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Agricultural Sustainability Research at ICARDA

A Presentation at Centers Week 1991, Washington, D.C.

by
Michael Jones
Leader, Farm Resource Management Program

International Center for Agricultural Research in the Dry Areas
Aleppo, Syria

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based at Aleppo, Syria, it is one of 16 centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work.

The CGIAR seeks to enhance and sustain food production and, at the same time, improve socioeconomic conditions of people, through strengthening national research systems in developing countries.

ICARDA focuses its research efforts on areas with a dry summer and where precipitation in winter ranges from 200 to 600 mm. The Center has a world responsibility for the improvement of barley, lentil, and faba bean, and a regional responsibility--in West Asia and North Africa-- for the improvement of wheat, chickpea, and pasture and forage crops and the associated farming systems.

Much of ICARDA's research is carried out on a 948-hectare farm at its headquarters at Tel Hadya, about 35 km southwest of Aleppo. ICARDA also manages other sites where it tests material under a variety of agroecological conditions in Syria and Lebanon. However, the full scope of ICARDA's activities can be appreciated only when account is taken of the cooperative research carried out with many countries in West Asia and North Africa.

The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training that the Center provides. A range of training programs are offered extending from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and by specialized information services.

Cover:
Regenerating degraded rangeland by planting shrubs (*Atriplex* spp. and *Salsola* spp.).

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Preface

After millennia of food self-sufficiency, the West Asia and North Africa region is no longer capable of feeding itself, and today imports more food per capita than any other region in the world. Inexorable market forces are compelling farmers to wrest from the earth a level of food production it simply cannot sustain. Soil erosion and nutrient exhaustion are becoming ever more common. Scarce water resources are being rapidly depleted. Overgrazing is creating deserts. The threat of an environmental catastrophe is looming large.

Population growth has already considerably outpaced agricultural production, and the gap between the demand and supply of food is bound to widen even more in the years to come. The land area cannot be increased for increased food production; on the contrary, agricultural land is being encroached upon for urban purposes to meet the requirements of the increasing population.

The experience of the last three decades has shown that increased crop productivity is only part of the solution to feeding the world. A comprehensive approach to agriculture, an awareness of both the long- and the short-term effects of any given crop or farming practice, is critical for sustained agricultural production. Despite this, only in recent years has agricultural sustainability become an issue.

Though agricultural mechanization and chemical fertilizers have enabled farmers to realize amazing yield increases, these innovations have also led to a fundamental loss of equilibrium. "Miracle" technologies of the past two or three decades made it easy for farmers (and agricultural researchers) to forget the importance of maintaining the fine balance between man's needs and the laws of Nature. With growing public concern over the global warming, environmental pollution, toxic wastes and the like, the concept of sustainability has finally begun to receive the attention it rightly deserves.

Since its establishment in 1977, ICARDA--the International Center for Agricultural Research in the Dry Areas--has incorporated a strong farming-systems component into its research. With its multidisciplinary, multicommodity mandate, ICARDA has developed its work in the context of the prevailing ecologies of the region. The Center's focus on the drier, less productive and more risky agro-ecological zones in West Asia and North Africa puts it at the forefront of research on agricultural sustainability. In close partnership with the region's National Agricultural Research Systems, ICARDA is seeking to develop improved barley, bread wheat, durum wheat, lentil, chickpea, faba bean, and pasture and forage crops. The livestock component of the Center's research focuses on increased livestock (sheep and goats) productivity through better nutrition and management practices. The Farm Resource Management Program of ICARDA integrates the results of commodity research and addresses issues of wider concern including the socioeconomic aspects of farming, agroecological characterization, and the sustainability of the resource base.

The pages that follow provide sample illustrations of how ICARDA is dealing with the issue of sustainability of agriculture in West Asia and North Africa.

Agricultural Sustainability Research at ICARDA

Two definitions of sustainable agriculture are relevant in the context of the research programs of the CGIAR (Consultative Group on International Agricultural Research):

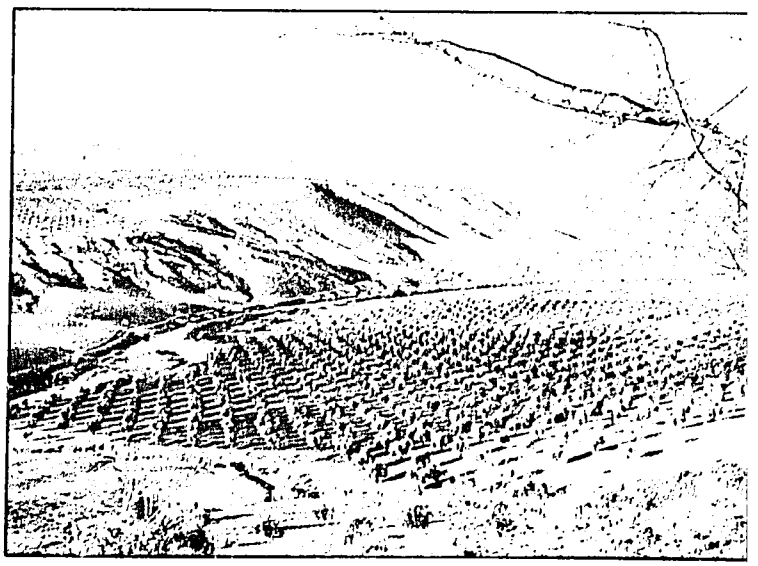
- "an agriculture that can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favorable to humans and to most other species"

- "the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the natural resource base and avoiding environmental degradation".

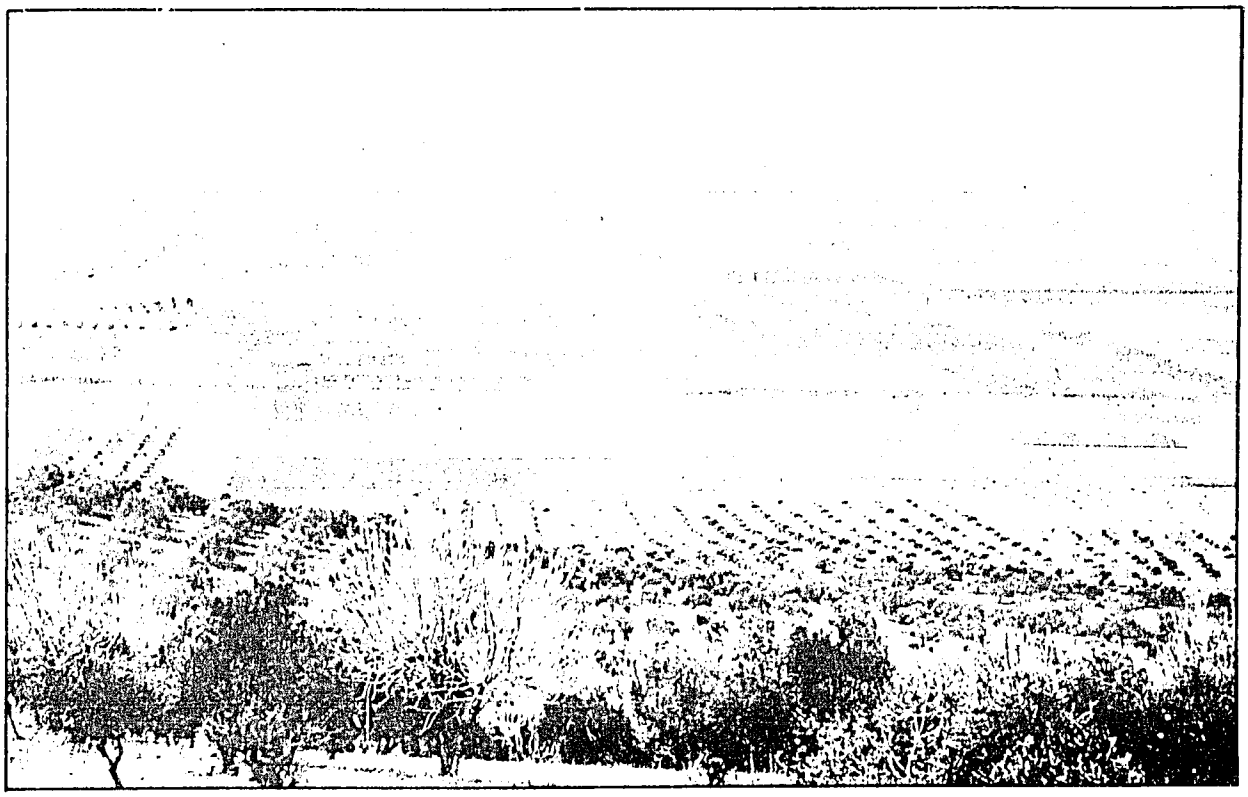
Three points may be noted. First, the recognition that any agricultural system, however well-adapted it is now, will likely evolve over time according to changing needs and external forces. Second, the concept of sustainability as being the maintenance of as many production options as possible to support varying human needs under evolving circumstances. Third, the importance of protecting the resource base. The last two points determine different priorities: a production priority that requires that agricultural output be maintained and, if possible, increased; and a resource-base priority that requires that the natural resources be maintained intact (even enhanced) and environmental degradation avoided.

