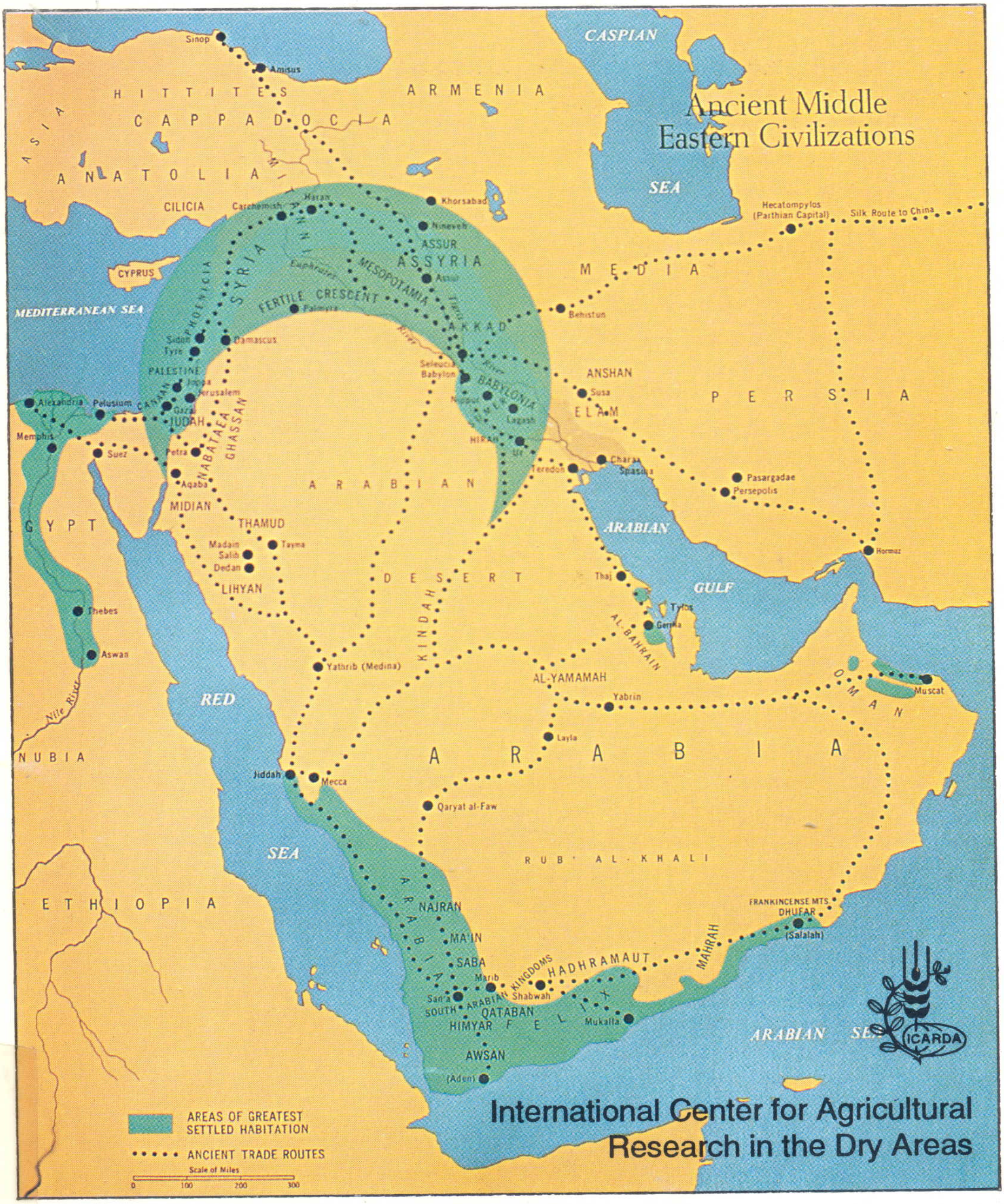
Conservation, Management and Sustainable Use of Dryland Biodiversity within Priority Agro-Ecosystems of the Near East



International Center for Agricultural Research in the Dry Areas

About ICARDA

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 mission of the CGIAR is to contribute, through its research, to promoting sustainable agriculture for food security in developing countries. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem-solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to strengthening agricultural research in developing countries.

In the context of the challenges posed by the physical, social and economic environments of the dry areas, ICARDA's mission is to improve, through research and training, the welfare of people in the dry areas of the developing world by increasing the production and nutritional quality of food while preserving and enhancing the resource base. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry area developing countries for on-farm water-use efficiency, small ruminants and rangelands; and the West Asia and North Africa region for production enhancement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural resource management practices.

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 and elsewhere in the world.

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 is offered extending from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.

Conservation, Management and Sustainable Use of Dryland Biodiversity within Priority Agro-Ecosystems of the Near East

Highlights of the Proceedings of a Workshop
31 October to 3 November 1995, Izmir, Turkey

Editors

Scott Christiansen and C.M. Anthea Vaughan

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Front cover: The Fertile Crescent (courtesy Don Thompson/Saudi Aramco).

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Foreword

Many of the crop species of temperate agriculture originated and were first domesticated in the Near East (including Turkey, Iran, Iraq, Jordan, Lebanon, Palestine, Syria and Egypt), where their wild relatives and numerous landraces are stll found today. It is an area of megadiversity of important food-crop, pasture and rangeland species.

The countries mentioned support a population of about 222 million which—with an average annual growth rate around 3%—is expected to more than double by 2025. Agricultural production, including pastoralism, is the principal economic activity of the majority of the population in this region. To meet national aims of food self-security, agricultural land use has been intensified and expanded, leading to severe erosion of biodiversity, and degradation of vegetation, land and water.

Large exclusionary reserves to preserve biodiversity, which remove land from productive use and do not take account of local needs, are unlikely to be popularly accepted; nor is exclusion necessarily the best means of conservation—for many species and habitats *active* management may be required to conserve their diversity. Consequently, existing traditional and multiple land uses, and the livelihoods that they support, must be taken into consideration: ways to build niches for the maintenance of biodiversity within these agricultural systems must be devised.

In-situ conservation of biodiversity over large areas of degraded arable- and range-lands in dry areas depends upon enlisting the active support of the land-users. This can only be accomplished by a wide range of participatory methods, and by ensuring that land-users appreciate the benefits which can accrue through participatory co-management of natural resources and biodiversity.

In June 1992, when world leaders at the Earth Summit in Rio de Janeiro agreed on UNCED's Agenda 21, they requested the international research community to consider specific contributions to its implementation. The International Center for Agricultural Research in the Dry Areas (ICARDA), with its sister institute, the International Plant Genetic Resources Institute (IPGRI), responded to this request by initiating a proposal in collaboration with the Arab Center for Studies of the Arid Zones and Dry Lands (ACSAD) to establish a consortium in partnership with concerned national research institutes (NRIs) and non-governmental organizations (NGOs). For this purpose a series of workshops was organized during 1994 and 1995 with support from the United Nations Environment Programme (UNEP).

The Izmir meeting proceedings reported in in this volume represent a follow-on to earlier meetings held in Amman, Jordan, to develop a regional project for biodiversity conservation in the Near East. The project, entitled *Conservation, Management and Sustainable Use of Dryland Biodiversity within Priority Agro-Ecosystems of the Near East*, was submitted to the Global Environment Facility (GEF) in September 1995 for consideration after extensive consultation with the institutions and countries involved. The

Izmir meeting was to construct a more in-depth plan for the use of geographic information systems (GIS) in support of natural resource and biodiversity conservation and utilization.

I hope that the information presented in this volume will be of interest and use to all those concerned with the preservation of biodiversity in the context of food security.

Adel El-Beltagy
Director General
ICARDA

Acknowledgments

Participants and organizers would like to thank the great efforts made by the Turkish National Program in hosting the meeting, in particular the Aegean Agricultural Research Institute, and its Director Dr Ertug Firat, Menemen, Turkey.

Workshop Venue - The Aegean Agricultural Research Institute, Izmir, Turkey.

Editors' Note

This publication is a synthesis of summaries of the papers presented. As such it fulfils the deliberate intentions of the Workshop Organizing Committee. The list of presented papers is numbered in the order in which the papers were delivered. In the main text, a number 1-29 in parentheses refers to the number of the paper from which the information was sourced. The bibliography comprises all the references cited in the full papers. It does not purport to be a comprehensive list of relevant literature. Photocopies of the original papers can be obtained by writing to ICARDA.

List of Presented and Contributed Papers

1. A Farming Systems Perspective. *M.J. Jones*
2. The Rangeland Biodiversity in Palestine: Challenges and Prospects. *J. Isaac*
3. Genetic Resources Database at ICARDA and Links to GIS. *J. Konopka*
4. Computing Environment, Data Resources and Activities for Geographical Information Systems in ICARDA. *Z. Abdul-Hadi*
5. Coordinating Soil and Biodiversity Conservation. *G. Abdelgawad and H. Habib*
6. Water and Ecosystem (Biodiversity) Conservation. *M.J. Jones*
7. Effects of Policy Measures on Agricultural Intensification and the Sustainability of Resource Use in Environmentally Fragile Watersheds. *B. Barbier*
8. Overview of GIS. *Z. Abdul-Hadi*
9. Use of GIS in Palestine. *J. Isaac*
10. Overview of ARC/Info and ARCView. *G. van Eeden*
11. GIS Laboratory Hands-on Session. *M.S.E. Owewi with J. Isaac, G. van Eeden, J. Konopka and Z. Abdul-Hadi*
12. Complementary Conservation Strategies: Turkish National Program as an Example. *A. Tan*
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16. Utilization of Plant Genetic Biodiversity for Cereal Improvement in Turkey. *I. Özberk*
17. Medicinal Plants of the Fertile Crescent. *K.H. Batanouny*
18. Restoring Plant Biodiversity in the Mediterranean-Type Arid and Semi-Arid Degraded Habitats. *M.N. Sankary*
19. Policy and Property Rights Research as Prerequisites for Biodiversity Conservation and Management in WANA. *T. L. Nordblom and G. Gintzburger*
20. Marginal-Land Improvement Using Annual Legumes, and the Need for Seed-Multiplication Strategies. *S. Christiansen and A. Osman*
21. Village, Farm and Pasture Resource Assessment in Planning a Forage, Livestock and Range Improvement Project for the Central Highlands of Turkey. *H. K. Firincioglu, S. Christiansen, E. J. Lamont, S. Unal, M. Peskircioglu and S.P.S. Beniwal*
22. *In-Situ* Conservation of Local Races of Livestock. *N.I. Hassan, M. Wardeh, M. Dawa and Z. Abdou*
23. The Survey of Economic Plants for Arid and Semi-Arid Lands (SEPASAL) and its Potential as a Tool for Recording Plant Uses Directly from the Field. *S. Davis, F. Cook and H. Prendergast*
24. Building Capacity for Environmental Information Management: Framework for Managers and Decision-Makers. *J.R. Busby*
25. Case Study: The Development of Appropriate Methods for Community Forestry in Turkey. *S. Arançli, P.R. Stevens and R.E. Dönmez*

Highlights of the Proceedings

'Our purpose here is to find ways to build bridges between resource users and resource protectors: to identify generic and sustainable mechanisms that may be used to reconcile the different interests of the two parties; to find satisfactory syntheses of the short- and long-term objectives between survival and production now and survival and production in the future.'

Mike Jones (1)

Biodiversity can be seen as an international public good sustained only through the concerted interest and support of many nations working together for the common good of mankind (19). That the world's biological and other environmental resources are rapidly degrading is, therefore, of international concern. The changes and potential impacts of this degradation include:

- biological diversity decline, as seen in accelerating species extinctions, reduction in the areas of distribution of species, and the destruction, modification and fragmentation of habitats and ecosystems;
- decline in the health and functioning of ecosystems, as seen in biodiversity loss, degradation in air and water quality and loss of soil; and
- decline in human quality of life, as seen in increasing world poverty, increasing disease, and social, political and economic instability (particularly, increasing conflicts over resources) (24).

Unfortunately, this negative scenario is very true of the dryland areas of WANA. 'Unsustainable' human activities are primarily to blame. Consequently: 'the concern is the sustainability of biodiversity through the *management* of the natural resource base. The viewpoint is agricultural and, in broad terms, the resource is land. The agriculturally manageable face of land comprises soil, water and vegetation in close interdependence' (1).

