Chapter I

Introduction

The Shaded Countries Are Highlighted in This Paper

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This background paper focuses on foreign and cooperative examples of what other countries are doing in arid and semiarid agriculture to cope with problems of aridity. The full assessment report, of which this is a part, focuses principally on U.S. efforts domestically.

This paper is designed to assist Congress in several ways. First, it provides information relevant to legislative activities on such broad topics as agricultural research, arid/semiarid land resource productivity, and water management schemes. Second, it illustrates approaches taken by foreign leaders on technology and policy issues affecting agricultural water use in arid/semiarid lands. Third, several examples illustrate the collaborative role of U.S. agricultural and scientific experts in international development and the mutual benefits to be derived by all parties. Finally, by providing examples of how other countries are coping with and using their arid/semiarid environments for productive agriculture, this paper contributes to the continuing congressional debate on ways to sustain agriculture in U.S. arid/semiarid lands.

This paper touches on only a few of the many examples of foreign and cooperative efforts in arid/semiarid agriculture. Numerous opportunities exist through these efforts for information exchange and scientific advancement in methods for making arid and semiarid lands productive.

Approximately 20 percent of all potentially arable land in the world is in arid and semiarid climatic zones, with Africa and Asia accounting for slightly under 10 percent and the United States about 3 percent (fig. 1).[1] About *16* percent of the world's population lives on these arid and semiarid lands (table 1), and about 90 percent of them live outside the Western Hemisphere. Research and development in semiarid and arid agriculture has global significance in light of these statistics. *

The maintenance of some land productivity in these fragile environments is a particular concern for countries that have a major portion of their population engaged in farming or livestock production. It is also of concern to countries with more diversified economies, such as the United States and the Soviet Union, since populations and economies may also depend on the productivity of such lands. A number of countries are trying to cope with aridity and agricultural production. Israel has a deliberate policy of settling its deserts and a system for managing water. The Soviet Union, with about one-fifth of its people living on semiarid and arid lands, has under consideration a partial diversion of north-flowing rivers to desert areas in the south.[2] In the United States, with about one-third of its land area (excluding Alaska) being arid and semiarid, water availability and degradation are topics of growing concern.

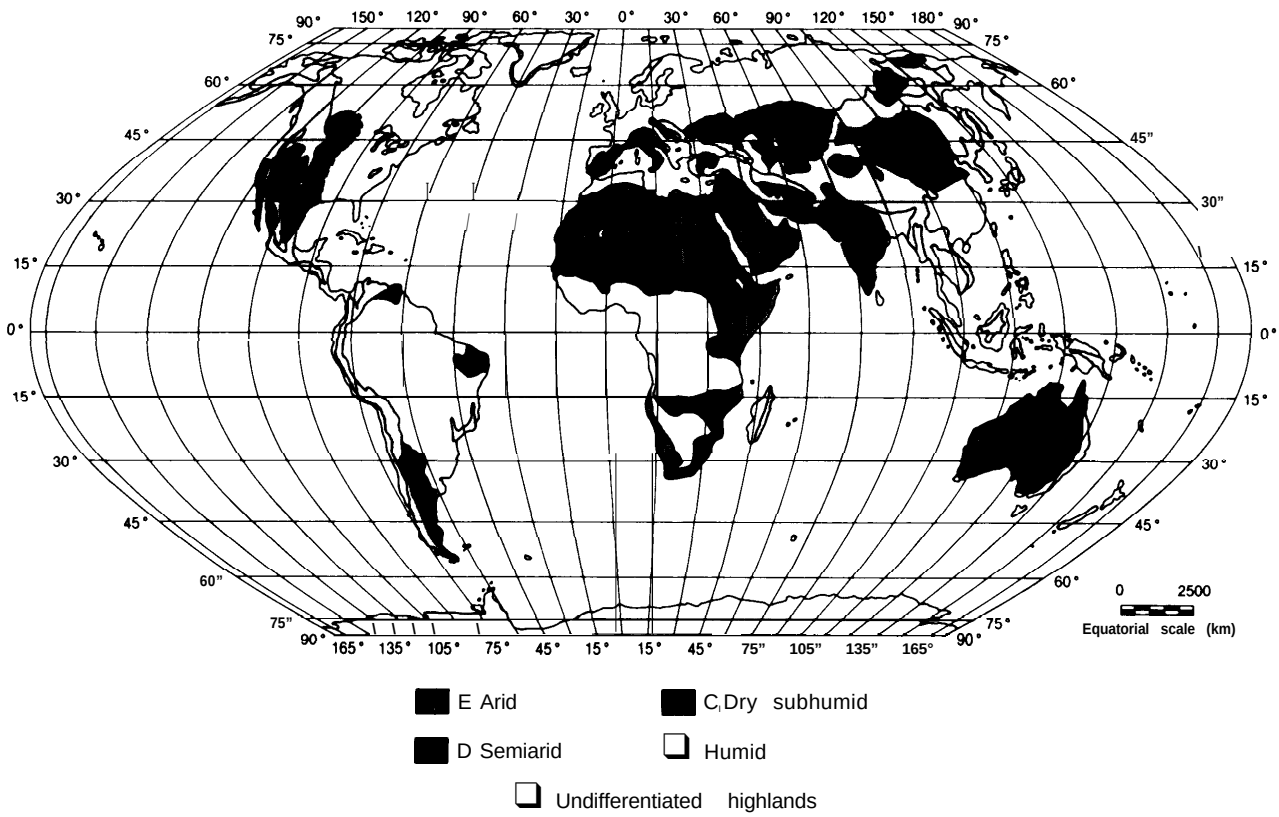
Ancient civilizations in arid and semiarid lands—whether located in the Southwestern United States, along the banks of the Nile, in the Tibesti massif of the Sahara, in the Negev Desert, within the Persian Empire, or on the banks of the Yellow River in China–all practiced agriculture through some form of irrigation. In some cases, great rivers, such as the Nile or the Euphrates, provided an inexhaustible source of fresh surface water. Systems of canals were constructed with ditches and sluices and animal- or human-powered devices for lifting water to higher ground.

