A Reference Guide to Sustainable Land Use in Arid and Semi-Arid Lands

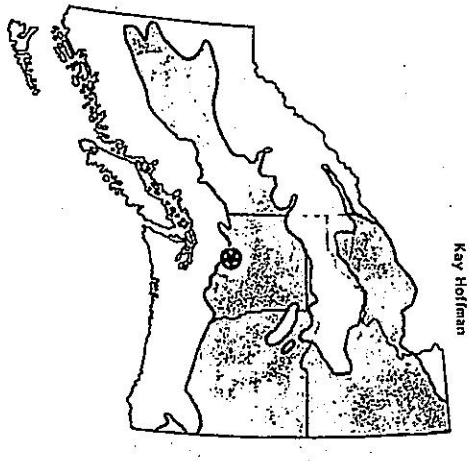
The following "Reference Guide to Sustainable Land Use in Arid and Semi-Arid Lands", had its beginnings when I worked on the Tilth Association's 1982 book The Future Is Abundant.

The subject can only be touched upon here, but the following references can lead to you to many of the world's major organizations, institutions, periodicals, books and resources concerning arid and semi-arid land use. -- Michael Pilarski

Foreword

I have been fascinated by deserts since I was a little child, particularly the deserts of Central Asia. Over the past 30 years I have read hundreds of desert books. In 1972 I moved to the semiarid Yakima Valley of Washington state and over the ensuing years I have gardened and farmed in a variety of semiarid locations in the interior Pacific Northwest using various irrigation and dry-land methods.

The words "Pacific Northwest" bring visions of rainy skies and dense rainforests, but it is equally correct to imagine dry, sagebrush landscapes, bunchgrass steppes, and ponserosa pine savannas; as well as extensive irrigation systems and dryland farming. In fact, as the accompanying map illustrates, nearly half of the region is semi- arid, receiving less than 20 inches of annual precipitation. Some areas recieve as little as 5 inches average annual preciptation. These dry landscapes are the result of the rain shadow of the Cascade Mountains and the Coastal Ranges.



Semi-Arid and Arid parts of the Pacific Northwest are the shaded area on the map. These areas recieve less than 20 inches of annual preciptation, some as low as 5 inches.

The map is from *The Future Is Abundant.*

What are Arid and Semi-arid zones ?

[The following is an exerpt from Irrigated Forestry in Arid and Semi-Arid Lands: A Synthesis, F.B. Armitage, see book review]

Arid climates

Arid climates are defined as those in which crops cannot be regularly raised without irrigation. They are generally characterized by low sporadic rainfall of great variability over time and space, averaging 200 mm [? inches] or less annually, which, when it arrives, can be of high intensity, resulting in devastating floods. Levels of incident radiation are high as are temperatures, at least in summer, and they are subject to high annual and seasonal variations. Evaporation rates are also high, particularly during the growing season. Atmospheric humidity is low a short distance from the sea. Strong winds with frequent dust- and sandstorms usually occur. . .

Semi-arid climates

Semi-arid climates have characteristics that are even more variable than those of arid regions, although, as implied, conditions do not preclude plant growth to the same degree. Fuchs labels as semi-arid all those regions in which rainfall deficiency calls for irrigation during part of the growing season. Dry farming is possible; however, its productivity is low and resricted to a few drought-resistant species.

Several climatological entities can be included within the pragmatically defined semi-arid zone; the tropical *savanna climate*, The subtropical *Mediterranean climate*, and the *steppe climate*. These embrace wide differences and variations in precipitation (in all cases up to about 750 mm/yr) and its distribution, temperatures, and their annual patterns.

The *savanna climate*, which occurs over most of the area covered by the intertropical convergence zone, is warm enough to support plant growth throughout the year, with the highest temperatures occurring in the growing season.

The *Mediterranean climate* has a mild, well defined winter during which most of the rainfall occurs. The summer is typically hot and rainless. This type of climate occurs throughout the world at the fringes between the tropical and temperate zones. Nonirrigated agriculture is based on winter crops such as wheat, whereas summer crops are restricted to a few species with very short growing seasons or plants with root systems that reach deep moist layers of the soil. Rainfall occurrence is unpredicatable and annual amounts highly variable.

The *steppe climate* , which comprises many variations, occupies larger areas than any other climatic category. It forms the transition between arid climates on the one hand, and the savanna, Mediterranean, or temperate subhumid types on the other. As with Mediterranean and savanna climates, solar radiation and summer temperatures are favourable for high production.

What is a desert ?

A few words about deserts. Desert is a good lay term to catch people's attention. But it should be applied specifically to hyper-arid regions with annual precipitation rates less then 5 inches ahd which may go for years without any rain. These areas have zero to low plant cover, but still, even here there are local patterns of vegetation where water is concentrated. Arid regions recieve an average annual precipitation of 5 to 10 inches inches precipitation/yr and often are shrub steppes. Semi-arid regions recieve from 10-25 inches of rainfall and their native ecosystems were generally grass steppe, shrub/grass steppe or tree savanna. Subhumid zones recieve 25 to 40 inches of precipitation. The ecosystems are commonly open forests. Much more of this area was forested prior to human intervention.

People from humid areas tend to consider shrub steppes and even grass steppes or savannas as "desert". Lumping so many diverse and rich plant communities under one term, "deserts", can be misleading.

The population of plants, animals and people a region can support generally increases with increase in rainfall, However even in the most arid regions there are many possibilities for comfortable habitation given human ingenuity coupled with a strong conservation ethic.

BOOKS ABOUT DESERTS

Origin and Evolution of Deserts
Stephen Wells and Donald Haragan, editors. 1983, Univ. of NM Press, Albuquerque. 228 pages.

This book is particularly valuable for those interested in North American arid areas. Notable authors present chapters on: Physiographic overview of arid lands in the Western U.S.; Some Land Management Problems in Our Western U.S. Arid Lands (both by Charles B. Hunt). Other chapters include the effect of Caliche on Desert processes; The paleobotanical history of the western deserts (by Daniel I Axelrod); and, The development of vegetation and climate in the Southwestern United States. The last three chapters examine geological and climatological perspectives to desertification including an overview of the deserts of Northern Africa by Farouk El-Baz.

Deserts of the World
by M.P. Petrov. 1976, John Wiley & Sons, NY, 447 pages. Translated from Russian.

Part 1 covers the physical features of each of the world's deserts; as well as the comparitive characteristics and classification of the worlds deserts.. Part II covers the specific environmental features of deserts. Part III is on the natural resources of deserts and prospects for their investigation and exploitation. Chapter 10 is titled "Phytoreclamation Types of Sand Deserts."

Reference Handbook on the Deserts of North America
Gordon L. Bender, editor. 1982. 594 pages. Available from the Boyce Thompson Southwestern Arboretum, PO Box AB, Superior, AZ 85273. $75.00

This book deals with all deserts of the North American continent. Treatments are provided for the vegetation, fauna, geology, soils, climate, archaeology and ethnology. Many useful networking/research appendices in the back.

Deserts of the World. An Appraisal of Research into their Physical and Biological Environments. W.G. McGinnies, Patrica Paylore and Goldman. 1968. Univ of Ariz Press, 788 pages.

This was a state-of-the knowledge work at that time. They review each desert of the world. A fantastic work which gives details on the water, geomorphology, soils, flora, and fauna. It leads you to the leading sources of further information in 1968.

Ecosytems of the World
Elsevier Sci. Pub. Co, Amersterdam

This is a fascinating series of books for the person who loves to read about far-away ecosystems. This series represents perhaps the most detailed survey of the world's ecosystems. I am not sure how many books are in this series but at least 13, since #13 in the series is Tropical Savannas by F. Bourliere, 1983, 730 pages.

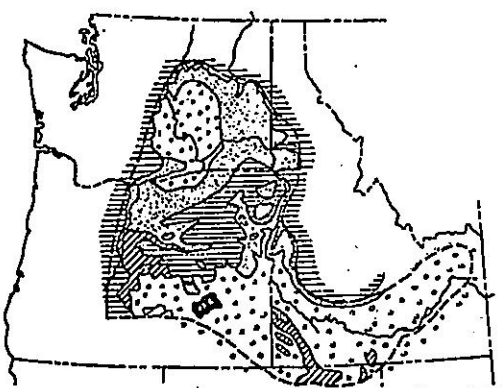
Temperate Deserts and Semideserts.
Ecosystems of the World: #5 of a series.
Neil F. West, Editor. 1983. Elsevier Sci. Pub. 522 pages.

Good quality. The emphasis is on ecology, geography, geology, and climate with some attention given to the effects of people on the desert ecosystems.

Hot Deserts and Arid Shrublands
In two volumes. Vol 1 covers Americas and Australia. 366 pages. Elseveir Sci Pub. PO Box 1663, Grand Central Station, NY, NY 10163.

Arid Land Ecosystems: Structure, Functioning and Management.
D.W. Goodell and R.A. Perry. 1979. Cambridge Univ. Press, Cambridge. Volume 1 contains 605 pages. Vol 2, 881 pages.

Pattern & Process In Desert Ecosystems
W.B. Whitford, editor.1986. University of New Mexico, Press, Albuquerque. 139 pages. Many references.



Map of natural vegetation on the Columbia-Snake River Plateau.

Spruce-Fir Forest in the Wallowa Mountains, includes some alpine grassland
Yellow pine and Douglas fir
Western juniper
Sagebrush Bunchgrass Marsh vegetation

Deserts and Arid Lands
Farouk El-Baz, editor. 1984, Martinus Nijhoff Pub. 22 pages.

Most of this book concerns the use of satellite photos in examining deserts and changes in deserts. The book includes satellite photos of many of the world's desert regions. A good way to examine different types of dune formation. Accompanying the photos are descriptions of the world's deserts. Many references.

The Desert Realm: Lands of Majesty and Mystery. 1982, National Geographic Society. Nice photos and text, from around the world. A good "coffee-table book".

Desert Plants and People
By Sam Hicks, 75 pages. 1971. Discusses the uses of desert plants by desert peoples.

Gathering the Desert
By Gary Nabham, 1985. Available for $14.95 from: University of Arizona Press, 1615 East Speedway Blvd., Tucson, AZ 85719.

"Many books have been written about the Sonoran Desert, but none explore the subtleties of its complex, intertwining relationships as this one does. Gary Nabham has gleaned fascinating details of the life cycles and ethnobotany of twelve native Sonoran Desert plants from a variety of sources, and has distilled their essence into this fine book. Through Nabhan's skillful prose we see anew the many faceted interactions of plants, animals, man and climate, in an unusual combination of science and mysticism." Book review from *Arid Lands Newsletter* .

Gary Nabham is one of the more prominent spokespersons for sustainable agriculture in the Southwest. Nabham has worked with the Office of Arid Lands Studies, is one of the founders of Native Seeds- Search and is currently employed at the Boyce Thompson Southwestern Arboretum.

How old are deserts ?

[The following paragraph by Daniel I. Axelrod (the most noted authority on paelobotany in North America) is the concluding paragraph in chapter 5: *Paleobotanical History of the Western Deserts,* in Origin and Evolution of Deserts (1983).]

"This brief summary of paleobotanical evidence shows that regional (zonal) desert environments are not "earth-old features" as some would have us believe. There is not one shred of evidence to support such a notion. On the contrary, sequences of progressively younger fossil floras from areas presently desert - whether here or on other continents - clearly show that these areas were earlier covered with rich forests and woodlands, and that desert vegetation gradually came into existence as progressively drier climate spread during the late Cenozoic. Never in the history of the angiosperm phylum have desert taxa been more abundant, more widespread, or more diverse than at present. Our regional deserts represent new ecosystems: they have just been born! Unless we take better care of them nothing will remain but a barren terrain like the largely man-made desert that now stretches uninterruptedly for 4,200 miles (6,758 km) from the Atlantic shore of north Africa to the Thar desert of western India. The choice is yours." Daniel I Axelrod.

DESERTIFICATION

Harvest of Dust

"Almost seven years ago [in 1977] the world's nations agreed to a sweeping Plan of Action to halt the process of destruction we call desertification. UNEP has just completed a two year assessment which reveals that the global threat posed by desertification, far from diminishing, has actually increased in severity.

Currently about 35 percent of the world's land surface is at risk and the livelihoods of the 850 million people who live there are directly threatened. Three quarters of the 45 million sq. kms that make up the world's drylands, which includes the subhumid tropics, is already affected, between half and a quarter severely so. That is the measure of the problem facing the world community. The international community must act now if we are to avoid shortages leading to chaos on a scale hitherto unknown.

In many ways the term "desertification" is misleading. The popular image of sand dune encroachment is only a minor part of the problem. Sometimes thousands of kilometres away from the margins of the Sahara, Gobi, Atacama and the other so-called "true" deserts, desertification is taking place. The situation has been accurately likened to a skin disease in which existing eruptions worsen and coalesce with new outbreaks of the disease. And as with any disease, treating the symptons is secondary to tackling the causes.

We need, as Indian Prime Minister Mrs. Indira Gandhi said at the launch of the World Conseervation Stategy to "once again put our ear to the ground so that the earth can whisper its secrets to us". We need also to listen to the inhabitants of the million or so villages of the developing world who are in the frontline. They know the problems and how difficult they are to solve." Dr. Mostafa K. Tolba, Executive Director and Secretary General of UNEP, in the introduction to the May, 1984 (Issue Number 10) of the *Desertification Control Bulletin*..]

What is Desertification ??

At the 1977 United Nations Conference on Desertification in Nairobi, Kenya, desertification was defined as the diminution or destruction of the biological potential of the land that can lead ultimately to desert-like conditions..

Some authorities on the subject would limit the term desertification to the extension of typical desert landscapes and conditions to the arid and semiarid areas surrounding hyperarid deserts.

Other authorities, including permaculturist Bill Mollison, do not limit desertification to arid & semiarid areas but include subhumid and humid areas which have been drastically impoverished of soil and plant cover by human activity. There are now wide areas of medium and high rainfall areas that have become desertlike through severe degradation of the environment, such as parts of Nepal, India and tropical rainforest areas with laterite soil.

We could take the concept still further and give a definition of desertification such as - the depletion of the biological productivity of any ecosystem. In other words, ongoing degradation of any environment could be termed desertification. Under this broad definition we would have to conclude that almost every part of the world is in the process of desertification, since few peoples of the world are increasing the biological productivity of the areas under their control. Desertification is a process rather than an end product. A biological desert is the result (a

ecosystem with low plant cover and inhospitable growing conditions).

The reduction of tree cover and plant cover almost invariably decreases the amount of rainfall an area recieves; plus, in many cases, rainfall in other areas is also decreased since a higher percentage of the precipitation is lost to the system by runoff and less is sent back to the atmosphere by transpiration through plants for rainfall downwind. It has been calculated that up to 85% of the preciptation on land is from non-oceanic sources i.e. plant transpriation, evaporation from fresh water sources. Also plants provide a significant amount of water in some ecosystems in the form of dew and hoarfrost. So desertification in any area leads to the area becoming dryer.

"The precise nature of the degradation depends upon local soil and vegetation conditions and landforms. Some of the more general changes that are typical of desertification include: reduction in biomass production; breakdown of soil structure; more rapid run-off; loss of top soil; and fall in groundwater level. When the equilibrium is delicate, as under water stress, even a small change in one component can have repercussions throughout the entire ecosystem; sometimes the system is disrupted beyond a critical threshhold whence natural recovery will not normally occur." [A quote from Chapter 7, *Desertification: A Climatological Perspective* by Derek Winstanley, in Origin and Evolution of Deserts, 1983.]

