conservation of resources so that their use in satisfying human needs minimizes damage to the environment. Consequently, sustainable agricultural development can most readily be achieved as a component of overall improved natural resources management and conservation.

C. Incorporating environmental concerns into national planning and policy formulation

Incorporating environmental concerns within national planning and policy formulation would require integration of these concerns at the administrative and procedural levels and the use of economic and non-economic instruments. The administrative work would entail streamlining responsibilities between the Ministry of Agriculture and Agrarian Reform and the Ministry of Irrigation with regard to assigning joint responsibilities. At the procedural level it would require changes in the policy formulation process, focusing on public participation in planning land and water use and rigorous environmental impact assessment. The most important aspect is to integrate instruments that use economic and regulatory approaches. It is important to make progress towards the concept of full-cost pricing, which will require adopting a combination of economic and non-economic instruments to internalize external costs. A number of economic instruments are available for implementing economic incentive policy to conserve natural resources and protect environments. These instruments are often classified into seven categories: (1) property rights; (2) market creation; (3) fiscal instruments; (4) charge systems; (5) financial instruments; (6) liability instruments; and (7) performance bonds and deposits refund system. Detailed studies and training are required on the topics of resource conservation and environmental economics.

D. Institutionalization of the environmental impact assessment in the agricultural sector

To ensure that the agricultural development options under consideration are environmentally sound and sustainable, the negative environmental consequences of these options must be recognized early and taken into account in project design. For this reason, environmental assessment procedures should be incorporated into the agricultural decision-making process in the Syrian Arab Republic for early identification of negative environmental issues, design environmental improvements into projects and avoid, mitigate, or compensate for adverse impacts. Towards this end, the Ministries concerned (Agriculture and Agrarian Reform, Irrigation, Health) must, in cooperation with the Ministries of Planning, Higher Education, Environment and Labour and Social Affairs, develop an environmental impact assessment (EIA) programme for the agricultural sector.

The EIA programme should ensure that the environmental impacts of major actions are identified and assessed early in the decision-making process, that scoping meetings are held with representatives from concerned ministries, that the assessments include several reasonable alternatives, and that the public and other relevant public institutions are involved in developing and reviewing EIAs for agricultural projects.

To be an effective decision-making tool, EIA cannot be the responsibility of one government institution; rather, it must be incorporated into the decision-making procedures of all government institutions. To ensure uniformity, most programmes should empower a central government institution to develop procedures and criteria for environmental impact assessment and to monitor implementation. Government agencies are required to incorporate the procedures into their decision making-processes. Private institutions and individuals are required to incorporate environmental impacts assessments into their decision-making procedures as a pre-condition for issuing permits and licenses.

The Syrian Arab Republic has not yet implemented environmental impact assessment programmes, but this should be done as soon as possible. The common goal of these programmes is to ensure that the negative environmental impacts of private and public actions are kept to their practical minimum. The new law on environmental protection (1994), in article 11 of chapter 4, contains provisions for preparing such programmes for EIA. This will require the creation of a national environmental impact assessment process that would ascertain the environmental impact of all new development and construction projects and other activities that might have an adverse effect on the environment in the country, before they are approved and initiated.

No institution in the Syrian Arab Republic has EIA programmes or comprehensive experience in producing EIA. The Supreme Council for the Safety of the Environment should have the responsibility for setting programme requirements and standards and for monitoring requirements and compliance, within a national framework.

E. STRATEGY FOR INTEGRATED WATERSHED MANAGEMENT

The misuse of land in watersheds areas in the Syrian Arab Republic is increasing with accelerated population growth and poverty. The destruction of natural vegetation on sloping areas without replacement by productive agriculture and forestry and in the absence of sound measures for soil and water conservation has caused severe soil erosion and torrential transport of sediment. Sedimentation has affected reservoir storage capacity, power generation and irrigation canals, particularly in the Euphrates.

The climate of the Syrian Arab Republic is characterized by intense rainfall that occurs in downpours. These heavy rains associated with eroded slopes, creates water run-off that produce floods in the lowlands. Flood abatement requires good land use of the watershed and the construction of storage structures. A sound watershed management policy aimed at creating stable conditions of vegetation, soil, and water and taking into consideration the various socio-economic factors, is a critical requirement for integrated and sustained watershed development and for flood protection.

Technologies of soil conservation are well known, but are durable only if the farming, practices, forest protection and land use are also improved. This is not always the case in many of the country's watershed areas, where the destruction of natural vegetation, overgrazing, forest fires and the misuse of agricultural land continue to happen.

The most critical aspects of upper watershed mismanagement, which directly affect the lives and property of downstream users, are the increased likelihood of flooding and the negative effects on water supplies and sediment transport.

In fact, the continuous destruction of hillside forests, followed by unskillful cultivation and by severe overgrazing of hill slopes, has caused heavy rainfall to be shed as surface run-off instead of infiltrating to recharge the groundwater reserves, and the result has been the falling of the water-table, accompanied with all the familiar signs of drought.

It should be emphasized here that the problem of soil erosion and flood damage will be effectively reduced only if decision makers and communities living in the watershed recognize that the watershed functions naturally as a single system, which implies the integration of the different ecological, socio-economic and technological factors in the management of the watershed, and a multidisciplinary approach for its development.

The most urgent major policy decision which should be taken by the Government relates to restoring soil and water stability in the different watersheds. This decision will provide opportunities to restore steep land to hydrological stability and to bring back wastelands to vegetative production on the basis of land capabilities, thus combining watershed improvement with better living standards for the rural communities.

It should be noted here that the improvement of scattered of small watersheds, which has been done in the Syrian Arab Republic, can have little overall hydrological effect, of misuse of land continues all around these watersheds.

F. Strategy for the conservation of biodiversity

The strategy for biodiversity conservation in the Syrian Arab Republic should be based on the following two considerations:

(a) That successful action to conserve biodiversity must address the full range of causes and should embrace the opportunities that genes, species and ecosystems provide for sustainable development;

(b) That, because the task is so broad, any biodiversity conservation strategy must also have a broad scope.

The strategy should include three major thrusts:

(a) Saving biodiversity;
(b) Studying biodiversity;
(c) Using biodiversity.

The strategy for biodiversity conservation should define the following key objectives for achieving effective action:

(a) Develop national policy frameworks to sustain biodiversity;
(b) Provide incentives for effective conservation by communities;
(c) Develop tools to conserve biodiversity;
(d) Develop human capacity for conserving and using biodiversity sustainably.

Biodiversity conservation can succeed only if people understand, believe and can manage biodiversity sustainably to meet human needs. Institution building and investment in biodiversity training and awareness in regard to biodiversity preservation are far from being adequate in the Syrian Arab Republic compared to the enormous magnitude of the task. Education, scientific and socio-economic research institutions and universities, particularly in the faculties of agriculture and sciences, need to develop competence in the area

of biodiversity to train people and generate knowledge in this field. Public institutions need to develop an understanding of the issues related to all aspects of policy, particularly research and economic policy, so that meaningful planning can be undertaken.

A failure to assign the highest priority to strengthening institutional capacities in biodiversity in the country will deny it the opportunity to build a stake in and commitment to biodiversity preservation, which is a prerequisite to long-term success in protecting biodiversity. Institution building per se probably merits being assigned a high priority in the national biodiversity initiative.

Teaching and research on biodiversity conservation should be introduced in the faculties of science and agriculture in the Syrian Arab Republic, and research should be strengthened in the national, regional (ACSAD) and international (ICARDA) centres, established in the Syrian Arab Republic. Cooperation among these centres should be encouraged at the national, regional and international levels.

It is highly recommended to strengthen the national biodiversity entity in the Ministry of Environment, which would catalogue the national biodiversity, consolidate a database and provide training opportunities for professionals for the multitude of tasks that the strategy will outline. This entity would serve as a catalyst for integrating biodiversity conservation into the national planning process.

It should be noted here that international cooperation in the biodiversity conservation must be linked to national planning, to incorporate biodiversity concerns into national development plan.

G. STRATEGY FOR SUSTAINABLE LAND MANAGEMENT AND SOIL CONSERVATION

The overall objective of land and water policy must be to ensure optimum land use and to reverse the current trend in land degradation. The soil conservation, should therefore include the following programmes:

(a) Develop land use planning and allocation based on land capabilities rather than on settlement zones;

(b) Encourage farmers to grow crops according to comparative advantage. This would lead to a shift in cropping patterns towards high-value crops, provided efficient use is made of water;

(c) Review existing production incentives and bring them into line with the resource conservation policy. For example, production subsidies can be directed to farmers adopting environmentally sound technology and production practices. In other words, it may be pertinent to introduce the principle of cross-compliance into the subsidy scheme;

(d) Shift the focus of policy reform in agriculture from food self-sufficiency to food security by establishing a market-oriented competitive sector based on principles of the sustainability of natural resources (especially water and rangelands) and protection of the environment. It is expected that correcting relative agricultural commodity prices and providing for greater private-sector involvement would contribute to improving rural income and to the sustainable development of the sector in the long run;

(e) Establish a regulatory framework. Reducing wind and water erosion and other types of soil degradation depends on the capacity of the national Government to establish and properly implement and enforce clear laws and regulations that promote the maintenance and use of natural resources. Changes are required in land tenure policies and other relevant policies, especially in badia and marginal lands to address the problem of common property access for grazing and digging wells;

(f) Future credit policy should encourage access to institutional credit for conservation practices, that include promotion of water saving operations and technologies such as land leveling, adoption of sprinklers and micro-irrigation.

A national strategy oriented to combating soil degradation and promoting sustainable production systems in the different agroecological zones of the Syrian Arab Republic is urgently needed. The basic elements for such strategy are outlined below:

1. *Salinity and waterlogging control*

The strategy for salinity and waterlogging control in irrigated areas should be based on the following essential elements water use efficiency, monitoring water use and quality, and water resource management.

(a) *Water use efficiency*

See sub-heading 3 (a) (*Water erosion*) below;

(b) *Monitoring water use*

Action is required in five areas:

(i) Providing adequate drainage, where necessary, for all new or rehabilitated irrigation projects or structures;

(ii) Introducing groundwater monitoring and water balance studies to predict drainage requirements;

(iii) Encouraging conjunctive ground- and surface-water use to prevent or reduce waterlogging;

(iv) Using pilot projects to verify design and management procedures and to train personnel. For example, The 7th of April Experimental Station at Deir ez-Zor must be replicated in the principal irrigated agro-ecological zones of the country;

(v) Introducing soil salinity monitoring in vulnerable areas by using an integrated system encompassing remote sensing techniques, field checks, geographical information systems (GIS) and expert systems;

(c) *Water quality management*

The strategy should have two main objectives: to prevent non-agricultural activities degrading water quality and to ensure that agricultural activities do not lower water quality. The following actions are required:

(i) Regulatory and market-based mechanisms need to be introduced or improved to encourage more efficient use of fertilizers and pesticides and to minimize water pollution from agriculture and agro-industries;

(ii) Similar mechanisms are needed to limit the contamination of urban/industrial wastewater to allow it to be used for agriculture;

(iii) Pilot projects of proven practices need to be introduced in areas bordering the sea (for example Lattakia, Jableh and Tartous) to ameliorate *or limit the impact of existing or potential salt-water intrusions;*

(d) *Water resource management*

Many of the foregoing strategic actions have an important role to play in water resources management, but they need to be placed within and complemented by a wider strategic framework and by actions of a more specific management nature. The long-term strategies should include the following:

(i) Development of land and water use policies and plans to improve the reliability of supply and maximize biomass production potential under conditions of extremely low rather than average water availability;

(ii) Preventing over-extraction from aquifers;

(iii) Introducing a number of adapted drought tolerant cultivars by long-term breeding and genetic manipulation techniques.

2. *Problems of gypsiferous soils*

As mentioned earlier, the problems of gypsiferous soils in the Euphrates Basin and the badia are of a technical nature. They are not derived from unsuitable technologies, but are rather inherent in the soils being irrigated. The dispersion of the problem of gypsiferous soils throughout the irrigated area makes the resolution of this problem a high priority for the country.

3. *Soil erosion control*

(a) *Water erosion*

The strategy for combating water erosion should be based on sound management of forest lands, rangelands and agricultural lands on steep slopes. Regarding agricultural lands, the strategy should focus on adopting the different methods of soil and water conservation to the local environmental and socio-economic conditions, and to encourage farmers to adopt them through special extension programmes carried out by extension workers well trained in soil and water conservation practices and by providing some incentives.

(b) *Wind erosion*

The strategy for combating wind erosion should be based on sound management of land in arid and semi-arid zones, particularly with regard to the following points:

(i) Stopping grazing in the most fragile areas and in establishing more protected areas;

(ii) Preventing ploughing in the steppe and of marginal lands;

(iii) Adopting legal measures to stop unsound cultivation practices;

(iv) Assessment of the wind erosion problem in order to identify the sources of wind erosion;

(v) Continuous monitoring of the affected lands, by the use of remote-sensing techniques and GIS.

4. *Strategy of fertilizers allocation*

The main principle which governs the current strategy of allocation of fertilizers, enforced by the Ministry of Agriculture is to provide the full fertilizer needs of the strategic crops, which include export crops or import replacement crops such as wheat, cotton and sugar beets. The type of farming is another important factor that affects decisions regarding the allocation of fertilizers, that is, whether it is irrigated or rain-fed. The general principle is that the needs of irrigated crops' in fertilizer should be met in full, since the economic revenue of the rain-fed crops is less than that of the irrigated ones and more risky.