These different priorities, though not in direct conflict, activate different research agendas. Output can be maintained, perhaps for a long time, through adjustments derived from specific pieces of problem-solving research (e.g. new varieties able to overcome increasingly unfavorable soil conditions, such as salinization; control measures against new pests; chemical or biological remedies for halting a decline in fertility). Some of these adjustments may require externally-derived inputs and so be ultimately non-sustainable due to a declining availability of raw materials (e.g. oil for tillage operations, chemicals or fertilizers). As others have noted before, the challenge is to create as large as possible a proportionality factor linking output to input. Thus, nutrient cycles need to be as closed as possible, and

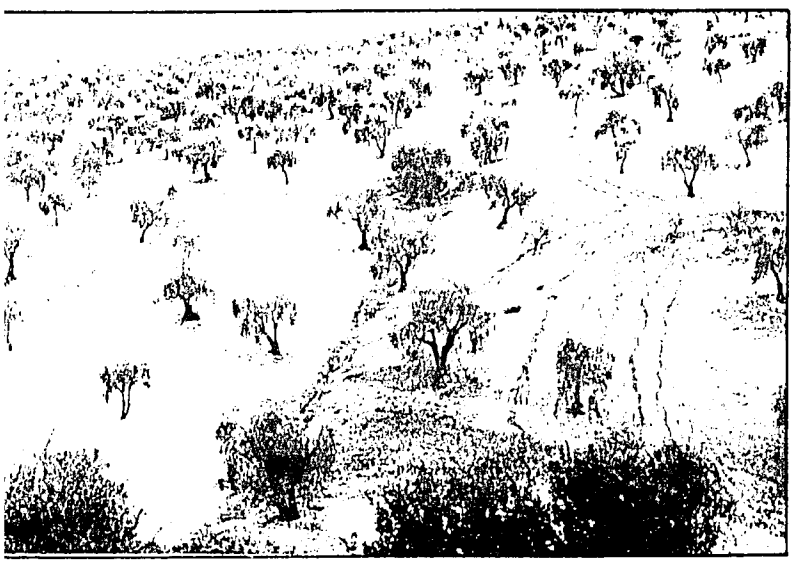
Byzantine olive farmers failed to sustain the productivity of this land (Syria).



Modern olive lands (Syria) .....



Much of their soil was washed into valleys (Syria).



. are also vulnerable (Syria),

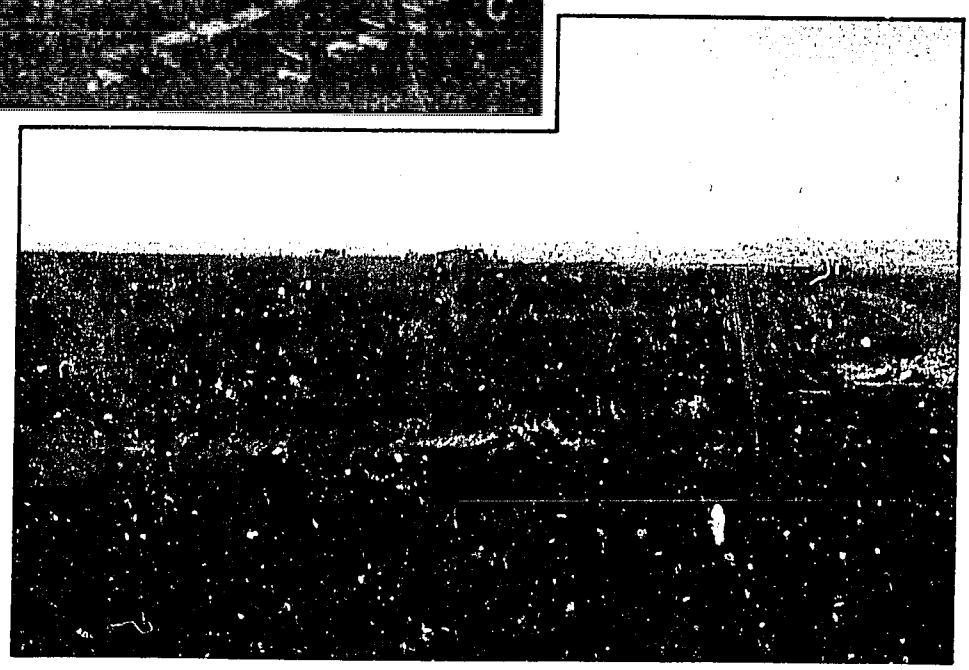
..... and so are arable lands (Jordan).

biological processes and controls internal to the system should be utilized, where feasible, in preference to chemicals and other external inputs.

Nevertheless, these adjustments, however individually sustainable, are unlikely to ensure general sustainability, particularly in less favored environments, unless due regard is paid also to the resource base. If we allow the resources of soil and water to deteriorate in both quantity and quality, the maintenance of production and of a range of production options becomes all the more difficult and, probably, all the more dependent on externally-derived inputs. The problems here are more fundamental and require a longer-term commitment. They are less amenable to relatively simple pieces of problem-solving research and much more subject to limitations imposed by political, social, and economic forces.

For International Centers, the production priority should require no more than some realignment of the philosophy of current research to ensure that the generation of problem-solving, output-raising innovations is planned and conducted with a sustainability perspective (as has been said, preferring low-input solutions and favoring biological over chemical control). The resource-base priority, however, requires the opening of a new research front on resource conservation and land management. It requires the acquisition of new expertise and new information bases. And it

Much of the land is still highly productive (Syria) .....

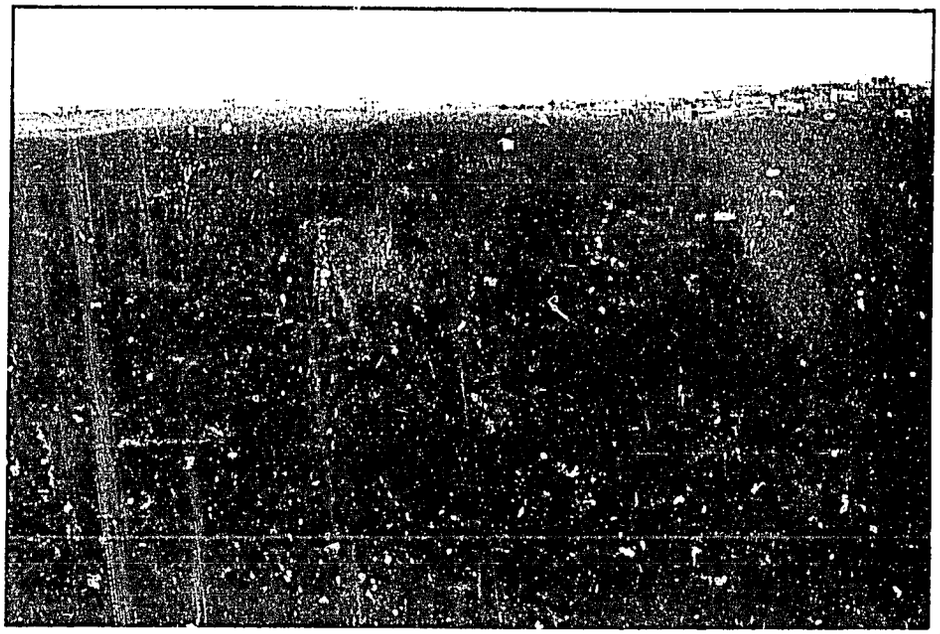


..... but poor techniques reduce output (Jordan).

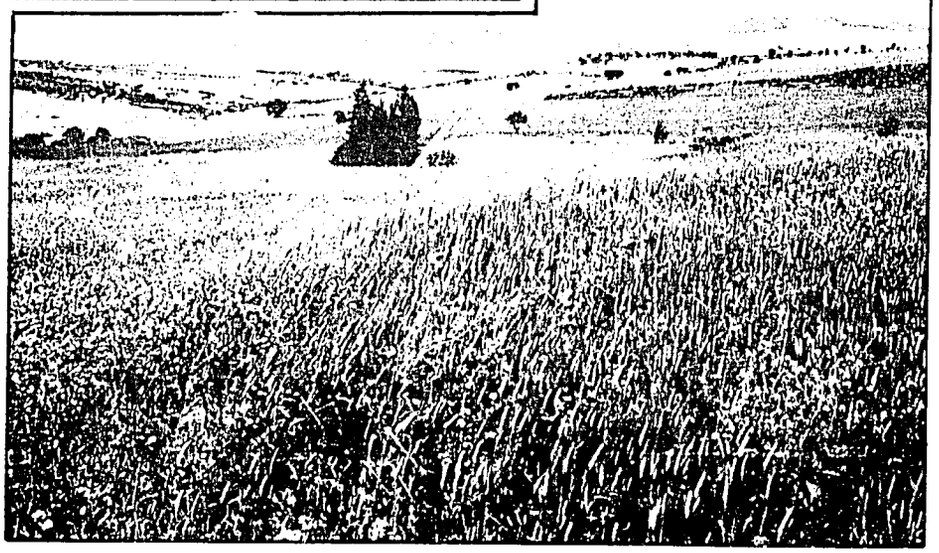
requires a careful selection of targets upon which to focus effort to achieve maximum effect within what is a very broad and multidimensional problem area.