[1] H. Dregne (cd.), *Arid Lands in Transition* (Washington, D. C.: American Association for the Advancement of Science, *1970),* pp. *32-33.*

*Arid and semiarid lands have been defined in a number of different ways. Their main characteristic is a low average precipitation or moisture, a condition which is directly affected by other variable elements of the climate, such as temperature, sunshine, wind, and moisture conditions.

[2] M. Biswas, "United Nations Conference on Desertification in Retrospect" (Laxenburg, Austria: International Institute for Applied Systems Analysis, September *1978).*

Figure 1.—Dry Climates of the World (highland areas [light tone] have not been analyzed)



SOURCE: H. P. Bailey, "Semi-Arid Climates: Their Definition and Distribution," p. 78, in Hall, et al., *Agriculture in Semiarid* Environment, 1979.

Table 1 .—Estimates of Drylands Population by Region and Livelihood Group[a]

Region	Total drylands		Livelihood populations in drylands				
	Population (thousands)	Urban based (thousands)	Percentage of total	Cropping based (thousands)	Percentage of total	Animal based (thousands)	Percentage of total
Mediterranean Basin	106,600	42,000	39%	60,000	57%	4,200	4 %
Sub-Sahara Africa	75,500	11,700	15	46,800'	62	17,000	23
Asia and the Pacific	378,000	106,800	28	260,400	69	10,300	3
Americas	68,000	33,700	50	29,300	43	5,100	7
Total	628,400	194,200	31%	397,100	63%	37,100	60/0

[a]Meigs classification (1953) including extremely arid, arid, and semiarid area. Secretariat of the United Nations Conference on Desertification, 1977. Sums are not exact due to rounding.

SOURCE: M. Biswas, United Nations Conference on Desertification in Retrospect (Laxenburg, Austria: International Institute for Applied Systems Analysis, September 1978).

Archeological evidence also suggests that since the beginning of recorded history ground water has been used to grow crops. The qanats of Iran, built some 3,000 years ago, were underground gravity flow channels for distributing water for distances up to 20 miles. They are still in use and supply 35 percent of Iran's freshwater. Their apparent durability is a result of a simple technology that used gravity for energy and kept withdrawals balanced with recharge.

Dryland farming, using runoff water collection and runoff waterspreading systems, also

was well known in antiquity. These techniques are still practiced in some arid and semiarid lands of the world. For example, Israeli researchers have reconstructed a number of runoff systems from that period. These systems work on the principle of collecting or diverting precipitation that is not immediately absorbed by the ground. One method has been to build a dam in a riverbed during the dry season. When heavy rains came, flood waters were collected and diverted to irrigate surrounding cultivated land, Runoff systems required large topographically suitable areas not under cultivation to collect rain that would not be immediately absorbed. This water would be carefully managed to meet surrounding agricultural needs,

Water runoff from slopes was enhanced by removing stones from surface canals to release the runoff to different fields. This system of water management flourished some 1,500 years ago. In evaluating such ancient practices one writer states, "for all their antiquity, these methods can form not only a basis for survival and income for many communities in developing countries, but a source of additional income to communities living in the deserts of developed countries."[3]

Ancient societies coped with their arid and semiarid environments through technologies which they tried to adapt to suit their natural environments. Similarly, societies and technologies today in such environments also must live within and respect certain natural limits, including the vagaries of climate. This report highlights a few examples of how some other countries are attempting to maintain or increase agricultural productivity on their arid and semiarid lands. For example, Israel has undertaken a national program of total water resource management (ch. VI). Several countries in Africa are experimenting with game ranching (ch. III). Senegal and international researchers are investigating the potential for greater bean and cowpea production in arid lands (ch. II).

