BIBLIOGRAPHIC DATA SHEET PN-AAJ-938

INTERNATIONAL ARID LANDS CONFERENCE ON PLANT RESOURCES; PROGRAM AND ABSTRACTS

PERSONAL AUTHORS -

CORPORATE AUTHORS - TEXAS TECH UNIV.

1978, 000P.
(SPONSORED BY AMER. ASSN. FOR THE ADVANCEMENT OF SCIENCE, TEXAS TECH. UNIV., A.I.D., U.S. FOREST SERVICE, AND NATIONAL SCIENCE FOUNDATION)
(CONFERENCE PROCEEDINGS: PN-AAH-030)

ARC NUMBER - 633.G652
CONTRACT NUMBER - AID/DSAN-G-0038
PROJECT NUMBERS -
SUBJECT CLASS - AF0000000000

DESCRIPTORS -

PLANT ECOLOGY	PLANTS
ARID LAND	DESERT
FORAGE CROPS	MEETINGS
VEGETATION	SEMIARID LAND
PLANT PHYSIOLOGY	LAND DEVELOPMENT

International Arid Lands Conference on Plant Resources

(Program & Abstracts)

Texas Tech University
Lubbock, Texas
October 8-15, 1978

INDEX

DESERT VEGETATION, ITS ORIGIN AND AGE

Daniel I. Axelrod
Department of Botany
University of California
Davis, California 95616

Desert taxa origirated in local xeric sites situated in forests, savannas and woodlands that occupied areas of the present deserts long before regional aridity appeared. Since the taxa were selected initially for some drought, the trend to drier Tertiary climate favored their spread (and that of their descendants) into the expanding dry areas (=new zone, sensu Simpson) that resulted from three major causes, individually or in combination. 1. Retreating seaways gradually eliminated sources of moisture from interior regions (Gobi, Takla-Makhan, Australia) that had supported forests and woodlands into the Miocene. 2. As Antarctica shifted to a polar position and North America-Eurasia rotated to close the Arctic basin, cold-water currents spread down the eastern Pacific and Atlantic. These gradually stabilized air over the subtropics and between the major wind systems. As tropical hurricanes met cold water they lost strength so summer rain was reduced over areas of the present tropical deserts. On their northern borders, mediterranean (dry summer) climates appeared only after the Early Pleistocene. 3. Elevation of mountain ranges in the late Cenozoic (Sierra Nevada, Peninsular Ranges, Himalayas, Tibetan Plateau, Andes) brought dry climates to their lee, eliminating forests and woodlands that had thrived there into the Pliocene. Tropical semideserts were present locally by 15 m.y., and very restricted areas of tropical desert may have been present by 5-6 m.y. However, forests, woodlands, thorn scrub and grassland all entered the present desert regions during the Late Pliocene and the pluvials. Thus, the present deserts are post-glacial, and man has greatly furthered their expansion. Tropical deserts

support the richest floras and vegetation because they have been accumulating dry-adapted taxa for a longer period than temperate regions, and warmer temperatures favor the survival there of a greater diversity of relict life forms.

DESERT SOILS

H. E. Dregne
Horn Professor and Director
International Center for Arid and Semi-Arid Lands Studies
Texas Tech University
P.O. Box 4620
Lubbock, Texas 79409

Desert soils are of four general types: shallow rocky soils on sloping land; deep coarse textured soils on smooth to undulating uplands; deep clay soils in depressions; and recent alluvial soils on river flood plains, with texture and depth sometimes varying widely over short distances.

Soil factors influencing distribution of native plants are mainly the physical conditions affecting infiltration rate, water holding capacity, and aeration. Soil salinity is locally important in many places. The nutritional status of the soil generally is unimportant, with a few notable exceptions.

DEVELOPMENT OF VEGETATION PATTERNS IN ARID AND SEMI-ARID LANDS

Otto Solbrig
Gray Herbarium
Harvard University
22 Divinity Ave.
Cambridge, Massachusetts 02138

Desert Vegetation is characterized by a diversity of life forms. Four types are characteristic of most desert areas: Phreatophytic trees, xerophytic shrubs, succulents and ephemerals. Within each of those life forms there is also variation such as low and tall shrubs, leafy or aphyllous shrubs, summer or winter active types, etc. Schimper at the turn of the century proposed a physiologico-adaptive explanation for this diversity, based on a model of plant water use efficiency. Maximov and others showed Schimper to be incorrect. A model based on the tradeoffs between carbon gain and water economy on the other hand predicts the basic desert life forms quite accurately, but not the more detailed diversity.

Evidence will be presented to indicate that the pattern of vegetation in desert areas is the result of many factors, among them are historical factors, topographical factors, environmental factors (especially intensity and distribution of rainfall) and ecological ones. It will be shown that a "satisfaction" type model explains arid plant diversity better than an "optimality" type model.

DESERTS, GYPSUM AND ENDEMISM

B.L. Turner
University of Austin
Austin, Texas
and
A.M. Powell
Sul Ross State University
Alpine, Texas

Gypsum ($CaSO_4 \cdot 2H_2O$) is a common surface evaporite in warm or hot regions of low rainfall throughout the world. Enormous deposits of gypsum were formed during the Mesozoic and subsequently covered over by mostly calcareous ($CaCO_3$) or silicaceous (SiO_2) deposits of the Cenozoic. Tectonic and erosional forces have reexposed such "fossil" gypsum, or its anhydrite form ($CaSO_4$). Strange and bizarre plant endemics tend to develop upon such substrates, especially in arid regions such as North Central Mexico where the surrounding flora is rich and the gypsum outcrops are of long standing. The nature and peculiarities of gypseous endemics are discussed, along with certain systematic "generalities" that seem to hold for plants that occupy gypsum outcrops in desert regions.

DEVELOPMENT OF VEGETATION PATTERNS IN ARID AND SEMI-ARID REGIONS OF INDIA

K. M. M. Dakshini
Department of Botany
University of Delhi
Delhi 110007, INDIA

The northwest region of India can be subdivided into three zones: 1) Aravali, 2) Semi-arid, and 3) Arid. This zonation is brought about mainly because of varying annual rainfall and topography through the region. Since the trend of variation of these factors follow a east to west direction even the development of habitat processes, especially physical and chemical characteristics, salinity, etc., are rather continuous from one end of the region to the other. The pattern of distribution of vegetation also follows this sequence of evolution of habitat features. Such a development and maintenance of habitats and their vegetational complexes have led to differential selection of plants and plant parts by inhabitants of these zones for economic purposes. Besides the overall correlation between vegetation, habitat characteristics and ethnobotany even the pattern of evolution of adaptive responses with special reference to morphology, physiology, phytochemistry, germination of seeds, and reproductive biology of an individual follow the micro-edaphic changes of the habitat. These responses seem to be so specific to the habitat characteristics that at times these may have meaningful predictive value. In fact the developmental patterns of vegetation either at the macro level (community or population) or micro-level (individual) are the unfolding of the cryptic potentials of the individual/community/population in response to the dynamic but directional ecological stresses peculiar to semi-arid and arid environments.

ARID LANDS IN SAUDI ARABIA

H. H. Hajrah
Vice-Dean of Institute of Meteorology and
Arid Lands Study
King Abdulaziz University
Jeddah, SAUDI ARABIA

Saudi Arabia (major part of the Arabian peninsula) is a desert located in the arid region of the world. Its land is of three soil types: rocky in the mountainous country especially along the Red Sea Coast, sandy in most parts of the Kingdom or silty in the deltas of the wadis dissecting the desert and in the oases. Saline and alkaline soils are usually present in the littoral and inland salt marshes. The plant coverage, which is thin and disperse, is mostly suitable for grazing. Woody scrublands are present in the upstream parts of the wadis of the Red Sea coastal lands.

Lands suitable for development in Saudi Arabia are available especially in areas of alluvial soils originated from sandstone, limestone in wadi banks and deltas and, in other depressed areas where potential water is available.

More than 70,000 hectares of public land have been distributed to utilizers. As the development of arid lands is highly costly, less than one fourth of these areas have been developed and utilized. Possibilities of, and problems behind the development of arid lands of Saudi Arabia are discussed.

THE ROLE OF POLYPLOIDY IN THE EVOLUTION OF *Atriplex canescens*

Howard C. Stutz
and
Stewart C. Sanderson
Dept. of Botany and Range Science
Brigham Young University
Provo, Utah 84602

In the rapid recent spread of *Atriplex canescens* throughout western North America polyploidy has played a major role in producing new species which have invaded and occupied available sites. Unreduced gametes appear to be responsible for most autoploid derivatives. Alloploids have apparently come from unreduced gametes as well as from chromosome doubling in somatic tissue.

Autoploid forms are usually woodier, shorter and slower growing than their parents and are thereby adaptive in harsher environments. Alloploids appear to show heterotic advantages from the additive effects of qualities derived from genetically distinct parents. They are usually successful in severe desert habitats.

The most successful autoploid appears to be the common woody form which is now distributed throughout most of the Intermountain West. Two unusually successful putative alloploids are (1) one which is common in the desert valleys of Nevada apparently derived from *A. canescens* x *A. falcata* parentage and (2) one which is common in the Mojave desert of California putatively derived from the parentage *A. canescens* x *A. polycarpa*.