After two decades of fertilizer use by farmers and the experience gained, there is a pressing need for a methodological review of the current fertilizer strategy in the country, which could be based on the following general principals:

(a) The need for an extensive and comprehensive data system to improve agricultural planning;

(b) The pressing need for a methodological review of the level fertilizer applications recommended for strategic crops such as wheat, cotton and sugar beets, as recommendations have not been modified since the 1970s;

(c) Reconsideration of the central planning system for allocation of fertilizers based on a priority procedure which would ensure that strategic crops would get their full need of fertilizers and which would take into account the nature of crop plantation whether irrigated or rain-fed, as the results of recent research have proved the benefit of barley fertilization in dry areas;

(d) Development of an economic framework that would be suitable for evaluating the efficiency of fertilizer allocation through reconsidering the methodology of the current fertilizer recommendations, and hence the orientation of the policies related to the allocation of fertilizers. This would help planners and decision makers to determine the most effective allocation of fertilizers and the distribution of the agricultural inputs system in general;

(e) Following up the levels of various nutrients, particularly nitrogen, phosphorous and potassium in various types of soils under the different agricultural systems and rotations enforceable in the country, and also investigating of the environmental impacts of continuous fertilization including the influence of fertilizer on the properties and productivity of soils and on the quality of groundwater, particularly for nitrogen fertilization;

(f) Despite the current low levels of the use of potassium fertilizers in the Syrian Arab Republic, it is expected that introducing potassium fertilizers into the allocation pattern will become decisive in the foreseeable future due to the expected rapid increase in the use of potassium fertilizer for fruit trees, and due to the significance synergetic interaction among nitrogen, phosphorous and potassium, since the optimal level of each one of them depends on the other two nutrients. Though most of the soils of the Syrian Arab Republic are rich enough in potassium to meet the need of most crops, monitoring the potassium level in soil remains important for the detection of potassium-deficiency symptoms in soil;

(g) The State fertilizer allocation policies should give consideration to the micro elements such as Fe, Cu, Zn, Mn, B and others. It is a certainty that many areas are suffering from severe and chronic deficiencies in these elements or making them available to plants as a result of the soil's chemical composition, such as high contents of Ca CO^3 or high pH;

(h) Providing guidance in the use of fertilizers within the framework of sustainable land management, and giving a special importance to the use of organic fertilizers, whether farm manure, compost or green fertilizers particularly those of legumes, in an attempt to build up the content of Syrian soils of organic matter and consequently to raise the biological activity of such soils.

H. STRATEGY FOR SUSTAINABLE DEVELOPMENT OF WATER RESOURCES

1. *Supply management*

The objective of supply management is to establish an efficient self-sustaining irrigation and drainage system that meets the present and future needs of the agriculture sector. In the future, the agriculture sector will be under increasing pressure to release more water to the domestic and industrial sectors. As surface supply is constrained by water flows from Turkey, greater reliance will be placed on groundwater.

The share of groundwater in meeting total demand for water in 1993 was estimated at 8 Billion cubic metres with the assumption that the maximum water requirement is about 13.450 cubic metres per hectare per annum given a crop intensity of 125%. Comparing the demand with estimated supply of 2.33 Billion cubic metres shows the extent of overpumping taking place. In many regions the pumping depth has already exceeded or is fast approaching the economic limit for most crops, except for some cash crops or crops supported with high subsidies.

Market failure is due to treating irrigation water as a public good; this approach inhibits much needed institutional reforms and the creation of independent, private irrigation institutions. The sustainability and efficient use of water resources require that hidden gains or rents need to be transparent and traded. The system should be driven by supply and demand of water based on a clear relationship between water charges and delivery. Combining property rights with water pricing and if possible developing water markets would provide a clear value of resources use in the Syrian Arab Republic. Substantial gains to sectoral output and income could be made by reallocating water among crops.

The policy question is whether to invest in rehabilitating or improving the old system, with is less than 50% in water use efficiency or to develop a totally different but much more efficient system with a very high return in the long run. The latest technology is expected to increase irrigation efficiency to 75-80% including irrigation methods such as improved surface irrigation and the introduction of pressurized irrigation systems such as sprinklers and micro-irrigation.

The advantage of new irrigation systems are the following: they are easy to operate, reduce operational losses, and provide a more reliable supply of water. Some systems are often more versatile in adverse soil and water conditions. There are also savings in operation and maintenance costs as they use less labour and are suitable for areas where the terrain is difficult. However, such systems need a continuous supply of water, but their high cost deters their use in many cases.

A combination of an open-channel system for larger capacity and a pipe-distribution system for the tail end is likely to provide the most economical solution.

Institutional and legislative reforms must be among the top priorities in order to promote water conservation and reduce water pollution. Institutional and policy actions should include establishing an independent water authority, preparing a coherent water strategy, and identifying and adopting regulatory and economic instruments to conserve water and control pollution.

In some areas, weak legislation has resulted in the overexploitation of groundwater resources. Legislation governing the development and use of groundwater has been enacted poorly in the Syrian Arab Republic. The institutions responsible for enforcing compliance are not well equipped to address the grave situation, and farmers drill wells in spite of legislative restrictions.

2. *Demand management*

Groundwater depletion could be reduced by demand management practices that would include, pricing the resource, more efficient use of water, improving land and water rights, land tenure policies geared to halt land fragmentation and inequitable sharecropping arrangements, and providing better extension services.

(a) *Rationalization of water charges*

Future water pricing should consider the following facts in designing a demand management strategy for the water sector.

(i) Rates are calculated at present on the basis of the size of the irrigated land, not on the basis of the quantity of water utilized. This encourages the utilization of larger quantities of water than are necessary and to an increase in wasted water. Legislation must be changed to reflect the strategic importance of water;

(ii) There is sound economic justification for increasing water charges: the present level and structure do not convey meaningful economic signals to farmers, because these charges constitute a very small percentage (6%-9%) of the overall cost and are not related to the production values. The proposal of this study to double the price of water is well within payment capacity of the farmers. The returns on water under residual budgeting bring the cost to 13%-16%. A review of literature in other countries suggests that water charges should be within 25 to 50 of additional net benefits (NCAER 1959; Harman 1964);

(iii) The current and proposed water charges to cover the O&M cost are well below the returns imputed to irrigation water. The return on water (or its financial value) is more than six to ten times what the price farmer is paying (depending on the crop). It is clear that these water rates are significantly lower than those rationalized under cost or marginal value product criteria. There exits a good rationale to enhance water charges;

(iv) The assessment mechanism is the key to water use efficiency. The institutional costs of the flat rate currently in operation are low compared with the possible option of water-metering or a crop-based assessment. A graduated tariff on water aimed at the rationalization and more efficient use of water is another option open to the Government.

(b) *Other issues of demand management*

The demand management of water resources was not explicitly included in water policies in the past in most of the Arab region, including the Syrian Arab Republic, partly because the focus initially was on expanding the supply and partly because socio-culturally water was believed to be a free good.

Lack of demand-management practices in the past also contributed to low efficiency in water use and consequent waste. In addition, improvement in the availability of water stemming from the past introduction of sophisticated technology diverted attention away from demand management and reduced emphasis on low-cost reduction of waste through maintenance (Qasahu 1993).

TABLE 11. GROSS MARGINS FOR CROPS IRRIGATED WITH WATER FROM DEEP WELLS, SHALLOW WELLS, RIVERS AND GOVERNMENT PROJECTS
(*LS/ha*)

Crop	Rank	Water Requirements per cm	Gross margin per m^3 for deep wells	Gross margin per m^3 for shallow wells	Gross margin per m^3 for river water	Gross margin per m^3 for government projects water	Area
Cucumber	1	15 600	2.72	3.36	3.59	4.04	10 941
Eggplant	2	12 000	2.05	2.88	3.17	3.76	7 436
Cotton	3	10 897	1.44	2.36	2.73	3.51	161 811
Onion	4	9 745	3.60	4.32	4.57	5.19	4 240
Tomato	5	9 311	2.91	3.99	4.36	5.12	22 575
Tobacco	6	8 130	3.96	5.19	5.68	6.60	3 494
Maize	7	7 494	-1.49	-0.45	-0.06	0.79	55 141
Fall potatoes	8	7 296	3.77	5.14	5.69	6.86	2 023
Sugar beets	9	6 779	4.25	5.37	6.24	7.28	17 175
Sunflower seed	10	4 630	1.32	3.05	3.70	5.10	3 899
Soybean	11	4 541	2.14	3.90	4.50	5.99	
Broad beans	12	4 444	3.13	4.71	5.27	6.17	947
Wheat	13	4 018	2.45	4.19	4.81	5.81	21 558

Source: Calculated from ESCWA, *National Farm Data Handbook*, Syrian Arab Republic, 1994, E/ESCWA/AGR/1994/8.

(c) *Improving efficiency in water use*

About 95% to total irrigated area in the Syrian Arab Republic is irrigated by traditional methods, which are easy to operate. Consequently, the average water use efficiency is only 50%. There is considerable scope for improving efficiency in water use if (a) Governments improve their policies and institutions to achieve more efficient operation and maintenance of the existing system; and if (b) more advanced on-farm irrigation technologies such as improved surface irrigation or sprinkler or micro-irrigation, are promoted. Of the modern irrigation technologies, micro-irrigation has the greater potential to conserve 30-50% more than traditional surface irrigation.

(d) *Rehabilitation of the existing irrigation system*

The very low water charges in the Syrian Arab Republic have constrained the Governments from mobilizing the funds required for efficient O&M of the irrigation system. The subsidy on water is the direct result of low water prices which have contributed to the inefficient use of the resource and the poor maintenance of infrastructure. As discussed above, a rational pricing policy should at least meet the operational costs.

The Government is embarking on a comprehensive plan to rehabilitate old projects by providing new irrigation techniques to increase irrigation efficiency and save additional water resources, especially for the

following projects: As-Sin, Homs, Hama. There is no doubt that additional investment for rehabilitating the irrigation infrastructure is required but the question is how much and what the possible returns would be.

In other countries, the marginal benefits of prospective future O&M investments suggest the need to allocate more funds for the O&M of the irrigation system. In addition to producers, who are the direct beneficiaries of O&M services, consumers should also be taxed to generate part of the funds required for O&M activities. The support programmes targeted to favour producers would provide an opportunity to finance O&M through enhanced water charges. Higher water charges would help to bridge the income distribution gap between irrigated and non-irrigated farmers.

Future rehabilitation work should undertake more diagnostic work in the technical, social, economic and environmental aspects to evaluate the existing system to determine the need to rehabilitate the system. Such analysis would require the long-term evaluation of production planning (the cropping pattern), market opportunities in the light of new regional and global economic developments, regional water balances and marginal value of water within the sector and intrasectoral in determining the rehabilitation of the irrigation system in the Syrian Arab Republic.

Although the Government continues to encourage the construction of irrigation networks to enhance overall supply and meet its objective of self-sufficiency and food security, the financial burden has begun to show its cumulative affect. It costs enormous sums of money to undertake new irrigation schemes, old infrastructure needs to be rehabilitated at a prohibitive cost, and funds always fall short of the requirements for maintaining the huge irrigation network. It costs now more than LS 600,000 to develop one ha of land for irrigation. Although this is the financial cost, the economic cost can be at least twice this amount. The policy question is whether to invest in rehabilitating inefficient old systems, yielding efficiency of less than 50% or to develop a completely different but much more efficient system with very high returns in the long run.

(e) *New irrigation schemes*

In the design of new projects, the latest technology can increase irrigation efficiency to 75-80%. These savings can be achieved by increased efficiency of the irrigation method, such as improved surface irrigation and the introduction of pressurized irrigation systems such as sprinklers and micro-irrigation. The best option would be to shift to joint utilization of groundwater by constructing pressurized irrigation networks equipped with gauges to control the amount of water drawn annually from ground sources. This could help reduce the number of wells and save energy. The credit policy could be reoriented to provide loans for investment in developing new irrigation techniques and methods.

The Government has already taken steps towards developing sprinkler and drip irrigation systems. In fact, these techniques are already being used in new projects, as well as in some old rehabilitated ones. The area irrigated by those new techniques amounts to a total of 71,000 hectares in different projects. It is to be noted that private sector has already invested in introducing drip irrigation in about 2,000 hectares and sprinklers in 35,000 hectares. The Government has also established a revolving funds to encourage the use of improved irrigation methods by importing sprinklers and localized irrigation systems, and distributing them to the farmers. The programme so far had limited success owing to excessive cost compared with other systems, and the lack of extension programmes to support and promote the new technology. In sum, adopting modern irrigation techniques remains the only option to develop sustainable agriculture and preserve scarce resources of water.

I. STRATEGY FOR SUSTAINABLE DEVELOPMENT OF RAIN-FED AGRICULTURE

With inadequate and erratic rainfall predominant in all of its land area, particularly in semi-arid and arid areas, the productivity of rain-fed agriculture is extremely unpredictable in the Syrian Arab Republic. However, it could be improved by better management of the natural resource base, which is very fragile, particularly in the sloping areas subject to erosion and in semi-arid and arid areas where wind erosion predominates and desertification is expanding.

There is an increasing realization that the rational use of natural resources is essential for the sustainable development of rain-fed agriculture in the Syrian Arab Republic. The following development objectives are proposed to improve rain-fed agriculture:

(a) Paying more attention to economic efficiency in the allocation and utilization of agricultural resources;

(b) Encouraging public- and private-sector involvement with natural resource conservation and development efforts in rural areas;

(c) Encouraging public and private-sector investment;

(d) Curbing urbanization encroachment on prime agricultural lands;

(e) Providing an integrated package of services to on-farm activities.

Achieving these objectives should be based on appropriate strategies and policies, which would pay greater attention to the conservation and improvement of the agricultural resource base and to the sustainability of production systems in the rain-fed areas.

Strategies for sustainable rain-fed agricultural development should be based on the following:

(a) Designing programmes to support soil and water conservation in the public and private sectors in cooperation with the soil and water departments in the Ministry of Agriculture and Agrarian Reform, the Directorate of Agricultural Research, the universities, ACSAD and ICARDA;

(b) Developing an integrated programme for grain/forage/livestock production in the Syrian Arab Republic which offers a great opportunity for increasing cereals and food legumes production, forage and livestock production, while at the same time reducing pressure on rangeland, thus conserving natural resources and combating desertification;

(c) Strengthening positive trends and providing incentives to attract greater participation by the private sector in natural resource conservation and development efforts;

(d) Strengthening research on sustainable production systems in rain-fed areas through collaboration among national institutions (ministries and universities), ACSAD and ICARDA.

(e) Encouraging fruit production in sloping areas to replace cereals in the suitable environments, taking into consideration soil and water conservation and supplemental irrigation possibilities.