Causes of desertification

[The following quote is from *Arid Ecology and Desertification,* Altenberg and Ramezani.]

"To try and address the complex socioeconomic, political and cultural conditions that are both cause and effect of the phenomenon of desertification is to address all of history and human societies' utilization of natural environments and resources. . . The economic exploitation of developing Third World countries' resources, by overdeveloped First World countries and their transnational (perhaps even metanational) corporations, has led to worldwide and severe ecological damage, as well as social decay.

Among innumerable social and institutional dynamics involved in this socioecological decay, dwindling agricultural productivity and spreading desertification can generally be ascribed to:

- changes in demographic patterns due to simple improvements in health care, such as vaccinations;
- changes in human settlement - nomadism and sedentarism patterns - and increasing urbanization;
- major shifts in agricultural land tenure systems;
- increasing abandonment of traditional pastoral and agricultural methods in favor of large-scale capital- and energy-intensive mechanized agribusiness, e.g., the Green Revolution;
- decay of regional and local social infrastructures, such as health care, food production, housing, transportation, distribution and marketing of goods, etc.
- changes in landuse and resource utilization practices, in the private and government sectors, including unsound and often careless road building, mining and drilling, and off-road vehicle travel;
- changes in technological development, with the growing migration of rural population away from agriculture to supply cheap labor for growing industry;
- changes in government institutions and the expansion of Western-styled bureaucracies;
- changes in national priorities and social goals, often at the expense of meeting basic human and social needs, typified by a superficial drive for modernization, militarization, industrialization and the accumulation of national wealth; and
- growing national debts and production of export agricultural and industrial products for foreign exchange capital, furthering the deficit of food and tools needed for local, regional and national (bioregional) development.

"Nonetheless, the scientific, ecological and technological knowledge exists; the capital investments needed are within reason for an internationally supported program; the social and institutional networks exist or can be readily established; and the masses of people afflicted with desertification are ready to take action, needless to say. Desertification can be halted and reversed; lost lands can be reclaimed and brought back into production. Peoples' needs for food, fuel, fodder and fiber can be met. The choice is ours, we - the people and national governments of the world - must make the choice all together, and we must make it soon."

The above statement is exerpted from: **Arid Ecology and Desertification.** An unpublished paper prepared by Ahmed Ramezani and Ted Altenberg for the Ecodevelopment program at the University of California Santa Cruz. 38 pages.

This statement expresses the Friends of the Trees editor's viewpoint.

The United Nations & the global "Green Front" against desertification.

"UNESCO, during the 1950's and into the 1960's and '70's, took the lead in a world-wide program of arid zone research. These and other studies produced over thirty volumes of ecological research, covering hydrology, plant ecology, energy resources, human and animal ecology, climatology and microclimatology , and more. Nearly 200 arid research centers in 40 countries have been established. The International Program on Biological Studies (IBP) contributed significantly to the studies of desert biomes and other aspects of arid landscape ecology, between 1964 and 1974.

In December, 1974, the UN General Assembly called for programs of international cooperation in assessing and confronting the peril of global desertification. Prominent scientists, researchers, diplomats and planners spent a number of years studying and inventorying world arid and semiarid regions and their landuse systems in relation to desertification. The UN Conference on Desertification (UNCD) was convened in August, 1977 in Nairobi, Kenya.

A World Plan of Action to Combat Desertification (PACD) was developed to halt and reverse desertification by the year 2000.

It is not possible here to review all the efforts made in these directions since the UNCD in 1977. Despite all these efforts, however, there is no doubt that the processes of desertification are accelerating, with millions of hectares of arable land being lost every year.

The potential for solving this ominous global crisis are encouraging, but the political barriers are hindering progress. As Dr. Tolba, Secretary General of the UNCD, stated in his review of the conference,

"The resources available to combat the menace of desertification are in no way commiserate with the seriousness of the problem faced. The prospects for concerted actions are dim, and there does not seem to be any indication that governments of the world are willing to take the problem seriously. They are

discouraged by the figure of additional resources needed ($1.8 billion/year for 10 years), while they ignore the costs of productivity lost every year (close to $25 billion). The potential benefits clearly outweigh the costs. . ." [From Arid Ecology and Desertification: Altenberg and Ramezani.]

Desertification: Its Causes and Consequences. UN Conf. On Desertification 1977. Pergamon Press, New York, 448 pages.

Many articles and references on the relationships of desertification vis a vis climate, ecological change, population, society, and technology.

Conference on Desertification: An Overview. United Nations, 1977. Pergamon Press, Oxford, England.

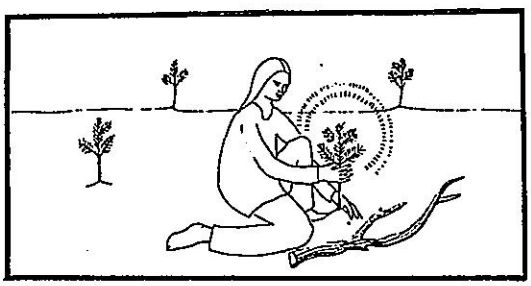
Desertification
By Asit K. Biswas and Margaret R. Biswas.1980, Pergamon Press. Associated Case Studies for the UN Conf. On Desertificaiton. 523 pages.

Case Studies on Desertification
A. Mabbutt & C. Floret, editors. 1980, UNESCO. 279 pages

Six main case studies are looked at in depth. Smaller coverage is given to other cases. Their problems, lessons, history, conclusions and recommendations.

Land, Man and Sand,: Desertification and its Solution.
By James Walls. 1980. Macmillian Pub. Co. 336 pages.

James Wall was a member of the Conference Secretariat for the 1977 UN Conference on Desertificaion in Nairobi, Kenya. His book reflects rubbing shoulders with many of the key researchers and policymakers for the Plan of Action to Combat Desertification. The book is based on the 15 case studies prepared for the conference: Nairobi, Mussayeb, Turfan, Gascoyne, Wushenchao, Aglat Merteba, Eghazar and Azawak, Combarbala'., Vale (Oregon), Luni, Mona, Golodnaya Steppe, Turkmenia, China, The Negev, and Turan. Wall's writing style is very readable as he brings in a host of intererelated factors leading to desertification, some success stories and some ideas on where to go from here.



Children of the Green Earth

Land Aridization and Drought Control. By Victor A. Kovda. 1980 Westview Press, Boulder CO, 277 pages.

Victor Kovda is one of the world's leading arid-land, soil scientists and ecologists. An eminent USSR scientist with decades of experience in the USSR's arid and semi-arid lands, as well as in China and other countries. In this book Kovda discusses the spread of deserts, causes, soils, dryland farming, irrigation, soil salinization and the improvement of salizined soils (the latter is Kovda's specialty). Kovda believes that the world's agricultural production could be tripled or quadrupled if we use the best (i.e. ecologically sustainable), agricultural methods known now. [see letter by Kovda in "remineralization section"].

Desertification: How People Make deserts: How people can stop: and why they don't.
Alan Grainger. 1982. Earthscan. 94 pages. Available in English and French.

Alan Grainger is one of the foremost ecological, tree-oriented writers in England. He works with the International Tree Crops Institute and is editor of several international tree journals. Grainger offers a studied look at desertification and what can be done to stop it.

World Desertification: Cause and Effect. A Literature Review and Annotated Bibliography. Patricia Paylore and W.C. Sherbrooke. 1973. University of Arizona, Tucson, 168 pages.

Desertification: A World Bibliography.
Patricia Paylore, Editor. Presented at the 23rd Int. Geog. Congress in Moscow. 1976. Univ. of Ariz. Office of Arid Land Studies.

Good coverage of Africa, poor coverage of North America.

Desertification of Arid Lands
by Harold E. Dregne.1983, 242 pages. $33.50. Harwood Academic Pub, N.Y.

The author is one of the world's most knowledgeable experts on arid and semi-arid lands.

Desertification: Environmental Degradation in and Around Arid lands.
Michael H. Glantz, editor, 1977. Westview Press, Boulder, CO. 346 pages.

This book addresses desertification as a global problem. Its nature and causes. Most of the book is devoted to a statement of the problem and a lesser amount to discussing solutions. Countries/regions covered in more detail include Nigeria, Somalia, the Sahel, South Africa, and the USSR.

Can Desert Encroachment be Stopped?
Ecological Bulletins/NFR 24
A. Rapp et al. UNEP & Swedish Natural Science Research Center (NFR). 1976. 241 pages.

Deals with ecological and social problems of desert encroachment and suggested remedies.

Combatting Desertification in the USSR: Problems and Experience. A.G. Babaev editor. Centre of International Projects, 120 pages. GHNT, PO Box 438
107053 Moscow, B.53 USSR.

Desertification and Its Control
By P.L. Jaiswal, Editor, 1977, Model Press, New Delhi.

Man and the Mediterannean Forest.
By J.V. Thirgood. 1981, Academic Press, NY.

One of the best accounts of the prehistoric forests of the Mediterannean, the history of their destruction and degradation, and the present-day situation.

National Plan of Action to Combat Desertification NPACD
US Dept of the Interior, Bureau of Land Management, Washington, DC 20240

This was supposed to be a report on, and recommendations for dealing with, desertification in the United States. The report was in the final stages of preparation when Ronald Reagan took over as President from Jimmy Carter. Friends of the Trees editor was on the mailing list to be sent a copy of the report. After publication date was past I wrote to find out where my copy was. I subsequently talked to Becky Thornton, the director of the project, on the phone and we exchanged several letters. The story that emerged is that shortly after Reagan took office the project had its funding cut out from under it. Although an abbreviated version of the report was published, little effort (if any) was made to disseminate them. Becky Thornton was soon out of that job. After a number of inquiries I have never got the government to send me a copy. Becky said she would try to get a copy sent to me, but to no avail. I still haven't seen a copy, nor has anyone seen a U.S. national plan of action to combat desertification.

Desertification in the United States.
David Sheridan, Washington DC: USGPO, 1981.

Written for the Council on Environmental Quality, this detailed, readable study analyzes the cuases and effects of desertification in the U.S., and suggests solutions. The report is welreferenced, and Sheridan pulls few punches in his vivid portrayal of the degradation of vast sections of our nation's farm and range land. One of the best studies on the U.S. desertification situation thus far.

Desertification in the United States, Status and Issues.
J. Eleanora Sabadell, et al. Bureau of land Management, Washington, DC: USGPO, 1982.

Survey of desertification trends in the arid West caused by human activity. Included is a review of current data and a brief discussion of successful rehabilitation projects.

Arid Lands In Perspective. William G. McGinnies and B. J. Goldman, editors, University of Arizona. 1969, 421 pages.

Another compilation of articles by McGinnies and Goldman. Some articles will prove useful to current dry lands researchers.

Appropriate Development Inappropriate Development

"Experience over the previous six years has shown that a precondition for success in carrying out field projects is community participation. Our evaluation of such projects show they are far more effective than large downward-directed projects.

The success of NGO-run schemes which have tended to be small-scale and directed at community problems is, in particular, something which UNEP is keen to extend.

. . . Equally important is the need for a dramatic change in the priorities of bilateral and multilateral development asssistance agencies. Far too much technical and financial assistance has gone to show-piece projects and into measures aimed at appeasing the more politically advantaged urban populations. By comparison rural population which tend to lack political clout - especially in the more remote semi-arid regions - are all but ignored. And even when it comes to alloting funds for rural development, agroforestry and other ecologically sound activities are nearly always at the end of the queue. For example, a recent breadown of the assistance provided by the Club Sahel - the grouping of OECD donor nations set up after the Sahelian drought - showed that under two percent of the overall expenditure went to support such activities." Dr. Mostafa K. Tolba, Executive Director and Secretary General of UNEP, in the introduction to the May, 1984 (Issue Number 10) of the *Desertification Control Bulletin*..]

Development Without Destruction: Evolving Environmental Perceptions. M.K. Tolba. 1982. Tycoolly International Pub., Dublin, Ireland.

The Politics of Natural Disaster: The Case of the Sahelian Drought.
By Michael H. Glantz.

Desertification and Development: Dryland Ecology in Social Perspective.
B. Spooner and H.S. Mann, Editors. 1982. Academic Press, New York, 407 pages.

Drought and Man: The 1972 Case History. Vol 1: Nature Pleads Not Guilty. Vol 2: Constant Catastrophe. Vol 3: Case Studies. By Rolando V. Garcia. 1981. Pergamon Press, New York.

This is a study of the Sahel famine in the early 1970's. It is a good look at the roots of starvation. Garcia addresses malnutrition, famines, and their relationships vis a vis International and multilateral food aid and drought and climatic variability.

Perspectives on Drought and Famine in Nigeria. By G. Jan Van Apeldoorn. 1981. George Allen & Unwin, London 184 pages.

This book focuses on the early 1970's famine in Africa. It shows that the famine was the result of political and economic arrangements; food as weapons, the pricing of food and its outcome for Third World residents. The book is written as a tool to gauge current developments and judge present policies to prevent famine in further droughts.

Food, Fuel and Shelter: A Watershed Analysis of Land-Use Trade-Offs in a Semi-Arid Region. Timothy D. Tregarthen, Westview Press.

Farming for Profit in a Hungry World: Capital and the Crisis.
By Michael Perelman 1977, Allanheld, Osmun & Co, Montclair, New Jersey. 238 pages.

Discusses the negative consequences of the "Green Revolution" - starvation, soil erosion, the role of corporate conglomerates, and governments, etc.

Studies in Himalayan Ecology and Development Strategies
Tejvir Singh, editor. A recent publication which contains a wealth of details on this wide-ranging subject. Recommended in a IUCN Journal.

Alternative Strategies for Desert Development & Management,
In 4 volumes. Proceedings of an International Conference held in Sacramento, Calif. in 1977. Editors, M.R. and A.K Biswas. Published by the UN Inst. for Training & Research in 1982.

Arid Zone Research & Development
H.S. Mann, Editor. Proceedings of an International Symposium on Arid Zone Research and Development held in 1978. 2 volumes, 1061 pages. Scienti. Pub., Jodhpur, India.

Appropriate Development and Desertification in Sudan

Community Forestry in Sudan
By Richard Webb. September 1985, 46 pages.

This report is the result of a study tour to the Nile Province of Sudan in 1985. The purpose of the tour was to collect information on community forestry projects in order to access their suitability as models which could be funded by Irish aid agencies as part of their strategy for long-term famine relief.

Richard Webb reports that much of Sudan is in advanced stages of desertification due to interrelated factors of increasing population, expanding agriculture, decreasing forage supplies, high prices for charcoal, low prices for gum arabic, an increased urban demand for cooking fuel, political systems, war and drought. Large areas have been denuded of trees and many areas with remaining tree cover have had all ground flora eliminated.

Most of the paper reports on various tree-planting projects underway in Sudan and draws conclusions from their experiences on what constitutes a community forestry projects which is likely to succeed. This is a good report to study, for those interested in sustainable development projects. For Richard Webb's address see Tree Concil of Ireland in international section. Also the Internation al Tree Project Clearinghouse has the report available.

Richard Webb's conclusion was that "Successful community forestry projects display the following characteristics:

- Flexibility, in order to adjust to changing circumstances or new problems;
- Selection of locations which will obtain the greatest benefits;
- Technical solutions based on research and field experiments;
- Full involvement with local people at all levels of project design and implementation, with provision for the benefit of less well off members of the community;
- Early involvement of the government forestry department at central and local level and the provision of an effective forestry extension programme;
- Approval of the native administration and local politicians;
- Early considerations of land ownership and ultimate use of the trees;
- Selection of species appropriate to local conditions and needs;
- Provision for protection and maintenance of trees;
- Incorporation within the project of programmes designed to improve local agriculture and supplies of water and fuelwood;
- A system for evaluating and monitoring the project.