CHANGES IN THE PATTERN OF DISTRIBUTION OF MESQUITE (Prosopis glandulosa, VAR. torreyana)

Robert A. Wright
West Texas State University
Canyon, Texas 79016

Changes in the pattern of distribution of mesquite (Prosopis glandulosa var. torreyana (L. Benson) M.C. Johnst.) were studied at 5 sites in southern New Mexico, about 35 km N of LasCruces. Site descriptions, dates for which data were available, and statistical methods used follow: 1. Two sets of plots (each plot 1.01 h (2.5 A), on two different range condition sites, designed to exclude cattle only; cattle and rabbits; cattle, rabbits, and small rodents; and no animals (check plot); 1948 and 1959; variance: mean ratio and nearest neighbor methods. 2. Two belt transects, 452.61 m (90 r) and 1,025.92 (204 r) long, originally extending from mesquite coppice duneland into black grama grassland; shorter transect: 1940, 1948, 1959, 1977; longer transect: 1940, 1947, 1953, 1959, 1977: Grieg-Smith's method of pattern analysis. 3. One 4105 h (10 A) plot from which all mesquite were removed in 1939, 1948, 1955, 1959, 1955; Grieg-Smith's mothod. In addition, along the shorter belt transect soil physical and chemical properties were studied in relation to the development of spatial pattern of mesquite.

PLANTS FOR MEDICINAL USES

Edward S. Ayensu
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560

After many years of benign neglect, many researchers and health administrators have renewed interest in the discovery of new medicinal plants of value in the solution of numerous ailments and diseases that modern western medicines have failed to conquer. Since the discovery of the so-called "Wonder Drugs", which are mostly of plant origin, pharmacologists and phytochemists have been relying on a vast number of plant species from whence they can obtain natural sources of new drugs.

Unfortunately, few attempts have been made to tap the incredibly large amount of information that is currently stored in the heads of herbalists and traditional healers, who have managed to keep w ll over 80 per cent of the world's rural population in reasonably good health. Furthermore, the arrogance with which many western-trained doctors, especially from developing countries, often dismiss the value of herbal medicine should be replaced with a careful analysis of the pharmacopoeia that has been cherished by human medical history for centuries.

The presentation will offer suggestions for the discovery of new medicinal plants that could be of help in our attempts to supply better medical care for the world's population by the year 2000.

THE DISTRIBUTION OF MEDICINAL PLANTS IN ARID AND SEMI-ARID TRACTS OF WESTERN RAJASTHAN-THAR DESERT

M.N. Tewari
Laboratory of Plant Biochemistry
Botany Department
University of Jodhpur
Jodhpur, India

The Indian desert covers an area of about 28,600 km^2. The soil is sandy and at places it is saline while some parts are rocky. In view of the agroclimatic conditions, the perennial vegetation has relatively few xerophytic characteristics. Many trees and shrubs which are distributed in the different parts of the desert contain great medicinal value. Species of Acacia, Prosopis, Salvadora, Tecomella, Cassia, Capparis, Euphorbia, Zizyphus, Tamarix, Calotropis and Commiphora are distributed in different parts of the desert and they form the perennial vegetative cover on the soil. In addition to these perennial plants, many ephemerals appear during the rainy season. The rainy season plants like Celeome, Argemone, Eclipta, Convolvulus, Indigofera, Tephrosia, Sida, Boerhavia, Datura and Tribulus are also important medicinal plants. This paper discusses the distribution of these perennial and annuals plants in different soil conditions and their ethnobotany.

The chemical analysis of the barks of Acasis, Senegal, Capparis decidua, Calotropis procera and Commiphora mukul has been worked out for carbohydrates and proteins. The distribution of alkaloids in different parts of Datura metal and Commiphora mukul has also been determined along with some of the chemical constituents of some of the ephemerals. The chemical composition and distribution of metabolities in different parts of the plants is presented as well as the chemical composition and uses of latex from Euphorbia Caducifolia, and Calotropis procera.

BIOLOGY, UTILIZATION AND MANAGEMENT OF MEDITERRANEAN SEMI-DESERT AROMATIC PLANTS

N. S. Margaris
Laboratory of Ecology
University of Thessaloniki
Thessaloniki, GREECE

Ecosystems in the semi-arid end of Mediterranean climate gradient, are adapted to the summer drought stress by the mechanism of seasonal dimorphism. Another feature of plants in mediterranean climate regions is their aromatic nature, mainly due to terpenes, the ecological role of which is attributed either to water economy and/or to allelopathy. Nowadays, results are available on the biology of some of the main species, viz. on anatomy, water relations, phenology, cambial activity, photosynthetic type, productivity, control mechanisms of seasonal dimorphism, etc.

The aromatic nature of these plants in combination with their medicinal action has found use for at least 3000 years in their utilization as food condiments, in preparation of teas, in cosmetics as well as in curing of several diseases. Collection of these plants, mainly during the summer, consists an important financial aid for the populations of semi-arid regions of mediterranean climate. In some regions, besides collection of wild plants, cultivation takes place too; but while cultivation is productive in terms of plant biomass, the quantity of useful ingredients is lower, decreasing, in this way, the economic yield. In Greece the Industrial Development Bank has already carried out an extensive study on the possibilities of utilization and management of aromatic plants.

NEW TRENDS IN THE UTILIZATION OF RENEWABLE RESOURCES FROM THE CHIHUAHUAN DESERT

E. Campos-Lopez,
A. Roman-Alemany
and
F. Niebla-Vargas
Centro de Investigacion en Quimica Aplicada (CIQA)
Saltillo, Coahuila, MEXICO

This paper discusses the role that renewable desert resources, and especially those of the Chihuahuan Desert, play in satisfying two parameters:

- Market demand: especially in the Mexican chemical industry;
- Regional needs: with regard to fuel, materials and food.

Developing a model which integrates on the one hand previous information and on the other the classification of different plant species and their chemical composition, research and development needs can be defined on different levels: elements of the ecosystem; plant supply; knowledge of the resources' chemical composition; accessibility or development of conversion technology; and finally improvement of the raw materials' properties to make them competitive as a substitute for presently used raw materials.

On this basis some current examples of development are presented and the different elements are analyzed: research, development, governmental regulations, etc., which will intensify the flow of materials in a marginal area like the Chihuahuan Desert.

PLANT RESOURCES OF ARID AND SEMI-ARID LANDS OF INDIA FOR HUMAN AND ANIMAL CONSUMPTION AND FOR MEDICINAL PURPOSES

K. L. Mehra
R. K. Arora
and
R. Gupta
National Bureau of Plant Genetic Resources
New Delhi, INDIA

The arid and semi-arid tracts of India compromise the cold belt lying between 70°-80°N and 30°-37°E in the Western edge of the Himalayas, above 3000 m, and the hot belt located in the northwestern Indogangetic plain between 68°-77°N and 23°-30°E and with a vertical spur-like southerly extension in the Deccan plateau (77°-78°N and 15°-18°E).

The cold arid lands of Ladkh, Lahual and Spiti, and adjoining areas, exhibit rich variability in wheat and barley, particularly naked barley and pseudocereals, buckwheat and amaranth. Much diversity occurs in cold tolerant maize, prosomillet, lentil and field pea; and in Pyrus and Prunus. The stony alpine habitat adjoining fertile valleys is rich in forage legumes - Medicago, Trigonella, Cicer, Lespedeza, Hedyserum, Caragana, Astragalus; and grasses - Festuca, Poa, Agrostis, Agropyron, Dactylis, Bromus, Stipa, Phleum and Trisetum.

The hot arid tracts of Rajasthan, Kutch and other areas, show diversity in drought tolerant hard wheats, hooded barley, pearl millet, Clusterbean, mothbean, cowpea, blackgram, gram, sesame and jujube. Promising variability occurs in forage legumes - Crotalaria, Indigofera, Desmodium, Rhynchosia, Alysicarpus; and grasses - Aristida, Cenchrus, Lasiurus, Dichanthinm, Pennisetum and Brachiaria.

A wide array of cultivated and wild types of plants are used for human and/or animal consumption. Arid habitats also hold promising resources in medicinal plants. Saussaurea lappa (Kuth) is an age old crop of the cold arid tracts. Henbane, Ephedra and Artemisia (wormseed), and many others occur in wild forms. In the hot arid parts Anethum graveolens, and some exotic adaptable types in Plantago, Papever somniferum, fennel and cumin occur, and much variability in these plant species has been generated locally. Of recent interest are Senna (Cassia angustifolia), Balanites aegyptiaca, Citrullus colocynthis and Salvadora persica.

CURRENT GUAYULE RESEARCH

George P. Hanson
Los Angeles State and County Arboretum
301 North Baldwin Avenue
Arcadia, California 91006

Current guayule research is under way at several institutions in the world. George Hanson at the Los Angeles Arboretum in Arcadia, California and David Rubis of the University of Arizona at Tucson have the largest agronomic research programs in the United States. Both institutions have made collections of native Mexican guayule and have test plots and a breeding program in progress. Test plots and some agronomic research is also in progress in Texas, New Mexico, and Nevada. Henry Yokoyama of the USDA Fruit and Vegetable Chemistry Laboratory in Pasadena, California is studying the rubber yield response of guayule to specific biogregulators.

In Saltillo, Coahuila, Mexico a small scale rubber extraction plant is in operation where native shrub is being harvested and processed. Enrique Campos Lopez is directing the facility where they are also conducting research on rubber quality and extraction procedures. Ing. Jose Angel De La Cruz, Rector of the Universidad Autonoma Agraria Antonio Narro in Saltillo, and his group are conducting various field studies of native guayule.

Numerous other projects are under way throughout the world by private and governmental units in attempts to ascertain the usefulness of guayule under their particular climatic and economic conditions.