(d) Encouraging sustainable supplemental irrigation in rain-fed agriculture. However, research should be strengthened and measures should be taken to ensure the efficient and rational utilization of groundwater resources;

(g) Exploiting the potential of barley production in the more favourable agroclimatic zones. ICARDA research has shown that barley yields are higher than wheat yields in rainfall areas of about 300 mm/year (280-380 mm/year);

(h) Replacement of fallow by legumes in the cereals fallow rotation and replace the cereals-cereal rotation with cereals-legumes rotation. Long-term trials in ICARDA have demonstrated that, at the same level of fertilizer application, barley-forage legume rotation produces up to 70% more dry matter and 100% to 200% more plant protein than barley-barley rotations. Further, cereals-legumes rotations have been shown to increase soil organic matter and nitrogen levels compared with continuous cereal production;

(i) Encouraging the use of fertilizers on marginal and rain-fed lands in order to increase their productivity on a sustained base (see policy action for rain-fed agriculture).

J. Strategy for sustainable development of steppe rangelands

Decades of overuse and mismanagement of the steppe by overgrazing, uprooting of shrubs and cereal cultivation has left much of the Syrian steppe rangelands affected by widespread degradation and low yield compared to their original production. Desertification is also progressing year after year.

There is a strong consensus among politicians and technicians that the Syrian steppe rangelands have reached the point where a decision must be made either to commit the necessary investments to reverse the desertification trends and move toward sustained productivity of the rangelands, or to maintain the present practices, which would result in further land degradation and desertification of the steppe rangelands. The productivity of the vast majority of the degraded lands in the steppe could be improved, and in some cases restored, by an integrated programme of rangeland improvement and management, and of improved livestock management and husbandry. Rehabilitated rangelands would contribute not only to improved and sustained forage and livestock production, and to halting desertification, but also to the improvement of the quality of the environment.

It should be emphasized that any serious development objectives for the steppe rangelands in the Syrian Arab Republic should be based on the realization that continued overgrazing and the uncontrolled movement of livestock are the root causes of the rangelands' degradation.

The broad objectives of a steppe rangeland strategy would be the following:

(a) Improve the economic, social and cultural conditions of the people inhabiting the steppe and depending on these rangelands for their living;

(b) Halt as soon as possible the degradation of rangelands and reverse as much as possible the desertification trends;

(c) Improve rangeland productivity and stabilize, forage and livestock production;

(d) Enhance the quality of the environment for the welfare of the people living in the steppe.

There is much that can be accomplished, with relatively small investment, to combat desertification, arrest the accelerated rangeland degradation and improve the production capacity of the steppe in the Syrian Arab Republic. These objectives could be achieved by adopting and implementing carefully drafted policies aimed specifically at finding solutions for problems affecting the rangelands and related resources. In the development of such policies, full consideration must be given to their economic and social aspects and to their environmental impacts.

K. STRATEGY AND POLICY FOR SUSTAINABLE DEVELOPMENT OF FORESTS

Forests have played an important role in the Syrian Arab Republic from the ecological, economic, social and cultural points of view. Presently, the Syrian forests are degraded due to overexploitation, overgrazing, deforestation and fire and are in need of rehabilitation; they should be managed on a sustainable basis.

The contribution of forestry production (industrial wood, firewood and charcoal) has only minor significance in the GDP of the country, and the Syrian Arab Republic is a net importer of wood and wood products, producing 5%-6% of its requirements. However, the real value of forest services, benefits and influences is difficult to quantify, and they should not be underestimated in a country as arid as the Syrian Arab Republic, where the forests provide stable feed resource for a large number of grazing animals and play a significant role in water catchment, desertification control prevention of soil erosion and flooding, and conserving biodiversity.

The need for forestry functions and outputs is increasing with the expanding population. For this reason, conservation and sustainable development of these forests have now emerged as a priority item in the context of conservation and sustainable development of renewable natural resources in the Syrian Arab Republic. The challenge will be to reconcile the role of forests in meeting national socio-economic objectives as well as environmental objectives. It should be mentioned here that, ecological considerations should be viewed not as subordinate, but as an integral part of economic policy and planning.

Sustainable development of forest lands and its multiple economic and environmental values involves maintaining indefinitely, without unacceptable impairment, the productive and renewable capacities, as well as the species and ecological diversity of the forest ecosystems found in the Syrian Arab Republic.

The formulation of strategy approaches to sustainable forest development requires the harmonization of human activities with the biological and physical aspects of forest ecosystems. Human activities and forest ecosystems as well as the interactions between the two are dynamic and change over time and space. Consequently, monitoring the two systems and their interaction is crucial when practicing sustainable forest development, and it involves a number of ecological, socio-economic, technological and political considerations.

The challenge of practicing sustainable development of forests may be pursued through number of specific actions, including research and extension, education, legislation, forest and environmental policy, forestry practices and management, which are discussed in the policy action programme in the next chapter.

A basic principle of the strategy for sustainable forestry development would be the incorporation of the social dimension into the forestry sector through the use of social analysis, which describes and analyses the potential effects of planned interventions upon people living in forest areas.

The forestry department should encourage the active participation of the local people in the social analysis of projects in the forestry sector: forest management, protected areas, plantations, combating forest fire and forest degradation.

Although the present policy reflected in the forest legislation provides the basis for the protection of forest lands, there is no well-defined and officially announced or adopted national forest policy in the Syrian Arab Republic, and this is urgently needed.

The following objectives could be taken into consideration in the development of a national forest policy in the Syrian Arab Republic oriented to the sustainable development of forestry:

(a) To dedicate as *permanent forest estate* the present forested areas strategically located in the different ecological zones of the country, in accordance with the concept of rational land use, in order to ensure the following:

(i) The sound climatic and physical conditions of the country; the safeguarding of water supplies, soil fertility and environmental quality; and the minimization of damage by floods and erosion to rivers and agricultural land. Such forest lands would be known as *protective forests*;

(ii) The supply in perpetuity, at reasonable rates, of all forms of forest produce which can be economically produced within the country and which are required for agricultural, domestic and industrial purposes and for export. Such forest lands would be known as *productive forests*;

(iii) The conservation of adequate forest areas for recreation, education, research and protection of the country's unique flora and fauna. Such forest lands would be known as *amenity forests* and *protected forests;*

(b) To manage the permanent forest estate with the object of maximizing social, economic and environmental benefits for the nation and its people in accordance with the principles of sound forest management;

(c) To pursue a sound programme of forest development through regeneration and rehabilitation operations in accordance with approved silvicultural practices in order to achieve maximum productivity from the permanent forest estate;

(d) To promote efficient exploitation of forest and to stimulate the development of appropriate wood-based industries with capacities commensurate with the resource potential in order to achieve maximum resource utilization and create employment opportunities;

(e) To undertake and support an intensive research programme in forest development aimed at improving the yield from the productive forests, obtaining the maximum direct and indirect benefits from harvesting and utilization and, above all, providing the maximum protection to and conservation of the resource base and obtaining the maximum yield from productive irrigated plantations;

(f) To undertake and support a comprehensive programme of forestry training at all levels in the public sector in order to ensure an adequate supply of trained labour to meet the requirements of forestry and wood-based industries.

The national forestry policy should be supplemented by specific guidelines to ensure sustainable forest management and development.

L. STRATEGY FOR RAISING PUBLIC AWARENESS

It is of high priority in the Syrian Arab Republic to increase public awareness of environmental issues and of the relationship between safety of the environment and sustainable development. Also of high priority are ways and means of increasing public participation in the conservation and protection of renewable natural resources. In this regard the following should be considered:

(a) Communication networks should be established by the Ministry of Environment in cooperation with other concerned ministries, and efforts should be made to raise consciousness and convert the general public into environmental advocates;

(b) Government and businesses should begin training their staff to take account of natural resources conservation and preservation of the environment in their respective professional disciplines. This is necessary to introduce and sustain the concept of sound and sustainable natural resources management at all levels;

(c) Educational television and radio programmes oriented to the general public should be developed in collaboration with professionals working in environmental conservation and management on topics such as desertification, land degradation, biodiversity, and soil and water conservation. For this reason, a training programme on broadcast journalism for press staff should be developed in natural resource conservation and management by the Ministry of Information in collaboration with other concerned ministries. The Ministry of Information has a crucial role to play in formulating a national policy to raise public awareness in the conservation of natural resources;

(d) Non-governmental voluntary organizations should be encouraged to expand their membership and activities. Such organizations are often well-suited to raise awareness about natural resource conservation and environmental issues in general, as well as soliciting community participation and advocate reform.

M. STRATEGY FOR BUILDING INSTITUTIONAL CAPACITY IN ENVIRONMENTAL CONSERVATION AND SUSTAINABILITY

In the past, the Syrian Arab Republic did not generally give the sustainability of renewable natural resources a high priority in its strategy for development. The country is now beginning to recognize that safeguarding renewable natural resources is central to achieving economic, social and cultural development, which makes the Government, business and the general public all responsible for the preservation of the environment as a whole.

It should be highlighted that any offence against natural resource conservation and the environment must be taken as seriously as a civil offence, because it depletes the country's resources and undermines the quality of life. The challenge ahead, therefore, is to direct the nation's energy toward changing prevalent attitudes in renewable natural resources management and assuming a constructive role in creating a better and more productive environment for the present and future generations.

There is an urgent need in the Syrian Arab republic to develop motivated, well-informed, well-educated and well trained human resources in environmental issues and sustainability, as well as capable national institutions, which are very important elements for fostering progress toward achieving sustainable development and natural resources conservation.

A programmatic approach to instil civic consciousness, raise awareness and attain scholarship and develop professionals in environmental issues needs to be carefully orchestrated to achieve the desired results, as follows:

(a) It should be emphasized that the education system in the Syrian Arab Republic must undergo a shift of emphasis. The new stress must be not so much on producing an *educated person* as on producing an *educable person* who can learn and adapt himself efficiently all through his life to an environment that is ceaselessly changing. If an education system is not adaptable to changing environmental conditions, how can it be expected to produce people who are?

(b) Conservation and the sustainable management of renewable natural resources, in addition to environmental concerns in general, should be integrated into the educational and research systems;

(c) Gaps in approaches to formal environmental education in primary and secondary schools and universities should be identified;

(d) Gaps should also be identified in the approaches in curricula oriented to the management and conservation of renewable natural resources at the university level, particularly in the faculties of agriculture, sciences, civil engineering (department of irrigation), medicine, Veterinary medicine;

(e) Plans should be formulated to revise curricula in order to incorporate the concept of sustainable development and sustainable conservation and management of renewable natural resources at the primary and secondary school level and at the intermediate institute and university levels;

(f) Ways and means for improving and expanding environmental education need to be identified;

(g) Professionals must be trained in priority areas in the different subsectors of agriculture; these areas should be oriented toward sustainable development and the sustainable management of renewable natural resources, particularly in the Ministries of Agriculture and Agrarian Reform, Irrigation, Environment, Planning, Social Affairs, Higher Education, and Culture. FAO, the United Nations Environment Programme (UNEP), and UNESCO could assist in this matter by providing expert advice and by financing projects;

(h) Research in the domain of natural resource conservation and management and sustainability of production systems should be encouraged in the concerned ministries, according to a national policy, and should be oriented to sustainable development. This recommendation is developed under "Orientation of agricultural research to the sustainable use of agricultural resources" below.

(i) Owing to the lack of trained professionals in the field of environmental impact assessment (EIA) in the country, and in order to develop guidelines for an EIA programme in the agricultural sector, it is recommended that the Supreme Council for the Safety of the Environment, in conjunction with the concerned Ministries (Agriculture and Agrarian Reform, Environment, Irrigation, Health, Higher Education, Planning, Labour and Social Affairs) host two workshops on the definition and principles of EIA (two to three days for each workshop). These workshops should be for upper- and middle-level managers in the ministries concerned. A third workshop should be hosted by MAAR for mid-level managers and key professional staff (see action programme for details concerning these workshops in the next chapter).

N. STRATEGY FOR ORIENTING AGRICULTURAL RESEARCH TO THE SUSTAINABLE USE OF AGRICULTURAL RESOURCES

Agricultural research is the key to generating more agricultural production to meet demand in the decades ahead in the Syrian Arab Republic. It is also a key element in redressing many of the problems associated with poverty and environmental degradation. Research on high-potential irrigated sector will continue to be essential for increased production needed to feed rapidly growing urban populations, for agricultural exports, and for achieving sustainability of these intensive production systems.

However, focusing research resources on irrigated areas is no longer enough. Research on rain-fed areas must be expanded. The "better" rain-fed areas in terms of potential for agricultural production will need to continue more and more to natural production as demand outstrips agricultural growth in irrigated areas. The poorer rain-fed areas, which are often prone to droughts and which have fragile soils, face severe natural resource degradation and major efforts will be needed to improve productivity in these areas.

It should be highlighted that research in agriculture should always be planned and conducted with a sustainability perspective. The successful management of agricultural resources need to satisfy changing human needs while maintaining or enhancing the natural resource base and avoiding environmental degradation. This principle should not be forgotten when approving any research project, and it is highly important to incorporate the sustainability issue into the research project proposal.

The real challenge in agricultural research in the Syrian Arab Republic should be to create, to the greatest extent possible, a proportionality factor linking output to input. Thus, nutrient cycles need to be closed as much as possible, and biological processes central to the system should be utilized, where feasible, in preference to chemicals and other external inputs. Biological control of agricultural pests, or integrated pest management, should also be utilized in place of chemical pesticides.

Nevertheless, these adjustments, however individually sustainable, are unlikely to ensure sustainability of the production systems, particularly in less favoured environments, unless due regard is paid to the resource base.

