Agricultural Sustainability Research at ICARDA

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by
Michael Jones
Leader, Farm Resource Management Program

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

Preface

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

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

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

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

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

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

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

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

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

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

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

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

Modern olive lands (Syria) .....

Grazing of stubble (Syria) .....

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

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

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

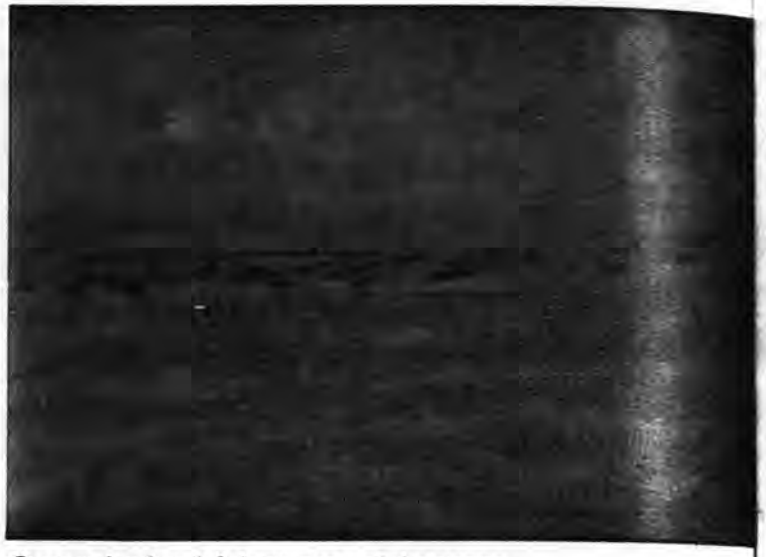
necessitates another cultivation to prepare the seedbed. Furthermore, it tends to destroy soil structure, prejudicing the long-term maintenance of the soil itself. In a five-year trial in Syria, no yield advantage was found from deep tillage; and although this result might be site- and soil-specific,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

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

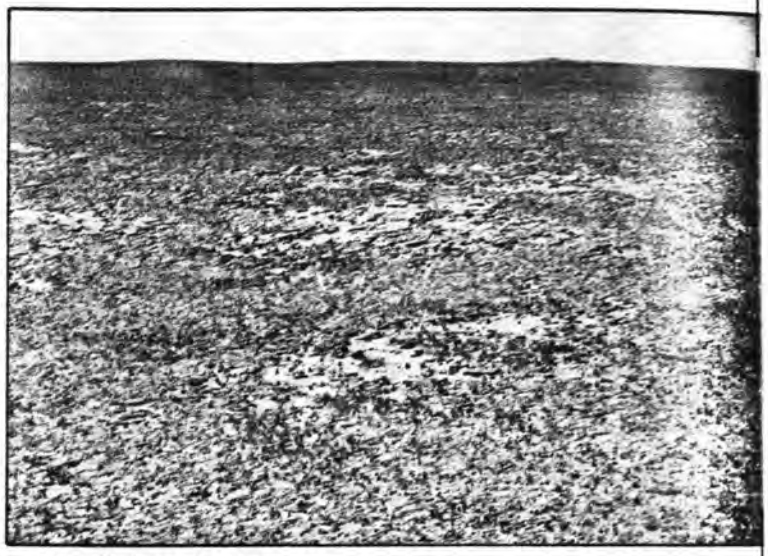
The main threat to soil is erosion by wind and water caused largely by inappropriate land management. Wind erosion occurs where the natural vegetation, particularly trees, shrubs and other perennial species, has been removed and not replaced by any other form of protection, a situation often exacerbated by a deteriorating soil structure. In drier arable areas, large tracts of land are cultivated without any trees or walls to break the wind and stand empty and vulnerable through the dry, windy summer. Stubble and other residues, which might have afforded some physical protection and contributed indirectly to the maintenance of soil structure, are removed or grazed off; and the frequent trampling of animals across the land increases the susceptibility of the surface soil to wind action.

The situation is similar in much of the adjacent range (steppe) grazing areas; the perennial vegetation has been almost totally destroyed by overgrazing and firewood collection, leaving the soil exposed. And the ever-decreasing biomass available for grazing encourages land users to plow and grow barley instead, thereby destroying the last vestiges of any dry-season soil cover.

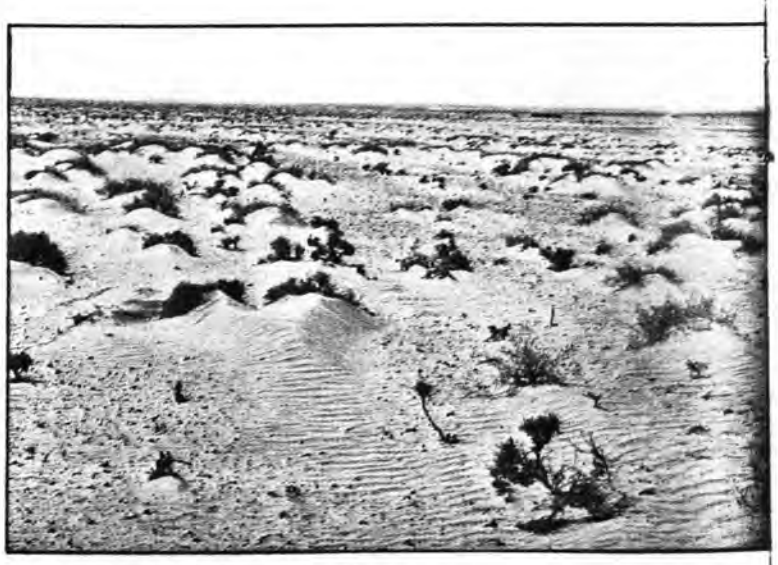
Erosion by water occurs widely in wet and dry areas. The immediate causes vary, but everywhere it represents inattention to long-term consequences in the urgency of current need. In wetter areas, steeper and steeper slopes are cleared for planting orchards. The clean-cultivated, widely-spaced trees afford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



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



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



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

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

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

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

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

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