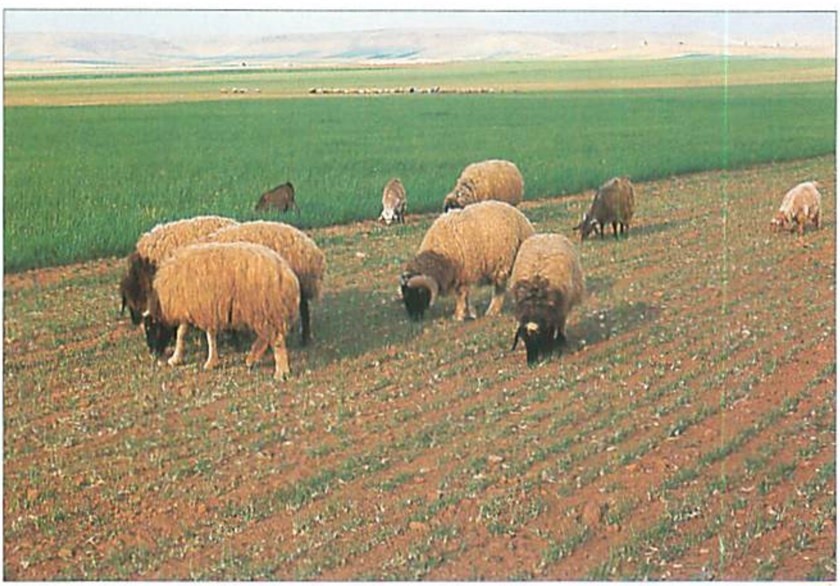
Herders and farmers use (and threaten) natural resources while engaged in a daily struggle for immediate survival (5; 18; 19). Their current needs tend to obscure the benefits of setting aside resources on behalf of future generations (19) i.e. their immediate concerns tend to be far removed from the more global 'idealistic' objectives of (preferably) *in-situ* conservation of natural biodiversity and the protection of soil and water for sustainability of production potential (1). People will (and must) continue to use natural resources in production systems that will need to be adapted and, probably, intensified as populations and economic pressures increase. Thus, the goal of sustaining biodiversity will be achieved only by working *with* these systems and influencing the relevant changes in more resource-conserving, yet more productive, directions (1).

Individuals, local communities and governments, industry, sovereign states and international institutions make decisions that directly affect biodiversity. That they all have widely differing perspectives regarding the multi-faceted and complex environmental issues involved, further complicates the situation. There are no simple answers and, all too often, main issues are obscured by a 'tyranny of small decisions' (24). Also, because the production systems are dynamic, no single solution to a particular problem will be permanently effective (1). A long-term commitment is essential if the evolving system is to be kept relevant to the needs of the major users (24).

This publication highlights the output from discussions between a group of resource-protectors with particular interest in the biological, agricultural and sociological aspects of biodiversity conservation in the Fertile Crescent, and technologists with specialist knowledge of geographic information systems and other modern technological tools for use in this field. All acknowledged that prerequisites for protecting natural resources are an understanding of their use and value (1) and the policies and property rights that affect land-use practices in West Asia and North Africa (WANA) (19). The first two sections, therefore, give due recognition to:

1. the human dimension (i.e. the essential involvement of the *in-situ* individuals and societies with the *in-situ* vegetation); and
2. the essential interdependence of the natural resources of soil, water and vegetation.

In the course of the workshop, reference was made to several different farming and land-use systems, including: cereal-livestock systems in areas with 200-300 mm annual rainfall occurring widely in the WANA region (1; 21); pasture, forage and livestock production (2; 18; 19; 20; 21; 22); rain-fed and irrigated crop production (13); and community forestry (25). A further two sections deal with methods of resource conservation, rehabilitation and development, and the tools and methods available to improve their execution, including the handling and storage of data.



Barley-livestock farming system (courtesy M. Jones).

Barley cultivation on marginal land (courtesy M. Jones).

I The Human Dimension

Related to the human dimension are the issues of state policy and property rights. Nordblom and Gintzburger (19) maintain that linking policy and property-rights research is an important issue in conserving and managing biodiversity. They point out how the 'old' tribal structures concerning rangelands demonstrate potential for biodiversity conservation and management. Changes in policy and property rights have altered land-use practices in WANA to patterns that appear not to be sustainable in the low-rainfall areas. Unless significant policy-, institutional- and technological-reorganization occurs, the problems of a degrading resource base and threatened biodiversity are likely to worsen due to population growth and increasing income needs. With appropriate reforms to policy and property rights and sufficient agricultural research of the right kind, however, it should be possible to remedy the situation and increase productivity in sustainable ways. If social (poverty reduction) and environmental benefits are considered in addition to productivity gains, public investments in these areas can be competitive with investments in higher-rainfall regions (19).

The application of the 'induced innovation' theory (Ruttan and Hayami 1990, in 7) to the problem of ecosystems suggests that, under conditions of increasing population pressure and expanding markets, both conservation and intensification practices will be adopted. It does not indicate, however, the effect on poverty levels. Farmers in favorably-endowed environments usually confirm this induced-innovation theory (7).

With reference to West Africa, but relevant too for the semi-arid conditions of much of WANA, it is reported (7) that farmers prefer to reclaim marginal land or to migrate to lower-density areas rather than intensify the production per land unit. Two opposing arguments for this situation are: that of the 'neo-Malthusian school' (constraints are poor agricultural conditions and the effects of excessive population density and excessive population growth); and that of the 'Boserup' school which latter suggests that, in Africa, population density is still too low to induce protection of resources and intensification per hectare. Because migrants and pastoralists generally are seen as being responsible for deforestation, overgrazing and loss of biodiversity and, in the belief that higher population density induces a more sustainable intensification, there is a growing pressure on governments to introduce policies that discourage migration and fix populations on present sites. However, migration may also be an opportunity for development, and pastoralism may be an efficient way of using rangeland. Of the policies which are most likely to influence farming systems toward more sustainable practices, population and migration policies are particularly important.

The absence of clear land tenure is usually considered a major cause of extensification and degradation. Hence, land allocation is among the more popularly proposed solutions. Designated property or land management rights are likely to secure tenure and diminish open access: they may also provide access to credit and create a land market. Reportedly, several economists are examining whether or not land tenure is in fact a major contributor to land improvement practices, crop productivity increases, environmental protection and/or pasture improvement.

Since the 1980s, output and input prices have become less-disputed topics because of economic liberalization policies, but governments still use prices to influence the development of the particular agriculture they advocate. As most fertilizer subsidies have been either reduced or abolished under structural adjustment programs, fertilizer use has decreased. Barbier (7) questions, therefore, whether intensification through chemical fertilizer use is still possible in most dryland regions or whether an alternative fertilization strategy should be promoted.

In 1984, Matlon and Spencer (in 7) emphasized the lack of reliable technologies capable of addressing the problem of intensification and land conservation in semi-arid systems. Since then, despite researchers having made tremendous efforts to classify the main systems, identify constraints and promote adequate technologies, it is not yet clear which kind of farming system will replace the traditional fallow system.

Nordblom and Gintzburger (19) give examples of policies and property rights that demonstrate beneficial or detrimental effects on biodiversity:

Tribal property rights (19)

- In the 'Gueddal' or 'Agueddal' system in North Africa, a tribal decision was made to set aside some feed reserves for war-time, for draft animals, and for small ruminants in case of a drought.

- The dismantling of tribal structure and property rights in the Maghreb and the Mashreq has encouraged open access and free grazing for everyone, with the result that inter-clan solidarity regarding pasture and water resources has weakened.
- The sinking of wells in remote areas may have a favorable impact on the well-being of settlers but has allowed longer and more damaging utilization of rangelands that, ormerly, were used only in the winter months.
- In Syrte, Libya, the Kadadfa tribe and others own the winter grazing rights deep into the Libyan desert and into northern Chad. Because of this, the coastal rangelands are spared for summer pastures. In terms of biodiversity, the Syrte rangelands are rich in early-maturing annual legumes which would have been long destroyed if the flocks had remained in the coastal zone during winter. Though conserved in the Syrte area, this precious biodiversity has totally disappeared from the nearby Jeffara plain where year-long sedentary grazing is now practised (Gintzburger et al. 1983, 1984).
- Because standing crops and both irrigated and rain-fed orchards in a farmland setting are not subject to open-access grazing, wild annual plant species develop as weeds. Such protection from flocks is not afforded to crop residues or private fodder-shrub plantations (Leybourne et al. 1995) which could reasonably be expected to have the same status as a crop. In fact, they are freely accessible to all.

State forestry reserves (19)

Many of the forestry plantations and state owned (and managed) reserves in WANA are not perceived as open grazing. This provides for tree growth, soil stabilization, habitats for wild relatives of economically important species of cereals, legumes and wildlife, and sources of genetic diversity. A GIS summary of the Jebal Abdal Aziz area of northeast Syria, for example, reports an unfenced, well-policed and locally-respected government forestry reserve surrounded by the heavily-grazed, overlapping lands of 56 families. There is a striking contrast in vegetative cover inside and outside the reserve. No grazing is permitted in this forest reserve. If never grazed, however, rangeland vegetative growth may become a fire hazard and it can disrupt long-term forest regeneration. What are required, therefore, are management rules that cover the needs and long-term objectives of the people whose rangelands were lost to the reserve, as well as re-establishment of a native forest. In densely populated areas and where there are no physical barriers (e.g. stone walls, ditches or fences) enclosing reserves, the land is protected by fragile rules derived from a mixture of customary tenure arrangements and state legislation.

Implication of public policy on biodiversity (19)

Tribal rights in WANA countries are being replaced by public policy that strongly supports subsidized feed (initially assigned for drought relief). In effect, it favors farmers who own large flocks and who have trucking facilities (encouraged by subsidized fuel). At the same time it reduces the mobility of the many owners of smaller flocks and limits them to the poorest pastures near water points, thereby augmenting overgrazing and soil erosion. A strict control on subsidized feed may help reduce the animal pressure on heavily-overgrazed range and farmlands.

On Algerian farmlands, high meat prices encourage the practice of weedy fallow plowed only at the end of Spring, after being clean-grazed by small ruminants. In so doing, the land owners secure a high income (US$ 150-200 per hectare per year) with lush pastures rich in annual legumes on the best agricultural land. This practice encourages biodiversity. A lowering of meat prices or state support to cereal production may lead immediately to early plowing of the fallow and the disappearance of these rich and biodiverse native pastures in agricultural lands.

If herbicides are not available, farmers may use deep plowing to control annual *Bromus* spp. and *Lolium* spp. In this way, not only are grass seeds destroyed but also native annual legumes (e.g. *Medicago* spp., *Onobrychis* spp. and *Hedysarum* spp.) - valuable genetic resources which cannot tolerate deep burying. Thus a mere policy change on herbicide availability to farmers may help to protect the diversity of native legumes while controlling grass competition in the cereal crops of North Africa.

Seed policy and property rights (19)

Another extreme case of policy affecting biodiversity encouragement and management, is that of pasture- and forage-seed availability to farmers in WANA. In this region, most formal plant breeding and conserving and characterizing of genetic resources is done by government institutions, with some help from international agricultural research centers (IARCs) and is aimed to serve the modern farming sector. These are services yielding 'public goods' especially with self-pollinating species (wheat, rice, barley, lentil, chickpea, etc.) as these can retain their genetic character and advantages through many generations. Varieties developed in the formal seed sector, however, are not always suitable for the conditions of farmers now depending on their own seed. The question arises, therefore, whether or not a 'promising line' is really useful over a large geographic area currently sown to locally-adapted landraces. It is likely that the 'improved' seeds have a narrow ecological spectrum and, as has happened in many countries (Jaffee and Srivastava 1994) they fail to meet the diverse crop and varietal requirements of farmers. Wide adoption of an 'improved' crop variety can mean the discarding of local genetic material - a tendency toward lower diversity. It can also mean risking huge losses due to adverse climatic conditions or pests and diseases.