In a sustainability context, ICARDA's research may be summarized first by examining current activities within the production priority and, secondly, and more fully, by examining our options and progress to date in developing work within the more problematic resource-base priority.

For the production priority we may identify four main thrusts, relating to germplasm, nutrient economy, water economy, and reduced tillage. Within the germplasm activity there are two broad areas of work: collection and conservation, and the development of new genotypes. Since much of the development is directed towards the creation of material adapted to low-input rainfed systems and tolerant of both biotic and abiotic stresses, ICARDA believes it is important to utilize locally adapted landraces, primitive forms, and wild relatives. This indigenous gene pool holds much potential for stress tolerance. To ensure that potential is not lost, germplasm collection is being concentrated in previously underexplored areas of the ICARDA region--West Asia and North Africa (WANA); and for barley, particularly, it is identified by selecting material for low-input, stress environments from local barleys grown under stress conditions. It is seen as essential to select material under the conditions in which it will ultimately be utilized.



Inputs help: fertilizer and improved seed (right hand field) enhance crop growth, (Jordan) .....



..... but improved weed control is also often needed (Tunisia).

The most economic way to control crop pests and diseases is to utilize genetic defence mechanisms. This is seen as the main strategy within a more general, integrated approach to pest management -- host resistance being supplemented with appropriate agronomic practices, biological controls and, only where unavoidable, with a moderate use of chemicals to suppress pest populations below economically serious levels while minimizing environmental hazards. However, it is important to use plant resistance in a way that ensures its durability. Many improved agricultural practices tend to produce a more favorable environment for pests and diseases, requiring cultivars with a greater level of resistance than at present. The search for new sources of resistance therefore remains urgent.

Most soils of the ICARDA region have inadequate contents of available N and P for optimum crop production. Technically, there is little difficulty in remedying such deficiencies, temporarily, crop by crop, by adding fertilizers; and (depending on price structure) it is often profitable to do so. Yields can be maintained and increased by the use of fertilizer. Nevertheless, the long-term sustainability of cheap fertilizer supplies must be doubtful, and so research seeks ways to increase the efficiency with which such inputs are utilized and to reduce dependence on them.

A major focus is the enhancement of the legume contribution to the soil-crop-animal N-cycle, both through the effects on N-fixation efficiency of microbiological improvement and pest control and through an increase in the range and utilization of legumes in the different farming systems. Lentil, chickpea, peas and faba bean are all important food legumes, grown largely in rotation with wheat in wetter areas. There are also many feed legumes (e.g. *Vicia* and *Lathyrus* species) which, though currently less extensively grown, have great promise as components of rotations with wheat and with barley in drier areas. Potential has also been demonstrated for ley-farming systems based on annual *Medicago* species and for the stimulation by phosphate fertilization of the indigenous legume component of the flora of rough grazing land. Given the widespread importance of small ruminants in WANA agriculture, an increased provision of relatively high-protein feeds based solely on biologically-fixed nitrogen offers a major contribution to sustainability. Further, in legume-cereal rotations, the post-legume balance of soil nitrogen available to the cereal may be no less, in some cases perhaps more, than after a fallow (and much more than

The main threat to soil is erosion by wind (Cappadocia, Turkey) .....

..... and water (Syria).

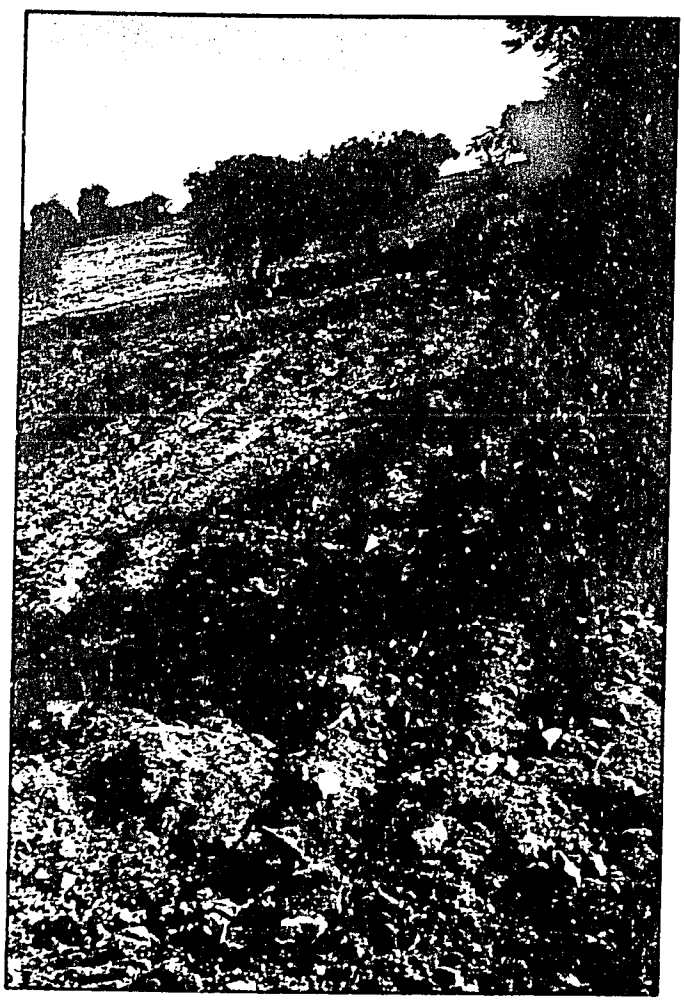
..... and both wind and water erosion can occur in the same place; wind begins to infill a water-cut gulley in unprotected barley lands (near Aleppo, Syria).

The water runs off hill pastures that are overgrazed (Syria) .....

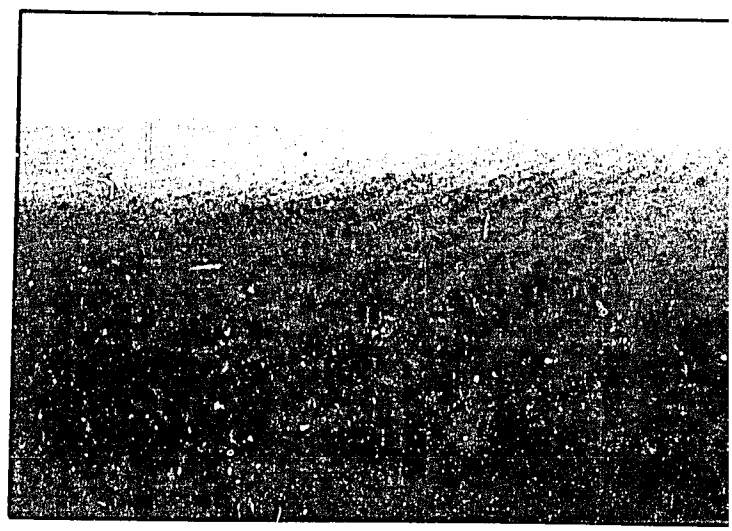
..... and are themselves eroding (Syria).

found in a continuous cereal sequence). This largely obviates the need for nitrogen fertilizer on cereals in drier areas and reduces it in wetter areas.

The dynamics of soil phosphate are very different. Low natural availability in most soils, together with only a limited scope for purely biological intervention, mean that some use of fertilizer will be required in nearly all cropping situations even in dry areas (indeed, particularly in dry areas). The general objective for sustainability is, therefore, to increase the efficiency of utilization. Even in conditions of soil deficiency, uptake of applied phosphate may be as low as 6-10%; further, since most soils have an appreciable "P-fixation" capacity, more than half the unused phosphate is likely to be rendered unavailable before the start of the next season. Current research is investigating the various relationships between soil mineralogy, phosphate sorption properties, availability, fertilizer input and crop uptake, with the practical aim of determining the minimum fertilizer schedule required to maintain a non-limiting soil-P status. One possible biological approach is to select genotypes for their ability to be productive in soils of low phosphate status, and this is a feature of the present procedure of selecting barleys for dry environments under low-input conditions. Similarly, P-efficient genotypes have been selected in chickpea. So far, only limited work has been done on mycorrhiza, which can improve crop uptake from soils with low phosphate availability; problems of inoculation for the field situation are, however, considerable.