The sustainability perspective in agricultural research if adopted in the Syrian Arab Republic would impose the following orientation:

(a) Research would have to be undertaken at different agro-ecological zones of the country due to the agroclimatic and social diversity, which implies close coordination among national, regional (ACSAD) and international (ICARDA) centres in the country;

(b) The research itself would be at the farming system level and would aim at improving farming and resource management systems rather than at improving specific commodities; it would involve greater participation of farmers in the research design and would likewise require a multidisciplinary approach;

(c) New modalities for making full use of research results should be established. Farmers and local communities need incentives and means to adopt improved technologies and farming practices, because the adoption of such technologies and farming practices is more complicated than continuing on with conventional agricultural technologies and traditional practices. This would require significant policy and institutional changes, investment in rural infrastructure, and the active involvement of local communities. Success would depend on the development of stronger linkages among agricultural researchers and other agents of change, including extension workers, local administrators, farmers, community leaders, non-governmental organizations and national policy makers. The research community in the Syrian Arab Republic has little experience in developing these kinds of linkages, and foreign expertise in this regard will be needed;

(d) The new priority given to the resource base conservation and sustainable development would require the development of research programmes on resource conservation and land and water management;

(e) Research priorities need to be identified by integrating information on environmental conditions and their variability in time and space. Ecology, climatology, geography, ecophysiology and other resource-based disciplines must play greater roles in sustainable agricultural research and development. The

agro-ecological characterization approach would be the best conceptual framework to integrate these different disciplines and to enable them to interact effectively and contribute to the progress toward sustainable agriculture;

(f) The socio-economic factors should be given more attention in research on production systems. No measures proposed to conserve natural resources and improve agricultural sustainability can succeed if they do not take account of socio-economic conditions of the farming community;

(g) A database should be developed for better-informed decision making;

(h) The move to research on sustainability of agricultural production and cross-sectoral planning would require the government to restructure its research system in order to accommodate the new concepts and to link agricultural research to sustainable development. Certain research entitles may have to be merged to eliminate duplication. Organizational changes will also be required to unify planning and priority-setting across the entire research system;

(i) As mentioned earlier, there is evidence of severe soil degradation, erosion, groundwater depletion, forest and rangeland deterioration in the Syrian Arab Republic. For this reason, natural resource conservation and management should be taken seriously. The longer action is postponed, the greater the risks of environmental and food crisis for the present and coming generations. Research to prevent environmental degradation in the short term is less costly than rehabilitating degraded agricultural soils, forests and rangelands. Furthermore, natural resource management research and conventional commodity research can complement each other; research on how to protect the environment and its resources does not necessarily have to come at the expense of increased production.

VI. PROPOSED ACTIONS FOR THE SUSTAINABLE DEVELOPMENT OF RENEWABLE NATURAL RESOURCES

A. RATIONALE

The Syrian Arab Republic is deeply concerned about the sustainable use of its renewable natural resources and the quality of the environment, which are the base for a sustainable development for both present and future generations. The challenge of practicing sustainable development, particularly in the agriculture sector, has been discussed previously in the context of national strategies and policies aimed at conserving the renewable natural resources and enhancing their productivity, in order to meet the future food needs of a growing population without degrading the environment. The practice of sustainable development includes policies, legislation, research and extension, education and training, integrated management of natural resources and environment impact assessment, in addition to sectoral action in the different subsectors of agriculture (rain-fed agriculture, irrigated agriculture, forestry and range).

The following presents a specific, sectoral policy action programme oriented to the development of renewable natural resources in the short, medium and long terms in the Syrian Arab Republic. An idea for a specific project is provided, that if developed, could facilitate the implementation of the action programme.

B. INSTITUTIONALIZATION OF ENVIRONMENTAL IMPACT ASSESSMENTS IN THE AGRICULTURAL SECTOR

No institution in the Syrian Arab Republic has an environmental impact assessment (EIA) programme, or any experience in producing EIA. The Supreme Council for the Safety of the Environment should have the responsibility for setting EIA programme requirements and standards and for monitoring compliance within a national framework. A specific EIA procedure is urgently needed in the agriculture sector and should be incorporated into the agricultural decision-making process, which would help in making identification of a timely negative environmental issues, designing environmental improvements into projects, and avoiding, mitigating, or compensating for adverse impacts.

Owing to the lack of trained professionals in the country in the field of environmental impact assessment, it is recommended that the Supreme Council for the Safety of the Environment, in conjunction with the concerned ministries (Agriculture, Irrigation, Health, Planning, Environment, Social Affairs, Higher Education) host two workshops on the definition and principles of EIA (two to three days for each workshop) as follows:

(a) The first workshop should be for upper- and middle-level managers in the ministries concerned. The purpose of this introductory workshop should be to develop a shared understanding and definition of EIA;

(b) The second inter-ministerial workshop should be attended by the same individuals who participated in the introductory workshop, and should apply the understanding of EIA to the development of procedural and content of guidelines for EIA in the agricultural sector.

The Supreme Council for the Safety of the Environment should be responsible for finalizing these guidelines, in consultation with the participants in the workshop and the relevant ministries.

After these two workshops, each ministry should incorporate these guidelines into its own decision-making process. FAO, UNEP and UNIDO could assist in the organization of these two workshops, which should be based on case studies (hands-on training).

A third workshop (two to three days) should be hosted by MAAR for mid-level managers and key professional staff, to recommend specific mechanisms for incorporating EIA into the decision-making of the Ministry. The third workshop would constitute the first step in implementing the guidelines for EIA within MAAR, in order to develop a common understanding and definition of EIA among ministry staff.

The third workshop should conclude with the presentation of guidelines for EIA developed by the second inter-ministerial workshop. Once a common understanding of EIA is developed and procedure and guidelines are established, MAAR should incorporate those procedures and guidelines into its making-decision process, after these are reviewed and approved by the Supreme Council for the Safety of the Environment.

C. Creation of a database for EIA in the agricultural sector

Adequate environmental impact assessments are possible if appropriate quantitative data are available on projects and programmes in the agricultural sector. It is highly recommended that relevant environmental data be compiled through the use of modern equipment and qualified staff to provide necessary information upon request. Such a database would be important in initiating EIA's in project design and in monitoring compliance with mitigation measures[1] at later stages (with data analysis that could provide environmental monitoring targets).

D. Setting up a department of environmental evaluation and monitoring in the Ministry of Agriculture and Agrarian Reform

This department would be responsible for reviewing annual plans and project proposals for compliance with EIA requirements. The specific tasks of this department should include the following:

(a) The department should report the result of its review of projects to the Undersecretary and the Minister;

(b) The department should have a consultative function with the Ministry of Environment, the Ministry of Planning and the Ministry of Irrigation;

(c) The department should also be a source of information on other government agencies and private institutions with regard to their capabilities to assist in EIA.

The head of the department and his staff should be trained in environmental impact assessment. The type and level of training should be determined on the basis of responsibility. The staff should also participate in the proposed workshops mentioned earlier.

It should be mentioned that both compliance monitoring and impact monitoring are critical components of any EIA programme. To implement its EIA programme, the Ministry of Agriculture will need to develop an environmental impact monitoring programme, which should have both a compliance and impact component.

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[1] Mitigation measures are measures taken to avoid, minimize, rectify or reduce the environmental impacts of a proposed action, or to compensate those affected.

The purpose of compliance monitoring is to ensure that mitigation measures developed in EIA are actually being implemented. Each Department within the Ministry of Agriculture should be responsible for conducting compliance monitoring on its projects.

The purpose of impact monitoring is to determine if mitigation measures are performing as predicted. Because the information generated from impact monitoring will be of use to the Ministry as a whole, it should be conducted under the supervision of the department of environmental evaluation and monitoring.

E. PRIORITIZING ENVIRONMENTAL ISSUES IN THE AGRICULTURAL SECTOR

In order to improve the tentative prioritization of environmental issues for the overall agricultural sector and for each subsector of agriculture (rain-fed agriculture, irrigated agriculture, forestry and range) outlined in this report, a study should be conducted in the near future using multi-objective analysis, which has proven to be very useful, especially in natural resource policy analysis. The analysis should use the following five criteria: human and animal health, irreversibility of processes related to the issue at hand, the rate of degradation, the geographic extent of the area where the impact of the given issue is detected, and socio-economic and cultural impacts.

F. ACTIONS TO PROMOTE SUSTAINABLE LAND USE

1. *Formulation of an appropriate national policy and strategy for land use*

There is an urgent need in the Syrian Arab Republic for the development of an effective national policy and strategy for land use and soil conservation. The results to be achieved are the following:

(a) Identification of irrational patterns of land use;

(b) Identification of ways and means (regulatory, technological and fiscal) for the rational use of land;

(c) Formulation of appropriate national land use plans and a national soil conservation strategy to promote overall sustainable development.

These policies and strategies should be developed by MAAR in close cooperation with the ministries of Environment, Planning, Irrigation, Tourism and reconstruction. FAO and UNEP could assist in this exercise.

2. *Development of a framework of sustainable land management*

Prior to developing a framework of sustainable land management, it is necessary to analyze each component and to evaluate the constraints, the causes of these constraints, the indicators of current unsustainability and the technology needed to attain a certain level of sustainability such analysis will help in the development of the framework.

(a) *Cartographic programme for land capability evaluation*

(i) The framework for sustainable land management would provide a scientific basis for evaluating the environmental impact of proposed land use changes and soil conservation. It has the potential to be used for evaluating land capability when coupled to modern computer technology such as simulation modeling, geographic information systems (GIS), and expert systems, which

integrate all available information about social, economic, agroclimatic, environmental and technical processes. It has the potential to emerge as one of the most powerful tools available for the sustainable management of land. This can be achieved by obtaining reliable data on land resources—including soils, plant cover and climate—which are accumulated in a data base, in order to carry out a land suitability evaluation;

(ii) An analysis of data accumulated would make it possible to set up a series of maps of different scales, showing the capabilities of each land mapping unit and its suitability for type of land use;

(iii) The general Directorate for Soil Research, as yet suggested by previous studies, will have a capacity to undertake land capability evaluation cartography, its development and updating;

(iv) Reviewing and analyzing the current land use data in combination with land capability maps would make it possible to identify the causes of land misuse, such as wrong agricultural practices and other socio-economic factors such as land ownership, land fragmentation, subsidies, water pricing and incentives as indicators of land degradation and unsustained productivity. Once these causes are known, it would be possible to remove or modify them.

(v) Three cartographic levels, aimed at producing the following three types of maps, should be distinguished:

a. Thematic maps: Vegetation including forest and ranges, land capability, land use, drainage density, climate, hydrology and water resources, slope, animal wildlife, human settlement;

b. Processes maps: Water and wind erosion, salinization and waterlogging, human and animal pressure;

c. Final maps of sensitivity, degree of degradation (agricultural land, rangelands and forests), desertification control;

(vi) The multi-stage approach taken would include the use of satellite images, aerial photography and ground realities;

(vii) Recording data on changes in the condition of land resource would give objective information on soil conditions through time. This information, if coordinated with socio-economic data, would lay the foundation for better land use planning.

(b) *Land tenure, land fragmentation and sustained farming*

The Government should assume responsibility in this area and should:

(i) Monitor and evaluate the impact of land fragmentation on land use practices and sustained land productivity;

(ii) Establish a minimum farm size for each class of land use in each agro-ecological zone;

(iii) Introduce legislation to halt the continuous breakup of land below the minimum size for economic viability;

(iv) Revise the land tenure policies of the badia and the marginal lands in order to augment the share of responsibility in common ownership.

(c) *Pricing and incentives for production and conservation*

The Government will need to introduce short- and long-term interventions capable of improving sustainability and land use, including adjusting energy prices, water charges, agricultural and food prices, input subsidies or land taxes, such as:

(i) Reviewing the feed subsidies on barley grain in relation to meat prices, as current price disparities encourage farmers to retain livestock numbers during drought periods. The challenge is to reduce livestock numbers to a level that could be supported by the steppe during periods of below average rainfall;

(ii) Investigating the feasibility of reducing the duty on a range of agricultural inputs that could be used to improve the productivity of land;

(iii) Allowing, as deductions from farm income for taxation purposes, the cost of all works undertaken by single farmers or cooperatives that could enhance to sustainable farming or land conservation.

(d) *Promotion of the extension service in the Ministry of Agriculture*

The activities undertaken by the extension service have been inadequate to counteract degradation. The Government should take the following steps to strengthen the extension service in the area of national resource conservation and management:

(i) Improving the capacity of extension services to provide farmers with information that would enable them to make rational decisions on better land management practices;

(ii) Providing the extension service with all the technical information it requires and establishing formal link between the technical directorate of the Ministry and the extension service;

(iii) Regionalizing the extension service, disseminating information of a local character on the different agro-ecological zones in the country taking into consideration the economic conditions of farmers in these zones;

(iv) Implementing training programmes in soil conservation practices, which would be organized for extension officers on a regional basis.

(e) *Promotion of non-governmental organizations*

Associations and unions of civil groups have recently emerged, with the objective of taking part in the fight against environmental degradation, such as the General Union of Peasants, G.U. of Youth, N.U. of students, G.U. of Women and other Professional syndicates.

Embracing the idea that the environment belongs to every human being allows people to consider that they have the right to share with the State the decisions and control measures related to their environment and that they, therefore, should attempt to take part, through a democratic system of participation in the political decisions concerning those processes that affect the environment.

Unions, syndicates and associations are particularly important as the most effective means of communication with large segments of population, and as an instrument to bring people to work together in preserving land resources. Additionally, they have an enormous value from the point of view of education, not only in terms of the acquisition of knowledge, but also in its diffusion.

(f) *Setting up a general directorate for soil research*

The establishment of a general directorate for soil research would constitute the core of the national land use policy which would improve the capacity of land and land use evaluation in the Syrian Arab Republic. This directorate would have a number of functions, namely:

(i) Undertaking land capability evaluation programmes and providing advice to the Agricultural Planning Council on the potential of each crop in each agro-ecological zone;

(ii) Carrying out the land monitoring programme and reporting annually to the Higher Planning Authority on current land use in the Syrian Arab Republic;

(iii) Advising on the formulation, assessment and revision of land conservation strategies and policy development in coordination with the various ministries;

(iv) Undertaking environmental assessments of proposals aiming at changes in land use; reviewing proposals to change the present land use in the Syrian Arab Republic proposed by any authority, ministry or private institution; and providing advice on alternative land use and on the potential hazards of intended use. This exercise should be done in close cooperation with the proposed department of environmental evaluation and monitoring in the Ministry of Agriculture.