Egypt, Morocco, Pakistan and Turkey are beginning to encourage private seed companies. This is all to the good providing there is competition among companies in quality, price and service: seed-quality standards are better enforced by competition than by arbitrary regulation. Private companies, though, can only be expected to involve themselves with the most profitable crops (e.g. vegetables), varieties (hybrids) and markets (irrigated farming), leaving NARS with responsibility for staple crops (mostly self-pollinating crops) and minor food and fodder crops (van Amstel 1994).

In line with the general trend toward privatizing public services, there are strong US, European and international movements to establish conventions on plant breeders' rights. An example is the International Union for the Protection of New Varieties of Plants

(UPOV). Individual plant breeders' rights could, however, lock germplasm in the control of a private company or an individual thereby restricting its movement; a situation which the CGIAR system considers not to be in the interest of the 'public good,' worldwide. Patenting of germplasm by the CGIAR could be justified as a means of ensuring its free accessibility to all.

An 'informal seed sector' accounts for the majority of seed used in WANA countries: farmers select, store and treat their own cereal and forage seed as landraces. In so doing, unique genetic material may be unwittingly preserved for the farmers' and the world's benefit. Typically, though, this sector is neglected by both NARS and IARCs. In the case of pasture and forage species (e.g. annual medics) a mixture of species is preferable to a pure stand of a single variety because of the different ecological advantages of each species under various weather conditions. Pure lines developed in the formal seed sector could well be blended and sown as pasture mixtures. Unfortunately, however, this practice further divides the small percentage of effort that NARS allocate to pasture and forage seed, increasing the cost per species and reducing the volume of each species offered. To circumvent this obstacle, ICARDA is working with NARS, but outside the formal seed sectors, in Algeria, Lebanon, Morocco and Syria.

An open question for discussion of policy is the desired balance of support to the formal and informal seed sectors given that the latter is often larger and touches a greater number of poor farmers. Nordblom and Gintzburger conclude that to develop biodiversity conservation and management it is necessary to devolve development and administration to the lowest level of farmers and pastoral communities, thereby allowing for the restoration of tribal public and property rights.

Economic modeling and policy (7)

As populations and the markets are putting growing pressure on natural resources, economists are trying to design policies that will enable farmers to increase their incomes in a more sustainable way while preserving biodiversity. In this regard, Barbier reports on the development of a dynamic linear programming model which simulates farmer behavior under different scenarios at the watershed (river basin) level. It is used in combination with a biophysical model that predicts technical coefficients on yields and soil status at the plot level. The method was calibrated for two villages (one located in a semi-arid and the other in a sub-humid region) of Burkina Faso, West Africa. Several simulations were carried out for different periods up to the year 2025. The results realistically capture how the cost of labor decreases and the cost of land increases with population increase. Such a situation induces the adoption of new techniques such as composting, anti-erosion practices, agroforestry, irrigation and more intensive crop and livestock systems. According to the model, however, farmers' per-capita net incomes are likely to decrease, despite the adoption of the new technologies. The costs of production intensification and protection outweigh the value of the increased yield. In other words, the shift from a fallow system to permanent agriculture will be especially expensive for farmers such as those in West Africa.

II Interdependence of Natural Resources

Recognition of the mutual interdependence of natural resources is fundamental to their sustainable management. Any alteration in the status of one elicits a reciprocal change in the others. Ideally, the development of systems to use and manage these resources requires integrated approaches to protect soils, water and flora.

Conservation of the natural resources, soil, water and vegetation, should be integrated (courtesy M. Jones).

Soil

Almost all Arab countries suffer from some degree of desertification or land degradation. In Palestine, for example, desertification is one of the most important issues that need to be addressed (2). Soil erosion is widespread in Eastern Anatolia (27). Both soil loss and degradation have been chronic in the region for decades: the area already affected is about 921 million hectares (Table 1) and is increasing (5). Throughout the Fertile Crescent a fairly uniform pattern of accelerating growth, intensification of farming systems and concomitant improper human use of natural resources is developing. No amount of scientific idealism or government legislation is likely to halt these activities in the immediate future - and the problem is immediate (1).

Sustainability of production depends fundamentally on the protection of soil against material loss (by wind and water erosion) and physical, chemical and biological deterioration. Ecologically-sound management practices and treatments that promote vegetative cover simultaneously enhance soil protection (1; 5; 13). Abdelgawad and Habib reported a study carried out by Jaloul and Kbabo (1993), in the coastal area of Syria: soil loss due to water erosion was 10-60 kg/ha under normal levels of vegetative cover, 200-550 kg/ha in burned forest, and about 3280 kg/ha in cultivated areas. However, recent studies on the cost of land degradation in African rural regions with rapidly-expanding populations show that in some regions the fallow system is insufficient to maintain soil fertility and limit erosion. The studies conclude that the effects of nutrient and organic matter depletion are more detrimental than are those of erosion (7).

Table 1 **Breakdown of desertified areas in the Arab world.**

Land use	Total area ha (mill)	Desertified area ha (mill)	%
Rangeland	938	887	90
Rain-fed agriculture	36	30	83
Irrigated lands	11	4	36

Source: Abdelgawad and Habib (5)

Water

That ecosystems and their associated natural elements depend on the quantity and quality of water available to them, is self evident. Availability, in turn, is dependent on 'rainfall and what happens to it.' The relative amounts of infiltration and run-off are a function of both soil condition and vegetative cover (6). Management that encourages greater plant cover (e.g. limitation of grazing, fertilization, re-seeding, shrub introduction, transplantation and afforestation with native and/or introduced trees at specific densities that encourage biodiversity, economical productivity and soil conservation) also enhances infiltration and hence the amount of water available for maintenance of the flora. Conversely, mismanagement of water supplies can cause soil erosion with concomitant depletion of both the seed bank and the volume of the rooting and water-holding medium (6) and soil degradation in the form of increased soil salinity and reduced organic matter and nutrient content. Coupled to land degradation is the loss of biodiversity (5; 13). Also of fundamental importance, therefore, is the promotion of infiltration and prevention of water run-off (6).

Remedies for poor infiltration in arable agriculture include ridging, tied ridging and contour bunding. Their essential common feature is that they restrict the flow of surface water so that it can infiltrate slowly, at a rate determined by the soil condition. Analogous approaches are required for non-arable land if the natural vegetation is to be reinstated and maintained. In some cases, contour ridging or bunding at intervals down the slope may be appropriate, although further destruction of the existing plants and the soil seed bank must be kept to a minimum. For gentler slopes, as in range land, the best solution may be some form of pitting, effected by a machine that scoops out a small depression at regular intervals. These depressions collect rain water and create a mosaic landscape of numerous 'islands' of vigorous growth, conserving species and also providing grazing potential. Under favorable management, colonization of the areas between the depressions may occur (6). Such water-spreading technologies brought about an increase in biodiversity of up to 100 species in a 5 ha plot at Wadi al Azieb, Syria, and increased flood-plain productivity up to 7.5 tonnes of hay per hectare (18).

In a hill-pasture at Tel Hadya (ICARDA), the application of small amounts of phosphate and the control of grazing stimulated a resurgence of the indigenous annual legumes, with subsequent benefit to the grass component and total biomass production. The only field on which run-off of rainwater was ever observed was the 'control,' to which no phosphate had been applied and grazing was at the highest intensity (6).

Water harvesting (6)
Increasing pressure on existing water resources for agricultural production in WANA has prompted a search for new sources of supply. In particular, for drier areas (say, 100-250 mm mean annual rainfall) hopes have been placed in water-harvesting systems that encourage rainwater to drain from designated catchment areas into cisterns, dams or directly onto cultivated land. Such concentration should increase the efficiency of utilization.

Run-off efficiency is enhanced by a sealed (crusted) soil surface, absence of obstructions (such as stones) and absence of vegetation. This is the converse of what is required for infiltration and is clearly inimical to the sustainability of biodiversity. Water-harvesting development is thus in conflict with the principle of resource conservation: efficient utilization of a limited resource (sparse rainfall), requires the destruction of the soil and vegetation on selected areas. Value judgments have to be made. It may be that some land slopes are already so degraded that further degradation to form an effective catchment may involve little additional loss.

Soil degradation due to salinization (courtesy H. Habib).

Groundwater (6)
Groundwater (i.e. shallow rechargeable aquifers) depends for its maintenance on the percolation of rain water downwards from the land surface. Reduced infiltration and increased withdrawal by pumping are rapidly lowering the levels of groundwater in many areas. The remaining deeper water is often more saline, which poses a severe threat to soil condition and plant growth where such water continues to be used for irrigation. Further, as a result of groundwater lowering, springs are drying up, streams are no longer perennial and wetlands dry out - all with detrimental effects on

local ecosystems. A yet-limited (but increasing) practice in some countries (e.g. Oman) is to recharge aquifers with water collected from dams filled by natural surface flows. Ecosystem effects of this practice are not yet clear.

Areas in Qatar affected by salinity (courtesy H. Habib).

Surface water (6)
Much of the surface water in WANA (principally rivers) is used for irrigation. Generally, the quality of this water is high (i.e. has low salt content); but to meet the rising demand, there is increasing re-use of water. Drainage water from irrigated land is returned by land drains, ditches and canals to rivers for downstream users. More directly, farmers pump from the groundwater underlying irrigated land or from adjacent drainage ditches to meet their needs. The inevitable consequence is salt build-up in the water and in the soil. Efficient management of irrigated lands is increasingly a matter of salt management. Effects of such salinization on local biodiversity may be unimportant simply because few indigenous, non-crop species remain. However, it may be noted that there is an increasing demand for salinity resistance (or tolerance) in new crop varieties. Some of the genetic material for this may be found where naturally saline habitats have been preserved.

Soil water (6)
Productive cropping in water-limited environments requires the efficient use by crop plants of soil water, whether from rainfall or irrigation sources; i.e. the proportion of available water transpired by the crop plants should be maximized. Essential to this is the suppression of weeds. One person's weeds, however, are another's biodiversity. Trends towards more intensive, mechanized high-productivity weed-free cropping, without the moderation previously provided by fallowing, increases the threat to species and local ecotypes which have survived previously within the protection of traditional farming practices.

Vegetation

The vegetation component of the natural resource base comprises:

- numerous and varied natural floral associations, valuable both as potential grazing resources and as a protective covering for the soil;
- individual plant species (and their local ecotypes) within the floral associations, valuable both as part of an ecosystem and as a large genetic reserve for agricultural utilization; and
- the crop plants, among which the landraces particularly are seen as an essential and vulnerable part of the total diversity.

In addition, various speakers testified to Sankary's (18) 'enormous and varied reservoirs of genetic variability that have accumulated . . . across each of the major phytogeographical belts' in the drylands region of the Middle East:

'One person's weeds are another's biodiversity.' Three wild forage legumes within a poor crop of barley (courtesy M. Jones).

- 'The region is rich in endemic biota which are adapted to the prevailing (and diverse) conditions. They represent an asset of genetic resources which is rarely met elsewhere. Enclaves in the mountainous regions are sites of endemic species. These are the "hot spots" of biodiversity.' (12).
- In a detailed account of Turkey's geography and associated plant genetic resources (9) the wealth of genetic diversity is described in the 163 families, 1225 genera and 9000 species found there. Of these species, 3000 are endemic. These rich plant genetic resources have provided the raw material for much of the temperate world's agriculture. Primitive landraces, crop wild relatives and other wild plant species from Turkey continue to provide new sources of important traits for improving agricultural production worldwide.
- Eastern Anatolia is the center of origin of many forage species (9; 14; 15; 21). More specifically, Kiziltan (14) and Alptekin (15) list the following cultivated species that originated in southeastern Anatolia: *Linum*, *Allium* spp., *Triticum monococcum* subsp. *monococcum* (eincorn wheat), *T. turgidum* subsp. *durum* (durum wheat), *T. turgidum* subsp. *turgidum* (Poulard wheat), *T. aestivum* subsp. *aestivum* (bread wheat), *Hordeum vulgare* subsp. *vulgare* (barley), *Secale cereale* (rye), *Avena byzantina* (red oat), *Cicer arietinum* (chickpea), *Lens culinaris* (lentil), *Pisum sativum* (pea), *Medicago sativa* (alfalfa), *Pistacia vera* (pistachio), *Vitis* (grape), *Amygdalus* spp. (almond), *Prunus* spp. and *Beta* spp.