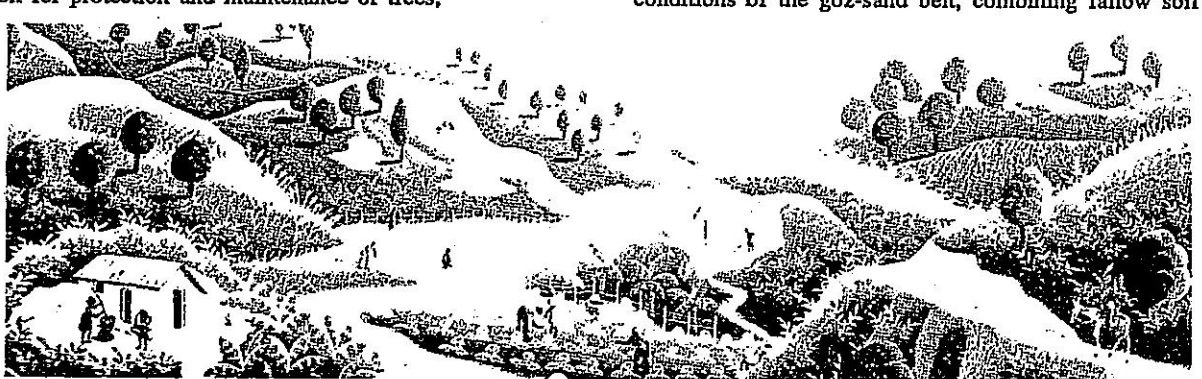
Local enthusiams for existing tree planting projects, the increasing demand for trees, an awareness of the role of trees in controlling desertification and the establishment of an effective forestry exension service, indicated that conditions in Sudan are favourable for community forestry projects funded by development aid agencies."

"Sudan , in east Central Africa - stretching from the Red Sea and Ethiopia in the east to the Central African Republic, Chad and Libya in the west, and from Egypt in the north to Kenya, Uganda and Zaire in the south - with an area of 2.5 million square kilometers [967,500 square miles], is the largest country on the African continent. [This is an area larger than the all of the continental United States west of the Great Plains!] It is part of the geographic region, known as the Sudan, that stretches from the Sahara (latitute 22 degrees N) to the rain forests of Central and Western Africa (latitude 4 degrees N). The total population of the country (1983) is estimated at 20.6 million made up of about 3.2 million urban and 14.4 million rural. Agriculture dominates the economy, accounting for over 40 per cent of GNP in the productive sector, and is also the main source of foreign currency [the two main exports are cotton and gum arabic]. About 70 per cent of the population depends for its livelihood on agriculture.

In Sudan the amount of rainfall and the duration of the rainy season diminish from south to north. Rainfall varies from about 1400 mm in the south to almost nil in the extreme north. The climatic conditions correspondingly vary northward from equatorial in the extreme south to wet-and-dry savannna, then semi-arid and finally desert conditions in the extreme north."

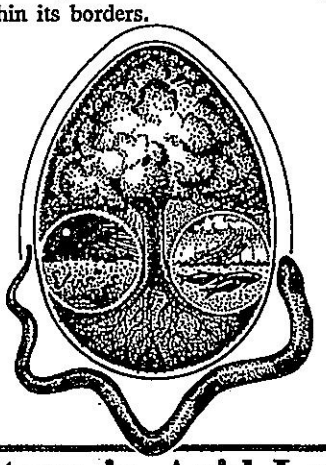
"Until recent times almost 70 per cent of Sudan was covered by forest or savannah woodland. Sudan faces a major energy crisis, as 80 per cent of the country's energy needs are supplied by wood, mainly in the form of charcoal in the towns, and fuelwood in rural areas. Current estimates of the duration of supply of chacoal from Blue Nile Province to the Khartoum and Gezira markets vary from around 10-20 years. In Kordofan energy supply will reach crisis proportions within 5-10 years. the total fuelwood consumption for the Kordofan regions is 4.5 million m cubed per year, equivalent to the production from approximately 3.5 million hectares of woodland [8.4 million acres].

"The traditional gum arabic land rotation, of cropping for five years followed by a fifteen year bush-fallow in which the tree *Acacia senegal* is tended for gum arabic, has almost collapsed in the north of the province. This system, developed over centuries, is the most efficient land practice for the environmental conditions of the goz-sand belt, combining fallow soil rehabili-



with a valuable dry season cash crop and source of fodder. In response to population pressure farmers attempt to cultivate their land for up to 8-10 years, exhausting soil fertility and predisposing the land to wind erosion...."

Richard Webb does not mention the civil war in Sudan between the southern tribes against the northern tribes which control the central government. The country's resources are also stressed by millions of refugees who have fled Ethiopia to escape the Ethiopian central government's war on many different tribes and peoples within its borders.



Permaculture in Arid Lands

Permaculture started in Australia, so not surprizingly, many of the permaculturists there have worked in arid and semiarid areas. Bill Mollison especially has worked with outstation aborigines for years. As a result of applying permaculture to these conditions Mollison has become a noted world authority on arid land settlement design.

Mollison details some of his arid land strategies in Permaculture II. The subject will be considered more at length in his Permaculture Design Handbook which is scheduled for publication in 1988.

Friends of the Trees editor was fortunate to have organized and attended a two-week, Drylands Permaculture Design Course taught by Bill Mollison in August,1986. This was the first Design Course Mollison taught which was specifically oriented to arid and semi-arid lands. I have reprinted here a few small sections of the course outline.

Friends of the Trees coordinator, Michael Pilarski will be teaching a 17-day Drylands Permaculture Design Course from November 25 to December 10, 1988. See the Permaculture section of this Yearbook.

Permaculture offers the best design methodology for feeding the people and healing the land throughout the world, certainly so in arid and semi-arid regions.

Exerpts from Permaculture Two by Bill Mollison.

"There are two approaches to the arid lands, neither as yet tried on a very extensive scale;

o using species and techniques of known effect (as for the Tucson Indians);

o devising new techniques in the modern idiom (as for the bitumen "mulch" used in Morocco).

Both need to be used in any integrated approach to desert rehabilitation. Although we have impoverished the flora and fauna of many deserts, we can recombine the remnant species of all deserts to make a rich agriculture. My own limited experience with Aboriginal Australians trying to farm in very arid conditions prompts the strategies given here.

. . . In many areas, run-off from bare or rocky areas increases effective precipitation, so that small areas of a few acres to fifty acres or so may be selected where good underground or runoff water is available for gardens. Rock-holes, some small dams, rock seepage, underground water in soaks or sandy river beds. bores, wells, windmills and tank-water from roof catchment all assist gardens, and run-off properly direcerted would make gardening possible in many places. The aim it to use many more deep-rooted and climatically-adjusted perennial plants for food and structural materials, in order that desert outstations may become more self-sufficient, and to devise low-maintenance systems of domestic agriculture.

The less these methods rely on sophisticated machinery, transport, and fossil fuels, the better it will be for future survival, so that more natural methods take preference in view of the state of the petrol economy.

The native vegetation of all deserts still presents a great resource, although fire/grazing interaction and the presence of very large numbers of feral livestock and (in some places) rabbits, make for great difficulty in establishing new plantings unless they are well-fenced and protected. Treeless areas are evolving due to overgrazing after fire. . .

Water lies close underground in many places. Mulch material, as plants or leaves, is abundant. Growth in desert soils is phenomenal if water is available. Modern drip-irrigation plus mulch will grow any domestic crop. While lawns, as such, are rather wasteful disasters, the potential is for a revolutionary forestry, and this increases rainfall, and a reduction of dust and disease. China is planting 7,500 km of her desert fringe; Australia could do the same, but hasn't as yet started on the first 7 km, preferring to have an unemployment problem, dust, salted soils, and large profts for a few graziers ! There has been little or no attempt to to develop large desert water-storages, or to encourage scour-hole lagoons, and no extensive use of keyline or Negev run-off techniques, although road graders are now available for such work.

The sad present conditon is that most food, not of good quality due to transportation difficulties, is imported to settlements, and as petrol becames scarcer and more expensive greater hardships will result for all sectors of the population. Therefore there cannot be too much emphasis on trials of new species on a broader scale and an emphasis on home gardens rather than commercial plantings is needed at this stage (these latter may come later as a result of the smaller trials in gardens and after the basic survival of residents is assured.). Bill Mollison

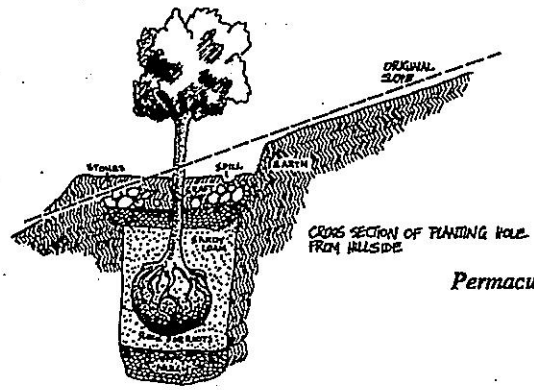
Erosion control on dry slopes:

The "net and pan" planting pattern of figs. 5.3 and 5.4 is an effective control in overgrazed, eroded, mined or bulldozed sites. If tyres are available, the "pans" can be made from these, filled with mulch, and the diversion drains led in above the tread level. Some fortunate people have access to logs, which can be staked cross-slope, on a slight downhill grade so that water is made to zig-zag across the erosion face, and hence absorb into the ground, Even small logs and branches, pegged across erosion channels build up a layer-cake of silt and leaves. Beside which willow, ti-tree, acacia, or any other fibrous-rooted and hardy species can be planted which then act as a permanent silt trap. Mulch behind logs and barriers quickly stabilizes the seed bed for planting. Fallen leaves and scattered dung also accumulate in these mini-deltas to provide plant nutrients.

On very steep slopes there is often no recourse other than to plant pampas, bamboo, and root-mat pioneers, and to make up-

slope plantings of chestnut, acacia, carob, olive or other large specie which will cascade seed downslope over time. Where implements such as chisel ploughs can be used, the same pattern of net and pan is effective in erosion control

What we tend to see however, are fairly massive contour trenches , allowing little soil absorption of water, creating dry strips on slopes, and exposing a great deal of subsoil; such heavy-handed approaches need massive machinery, and achieve little in the way of water control and soil improvement, compared with plannned chiselling and planting, which makes a permanent and stable change on hillsides. Bill Mollison



Permaculture Two

The following are several exerpts from the 1986 *Drylands Permaculture Design Course Handbook.*

Section 4: Desertification

Desertification is the creation of collapsed, eroded & salted soils. It is primarily a socio-political problem.

Causes Are:

o Headwater & local deforestation; allows increased wind effects, rainsplash, erosion, fast overland flow, more infiltration to salty layers, groundwater rise, release of soil salts.

o Cultivation: breaks down topsoil structure, compacts subsoil layers.

o Overgrazing: combines above effects.

o Burning: combines above effects, may bake topsoil, removes soil humus & nutrients (usually, it takes 20-30 years to replace nutrient loss.

o Local concentration of livestock by (e.g.) wells, hence settlements of nomads at one place, demand for firewood & fodder.

o Increased hot wind evaporative effects as trees are cut down.

o Salting of drylands leads to soil collapse by deflocculation, concretions, salt ponds off streams, permanent deforestation, swamping of collapsed soils in rain.

IT IS POSSIBLE TO RECLAIM DESERTS:

Some cures

o Reforest intake areas on rocky hills, ridges, headwaters

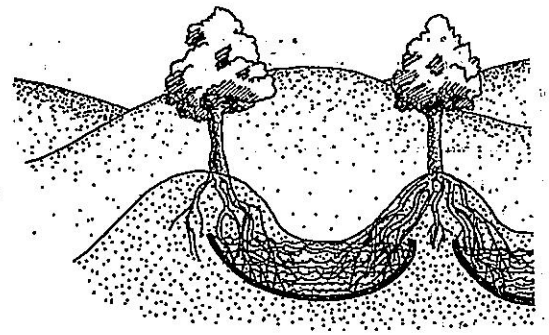
o Interceptor banks to prevent overland flow & to lead salty water to streams.

o Swales plus trees to permit sweet groundwater recharge.

o Gypsum to restore soil structure, allow salt to wash out in rains.

o Change of land use to forestry, mulch, green crop, sparse livestock systems, reduction of cultivated areas.

o Supplanting fire regime by slashing or strategic grazing, reduction of litter to mulch by any means but fire (rollers, slashers, chippers, livestock).



Permaculture Two

HUMAN AND SOCIO-POLITICAL FACTORS OF DESERTIFICATION:

Great changes may be resisted on the basis of:

o Risk; Traditional methods work well and are "safe".

o Land ownership: benefits may accrue to already privileged people.

o Increased work & expense for families, farmers.

o Culture prevents the use of some foods & strategies.

Effective approaches

o Multiple small trials & feedback. Meaningful local solutions & work. Must be moderated by a land ethic.

o Education of large groups, tie education to field trials, create field days, have effective non-institutional extension & education.

o Whole-system approach is essential, as is long-term planning for new evolutions. Inter-dependent services must be provided.

o Emphasis on local, familial, regional self-reliance.

o Work only with people who at first volunteer to change; others will watch & assess.

o Local associations and work-nets (not networks) raise morale

PLACEMENT OF VEGETATION AROUND HOUSES

o Deciduous trellis on sun side: shade in summer, open in winter.

o Permanent trellis to shade west side of house

o Trellis shadehouse or verandah on shade side

o Tall trees (e.g. palms) to the sun side (no short evergreen trees to obscure sun in winter). Trees can be tall, feathery, deciduous.

o Fast-growing, drought tolerant windbreak trees to the shade side to stop cold winds.

o Shrubs to west side to act as windbreak against hot dry winds. *[End of Bill Mollison exerpts]*

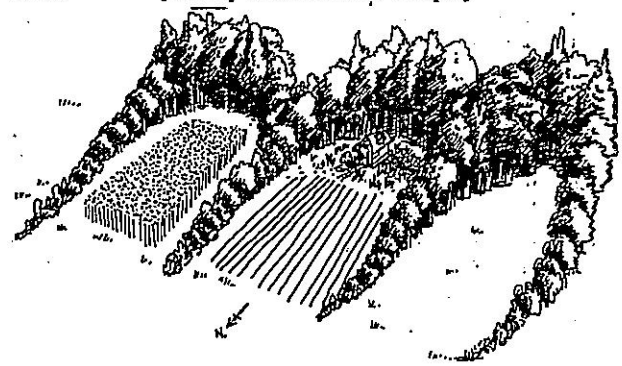


FIG.4-5: BASIC SUN TRAP STRUCTURES FOR HOUSE, FIELDS. *Permaculture T*

Arid Land Institutions In Other Countries

Desertification Control Programme Activity Centre
United Nations Environment Programme
PO Box 30552
Nairobi, Kenya

The Desertification section of UNEP started out in 1978 with the mandate to follow-up and coordinate the Plan of Action to Combat Desertification (PACD), which emanated from the United Nations Conference on Desertification., held in Nairobi in 1977. The branch was upgraded to a Programme Activity Centre as of January 1, 1986. PAC had a staff of nine professionals in 1987.

DC/PAC's activities include: (1) assisting governments in national policy and planning, (2) support to international bodies, (3) co-ordination and catalysis, (4) monitoring, assessment and mapping, (5) pilot demonstration projects (6) research and training and (7) information dissemination and database establishment.