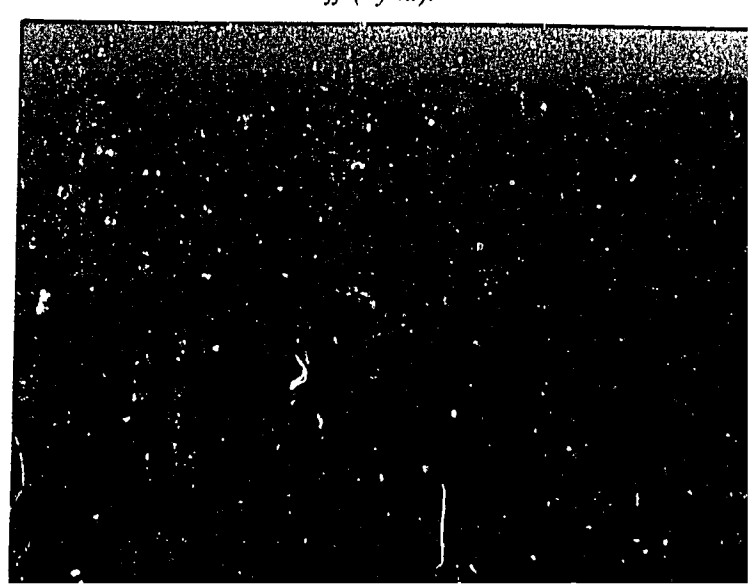


Clearing and clean plowing puts steep slopes at hazard (Syria).



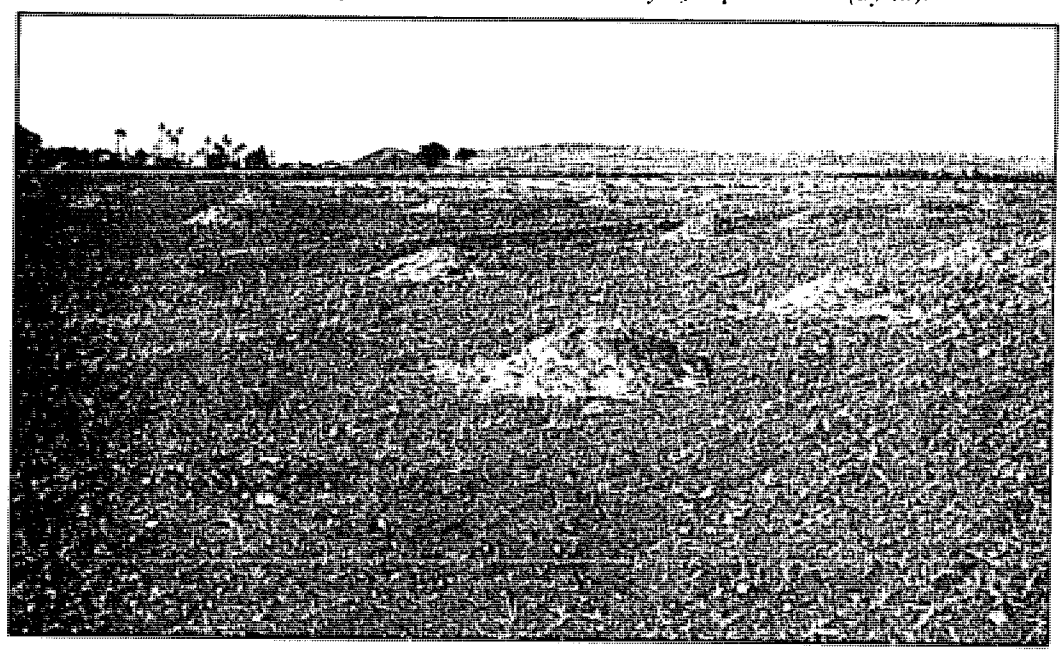
Lack of wind breaks makes dry arable areas vulnerable to wind erosion (Syria) .....

..... and the soil is blown off (Syria).



Grazing of stubble (Syria) .....

..... and harvesting of whole plants increases vulnerability of exposed soil (Syria).



Wherever water is available for agriculture in the WANA region, it is used liberally to irrigate crops. Some farmers appear to believe 'the more water, the better' almost without limit. The average supplemental irrigation given to rainfed wheat by a surveyed group of Syrian farmers was three times the research optimum, although their yield was nearly 20% lower. Whether the source of water is a non-renewable aquifer (which is a resource-base issue as well) or a perennial river, the energy costs of unlimited pumping are unlikely to be sustainable. ICARDA is researching and extending the concept of minimum supplemental irrigation, whereby water is added to rainfed crops in small amounts sufficient to prevent stress, especially at sensitive growth stages. The very substantial yield responses achieved represent a very efficient use of water and of pumping fuel.

Large quantities of fuel are also expended on cultivation. Following the widespread introduction of mechanization into rainfed farming systems over the last 40 years, shallow tillage with simple animal-drawn implements has been replaced in many areas by disc and moldboard plowing to 20-30 cm depth. Not only is deep tillage itself costly in fuel use, but it

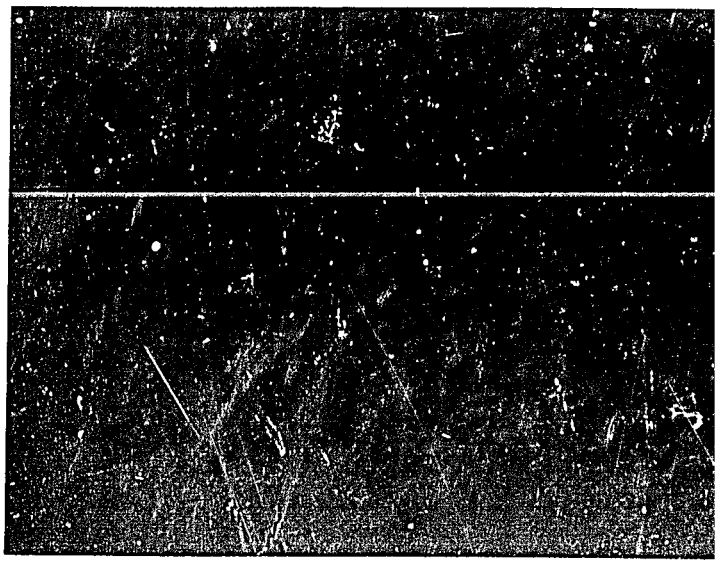
necessitates another cultivation to prepare the seedbed. Furthermore, it tends to destroy soil structure, prejudicing the long-term maintenance of the soil itself. In a five-year trial in Syria, no yield advantage was found from deep tillage; and although this result might be site- and soil-specific, it suggests that the use of deep tillage should be more critically appraised wherever it is used. For long-term sustainability, the aim should be to reduce all cultivations to a minimum.

Within the resource-base priority our concern is to maintain (and, where possible, enhance) the quantity and quality of soil, water, and native vegetation.

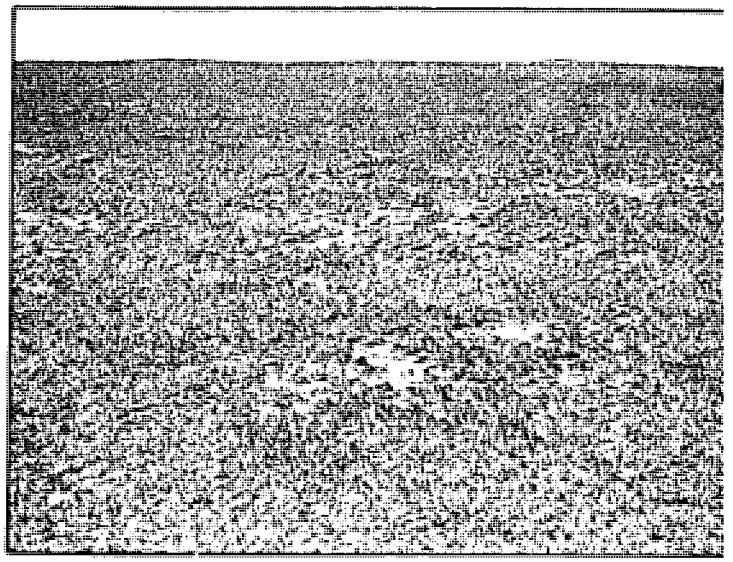
The main threat to soil is erosion by wind and water caused largely by inappropriate land management. Wind erosion occurs where the natural vegetation, particularly trees, shrubs and other perennial species, has been removed and not replaced by any other form of protection, a situation often exacerbated by a deteriorating soil structure. In drier arable areas, large tracts of land are cultivated without any trees or walls to break the wind and stand empty and vulnerable through the dry, windy summer. Stubble and other residues, which might have afforded some physical protection and contributed indirectly to the maintenance of soil structure, are removed or grazed off; 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 adjacent range (steppe) grazing areas; the perennial vegetation has been almost 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 instead, thereby destroying the last vestiges of any dry-season soil cover.