The Eastern Slopes in Palestine (courtesy J. Isaac).

- According to Iranian botanists there are 10,000-12,000 plant species in Iran (29); 95 landraces of bread wheat have been collected from the western part of Iran (28).
- Palestine, highly influenced by a Mediterranean type climate and

Bryonia dioica *Jacq - purgative (courtesy K. Batanouny).*

Capparis spinosa *L. - diuretic, astringent and tonic (courtesy K. Batanouny).*

Papaver somniferum *L. - sedative (courtesy K. Batanouny).*

Calendula officinalis *L. - emetic (courtesy K. Batanouny).*

diverse topography and altitude, is divided into five main distinct climatic regions: the Jordan Valley, the Eastern Slopes, the Central Highlands, the Semi-Coastal region and the Coastal region of the Gaza Strip. These regions house a rich stock of natural flora of approximately 718 genera and more than 2250 species (Hosh and Laham, 1993). This number is large relative to the small area of Palestine. The Eastern Slopes, constituting close to 40% of the West Bank, is a 'gold mine' in biological diversity. Over 2000 plant species are known to exist along these slopes; many are biologically specific to the Fertile Crescent. At least 16 of these have been identified having of economic importance to pastoralists. Many others are known to have medicinal properties and are much used by the local population. The gene stock for future agricultural advances may very well exist in the grasses and legumes which grow naturally in this region.

- Numerous treatises have been written, in various languages, about the use of medicinal plants in the region. The monumental and celebrated 'Materia Medica' (written in AD 78 by Pedanius Dioskorides) describes 950 drugs which come from plants, many of which grow wild in the Fertile Crescent. Batanouny (12) refers to many other writings on the medicinal plants of the Near East, indicating how important a role they played in the lives of people, their scientific knowledge and economies. A short list of some medicinal plants of the region is given in Appendix 1.

Conservation and collection efforts to save at least a part of the remaining genetic diversity in drylands have, in the past several decades, netted a formidable assortment of accessions from hundreds of species. For example, at ICARDA alone there are holdings of the following genera: 7888 *Medicago* (85 taxa), 3405 *Trifolium* (66 taxa), 1849 *Lathyrus* (56 taxa), 5481 *Vicia* (101 taxa) and 8337 accessions from an additional 196 taxa (20).

III Resource Conservation, Rehabilitation and Development

The threat

The profound loss of natural vegetation in the Fertile Crescent in recent decades has been quantitative, in terms both of area and of annual biomass production per unit area, and qualitative, in terms of biotypes, species and of local, specialized types (1 and 2). Abdelgawad and Habib (5) maintain that, especially in the more fragile and arid ecosystems, many species of plants, animals and other organisms have been lost (Table 2).

Spread of Sarcopoterium spinosa *(courtesy J. Isaac).*

They explain qualitative changes as a dominance of low-value species of range plants and the substitution of perennial plants with low-value annual plants. In Palestine, for example, many of the lost plant species have been replaced by the unpalatable *Sarcopoterium spinosa*, preventing the growth of useful plants. These effects are largely unquantified though the current percentage of endangered species in the local flora is between 8 and 19%.

Exploitation of medicinal plants in their natural habitats has been long and continuous. Many are now endangered as a result of the impact of other human activities and no systematic effort has been made to ensure their availability on a continuing basis: important genetic resources are being lost (17).

Strategies for biodiversity protection and restoration

The long-term aim should always be to achieve protection naturally, *within* profitable (and evolving) farming systems and *without* the provision of external inducements and inputs.

Table 2. Approximate number of endangered or extinct species in the flora of some Arab countries

Country	No. plant species	Endangered & extinct species (%)
Syria and Lebanon	3,070	8
Palestine and Jordan	24,550	10
Iraq	1,985	14
Saudi Arabia	2,030	17
Egypt	1,732	19

Source: Sankary, 1995 in (5)

In other words, 'indiginize conservation' (1). Two broad strategies are suggested: which of the two to follow will depend on the local circumstances of each particular case. They are:

i. protection of the 'islands' (or relict areas) where damage has been least - these may be very local pockets of relative inaccessibility and apparent low potential, or larger areas, relatively isolated by geographic remoteness and/or poor communications, often with low population density and subject to emigration;
ii. working through and alongside the development process to build in safeguards wherever possible, e.g. creating uncultivated 'islands' on contour banks and other soil-conservation or water-harvesting structures.

Sankary (18) advises that areas with specific and important endemic biodiversities be given particular attention. He maintains that 'growth in bioproduction should be sought through restoration of climax, subclimax and seral biodiversities and/or reconstruction of super-productive phytosystems' and can be achieved by:

- establishing reserve areas and enclosures;
- adjusting or arresting plant succession;
- adjusting stocking rates and regulating long-term carrying capacities;
- ecologically-sound planning of afforestation and management;
- formulating communities of grazing plant;
- formulating agro-sylvi-pastoral-systems;
- applying soil-management practices;
- introducing water-spreading technologies;
- restoring or introducing economic and salt-tolerant biodiversities to the drainage systems of agricultural lands;
- searching for evolutionary biodiversities for conservation and utilization;
- controlling biofragmentation; and
- identifying useful genes for incorporation into crop plants to improve biodiversity, productivity and resistance to pests.

Instead of plowing marginal and arid low-lands for cereal production, an alternative approach for application in the ecologically suitable areas of the floodplains is advocated (18): it uses forage shrubs in composite varieties or species mixtures alternating with consecutive belts of undisturbed native vegetation and barley cultivation.

ARIJ hydroponics unit (courtesy J. Isaac).

Recognizing, too, that the current cause of much of the soil degradation (and hence biodiversity loss) is grazing, the Applied Research Institute of Jerusalem (ARIJ) experimented with new plant varieties and technologies in order to relieve the pressure of overgrazing and, hopefully, to allow for the restoration of these areas. For example, the Institute introduced a hydroponics system to produce an alternative source of green fodder for animals. Several trials and demonstrations have also been conducted in cooperation with local farmers to identify more productive and drought-tolerant field crops which could adapt to the climate of the Eastern Slopes. While the results were encouraging, the need for a more comprehensive strategy for the restoration of Palestine's rangeland, preservation of biodiversity and prevention of desertification is recognized (2).

In highlighting the need for developing a regional strategy for the conservation of wild medicinal plants Batanouny (17) suggests that the medicinal plants be integrated with agricultural development.

Recommended action includes:

- the identification of areas of special concern ('hot spots');
- the identification of species or taxonomic groups of plants which require *in-situ* conservation and those that require *ex-situ* conservation; the identification of regional support mechanisms for conservation e.g. education, training, referenced collections;
- establishment of a regional network for monitoring and exchange of information; establishment of a program in ICARDA for propagation and conservation of wild medicinal plants of the region; and
- establishment of a network to make inventories of medicinal plants (native ones), record their distribution, uses, status and reproductive ecology, etc.

Execution of the above activities can be greatly facilitated using remote sensing, a powerful tool for monitoring changes in land use, and surface cover, over wide areas. There is still a need, though, for complementary ground-truth studies of land use, vegetation, soil condition and socioeconomic conditions and considerable monetary and human resources are yet required (1).

Preliminary surveys and planning

Abdelgawad and Habib (5) stress the importance of proper land-use planning in conserving both soil and biodiversity to achieve the objectives of production and protection. Such planning requires thorough knowledge of the degree of degradation and biodiversity loss, the socioeconomic context and the type of farming system of the location.

Surveys and inventories (14) are required before any actual restoration activities can be implemented: the information gained can be used to determine habitats suitable for *in-situ* conservation management and, while making inventories, samples can be collected for complementary *ex-situ* conservation in genebanks. Specific sites set aside for the *in-situ* conservation of wild relatives of crops are known as gene management zones (GMZs). They are biological reserves selected to represent the ecogeographic ranges needed for targeted species and protected by management practices adapted to the different species. A series of GMZs can be selected to represent the ecological range of an area. Turkey's national plan for *in-situ* conservation includes the establishment of a network of GMZs to ensure the protection of wild relatives of crops and forest genetic resources in their natural habitats (14). In explaining the Turkish national conservation program, Ayfer Tan (12) summarized the complementarity of *in-situ* and *ex-situ* conservation strategies (Table 3).

Table 3. Comparison of *In-Situ* and *Ex-Situ* Strategies.

Strategy		Advantages		Disadvantages
In situ	1	Dynamic conservation and continuous evolution	1	Reserve size under discussion
	2	Understanding of evolution and diversity	2	Management and monitoring not yet clarified
	3	Crop/pathogen interaction	3	Vulnerable to outside influences
	4	Best for species with recalcitrant seeds	4	Limited amount of diversity can be conserved in the GMZ
	5	Biological and ecological information	5	Conservation method of landraces under discussion.
	6	Socio-economic information	6	Limited access to material
Ex situ	1	Long-term storage	1	*In-vitro* facilities or field genebank required for those recalcitrants that can be stored
	2	Conservation of wide diversity in form of seeds	2	Diversity of recalcitrants that can be stored is very limited
	3	Easy access to material	3	Evolution arrested
			4	Some diversity loss during each regeneration cycle
			5	*In-vitro* conservation may cause loss of diversity

The choice of strategy used to conserve genetic diversity depends on the nature of the material and must take into account the relevant technical, biological and management factors (12).

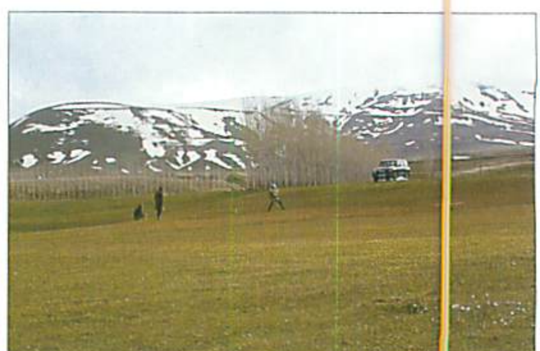
SEPASAL (Kew Gardens' Survey of Economic Plants for Arid and Semi-Arid Lands) is a major computer database (developed in Microsoft Access) with records on nearly 6000 species of plants that are useful in dryland areas (excluding major crops). It assimilates traditional and academic knowledge to enable evaluation and assessment of plant species for particular purposes and disseminates this information to aid agencies, development organizations, governmental and non-governmental organizations and individual research workers and growers. SEPASAL is also used to target species for germplasm collection and storage by the Kew Seed Bank at Wakehurst Place, UK. The plants on which SEPASAL focuses are taxonomically and geographically diverse: though of wide-ranging uses many have hitherto been of little interest to either the agricultural or conservation communities. International standards are adopted for recording plant uses and geography. SEPASAL currently has records on 388 taxa found in Turkey, of which 190 are herbs or subshrubs used as animal food. These data could provide a useful starting point for any *in-situ* genetic biodiversity conservation pilot project.

Examples of current conservation/restoration implementation

Production Improvement of Pasture and Fodder Crops in Eastern Anatolia (27)

This joint UNDP/FAO/Government pilot project, was implemented in Eastern Anatolia (EA) between 1989 and 1993. The objective was to improve, in a sustainable manner, the pasture, forage and livestock production in a pilot project involving four villages representative of the 10 least-developed (government-assessed) provinces of EA. Diagnostic surveys revealed the existence of many production-limiting, socio-economic problems, most of which were beyond the control of the project. It was concluded, however, that improvement of production techniques by the introduction of new innovations would raise the living standards of the local rural poor. Using the survey results in a participatory approach which emphasized sustainability and adaptability, a series of integrated technical packages (TPs) was prepared: a research program to gain further information; demonstrations that focused on the introduction of new technologies; and a program to evaluate the overall effects of the TPs on farming systems and develop a model grazing system. The TPs aimed to improve livestock production by

Winter in Guzelyurt village, near Erzurum (courtesy L. Tahtacioglu).



Good range in Guzelyurt village, near Erzurum (courtesy L. Tahtacioglu).

changing traditional, cereal dominated, subsistence-type farming to pasture- and forage-crop dominated farming systems.