3. *Promulgation of a land and soil conservation law*

A land and soil conservation law should be promulgated by the government, within the overall framework of sustainable land management, whereby studies would be obligatory before performing any work or activity that is expected to affect sustainable development or any of its components.

The spirit of the forest act No. 7 of 1994 need to be extended to land and soil conservation. The necessary legislation would encompass the following aspects:

(a) Incorporation of principles of rational land use and management and conservation of soil resources into appropriate resource legislation;

(b) Designation of responsibilities for formulating urban and regional plans;

(c) Provisions to ensure strict adherence to plans and their implementation, including penalties;

(d) A provision regarding land fragmentation;

(e) Requirements for environmental impact assessments of development projects.

4. *Research*

Research in the field of soil and water conservation and land management is still lagging behind other agricultural research, such as that on crop varieties and the use of chemical fertilizers and pesticides. The

application of chemical fertilizers can hardly be economic in degraded soils. Research programmes should give special attention to soil conservation and sustainable land use management, in order to develop criteria on which environmentally sound technologies could be applied.

Research, is also required on changes in soil characteristics, as result of land use under different crop patterns or agricultural practices.

In the Syrian Arab Republic, agricultural research is entrusted to certain directorates of MAAR. In addition to ICARDA and ACSAD as international and interregional research organizations respectively, there are also some national centers, such as the General Organization for Remote Sensing (GORS), the Syrian Agency for Atomic Energy, SRC-ISAT, and four universities, which carry out different research programmes in specific areas. Some United Nation agencies, undertake studies and research that is usually limited and thematic in its application.

The agricultural research programme carried out by MAAR is impeded by lack of both trained staff and facilities. As a result, it is unable to deal with multidisciplinary research, which is basic to the national soil conservation and land management programme. The chance of success for such a programme lies in a unified corporate multidisciplinary plan for the directorates of MAAR, and in the coordination of all the necessary disciplines, through the National Agriculture Research Council (NARC) proposed later, which would play a major role in programme coordination in the different fields of agriculture research at the national level.

Cooperation between United Nations organizations, such as FAO and UNEP, and the national research teams engaged in the universities, research centres and agencies is an option that should be pursued.

5. *Agricultural extension*

The success of any plan for sustainable land management depends on the confidence which the farmers place in the advice given to them by soil conservationists and/or extension officers. This confidence can only be built up by continuous dialogue and practical demonstrations. The most convincing demonstrations are those which are carried out on the farmer's field.

There is a need to establish a specialized soil conservation service, initially with a small nucleus of extension staff fully trained in soil conservation. This nucleus should be provided with the necessary teaching equipment, survey equipment and machinery to assist farmers in implementing soil conservation programmes which they cannot carry out themselves. The soil conservation extension service would concentrate on areas most in need of help, and at the same time train field staff. The next step would be to establish an organization and set up services throughout the country. Once country-wide coverage has been achieved and soil conservation measures applied, the effectiveness of these measures should be continuously evaluated and revised to introduce improved methods.

There is a general belief that the extension service of MAAR, of more than 600 extension posts in the different agricultural zones, does not appear relevant to the farming community, and not capable of promoting sustainable land management practices.

This is unfortunate, because the agricultural extension service is supposed to be the interface between agricultural research, transferring research outputs and new technologies to farmers and providing them with technical assistance, on its use.

G. Formulation of an appropriate national policy for the rational use and management of water resources

There is an urgent need in the Syrian Arab Republic for environmentally sound management of water resources, with special emphasis on increasing the efficiency of water use in different sectors and on recycling wastewater. A coherent and updated national policy on water resources should be formulated as soon as possible. The following needs to be done:

(a) Identify gaps in water supply/demand and estimate the volume of water use;

(b) Identify and recommend ways and means (regulatory, technological, fiscal) of increasing the efficiency of water use, and of developing water resources in an environmentally sound fashion;

(c) Formulate appropriate national policy and strategy for the rational use of water resources and the promotion of public awareness of the importance of water conservation. These policies and strategies should be developed by the Ministry of Irrigation, in close cooperation with the Ministries of Agricultural and Agrarian Reform, Environment, Industry, Planning and Construction;

(d) Chart a comprehensive water map for the Syrian Arab Republic to be used in integrated development plans for water resources, especially for the long run.

Under the semi-arid climatic conditions in the Syrian Arab Republic, rain-fed yields of wheat (which is the principal food staple) are low and highly variable. However, because of supplemental irrigation, the average yield on "rain-fed" land has increased from 1.07 tons per ha to over 3.5 tons pert ha (Salkini 1992). However, ignorance of the crop's water requirements, poor management practices, the low efficiency of many irrigation systems and the generally low cost of water have led to overpumping and excessive water use.

Groundwater in the Syrian Arab Republic is a limited and valuable resource, and expanding the irrigated area for increasing production is crucial. Therefore, the concept of optimum efficiency in water use is vital to the country for the maintenance of productive and sustainable agricultural systems. Thus, water resource planning and use should be viewed from a long-term perspective. According to Wakil (1993), a water crisis at the national level will occur by the year 2000, and by the year 2030, an estimated water deficit of about 5.5 billion m^3 (or 26% of currently readily available water resources) is expected, putting severe constraints on economic and social development. Measures to ensure the efficient and rational utilization of water resources are urgently needed. Research should be developed on promoting and transferring improved supplemental irrigation technologies by the Ministry of Agriculture, in collaboration with ICARDA, which initiated such research in 1986.

Research should also show the impact of water price fluctuations on the optimal rate of supplemental irrigation and the optimal production levels of wheat under input/output price situations.

At present, water from public irrigation schemes (surface) is provided virtually free of charge to users, and groundwater costs do not reflect their real value because the energy required for pumping is obtained at a subsidized price. As a result, most farmers tend to over-irrigate. Research conducted jointly by ICARDA and the Ministry of Agriculture and Agrarian Reform has shown that the amount of water used in supplementary irrigation for wheat is up to three times the optimal rate defined by research trials. With the drying up of some aquifers and the continuous lowering of water table in many others, effective measures to control the overpumping of groundwater need to be identified and adopted. Such measures include the following:

(a) Controlling unlicensed digging of wells;

(b) Review the price subsidy system;

(c) Taxing water pumped in excess of a specific quota;

(d) Improving irrigation efficiency by reducing water losses;

(e) Demonstrating simple scientific methods of scheduling supplementary irrigation to farmers.

It should be mentioned here that the last measure is a major technology transfer objective of the ICARDA/the Ministry of Agriculture and Agrarian Reform supplementary irrigation project high is now being implemented, but it needs to be strengthened and generalized in the supplementary irrigation zones.

H. ALTERNATIVES TO CHEMICAL FERTILIZERS AND CHEMICAL PESTICIDES

1. *Chemical fertilizers*

A programme of action should be launched by the Ministry of Agriculture and Agrarian Reform to encourage Syrian farmers to use more organic fertilizers to complement chemical fertilizers.

Crop residues and farmyard manure are potential sources of soil nutrients. They improve the soil's fertility and the water-holding capacity, augment soil resistance to water and wind erosion, prevent the degradation of the environment (in particular soil and water pollution by chemical fertilizers) and prevent eutrophication of the lakes. There are other benefits as well:

(a) The use of farmyard manure, especially in conjunction with intercropping and crop rotation, can greatly lower production costs;

(b) Natural systems of biological nitrogen fixation through the use of certain annual plants, trees and micro-organisms have a high potential for improving agricultural production at a lower cost;

(c) Overall systems efficiency is enhanced if manure or vegetable biomass is anaerobically digested i biogas plants, yielding energy for cooking and for operating pumps, motors and electric generators.

It should be emphasized that composting is a viable waste processing option for Syrian agriculture, cost effective and environmentally sound. It offers a rudimentary and intermediate technology alternative, and reduces dependence on chemical fertilizers by providing a biodegradable soil conditioner for use in land reclamation, agriculture and landscaping. Compost also provides some nutrients and improves soil structure, help to increase agricultural production and to conserve soil without having to resort to excessive use of chemical fertilizers.

However, this programme of action should be supported by advanced applied and academic research by a multidisciplinary team. Such research could be conducted in cooperation among the Research Center in the Ministry of Agriculture and Agrarian Reform, the various university faculties of agriculture, and ICARDA. Extension service personnel should also be trained in this field.

2. *Chemical pesticides*

A programme of action should be launched by the Ministry of Agriculture and Agrarian Reform to consolidate and promote the strategy applied by the Ministry to decrease the use of chemical pesticides and increase the use of biological control for important crops such as citrus, olive and cotton.

In its programme of action the Ministry should also encourage the use of integrated pest management (IPM) so that pest control in agriculture would be based increasingly on the use of natural control methods. In fact, IPM reduces the need for agrochemicals and would therefore improve the country's balance of payments and release foreign exchange for other uses.

However, IPM requires detailed information about the different pests and their natural enemies, pest resistant varieties, cropping patterns, and farmers who support the approach and are willing to modify farm practices to adopt it. A successful implementation of the IPM approach would require a multidisciplinary research team and a reorganization of the national research system as proposed in the section above on strategy for orienting agricultural research to the sustainable use of agricultural resources.

The most efficient way to promote IPM research would be through formulating and implementing a cooperative research among the National Research Center in the Ministry of Agriculture and Agrarian Reform, the faculties of Agriculture at the Syrian universities, ACSAD and ICARDA. The present research collaboration on IPM should be strengthened and given more weight. Collaboration with advanced foreign research centers particularly those of the Mediterranean region, should be promoted.

Extension service personnel in MAAR should be trained in IPM so that they can transfer this method of pest control to farmers and encourage them to adopt it.

I. ACTION FOR DEVELOPING PROTECTED AREAS AND CONSERVING BIOLOGICAL DIVERSITY

1. *Introduction*

In this report, the concept of protected areas represents an integrated approach to conservation, combining the preservation of genetic and ecological diversity with scientific research, environmental monitoring, education and training. This concept emphasizes the importance of conserving entire, representative ecosystems where evolutionary processes can continue, as opposed to the preservation of single species and their habitats.

The representative aspect of protected areas is not limited to climax or subclimax ecosystems, but applies also to seral and azonal ecosystems, such as man-modified ecosystems, including degraded areas capable of restoration.

Although it would be unrealistic to imagine that protected areas will remain forever, it is nevertheless very important to stress that every measure should be taken to ensure their protection over the long term to enable them to serve as true reference points for monitoring environmental and ecological changes over time, and at the same time to allow the natural evolutionary processes to continue as much as possible.

2. *Importance at the national level*

There is a general lack of awareness at the national level regarding the importance of establishing protected areas and the significance and importance of conserving biological and ecological diversity. For

this reason, there is an urgent need to emphasize the importance of these activities among decision makers and the general public in order to obtain broad-based support for the policy of establishing protected areas and conserving biological and ecological diversity. Broadly speaking, protected areas make important economic contributions by helping to maintain clean air, pure water, a green earth, a balance of creatures and gene conservation of animal and plant species. These functions enable humans to obtain the food, fiber, energy and other material needs they have to survive. Many benefits are unquantifiable, however, and rather like schools, police forces or hospitals, relatively few protected areas are able to capture the "profits" from the benefits they provide for society.

As legitimate public investments, conservation investments are as essential to the welfare of society as those directed towards defence, communications, justice, health and education.

The optimum situation for long-term conservation is obviously to procure the maximum enforced legal protection for as large an area as possible. The difficulty lies in applying appropriate measures when these two conditions are only partly fulfilled. Ensuring long-term conservation then becomes a question of obtaining the support of the people that rule over and live alongside the reserve, and of managing it in a way that meets its conservation objective.

Protected areas need to be understood and supported by both decision makers and local people in order to survive. First of all, it is necessary that people perceive that there is a real problem related to the loss of the biological and ecological diversity, that is, animal and plant species and their habitats, and that they understand the importance of the long-term protection of natural areas. Forestry extension, environmental education and training should address these particular subjects.

At the local level, it is necessary that the people who live near or within the protected area not only understand the objectives of protection, but also help in the effort by actively participating in setting up and running the protected area. They should also, if possible, benefit directly from the protected area, for example by receiving some of the profits from tourism, by selling local produce and handicrafts to visitors, or by being of help in experimenting with other alternatives for development.

It is only when a protected area is integrated into its region and constitutes a positive element in the local society and economy that it can really be ensured a future.

3. *Proposed medium-term action*

The following actions are proposed for the development of protected areas and the conservation of biological and ecological diversity in the Syrian Arab Republic and in the Near East:

(a) Development of a national strategy for the conservation of biological diversity as discussed in the chapter on proposed strategies under the section on strategy for the conservation of biodiversity;

(b) Setting up a national biodiversity entity in the Ministry of Environment composed of members of the relevant Ministries (Agriculture and Agrarian Reform, Environment, Higher Education, Planning, Irrigation). This entity would be responsible at the national level for the issues concerning biodiversity such as strategy and policy for training, research and extension, public awareness, and regional and international coordination;

(c) The accelerated rate at which the biological and ecological diversity in the Syrian Arab Republic is being eroded can be attributed in large part to socio-economic factors that encourage deforestation, range deterioration, forest fires and uncontrolled development while discouraging conservation. For this reason,

action by economists working in conjunction with agriculturists, foresters, pastoralists, ecologists and development specialists should be urgently called for to employ a more meaningful valuation of the real long-term economic loss associated with the extinction of ecosystems or species in the country;

It should be noted here that biological resources are not valued by economists at appropriate prices and that conventional measures of national income do not recognize the drawing down of the stock of natural capital, and instead consider the depletion of resources, that is the loss of wealth, as net income. In general, the economic value of biodiversity is inappropriately assessed and underestimated as a resource. Efforts should be made to develop alternative valuations of biological and ecological diversity that reflect the long-term importance of natural resources;

(d) The depletion of biodiversity in the Syrian Arab Republic is also a result of social processes. For this reason, a study of the causal mechanisms and options for changing current practices might lead to the identification of solutions that could halt and (it is hoped) reverse the depletion. The complex social patterns that are engaged in land clearing, deforestation, dam- and road- building, and logging need to be studied to gain an understanding of the incentives and disincentives that govern social thinking. There is no research or study in this area in the Syrian Arab Republic or in the Near East region, and the probability of formulating effective projects for knowledge is small.