In many instances, foreign projects in arid / semiarid agriculture are being aided by U.S. funds and researchers. The United States, through the Agency for International Development (AID), for example, has been working on irrigation water management in Pakistan (ch. IV). New South Wales, Australia, has received assistance for its research program on developing natural rubber from the guayule shrub from the U.S. Department of Agriculture (USDA) (ch. V). The Office of Technology Assessment's publication *An Assessment of the United States Food and Agricultural Research System,* in chapter VIII, "International Dimensions of Research, " provides a historical overview of the agricultural programs of these agencies.

At the start of the 1980's, USDA alone was involved in more than 300 international cooperative research projects. The Office of International Cooperation and Development, USDA, initiates and administers these projects abroad. Some of the countries with which the United States has cooperative research or scientific exchange agreements are Australia, Canada, Great Britain, Japan, Israel, the Netherlands, and Spain.[4]

Besides bilateral agreements, the emerging international agricultural research network offers further opportunities to share in the world's agricultural expertise and knowledge. Since 1960, 10 international agricultural research centers with budgets of nearly ***$140*** million in 1981 have been established. The Consultative Group on International Agricultural Research (CGIAR) sponsors them as well as three other related programs. The United States, through AID, is a charter member and provides about 25 percent of their total funding. Two of them—the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India and the International Center for Agricultural Research in the Dry Areas (ICARDA) in Lebanon–specialize in problems of aridity and agriculture. See table 2 for a list of these centers and programs,

[3]A. Issar, "The Reclamation of a Desert by the Combination of Ancient and Modern Water Systems, " *Outlook on Agriculture,* vol. 10, No. *8,* 1981, p. 393.

[4]U.S. Department of Agriculture, Office of International Cooperation and Development, *Foreign Development, USDA Role* (Washington, D. C.: U.S. Government Printing Office, January 1981), p. 12.

Table 2.—CGIAR-Sponsored International Agricultural Research Centers and Programs

	Location	Year established	Core funding, 1980[a] (in millions)
Centers			
1. International Rice Research Institute (IRRI)	Philippines	1960	$15,032
2. International Maize and Wheat Improvement Center (CIMMYT)	Mexico	1988	16,056
3. International Institute of Tropical Agriculture (IITA)	Nigeria	1988	14,038
4. International Center for Tropical Agriculture (CIAT)	Colombia	1988	14,275
5. International Potato Center (CIP)	Peru	1972	7,100
6. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	India	1972	10,375
7. International Laboratory for Research on Animal Diseases (ILRAD)	Kenya	1974	10,031
8. International Livestock Center for Africa (ILCA)	Ethiopia	1974	8,954
9. International Center for Agricultural Research in the Dry Areas (ICARDA)	Syria, Lebanon	1975	11,292
10. International Food Policy Research Institute (IFPRI)	United States	1975	2,305
Programs			
11. West African Rice Development Association (WARDA)	Liberia	1968	2,562
12. International Board for Plant Genetic Resources (IBPGR)	Italy	1973	2,925
13. International Service for National Agricultural Research (ISNAR)	Netherlands	1979	1,095

[a]Does not include special projects. Some contributions remained to be allocated to individual centers/programs.

SOURCE: U.S. Agency for International Development, 1981.

Collaborative agricultural research and information exchange is an increasingly important requirement for countries concerned about maintaining the productivity of their arid lands in order to meet the needs of their economies and people. U.S. attention to foreign experience and commitment to cooperative exchange of research and knowledge in arid/semiarid agriculture have several ongoing and long-term benefits, including:

- avoiding costly duplication by building on the experience and research of other countries and of U.S.-funded international agricultural research centers;
- assuring that the results of U.S. foreign assistance activities in agriculture are made available to U.S. citizens, adapted to the fullest extent possible to U.S. lands, and analyzed for relevance with future foreign assistance;
- providing ideas for U.S. farmers who are interested in direct field experimentation or adaptation of foreign examples to make their operations more economical as water and energy costs rise; and
- building good will and channels of international communication of benefit beyond the agricultural sector.

Over the long term, diversification, rather than duplication, of research and development can help to strengthen economies. Development of productive agricultural systems that can be sustained on arid/semiarid lands can help meet growing worldwide demand for food and fiber.