Initial pilot studies yielded information on the condition and relative composition of the rangeland throughout the year. From Fig.1 it was concluded that the maximum grazing period should be from mid-May to mid-October. The rangeland was then divided into three categories: that with more than 30% ground cover comprising a good proportion of climax species; areas with less ground cover and a dominance of unpalatable species; and areas devoid of ground cover and subject to serious soil erosion (approx. 20% of EA). The first category was further subdivided into 'good,' 'average' and 'poor' rangeland areas. Project activities for improving the rangeland included: phosphorus-fertilization of the first category, to increase the proportion of legumes (Fig. 2); and, in the second category, deferment and limiting of grazing along with two methods of overseeding with four plant mixtures (Fig. 3).

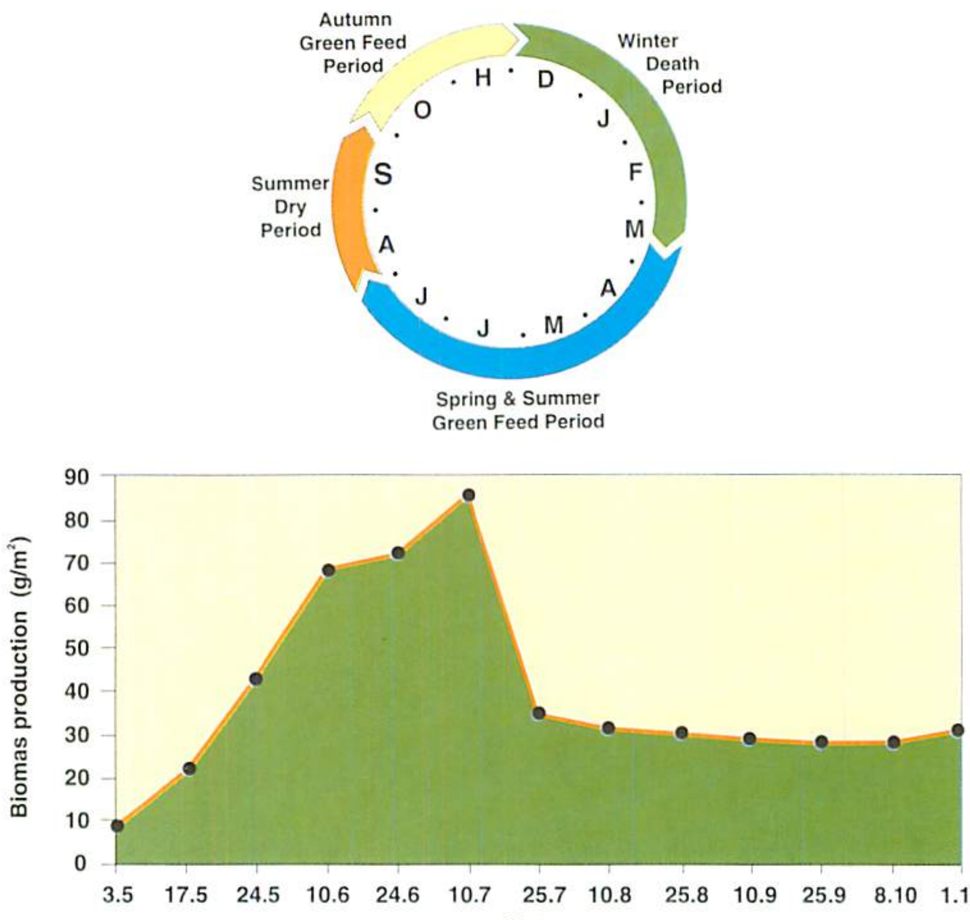


Figure 1. Annual feed cycle and biomass production on rangeland.

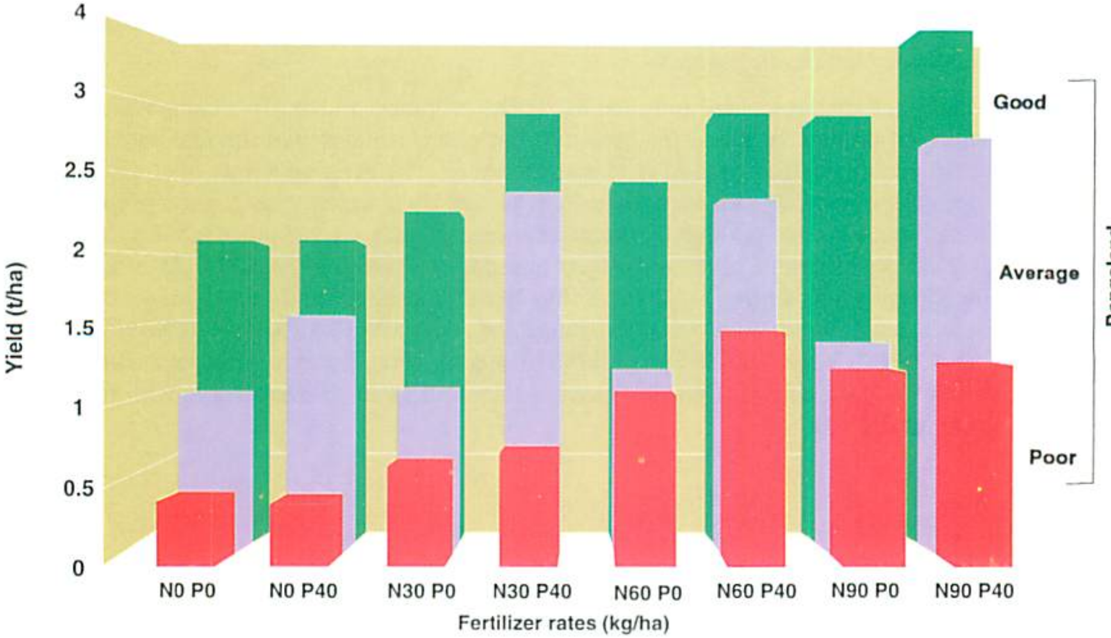


Figure 2. Effect of fertilizer on dry-matter yield in different quality rangelands, in Turkey.

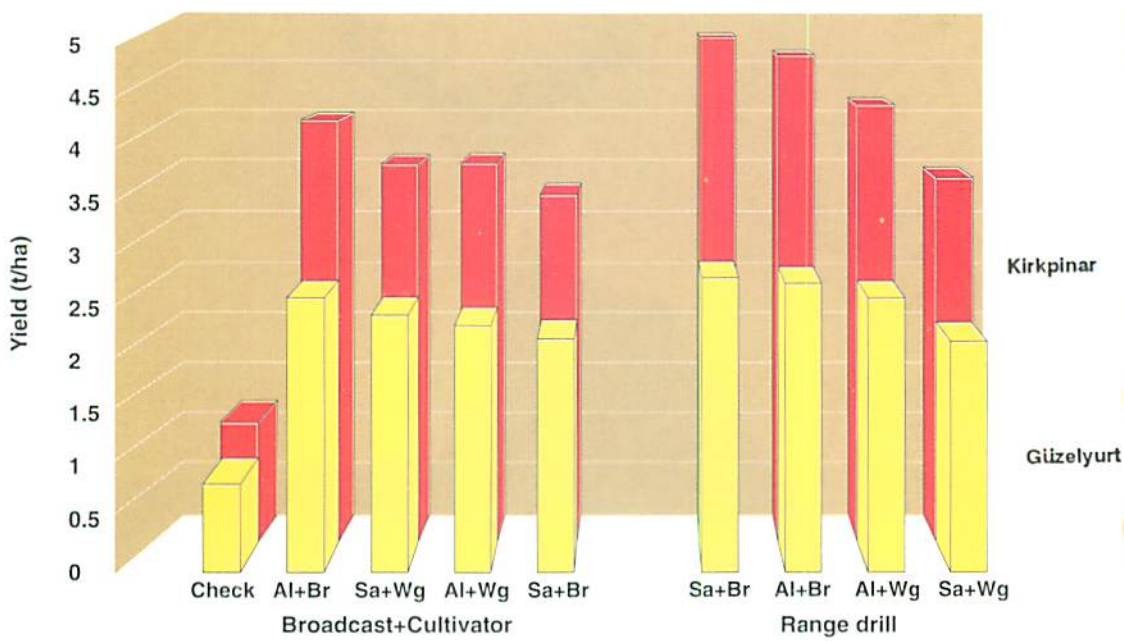


Figure 3. Overseeding on rangeland with combinations of alfalfa (Al), brome (Br), Sainfoin (Sa) and wheatgrass (Wg) at two siks in Turkey.

Class 2 range in Oltu district (courtesy L. Tahtacioglu).

Deteriorated (class 3) range in Oltu district (courtesy L. Tahtacioglu).

Because of the huge variation in existing approaches to using communal rangelands, the project concentrated on the improvement of traditional grazing practices and developed a simple grazing model based on existing systems. The approach was to improve the range, step-by-step with active participation of village communities. It has become well-established and sustainable in two villages but was not adopted by all villages. Implementation of the project on private, meadow and fodder crop areas achieved results beyond expectation. Based on the findings, model TPs were prepared for the implementation of large-scale projects.

Overseeding range land in Kasimoglu village, Van province (courtesy L. Tahtacioglu).

Overseeding of marginal land in Guzelyurt village, near Erzurum (courtesy L. Tahtacioglu).

Marginal-Land Improvement using Annual Legumes, and the Need for Seed-Multiplication Strategies (20)

Because of more profitable options for the scarce arable lands of WANA, ICARDA's current research focus on feed needs has the practical goal of rehabilitating the expansive drylands that are not cultivated and are used mostly for grazing. In the Near East, there are millions of hectares where cereals cannot be grown despite an annual rainfall of 200-600 mm. This is particularly the case in Syria and Lebanon.

Forage planting in Busakli village (courtesy L. Tahtacioglu).

An examination of the flora reveals that many native forage grasses and legumes survive in this harsh environment and prosper with a minimum of management, provided that grazing is properly managed during flowering. Centuries of overgrazing has gradually reduced the seed banks of even the hard-seeded annual legumes. Re-vegetation efforts, focusing on plants that are already adapted, must be based on information gained from ecogeographic surveys (Ehrman and Cocks 1990). Once this information is known, seed of these useful species must be increased.

Seeds of annual legumes such as *Trifolium campestre* or *T. tomentosum* have properties vital to future re-vegetation and use of degraded rangelands. Most pass through the digestive tracts of sheep or goats and the impermeability of the seed coat permits these species to persist over many years in the soil seed bank (Russi et al. 1992 a, b). Christiansen and Osman, therefore, began with annual legume species which have very small and hard seeds. It should be noted that the within- and between-species genetic diversity of herbaceous pasture legumes of the target area is high and their agricultural exploitation is low.

A positive relationship between dry-matter yield and seedling density has been demonstrated already with annual medics in Syria (Abd El Moneim and Cocks 1986). The next step, therefore, is to concentrate on creating, in the natural environment, a community effect through dense populations of seedlings. Once such vegetation is established on a rehabilitated site and its seeds are ripe, sheep can be used to spread the seed further by alternating the grazing flocks between the source of seed on a rehabilitated pasture and the target pasture that needs rehabilitation. These simple principles have been successfully followed by farmers in Syria but more in-field demonstrations of the principles are needed (Osman and Cocks 1992; Osman et al. 1991, 1994).

During 1994/95, ICARDA scientists demonstrated some of these principles to the farmers in El Bab, near Aleppo, Syria (an area with 266 mm of annual rainfall). Over 100 ha of marginal, uncultivated grazing land in four villages was re-vegetated by oversowing with adapted clovers and medics, applying phosphate fertilizer and deferring grazing in the spring of the establishment year. Seedbanks are being monitored and the results are positive.

A seed multiplication strategy, using inexpensive, mechanized methods, is required to supply the farmers with locally-adapted pasture seed (Christiansen, 1993). Each plant has its own mechanism for shedding seed and these mechanisms must be understood for use in seed production systems. Table 4 shows that the medic species drop their pods and can be easily harvested by sweeping. On the other hand, *T. campestre*, *T. scabrum* and *T. lappaceum* retain their seed in the heads, making it possible to cut them at harvest and carry them to a thresher. Other species such as *T. stellatum* and *Scorpiurus muricatus*, although valuable, require more operations and are therefore more expensive to harvest. Seed-shedding characteristics and the wide variability of seed yield capability shown in Table 4 must be considered when transferring annual legume seed-increase techniques to farming communities.