A study is needed on the disincentives that are leading to depletion of biological and ecological diversity in the country, and economic incentives to facilitate the replenishment of this diversity. This study could be enlarged as a regional project to cover the entire Near East and could be assisted by international organizations such as UNEP, FAO and the International Union for Conservation of Nature and Natural Resources IUCN;

(e) Another social aspect of biodiversity preservation that deserves immediate attention is that of indigenous cultures, which possess a great deal of knowledge of the usefulness of natural species accumulated over time. Of particular importance are the popular and traditional medicinal uses of certain species by rural people and nomads whose cultures are disappearing. It is noteworthy that in spite of scientific advances, the active ingredients of most modern pharmaceuticals are still based on natural products. However, pharmaceutical should not be the only focus of these research and information gathering activities. The work should include other practitioner groups such as subsistence agriculturists for unconventional crops and animals, and artisans using natural resources in their crafts. Audiovisual materials could be prepared on the most important plant species surveyed, to be used in television programming and in teaching.

None of the protected areas declared in the Syrian Arab Republic has been established and managed to the international standard required for a protected area, owing to the lack of financial resources to establish a park or a biosphere reserve, the absence of qualified rangers/staff to manage the resources and facilities, the lack of participation from the people living in the vicinity of the protected areas, and the general public's absence of awareness.

4. *Proposed short-term action*

The following action could be taken in the short term:

(a) Promote national public awareness campaigns through the medium of radio, television, seminars, journals, prospectuses and so forth;

(b) Prepare a management plan for each of the declared protected areas. Central to any such plan is a statement of goals and measurable objectives that form the framework for determining what action to

take, when it will be taken and the budget and personnel needed to implement it. The management plan should be preceded by a general survey of the protected area;

(c) Qualify a sufficient number of staff to manage the protected areas through cooperation among ministries and universities in the Syrian Arab Republic and regional and international organizations;

(d) Encourage and upgrade ecotourism. A colorful illustrated booklet on the endangered plant and animal species is highly needed as a practical guide for students and tourists. This booklet could be published through close cooperation among the Ministry of Agriculture and Agrarian Reform, the Ministry of Environment and the Syrian universities;

(e) Strengthen curricula at the universities and at, secondary and primary schools in the fields of conservation of natural resources and biological and ecological diversity, as developed above in the section on strategy for the conservation of biodiversity;

(f) Strengthen research in the same fields in the national, regional and international research centres established in the country (ACSAD and ICARDA) and at the universities particularly in the faculties of agriculture and the faculties of science, in the form of M.Sc. and Ph.D. theses.

(g) Establish botanical gardens in Damascus, Aleppo, Homs, Lattakia and Deir ez zor under the supervision of the faculties of sciences and agriculture of the Syrian universities. These botanical gardens would contain plants becoming rare or endangered (as a protection for the plants) and would be useful for research, teaching and ecotourism;

(h) Promotion of a protected area in Talielah, near Palmyra in the steppe, devoted to the protection of the rangeland and the remnant wild animals and to the reintroduction of wild fauna that have become rare or endangered. A preliminary survey should be done to choose the area to be protected and to select the wild animals to be introduced or saved from extinction, in addition to a detailed study of the physiographic features and the soil, water, climate and natural vegetation. The preliminary survey and study should be done by National Committee under the authority of the Ministry of Agriculture and Agrarian Reform and the ME in close collaboration with the universities, ACSAD, ICARDA and international organizations such as FAO, UNEP and IUCN;

(i) Organization of a regional seminar and training courses on biodiversity conservation for the Near East countries with collaboration among national, regional and international institutions and organizations.

(j) Producing audiovisual materials on biodiversity conservation problems in the Syrian Arab Republic, under the supervision of the Ministry of Environment, in collaboration with Syrian television, the Ministry of Agriculture and Agrarian Reform and the universities (the faculties of sciences and agriculture), as a practical and efficient means of raising public awareness and supporting teaching regarding the conservation of biodiversity.

The ongoing projects on biodiversity conservation in the region could be integrated into a regional project and enlarged in order to embrace the different aspects of biodiversity at the ecosystem and plant and animal species levels. Owing to the importance and the complexity of the studies and research needed in this field in the region, it is recommended that the United Nations organizations (UNEP, FAO) assist the region in the establishment of regional centre for biodiversity conservation.

J. POLICY ACTION FOR RAIN-FED AGRICULTURE

The development objectives of rain-fed agriculture may be realized by implementing policy action comprising improvement of productivity in the different production systems, sound management of agricultural resources, and institution-building.

1. *Improved productivity*

Research strategy should focus on developing modern packages of technology and farm practices and inputs (crop rotations agricultural practices, improved seeds, fertilizer use, soil and water management, supplemental irrigation, and mechanization) for each agro-ecological zone in the country. Profitability and socio-economic conditions as well as the likelihood of their being adopted by farmers should also be taken into consideration.

The use of supplemental irrigation should be encouraged, even in the more favoured agro-ecological zones, such as the coastal regions, through the development of groundwater and surface-water sources. The use of treated wastewater for supplemental irrigation should also be encouraged in the rain-fed areas. In effect, supplemental irrigation would ensure that poor or inadequate rainfall would not result in the loss of production potentials. The application of 1,500 cubic metres of water per hectare as supplemental irrigation in areas receiving 300 mm of average rainfall per year could increase average wheat yields from an average base of 1.2 tons per hectare to about 4 tons per hectare (In Jordan Agricultural Sector Review 1993).

A large, long-term trial under way at the ICARDA Tel Hadya station near Aleppo designed to show the effect of (N) level under a number of crop and pasture rotations with wheat, vetch, medic, chick-peas, lentils, watermelon and fallow, has shown after eight years (Harris 1992), differences in soil N and organic matter under this trial. This trial however, provides the first quantitative measures of the combined effects of rotation and a range of (N) rates of application in the Syrian Arab Republic. Syrian farmers are already aware of the dangers of continuous cereal cropping and the value of (N) fertilizer.

Based on trials in the northern part of the Syrian Arab Republic (Cooper and Bailey 1989, 1991), it was concluded that reducing the areas of barley in the driest zones (more suited to use as rangeland) and improving production on the remaining barley areas through introduction of simple practices such as seed bed preparation, using of seed drills for sowing, use of nitrogen and phosphorus fertilizers, and the maintenance of barley/fallow rotation (rather than continuous barley), has the potential to meet the national livestock requirements in 75% of the years and to increase the stability of production over time. In addition, the introduction of forage legumes in rotation with barley, in place of fallow, would further enhance the national feed supply in all but the driest years.

The Ministry of Agriculture and Agrarian Reform should support farmers carrying out simple on-farm water harvesting methods, including the establishment of impermeable slopes, contour tillage, cisterns and check dams.

2. *Sound management of agricultural resources*

The following action would help ensure that agricultural resources are managed soundly:

(a) Research should be oriented to developing special recommendations for marginal lands within the steppe which could be applied to both steppe and barley-zone condition in order to curb wind erosion and halt desertification. One alternative would be to grow barley in arable strips between rows of *Atriplex* bushes. The shrub hedges, planted transverse to the prevailing wind direction, would provide erosion control and a

grazing resource, while the greater part of the land surface could still produce barley and other feed crops (ICARDA 1991);

(b) Urban and industrial encroachment on prime agricultural lands should be stopped, and urban growth must be managed in such a way that would complement agricultural development. A policy to halt the conversion of agricultural land to urban and industrial uses could include the following:

(i) A survey of the rate of urbanization in the different zones of the country on prime rain-fed agricultural lands, taking into consideration the use to which the converted lands are being put;

(ii) Imposition of a five-year freeze on the expansion of urban boundaries while policies and strategies dealing with this problem are being put in place;

(c) Urban wastewater should be treated and carefully monitored for quality to be used on irrigated land immediately adjacent to urban boundaries;

(d) Land use classification according to the land's capability should be encouraged at the national and departmental levels of the country as a guide for the optimal use of land from the ecological and economic points of view. Any land with more than 75% of its surface covered with bedrock could be used for urban and industrial purposes;

(e) Further fragmentation of land should be discouraged. It is advisable to impose minimum plot sizes according to the production potential of the land for better use of soil and water conservation practices;

(f) Sound measures for soil and water conservation in rain-fed agriculture need to be employed in order to combat water erosion on sloping areas, particularly in the mountains, and wind erosion on flat, windy areas, particularly in semi-arid and arid zones. Different types of soil and water conservation practices should be tailored to each agro-ecological zone, taking into consideration the individual farmer's experience and the ecological factors (rainfall intensity, slope, wind intensity and frequency). A practical guide to soil and water conservation practices could be prepared by the Department of Soils in the MAAR in collaboration with the universities and the regional and international centres in the country.

3. *Institution-building*

The following measures could be taken to build stronger institutions related to agriculture:

(a) Institutional capacity and awareness in sustainable production systems in rain-fed areas are inadequate in the Syrian Arab Republic to meet the enormous magnitude of the task. Education at the universities and research in the national, regional and international centres need to develop competence in this field, to train people and generate knowledge. Several years ago, ICARDA began developing research on sustainable production systems in rain-fed areas. This should continue, in close collaboration with the National Research Center, the universities, ACSAD and ICARDA;

(b) A highest priority should be given to strengthening institutional capacity in the Syrian Arab Republic in sustainable agricultural production in rain-fed areas, through seminars and training programmes inside and outside the country;

(c) A political commitment is essential and needs to be backed by provision of the necessary resources and expertise as well as appropriate legislation in order to develop sustainable production systems

in rain-fed areas. This would be a strong basis for combating land degradation and desertification and for preserving the long-term productivity of the rain-fed areas;

(d) An improvement of the ongoing programme on rain-fed agriculture for extension staff and farmers is highly needed and should be based on the concept of sustainability of production systems.

K. POLICY ACTION IN THE STEPPE RANGELANDS

There is now a strong consensus in the Syrian Arab Republic that the situation in the steppe has reached the point where a decision must be taken either to commit the necessary investments to reverse the desertification process and move toward sustained productivity of the rangelands, or to maintain the present practices, which would ensure further land degradation and desertification of areas that were once stable and productive.

It should be emphasized that any serious action for the development of the steppe should be based on the realization that continued grazing, the uncontrolled movement of livestock and crop cultivation are the root causes of rangeland degradation.

The following policy actions are recommended for sustained rangeland development in the steppe:

1. Enforcing the laws of 1970 and 1973 that are related to the protection of the steppe, and in particular to the prohibition of plowing for cereal cultivation in dry farming, is imperative. This is a very important step that should be made by the Government to arrest the accelerated deterioration of the steppe, stabilize rangeland production, enhance environmental quality, improve the life of the users, and increase meat production. It would be an important means of combating the accelerated desertification of the steppe.

Political decisions are needed to secure grazing rights while forcefully reducing the time of grazing on the range and matching grazing pressure to carrying capacity. The arrangement should consider the national interest of conserving natural resources and enhancing productivity, as well as the interests of the range users, who are likely to continue employing migratory systems to capture the feed value of crop residues in the high-potential zones and the free seasonal pastures of the steppe.

2. The collapse of control over access to grazing resources in the steppe rangelands by a community of users was the single most important reason behind the present disastrous state of affairs. To arrest the pattern of resource degradation, it is suggested to abolish the common property of the rangelands in the steppe, which has led to the present degradation and instead to allocate the rangelands to the hema cooperatives. This policy would guarantee the protection and improvement of the rangelands and ensure a better standard of living for the inhabitants of the steppe.

In other words, it suggests the formation of hema range cooperatives under the control of their members and with control over designated rangelands. Such a system would empower those people who have the most to lose from the disappearance of the rangeland plant communities, and could be a viable replacement for the traditional forms of tribal control. In terms of past experience with common property resource management, the responsible involvement of a homogenous user community is essential for success.

It should be mentioned here that the hema range cooperatives, the main purposes of which are to delineate range areas and limit grazing, are in fact too narrowly based. The main attraction for membership is the purchase of feed or vehicles, and the membership is more concerned with these limited economic interests, rather than with broader economic interests such as marketing activities, or with family and tribal goals in general.

In the absence of a sound, coordinated base of individuals, it follows that those tribal and government programmes aimed at the economic development of the sheep industry and rangelands, together with programmes to establish schools, medical facilities, roads and utilities, are likely to be unevenly or unwisely applied.

3. Sound management programmes need to be applied as soon as possible to stop the accelerated deterioration of the steppe rangelands, using the grazing management unit approach, so as not to interrupt the progress made under the hema range development cooperative system, but rather to facilitate further development, develop grazing plans and at the same time manage rangeland not yet under the control of cooperatives. Each grazing management area would encompass steppe rangeland with similar ecological conditions. It would be contiguous and of a size that would allow ready access for mapping, range surveying, and monitoring of grazing by a staff of range and animal husbandry technicians.

An important function of the grazing management area staff would be the monitoring of unauthorized plowing in the steppe.

4. Feed supply from sources other than rangeland, especially from arable land, should be emphasized.

The most limiting factor for increasing livestock production in the Syrian Arab Republic is feed supply. Obviously, rangeland and marginal land in their present condition can not supply the required feed. Moreover, any improvement programmes on these land, especially seeding/plantation programmes would require animals to be excluded for a period of one to three years. Therefore emphasis will have to be placed on feed supply from other sources, especially arable lands.

Forage production in these lands is expected to have a positive effect on rangeland by making it possible to reduce overgrazing problems and by allowing for the adoption of proper grazing systems. With this forage, it should be possible to take large numbers of animals off the range to be raised entirely on arable lands. At present, livestock move to the range at the beginning of the rainy season, causing great damage to the newly sprouting vegetation. This would not be the case if feed in the form of conserved hay or pasture (medic) were made available on arable land to support animals well through the winter and beyond.