DC/PAC has already assisted Tanzania, Burundi, Uruguay and Tunisia to formulate national plans of action to combat desertification. DC/PAC is involved in setting up various networks including assisting the FAO to establish dune fixation and afforestation networks.

DC/PAC provides the secretariat for the Inter-Agency Working Group on Desertification (IAWGD). The IAWGD co-ordinates UN system and other activities in the field of desertification control. DC/PAC also provides the secretariat for the Consultative Group on Desertification Control (DESCON). DESCON is a forum, convened about every two years, where donor and recipient country representatives can get together to discuss overall desertification control policy. At the same time specific priority proposals are tabled by affected countries for consideration for support by the donors. Over $30 million has already been raised for anti-desertification projects by the DESCON mechanism in five meetings since 1978.

DC/PAC supports demonstration pilot projects.

One of the most important activites of DC/PAC is to gather substantive data on all aspects of the problem, analyze them, organize and store the data and then to disseminate useful and informative information to governments, researchers, NGO's, the news media and to the interested public. DC/PAC is now establishing a **computerized Desertification Information System (DESIS)** which will consist of several databases including" an annotated directory of institutions involved in desertification work (with more than 500 entries), an annotated bibliography, A UN compendium of desertification control activities, and a database of wind erosion resarch and control solutions.

DC/PAC also disseminates information through its biannual *Desertification Control Bulletin*, by TV documentaries, slide shows, radio programmes, publications in scientific journals and magazines.

"All in all, the job of the DC/PAC is a complex one involving many different tasks and areas of expertise. It is an extremely important one, however, if the scourge of desertification - destruction of the land resources of our planet - is to be halted. Not to do so is to condemn our descendants to a world which will be significantly less able to support them."

Desertification Control
UNEP
PO Box 30552
Nairobi, Kenya

Desertification Control is an international bulletin published at six-month intervals by UNEP to disseminate information and knowledge on desertification programmes, activities and achievements in the implementation of the Plan of Action to Combat Desertification around the world. Each issue contains a number of articles, news from UNEP, news from other organizations, and book reviews. *Desertification Control* is published in English. Subscriptions are free upon request.

Arab Center for the Studies of Arid Zones and Dry Lands
PO Box 2440
Damascus, Syria

Established by the League of Arab States in 1971. It has a staff of 190.

International Center for Agricultural Research in the Dry Areas
PO Box 5466
Aleppo, Syria

Founded in 1977. Its focus is grains and legumes in north Africa and west Asia.

Desert Institute
El Matariya
Cairo, Egypt

Publications available on deserts.

Negev Institute for Arid Zone Research
Beersheba, Israel

Michael Evenari and other Israeli researchers have been some of the leading scientists in the world at developing agricultural techniques for dryland regions. Especially notable is Evenari's work with discovering and detailing the ancient Nabatean's sophisticated, agricultural systems based on dryland water harvesting. [See book review The Negev: The Challenge of a Desert.]

Central Soil Salinity Research Institute
Karnal 132001
INDIA

They hosted the **"International Symposium on Afforestation of salt-affected Soils"** in February, 1987. For further information contact the Director, Dr. J.P. Abrol.

Arid Zone Research Association of India

Publishes the quarterly: *Annals of Arid Zone* .

Centrol Nacional de Investigacion Para el Desarrollo de Zonas Aridas.
Buenavista, Saltillo,
Coahuila, Mexico

Interests include dry land farming, utilization of native arid and seminarid zone plants, range management, and development of water supplies.

ARID LAND INSTITUTIONS IN THE UNITED STATES

Office of Arid Lands Studies
University of Arizona,
845 North Park Avenue
Tucson, Arizona 85719

Established in 1964, The Office of Arid Lands Studies has become one of the most active, and effective, institutions devoted to arid lands internationally and in the United States. A lot of it is due to the efforts of William McGinnies and Patricia Paylore, whose names you will find as authors of a number of the books reviewed in this Friends of the Trees Yearbook. Their activities have included bibliographic inventories of world deserts, directories of arid land research institutions and arid lands research scientists, and studies on economic development of native desert plants, including jojoba and guayule.

Arid Lands Newsletter

The Arid Lands Newsletter is back again with the publication of Volume 25 (Fall-Winter, 1987). Publication was temporarily discontinued when Patricia Paylore, its long time director, retired.

This newsletter is probably one of the most widely read periodicals of its kind in international arid lands circles. Its international focus makes it relevant anywhere English is read. Each issue contains several articles, book reviews, announcements of conferences and information on the current activities of the Office of Arid Lands Studies. Although the tone is scientific, it promotes sustainable management. The only complaint I have about this newsletter is that it is too small. It should be at least10 times the size !

Arid Lands Newsletter is published semiannually, and is distributed worldwide without charge.

Arid Lands Research Institutions: A World Directory. Editors B.S. Hutchinson and R.G. Varady. 1988. Available for $20 from Office of Arid Lands Studies.

The third edition will be published in early 1988. Many directories are only published once and their usefulness diminishes yearly. Directories that go through several editions usually get better each time. First published in 1967 and again in 1977, this work was originally based on UNESCO's 1953 *Directory of Institutions Engaged in Arid Zone Research.* During the past twenty years the directory has been an invaluable tool for promoting organizational contacts and linkages. The new volume will include nearly twice as many entries as did the previous edition, and coverage has expanded to include virtually twice as many countries. This is an up-to-date, comprehensive directories of arid lands organizations in the world.

The Dry Lands Research Institute
PO Box 112
University of California, Riverside
Riverside, California 92521 (714) 787-3785

The Dry Lands Research Institute was established by the Regents of the University of California in 1964 to create a center for agricultural and environmental research in arid and semi-arid lands. The Dry Lands Research Institute emphacizes research, education, and training for scientists and students working in the dry lands. It encourages association and interaction between investigators involved in dry land research within the University of California System and with other research centers and scientists around the world. Both basic and applied research is undertaken with an emphasis on long-term interdisciplinary studies in environmental sciences and agriculture. Wesley M. Jarrell, Director. David A Bainbridge, Public Information Representative.

The Institute supports faculty and departmental research on arid-zone problems; and supports, staffs, and develops research and training projects in less-developed arid regions outside the United States. Like so many other such institutions, the Institute has had to adapt to periods of high funding or funding droughts. A recent revivial of interest in arid lands has stimulated new directions at the Institute including greater public outreach through the starting of the Drylander newsletter.

A University agricultural institute with an emphasis on sustainable, biological methods is a rarity in the present political climate, so it deserves the support and collaboration of people researching or involved in sustainable systems in dry regions.

Drylander
Geology Building
Editor: David Bainbridge
Geology Building
U.C. Riverside
Riverside, Calfiornia 92521 (714) 787-5797

The Drylander is an affordable, relevant drylands periodical for those folks involved with sustainable systems in arid and semi-narid areas. Issues of the Drylander have been small thus far, but editor, David Bainbridge always fits in lots of useful information.

Issue No. 1 of the Drylander had articles on: Breeding Improved Crop Varieties for Dry Lands; Deep Ecology - Nitrogen Fixation in the Deep Soil; How Much Water does Jojoba need?; Sand Tanks for Dry land Water Storage; Suspension Fencing; and Hopi Corn.

Issue Number 2 (summer 1987) included short articles on Sustainable agriculture; Biotechnical Solutions to Environmental Problems; Using Trees to manage groudnwater; Fire in Southern California Deserts; Biological Prospecting; Erosion Control with Live Cuttings; Agroforestry; Xeriscape, Tepary Beans, Range dieoff in the Great Basin; Apple Variety Trials, and Multi-purpose Tree Crops. Each article introduces the subject and gives several references to sources for more detailed information.

David Bainbridge has been a resource person at various Permaculture Design Courses, and permaculture conferences. The Drylander welcomes contributions of articles or material. Macintosh disk, Word 3.0 preferred.

Issue Number 1 gives no subscription price. However it does say "Donations welcome: Please help us continue this publication and improve distribution overseas. Donations should be made to the UC Riverside Foundation: Dry Lands Research Institute Newsletter."

International Center for Arid and Semi Arid Lands Studies
PO Box 4620
Texas Tech University
Lubbock, Texas, 79409

Established in 1966 to develop and disseminate information about arid and semiarid lands. This is one of the top five university centers in the United States concerned with arid and semiarid lands. Their name is mentioned over and over again in the literature. Harold Dregne was the former director. A newsletter is published.

Committee on Arid Lands (COAL)
COAL is a national committee established by the American Association for the Advancement of Science in 1965. Its charge is to increase public understanding of arid lands problems, contribute to the solution of these problems, promote communication among scientists engaged in arid lands research, and serve as a catalyst for international cooperation on arid lands problems. COAL has published a number of books.

Arizona State University Newcast Center
Center for Arid and Tropical New Crops
Applied Science and Technology
Div. of Agriculture
Tempe, Arizona 85287 (602) 965-1260
Founded in 1979. Emphasis on biotechnological research.

Washington State University
Dryland Research Unit
Lind, Washington 99341 (509) 677-3671
The majority of its research is on mechanized, field crops.

Northern Plains Soil & Water Research Center
Montana State University
PO Box 1109
Sidney, Montana 59270 (406) 482-2620 USDA research center on controlling wind and water erosion.

Desert Plant Society of Vancouver
2941 Parker Street
Vancouver, B.C. Canada V5K 2T9

DESERT INSTITUTIONS IN THE SOUTHWEST UNITED STATES

Boyce Thompson Southwestern Arboretum
PO Box AB
Superior, Arizona 85273
A major researcher and publisher on the flora of the Sonoran desert. Many excellent publications. The arboretum must be worth a visit since it was orginally established in 1929. Started publishing the journal *Desert Plants* in 1979. A one year subscription is $12. As of 1982 the journal had a subscribership of 4,000. As the subscription list has grown it has been possible to make various improvements, to publish longer manuscripts, to use more illustrations and to publish some photographs in full color.

Perhaps their publishing epitome thus far is Volume 4, 1982, Published in one large issue of 342 pages ((8.5"x11"). Titled: ***Biotic Communities of the American Southwest - United States and Mexico.*** David E. Brown, editor. This special issue deals with Arizona, New Mexico Baja California del Norte, major parts of Sonora, Chihuahua, California, Nevada, and Texas, as well as minor parts of Baja California del Sur, Cahuila, Utah and Colorado. This part of the North American continent is well known for its checkerboard of vegetation which includes major arid and subarid categories

This issue of *Deseri Plants* is a collector's item. Perhaps they still have some copies left. Price listed is $13.95. A pittance for a book of this quality. Almost every page has large photos of plant communities as well as an excellent text. This is presently the definitive work on the vegetative and faunal zones of the Southwest. If you live in the Southwest, you should obtain a copy of this book and read it.

The Committee on Desert and Arid Zones Research
of the Southwestern and Rocky Mountain Division
of the American Assoc. for the Advancement of Science.
Colorado Mountain College
300 County Road 114
Glenwood Springs, Colorado 81601-9990
The objective of the Committee is to encourage the study of phenomenoma relating to and affected by human occupations of arid and semiarid regions, primarily within the Southwestern and Rocky Mountain regions of the United States. This goal involves education and research activites. They have published at least 19 books.

Natural Areas Association

Arizona-Sonora Desert Museum
Rt 9, Box 900
Tucson, Arizona 85743
Studies the flora and fauna of the Sonoran desert, and soil and water conservation. Publishes an annual bulletin.

Chihuahuan Desert Research Institute
Alpine, Texas 79830
Founded in 1973 to promote public awareness and research in the Chihuhuan Desert. Field seminars are held seasonally. Publishes a newsletter.

Desert Botanical Garden
Phoenix, Arizona 85010
Plants from desert areas from around the world are incorporated into natural settings. Educational programs are available.

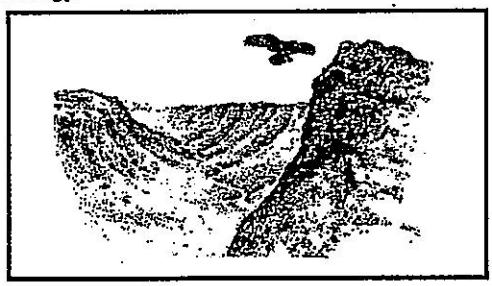
Desert Research Institute
Boulder City, Nevada 89005
The Institute specializes in research in physicology and desert ecology of the Mojave Desert.

Desert Botanical Garden
PO Box 5415
Phoenix, Arizona 85010

Established in 1937, the Botanical Garden has a research program into Agaveaceae, Lilliacea, and Cactaceae which involves classification of plants, collection of seeds, locations of plants, and photograph species in their habitat. Herbarium, garden and a 150 acre experimental area. Publishes Saguaroland Bulletin 10 times a year.

Desert Research Institute
University of Nevada
Reno, Nevada 89557

One of the departments is the Center for Water Resources Research: hydrology-hydrogeology (determination of basic fundamentals of source occurrence, chemical quality, storage, movement and utilization of water in arid lands). Other departments include Laboratory of Atmospheric Physics, Laboratory of Desert Biology.



Desert Notes
Committee for Idaho's High Desert
PO Box 463
Boise, Idaho 83701

A quarterly which stands up for the flora, fauna, rivers and landforms of the high desert in southern Idaho and adjacent southeast Oregon. Annual membership is $5 to $10/yr.

Malheur Environmental Field Station
Burns, Oregon 97720

This station is located on the western edge of the Malheur National Wildlife Refuge near the northern border of the Great Basin Desert. Courses are offered during the summer.

Proceedings of the Workshop on Southwest Habitat Types
Held April 6-8,1983, Albuquerque, NM. W.H. Moir and Leonard Hendzel, technical coordinators. USDA Forest Service, Southwestern Region. 110 pages.

This collection of papers deals with methods of habitat type classification. Many Southwestern U.S.habitat types described.

PERIODICALS

Journal of Arid Environments
Academic Press
24-28 Oval Road
London, NW1 7DX England

A scientific journal. Volume 1 was published in 1978. Most articles are so specific and arcane as to be of value to few people, but a few are more practical and broadly usable. Although each issue of this journal may only contain one article of interest to the individual reader, taken all together this is a valuable compendium of information. Those who cannot afford the subscription have recourse to University and public library systems, It is worthwhile for each dryland student to go to a libary and look over the tables of contents to locate the articles most useful to you. Perhaps they have a cumulative index ?

Six issues a year for $133 (£55). Requests for a sample copy will usually be sent to those who request one (helps to have a letterhead).

Articles of the January 1986 issue included Lunette dunes in southern Africa. Rainfall patterns in the Gran Desierto, Sonora, Mexico; Forage selection and performance of sheep grazing dry annual range; The application of Landsat image data to rangeland assessment and monitoring; the development and demonstration of a land image-based resource information center (LIBRIS).

Arid Zone Research
UNESCO

Arid Lands Abstracts
Commonwealth Agricultural Bureaux.

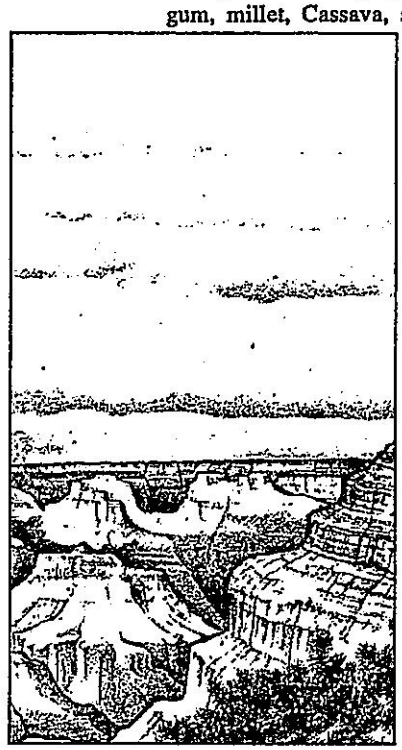
This abstracting service reviews a wide variety of scientific journals for the latest articles on subjects related to arid lands. Consult at major libraries.