GENETIC AND ENVIRONMENTAL RESEARCH IN DEVELOPING JOJOBA AS A COMMERCIAL DRY LAND CROP

Demetrios M. Yermanos
Department of Plant Sciences
University of California
Riverside, California 92521

A great deal of variability has been observed within and among natural populations of jojoba in terms of seed production. Single plant selections from these populations planted in breeding nurseries are now providing source material for the development of commercial cultivars of jojoba. At the same time, research for the development of appropriate cultural practices is beginning to formulate some basic facts as to how commercial plantations of jojoba should be laid out and cared for.

RUN-OFF FARMING FOR JOJOBA

Dwayne H. Fink
and
William L. Ehrler
U.S. Water Conservation Lab
Phoenix, Arizona 85040

Jojoba (Simmondsia chinensis) is receiving considerable attention world-wide because the liquid wax it produced has many potential commercial applications, and because jojoba wax directly substitutes for the now rare sperm whale oil. Jojoba is indigenous to the Sonoran desert, which implies extreme drought tolerance and low water requirement. However, within its natural range, plants growing in washes are usually bigger and more productive than those on the high ground between washes. The washes exemplify natural water harvesting. We selected 30 obviously water-stressed plants on high ground in a natural stand, and applied water harvesting techniques to determine their water requirement and ascertain yield benefits from the extra water. Three treatments of 10 plants each were subjected to three water application levels as controlled by three water harvesting methods. Treatments were: (1) untreated control; (2) individual smoothed and rolled 20 m^2 catchments directing runoff to 4 m^2 collecting basins surrounding each shrub; (3) treatment (2) with the catchment surfaces treated with paraffin to increase runoff efficiency. Amounts of water delived (4-year averages) were 150, 440, and 880 mm, respectively, for the three treatments. Average seed yields (year 4) were 27, 76, and 208 g/plant (relatively 1, 3 and 8 times the control). Maximum yield was 514 g/plant.

SOCIOENVIRONMENTAL FEASIBILITY OF ESTABLISHING A JOJOBA INDUSTRY ON INDIAN RESERVATIONS IN THE ARID AND SEMI-ARID UNITED STATES

S. J. Turner
H. J. Kassander
and
C. E. Wittles
Office of Arid Land Studies
University of Arizona
Tucson, Arizona 85719

Jojoba (Simmondsia chinensis, Link.) is a perennial shrub native to the Sonoran Desert. The seeds are produced annually and have a liquid wax content of approximately 44 percent by weight. Jojoba wax is a mixture of fatty acid esters of decyl alcohol which has commercial importance as a replacement for sperm whale oil and in other uses.

Currently, jojoba seed is being harvested from natural stands on the San Carlos Apache Indian Reservation in Arizona as well as in other areas of Arizona, California and Mexico. The harvested seed is mechanically pressed. The extracted oil is used in a cottage industry on the reservation and sold commercially.

This paper explores the environmental, sociocultural and legal feasibilities of developing a jojoba industry on the San Carlos Apache Reservation. A description is presented of the reservation environment and existing jojoba industry. Discussion includes factors influencing further expansion.

RESEARCH AND DEVELOPMENT ON GUAYULE: PRESENT STATE OF KNOWLEDGE

E. Neavez-Camacho
and
E. Campos-Lopez
Centro de Investigacion en Quimica Aplicada (CIQA)
Saltillo, Coahuila, MEXICO

Since 1974, Guayule (Parthenium agrentatum) has been the focal point of the research and planning of various groups. An important aspect which has made agronomical studies possible, is the intensive technological development and applied research program which is being realized both with Guayule and its various by-products.

The work presented here shows the latest techniques and developments in this area, giving the results of experiments in the development of products obtained from this shrub. Finally future research and development needs are presented schematically, on the basis of future opportunities to develop new substitutes for synthetic materials presently obtained from petroleum sources.

GUAYULE AS A COMMERCIAL SOURCE OF NATURAL RUBBER

Don L. Weihe
Firestone International
1200 Firestone Parkway
Akron, Ohio 44317

Increasing natural rubber consumption and predictions of future shortages have lead to a renewed interest in the guayule shrub (Parthenium argentatum) as a commercial source other than tree rubber to fill the raw material needs of the rubber industry. Firestone, the largest industrial producer of natural rubber, with 130,000 acres of Hevea plantations in five countries, is expanding current acreage to help meet this need. In addition, Firestone has launched a two-phase research and development program to commercialize the rubber from the guayule shrub. One phase involves product and process development studies using wild Texas shrubs. The other, an agricultural phase, includes the establishment of a nursery and several thousand acres of test plantings at Fort Stockton, Texas. Progress in these programs is discussed. Deresinated stabilized guayule rubber is shown to be comparable to, and a satisfactory replacement for, Hevea rubber (H. brasiliensis) in most tire applications. Factors affecting guayule economics and commercialization are presented. These include rubber price, agricultural costs, processing costs, by-product credits, and the economic climate in the eighties and nineties. Preliminary cost calculations are given to point out critical areas and to show a potential for commercialization during the next decade.

DOMESTICATED *Proboscieda* AS AN ARID LAND CROP WITH OILSEED POTENTIAL

Gary Nabhan
College of Agriculture
Dept. of Plant Sciences
University of Arizona
Tucson, Arizona 85721
James Berry
Nutrition and Food Sciences
University of Arizona
Tucson, Arizona 85721
and
Peter Pretting
Dept. of Biology
Indiana University
Bloomington, Indiana 47401

Proboscieda parviflora, or devil's claw, is a summer ephemeral of the arid regions of the U.S. Southwest and northern Mexico. Since 1915 agriculturalists have recognized wild-growing, black-seeded *Proboscidea* as a potential oilseed crop. Early attempts at bringing wild germ plasm into field cultivation were riddled with difficulties involved with threshing the seed from the fruit, and the slow and irregular germination of the "wild" seeds. Previous researchers were unaware of a domesticated, white-seeded race of devil's claw grown by more than ten Southwestern Indian groups for basketry fiber. The domesticated plants bear more fruit containing more seeds which germinate reliably and rapidly. Seeds of certain domesticated plants contain more unsaturated, edible oil (up to 40.3% of total weight) and more crude protein (up to 27% of total weight) than any of the wild seeds sampled. These data indicate that domesticated *P. parviflora* could be superior to wild *P. parviflora* in producing an oilseed crop with a proteinaceous seed meal by-product. Biosystematic and agronomic studies are investigating the total gene pool available for crop improvement via hybridization, and the crop ecology of the domesticates in Indian fields.

PLANT RESOURCES OF INDIAN ARID ZONE FOR INDUSTRIAL USES

R. S. Paroda
Division of Plant Studies
Central Arid Zone Research Institute
Jodhpur, 342003, INDIA

Research on plants of the Indian Arid Zone has shown good promise for industrial utilization. Guar (Cyamopsis tetragonoloba L. Taub), a drought hardy crop of the arid zone, has already become an important foreign exchange earner mainly on account of seeds having 35-40 per cent gum. Studies have revealed that productivity of guar could be increased substantially through both genetic improvement and management. Til (Sesamum indicum L.), an oilseed crop, and Isabgol (Plantago ovata), a crop of medicinal value, are also valuable industrial crops of the Indian arid zone. Important among other plants are: Balanites roxburghii for diosgenin, Acacia senegal for gum arabic, Cymbopogon martinii for essential oil, Citrullus colocynthis for non-edible oil, Citrullus lanatus for edible oil, and Sachharum munja and Calotropis procera for fiber. Some exotic plants like Euphorbia antisyphilitica, Agave sislana, Bursera delphachiana, and Eucalyptus viridis have also shown promise for production of candelilla wax, fiber, essential oils, etc. Discussion is mainly confined to research information gathered at the Central Arid Zone Research Institute, Jodhpur, India.

OIL YIELDING PLANTS OF THE INDIAN DESERT

D. D. Chawan
and
D. N. Sen
Laboratory of Plant Ecology
Botany Department
University of Jodhpur
Jodhpur 342 001, INDIA

In a preliminary search of wild plants in the Indian desert, a number of species were discovered which could be exploited on a large scale for various purposes. Some of such plant species are: trees, Salvadora oleoides Decne. and S. persica Linn,; creeper-like, Citrullus colocynthis (Linn.) Schrad. and C. lanatus (Thunb.) Mansf. for varying quality of oils in the seeds.

S. persica has a wider range of distribution in sandy plains, whereas S. oleoides is commonly found growing on sandstone, mostly in arid regions of the Indian desert.

S. persica was found to possess two types of seeds. The smaller type are purple brown and less than half in size as compared to the larger type, which are greenish yellow in color. The seeds of S. oleoides resembled the larger seeds of S. persica. The oil content in seeds of S. oleoides was slightly higher (45.50%) than S. persica. The percentage of oil in small seeds of S. persica was lesser (18.92%) than the larger types (44.44%).

C. colocynthis inhabits sandy plains and dunes of the arid region of northwest part of Rajasthan (India). This species is a source of drugs, oil and proteins. The mature seeds are brown in color and are a good source of crude oil (20-25%). The oil is pale yellow with a pungent smell. It is mainly used for preparing washing soaps. It is also used to adulterate mustard oil.

C. lanatus (Thunb.) Mansf. is cultivated, as well as being a wild prostrate creeper (Kharif crop) in arid regions of India. The seed color varies from white, to yellow, red and black. The fruit pulp is eaten by man, being very rich in sugars with a high percentage of water. The oil yield in these seeds is comparatively less than C. colocynthis.