Rain-fed studies at ICARDA (Osman 1990) in 350 mm/year zones of the north indicate that adapted *Medicago rigidula* and *M. noeana* could produce between 40 and 50 kg/DM/ha/day during winter which could easily support 12 sheep/ha. Spring productivity of the same pasture was between 100 and 160 DM/ha/day, providing enough feed for 12 sheep/ha and at the same time allowing for high levels of seed production. The excess spring production could provide for an additional 100 days of grazing in summer, thus carrying 12 sheep/ha for most of the year.

5. The use of fertilizers on marginal lands should be encouraged. Research on the use of superphosphate fertilizers in the northern part of the Syrian Arab Republic, showed that, annual applications of phosphate in marginal lands, even at 25 kg/ha, improved pasture and sheep productivity (Osman et al. 1991). Milk production was also higher on phosphate-treated plots, and the need for supplementary feeding was reduced, especially when rainfall was below average. The work suggested that stocking rates could be significantly increased by annual applications of small amounts of superphosphate. Likewise the use of small seeded local pasture legumes is useful in enriching the seed bank of the degraded marginal lands and in improving pasture productivity. These legumes were found to have high seed recovery after ingestion by sheep (Thompson et al. 1990).

6. Range-based livestock production should be optimized by improving rangeland fodder production and livestock genetics. It is possible to improve the production of the livestock commodities of rangeland through the judicious application of known rangeland management and animal husbandry practices, especially since such knowledge exists in the Syrian Arab Republic.

Close cooperation is required among livestock producers, government institutions and hema cooperatives, with rangeland responsibility and interests.

7. The decline of forage production on local rangeland forces livestock owners to overgraze rangeland and seek other feed sources outside the country to sustain their herds.

A policy should be adopted for regulating border crossing by nomads and livestock in order to promote cooperation and agreement with the neighbouring countries of the Syrian Arab Republic concerning crossing by nomads and livestock and grazing rights.

8. The concept of range rehabilitation should not be restricted to reseeding rangeland, whether or not new species are introduced in the process. In fact, rangeland rehabilitation is not simply a physical and biological question of what has the potential to grow and flourish in the given ecological circumstances. There are numerous examples of protected experimental sites where ground cover has been (re-)established, but from which there has been no productive, economic benefit in term of livestock grazing. Technical inputs without proper use are useless. For this reason, control of access to grazing areas needs to be established and organized before rehabilitation can occur.

9. Research policy should give high priority and more adequate financial resources to the sustainable management of steppe rangeland. Emphasis should be placed on applied research oriented to developing appropriate techniques and to plant and vegetation development for rangeland rehabilitation and productivity. It is also essential to develop reliable low-cost methods that the rangeland users can employ, such as the use of phosphate fertilizer on marginal lands, shrub plantations and so forth.

Added research emphasis should be given to the study of flock management, optimum stocking rates, and plant response to variable grazing practices, as well as to plant palatability and feed value.

It is important to initiate studies on stocking rates, grazing seasons and rotation grazing which observe sheep production rates and range condition trends. Data would be obtained over time, so that reliable systems and methods of grazing could be evaluated economically and put in the form of recommendations to Bedouin sheep raisers in the area.

The research personnel involved in such studies, together with extension service representatives, should determine whether key Bedouin leaders are informed of research plans and should discuss the plans in detail together. This procedure would enhance the chances of the research being relevant to the needs of the sheep raisers, while providing them with incentives to follow the research at it progresses.

The policy question to be faced by the researchers is the optimal balance of veterinary services, animal genetic improvement and better livestock nutrition and management The latter is closely linked to, or part of, crop and resource management because animal nutrition encompasses crop residues and forage crops, native pasture grazing and feed grain and other concentrates.

It should be highlighted that research aiming at developing the deteriorated rangelands should be conducted on multidisciplinary bases and taking into consideration the entire ecosystem with its different constituents; soil, water, vegetation, animals and socio-economic and cultural factors.

It is highly recommended that research on sustainable steppe rangeland development be strengthened in the Ministry of Agriculture and Agrarian Reform and in the universities and close collaboration with ACSAD and ICARDA, which possess a research programme on the development of marginal land and rangeland be promoted.

L. POLICY ACTION IN FORESTRY

1. *Rationale for sustainable forest development*

Policy development must be followed by legally binding norms. National policies, involving greater emphasis on sustainable forest resources development than was previously the case must lead to a systematic review and modification of legislation, whether it specifically addresses forests and forestry or has an indirect impact on forestry.

The new forest law of 20 June 1994 is an improvement of the old one of 1953, particularly in relation to the following: the rights and obligations of private forest owners; afforestation of public and private lands subject to water and wind erosion as well as for the conservation of a particular landscape and the protection of the environment; the establishment of protected forest areas; and the categories and nature of usage rights.

It should be noted that the acknowledgement of forest usage rights contained in the new law should be completed by adequate provisions to protect these rights and to allow their practice in a sustainable manner in specified areas.

Experience has proved that the recognition and institutionalization of communities' rights to have access to the use of forest resources in a sustainable manner is in many cases one of the principal factors determining local interest in maintaining forest cover.

The new law is still of a regulatory nature. The policy makers who shaped it focused on the immediate benefits of the forests and on protecting them from fire, illegal cutting of trees and deforestation. One assumption was that it would be sufficient to regulate the maintenance of the forest cover and prevent destructive utilization practices. Regulatory measures of this kind will certainly remain an important part of the standard pattern of forest law, but there is ample evidence that implementation of a comprehensive, sustainable forest management policy cannot be ensured exclusively through such measures. It is necessary to integrate the principle of sustainability more consistently in the forest laws and regulations as follows:

(a) First, a forestry policy should be declared as a statement of basic objectives and orientation of government policies regarding the sustainable development and conservation of forest resources in the Syrian Arab Republic.

(b) Sustainable forest management must address the conservation and management of forest ecosystems as a whole as well as the issue of present and potential forest uses. This means that the law must provide a clear definition of the concept of sustainability in the context of forest management and that it must determine the meaning and relevance of sustainable management with regard to present and potential outputs, including but not limited to the following:

(i) The production of wood for local conservation as an input for rural development;

(ii) The production of various categories of industrial wood for an industrial sector economy;

(iii) The supply of non-wood products for both local and industrial uses;

(iv) The provision of protective services against the consequences of natural calamities such as erosion, landslides and floods;

(v) The maintenance of the protective role of forest cover for groundwater resources;

(vi) The provision of recreational uses for urban areas and/or tourism development.

(c) The new forest law contains no provisions on public participation in the decision-making process, because forest management planning is considered a technical issue with responsibility being delegated exclusively to forest services. It should be noted that sustainable and multifunctional forest management aims at integrating public and private interests in forest resources utilization, based on an equitable sharing of costs and investment. Such an approach is feasible only if the community is fully involved (at the local, regional and national levels) in the relevant decision-making processes.

Legislative revisions are necessary to do the following:

(i) Formalize processes for forest owners (public and private), user groups and political entities to participate in making decisions determining the range of forestry outputs, the objectives of management and the measures necessary to achieve such objectives;

(ii) Generate the political commitment essential for the implementation of sustainable resources development and provide the necessary financial means based on equitable cost-sharing between forest owners and public entities;

(iii) Ensure appropriate coordination between sustainable forest utilization and other land uses.

(d) Legislation should facilitate a balance between the interest of private forest owners responsible for the resources and those of the national community, which benefits from adequate multifunctional resources management. Incentive measures can promote sustainable forest uses, particularly in regard to those practices and benefits that are of concern to the community as a whole. The financial measures which could be considered in this context include:

(i) Grants for the improvement of the long-term wood production potential, for example, irrigated poplar plantations and grants for sylvicultural improvements and for the establishment of infrastructure;

(ii) Compensation for costs of specified management measures to be taken by the forest owners in the public interest, for example, construction measures against soil erosion and floods;

(iii) Compensation for prescribed losses, for example, benefits foregone by private forest owners because of harvesting reductions or tree-cutting prohibitions in certain areas for the sake of environmental protection or landscape conservation, even if the loss of benefits is temporary.

(e) Legislation should provide an institutional base for evaluation and monitoring, an aspect that is completely absent in the present Syrian legislation. For this reason the forest law should be adapted to include provisions that would do the following:

(i) Establish the principle and necessary mechanisms for the regular monitoring of the State forests at national and regional levels;

(ii) Assess the impact of forest management planning, in particular with regard to forest area, biodiversity and the health of forest stands and outputs of public interest;

(iii) Provide for the use of monitoring and assessment data as feedback in the process of policy formulation or modification.

It should be stressed that the sustainable development and management of forest in Syrian Arab Republic will increasingly be in situations of complex interdependence and interaction with other land uses and economic and social factors. This implies interdisciplinary approaches within effectively coordinated rural development policies and regulations.

A final observation is that, even though a new forest law has been promulgated in the Syrian Arab Republic, the most serious problems remain the implementation and enforcement of that law. All too often, legislation remains a dead letter, because it is not enforceable. This was the case in the Syrian Arab Republic for deforestation and forest fires. Only forestry legislation that is both theoretically valid and practically viable can contribute significantly to the sustainable development of Syrian forestry.

Also important for an adequate implementation of the new forest law is a different attitude towards forestry officers, who should no longer be seen simply as guardians of on the public's compliance with legislation, but rather as possessing a set of competencies in training and extension. For this reason, these forestry officers should be trained in sustainable forestry development so that they can convey this message to the communities they serve.

2. *Action toward sustainable forest development*

The following action should be taken to promote sustainable forest development in the Syrian Arab Republic:

(a) Make fuller use of the existing knowledge about Syrian forests acquired since the time of the French mandate, which includes reports, maps and publications related to species, forest communities, ecology, management, wood products and so forth;

(b) Establish a network of demonstration areas for forest management and exploitation in the different ecological zones and for the main forest types such as Pinus brutia, Quercus calliprinos and Quercus pseudocerris, in order to increase forestland productivity in the best sites through improved management of forests and forest plantations and in order to reduce losses from fire, insects and disease.

(c) Reduce waste in forest harvesting operations and in product manufacturing, improve the utilization of wood for a variety of end-products, and encourage recycling where appropriate to reduce demand for raw materials;

(d) Strengthen forestry research, extension and education on the basis of sustainable development and management of forest ecosystems and on the potential role of forest trees and shrubs in agroforestry. Forestry research is conducted in the faculties of agriculture at the universities of Damascus, Aleppo and Tichrine Universities, and it is completely absent in the Ministry of Agriculture and Agrarian Reform. A department of forestry and agroforestry research should be established in the Directorate of Research in the Ministry of and should be set up in a way to make it easy for it to interact with other departments of agricultural research for integrated natural resources management;

(e) Dedicate more resources to systematic policy research so as to understand and influence policy-making processes in the forest sector and develop innovative approaches, to harmonize different economic, environmental and political time horizon;

(f) Strengthen the extension programme on forestry to help explain to those concerned the necessity of protecting the forest from fire and, overgrazing, the importance of forest trees in agroforestry, and the different roles of forestry and agroforestry in food security and conservation of natural resources;

(g) Make a critical examination of present institutional arrangements and of the skills of the people involved in developing, disseminating and implementing sustainable forest management practices. Support needs to be significantly expanded and should concentrate on strengthening capacities in the crucial elements brought to forest management by the concept of sustainability, while also monitoring the effectiveness of results. The departments of forestry and ecology in the faculties of agriculture at the country's universities could play an important role in this forest capacity-building at the national and local levels;

(h) Although the policy presently reflected in forest legislation provides the basis for the protection of forestland and trees, there is no well defined and officially announced or adopted forest policy in the Syrian Arab Republic. However, since the natural forests of the Syrian Arab Republic will most likely play a role in meeting society's basic needs for wood products, policies governing their direct and tangible contribution to environmental stability, biological diversity and socio-economic well-being should be of primary importance. It is necessary that the Syria Arab Republic develop a comprehensive *forest policy statement* to circumvent the steady loss of forestland, and uncontrolled forest fires and grazing in forest areas. Consideration should also be given to the extension of forest cover, improvement of forest productivity and development of forestry institutions and the public administration of these, as well as the need for revenue-generating activities and general forestry education. Based on a well-thought-out and comprehensive forest policy, the Syrian Arab Republic should improve the present legislation to make it suitable for sustainable development and administration of forestry resources, as discussed above;

(i) Promote the establishment of or further develop national protected areas of (1) endangered forest ecosystems such as those of Abies cilicica, Cedrus libani, Juniperus excelsa and Pistacia atlantica and (2) of representative and unique forest types (for example the forest of Quercus pseudocerris in Froulok) to protect biodiversity and ecological diversity, as well as to provide baselines against which the environmental consequences of human activities can be determined. In the Froulok region of the coastal mountains the forest area of Quercus pseudocerris and Pinus brutia, near the spring should be protected as a scientific natural area of particular significance from an ecological point of view. The present uncontrolled use by tourists is rapidly deteriorating the ecosystem and if unchecked will destroy it. This forest area should not be harvested for commercial use of its wood, but rather protected and managed as a biosphere reserve;

(j) Reduce pollutants from the non-forest sectors, including industrial and consumer activity that causes forest decline through reductions in productivity, renewability, and species and ecological diversity;

(k) High priority should be given to establishing permanent legal boundaries and to surveying the forest lands in order to protect the forests from the encroachment of agriculture, which is one of the main factors behind the shrinking of forestland, particularly in the coastal region.

M. DEVELOPMENT OF NATIONAL AGRICULTURAL RESEARCH AND EXTENSION

1. Despite the importance of the national agricultural research system in the Syrian Arab Republic, this system is still hampered by the following problems:

(a) No significant impact in agricultural productivity and sustainability of agricultural production systems, despite the growth in the number of research workers;

(b) Lack of adequate funding, facilities and equipment;

(c) Deficiencies in management and coordination of research;

(d) High rate of attrition;

(e) Ineffective link of the country's universities with the national research system in the Ministry of Agriculture and Agrarian Reform and other ministries;

(f) Poor linkage of research and extension with the individual farmers;

(g) Ill-defined priorities;

(h) Lack of incentives and promotional opportunities based on excellence and productivity on the job;

(i) A considerable amount of human and financial resources spread thinly over many disciplines and substations in small isolated groups, which suffer intellectual isolation;

(j) Lack of multidisciplinary research teams;

(k) Lack of research on integrated and sustainable natural resources management, watershed management, agro-ecological characterization, forestry and agroforestry, biodiversity conservation, and sustainable agricultural production systems.