Erosion by water occurs widely in wet and dry areas. The immediate causes vary, but everywhere it represents inattention to long-term consequences in the urgency of current need. In wetter areas, steeper and steeper slopes are cleared for planting orchards. The clean-cultivated, widely-spaced trees afford little resistance to erosion, and, so often, stones and rocks that could have been used to build simple terraces are cleared into useless heaps. Whether under orchard or arable, land is tilled without regard to the contour, usually up and down the slope. Indeed, this is almost unavoidable where land allocation and inheritance have resulted in long and narrow

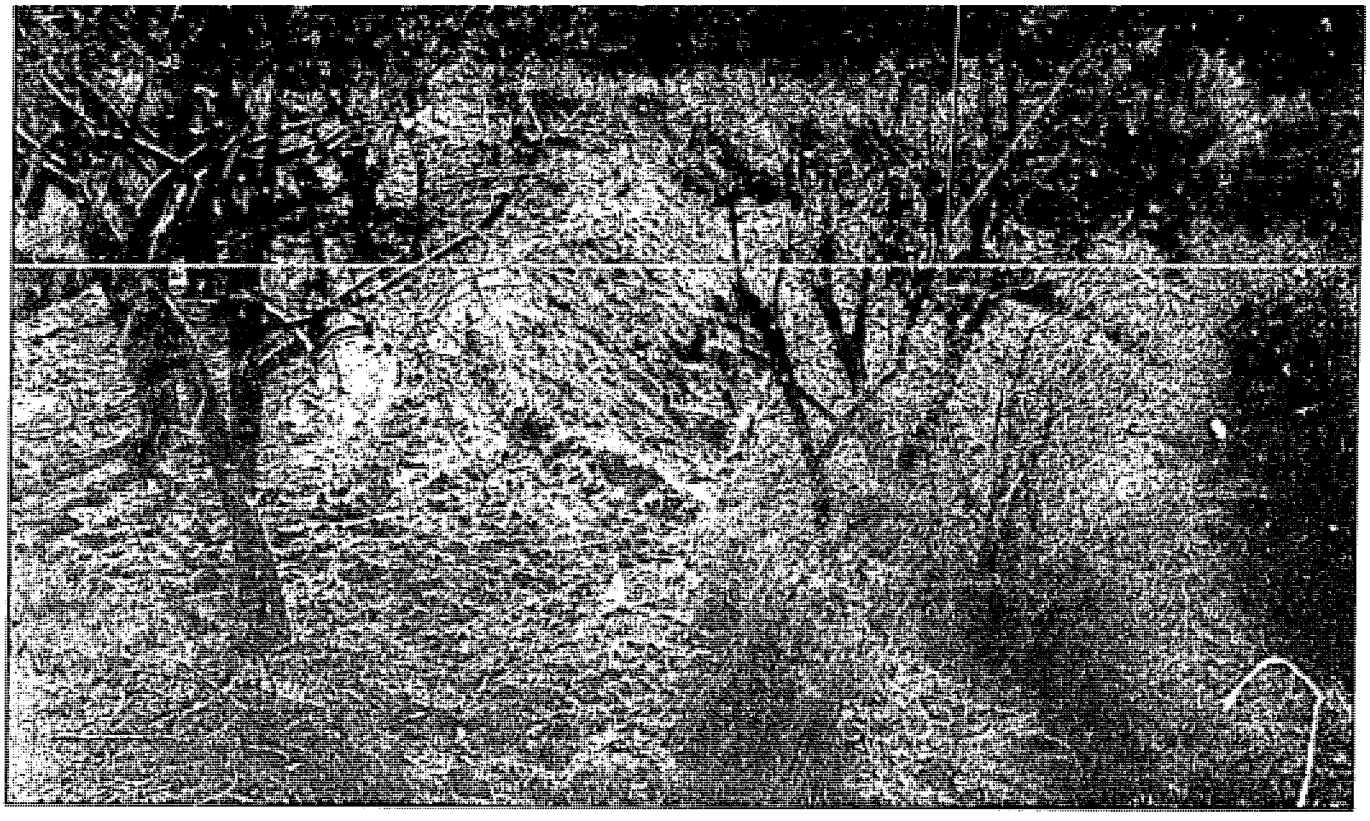


Overgrazing has left large parts of the steppe (Syria) .....

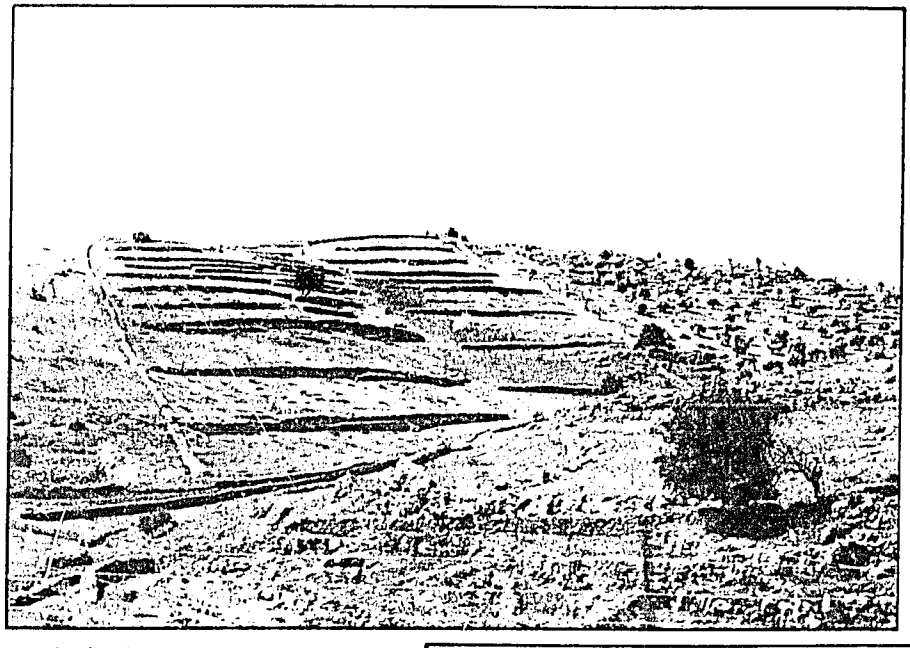


..... totally bare (Syria) .....

..... and turning into a desert (Syria).



Terraces reduce the risk of water erosion on steep slopes in Turkey,



..... in Jordan .....

..... and in Tunisia.

individual holdings running up the slope. Rough hill pastures lying above the arable land often make the situation worse, since bare soil and rock exposed by overgrazing provide catchments which concentrate storm water on to the land below.

The spread of people and agriculture into drier areas has been greatly facilitated by the widespread existence of underground aquifers. The well-boring machine is a common sight even in remote areas. But few aquifers, even those that are rechargeable, can sustain current rates of use for long. Levels drop, wells dry up, the machines bore deeper, but even in the relatively short term the process is not sustainable. Some areas previously irrigated are now back under rainfed farming.

Loss of range vegetation has been cited as a contributory cause of soil erosion, but it is also itself a degradation of resources. With increasing overgrazing, palatable species die out and unpalatable species become dominant. And where the now unproductive land is plowed for barley the whole ecosystem--previously sustainably productive at a low level of output--is irretrievably destroyed.

Contour banks are sufficient to control erosion on gently-sloping arable land (Tunisia).

Contour planting of crops conserves soil between olive trees (Syria).

For barley lands vulnerable to wind erosion, ICARDA is testing stubble mulching (Syria) .....

..... with direct-drill planting.