CREOSOTE BUSH (L. tridentata) INDUSTRIAL POTENTIAL

S. Fernandez-Tavizon
and
M. A. Ponce-Velez
Centro de Investigacion en Quimica Aplicada
Saltillo, Coahuila, MEXICO

The creosotebush, Larrea tridentata, is one of the most ubiquitous plant materials of the semidesertic and desertic areas of the United States and Mexico. Its habitat, an estimated 135 million acres, is continually on the increase to the extent that regions previously used as grassland have been totally dominated by it. Its vigorous growth is a consequence of the ease of adaptation of the plant to extreme stress, its sparse canopy is well suited to avoid overheating, and its leaves are coated with an abundant resinous exudate considered by many to function as an antiherbivore defense mechanism as well as an antidessicant adaptation.

The resin is made of a complex mixture of hundreds of components, primarily phenolic lignan and flavonoid aglycones; other minor constituents are waxes, steroids and volatile oils. It was used for some time as a source of nordihydroguaiaretic acid (NDGA), as phenolic lignan that sometimes makes up as much as 50% of the resin. The NDGA has been used extensively in the past for industrial purposes: fat and oil antioxidant, polymer stabilizer, lubricant, and others. We have been primarily interested in developing uses of the crude resin without separating it into its components. It can be used as an antioxidant for a number of polymers such as hevea rubber, guayule rubber and several of the synthetic polymers. In several applications it competes favorably with a number of commercial antioxidants. Some commercial fungicides are phenols or derivatives of them, and creosotebush can also be used for this purpose. In vitro testing against some phythopathogenic fungi has proven it to be

quite an effective fungicide, and *in vivo* field tests have given satisfactory results. Other uses of the resin as a polymer material have been elaborated. Finally, the residual plant material can be used as animal feedstock; alternatively, other conventional cellulose uses may be developed for it.

PLANT RESOURCES FOR ENERGY

Edward S. Lipinsky
and
Stephen Kresovich
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

The high solar insolation and low economic value usually assigned to many arid and semi-arid lands renders consideration of these lands for energy crop production an appealing concept. However, ecological realities must be taken into account so that meaningful opportunities can be identified and developed. The selection of energy crop species thus keeps in view both the energy output in terms of the quantity and quality of fuel that can be obtained and the agronomic demands in terms of water, nutrients, equipment and labor. Controlled environment agriculture in the arid and semi-arid areas can overcome many of the ecological disadvantages but only at high captial costs. Opportunities for direct production of hydrocarbons by extensive agriculture with multi-year rotations appear most appropriate to achieve ecological improvement combined with fuel production.

WOODY PLANTS, A RENEWABLE FERMENTATION SUBSTRATE

D. W. Thayer
Dept. of Biological Sciences
Texas Tech University
Lubbock, Texas 79409

Woody plants may be used as fermentation substrate for production of solvents, methane, and protein. Proper integration of technologies should allow economic utilization of woody materials such as forestry wastes, mesquite brush, cotton ginning trash and straw as the raw material for the production of fuels, solvents, cattle feed, and edible gums. Yields of single-cell-protein were improved by treating mesquite with sulfuric acid or sodium hydroxide. Sodium hydroxide solutions of 0.0, 0.125N, 0.250N, 1.25N, and 2.50N were used to treat ground mesquite wood for varying periods of time and temperature before fermentation. Increases in alkali concentration, or length of treatment, or temperature decreased the lignin content and increased wood solubilization. Washed wood residues prepared as above were most susceptible to attack by a mixed cellulolytic bacterial culture following treatment with 2.5N NaOH for four days at 35^{o}C. The biomass yield was improved six fold.

IMPROVED UTILIZATION OF WOODY RESIDUES BY THERMOCHEMICAL MODIFICATION

Harry W. Parker, Professor
Department of Chemical Engineering
Texas Tech University
Lubbock, Texas 79409

Woody residues from semi-arid lands are difficult to utilize since they frequently have low digestibilities for ruminates, and the means to effectively utilize their fuel value for farm and ranch energy needs are not readily available. This paper reports data demonstrating the effectiveness of sulfur dioxide treatment for increasing the in vitro dry matter digestibility of whole harvested mesquite trees. Preliminary results are reported for a 50 pound per batch pilot plant processing this material.

Woody residues may also be used to fuel internal combustion engines for irrigation wells if the residues are first converted to producer gas. Results are given for operation of a nominal 100 horsepower engine on producer gas made from gin trash.

SALT TOLERANT CROPS AND SALINE WATER: RESOURCES FOR ARID LANDS

D. B. Kelley
J. D. Norlyn
and
Emanuel Epstein
Department of Land, Air and Water Resources
University of California, Davis
Davis, California 95616

Where water is available for irrigation in arid lands problems frequently arise because the water in these regions is often saline and evapotranspiration rates are high, aggravating the salinity problems.

The use of saline water for irrigation has been limited for two main reasons: (1) most crop plants cannot tolerate even moderate levels of salinity, and (2) the distribution of saline water over agricultural lands results in a build-up of salts in the soil. Sophisticated technologies of irrigation management have been developed to deal with the second-named problem, but little attention has been given to the first - specifically, to the possibility of bestowing on crop species a much higher degree of salt tolerance than the existing ones possess.

We report here on our attempts to exploit the genetic diversity existing in several crop plants (barley, wheat, and tomatoes) for salt tolerance. By using appropriate selection and breeding techniques and some knowledge of the basic biology of the species mentioned, we have identified and generated genotypes capable of providing a crop yield under an irrigation regime using water of high salt content, up to the salinity of seawater. Many years of laboratory experimentation and three years of field tests show the potential for this type of agriculture. The conditions under which these crops were produced will be described, as will the physiological responses

of the plants to saline media. The potential for crop production in arid lands, using saline water, exists; the use of these lands for this purpose depends on the appropriate implementation of irrigation techniques developed for the special conditions prevailing and the development of crop genotypes adapted to these conditions.

SAHARA FARMING - WHEAT PRODUCTION IN THE SARIR REGION

Khairi Sgaier
President of University of Al-Fateh
P.O. Box 398
Tripoli, LIBYA

Sahara farming in its modern form in Libya is an attempt to bring together the far too long unknown fossil water, poor soil and rough climate and man with his inputs and management to produce food and feed for humans and their animals.

The Sarir region is a vast barren flat sahara located in the southeast of Libya, between 24° and 30° n rth latitude and 19° and 25° longitude.

The climate is arid with mean annual temperature of 21°C, maximum and minimum temperatures 38°C and -3°C respectively. Hot and dry winds prevail in spring and summer, and there is no measurable precipitation. Soils are predominantly sandy with a small fraction of silt and clay, the pH ranges from 7.3 to 8.7, OM is less than 0.2%, and total N and available P are generally low.

Three hundred m deep wells with center pivot systems irrigate circular fields, 100 ha each. The wells are 2.5 km apart in two parallel lines in each strip and the strips are 10 km apart.

Bread wheat cultivars (Triticum aestivum L.) have been in production since 1975/76, with seeding rates of 100 kg/ha. N, P, and K are applied at the rate of 100, 120 and 60 kg/ha, respectively. Irrigation requirement ranges from 10-11,000 m^3/ha. The goal is to reach 16,000 ha of wheat by 1980 with grain yields higher than the present 2.3 tons/ha which is lower than the potential. Information has been accumulating which will be of benefit to areas under similar conditions.

FOOD PLANT RESOURCES OF THE INDIAN DESERT

David N. Sen
and
R.P. Bansal
Laboratory of Plant Ecology
Botany Department
University of Jodhpur
Jodhpur-342 001, India

Due to unpredictable rainfall conditions in the Indian desert, a number of indigenous plants are used as food resources. This is more so in the extreme western desert where plants in different stages have to be preserved for the time of scarcity. These food plant resources can be classified as follows:

1. Grains and seeds: There are a number of seeds which substitute for cereals. Nearly all species of Cenchrus, including Panicum antidotale and P. turgidum provide edible grains in times of famine. Seeds of a legume Indigofera cordifolia are ground and mixed with pearl millet flour and baked into bread.

2. Vegetables: Unripe young fruits of Capparis decidua, Cordia myxa, Cucumis callosus, Prosopis cineraria and mature seeds of Acacia senegal form popular vegetables. Unripe fruits of Cucumis callosus being sour are also mixed with other vegetables. Flowers of Calligonum polygonoides and Capparis decidua are used as vegetables. Fleshy leaves of Euphorbia caducifolia are extremely sour which are cooked as vegetable or boiled and mixed with curd for edible purposes, as are leaves of Celosia argentea, Portulaca oleracea and Suaeda fruticosa. Fruits of Acacia senegal, Capparis decidua, Cucumis callosus, Cyamopsis tetragonoloba and Prosopis cineraria are dried and preserved to be used in time of scarcity.

3. Fruits: A number of wild plants of the desert are good sources of nutrition such as Capparis decidua, Citrullus lanatus, Cordia spp., Cucumis callosus, Grewia Tenax, Physalis minima, Salvadora persica, and Zizyphus nummularia. A wild form of Citrullus lanatus provides plenty of sweet pulp and water to the

thirsty man of this desert. Pulp of Citrullus colocynthis is washed to make it free from its bitter components and cooked with pearl millet. Tubers of Cyperus bulbosus are used as stored starch.