Arid Lands Development Abstracts
Commonwealth Agricultural Bureaux
Farnham House, Farnham Royal Slough
SL2 3BN United Kingdom.

This series of abstracts was only published from 1980 through 1982. They are a good guide to the arid lands literature published in those years.

ECHO
RR # 2, Box 852
North Fort Myers, Florida 33903 (813) 543-3246

ECHO Notes covers primarily little-known crops and agriculture. One pamphlet is titled "Plants for Arid Regions", which briefly reviews Tepary Beans, Chaya, Pigeon Pea, Corn, Sorgum, millet, Cassava, sesame, mung bean, urd bean and chick peas.



ECHO Technical Note 6-4, "Dry Farming" by Randy Creswell (Cornerstone Enterprises, Kouroukoula, B.P. 211, Kayes, Mali, West Africa). is a 17 page technical note describing basic dryland farming practices for cereal grains, and pulses. Tillage, cultivation, mechanization are emphacized, along with strip cropping, bunds, rotation. The table giving data on various crops is useful. it describes: # of days from sowing to 50% flowering for both early maturing varieties and for late maturing varieties; Number of days from sowing to harvesting for early maturing and late maturing varieties; the amount of rainfall and timing of rainfall for early maturing and late maturing varieties.

ARID LAND PLANTS

See also the Plant Species Index section for further sources on arid land plants.

Food, Fiber and the Arid Lands
William G. McGinnies, Bram J. Goldman and Patricia Paylore, Editors. 1971. University of Arizona Press.

This book is an excellent addition to the library of any serious student of arid lands development. Part One contains 9 papers on cultural and social Problems. Part Two is on Land And Resource Uses. Part Three: Water and Agriculture. Part Four: Ecology of Arid regions. including an article on *Stabilization of sand dunes* s by Mikhail P. Petrov. and *Stabilization of Sand dunes in Argentina* . Part Five: Information Sources. Many references are cited throughout the book.

A notable part of this book is an extensive appendix of ***Select Economic Arid-Lands Plants and Their Uses.*** Over 750 species and their use are listed. This list is taken from citations in *Economic Botany* through April, 1969 [Vol 1-23]. So each species listed has the volume no(s) in *Economic Botany* which can be referred to for further information. A very useful tool for the plant researcher.

The Office of Arid lands Studies at the Univ. of Ariz. informed Friends of the Trees that they do not have any copies left to sell. If you can get your hands on a copy through a library, xerox a copy of this appendix.

Plant Resources of Arid & Semiarid Lands: A Global Perspective.
J.R. Goodin and David K. Northington, Editors. 1985, Academic Press, New York. 336 pages.

At the time of publication the editors were at Texas Tech Univ., Lubbock Texas. The book covers not only plants but also physiography, water resources and climate. Each continent is covered. Several hundred species are listed in each section but there is no plant species index. Extensive references.

Ecology and Culture of Selected Species Useful in Revegetating Disturbed Lands in the West.
By Clinton H. Wasser. 1982. Publication No. FWS/OBS-82/56. Prepared for Western Energy and Land Use Team, Office of Biological Services, Fish & Wildlife Service, US Dept. of Interior, Washington DC 20240. 347 pages.

This handbook presents ecological information on 100 of the more important species commonly used in revegetation and reclamation projects. Grasses, perennials, shrubs and trees. Information given for each species includes: Origin, Species characteristics, environmental relationships, culture, management, associated species, pests and diseases, improved varieties and references. Under culture is contained: planting depth, rate, and time; seed cleaning and quality; and germination and seedling characteristics. Very useful information for the species covered.

The use of Trees and Shrubs in the Dry country of Australia. Forest and Timber Bureau, 1972. Available fromThe International Tree Crops Institute, PO Box 4460, Davis, CA 95617.

Information on the use of trees for soil conservation, windbreaks, honey production, livestock fodder, multiple-use forestry.

Plants for Arid lands.
G.E. Wickens, J.R. Goodin and D.V. Field, Editors. 1985, George Allen & Unwin, London, 452 pages.

This book is the result of the Kew International Conference of Economic Plants for Arid Lands, held July 1984. About 1,000 plant species are mentioned.

Multipurpose tree crops: Bibliography
By David Bainbridge, Dry Lands Research Institute. 8 pages.

Wildland Shrubs: Their Biology and Utilization.
Cyrus M. McKell, James P. Blaisdell and Joe R. Goodin, technical editors. 1972. USDA For. Serv. Gen Tech. Report INT-1. 494 pages.

Papers presented at an international symposium at Utah State Univ. , Logan, Utah, in July 1971. The many papers presented are on the subjects of present and possible uses of shrubs, distribution, synecology, physiology, nutritive quality, and regeneration. The emphasis is on arid and semi-arid shrubs.

Arid Lands: Today and Tomorrow
Proceedings of an International Research and Development Conference held October 20-25, 1985 in Tucson, Arizona. $85.00. Published by Westview Press, Central Ave, Boulder, CO 80301.

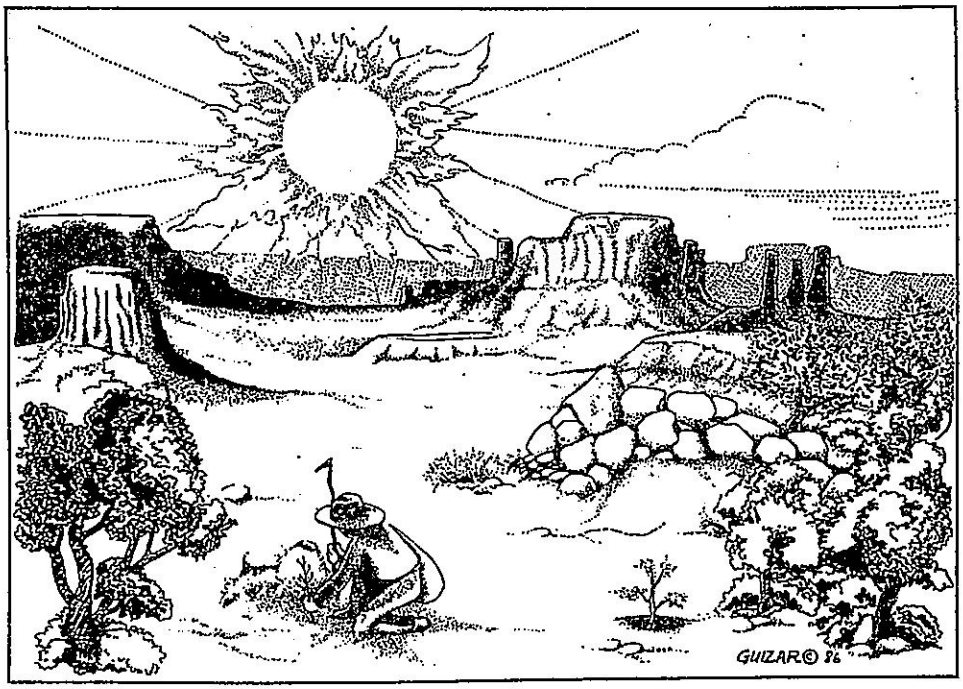
More than 400 registrants from 40 countries attended the conference.Included in this volume are papers by more than 125 arid lands scientists covering a broad range of topics on critical arid lands issues.

Geology in Environmental Planning
By A.D. Howard and I. Remson, 1978, McGraw Hill Publ.
This book contains a good drylands section.

Crop Production in Dry regions
Vol. 1, Background and Principles. Vol. 2, Systematic Treatment of Principal Crops. By I. Arnon. Nicholas Polunin, editor. 1972. Leonard Hill, London.

The information given for each crop includes: origin and adaptation, Species and varieties, crop management, diseases and pests, yields, and utilization. Extensive bibliography. A very detailed treatment.

Bibliography of Dryland Agriculture.
3rd edition, November, 1980. Compiled by S. Riehle, Michael Kich, A.E. Worlff and Khan. Published by the Dryland Agriculture Technical Committee, Oregon State University, Corvallis, Oregon 97331. 485 pages. Vol one (485 pages) contains a bibliography of 4,703 titles. Volume 2 is an author and subject index. The books and articles listed here are from all over the world, but almost all of them in English. A wide variety of subjects are covered but the majority of listings are on rangeland, hayland and pasture management or on mechanized grain production in dry regions.



Settling the Desert
L. Berkofsky, J. Gale, and D. Faimon; editors. 1981. Gordon and Breach, New York.

A collection of 15 papers summarizing Israel's approaches to arid land agriculture. Included is a review of ancient terracing, diversion and micro-catchment systems, algae production, solar energy utilization, and ecology as a tool for desert management.

Proceedings of An International Symposium on Rainfed Agriculture in Semi-Arid Regions.
Glen H. Cannel, editor. 1979, University of Calif. Riverside.

Held in Pendleton, Oregon, the symposium covered dryland farming methods in the Northwest and around the world, spotlighting the work of Oregon State Unviersity in International research on arid land agriculture. Most information cnetered on broad-scale, cultivation of grain crops.

Agriculture in Semi-Arid Environments
A.E. Hall, et al, editors. Springer Verlag, New York.

Chapter 1 covers ancient agricultural systems in dry regions.

Dryland Agriculture
Harold E. Dregne, and W.O. Willis, editors. Soil Science of America, Madison.

Irrigation in the World.
By H. Fukuda. 1976, Univ. of Tokyo Press.

See review in "world agricultural systems" section.

Physical Basis of Salt Tolerance in Plants
B.P. Strogonov. First published in the USSR. Translated by the Israel Program for Scientific Translations. 1962

Hopi Indian Agriculture and Food
1954. Museum of Northern Arizona.

TREE PLANTING IN DRY REGIONS

Friends of the Trees 1986 Yearbook (pages 34-40) contains a section on tree planting in the Pacific Northwest.

Forest Tree Planting in Arid Zones
by Goor and Barney, 1976.

One of the best textbooks on the subject. This book is designed for Third World countries in the tropical, subtropical and Mediterranean zones. Good information on establishing nurseries with limited resources, on planting techniques in deserts, and on taking advantage of micro-climates.

Reforestation in Arid Lands
By Fred R. Weber with Carol Stoney. 2nd edition 1986. 335 pages. VITA (Volunteers in Technical Assistance), 1815 North Lynn St., Suite 200, Arlington, Virginia 22209.

A highly recommended book. The new edition is broader in scope and better organized than Edition #1 (published in 1976) . The book is intended for field workers. Main chapters of the book are: Project framework, Project Design, Soil Properties, Site/Species Selection, Nursery management, The planting site, and Agroforestry methods; as well as information on 200 tree species for use in arid Africa. The appendices on Information Sources and Suggested Reading are quite extensive and useful. The addresses of many organizations and periodicals concerned with reforestation are given. One of the best compilations of major tree-planting, organizations in the world. The book has many illustrations to help describe the techniques discussed.

"While the manual focuses on Africa, many of the problems that project planners face are similar throughout the world. The major obstacles to reforestation programs are usually caused by a lack of understanding of the social context within which the programs must be carried out, rather than by a lack of technical expertise, equipment, or funding. Local acceptance of a project is indispensable to widespread participation in project activites, which in turn is essential to ensure seedling protection and sur-

vival. This book deals with the broad subject of project design and implementation, and presents methods and planning guides useful in different cultural contexts.

Tree Planting and Agroforestry in Semi-Arid Zones of Kenya
Proceedings of the KENGO workshop held in Kitui in 1982. Published by Kenya Energy N.G.O's Association. 48 pages. Achoka Aworry, KENGO Sec., PO Box 48197, Nairobi, Kenya.

Tree Planting Practices for Arid Areas.
FAO, 1955, 126 pages.
Covers seeds, nurseries, site preparation, planting and care.

Tree Seed Notes
FAO 1955, 354 pages.
Vol 1 Arid Areas. Vol 2, Humid Tropics.

Tree Planting in Semi-Arid Regions.
Proceedings of a Symposium on Establishment and Productivity of Tree Plantings in Semi-Arid Regions, Held at Texas A & I University, Kingsville, Texas, April 19 -May 2, 1985. Edited by P. Feleker, 444 pages. Published by Elsevier Science Publishers, Amsterdam, The Netherland, $109.00.

Afforestation in Arid Zones
by R.N. Kaul. W. Junk, The Hague, 1970.

Irrigated Forestry in Arid and Semi-Arid Lands: A Synthesis.
By F.B. Armitage. 1985, International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9. 160 pages.

Past experiences in forestry plantations are given for about 20 countries, mostly in Asia and Africa. The different types of irrigation are reviewed as well as tree establishment and tending, water management and use. A useful book which lists a special section of "key sources" plus hundreds of references.

This synthesis is aimed at enhancing irrigated forestry through an examination of past experience, the range of inputs required, and the benefits of integrating tree plantations with irrigated agriculture. It reviews the potential for irrigated forest plantations and provides a checklist of economic, sociological, and technical criteria needed to guide decisions as to the feasibility of such developments. Actions to be covered in the planning, implementation, and operational phases of irrigated forest planations are indicated as are illustrative production levels and research needs.

SUMMARY

THE UP TO DATE EXPERIENCE WITH THE «KALLIDENDRON» SYSTEM FOR THE GROWTH OF FRUIT TREES IN ARID AND DESERT AREAS

George KALLISTRATOS and Ursula KALLISTRATOS
Department of Experimental Physiology, Laboratory of Nutrition Physiology The University of Ioannina, Ioannina GREECE

Among the problems which hinder the plantation of fruit trees in arid areas and deserts, which were investigated in the present study, are:

1. Lack of water
2. Infertile soil
3. Lack of fertilizers
4. Financial difficulties
5. Formation of a salt layer, especially in hot climates, through the continuous evaporation of the irrigating water.

The above mentioned problems could be partially eliminated by a system developed called «KALLIDENDRON». This is a very simple and economic method, and can be widely applied, especially in the Third World Countries for the production of foods necessary to cover the greater part of the calories requirements of the population living in these areas.

From the technical point of view, in a plastic bag of about 50 liters of volume (for biger trees up to 300 liters and more) we put 10 liters of perlit and some organic polymers, such as Agrosok, Terra-sorb, Aquastore etc, which can absord water 30 to 100 times and more their volume to form a gelatinous compound, which can be gradually used by the roots of the tree. This quantity of the water is sufficient enough to supply the tree for many months with the necessary amount of moisture even during a dry period without rain. The plastic bag contains also all necessary nutrients, which a tree needs for its physiological growth. In order to inhibit the evaporation of water, the upper end of the bag, about 20 cm from the top, is tightened with a piece of cord, so that a funnel is formed, which also allows the entrance of rain water into the bag. Finally, the whole system, that means the contents of the perforated bag together with the young tree, is buried into the soil.

According to our calculations, with this system we can save:

— more than 80% of water necessary for the irrigation of each tree,

— about 95% of fertilizers, because only the necessary amount of fertilizers is introduced into the bag through the funnel,

— to avoid environmental pollution, because all fertilizers are inside the bag and therefore, cannot be washed away through the rain water,

— over 50% of manual work,

— to avoid the formation of a salt layer through the evaporation of water in hot climate because the surface of the entrance of the funnel is about 20 to 30 cm^2 compared to the evaporating surface around a tree by the usual methods, which is one square meter and more,

— the method is relatively cheap taking into consideration a) the water quantity needed b) the fertilizers used c) the economy of manual work as well as the other advantages already mentioned, it is obvious that this system offers many new possibilities for the agriculture.