The principles described are well tested and ready for wide-scale technology transfer to even drier rangelands, such as those in the Syrian steppe. Unfortunately, the current practice of open access and lack of ownership limits the scope of practical intervention. Until such a time as new policies are developed to correct the problems of proper land stewardship in the steppe, the focus will be on villages where grazing control can be exerted and rangeland rehabilitation can be successful.

Village, Farm and Pasture Resource Assessment in Planning a Forage, Livestock and Range Improvement Project for the Central Highlands of Turkey (21)

Climatic extremes hinder the development and maintenance of satisfactory plant cover in the steppe-like rangelands of the central highlands of Turkey and, over the last 50 years, most of the pastures have been replaced by cereal production. Mismanagement, mainly by overstocking and grazing too early, has resulted in severe degradation of the remaining pasture species. Livestock numbers are in the region of two million head of large ruminants and 12 million head of sheep and goats. The deteriorating situation prompted the question: 'Is it possible to conserve in a sustainable manner pasture resources that might otherwise be lost forever?' Past experience suggests that an approach which involves the full participation of village farmers in the work is needed for rangeland rehabilitation. Also, feed production must be integrated with livestock production.

In response, the Central Research Institute for Field Crops (CRIFC) of the Turkish Ministry of Agriculture and Rural Affairs (MARA) and the International Center for Agricultural Research in the Dry Areas (ICARDA) initiated, in 1995, a multidisciplinary research project on the management and rehabilitation of village rangeland in three districts of Ankara Province. The project's objectives, to identify representative villages for implementation of a participatory project to increase feed availability (through range

Table 4. Estimates from ICARDA's Terbol Station, Lebanon, showing successive pod or seed harvesting operations and the percentage of seed obtained with each technique.

Species in groups based on harvest characters	Cut and remove seed with straw	Remove straw then sweep pods or heads	Hand harvest remaining seed	Vacuum remaining seed	Difficulty (5 = difficult; 1 = easy)	Max. kg seed/ha
	(Percentage of seed harvested in sequential operations)					
Trifolium speciosum	85	0	10	0	1	400
Trifolium campestre	85	0	10	0	1	400
Trifolium scabrum	75	10	10	0	1	400
Trifolium lappaceum	85	0	10	0	1	600
Medicago ridigula	0	85	10	0	2	1200
Medicago noeana	0	80	10	0	2	800
Medicago rotata	0	80	10	0	2	1000
Trifolium pilulare	60	25	10	0	2	800
Trifolium purpureum	75	0	15	5	2	800
Trifolium angustifolium	65	0	20	5	2	800
Trifolium haussknectii	65	0	20	5	2	800
Trifolium tomentosum	50	0	20	25	3	400
Trifolium resupinatum	60	0	20	15	3	300
Trifolium stellatum	25	25	25	20	4	200
Scorpiurus muricatus	40	20	25	10	4	900
Hippocrepis unisiliquosa	45	0	25	25	5	200

Note: Numbers do not add up to 100% because about 5-10% of the pods for each species were lost in cracks in the clay loam soil present at the Station (Adel Nassar and Ahmed Osman, ICARDA, personal communication).

rehabilitation, forage crops and perennial legume/grass mixtures) and to develop livestock-feeding recommendations based on village-based feed resources and practical livestock-management techniques that will improve flock (or herd) health, have been partially fulfilled. Objective methods were used to diagnose village structure and the botanical state of the rangeland. Objectivity, combined with a participatory approach, helps to broaden potential solutions to the livestock-feeding problems by including land-users, extension agents and scientists in the dialogue on natural-resource use.

The large amount of valuable information obtained from the village surveys and the biodiversity studies enabled the researchers to select and make comparisons between two villages (Kargali and Gölköy) representative of two important ecosystems - the mountains and plateaus of Central Anatolia in Turkey. The study shows that there are pockets of remnant vegetation that could be the basis of a rehabilitation program, using grazing management (on sites with good plant cover and botanical composition); phosphate fertilization to encourage annual legumes (on sites where they exist); or oversowing, fertilization and rest for the most degraded rangeland.

Utilization of Plant Genetic Biodiversity for Cereal Improvement in Turkey (16)
Turkey is the center of origin and a source of important genetic diversity of many globally important crops. Both *ex-situ* and *in-situ* genetic conservation projects are ongoing in the country.

Landraces and wild progenitors of cultivated wheat originate in Southeastern Anatolia and most are still grown commercially in the area. Having survived natural selection pressures, these genetic resources are a major component in developing the use of germplasm under the various conditions of biotic and abiotic stresses in different areas of Turkey. By using techniques such as direct hybridization, bridge-crossing, and chromosome and physiological manipulations, some useful traits of wild species can be transferred into cultivated species. Wheat has long been subjected to gene-transfer efforts from wild relatives. Induction of homologous pairing, the use of ionizing radiation and exploitation of the tendency of univalent chromosomes in wheat to misdivide, are some of the methods for transferring genes from relatives. The focus of wheat-breeding studies in the future will be on the development of hybrids: the cytoplasmic male sterility needed for this can be achieved only by using some of its wild relatives.

Ceylanpinar State Farm, located in the area, was selected as a pilot site for an *in-situ* genetic biodiversity conservation project. About 16 species were detected in four exploration missions carried out in the 1994 and 1995 cropping seasons.

It is also proposed that a herbarium be established at the Southeastern Anatolian Agricultural Research Institute in Diyarbakir.

***In-Situ* Conservation of Genetic Diversity Project (15)**
When exploring the vegetation of the Ceylanpinar State Farm, botanists collected herbarium samples and prepared a list of all plant species found. A series of survey and inventory missions investigated the surrounding vegetation and the existence, distribution, abundance and density of target species.

The surveyors used a 'Potential Land Use Map' (scale: 1:25,000) which had been prepared by the Department of Soil Science of Çukurova University. Marginal areas and non-arable lands were marked on the map and the surveys concentrated on these. Visible variations within and between populations, soil characteristics and topography were noted. The exact location of the each site was determined with a geographic positioning system (GPS) receiver and marked on the map.

Based on the survey results, several sites were selected for which inventories were made and which were sampled according to a basic unit or 'transect' i.e. a straight line of predetermined length (50 m in this case) and number of divisions, directed in a defined direction from a particular starting point. The number of transects per site depended on the distribution, abundance/density and pollination biology of the target species, and the geographical and ecological characteristics of the area. On a 50 m transect, plant species found within circles, 2 cm in diameter and 50 cm apart, were recorded. Thus, for every transect 100 inventories were made.

Target species were sampled on the same transects as those used for inventories. In this case, though, the abundance and density of target species within circles of 1 m diameter and 5 m distance were recorded and one spike (or all pods of legumes) per target species was sampled for subsequent genetic diversity analysis.

Several GMZs varying in size from 5 to 150 ha, were selected for researching improved management practices. Among them are two sites each for *Aegilops tauschii*, *Triticum turgidum* subsp. *dicoccoides* together with *Lens orientalis*, *Ae. speltoides* var. *speltoides* with *Ae. speltoides* var. *ligustica* and *T. monococcum* subsp. *aegilopoides* (*T. baeoticum*). The diversity of the physical conditions which modify the degree of genetic diversity have been taken into consideration.

As this is the first *in-situ* conservation study in Turkey, management practices for these sites should be planned according to the physical conditions, target species and experience gained in past pasture-management studies. For example, one earlier study showed that: after eight years of rest, annuals were replaced by perennials; the percentage of grasses in the vegetation declined from 50 to 34%; plant cover increased by 100%; and two *Aegilops* species, dominant in the original vegetation, were replaced by other plants. This means that a certain degree of grazing is necessary for an area not to be covered with perennials and for the sustainability of genetic diversity of wild relatives.

It is too early to draw conclusions regarding this work but a greater knowledge of the floral compositions of the selected areas has been gained.

In-Situ Conservation of Local Races of Livestock in the Arab Countries (22)

Eight species (161 breeds) of domesticated mammals are important in the Arab countries (Table 5). The relatively low annual rate of increase in livestock numbers (1.30, 0.16 and 0.18% for sheep, goats and cattle, respectively) is due, primarily, to insufficient forage production.

Table 5. Livestock breeds and numbers in the Arab countries

Species	No. of breeds*	No. of animals** (millions)	Animal units (millions)	Importance of units (%)
Cattle	33	39.1	27.4	36.0
Buffalo	5	3.3	3.3	4.3
Camels	27	11.5	11.5	15.1
Sheep	46	111.0	22.2	29.1
Goats	33	57.0	9.1	11.9
Donkeys	6	5.0	2.5	3.3
Horses	11	0.4	0.2	0.3
Total	161	227.0	76.2	100.0

Source: * Encyclopedia of Animal Resources in the Arab Countries, ACSAD (1981-1990)
** FAO (1994)

Information regarding the erosion of animal genetic resources in the region is scarce. Because some livestock genotypes are not well defined in the production system, what genetic-erosion information is available is based on the accelerated rate of diminishing genotype numbers that exceeded the normal reproductive capacity. That considerable losses are occurring is illustrated, to a limited extent, in Table 6.

Table 6. Endangered breeds of livestock in the Arab Countries (thousands).

Breed	Origin	Previous status		Present status		Difference	Reasons
		Year	No.	Year	No.	(%)	
Shami cattle	Syria	1978	855.4	1994	8.0	-16.0	Crossing
Shami goats	Syria	1987	77.0	1994	38.4	-10.5	Crossing and exportation
Zaraibi goats	Egypt			1993	20.0		Exportation
Black Bedouin goats	Egypt			1990	10.0		Illegal exportation
Shami camels	Syria	1954	106	1994	3.0	-27.7	Range degradation
Maghrabi camels	Morocco	1970	205	1994	36.0	-17.5	Range degradation
Shami buffalo	Syria	1958	7.0	1990	0.86	-5.39	Swamp drying up
Fellahi sheep	Egypt						Crossing
Bonni sheep	Yemen						Low production
Noir de Theibar sheep	Tunisia						

As most Arab countries are signatories to the Convention on Biodiversity, they are obliged to halt genetic degradation. Recommended activities (Hassan et al. 1995) include the development of natural resources (particularly rangelands and water), implementation of rational breeding programs and the establishment of relevant regulatory associations for the different breeds. Relevant to the breeding programs, are the measures for livestock genotype conservation summarized by Duplan (1995 in 17).

i. Collect statistics for breeds and/or genetic types to establish which are endangered or critically threatened.
ii. Select for characteristics such as resistance to stresses, illness and parasites.
iii. Establish hemotype and gene frequency for alleles known to code for particular proteins in threatened populations, in order to calculate their relationship with other populations.
iv. Select breeds with peculiar traits and high originality to preserve them on provisional terms.
v. Complete the evaluation of these breeds to choose those for permanent preservation.

Practical considerations for implementation of the above activities are advocated (22).

- National programs need to identify the various genotypes below species level and establish accurate measurements of the numbers of each.
- Socio-economic studies of the production systems encompassing the endangered genotypes need to be conducted.
- Conservation initiatives such as the establishment of reserves should be backed by an emergency program of feeding and disease control.

The Arab Center for the Studies of Arid Zones (ACSAD) is doing much to address the loss of biodiversity in the region. Some of the conservation programs are:

i. botanical composition and diet selection for sheep, goats and cattle in coastal grasslands (Somalia);
ii. grazing habits of sheep, goats and camels in Syrian steppes;
iii. improving Syrian rangelands with *Atriplex;*
iv. identification and control of internal and external parasites (Mauritania);
v. identification of forage resources in Arab countries; and
vi. livestock genetic resources conservation project.

Eastern Anatolia Watershed Rehabilitation Project (26)

This project uses participatory techniques for natural resource management. Important problems of rural poverty and natural resource degradation in the Euphrates Basin are being addressed through implementing a micro-catchment rehabilitation plan. By participating in an activity that they select from a menu of project-financed activities - such as range management and rehabilitation, forest rehabilitation and reforestation, or improved agricultural and livestock systems - the villagers gain improved infrastructure and income-generating opportunities.

The main components of the project include:

- Rehabilitation of an estimated 54 micro-catchments on cultivated, range and forest lands with the participation of the villagers living in each micro-catchment.