4. Gums and oils: Gums obtained from Acacia nilotica and A. senegal, fried in fat and made into puffs, are supposed to be very nutritive. Sesamum indicum is also an oil yielding crop of the Indian desert.

INTRODUCING SOME OF THE EDIBLE PLANTS OF WEST AZERBAIJAN AREA OF IRAN

Ahmad Mozafar
and
Abbas Siami
College of Basic Sciences
University of Rezaiyeh
Iran

There are a number of unusual plants used in preparing foods by the people in the West Azerbaijan area of Iran. These plants are collected from remote and mountainous areas (elevation 1300-2000 m) by the villagers and are sold at the village or city markets. The leaves are the parts mostly used in making a traditional Iranian thick soup called "Aash" which is made with vegetables, meat and pulses or with cold yogurt. Some are also used to make pickles and others are eaten raw with meals. In the spring, when most of these plants are picked as soon as they emerge from the soil, they are very tender and tasty specially to the local people who usually do not get enough green vegetables all winter long.

Slides accompaning this presentation depict the plants, their marketing, and some popular dishes prepared from them. Some of the plants could be potentially marketable for commercial purposes once their tastes and usage are tested and introduced.

THE VERSATILITY OF THE FERAL BUFFALO GOURD, *Cucurbita foetidissima* HBK

W. P. Bemis
University of Arizona
Tucson, Arizona 85721

A wild perennial gourd, native to the arid regions of Western North America may be the key to additional food and feed crops adapted to low water use agriculture. This plant is *Cucurbita foetidissima* HBK, the Buffalo gourd. It has probably been growing in our western deserts long before the advent of man. It has developed a highly efficient method of asexual propagation by producing roots along its vines when they are in contact with moist sand or soil, principally during periods of summer rains. Large homogeneous colonies of plants are formed in this manner. While the asexual propagation is the primary method of reproduction, this plant is still a prolific producer of fruit and seed. A single plant may produce several hundred fruit, each about 7-8 cm in diameter, containing about 300 seeds weighing about 12 grams. The seed when dried contain from 25 to 40 percent oil, and 30-35 percent protein. The oil contains about 65 percent linoleic acid, a polyunsaturated fatty acid which is an essential dietary requirement of humans and animals. In addition to the oil and protein of the seed, the vine growth which dies back with the advent of frost can be used as fodder. The perennial root develops into a large fleshy storage root containing 15 to 18 percent starch. A single root several seasons old may weigh 20 to 30 kilograms.

A research program is under way to study the domestication and utilization of this plant which in its own fashion has developed crop attributes and is adapted to our hot dry environments.

TOWARDS THE INTERGRAL USE OF Yucca filifera

Vicente E. Ridaura-Sanz
and
Victoria Valdes-Castro
Centro de Investigacion en Quimica Aplicada (CIQA)
Saltillo, Coahuila, MEXICO

In the Agavacear family the Yucca genus is one of the most representative of the desert area. Of this genus Yucca filifera is one of the most abundant in the Chihuahuan Desert. Traditionally yuccas have been used in Northern Mexico as a rudimentary construction element, source of fiber and in some cases as a source of food.

Chemical analysis of Yucca filifera seeds shows that they contain:

- -20% oil, similar to that of Soya;
- -8% Sarasasapogenin (isolated in the form of a Saponin).

Since 1974 CIQA has been studying possible industrialization processes of these two components. Regarding the oil, epoxidized oil derivatives have been obtained which were evaluated as PVC plasticizers. Results obtained showed behavior similar to commercially available products. Another alternative which is presently being studied is the preparation of vulcanized oils as rubber processing aids.

The Saponin extracted from the seeds can be used as a raw material in the production of steriods. The hydrolysis of the Saponin, the degradation of Sarsasapogenin to the corresponding Pregnanolone and the utilication of this product as a starting material for progestagens have all been studied.

PHOTOSYNTHETIC STRATEGIES OF DESERT PLANTS

Bruce N. Smith
Cynthia B. Johnson
Glen E. Martin, II
and
Thomas W. Boutton
Department of Botany and Range Science
Brigham Young University
Provo, Utah 84602

Several photosynthetic strategies have evolved in response to geologically recent desert environments. Some C_3 plants have special affinity for those small segments of time or space where a mesic environment persists (e.g. hanging gardens or growth during cool, moist seasons). Other plants, mostly C_4, are adapted to rapid, highly efficient carbon fixation during hot, dry conditions. CAM plants conserve water - even at the expense of rapid growth. However some plants are facultative CAM: they use this mode only under stress, thus preserving some capacity for rapid (C_3) growth. The challenges of newly formed deserts have been met by the evolution of C_4 and CAM photosynthesis which allow plant growth to occur during the most extreme conditions and during seasons when C_3 photosynthesis is less effective. Carbon isotopic evidence along with morphological and distributional evidence will be presented for a trend from C_3 to C_4 to facultative CAM to obligate CAM as desert conditions became progressively more hot and dry.

THE USE OF THE COMPARTMENTED RESERVOIR IN WATER HARVESTING AGRISYSTEMS

C. Brent Cluff
Water Resources Research Center
University of Arizona
Tucson, Arizona 85721

Research at the University of Arizona indicates that surface storage is essential for water harvesting agrisystems to maintain high productivity in dry years. Evaporation losses in the past have prevented economic storage of water in small reservoirs. The paper discusses the use of the compartmented reservoir as a means of reducing evaporation loss.

Shallow impervious reservoirs can be compartmentalized making it possible to concentrate water by pumping it from one compartment to another. This concentration reduces the surface-area-to-water-volume ratio to a minimum thus decreasing evaporation losses by reducing both the temperature and exposure of the water to the atmosphere.

Saving up to 80 percent on some systems have been estimated. Low-head high-capacity pumps are commercially available that keep the cost of evaporation control to much less than other methods such as floating covers. The use of this economic method of evaporation control makes surface storage of water in small reservoirs economically viable to use on most agricultural crops in water harvesting agrisystems.

The paper will further discuss the development of a compartmented reservoir optimization computer program that has been used in designing several water harvesting agrisystems in Mexico and the United States.

DROUGHT TOLERANCE AND PROTOPLASMIC QUALITIES IN MESOPHYTIC HIGHER PLANTS

OkYoung Lee-Stadelmann
and
Eduard J. Stadelmann
Dept. of Horticultural Science and Landscape Architecture
University of Minnesota
305 Alderman Hall
1970 Folwell Ave.
St. Paul, Minnesota 55108

Drought tolerance, i.e. the ability of the living protoplasm to withstand the adverse conditions of water deficit, can develop to various degrees in higher plants also. Analysis of the effect of water stress on the subepidermal cells of the stem basis of Pisum sativum under different stress conditions gave some clue for the development of drought tolerance.

Stopping watering from the seedling stage and a gradual decrease of the soil water potential are conditions required for the development of drought tolerance. Xeromorphic characteristics in the younger parts of the plant may develop simultaneously.

Sugars may associate with cytomembranes or may be incorporated into the ground plasm. There sugar molecules could associate with membrane phospholipids and with proteins and replace the water removed by dehydration. Furthermore, sugars transported and accumulated in the vacuole make the osmotic potential of the cell sap more negative and counteract the water withdrawal by drought. The cytokinin level in the stress-adapted cells may be increased by higher metabolic activity at the beginning of the stress regime and later by low transport rates. Thus, cell aging will be delayed and the proteins may remain in a configuration suitable for the association with sugars, which protect against drought damage.

THE EFFECTS OF WATER STRESS ON PHENOLOGY AND CARBOHYDRATE STORAGE IN THE SHORTGRASS PRAIRIE

Jerry R. Cox
Sul Ross State University
and
Herb Fisser
University of Wyoming

A study was conducted to determine the effects of plant water stress on plant phenology and total nonstructural carbohydrates (TNC) in the roots of western wheatgrass (Agropyron smithii) and blue grama (Bouteloua gracilis). Individuals of each species were marked biweekly throughout the growing season on clayey, loamy, and sandy soils and sampled with a hydraulic press to determine plant water stress. Roots of the same plants were collected to determine TNC levels. There was no significant difference in the storage of TNC in either species as related to soil type. The initiation of vegetative growth was earlier on sandy soils for blue grama. Reproductive development for both species was more rapid on loamy soils and was correlated with an increase in water stress. Seed shattering and a reduction in photosynthetic area in the third week of August was associated with a water stress measurement of 40 bars in western wheatgrass. During the same period water stress measurements of 65 bars were related to an increase in photosynthetic area and the initiation of seed stalks in blue grama. Water stress measurements were 15 to 20 percent less on clayey and sandy soils.

SEASONAL CHANGES IN NUTRITIONAL QUALITY OF Agropyron desertorum COMPARED WITH SIX OTHER SEMI-ARID GRASSES

Robert B. Murray
Range Scientist, U.S.D.A.
U.S. Sheep Experiment Station
Dubois, Idaho 83423
H.F. Mayland
Research Leader
Snake River Conservation Research Center, SEA-FR, USDA
Kimberly, Idaho
P.J. Van Soest
Animal Science Department
Cornell University
Ithaca, New York

Mineral and disgetibility components of Agropyron desertorum, an introduced perennial widely used in semi-arid pastures in the western U.S. and Canada, are compared with those of an introduced annual and five native perennials. The seven grass species were harvested to a 2-cm stubble height throughout the spring-fall grazing season over an 8 year period.