The most important contribution of the «KALLIDENDRON» system will be its application in the arid areas and deserts of the under-developed countries in order to reduce starvation through the local production of fruits and other human nutrients.

Βιβλιογραφία

1. ΚΑΛΛΙΣΤΡΑΤΟΣ Γ. και συνεργάτες. *Πεπραγμένα Κέντρου Υδροβιολογικών Ερευνών (Κ.Υ.Β.Ε.).* Πανεπιστήμιο Ιωαννίνων 1981.
2. ΚΑΛΛΙΣΤΡΑΤΟΣ Γ. και ΚΑΛΦΑΚΑΚΟΥ-ΒΑΔΑΛΟΥΚΑ Β. *Πειράματα εγκλιματισμού διαφόρων εκμεταλλεύσιμων φυτών στην Ελλάδα.* Σύγχρονη Γεωργική Τεχνολογία, τεύχος 9, 1982, σελ. 37-40.
3. ΚΑΛΛΙΣΤΡΑΤΟΣ Γ. *Δυνατότητες ανάπτυξης της Ηπείρου, ιδιαίτερα στον τομέα της ιχθυοκαλλιέργειας.* 3ο Παγκόσμιο Πανηπειρωτικό συνέδριο, Γιάννενα 27-29 Αυγούστου 1982. Πανηπειρωτική, σελ. 67-70.
4. ΚΑΛΛΙΣΤΡΑΤΟΣ Γ. *Προβληματικές ακριτικές περιοχές της Ελλάδας και δυνατότητες αναπτύξεως αυτών.* Ανακοίνωση στην Ακαδημία Αθηνών από τον Ακαδημαϊκό Καθηγητή Γ. ΜΕΡΙΚΑ - Πρακτικά Ακαδημίας Αθηνών 58, 1983, σελ. 192-211.
5. ΚΑΛΛΙΣΤΡΑΤΟΣ Γ. *Η κοινωνική συμβολή του Εργαστηρίου Πειραματικής Φυσιολογίας του Πανεπιστημίου Ιωαννίνων στην ανάπτυξη της Ηπείρου.* Διάλεξη στην Ηπειρωτική Εταιρία Αθηνών 20.2.1985.
6. ΚΑΛΛΙΣΤΡΑΤΟΣ Γ. *Η εφαρμογή του συστήματος «ΚΑΛΛΙΔΕΝΔΡΟΝ» για την αξιοποίηση και ανάπτυξη άγονων περιοχών - μια συμβολή στην καταπολέμηση της πείνας στον Τρίτο Κόσμο.* Ομιλία στο Saudi Fund for Development, Ριάντ Σαουδικής Αραβίας 31 Μαρτίου 1985.

The Man Who Planted Hope *Chelsea Press*

Afforestation in Arid Zones
R.N. Kaul, 1970, W. Junk Pub.

Proceedings of the International Symposium on Strategies and Designs for Afforestation, Reforestation, and tree planting.
K.F. Wiersum, editor. 1984. Pudoc. 350 pages. $16.50 (avaiable from Unipub - see book sources).

A systematic framework for strategies and designs for afforestation which encompasses both small- and large-scale, private and industrial schemes.

Savanna Afforestation in Africa.
FAO Occasional paper #11. 1977. FAO Kaduna, Nigeria. 312 p.
Tree Planting Practices in Tropical Africa. 1986. FAO 302 pages.
Tree Planting Practices in Temperate Asia: Japan. FAO, 1956. 156 pages.
Tree Planting Practices in Temperate Asia: Burma, India, Pakistan. 1959, FAO Paper #14.

Tree Planting in Africa south of the Sahara.
1984. 75 pages. Free from Environment Liaison Centre. PO Box 72461, Nairobi, Kenya. The importance of quality care for seedlings is emphacized. Strong plants are more likley to survive, and are therefore more cost-effective.

Tree and Shrub Planting Handbook for Arizona and New Mexico.
Available from the New Mexico Cooperative Extension Service. This is a large ring-bound collection of several hundred pages. Section III gives brief information on about 100 preferred species: description, adaptability, uses, establishment, management and care. Other sections are on: Planning & Design; Planting Stock; Cultural Techniques; Management and Renovation. Much of the information is related specifically to windbreaks and shelterbelts. One notable feature is a list of about 150 major nurseries in the Western U.S., predominantly in New Mexico. This book would be useful to southwestern tree planters.

Mesquite Fencing Units

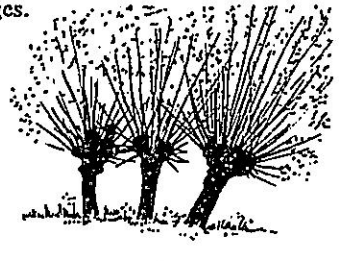
[The following description of an interesting type of fence developed by a Green Deserts Project in Sudan is by Richard Webb from *Community Forestry In Sudan* (See Reforestation section).]

Shelterbelts of mesquite *(Prosopis chilensis)* have been extensively planted in Nile Province in the Northern Region of the Sudan over the last ten years, and constitute a valuable resource. The trees can be selectively thinned to provide a sustained yield of small diameter poles and brushwood without prejudicing their function as shelterbelts. This project has used such thinning to construct fencing units that are cheap and easily transportable, are made entirely from locally grown materials, and are produced by local unskilled labour. So far, after eighteen months use, they have proved to be durable and effective at excluding livestock providing the fences are inspected regularly. The units are also more acceptable than barbed wire to the local population, and are generally more acceptable in the landscape.

They are constructed as follows: 12 to 16 stems are cut 200 cm long and 2 to 3.5 cm. in diameter. They need not be particularly straight, and seldom are, and should retain plenty of side shoots. These stems are then laid out in a metre square lattice, with half of the stems vertical and half horizontal. The stems are interwoven and tied together with rope made from leaves of the Dom Palm *Hyphaene thebaica*. When the framework is complete any large holes are filled by weaving small thorny branches into the lattice. The more thorns the better, although this can cause problems for the fencemakers. The finished units can be stacked ready for transport. Each unit has little structural strength on its own, but when tied to a supporting stake in the ground it becomes a formidable barrier to animals and people alike. If animals are seen to browse on the fencing, used sump oil can be painted on as a deterrent.

Cost: Fence makers were paid £S2 for each unit plus stake they produced. (£1 = £S2.25). the mesquite cost £S1.5 for 1 unit plus stake, and the rope £S0.14 per unit. total cost per unit plus stake = £S3.64. Cost to fence 1 feddan (1 acre) = £S473 excluding transport and erection costs. [About $US250/acre]. This is less than a quarter of the cost of a barbed wire fence for materials alone. The concept of "Grow your own Fences" is both ecologically sound and cost effective.".

Literature on the Mesquite (Prosopis) of North America. An Annotated Bibliography. Texas Tech Univ. 1969. 83 pages.



Sand Dune Stabilization, Shelterbelts and Afforestation in Dry Zones
FAO Conservation Guide No 10, 1985, 232 pages.
This is a compilation of 21 papers.

ARID LAND TECHNIQUES

Dry Lands: Man and Plants
Robert Adams, et al. 1978. Architectural Press, London. 152 pages. This book really packs in the practical information. Well illustrated with photos and drawings. This is one of the best books I have seen describing reforestation and how to set up water harvesting systems and other practical techniques. Recommended.

Dune Stabilization: A Survey of Literature on Dune Formation and Dune Stabilization.
by H. Hagedorn, et al. 1977. German Agency for Technical Cooperation (GTZ), Dag-Hammarskjold-Weg 1, PO Box 5180, D 6236, Eschborn, West Germany. 193 pages of text. Followed by hundreds of references.

This book is a treasure trove of information for anyone who lives in sand country or does development work there, or is simply interested in sand dunes. The sand regions of the different continents are briefly described.

Sand dunes and drifting sand are categorized as to their different types, shapes, sizes, morphogenetic processes, and origin. Ergs, Draas, Barchans, Lunnettes, traverse, longitudinal, parabolic, nebhkas, fore dunes, lee dunes, echo dunes, climbing dunes, falling dunes, Sief dune, Akle' dune, Zibar, Rhourd, star dunes, etc. How the different dune types move, characteristics, water infiltration rates, influence of topography etc. There is a section on the agricultural land-use of dune areas and summary of damages induced in the course of desertification.

The second part of the book is concerned with methods for the stabilization of dunes and drifting sand. Each section of text gives references for more detailed information. A list of some of the sections gives an idea of the types of methods used to stabilize sand dunes.

Sand Fences; Types of Material and Methods of Construction; Diversion Type Fences; Impounding Sand Fences; Porous and Solid Fences; Location of Fences; Alignment and Height of Fences; The Pattern of Wind-Speed around Impounding Fences; Sand Deposition at the Fence; Maintenance Costs; Advantages and Drawbacks of Various Methods.

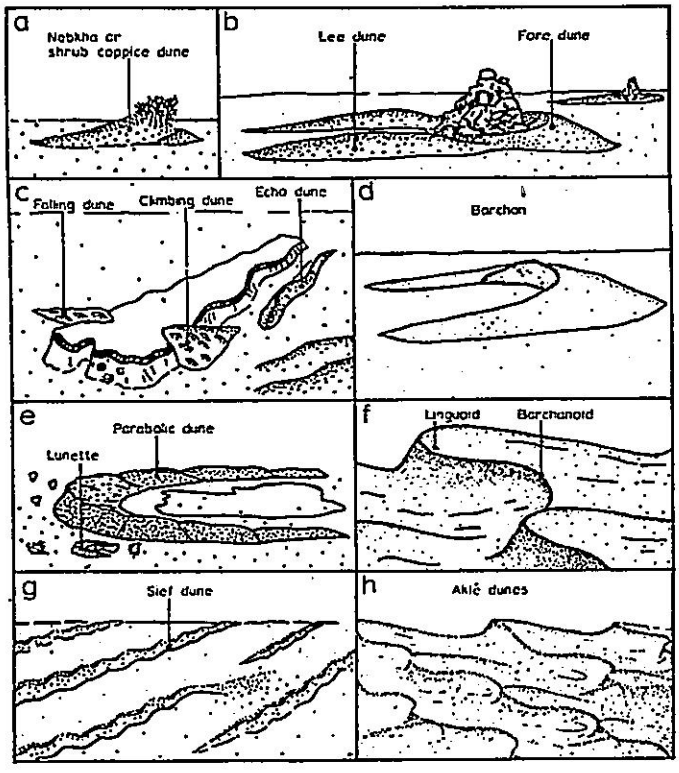
Surface Stabilization Sprays; Water; Oil; Application costs and durability; Chemical Soil Stabilization; Toxic Effects; Advantages and Drawbacks;

Biological Dune Stabilization; Advantages and Disadvantages; The Natural Regeneration of the Vegetation Cover; "Semi-natural" Redevelopment of Vegetation; "Artificial" Development of a Vegetation Cover; Selection of Plants for Stabilization of Coastal Dunes, and for Inland Dunes; The Necessity for Artificial Soil Improvement; The Use of Agrosil for Soil Improvement.

A brief exerpt from the "Biological Dune Stabilization" section

"As already stated in the preceding chapters, effectiveness and life-span of mechanical dune stabilization structures are more or less limited. A permanent stabilization of dunes can only be achieved by the development of a vegetation cover of the dune areas. Vegetation will not grow, however, as long as there is still a strong movement of sand. Effective stabilization therefore means the combination of mechanical, chemical and biological methods at least for the initial phase of vegetal growth. In many cases the mechanical defences against moving sand will no longer be needed, once the vegetation has been firmly established. They will then be simply left to decay.

"The advantages of vegetal dune stabilization may be summarized as follows:
1. effective long-term protection against wind;
2. effective protection of the ground, the plants being a natural and homogenous sand-trapping system;
3. positive influences on the ecology of the respective area (e.g. soil moisture and micro-climate);
4. potential source of income by controlled grazing, fuel wood extraction, etc.;
5. potential biomass reserve for drought periods."



Methods used for Controlling and Reclaiming Sand Dunes.
By A.S. Hitchcock. 1904, USDA Bureau of Plant Industry, Bulletin No. 57. 36 pages plus a number of photographs.

This bulletin was published mainly to address stabilizing coastal dune areas in the United States. However the researcher for the bulletin included a summary of the most successful methods in use at that time in the Netherlands, Denmark, Germany and France based upon his personal observation. Types of control methods discussed include: binding by means of grasses, transplanting, arrangement of the plantation, formation of the barrier dune, binding with heather, binding with sand hedges, and forestation.

A Bibliography of Desert Dunes and Associated Phenomena. Andrew Warren. pages 75-100. In Arid Lands in Perspective 1969, University of Arizona.

Almost half of the publications listed are French language. The emphasis is on the Sahara, the United States and Poland.

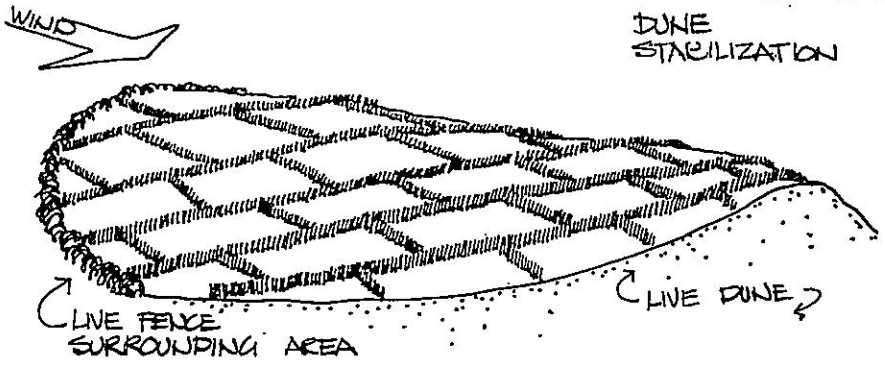
Sand Dune Stablization
Reclaiming some of the world's sandy wastelands is possible using the proper plant species and techniques

Paradoxically desert sands can have more water available to plants then adjacent land with more finely textured soil. Water drains rapidly through sand and thus can penetrate quickly to deeper soil layers where moisture loss through evaporation is

very minimal. Whereas water is held nearer the surface in fine textured soils and quickly evaporates when dry conditions return. Plants adapted to the fine textured soil often have a shallow root system and storage mechanisms for water so that when rains do fall they are quickly taken up from the surface soil and stored in underground or aboveground storage organs. On the other hand, trees and plants with deep rooting systems are adapted to reaching deep water layers below sand.

An example of this exists in my home area of north-central Washington. The fine-textured soils of the Okanogan Valley floor support bunchgrass and sagebrush plant communities (an 8 inch precipitation zone). The Okanogan lobe of the cordilleran icecap reamed out the Okanogan valley during the ice ages and when it retreated it left several moraines of virtually pure sand. In these hummocky, sandy areas exists an open forest of ponderosa pines, taking advantage of the deep moisture below the dry sandy surface. The ponderosa pine forest stops at the edge of the sand. The fine textured soils around it support sagebrush.

There often are lens (pools) of water underneath sand dunes or sandy areas. The water may be fresh or various levels of salinity. This aquifer water is a limited resource with slow recharge rates. In many arid and semiarid regions of the world modern well-drilling techniques and water pumps have been installed in many aquifers and most are being drawn down at an unsustainable rate. Less emphasis should be made on crops that can live with natural rainfall, as well as croops that require little supplementary irrigation. All irrigation water should be used with the utmost care to efficiency, considering also that soils do not to be flushed periodicially to keep soil salinity levels down.