Activities include fallow reduction, fodder and forage production, soil and moisture conserving farming techniques, improved range management and range enrichment, oak coppice rehabilitation and afforestation.

- Income-generating activities including small-scale irrigation, animal husbandry, horticulture, and apiculture.
- Servicing activities to support project planning, implementation and management.
- Adaptive research and pilot work to supplement and improve the menu of activities.

The project has an associated component financed by the Global Environment Facility (GEF) which will finance *in-situ* biodiversity conservation of important agricultural and horticultural plants in Eastern Anatolia.

Project objectives

The principal objective of the project is to restore and maintain the productivity of forest, range and cropping lands in upland catchment areas of Adyyaman, Elazyd and Malatya. Productivity will be increased by working with villagers to reduce soil degradation, erosion and sedimentation in reservoirs as well as increasing village incomes. A key underlying objective is environmental rehabilitation of degraded land and the project activities will be implemented in micro-catchments of the hills, rangelands and sloping cropped lands

Another objective of the project is to increase the participation of village communities and individual farmers in the management of natural resources in Eastern Anatolia. This will be achieved by using a participatory technique, known as *Sor-Sap-Çöz*, for natural resource planning. Villagers will be encouraged to participate in the project by linking income-generating activities to the adoption and maintenance of productivity and environmental rehabilitation activities. The linkage between project activities is integral to the success of the project.

Watershed rehabilitation is a continuous process in which the main rehabilitation phase is followed by a maintenance and management phase to ensure that improvements are sustained and growth in productivity keeps pace with population and the needs for income and employment. The main features of the project are listed below.

- Interactive micro-catchment planning using *Sor-Sap-Çöz* as a basis for agreement on a plan of activities to solve problems which fall within the project's mandate.
- A flexible design which incorporates lessons of experience, results of adaptive research, and demonstrations. Plans for participating villages in each micro-catchment will be the building blocks of the micro-catchment plans and annual budget requests.
- Coordination of provincial departmental efforts within the framework of the micro-catchment plans to ensure that the treatments of cultivated land, rangelands, and forest lands reinforce each other in restoration of productivity in the project area.
- Strengthening the village capacity to organize management of communal rangelands to form a partnership with the Ministry of Forestry for protection and resource sharing for forest lands.
- Emphasizing soil-fertility management and vegetation cover as a means of soil and moisture conservation rather than expensive terracing and drainage treatments.

- Emphasizing stall feeding, forage production and conservation and integration of livestock into rain-fed cropping systems to reduce pressures on range.

Formal *in-situ* conservation is a relatively new approach, although informal *in-situ* conservation has been carried out, perhaps unwittingly, for centuries. In the past, little recognition was given to the value of indigenous knowledge and practices, or to the need for community (resource users) participation. Frequently, farmers resisted the adoption of new technologies. Any 'top-down' imposition of methodologies to manage natural resources is also likely to be resisted especially where they are perceived to conflict with resource use. Practical methods for participatory community forestry, village development and integrated natural-resource management have been developed in a project that was implemented in Turkish forest villages. A case study follows.

The Development of Appropriate Methods for Community Forestry in Turkey (25)
The Ministry of Forestry is required to manage forest lands sustainably for local and national social, environmental and economic benefit. Conversely, villagers have to meet their immediate needs for food, cash, fuel for heating and cooking, and shelter. These objectives often conflict. Conciliatory and people-oriented community forestry has effectively healed social rifts and improved ecological situations in many other countries so these approaches were tested and adapted to Turkish conditions by sensitive and skilled community foresters. The project worked with 20 very poor Turkish forest villages.

Sustainability of forest resource use occurs *only* if the community is *really* willing to help itself, and if the bureaucracy is *really* willing to create the appropriate conditions to help the community to help itself. The overall objective of co-management of land to improve the socio-economic levels of forest village populations and to reduce the pressure on local natural resources, involved changing the institutional culture of the Ministry and the personal attitudes of foresters and villagers. The project tried to expose the usual invisibility of gender issues in policies and project implementation, to provide equitable participation in activities and training, and to assist women in small income-generating activities.

With funding from the villagers, the Development Foundation of Turkey (TKV), the Ministry, the County Governors and the project, the following activities were undertaken:
- provision of drinking water and minor irrigation;
- provision of seeds of sainfoin, alfalfa and vetch to establish about 230 ha of improved fodder;
- help given with rangeland grazing management;
- provision of materials for 16 plastic-covered greenhouses;
- provision of about 200 efficient stoves, 10 experimental solar and biogas installations, house insulation and three communal laundries thereby reducing fuelwood demands;
- energy forest management trials;
- provision of about 20,500 grape seedlings;
- provision of 1260 beehives, other equipment and training;
- provision of about 49,000 seedlings of 8 types of fruit and nut trees and 3 walnut nurseries;

- provision of seedlings of poplars (about 27,200), and *Ailanthus*, *Robinia*, *Tilia*, *Gleditsia*, Oleaster, *Betula*, *Prunus mahalep*, maple and *Pinus* (about 273,000);
- assistance given in household food preservation;
- building a fish hatchery;
- demonstrating erosion control;
- and initiating participatory catchment planning and management.

Five conditions were found to be essential for successful community forestry:

i. sympathetic government agencies;
ii. effective village leadership;
iii. willingness of villagers to help themselves;
iv. some potential for development; and
v. constant use of appropriate 'bottom-up' methods for participatory development.

Practical and appropriate methods for community forestry have been devised, tested and refined, but they are not yet fully sustainable within the institutions responsible for forest management in Turkey. The range of methodologies that have been developed are the following:

- participatory rural appraisals to gather facts about the ecological, economic, social and other problems of the village;
- participatory explorations of village problems and possible solutions to clarify what can and cannot be done by the villagers within the project framework;
- formal and informal provision of competent technical skills in training, feasibility studies, group behavior, marketing, economic assessment of activities, and in the particular activities; and
- management methods to approve and fund various proportions of the selected household-based and communally-based activities.

The basis now exists in most project villages for: a program of simple lessons on environmental principles and protection in village schools; commitments to communally-agreed systems of rangeland rehabilitation and 'cut-and-carry' fodder systems; and the organization of differential responsibilities for participatory planning and management of the rangelands. Non-project villagers are now trying some of the same activities, using their own funds.

IV Data Acquisition and Management

Geographic information systems (GIS)

The powerful analytical capabilities of GIS have revolutionized approaches to selecting and gathering information for agricultural development purposes. In 1992, a special GIS unit was established at the Applied Research Institute of Jerusalem (ARIJ) and new equipment and software were obtained. The software packages employed are IDRISI, ARC/View, ARC/Map, MapInfo, PAMAP and ERDAS; FoxPro is used to provide and organize data gathered from the field to facilitate the GIS team's work (8).

Sources of data for building up this GIS are mainly the following.

- Base maps
  1. British Survey of Palestine (1942), scale 1:20,000
  2. US Army Corps of Engineers (1956, 1964), scale 1:50,000
  3. Israeli Survey (1990-1993), scales 1:50,000 and 1:500,000
- Aerial photographs
  Full-color aerial photographs (scale 1:20,000) which cover most of the West Bank.
- Field observation
  On-site visits to areas under study (information is recorded either on specially designed maps or on form papers)
- Geographic positioning system (GPS)
  With an accuracy of 20 meters, the GPS is used to obtain the longitude and latitude of a particular site (e.g. wells, springs, quarries)
- Satellite images
  An ERDAS software package is used to analyze LANDSAT and SPOT satellite images and generate required information on land-use patterns, soil, vegetation cover and many other fields.

ICARDA's computer system was also described in terms of the development of GIS capabilities (4) and in relation to GIS links to the genetic resources database (3). In general, the software and strategies in place fit well with the operation of a GIS.

Projects in which ARIJ is involved and which are supported by the GIS facility are:

- identifying land-use patterns in Palestine;
- conducting environmental impact assessment studies for development projects and strategies;
- building an environmental database;
- building a water-resources database;
- modeling and future projection studies;
- digital elevation model (DEM) for Palestine; and
- identifying the shifts in the geopolitical boundaries resulting from the current Peace Process and assessing their impact on Palestine.

ICARDA's ongoing and planned GIS activities include:

- a comparative study of physical constraints to wheat yield in selected areas in northwest Syria and central Morocco;
- an assessment of durum wheat production risk across agro-climatic zones of northwest Syria.
- the study of potential water-harvesting areas and methods for the arid regions of WANA - processed satellite imagery and subsequent use of GIS are involved;
- a project in the area of Abdal Aziz mountain in northeast Syria focuses on land degradation under the effects of wind and water;
- the development of strategies to improve chickpea production and the adaptation of chickpea in different agro-ecological conditions in WANA - in cooperation with the

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the NARS;

- a leading role in a proposed regional project (within the scope of Agenda 21) aimed at sustainable dryland biodiversity conservation and management within priority ecosystems in the Near East; and
- maintenance and extension of the many accessions - predominantly landraces and wild relatives of ICARDA-mandate crops - currently held in its Genetic Resources Unit.

Management of the wealth of scientific information that exists at ICARDA is improving and several databases with geographical components are being developed. ICARDA's potential for applying GIS includes:

- characterization of the major agro-ecological 'zones;' not as static entities but as entities which are crop- or pasture-species dependent and which can be modified through soil and water management and plant breeding;
- identification of target zones helps determine the requirements for appropriate test sites and the focus of technology extension;
- examination of spatial correlations between different layers allows prediction of likely stresses in areas identified as having the same environmental conditions;
- extrapolation from a field-trial environment to a matching environment can be used to define appropriate genotypes and to target technologies;
- mapping of country crop statistics for information on crop distribution and, in conjunction with data on biophysical parameters, for constraint identification;
- illustration of uncertainty through mapping of statistical parameters of data (e.g. values of crop yields, rainfall, extreme of cold and heat);
- facilitation of the characterization of plant genetic collections through integration of information on collection sites and biophysical data;
- characterization of improved germplasm for of different agroclimatic zones;
- spatial extrapolation of site-specific experiment data;
- spatial integration and interpolation of multi-location experiment data;
- identification of appropriate test sites and areas for focus of extension of mature technology;
- mapping of specific diseases in different geographical areas;
- incorporation of socio-economic data (population distribution, land tenure, farm types, market and transport infrastructure, etc.) with the aforementioned biophysical data; and
- modeling, for which there is already established expertise in ICARDA but system facilities are limited - the interfacing of GIS to various simulation and optimization models poses a special challenge (4).

Maps and mapping

With respect to biodiversity specifically, ARIJ has pooled its resources and GIS capabilities to create computerized maps that could serve in the conservation and promotion of Palestine's natural biological resources. These maps, supported by a database, allow the identification of problem areas, evaluate mitigation strategies and explore potential sites which could be employed for *in-situ* gene collection and conservation. They contain most of the elements that relate to biodiversity such as soil type, climate, topography, vegetation, watershed, wells, springs, land-use patterns and built-up areas. Efforts are currently being made to expand the scope of these maps to include the countries of the Fertile Crescent and to invest in establishing ties and cooperating with biodiversity-interested organizations in these countries (9).

ICARDA obtains data from other organizations in the form of maps, it uses maps internally, and presents the results of its work in the form of maps. The display facilities of a GIS provide graphic output of the data stored in the system. Probably more importantly, maps can be overlaid and compared and thus provide for qualitative or semi-quantitative analyses on a spatial basis. This is particularly significant to ICARDA, dealing as it does with a large region of considerable spatial diversity and temporal variability (4).

Genetic resources database at ICARDA

ICARDA's Genetic Resources Database stores computerized records of the approximately 110,000 accessions (of its mandated crops) that are held in its genebank. The Genetic Resources Unit (GRU) also maintains databases on wild relatives of wheat and Mediterranean forages as separate systems within the 'germplasm database.' Occasionally, databases received from collaborating institutes are kept on a temporary basis.

Because standardization of descriptors is the only way to stimulate and sustain meaningful communication worldwide between people working with genetic resources, ICARDA scientists participated in the development of the international descriptor lists published and promoted by IPGRI. Where possible, therefore, the suggested standards for documentation are followed.