Exponentially decreasing trends were found for N. K, P, S, Zn and Cu concentrations and N:S and K/(a + Mg) ratios, while DCW and TDDm decreased linearly as forage matured. The Ca:P ratios increased exponentially. Calcium, MG, Na, Mn, and Fe lacked or exhibited weak trends in relation to forage maturity. Depletion of soil moisture reserves results in maturation and accompanying decreases in forage quality. By the end of June N, K, P, S, and Zn were below levels considered adequate for good nutrition in cattle. Except for Bromus tectorum and Agropyron desertorum, Ca:P rations exceeded the recommended 7:1 level by late October. Supplementing crude protein, K, P, Zn, and energy has in some cases enhanced animal performance late in the season. Adding Mg to diets in early spring may reduce the incidence of grass tetany on Agropyron desertorum pastures.

EFFECT OF NPK FERTILIZERS ON THE NUTRIENT INFLUX INTO PLANTS

S. E-D. A. Faizy
Dept. of Soil Science
Faculty of Agriculture
University of Tanta
Kafr El Sheikh, EGYPT

Tomato plants (Lycopersicum esculentum) were grown in pots containing alkali-saline soils from the northern part of the Nile Delta. Different grades of NPK fertilizers were prepared by mixing ammonium nitrate, superphosphate, and potassium sulphate. The influx of N, H_2PO_4 and K as well as its effect on that of Na, Ca, and Mg ($me/cm^2/day$) were discussed. High levels of N were found to inhibit growth and increase infection by stem-rot disease. This was asscciated with an increase in the rate of transpiration by cut off leaves. These effects were largely reduced when the percent of potassium in the fertilizer was increased.

WESTERN OKLAHOMA SANDHILL PRAIRIE YIELD AND CRUDE PROTEIN RESPONSE TO ATRAZINE, NITROGEN, AND 2,4-D DURING DROUGHT

Roger L. Baker
and
Jeff Powell
Dept. of Agronomy
Oklahoma State University
Stillwater, Oklahoma 74074

Drought conditions during the growing season in 1975 and 1976 followed applications of atrazine, nitrogen fertilizer (N), and 2,4-D on western Oklahoma sandhill prairie vegetation. Total herbage production on untreated areas was less in the drier 1976 season than in 1975, but production on treated areas was as great in 1976 as in 1975. Total grass production on areas retreated with herbicides in 1976 was greater than that on the same areas treated the first time in 1975. Total grass production was greatest on areas treated with N plus atrazine, and 56% and 37% greater on these areas than on N-treated and atrazine-treated areas, respectively. All herbicide treatments reduced forb production. Atrazine caused a greater reduction in forbs than did 2,4-D. All herbicides and fertilizer treatments increased Andropogon hallii production with the greatest increase on areas treated with N plus atrazine increased Sporobolus cryptandrus production with the higher rate causing a greater increase. Nitrogen fertilization increased production of Bouteloua gracilis and Panicum virgatum. Atrazine and N applications increased protein content in selected species, but the effects of atrazine and N on protein content were not additive as they were on biomass production. Atrazine, applied alone or in combination with N, appears to have a potential for use on arid rangelands by decreasing undesirable forb competition, increasing protein content, and possibly increasing soil water use efficiency by grasses.

YIELD POTENTIAL OF HALOPHYTES AND XEROPHYTES

James W. O'Leary
Department of Cell and Developmental Biology
University of Arizona
Tucson, Arizona 85721

The means of increasing crop productivity in a stress environment heretofore have been based largely on attempts to increase stress resistance in present crops. An alternative approach is to increase productivity of already stress-resistant plants. This involves selecting stress-resistant plants which have characteristics that make them potentially useful as crop plants and improvement of those characteristics, such as increasing seed size and number or increasing palatibility, through breeding.

A fundamental question in such an approach is whether high degree of stress resistance and high yield are compatible in the same plant. It is a common observation that in general the more arid or more saline the environment, the slower the growth rate and the smaller the ultimate size of plants native to those environments. This could be due to (1) less total energy "fixed" and available for all processes in the plant, or (2) more of the total energy pool available is diverted to coping with the stress thereby reducing the amount available for growth processes contributing to "yield." Utilizing existing data in the literature on resource allocation in plants, a critical analysis of these points suggests that it may be unrealistic to expect high agricultural yields from halophytes and xerophytes.

ECOLOGICAL STUDIES ON THE MICROFLORA OF SALINE EGYPTIAN SOILS

Sami El-Abyad
Faculty of Science
Department of Botany
University of Cairo
Giza, Egypt

This work is a prelude to an extensive investigation that will be made on the microflora of Egyptian saline soils.

Thirty-six soil samples collected from saline areas in Egypt were analyzed chemically and microbiologically. Generally the soils were dry, except for the peaty soils. The total water-soluble salts were normally high in the majority of samples reaching 85.5 per cent in one sample. Chlorides followed the same trend. The sulphates and total carbonates were relatively high, the sulphates ranging from 0.329 to 4.025 per cent and the total carbonates from 4.5 to 47.7 per cent. All the soil samples were alkaline.

The results indicate that the increase in salinity is associated with a decrease in the total counts of fungi and bacteria. Sixty-five fungal species were isolated from the soil samples of which Aspergillus flavus and Aspergillus niger were abundant; A. ochraceous, A.terreus, Fusarium sp. I and Spicaria silvatica were of low occurrence. The rest of the species isolated (56) were of rare occurrence. However, it was found that the frequency of occurrence of these fungi did not coincide with their intensity in soils as some of the rare species contributed higher counts than the abundant ones.

EFFECT OF USING SEWAGE EFFLUENT ON CALCAREOUS SOILS

B. D. McCaslin
and
V. Lee-Rodriquez
Department of Agronomy
New Mexico State University
Las Cruces, New Mexico 88003

Under a research contract with the United States Department of Energy, Albuquerque Operations Office, and in cooperation with Sandia Laboratories (Albuquerque, N.M.), the potential use of gamma radiation treated sewage solids as a fertilizer material is being examined. Previously published greenhouse data indicated little or no effect of the gamma radiation pathogen reduction treatment on the plant availability of nutrients, allowing direct comparison of gamma radiated and non-irradiated materials, and demonstrated considerable benefits from usage of sewage materials on calcareous soil. Soils in New Mexico have developed under semi-arid conditions and typically they range in pH from 7.3 to 9.0, which limits the plant availability of many heavy metals. Studies of soil samples and plant tissues collected from adjacent fields near Clovis, New Mexico, having 40 year and no history of sewage effluent irrigation indicated beneficial increases in plant available micronutrients. Longterm buildup of plant available heavy metals or other toxins was not apparent from the effluent usage both in the soil and plants. Usage of sewage solids and/or effluent waters on calcareous soils could increase agricultural acreages in arid lands with little risk, especially when plant products not entering directly into the human food chain are produced.

APPLICATION OF REMOTE SENSING TO DETECTION OF DESERTIFICATION PROCESSES

B. K. Worcester
and
K. J. Dalsted
Remote Sensing Institute
South Dakota State University
Brookings, South Dakota 57007

Desertification or desert encroachment, reduced to its simplest terms, is a reduction in the potential productivity of arid and semi-arid lands. More specifically, it is the lateral extension of areas characterized by sparse vegetation and low biological activity.

Remote sensing, particularly Landsat imagery, offers techniques which have been shown to be both time and cost effective. The primary advantages of Landsat are the multi-spectral and multitemporal synoptic coverage. The near-orthographic imagery is useful for resource inventories and for monitoring time related changes such as land degradation, shifting vegetation patterns and extent of flooding. The broad areal coverage offers an opportunity to place the entire environment in perspective.

Landsat 1 - 1972-
downlooking 1978

Landsat III in operation

REMOTE SENSING FOR INTERPRETATION OF SOIL-PLANT INTERACTIONS AS INDICATORS OF DESERTIFICATION IN WESTERN AFRICA

K. J. Dalsted
and
B. K. Worcester
Remote Sensing Institute
South Dakota State University
Brookings, South Dakota 57007

The decimation of productive and marginally productive lands by the advance of desert environments is of world-wide concern. Recently, population and climatological pressures have increased the stress in these already fragile, transition areas. We evaluated temporal Landsat satellite imagery in one such area, parts of Senegal, Mauritania, and Mali, to determine the usefulness of Landsat in assessing indicators of desertification. Although no field confirmations were made, U.S. AID personnel assisted with and authenticated many of the interpretations. Three mosaics of the study area (1972-dry, 1976-normal, and 1977-dry) were prepared at 1:1,000,000 scale; selected areas were enlarged further, 1:500,000 and 1:250,000 scales. Land use, drainage, soils, and transportation interpretive overlays (existing information was used as an aid in these interpretations) were made. Comparison among Landsat scenes provided many indications of soil and vegetation and land use alterations. These indicators of desertification were classified as short, medium, and long term. The three classifications were then correlated to general soil information thus indicating, in this region, where the expression of desertification is most likely to occur and its stability. Examples of the comparative temporal indicators that we found are: 1) extent of flooding and farming in the Senegal River Valley; 2) amount and extent of interdune vegetation in dry and average precipitation years; 3) size and location of burn patterns; 4) salinization of aridic soils; and 5) dune encroachment.