Graphic from *Reforestation in Arid Lands*

Sand Dune Stabilization in China

The Chinese have developed a system of sand dune stabilization over the past several decades which involves burying grass, straw, branches, shrubs, or crop residues in rows running both ways to create a square grid. The squares vary from several feet to 10 feet across. The organic material only projects a foot to several feet above the surface. Large areas of these mini-windbreaks trap the sand long enough to successfully establish grasses, shrubs and other plants which stabilize the soil even further. Then the newly-stabilized area is gradually enriched by an increasing plant community. Also the areas which were being damaged, or endangered, by sand movement are protected. Seedings and plantings are generally done by people rather then by self-seeding. The Chinese have rehabilitated large areas in various parts of China using local variations of this method.

Sand Dune Stabilization in Africa

Somewhere I saw a photo of a treeplanting project in a sand dune area of the Sahara which greatly impressed me. Rows of windbreaks were being created across an area of extensive sand dunes. It looked like sandbox sand. The windbreaks were created by burying huge sheaves of some tall grass (or rush?) in trenches. The trenches must have been at least 2 feet deep and the sheaves 7 feet tall and several feet thick. They made quite an impressive windbreak. In back of the windbreak were planted trees which could grow in the sands.

Senegal: fighting the desert

by Louis Michon in *Development*, (Autumn 1986) the Journal of the Canadian International Development Agency. pages 20-24. An exerpt:

Dune fixation

The Dunes Fixation Project, near Saint-Louis in northern Senegal, affects about 9,000 people scattered over some 20 km of coastline managed entirely by Senegalese personnel, the project is financed through the Canada-Senegal counterpart fund - money generated by the sale of Canadian wheat on the local market, and used to pay for development projects.

The first step was to protect the crops from sand washed up from the sea. A screen of trees, 200 metres wide and 31 km long, was planted to halt the march of the sand dunes. To do this, a fence - made of panels of plant material and nylon screens - was built perpendicular to the prevailing winds, facing the sea 60 metres from the highest tide. thus creating a dune break. In its shelter, the 200-metre wide strip of trees was planted between the farming basins and the ocean.

This work began in 1980 and still continues. From January to June, sites are prepared for planting and fences are built. Experience has shown that such protection is essential. In 1982, trees were planted in areas with no protection and the survival rate of seedlings dropped sharply.

The annual tree-planting period is very short - about 10 to 20 days in July or August, when the rains are heaviest. The only variety planted is filao, which looks like a pine although it is not coniferous. It grows quickly, then spreads out. Filao was selected because it has two key qualities. It will tolerate the salinity of sea air, and it can subsist and grow by absorbing humidity from the ambient air and dew, using this as its only source of water. This allows the seedling to survive through years of very little rainfall. There was no more than 97 mm of rain in the region in 1983, 140 mm in 1984, and 197 mm in 1985. Some years, only half the seedlings survive - which means that the other half must be replaced the following season. From 1980 to 1985, almost a million seedlings were planted over a distance of 31 km. Some of the trees, - those planted early in the project have now grown to a height of six or seven metres. In some parts, the strip of trees has begun to look like a genuine forest.

. . A start has been made, as well, on establishing village woodlots. Various species of trees, 10 per cent of them fruit-bearing, are being planted, with the work carried out by women's committees.

The Negev: The Challenge of a Desert.
By Michael Evenari, et al. 1971. Harvard University Press, Cambridge. 345 pages.

This is one of the more fascinating books I have read on agricultural practices in arid regions. It is especially fascinating that the methods discussed here were developed 2,000 years ago, and only rediscovered in the 1950's and 60's. This is one of the best works describing water catchment systems of agriculture. Well illustrated with many aerial and ground photographs and drawings. These age-old methods are still very applicable today in many dry regions of the world.

This book describes the agricultural systems developed by the Nabateans in the period before the year 1 A.D. Their agricultural methods were developed over a fairly long period of time. The Nabateans lived in the Negev desert of the Sinai Peninsula and operated an important caravan route. They produced their food in a very arid region by water harvesting methods. Runoff from hillsides was channeled via dug channels and via conduits formed by piling stones and rocks in long windrows across the contour. These directed water into fields at the bases of hills and on Wadi floors. Wadis are relatively flat bottomed draws and valleys. Some systems were small and served one small field. Others were large and worked with large volumes of water which were conducted via channels to a number of fields. The rock terrace walls, channels, spillways, rock aprons, division boxes, etc had to be well engineered and constructed to handle the peak flows of large volumes of water during intense rains.
The ratio of catchment area to irrigated area ranged from 17:1 to 30:1 with an average of 20:1. That is, it took an average of 20 acres of catchment area to obtain enough water to irrigate 1 acre (under Negev conditions). Catchments were often treated to increase runoff by rock removal, smoothing, stone mounds, and gravel strips running down gentle slopes.

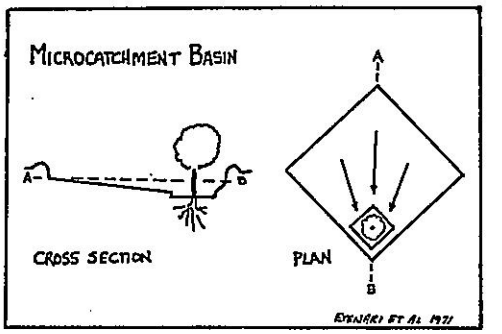
Dams and lines of rocks were used for water spreading in wide floodplains. Chains of wells were dug in gravel fans at foothills. Water from catchment areas was also funneled into cisterns for home use and agriculture. Some of the home cisterns were dug right below the dwellings. Some cisterns were very large and were hollowed out of rock. Microcatchments were also built which channeled water to single trees.

Overall, the Nabateans had an impressive, complex system of agriculture relying on labor-intensive methods which covered an estimated 720,000 acres. Even though 2,000 years old or more, some of the systems are still in operation by Beduoin people. Evenari and associates rebuilt some of the systems and have demonstrated that they are still applicable today.

More Water for Arid Lands: Promising Technologies and Research Opportunities.
National Academy of Sciences. 1974, Washington, D.C.

Little known but promising technologies for the use and conservation of scarce water supplies in arid areas are the subject of this report. The descriptions of each of the methods are short and not technical. Rather, these are brief summarys of the different methods. The chapter on each technology is arranged under these topics: Methods; Advantages; Limitations; Stage of Development; Needed research and Development; Selected Readings; Contacts (a list of individuals or organizations the panelists know to be involved in relevant research).

A good introductory book to Rainwater Harvesting o Runoff Agriculture o Irrigation with Saline Water o Reuse of Water o Wells o Other Sources of Water o plus chapters on a variety of methods of water conservation.



Microcatchment Farming

The following is an exerpt from More Water for Arid Lands (pages 29-31).

"A plant can grow in a region with too little rainfall for its survival if a rainwater-catchment basin is built around it, forcing rainfall from a larger than normal area to irrigate the plant. This practice is called microcatchment farming. The previously described principles apply to this microscale runoff agriculture; many of the same soil treatments mentioned in chapter 1 can be used.

Microcatchments used in the Negev Desert range from 16 sq/m to 1,000 sq/m. Each is surounded by a dirt wall 15-20 cm high . At the lowest point within each microcatchment a basin is dug about 40 cm deep and a tree planted in it. The basin stores the runoff from the microcatchment. The side of the basin is matched to the water harvest expected.

The basins are fertilized with manure, and, unlike the catchment area, their soil surface is kept loose to encourage water penetration. A mulch may also be used to decrease water evaporation from the soil (see Chapter 9).

On an otherwise barren desert plain, microcatchments provide enough additional water to ensure the growth of fruit trees and forage plants. Microcatchments and variations of this method are used in Tunisia for growing olives - and apparently have been since ancient times.

In the Negev microcatchment contruction costs are very low - from US$5 to US$20 per ha [$2 to $9 per acre], depending on the catchment size. The cash return from crops repays their construction costs within a few years.

Microcatchments are more efficient than large-scale water-harvesting schemes because conveyance losses are minimized. In light rains, they provide runoff water when others will not. It is much cheaper to convert a certain area into microcatchments than to construct a runoff farm because microcatchments do not need channels, conduits, terraces, and terrace walls. Also, microcatchments can be built on almost any slope, including almost-level plains, enabling the farmer to use large, flat areas unsuited for runoff farms."

Self Reliant Agriculture for Arid and Semi-Arid Lands. By David Bainbridge, Dry Lands Research Institute [see U.S. Arid Lands Institutions section]

"This paper was written to address the vast majority of dry-land dwellers who are and will remain subsistence farmers and who must use expert water management and complex polycultures if they are to minimize risk and still achieve moderate yield."

The copy I have is David Bainbridge's 2nd Draft (1986). It is one of the more comprehensive lists of sustainable, arid land agricultural techniques, building design and appropriate technology available. There is a short description of each technique. Further references are given for follow-up. *continued*

Water

[Following are several exerpts from Bainbridge's paper *Self Reliant Agriculture for Arid and Semi-Arid Lands.*]

Skillful water management is the key to survival in the drylands. Rainfall is often erratic and may include intense, brief storms in summer and gentler storms of rain or snow in winter. With clever design of collection systems and very careful use of water supply, even very arid regions can be productive. The Nabateans successfully farmed over 300,000 hectares of the Negev Desert highlands (rainfall less then 100 mm/yr) in Roman times using refined runoff designs. And the Indians of the Southwest United States have grown corn for more than a thousand years in areas with rainfall of only 150 mm/yr. Combining the skill and understanding of these "primitive" cultures with modern materials, scientific knowledge, and increased ability to select and modify plant materials, we can do much better.

The emphasis of most subsistence farming should be on rainfed agriculture -- because it is less likely to cause soil salinization, is much cheaper, and can be managed without vast inputs of energy for big dams, ditches, pumps, and wells. The most common elements of rainfed agriculture are: conservation farming of drylands in semi-arid regions, use of microcatchments and concentrating systems, and more sophisticated runoff management systems in more arid areas.

Microcatchments

The use of microcatchment basins of various designs has been practiced for thousands of years. A microcatchment basin can concentrate the avialable precipitation for desired crops. Experiments have show that under arid conditions a higher relative water yield can be achieved with small rather than large catchment areas. Smaller areas are also easier to build with limited equipment and labor and are less likely to fail catastrophically during intense storms.

Microcatchments have been used continuously in south Tunisa since they were introduced by the Phoenicians. Over 10 million olive trees are cultivated in this area with less than 300 mm of preciptation/yr. Microcatchments have also been used with considerable success in Israel, Mexico, and the Southwest U.S.

The catchment systems developed in Australia for watering stock, particularly the roaded catchment, may also be of value to the subsistence farmer. Precipitation enhancement can enable the farmer to grow crops that coudl not otherwise survive. These may be either cash crops or preferred foods, such as olives, apples, apricots or grapes.

Runoff Farming

Very sophisticated methods of runoff farming have been developed and used in Jordan, Yemen, Israel's Negev Desert, Mexico, North Africa, and the American Southwest. These systems include a variety of techniques, including: (1) contour ditches to collect slope runoff -- with or without treatment to increase runoff; (2) dams of brush or stone to raise stream water high enough to fill side ditches which irrigate adjacent fields (3) check dams of brush or stone to hold water long enough to fill field capacity; (4) planting in alluvial fans where water is naturally concentrated; (5) planting alongside or using water naturally concentrated by rock outcrops; and (6) planting directly in the water course (and accepting the risk of loss in a flood).

These techniques are proven and in combination could enable the inhabitants of the drylands of the world to achieve much better yields. Refining these strategies for different soils, rainfall regimes, and crops is an important task which has received little attention.

Specialty crops or "survival insurance" crops can be grown with supplemental water from drip irrigation (cistern or well source) or unglazed pots set in the ground. both offer maximum water efficiency with relatively simple operation. Experiments with the unglazed pot watering method have been very successful and have produced crops with an effective water use of only 20 mm/ha.

Dew, Frost, and Fog Precipitators

Water may also be collected from specially designed dew, frost, and fog precipitators. Dew and frost may form more than 200 nights a year even in the very dry deserts as night sky cooling takes place. some plants and animals use this moisture naturally. The farmers of the Wiltshire Downs in England have relied on dew ponds for stock water for hundreds of years. With special traps built using shielded high emissivity plates with special coatings, much higher water yield could be generated and funneled directly to the crops or to storage.

Fog is also common in some deserts and fog drip may greatly exceed rainfall beneath trees. Fog collectors have been used to collect water for many years in the coastal desert of South America. using modern materials and scientific understanding of the principles involved should make fog collectors much more efficient.

Snow Traps

In desert areas that receive winter snow the use of snow fences and snow traps can be used to concentrate snow and provide added water for crop growth. Design recommendations and studies would help farmers build these traps economically with locally available material.

End of exerpt from David Bainbridge's paper.

Kanats

Kanats (underground irrigation tunnels) are now used from Sin-Kiang Province, China, in the east to Morocco in the west, and in some spotted areas in other parts of the world as well. The Kanats sometimes reach 20 km in length; it has been estimated that all the kanats in Iran laid end to end would circle the earth.

The number of kanats dug in the past 2,500 years is estimated to be about 30,000, of which 22,000 are still in use.

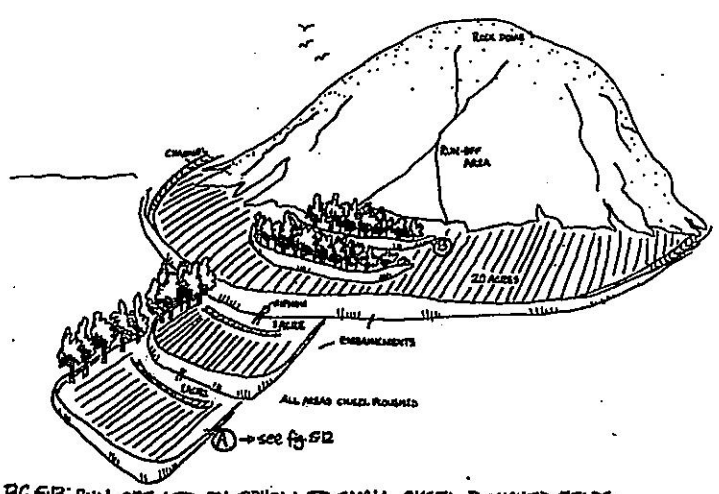
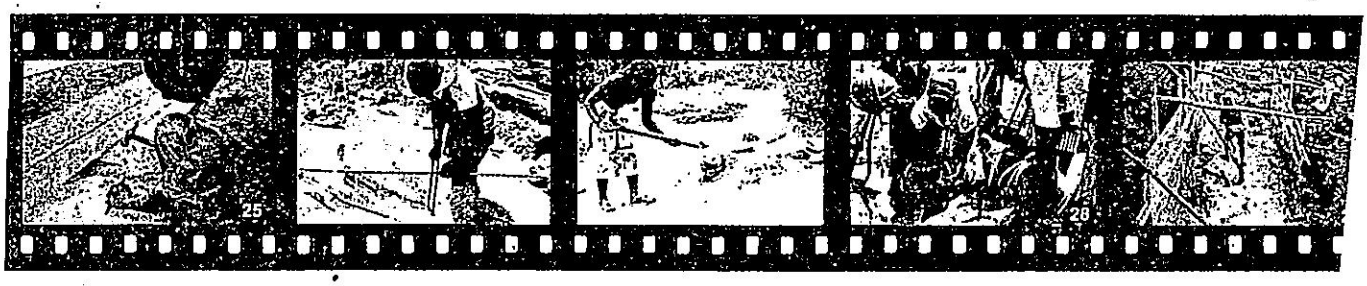


FIG 5.B: RUN-OFF LED BY SIPHON TO SMALL CHISEL PLOUGHED FIELDS



25. Drill holes in the rock bed to hold reinforcing bars. The holes should be at least 1 inch deep, and be in two rows about 6 inches from each form. In each row, the holes are about 4 feet apart.