Future developments and links to GIS (3)

The GRU plans the following activities.

i. A changeover to the Windows environment to take advantage of Graphical User Interface (GUI) and to assure better interaction with data analysis software - both statistical software and GIS (or map making) programs. With the development of CGIAR's System-wide Information Network for Genetic Resources (SINGER) it is likely that a SQL database server, run on a Windows NT operating system, will be used.

ii. Integration of the genetic resources database with a GIS database to be established in ICARDA. ARC/Info and ARC/View software packages were recently acquired. The Digital Chart of the World will provide basic layers (scale = 1:1,000,000) though, currently, MAPMAKER is used to produce species-distribution maps and to map out itineraries of recent collecting missions.

Integrating the germplasm and GIS databases is expected to provide information on germplasm that was never recorded or is otherwise not available. It should be noted, however, that the derived data are bound to be less accurate than that provided by collectors. The extended range of information will provide answers to queries relating to spatial aspects e.g. distances between germplasm sampling sites, and location of potential collection sites with similar characteristics to those already sampled. While it may take time to assemble accurate GIS layers to perform sophisticated spatial analyses, immediate benefits are improved map making and the ability to access the germplasm database via GIS software.

Environmental information management (24)

It is obvious from the above that the WANA region encompasses an increasing wealth of data relevant to the sustainable use and conservation of its biodiversity. Though much of this knowledge is already being gainfully used, of itself data has little value: dumping large volumes of raw data into the hands of decision-makers is ineffective. Decision-makers act on information and require data to be assessed for quality and relevance, then integrated, analyzed and interpreted. The process of transforming data into information requires access to a wide range of data management, manipulation and visualization tools, the salient literature, and scientific and other kinds of advice. Whether determining some optimal use for local land or negotiating obligations for a treaty, authoritative information will inform the process, increasing the likelihood that the outcomes will be sustainable and acceptable to all.

In his paper on capacity building for environmental information management, John Busby, of the World Conservation Monitoring Centre, outlines a framework to guide senior managers and decision-makers at all levels (local, national and global) to assess their own needs and set their own priorities for addressing those needs. Integrated environmental information systems can be built, in a step-by-step process, across both organzational and electronic networks. They include, therefore, but extend well beyond, the provision of technical tools (such as computer hardware and software) and training. In brief, these steps are:

i. analyze the information needs of decision-makers;
ii. identify the custodians of the priority datasets and services;
iii. analyze the data required to underpin the information needs; and
iv. identify, make available and facilitate further development of decision support and communication tools.

The *Framework* will be supported by a training course (developed), a number of printed and electronic *Guidelines* (under development; see Appendix 2), case studies and worked examples (to be incorporated as available), and a comprehensive electronic information management toolkit (available) that will provide additional technical and operational details.

Discussion

In his opening speech, Ertug Firat, Director of AARI, stressed the need for cooperation in West Asia. He was referring especially to the regional and international institutions, and advocated the formation of new networks along the lines of WANANET. Implementation of the GEF program should address this need for a planned program of development in the region.

The practical application of project activities was discussed at length. It was agreed that crop improvement is not the answer to ensuring food security nor is *ex-situ* conservation the full answer to ensuring the survival of species and the maintenance of biodiversity. The situation is far more complex. A degree of vision, ingenuity, flexibility and sensitive persuasiveness are considered necessary elements for working alongside the development process to gain the confidence and trust, and to understand the needs, of the users of natural resources. Thereafter, practical solutions can be discussed.

Endangered species and landraces need to be targeted and, though much has already been done, considerably more taxonomic classification of species is required. Wild relatives of economically-important crops such as wheat need to be preserved for breeding purposes. Though the aim should be to conserve biodiversity naturally, within profitable farming systems, *ex-situ* conservation will continue to be used, primarily, as a complementary measure but, in some instances, as the only feasible strategy. In the short term, some 'islands' (where no degradation has occurred) and 'hot spots' (threatened areas of special concern) of primitive systems may need to be fenced off to ensure protection. It was noted that any policy measures to protect reserves or marginal land will only work with village support, illustrating again the need for a participatory approach. A proposal that ICARDA be the catalyst in a network of participatory activities on sites in each area, received firm support: cooperation would be enhanced and duplication of activities, reduced.

Participants stressed the need for good databases, that are accessible to all. In some fields, e.g. crops (ICARDA) and soil degradation (ACSAD), a good foundation is already in place and support for expanding the former is available from organizations such as Kew and IPGRI. Other fields for which databases are required include farming systems, and geographical mapping to provide accurate maps for use in GIS. Those with experience in GIS warned of the dangers in relying solely on information derived from remote sensing sources. They stressed the importance of verification by field observations: in certain seasons, for example, it is not always possible to distinguish between rain-fed and irrigated agriculture.

The benefits derived from GIS applications include better use of trial results and the potential reduction in the number of test sites required. To maximize these benefits, the information must be shared among countries to avoid duplication of activities on a regional basis. Much investment is yet required though to make the information widely accessible. In many countries of the region the physical resources are limited or non-existent. The considerable cost involved in setting up a GIS led to much discussion of the merits of different computer systems and software, and the need for standardization when new equipment is bought. The advice of the experts is to start modestly and upgrade rather than change. The whole field is developing so rapidly that equipment is liable to become obsolete in a fairly short time, e.g. approximately four years in the case of computer processing units. Already, though, the leaders in this field do not function on entirely compatible systems.

General recommendations formulated from the discussions follow.

General Recommendations

1. The group draws attention to the need for continued work on biodiversity conservation within a participatory social approach and broader resource-management framework.
2. It is envisioned that, for each country, national programs will identify a set of relevant agro-biodiversity activities within a priority ecosystem.
3. The identification of activities should be elaborated in an iterative way among land-users, scientific and extension staff, and decision-makers.
4. Each national activity will be identified, formulated and operated at the level of the NARS. It is recognized that the success of projects will depend on the individual enthusiasm of the NARS.
5. The activities within each country should be viewed as stand-alone modules that could be initiated with existing funds, infrastructure and personnel; however, it is recommended that bilateral funding could be sought to expand the effort.
6. A consolidated effort should be channeled through ICARDA, ACSAD and other regional and international organizations to continue to promote a regional multilateral project. National programs would like official feedback on the acceptability of currently submitted proposals, as this project would accelerate any action plans arising from this workshop.
7. Parallel activities are needed to build capacity in national programs and international centers so that the programs of work and training could run simultaneously. Examples are: rapid rural appraisal; natural resources surveys (water, soil, flora, fauna); information management (GIS, databases, policy-maker and public awareness).
8. Training in how to assess biodiversity is a big issue in the region. The techniques and studies should follow the Convention on Biological Diversity. The NARS need help in identifying the 'hot spots' or 'islands' of biodiversity within countries and in taking measures to conserve and monitor species in these locations. In addition, the conservation and use of historically used medicinal plants should be highlighted as an important part of the region's biodiversity.

   GIS is considered a major tool for future land management decision support and it is recommended that a training program be held to standardize the approach used across national programs.

Recommendations of the Geographic Information Systems Working Group (GIWG)

1. NARS-ICARDA-ACSAD GIS Working Group

It is recognized that GIS is an important tool in setting objectives for the exchange of experiences and data related to natural resources management for sustainability of biodiversity. The workshop recommends a permanent GIS working group be established to facilitate regional capacity building, data exchange, compatibility, standardization, analysis and modeling of data.

Action: Establish institutional leadership for coordination
Nominate members
Determine terms of reference

2. Standardization of GIS tools and data

The workshop noted that a wide variety of GIS software could jeopardize data sharing between countries and regional organizations. It is recommended that organizations standardize on ARC/Info for high-end users, IDRISI for entry-level use and ARC/View for demonstrations.

Furthermore, work on establishing common definitions for data attributes and descriptors used for biodiversity-related studies should be agreed upon. The precise mechanism could be worked out by consultation between NARS, ICARDA, IPGRI and ACSAD. Specifically, digital base maps (at pertinent scales) covering topography, soil, climatology, administrative boundaries and other important layers for the countries of the region, should be developed and shared.

3. Training

ICARDA, IPGRI and ACSAD, in conjunction with ARIJ, should play a leading role in developing GIS and remote-sensing capacity in the region for NARS. The GIS Working Group will coordinate training courses in the region and link with GIS teams in other parts of the world.

4. GIS capacity building

It is recommended that steps be taken to enhance organization and facilities for GIS work to support NARS' natural-resource management and biodiversity activities. When necessary, assistance in choosing the appropriate hardware and software environment will be provided by the GIS Working Group.

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2. Some Medicinal Plants in the Fertile Crescent (and their uses)

Family	*Botanical name*	Uses
Anacardiaceae	*Pistacia terebinthus* L. subsp. *palaestina* (Boiss.)	cold and diuretic
Berberidaceae	*Berberis libanotica* Ehrenb.	bitter tonic stomach
Boraginaceae	*Borago officinalis* L	leaves emolient
Capparidaceae	*Capparis spinosa* L.	diurete, astringent, tonic
Compositae	*Artemisia absinthium* L	anthelmintic, vermifuge
	Calendula arvensis L.	emetic
Cruciferae	*Anastatcia hierochuntica* L.	emetic, for epilepsy
	Sinapsis alba L.	laxative
Cucurbitaceae	*Bryonia dioica* Jacq	purgative
	Ecballium eletarium L.	anti-viral
	Citrullus colocynthis Schrad.	purgative
Fagaceae	*Quercus libani* Oliv.	insect bites, astringent
Gentianaceae	*Gentiana olivieri* Griseb.	bitter tonic
Iridaceae	*Crocus sativus* L.	condiment, stimulant
Labiatae	*Melissa officinalis* L.	antispasmodic, stomach complaints
	Salvia officinalis L.	emetic, diuretic
	Teucrium polium L.	for fevers
	Thymus capitatus (L.) Hoffm.	tonic, for coughs
Lauraceae	*Laurus nobilis* L.	condiment and gastric stimulant
Leguminosae	*Anagyris foetida* L.	purgative, vermifuge
	Astragalus gummifer Labill.	produces medicinal gums
	A. gossypinus Fisch & Hoh	produces medicinal gums
	A. ascendens Boiss & Hausk.	produces medicinal gums
	A. kurdicus Boiss.	produces medicinal gums
	A. microcephalus Willd	produces medicinal gums
	Cassia senna L.	laxative
	Glycyrrhiza glabra L.	diuretic, for gastritis

Family	Botanical name	Use(s)
Liliaceae	*Colchicum autumnale* L.	contains colchinio
	Urginea maritima (L.) Baker	contains glycosides for cardiac conditions, expectorant
Myrtaceae	*Myrtus communis* L.	Stimulant, antidiarrhetic
Oleaceae	*Fraxinus syriaca* Boiss.	verbifuge, antirheumatic
Paeoniaceae	*Peaonia coriacea* Boiss.	antispasmodic for convulsions in infants and epilepsy attacks
Papaveraceae	*Papaver somniferum* L.	sedatives, opium, many alkaloids
Polypodiaceae	*Dryopteris felix-mas* L.	anthelmintic
Ranunculaceae	*Nigella sativa* L.	chest diseases
Rosaceae	*C. oxyacantha*	antispasmodic, tonic, cardiac conditions
	Potentilla kurdica Boiss.	astringent, vermifuge
Scrophulariaceae	*Digitalis ferrugineae* L.	contains glycosides
Solanaceae	*Hyoscyamus niger* L.	contains alkaloids
	Mandragora officinarum L.	soporific
Umbelliferae	*Ammi majus* L.	for asthma
	A. visnaga (L.) Lam.	diuretic, antispasmodic
	Ferula spp.	vermifuge, emetic
Urticaceae	*Urtica urens* L.	antirheumatic, aphrodesiac
Zygophyllaceae	*Peganum harmala* L	emetic, oliuretic

3. Capacity Building Framework

Guide for managers and decision-makers

Guidelines for conduction user-needs analyses

Guidelines for strengthening institutional relationships

Guidelines on determining capacity-building needs

Guidelines on data custodianship and access

Guidelines on metadatabases and cataloges

Guidelines on data development

Guidelines on data quality management

Guidelines for information system design and development

Guidelines for information analysis and presentation

Guidelines for electronic data exchange

Resource inventory

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