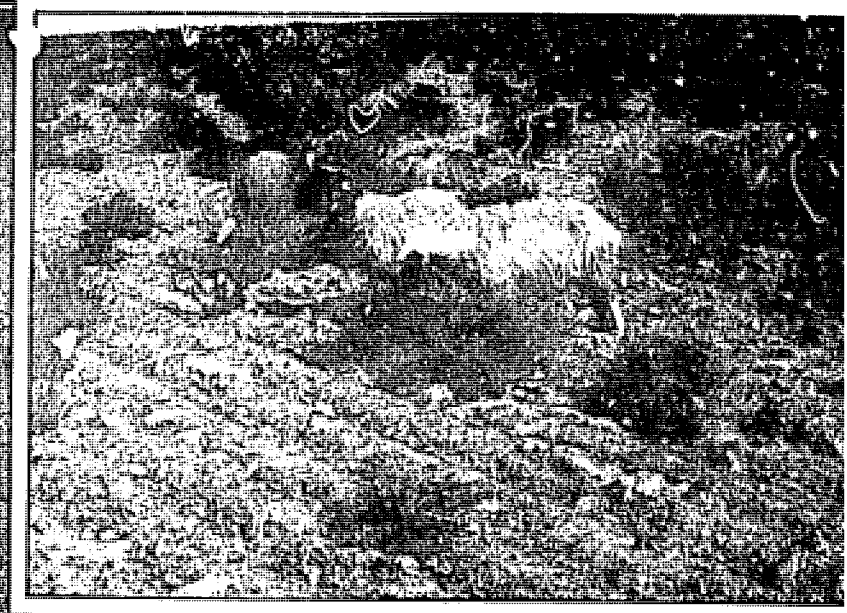
All the above threats are only the physical and biological expression of the impact on the agricultural environment of a burgeoning and rapidly evolving human society. Increasingly, it is the larger social and economic factors that determine how agriculture is conducted and how it utilizes the land. No measures proposed to conserve natural resources and improve agricultural sustainability can succeed if they do not take account of this.

The main socio-economic forces are increasing population and, particularly, an increasing and increasingly sophisticated urban population, which creates a market demand and consequent commercialization. Aided by rapidly improving communications, rural households are increasingly linked into the national economy, as suppliers but also as consumers–reducing their previous self-sufficiency. The largely subsistence agriculture of the past is rapidly disappearing.

But, despite migration to the cities, rural populations are still increasing and have increasing market incentive to produce. To keep pace, more land, even of marginal quality, is being plowed and more animals kept on the grazing lands. Moreover, there are considerable financial incentives to externally-based entrepreneurs to invest in large-scale enterprises like stock-raising and cereal cropping in areas where controls are weak, as in the steppe.

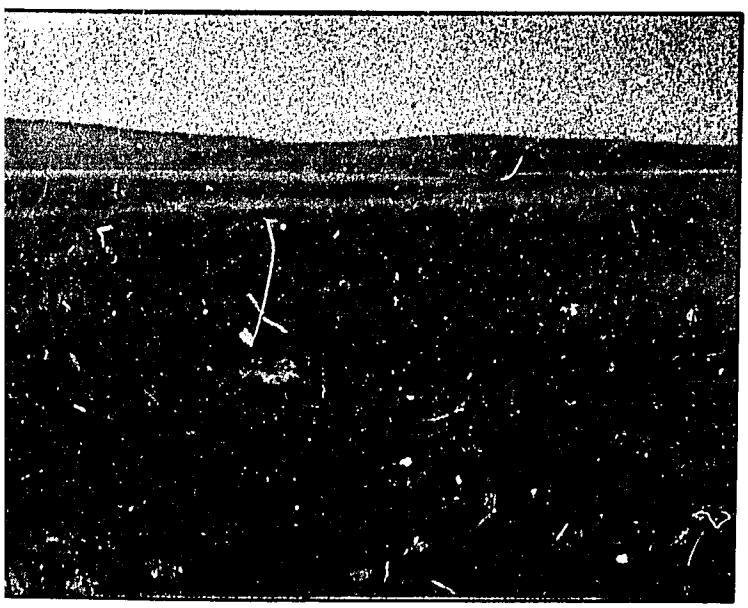
Paradoxically, it has been the relatively recent extension of central government authority to the remotest areas that has broken the traditional tribal power that previously imposed some control on steppe grazing. New government laws on land utilization, even where they exist, are difficult to enforce; and invading commercial interests may in any case be strong enough to circumvent them. Where laws and customs still prevail, as in land tenure, they tend to be such as to impede the implementation of conservation measures.

Planting Altriplex bushes makes the steppe potentially more productive and protects the soil from wind erosion (Syria) .....



..... but much depends on grazing management--ICARDA experiment in Syria.

The local land-users often prefer to plow the steppe and grow barley (Syria).



ICARDA's research strategy to cope with this situation is still evolving, but it may be seen as comprising three interlinked strands:

a. *Technical*: developing, testing and adapting likely techniques in forms potentially suitable for local adoption;

b. *Social*: documenting current practices, customary laws, government policies and, not least, landuser perceptions concerning the agricultural use of natural resources;

c. *Information handling*: development of an information base from the above work and from other data sources for better informed decision-making, implementation of new techniques and, where appropriate, in conjunction with modelling.

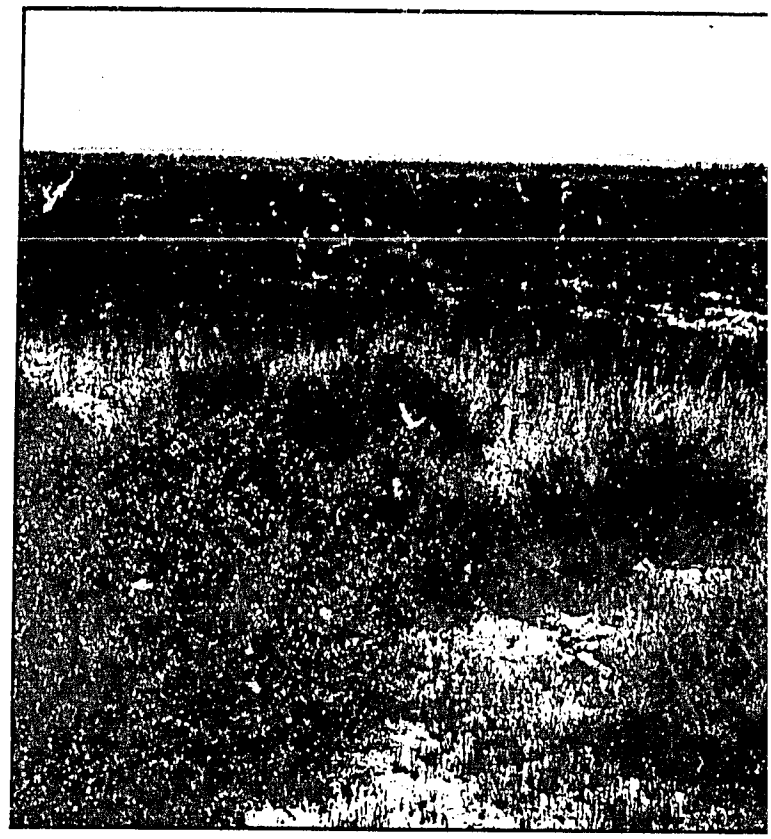
Few of the technical problems of resource management are unique to WANA, and many potential solutions have been devised elsewhere. It is adaptive research that is needed, taking basic

concepts, such as reduced tillage, stubble mulching, contour farming, and terracing and modifying them to local circumstances. This requires technical experimentation backed up by an understanding of local society--who are the land users, how do they interact, and what are their objectives? ICARDA has already started some technical studies.

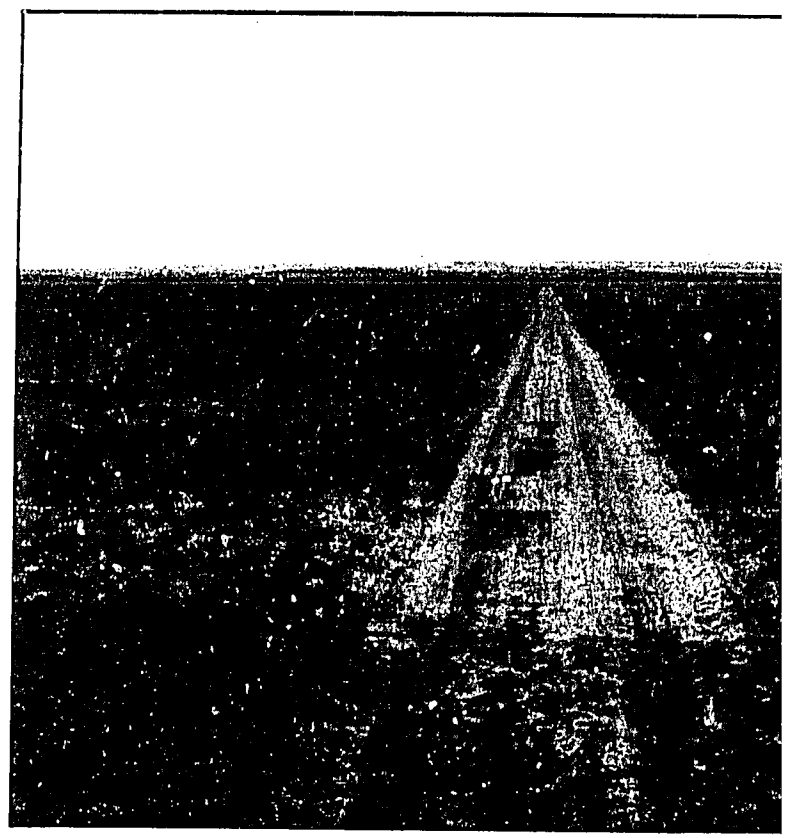
For instance, at one site in a typical barley-growing area, we are looking at no-tillage (*versus* normal tillage) in combination with ungrazed (*versus* grazed) stubble management. These plots will provide hard data on the effects of conservative management on soil properties and crop yields. We hope to demonstrate that tillage is not essential, that crops can be successfully established by direct drilling into last year's stubble, and that stubble retention and less frequent tillage improve the soil physical condition. We anticipate that direct-drill equipment might be adopted, at least by larger-scale operators, if the incentives were right, although the achievement of any reduction in stubble grazing presents greater difficulties.