26. Cut pieces of ½-inch reinforcing bar. Each piece should be 6 - 8 feet long.

27. The concrete for the first level of the dam is made by mixing 3 wheelbarrows of sand with one bag of cement.

28. Some water is added.

29. Before putting concrete into the for sprinkle a layer of cement onto the base. This will help concrete to stick to rock base.

FILMSTRIPS on Subsurface Dams and Rain Catchment Ferrocement Tanks. These are how-to, educational filmstrips specifically developed for use in Third World villages. However they have appropriate uses in developed countries as well. Each slide is accompanied by a written explanation. Available in English and French script. $10 each from World Neighbors Development Communications, 5116 North Portland Ave, Oklahoma City, OK 73112.

Sub-Surface Dams

A water Catchment System Built By Villagers.

Many villages lack an adequate supply of clean water throughout the year. This filmstrip tells of a project in Kenya that improved conditions in the community by building dams across dry riverbeds which can trap the rush of rainwater and silt during the rainy season. These sub-surface dams hold back rainwater that would otherwise run off, store it in the sand and silt that collects behind the dam and protects and filters the water, producing a source of easily collected drinking water year round. The filmstrip presents the techniques necessary to successfully build a sub-surface dam. How to select and prepare a site for dam construction is discussed. Dimensions and materials are suggested, and the step-by-step procedure for completing a sub-surface dam is given in detail. Although photographed in Kenya, the construction methods are appropriate to all countries. This 83-frame filmstrip has a full-scale format and is produced in color.

Rain Catchment Ferrocement Tanks

Rain water catchment tanks near the home are a solution to water supply problems for many village families. Built using ferrocement, these water tanks are capable of storing 1,700 gallons of water that can be gathered during the rainy season, and easily accessed when needed. This filmstrip tells of a project in Kenya that successfully adapted, tested and developed a technology for water tank construction. The filmstrip describes how to select the best site for a tank, gives dimensions and step-by-step instructions for construction, and explains what materials are needed. Although photographed in Kenya. this process of construction is applicable to all countries. The 106 frame filmstrip has a full-frame format and is produced in color.

Arid Zone Research
In seven volumes. UNESCO. 1950's.
This series of UNESCO publications includes:
Vol 1. Reviews of Research on Arid Zone Hydrology
Vol 2: Ankara Symposium on Arid Zone Hydrology.
Vol 3: Directory of Institutions engaged in Arid Zone Research.
Vol 4: Review of Research on Problems of Utilization of Saline Water.
Vol 5: Proceedings of the Montpelier Symposium on Arid Zone Plant Ecology.
Vol 6: Reviews of Research on Arid Zone Plant Ecology.

Proceedings of the Ankara Symposium on Arid Zone Hydrology.
UNESCO, 1953. 268 pages.

A compilation of papers presented by authors from many parts of the world, although Turkey and the Mideast recieved prominent coverage. Sections include: The physical and chemical properties of underground water, The statics and dynamics of underground water; the hydrological balance and the influence of utilization of underground water upon it; prospection for underground water, and adaptation of drilling methods and relationships between the hydrology of underground water and other sciences.

Handbook of Water Harvesting
By Gary W. Frasier and Lloyd E. Myers. 1983. USDA Agriculture Handbook Number 600. 45 pages.

This handbook presents a stepwise guide for the design, selection of materials, installation, and maintenance of water-harvesting systems. All methods and materials described are being used in operational systems for supplying water. A good overview of water harvesting methods using technological inputs (plastic, wax, metal, asphalt-fabric membranes.). Dozens of references are cited.

Roaded Catchments of Farm Supplies. Dept. of Ag. of Western Australia. Bulletin 2393, Perth, Australia.

Rainwater Harvesting : Collection of Rainfall and Runoff in Rural Areas.
Arnold Pacey. 1986, IT, 224 pages $17.95 available from Agribookstore (see book sources section).

Describes techniques ranging from collection of rainwater from roofs to direct use of runoff on fields of growing crops. Examines the design, organization, and implementation of various rainwater harvesting schemes.

Rain and Stormwater Harvesting in Rural Areas
UNDP, 1983, Tycolly International, Dublin, Ireland.

Water Managment for Arid lands
Samaha, et al. Pergamon Press.

Variation of Urban Runoff with Duration and Intensity of Storms.
By Dan M. Wells, et al. 1971. Texas Tech Univ. Publication WRC-71-5. 140 pages
Lots of figures and formulas to make calculations.

Urban Geomorphology in Dry Lands
By R.U. cooke et al. 1982. Oxford Univ. Press. 324 pages.
Discusses urban development in Dry lands. Chapter 5-6 cover : Water and sediment problems; and sand and dust movement.

Sand Tanks for Water Storage in Desert Regions.
Southwest Forest and Range Exper. Stn: Research Notes No. 9,

Water in Desert Ecosystems
Daniel D. Evans, and John L. Thames, editors. Dowden, Hutchinson & Ross, Inc. Stroudsburg PA, US/IBP Synthesis Series, #11. 1981. 279 pages. The editors are from the Univ. of Ariz.

Nitrogen in Desert Ecosystems
Neil E. West and John J. Skujins, editors. 1978. Dowden, Hutchinson & Ross, Inc. Stroudsberg, Penn. US/IBP Synthesis Series, #9. 307 pages.

The Reclamation of Disturbed Arid Lands.
Robert A. Wright, editor. 1978. Univ. of NM, Albuquerque.

Conservation in Arid & Semi-Arid Zones
FAO 1976. Very good information. Well-illustrated with many graphics and line drawings.

Reclamation of Solonetz Soils in the USSR
by I.V. Tyurin et al., 1960, First published in the USSR. Translated by IPST (Israel Program for Scientific Translations).

Origin of Saline Soils and Their Regime II
V.A. Kovka. 1947, Moscow. Translated by IPST, 1971. 311 p.

Saline Irrigation for Agriculture and Forestry.
Hugo Boyko, editor. 1968, W. Junk Pub. 325 pages.

Soil Erosion and its Control in Arid and Semi-Arid Zones.
Proceedings of the Karachi Symposium 1960. Food and Agriculture Council, Ministry of Food and Agriculture, Pakistan. 400 pages. Excellent information from 3rd World experts.

Gravel-sand mulching in north-west China.

[The following is exerpted from *Fruit trees and vegetables for arid and semi-arid areas in north-west China.* by Wang Ming and Sun Yun-wei, in Journal of Arid Environments (1986) 11, page 14. See further review in 'Fruit Section'.]

The gravel-sand mulched fields, known locally as 'sand fields', were created by the farmers in Gansu province about 300 years ago. Nearly 86,000 ha of such fields are distributed between 35 degree and 38 degree N and 103 degree N and 105 degree E on the loess plateau; nearly 80,000 ha or 93% of them are in Gansu province.

The fields are covered by a 5-16 cm layer of water conserving mulch, made up of a mixture of different-sized pebbles, gravel and sands taken from river alluvium or glacial deposits. These fields are tilled and fertilized by means of special farm tools and implements to prevent the mixing of soil and mulch so that the benefits of the mulch can be maintained for as long as possible! This mulch is used mainly on the non-irrigated fields known as 'dry sand fields', but some irrigated fields are also mulched in this way and are referred to as 'irrigated sand fields'. The dry sand fields recieve a much thicker mulch than the irrigated sand fields and therefore can last for 30-40 years. The crops in the dry sand fields consist of spring wheat and other cereals, legumes, vegetables and especially melons.

The crop yields of the gravel-sand fields are two to three times greater than from unmulched fields. The mulch is partly removed during sowing and manuring and restored immediately afterwards. When 25% by weight of the sand mulch has mixed with the underlying soil, its function will almost entirely diminish. The old mulch should then be removed and replaced by a new mulch (Niu Pu & Zhai Yunzhi, 1981). In recent years, a plastic film over the gravel-sand mulched fields has achieved good results.

Distribution of the arid and semiarid areas in China and their major climatic characteristics. By Wang Qian (1983). Agricultural Research in the Arid Areas. (Northwestern College of Agriculture, Wugong, Shaanxi, China.), **1:** 9-24.

Irrigation in arid and semiarid regions in northwest China. by Xiong Yunzhang (1981) Agricultural Newsletter for Arid and Semiarid Areas (Northwestern College of Agriculture, Wugong, Shaanxi, China.) **12:** 1-4.

Small-Scale Irrigation
Peter Stern. IT, 1979, 152 pages $13.50, available from Agribookstore (see book sources section).
Describes various irrigation systems and methods including less well known simple technology.

Rangeland Management

Forest Grazing Management: Guidelines for Agro-Silvo-Pastoralism.
By Harold F. Heady. 1985
This is a review of the worldwide literature on agroforestry with an emphasis on grazing. Over 1000 publications were searched and about 140 cited.

Range Management Handbook for British Columbia
Alastair McLean, Editor. Ag Can Res Stn. Kamloops, BC. 1979.

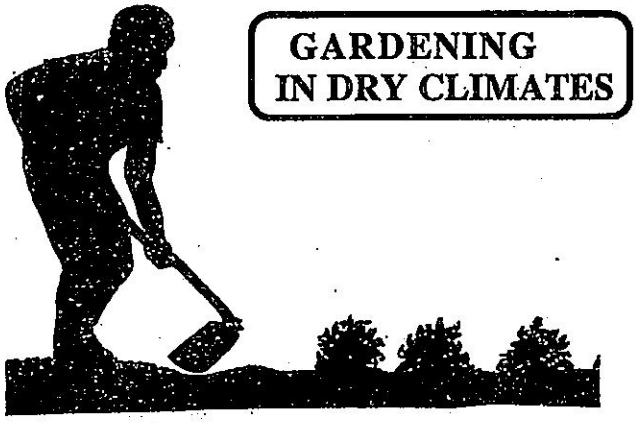
California Range Brushlands and Browse Plants
By Arthur W. Sampson and Beryl S. Jespersen. Publication No. 4010, Ag. Sci. Pub., Univ of Calif. Berkeley, CA 94720. 162 pages. Price $6.00

Vegetation Changes on Western Grasslands
Farrel Branson. April, 1985. Range Monograph No. 2, Soc. of Range Management, 2760 W Fifth Ave, Denver, CO 80204.
This is one of the few (and most recent) attempts I have seen to describe the vegetation changes in the Western United States. The author approaches the subject from the viewpoint of an apologist for the cattle industry. Although somewhat understated, this book gives a good idea of the overall damage suffered by the open forest, grass, and shrub communities in the western U.S. as a result of overgrazing and poor farming practices.

Arid and Semiarid Lands: Sustainable Use and Management in Developing Countries
By R. Dennis Child, Harold F. Heady, et al. 1984. Winrock International, Morrilton, AR 72110. 206 pages.

This report was prepared for a branch of US AID. It is concerned with rangeland management primarily. This book demonstrates the progress being made in government aid & development programs. This book on rangeland management stresses the need for more people-oriented approachs, social scientists working with land management scientists, more environmental analysis; longer projects; and more attention to multiple-use land-management systems that utilize local knowledge and indigenous plant and animal genetic material available in developing countries. It is an attempt at an overview of the progress and problems of rangeland development extension and aid from overdeveloped countries to Third World countries. This book is certainly a step in the right direction by U.S. range management specialists. Chapter 1 briefly covers the major rangeland systems of the world.

Other books on range management
Friends of the Trees Newsletter #8 (page 42) reviews a number of noteworthy books on range management.



Desert Gardening, Desert Plants and Their Cultivation: An Annotated Bibliography.
Compiled by Gerard McKiernan. 1977. Library of the New York Botanical Garden, Bronx, New York.

This bibliography is primarily intended as a guide to the literature on the cultivation of native desert plants for use by gardeners. The majority of works listed deal with flora of the southwest United States. Hundreds of books are reviewed as well as periodicals and organizations.

Desert Gardening
A Sunset Book; 1967. 96 pages

A book designed for suburban gardeners. Nonetheless there is much information on plants adapted to dry Californian climates. I suspect there may be a later edition (and better) than the 1967 edition I have on my bookshelf.

Successful Gardening with Limited Water
by Margaret Tipton Wheatly. 1978. Woodbridge Press, Santa Barbara, Calif. 128 pages.

Written especially for Californian gardeners and home landscapers. Like the general trend these days, Wheatley's advice is more along the lines of native plants, natural setting, and drought enduring plants. She gives many lists of plant species for use in various sites including sand and sea-shore gardens.

Landscape design for the Middle East.
Timothy Cochrane ALI and Jane Brown, Editors. 1978. Proceedings of a symposium held in London in May, 1977. RIBA Publications, Finsbury Mission, Moreland St. London EC1V 8VB. 160 pages.

This book is written primarily by and for professional landscape architects working in the Middle East. The chapters on irrigation are useful. A notable feature of the book are lists of plants suitable for landscaping in: the Suez region, Western Saudi Arabia; the Gulf region and Riyadh.

Easy Gardening with Drought-Resistant Plants.
By Arno and Irene Nehrling. 1968, Dover, NY. 320 pages.

This book covers some of the essentials for designing drought-tolerant gardens, soil improvement and garden maintenance, mulching, watering, etc. The 2nd half of the book contains decriptions of recommended hardy trees, hardy shrubs, ground covers, vines, annuals, perennials and desert flora.

Trees and Shrubs for Dry California Landscapes.
By Bob Perry. 1981. Land Design Pub, PO Box 857, San Dimas, CA 91773

An introduction to 360 native and introduced plants which survive in California's dry climates. Many color photographs.

Plants for California Landscapes
A catalog of drought tolerant plants.
Sept 1979, Bulletin 209, State of Calif. $1.25 from The Resources Agency, Dept of Water Resources, PO Box 388, Sacramento, CA 98502. 127 pages.

Plants for Dry Climates
By Mary Rose Duffield and Warren D. Jones. 1981. Horticulture Books. 176 pages. $9.95.

Desert landscaping plants lavishly illustrated in full color with 500 color plates. The book contains information on "how-to" establish plants and lists sources of plants.

Southwestern Landscaping with Native Plants
By Judith Phillips. 1987, Available for $17.95 (paperback) or $27.95 (hardback). Museum of New Mexico Press, PO Box 2087, 228 E. Palace Ave., Santa Fe, NM 87503 (505) 827-6454

Subjects covered include: How to design gardens for low maintenance o How to plant and maintain your landscape o Propagation from seeds and cuttings o Profiles of arid-land trees, shrubs, and ground covers.

Landscaping to Save Water in the Desert.
By E.A. Johnson and DG Harbison, 1985. $8.95 from Eric A. Johnson Co., 74228 Angels Camp Rd, Palm Desert, CA 92260.

Gardening on Sandy Soil in North Temperate Areas
By Christine Kelway. 1965 Dover, 144 pages.

Written in England the author is familiar with English sandy soils. So she is in a humid rainfall zone and much of the sandy areas are acid. However sand gardeners in different climates may find some of her sandy soil advice useful.

Westscape
Rick Hassett
369 E. 900 S.
Salt Lake City, Utah 84111

Quarterly, general gardening newsletter oriented to the intermountain West. $10/yr.