2. There is a strong need for immediate action to upgrade, consolidate, reorganize and reorient research topics with regard to integrated natural resources management and conservation and sustainable agricultural production systems in each of the agroecological zones. Further sustained funding and provision of incentives, is also required, if national research system is to contribute to agricultural development that conserves the resource base;

3. It should be emphasized that the development of economically viable agriculture production systems in the different agroecological zones in the Syrian Arab Republic should be a major objective of agriculture research. This research should be based on selection of one or more production systems from among several alternative systems to evaluate the optimum combinations of inputs in such a way that the lowest cost of input per unit of output is achieved for maximum yield. This type of research should be conducted by a multidisciplinary team and would require a reorganization of the research structure.

At the systems level, an agricultural production system is location specific, and it is uniquely determined on the basis of interacting physicochemical, biological, technological, managerial and socio-economic elements that satisfy specific objectives. For this reason, the development of sustainable production systems in the Syrian Arab Republic in the different agro-ecological zones would require multidisciplinary research development with a sustainability perspective, aimed at increasing knowledge, skill and understanding of the following:

(a) **Physicochemical factors** such as soils, climate, moisture, radiation and day length, and the way they change and interact so that they can be manipulated or given due consideration in efforts aimed at creating favourable conditions for the

(b) **Biological elements** of the production system in terms of crops and/or animals whose products are required in relation to their interaction in the agro-ecosystem with weeds, pests, and even beneficial and nonbeneficial organisms that shape their environment on the basis of

(c) **Changing and appropriate technologies** put at the disposal of the farmer, that are acceptable and relevant to his circumstances on the basis of his

- **Sociocultural background**, in relation to education, experience, community organization, social relations and institutions, and legal systems, to the extent that they interact compatibly to determine the

- **Economic viability and ecological soundness**, based on the farmer's managerial ability and operational cost effectiveness, market and pricing structure, trade-off with respect to maintenance of environmental quality, prevailing infrastructure, and policy environment. (Of course, the measures that ensure long-term sustainability may be unattractive in the short term to the farmer, in which case certain technology characteristics or state policy may be used to achieve the desired objective).

4. The setting up of an agricultural research council is highly needed for the following:

(a) Coordination of agricultural research topics and efforts in the country, including forestry, agroforestry, range and watershed management;

(b) Reorientation of research topics to integrated and sustainable resources management and conservation as developed above in the proposed strategy for research development;

(c) Promotion of multidisciplinary research according to national priorities for agricultural production and the conservation of renewable natural resources;

(d) Preparation of research priorities according to the national plan for agricultural development;

(e) Integration of environmental and socio-economic impact assessment into research projects;

(f) Identification of staffing and financial requirements and training needs;

(g) Strengthening cooperation among the national research system, and the regional and international centres in the field of sustainable production systems and conservation of the agricultural resource base.

There is an obvious deficiency in extension and communication services. The extension services suffer from lack of logistical support, from few contact hours with farmers owing to the high number of farmer per extension worker, and from the fact that the more experienced extension workers work more in the office than in the field. Related to extension is the fact that despite the explosion in infractions and infirmities, there is poor communication among research workers themselves and among researchers, policy makers, extensionists and farmers.

Urgent action should be taken to improve the present situation by strengthening linkages between research and extension services, between researchers and policy makers, and between extensionists and farmers.

Finally, it should be highlighted that the development of sustainable agricultural production systems in the Syrian Arab Republic and sound management of renewable natural resources involve more work and a wider scope of activities, and of design, analytical and evaluation capabilities than have been needed in conventional agricultural research to date. These call for a more holistic or systems approach and for monitoring performance over a longer period of time than has been the practice so far in the national research system in the country. This also necessitates the use of evaluation criteria into which a sustainability perspective is incorporated.

N. SUMMARY OF THE PROPOSED ACTIONS

1. Short-term action includes the following:

   (a) Institutionalization of the environmental impact assessment;
   (b) Raising public awareness;
   (c) Holding a regional seminar and training on protected areas and biodiversity;
   (d) Actions for the development of the steppe rangelands.

2. Medium-term action includes the following:

   (a) Prioritization of environmental issues in the agricultural sector;
   (b) Development of a framework for sustainable land management;
   (c) Formulation of an appropriate national policy for the rational use of water resources;
   (d) Encouraging the use of alternatives to chemical fertilizers and chemical pesticides.

3. Long-term action includes the following:

   (a) Development of protected areas and conservation of biological diversity;

   (b) Agricultural research reorganization and reorientation;

   (c) Various actions within the education system;

   (d) Development of a comprehensive forest policy statement and improvement of the present forest legislation;

   (e) Actions to stop the accelerated degradation of the steppe.

REFERENCES*

ANON. 1981 - SYRIA, Agricultural Sector Assessment, vol. 1, Summary Report, US Department of Agriculture in cooperation with USAID and the State Planning Commission of the Syrian Arab Republic.

ANON, 1981-SYRIA, Agriculture Sector Assessment, vol 2, Natural Resources Annex. Report : US Department of Agriculture in cooperation with USAID and the State Planning Commission of the Syrian Arab Republic.

Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), 1987- Plan of Action to combat desertification in Syria. Damascus.

DEAN F.A., 1994- Wildlife conservation for sustainable development in Arab Countries. Report prepared for Joint ESCWA/FAO Agricultural Division, Amman, Jordan.

Draz O. 1978 - Revival of the "Hema" system of range reserves as a basis for syrian range development program. Proc. 1st International Range Congress. Denver, Colorado, pp:100-103.

El-HAJ K.; SAADE M.; MEDA L., 1990 - An Economic Analysis of Fertilizers Allocation Strategies in Syria, volume 1, (MAAR / ICARDA).

ESCWA. 1994a. Evaluation Agricultural Policies in the Syrian Arab Republic (Policy Analysis Matrix Approach), E/ESCWA/AGR/1994/5.

ESCWA. 1994b. Land and Water Policies in the Near East Region. (E/ESCWA/AGR/1994/10).

ESCWA / FAO, 1994a - Land and Water Policies in the Arab Region. Expert Consultation on Sustainable Agriculture and Rural Development, Cairo, 25-29 September 1994.

ESCWA / FAO, 1994b - Farm Data Handbook in Syria.

FARES F.; ABIDO, M.; HABIBI, H.; and BATHA, A., 1992 - A Study of Soils and Forest of The Coastal Region by Using Remote Sensing, Lattakia Province. Survey, Evaluation and Land Use. Part 1, Damascus Univ. (SWESU / GORS).

FARES F., 1993- Système de Gestion de l'Irrigation dans la Vallée de l'Euphrate par Télédection. IGN France International. (Report)

FARES F., 1994 - Soil Water Erosion in Mediterranean Zone. *In* : Intensive Course on Soil and Water Conservation in Arid Environments, 29 May-12 June, ICAMAS / CEC / MAAR, Damascus.

FAO, 1993 - Follow - up of the UNEC : Integrating environment and sustainability into Agricultural Policy Analysis. Near East Regional Economic and Social Policy Commission, Nauakchott, Mauritania, 17-21 Oct., August, ESCP / NE / 93 / 5.

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* Reproduced as submitted.

FAO, 1994 - the State of Food and Agriculture. p.245.

FAO / UNDP, 1993 - Syrian Arab Republic, Irrigation Sub-Sector Review, Mission Report, February, p 11.

FAO, 1993 - Sustainable Development of Drylands and Combating Desertification, FAO position paper.

FAO, 1994. State of Food and Agriculture, Rome.

GERSAR / SCET / GADEB, 1984 - Development of the Lower Euphrates Valley, Tech. Report Zone 2 & Zone 3.

GERSAR / SCET / GADEB, 1984 - Development of the Lower Euphrates Valley, Irrigation & Drainage Project, Zone 1, Sector 7.

GINTZBURGER G.; NORDBLOM T.; OSMAN A. E., 1994 - Agro-pastoral systems, feed calendared and feed resources in the Arab countries of the Mediterranean region. Report presented to the Expert consultation on management and sustainable dryland development of the Arab World, ICARDA, Aleppo, 10-13 Nov. 1994.

HAJJAR S., 1984 - Contamination of Water of the River Al-Assi by Al-Ghab Sugar Factory Sewage Water. *Research Journal of Aleppo University*, vol. 6, (in Arabic with summary in English).

ICARDA, 1993 - Farm resource management program. Annual report, Aleppo, Syria, 227 p.

ICARDA and MINISTRY OF AGRICULTURE 1986 -1992. Annual reports of the Scientific Cooperation Projects, (in Arabic), Aleppo, Syria.

IFAD, 1992 - The State of World Rural Poverty . pp: 380-381 and 428-429.

ISNAR, 1993 - Theme essay : Natural Resource Management, Annual report, ISNAR, The Hague.

JONES M., 1991 - Agricultural Sustainability Research at ICARDA. Centers Week, Washington D.C., ICARDA, Aleppo.

KHALDI N., 1993 - Agricultural Policy analysis project, phase II. Jordan agricultural Sector Review : Synthesis. USAID Amman, Jordan. APAR II, Technical Report, No. 132, Volume VI.

MAAR / SAR 1994 - The Agricultural Sector in Figures (1972-1992), 127p.

MASRI A., 1991 - The Tradition of Hema as a land tenure institution in arid land management : The Syrian Arab Republic. FAO / ESH working paper on particle and agropastoral societies, No. 12, FAO, Rome.

MAHMOUD M., 1993 - Water resources development in Orontes basin. Regional seminar of fresh water quality and efficiency : optimizING sustainable beneficial use in Arab Countries. CEDARE, Cairo, Egypt.

MEKOURA M. A., 1993 - Mission report on forestry legislation. Presented to the MAAR, Damascus.

MINISTRY of Irrigation, Syria, 1982 - Scheme of water resources in four areas of the Syrian Arab Republic. Prepared by the Georgian State Institute for Design of Water resources development projects.

NAHAL I., 1989 - Contribution à l'étude de la diversité biologique en Syrie. *Research Journal of Aleppo University, Agricultural Sciences series,* vol. 12, pp. 123 - 140, Aleppo, Syria (in Arabic with summary in French).

NAHAL I., 1991 - Les systèmes agroforestiers en Syrie et leurs rôles dans le développement rural. *Research Journal of Aleppo University, Agricultural Sciences Series,* vol. 16, pp:189-203 (in Arabic with summary in French).

NAHAL I., 1991 - L'homme et la désertification au Proche-Orient. Sécheresse, vol. 2, pp:271-238, France (with summary in English).

NAHAL I., 1994 - Environmental and socio-economic effects of irrigation schemes in the Arab World. *Desertification Control Bulletin*, No. 24, pp:42-47, UNEP, Nairobi, Kenya.

NORDBLOM T. L.; SHOMO F., 1994 - Food and feed prospects to 2020 in the West Asia / North Africa region. Working paper, ICARDA.

OSMAN A. E., 1990 - Forage production: A step towards better management of arid and semi-arid rangelands of North Africa and Western Asia. *In* Advances in Range Management in Arid Lands (Ed. R. Halwagy, F.K. Taha and S.A. Omar), pp. 163-172. Kegan Paul International, London and New York.

OSMAN A. E. et al, 1991 - Response of Mediterranean grassland to phosphate and stocking rate: biomass production and botanical composition. *Journal of Agricultural Science*, Cambridge, 116 : 37-46.

PERRIE E. R.; SALKINI A. B. (eds) 1991 - Supplemental irrigation in the Near East and North Africa, Kluwer Academic Publishers, Dordrecht, The Netherlands.

RAMADAN A.; MANDIL H., 1988 - Determination of Arsenic in polluted vegetables, tobacco and farmland soil by anodic stripping pulse voltammetry. *Research Journal of Aleppo University, Basic Sciences Series*, No. 10, pp:93-104, Aleppo.

RAMADAN A.; SABBAGH G., 1993 - Effects of solvents on nitrate ion selective electrode and determination of pollution of vegetables, fruit and well water by nitrate ions. *Research Journal of Aleppo University, Basic Sciences Series*, No. 16, Aleppo.

RAMADAN A.; SABBAGH G., 1994 - The effect of non-aqueous solvents on potentiometric titration of Cu (II) and Pb (II) by iodide and determination of pollution by copper and lead using ion selective electrode. *Research Journal of Aleppo University Basic Sciences Series*, No. 17, Aleppo.

RAMADAN A.; MANDIL H.; 1990 - Determination of Chemical Pollution of Water in the basin of Quick - River in Aleppo. 30th Science Week, 3-8 November, Damascus.

SALKINI, A. B., 1992 - Impact assessment of supplemental Irrigation on rain-fed wheat - based farming systems in Syria. Unpublished Ph.D. thesis, University of Reading, UK.

SOUMI, G. 1994 - Development of Agricultural Sector in Syria. Report, Directorate of Irrigation and Water Use / MAAR.

UNEP, 1992 - Syria: Human - Induced Soil Degradation, *In*: Atlas of Desertification, ILAIWI, M. et al., ACSAD / MAAR.

UNEP, 1994 - Summary of the Activities Carried out as Part of the Coastal Area Management Programme (CAMP) of the Syrian Coastal Region, MED, WG, 88/2, Damascus.

WAKIL M., 1993 - Ground Water Potentialities in Khabur Basin under supplemental irrigation. Regional seminar on role of supplementary irrigation on cereal production. 11 - 17 May, Damascus, Syria.

WAKIL M., 1993 - Analysis of future water needs for different sectors in Syria. *Water Inst.*, 18, pp:18-22.

WINROCK INTERNATIONAL, 1994 - Environment and Agriculture Rethinking Development Issues for the 21st Century. Proceedings of a symposium in honor of HAVENER R.D. Arkansas, USA., 285 pages.

WORLD COMMISSION ON ENVIRONMENT, 1987 - *Our common future*. Oxford University Press, Oxford, New York, 400 p.