At another site within the steppe margins a comparison is being made between different small-ruminant stocking rates on "unimproved", i.e. already seriously-degraded, rangeland, and rangeland "improved" by the establishment of fodder shrubs, *Atriplex* spp. (saltbush) and *Salsola* spp., in terms of both animal productivity and soil and vegetation effects.

The successful planting of such shrubs almost certainly controls wind erosion, but shrubs may be less attractive to land users than the quick returns obtained from plowing and planting to barley; and improvements achieved by research in respect of barley varieties and production techniques for drier conditions are likely only to increase those returns. One possible compromise--with application to both steppe and barley-zone conditions--would be to grow the barley in arable strips between shrub hedges. The hedges, planted transverse to the prevailing wind direction, would (it is suggested) provide erosion control and a grazing resource, while the greater part of the land surface could still produce barley (and other feed crops). ICARDA has recently established a trial at a dry arable site to investigate the effects of *Atriplex* spp. hedges on barley and feed legumes grown in strips between them, and to evaluate the productivity of the hedges as feed. Before attempting to introduce hedges on a larger scale, we need to know more about the likely economy of the system.

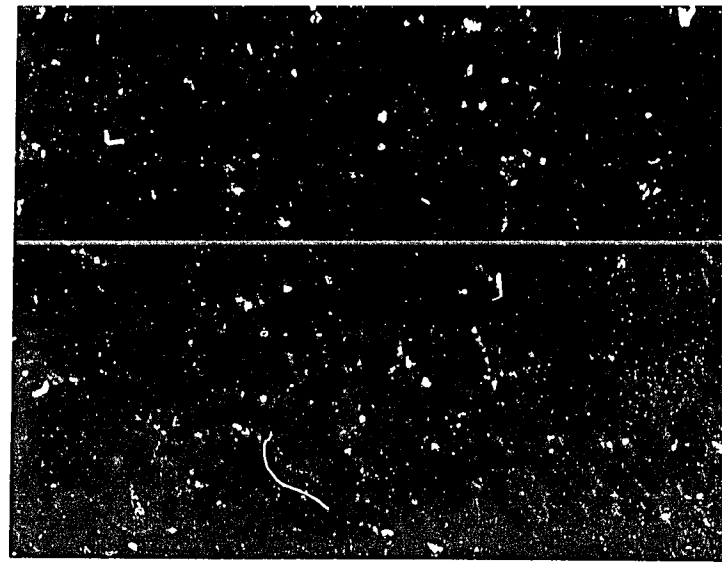


One alternative is to grow barley between rows of Atriplex bushes (Syria).



ICARDA has started a new Atriplex/arable cropping trial (Syria).

The long-term aim is to avoid soil loss (Syria) .....



..... and degradation

Soil conservation measures, however potentially beneficial in the long term, are acceptable to land users only if they can be seen to be profitable also in the short term.

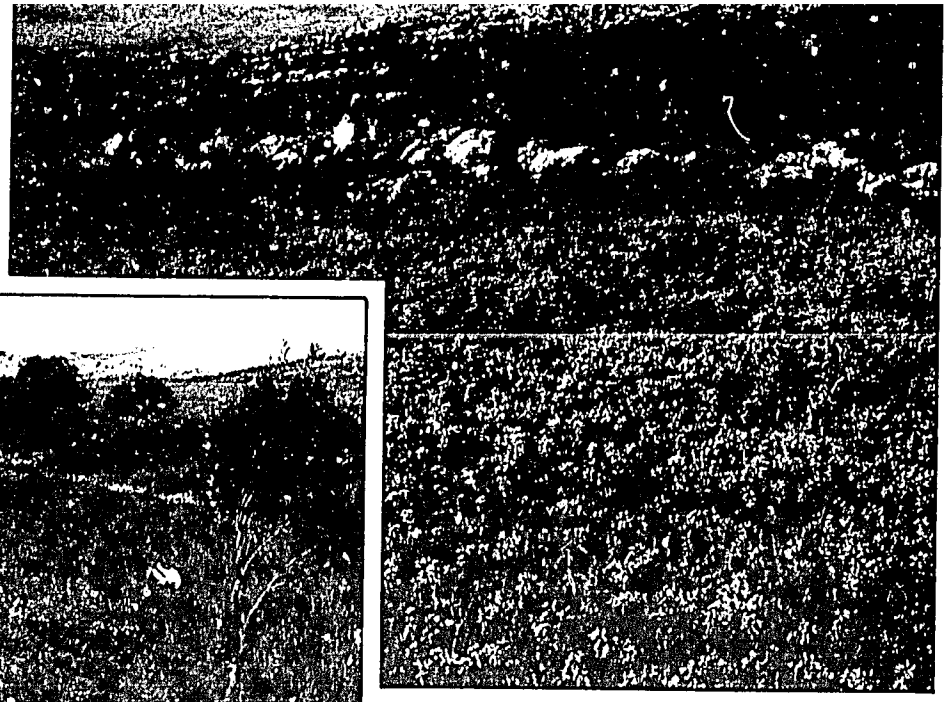
Parallel with this work, we have recently begun testing methods to measure wind erosion. We will apply those methods at the experimental sites mentioned above to compare the effects on soil movement of site characteristics, surface management and potential erosion control treatments; and the data obtained will be used to calibrate a computer model of wind erosion.

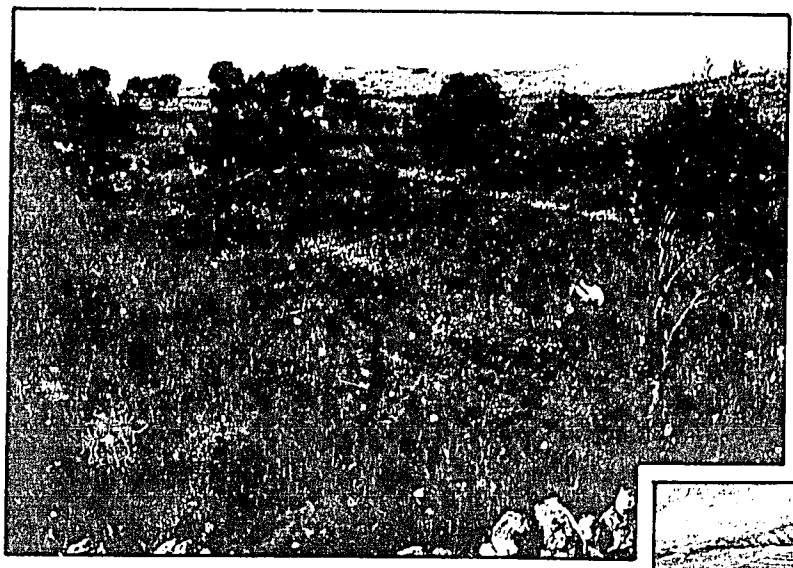
Any large-scale implementation of new land management systems, such as windbreaks, requires first a clear understanding of current agricultural practices and the underlying rationale of the landusers in relation to their biophysical and socio-economic context. ICARDA is currently initiating studies of sheep-flock and land-use management and the associated linkages between cultivated and uncultivated areas in Syria. The underlying hypothesis is that the social and economic organization of production should serve as a base to approach and improve resource management practices. The studies will follow the year-round activities of the groups tending semi-nomadic flocks.