HALOPHYTES FROM COASTAL MARSHES: AN UNEXPLOITED SOURCE OF CROP PLANTS FOR ARID LANDS

G. Fred Somers
School of Life and Health Sciences
University of Delaware
Newark, Delaware 19711

Based upon the premise that saline water sources and habitats are in some measure characteristic of semi-arid and arid land, a search being made for halophytes might yield plants useful as crops plants for such areas. Some plants from coastal marshes have been used to a limited extent as forage; some have been eaten as food. These plants vary greatly in salt tolerance; some are highly salt-tolerant. There is considerable variability in the growth characteristics of these plants and this appears to be in a large measure genetically determined. Hence, improvement by selection and breeding should be feasible. Searches have been conducted in the coastal marshes of the eastern U.S.A., in marshes of the Gulf of California, and elsewhere. These materials are now being grown for testing, but much remains to be done.

PROTEIN, OXALATE, AND CHLORIDE LEVELS OF *Atriplex canescens* IN RELATION TO FORAGE POTENTIAL

J.R. Goodin
Department of Biological Sciences
Texas Tech University
Lubbock, Texas 79409

The forage potential of various species of *Atriplex* as emergency feed and browse for wildlife has long been recognized throughout those regions of the world subjected to drought and salinity. As a halophyte, *Atriplex* exhibits exceptional tolerance to high levels of salinity and is able to survive long periods of drought if protected from overgrazing. The protein level of various forage species of *Atriplex* has been documented at or near that for alfalfa, although there has been some concern about the accumulation of oxalates and possible mammalian toxicity. The studies reported here were conducted in Texas and indicate that *Atriplex canescens*, the Fourwing Saltbush, is an excellent producer of high-quality forage, high in protein and low in oxalates. Our ecotypic selection from various edaphic sites leads us to believe that the gene pool is great in this undomesticated species, and that there are many opportunities for selection.

Atriplex canescens AS A POTENTIAL FORAGE CROP INTRODUCTION INTO THE MIDDLE EAST

David K. Northington
J. R. Goodin
and
James K. Wangberg
Texas Tech University
Lubbock, Texas 79409

Atriplex canescens (Chenopodiaceae) is a shrub native to the arid and semi-arid portions of western North America. Because of its high protein levels, annual biomass productivity, palatability, salt and drought tolerance, browse resistance, and low oxalate levels, it is potentially an excellent forage crop. Seed germination is poor, and therefore commercial production is hampered. In Egypt, hand labor, space, and various sources of either fresh or brackish water are abundant. Combined with the need to free some of the land now in cultivation with clover and other forage plants, *Atriplex* is being introduced in controlled transplant gardens to study its adaptability, yield, and seed set. Potential insect pests, soil microbiology, and competitor weeds are also being examined. Several different ecotypes in North America are being used as the seed sources.

RUSSIAN-THISTLE, A POTENTIAL FORAGE FOR ARID LANDS

James L. Fowler
Department of Agromony
Box 3Q
Las Cruces, New Mexico 88003

The greatest limitation to increased agricultural production in the arid Southwestern United States is the limited availability of water for agricultural purposes. Agricultural production in areas of limited water resources can be increased, however, by improving water use efficiency. Some plant species are much more efficient producers of dry matter than others. Many of these same species also have a high water use efficiency. Russian-thistle (Salsola sp.) is one of these species. Over the past three years, we have preliminarily evaluated the yield, water use efficiency, and some of the nutritive quality characteristics of Russian-thistle as a forage under a limited number of cultural conditions. The results are promising with dry matter production of 10,000 kg/ha on as little as 24 cm of water applied (irrigation plus rainfall) and nutritive quality comparable to many cultivated forages. These data suggest a potential role for Russian-thistle as a forage crop for arid and semi-arid regions of the world. Sporadic published reports of the nutritional qualities and digestibility of Russian-thistle forage and its use as an emergency feed during periods of drought support this supposition.

KOCHIA: ITS POTENTIAL FOR FORAGE

Ralph M. Durham
and
John W. Durham
Durham Farms
Smyer, Texas

Kochia scoparia is an annual plant whose recognized use is ornamental. Considered a weed by farmers, Kochia grows profusely and is very drought tolerant. Although rainfall at Durham Farms was less than 175 mm during the past twelve months, large numbers of cattle are still grazing on a small acreage. One hundred and thirty cattle grazing 4.86 hectares for twenty-nine days, gained 265 kg per hectare. Native grass has made no growth. Past research showed Kochia high in protein, lower in fiber than alfalfa, high in seed production, drought tolerant, winter germinating, and having stand establishment and seed maturation problems. Our solution to the problems is stirring the soil in December and grazing heavily until late August. Grazing is an excellent harvesting technique. Virtually all forage from annuals can be consumed, leaving only enough seed to grow the next year. Kochia exhibits excellent regrowth, lending itself to strip grazing. One hundred and thirty cattle were grazed on successive four acre strips for two day periods during the severe drouth. Regrowth during the drouth occurred in fourteen to twenty days. Many leaf and seed shoots regrow after a single stem is cut off by grazing. Since germination is early, grazing begins in April and continues until December. Kochia contains saponin and oxalates; however, no losses have occurred in four years of grazing experience.

FEASIBILITY OF IMPROVING BIG SAGEBRUSH

Bruce L. Welch
and
E. Durant McArthur
Intermountain Forest and Range Experiment Station
Ogden, Utah 84401

We believe that big sagebrush, an aggressive, productive, and persistent range plant, can be improved through selecting and breeding schemes aimed at increasing its palatability and forage quality. This optimistic point of view is based on our studies which reveal that populations of big sagebrush grown under uniform conditions varied greatly in key characteristics. We discovered that some populations are higher in crude protein than others; some are lower in monoterpenoids than others; some grow faster than others; and some are more palatable to wintering mule deer than others. Other characteristics of concern to our improvement program such as disease, insect, and drought resistance; seedling vigor; and fire tolerance are discussed. The variability of these characteristics clearly demonstrates the rich germplasm of big sagebrush. Sagebrush improvement is likely possible through the techniques developed by agronomic crop and tree breeders. Recurrent mass selection of natural populations with some preexisting favorable characteristics can probably be augmented through hybridization with other populations. Our initial hybridization studies indicate some hybridization control is possible. We are developing means to confirm hybrid seedlings. Our efforts, if successful, can greatly improve the value of a widespread and underused plant resource.

ECONOMIC POTENTIALITIES OF Juncus PLANTS

M. A. Zahran
Institute of Meteorology and
Arid Lands Studies
King Abdulaziz University
Jeddah, SAUDIA ARABIA
Amal A. Abdel Wahid
and
M. A. El-Demerdash
Botany Department
Faculty of Science
Mansoura University
Mansoura, EGYPT

The successive world demands for food, forage and raw materials for fiber and drug industries, create serious problems especially in the developing countries of the arid and semi-arid regions. Most of these countries possess vast areas of saline soils which seem non-productive. Reclamation and improvement of those areas might turn them into productive ones.

The cultivation of Juncus rigidus and J. acutus on the saline soils of Egypt was encouraging. The salt content of the experimental soil was progressively decreasing. The successive vertical extension (green coverage) of Juncus new generation (especially that of J. rigidus) was so great that the land is expected to be covered (100%) with vegetative growth of Juncus within a few years. The green culms of Juncus can be used as raw material in paper making (grade index of Juncus pulp - 75%). High nitrogen fertilizer favored high green yield of Juncus culms while high phosphorous fertilizer favored a high percentage of the longest fiber (> 1000 micrometers) and the highest amounts of α -cellulose and pentosans in the culms.

Seeds of Juncus are rich in non-volatile organic acids (oxalic, succinic, citric, tartaric, and malic), free and combined sugars (sucrose, glucose, fructose, galactose, xylose,

and arabinose), and amino-acids (histidine, arginine, serine, glycine, aspartic, glutamic, threonine, proline, valine, lysine, phenylalanine, isoleucine and leucine). Fatty acids, glycerides and phospholipids were also extracted from Juncus seeds.

Consequently, Juncus plants have both agricultural and industrial economic potentialities. Their cultivation desalinates the soil biologically, the culms could be used in the paper industry, and various compounds can be extracted from seeds.

Thymelaea hirsuta, A NEW RAW MATERIAL FOR PAPER MANUFACTURE

Aly A. El-Ghonemy
Department of Botany
Faculty of Science
University of Tanta
Hussein K. El-Din
Department of Chemistry
Faculty of Science
and
Hafez Abd El-Razzak
National Paper Company
Egypt

This paper reports data aimed at providing a scientific basis for using Thymelaea hirsuta as a source of raw material for the manufacture of paper. It includes the results from further investigations on its autecology and chemical and technological properties of its fibers.

Thymelaea hirsuta is one of the most common species in the Mediterranean region. In Egypt, it covers vast areas along the Mediterranean costal belt with inland extension for about 85 km. Autecological studies have revealed that seed production and the seed reserve in the soil are quite high, but the rates of germination and establishment of seedlings are rather low, and varies according to environmental conditions. Propagation by stem cuttings is rather difficult to achieve, but is much easier by seeds, particularly if pretreated to break the seed coat dormancy and to initiate growth of embryo.

The following results of chemical and technological experiments carried out on the two types of Thymelaea hirsuta fibers are presented: phloem and xylem fibers show that they contain low percentages of ash and lignin and a high percentage of cellulose; the high grade index of the phloem pulp (112.8%), compared with that of the imported soft wood Long-fibered Kraft pulp (100%) suggests the possibility of its use in manufacturing special kinds of paper, particularly those needed by the cigarette industry.

GEOGRAPHY AND ECOLOGY OF THE ARID LANDS OF ECUADOR

Misael Acosta-Solis
Ecuadorian Institute of Natural Sciences
Apartado 408
Quito, Ecuador

This paper highlights the location, distribution and the ecology of the dry lands of Ecuador, which are spread over an area of about 35,000 square Kms.