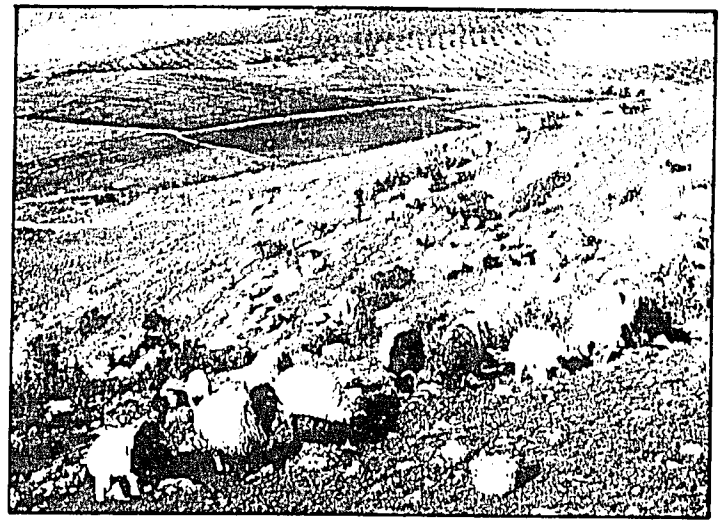
Although there are commonalities, the results of such studies tend to be country- or location-specific. It is important then that the management problems of fragile agricultural resources be examined nationally. ICARDA has initiated a project to promote national case studies by small multidisciplinary teams of specific problem areas, with the general aim of assessing the impact of existing production systems on the natural resource base and seeking, with land-users' participation, safer, more sustainable farming practices. One such study will be conducted by Jordanian scientists at Lajoun in southern Jordan, along a short transect that covers several different land-use systems: open rangeland (i.e. uncontrolled grazing with barley-growing incursions), government and cooperative range reserves, and settled arable areas. It will appraise the current situation in the open range area (aims and perceptions of land users; condition of soil and vegetation) and compare it with that in the two reserve areas, in terms of resource degradation, current productivity and the needs of the local communities. Other case studies have been started in southern Tunisia and Libya, and are proposed to be initiated in Lebanon and, possibly, Yemen. Findings will be shared at a joint workshop.

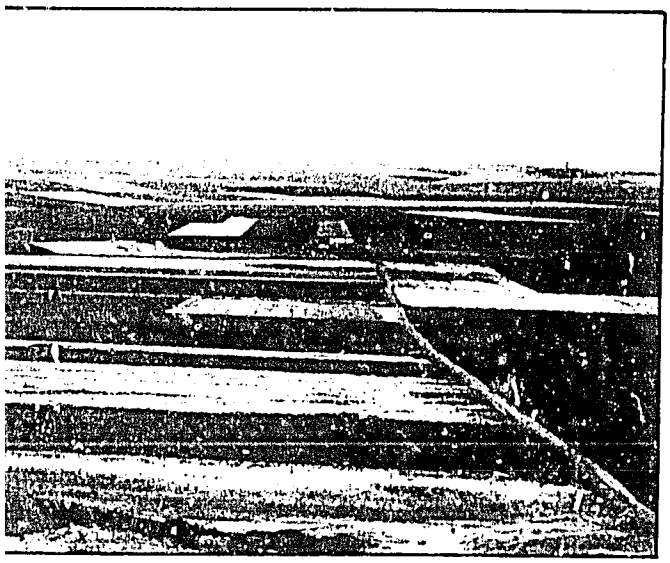
All the present ICARDA actions directed towards resource-base conservation are in the drier areas, the barley-livestock systems and the steppe fringes, and concern problems of vegetation degradation and wind erosion; but sloping lands in wetter areas are no less at risk. The botanically rich flora of maquis and garigue, which, utilized only as rough grazing, afford the often shallow, stony soils some protection against erosion by water, is being replaced by clean-tilled orchards of olive, apricot, fig,

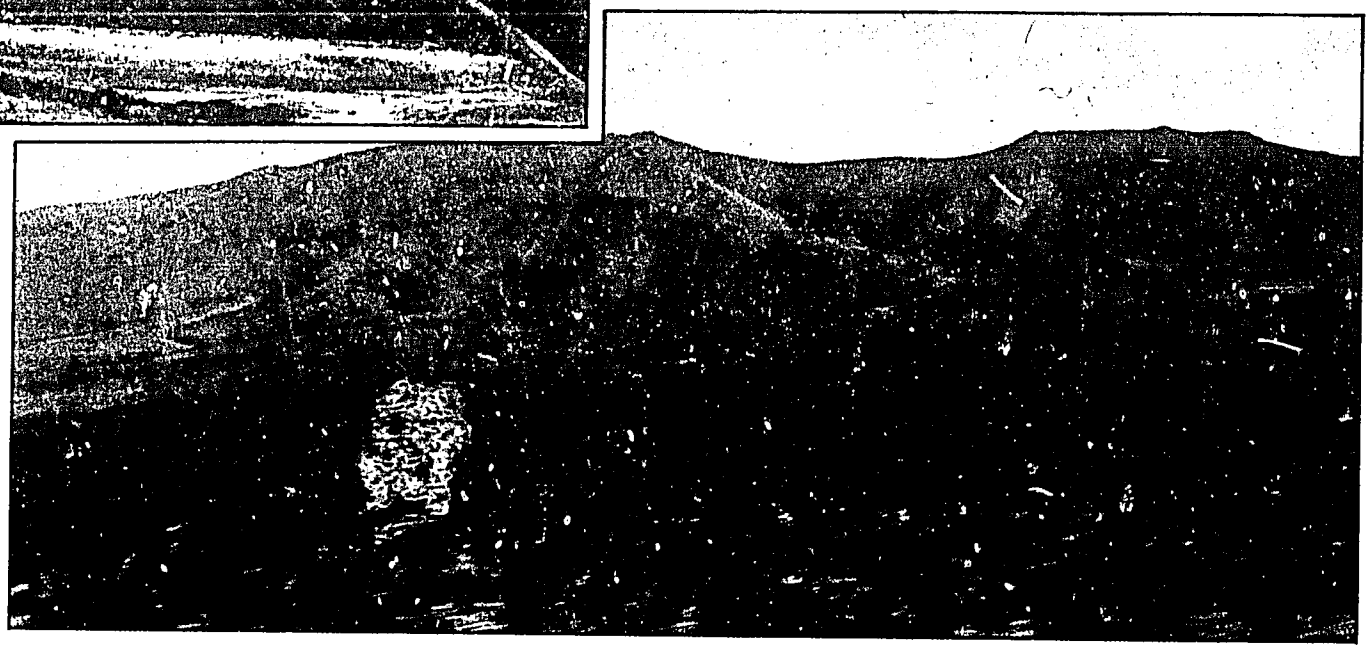
and to promote productive and stable agriculture in a wide variety of landscapes and environments.











and vine. In the absence of terracing, one can only be pessimistic about the likely lifespan of these orchards and the soils that support them.

Possible research topics include the technical and socio-economic aspects of simple terracing, bunding, or the planting of vegetated contour strips in orchards, and changes of land use such as the rehabilitation of steep arable slopes as permanent pastures or terraced orchards. There is also the question of replacing the clean tillage between trees with soil-protecting forage crops or permanent pastures; for this, technical research is required first to quantify the competition for water between trees and crops and to assess the economic implications.

On lower, gentler slopes carrying arable crop rotations, there is often a need for softer conservation measures, such as contour plowing. In such cases, it is not technical research that is required, but socio-economic studies seeking ways to make soil conservation programs, imposed by government agencies, more acceptable and profitable to farmers and, hence, sustainable.

Throughout the resource-base priority there is a paradox: although every sustainability issue is, to a degree, unique--location-specific not only in the particular combination of physical parameters, such as climate, slope, vegetation, soil-type and land-use history but also in the requirements of the land users and the society to which they belong-- nevertheless, similar problems recur in many places, and for many of them adaptable solutions already exist. ICARDA believes its function is to bridge this paradox, on the one hand by encouraging location-specific research and development, and on the other hand by synthesizing the results of such work into a body of broadly applicable experience.

Two ICARDA initiatives are relevant here. First, a core project 'Agroecological characterization for resource management' has for some years been gradually assembling a small pool of expertise in the modelling of crops, weather/climate and soil erosion, and in geographic information and other data management systems. In large part, its work consists of selecting from existing models and systems worldwide and adapting them and interfacing them. There are major problems in acquiring data and in validating the models. In the case of wind erosion we must start from scratch, collecting data to validate an off-the-shelf model for steppe and dry barley-area conditions. There are also the questions of if and how to build in relevant social and economic factors. The general aim is not to capture electronically the agricultural environment of the whole region but to contribute, to national governments and other users, tested systems and software for defining and matching environments, production systems and sustainable technologies.

Secondly, ICARDA is recruiting a specialist in soil conservation and land management, to identify the main technical, social, and policy issues of sustainable soil and land management and to develop linkages to current research and development activities in the WANA region. His role is intended to be catalytic, stimulating new concern and action towards preserving the resource base; and connective, distilling the wisdom of different national experiences and liaising between national scientists and development agents, ICARDA scientists, and the management realities faced by land users. This work will also contribute to, and be supported by, the agroecological project.

Altogether, by placing research into crop and animal production problems more explicitly into a sustainability context and by opening a new research front on resource conservation and land management, as detailed above, ICARDA believes it has realigned its program towards the long-term agricultural production needs of its region. Through its own research and the research it stimulates in the national programs, ICARDA will promote the cause of sustainable agriculture throughout West Asia and North Africa.