Although world maps of arid lands do not include those of Ecuador, the southern Ecudorian coast, the Inter-Andean region, the Santa Elena peninsula and the country's south-western borders with Peru could well be characterized as arid or semi-arid.

The Inter-Andean Region covers several areas including Chota-Salinas, Jerusalem, Calderon, Pansaleo, Picaigua, Salasaca, Ona, Santa Isabel, Jubones, Catamayo, Malacatos, Oton, Guayllabamba, Tanlagua, and San Antonio de Pichincha.

Water is the only critical factor affecting agricultural production in the Santa Elena area, which experiences the Humboldt cold currents of the Antartic. The Toachi and Duale rivers, located at higher elevations, could provide the water for that area by way of canals. Historically, the area was rich in agricultural production. The same waters also have potential to be used in the Inter-Andean valleys.

The Calderon and adjacent equinoctial areas could be fed with water from the Mindo river, carried through San Antonio of Pichincha over a distance of about 35 Kms.

EFFECTS OF SOIL SALINITY AND DESERTIFICATION ON THE PRODUCTIVITY OF ARID AND SEMI-ARID REGIONS

Mohamed El-Karouri
Agricultural Research Council
P.O. Box 6096
Khartoum, SUDAN

Soil salinity and desertification are essential elements of arid and semi-arid zones. Sudan ecological conditions vary from the desert regions of the north to the arid and semi-arid savannahs of the central and western Sudan, to the tropical rain forests of the south.

Salinity problems are encountered mainly in northern and central Sudan in irrigated and potentially irrigable areas. More than 250,000 hectares along the banks of the Nile are affected to some degree by salinity and sodicity. Agricultural development in this region will depend entirely on the utilization of such lands since nearly all of the good land in the area is under cropping. Sizeable areas of salt affected soils are also found south of Khartoum between the Blue and White Niles. In the gezira scheme, "the largest irrigated scheme in the world", salinity and sodicity are among the major non-biological and non-human factors that control cotton yield.

Desertification which is a process of land degradation essentially initiated and sustained by land mis-use is causing soil deterioration and loss of land in many arid and semi-arid regions. In Sudan desertification is a serious problem threatening most of the Nile irrigated agriculture (about 2.3 million ha.), 3 million hectares of mechanized crop farming, 75% of the world's gum arabic production and pastures supporting about 10 million animal units, as well as various areas of woodland. At present the desert is advancing at the rate of 5-6 kms per year.

ECOLOGY, USE PATTERNS AND SUGGESTED MANAGEMENT CHANGES ON RANGELANDS IN SUDAN

A. O. El-Mekki
Range Management Officer
Sudan Range and Pasture Administration
Ministry of Agriculture
Khartoum, SUDAN

The grazing resources constitute half of the total area of the Sudan. There are many divergent environments resulting from the interaction of soil, climate, topography and water resources. The rainfall and the type of soils are major factors defining the ecological zones. Communal grazing and nomadism prevail over most of the Sudan. The unpredictable and erratic state of the nomadic system of management is governed by seasonal environmental sequences such as range condition and water availability. A basic feature of nomadism is the use of natural untamed resources without contribution to their improvement or conservation. The current deterioration of vegetation and soils is mainly a reflection of overgrazing and misuse. Seasonal migration brings the nomads into contact with stable population segments intensifying competition not only for grazing lands but for water points as well. Water is the key factor for proper range management and conservation. The criteria adopted for water allocation at present is based on human and animal requirements, regardless of the grazing capacity resources or the nomadic pattern of seasonal movements or concentration. Settlements of nomads, conservation management and adequate water supply are the essential factors for improvement of rangelands in the Sudan.

The present work will discuss the feasibility of incorporating the use of Sarsasapogenin as a starting material in the industrial production of steroidal hormones.

GRAZING MANAGEMENT OF PLANT RESOURCES IN EASTERN SENEGAL AS INFLUENCED BY WATER DEVELOPMENT

Pete W. Jacoby, Jr., Associate Professor
Texas Agricultural Experiment Station
P.O. Box 1658
Vernon, Texas 76384

This paper discusses the impacts of water development on the grazable plant resources in the Sahel region of western Africa. The region of study, conducted in 1975, lies southwest of Bakel, Senegal near the point where Senegal, Mauritania and Mali share a common border. Vegetation comprising the forage resource consists mainly of annual grasses which flourish during the summer rainy period and, upon curing, sustain grazing animals for the balance of the year. Development of dependable water supplies in the form of hand-dug wells has resulted in permanent settlement and village development, whereas seasonal water supplies support temporary grazing use during and following the rainy season. Data collected in the study region show a direct correlation between abundance of permanent water and livestock numbers. Tribesmen living in the study area generally consider water as the primary limiting factor of animal numbers rather than available forage for livestock. Results conclude that indiscriminate development of permanent water supplies are a prime reason for concentrations of livestock numbers in excess of available plant resources which inevitably lead to range deterioration, soil erosion and desertification. It is suggested that permanent water supplies be used to limit annual base herds and that well-designed temporary water developments utilizing surface water runoff be used to better distribute grazing and balance forage with proper livestock numbers.

RANGELAND DEVELOPMENT AND IMPROVEMENT IN LIBYA, AFRICA

O. M. Shawesh
Department of Forestry & Range Management & Natural Resources
Ministry of Agriculture
Tripoli, Libya, AFRICA
and
H. G. Fisser
Plant Science Division
University of Wyoming
Laramie, Wyoming 82071

The Libyan desert represents one of the most arid parts of the world in which several years may pass without any incidence of rainfall. The northern part of this desert along the Mediterranean Coast is less arid due to its relatively high rainfall. In the southern part the amount of rainfall is very low. For example, in Kufra the total amount of rainfall was 0.2 mm in 12 years.

The present plant communities in the Libyan desert are very far from the climax. Man has been the main debilitating agent through overgrazing and clearing for occasional dry farming.

Wind erosion which should be controlled by plant cover has already removed soils from large areas. In these areas where calcareous flagstone is outcropping, no more plant resettlement is possible without a new accumulation of soil. In sandy areas wind is an obstacle to plant establishment and maintenance of even unpalatable species, which can be advisable as a measure to facilitate the multiplication of forage plant species under shrub protection. The planting of wind breaks could be expected to make plant multiplication easier and to improve microclimate at least in the long term.

The observation of areas which have been completely protected for four to five years has shown that vegetation

reestablishment is very slow but is at least occurring. The establishment of plantings with drought tolerant species in the protected areas, to hasten the rehabilitation process, shows much promise.

RANGE RESOURCE DEVELOPMENT IN KUWAIT: THE STATE OF KNOWLEDGE

Faisal R. Taha
Kuwait Institute for Scientific Research
P.O. Box 12009
State of Kuwait

The state of Kuwait is situated in the northeastern part of the Arabian Peninsula, between latitudes 28° 30' and 30° 05' N, and longitudes 46° 30' E. It covers an estimated area of 17,818 km^2 out of which 16,280 km^2 are designated as rangelands.

Management of rangelands in Kuwait has received attention in the past mainly from the Department of Agriculture, Ministry of Public Works. Recently, the Kuwait Institute for Scientific Research has joined in research activities related to rangelands. Results of reported work can be summarized into:

1. Delineation of the five major plant communities in Kuwait. These, in order of importance, are:
   A. Rhanterium epapposum
   B. Cyperus conglomeratus
   C. Panicum turgidum
   D. Haloxylon salicornicum
   E. Zygophyllum coccineum
2. Preparation of a list of plant species found in Kuwait as well as establishment of a small herbarium.
3. Identification of sixty species that are grazed primarily by sheep, camels, goats and cattle.
4. Identification of some plants of medicinal value.
5. Conduct of some field trials of irrigated fodder.

This information has provided an excellent background for range management investigations. More detailed and ecologically oriented research for management of Kuwait's rangeland resources is now underway.

RANGE REHABILITATION PROBLEMS OF IRAN

Nasser Nemati
Deputy Director General
Bureau of Soil Conservation and Watershed Management
Iran

Establishment of vegetation on depleted and eroded lands in the Steppic Zone of Iran is a difficult problem. This analysis of the range problems of Iran is intended to serve as a guideline for revegetation of the Steppic Zone. The Steppic Zone, which covers about 2/5 of Iran, is an area of 100-200mm rainfall annually where the temperature is highly variable and dependent on altitude and latitude. The area has been severely overgrazed and depleted since the dawn of history. The number of livestock grazed now exceeds the forage producing capacity of rangeland at least 5 times and damage to watersheds is severe. Because of low precipitation and dry, hot summers(and at higher elevations extremely cold winters) and commonly saline alkaline soils with low amounts of or lack of organic matter, natural revegetation is extremely slow and reseeding of grasses and legumes has not shown success.

RANGELAND MANAGEMENT FOR INCREASED PRIMARY AND SECONDARY PRODUCTIVITY IN THE INDIAN ARID ZONE

R.S. Paroda
and
H.S. Mann
Central Arid Zone Research Institute
Jodhpur 342 003, India

Rangeland management research at twelve areas in Western Rajasthan, representing arid and semi-arid conditions, has revealed considerable potential for improvement in both primary and secondary productivity on a long term basis. Data for more than 10-15 years have shown that productivity of forage could be increased from 300-400 kg/ha to 1500-3000 kg/ha in 2-3 years through adoption of proper rangeland management techniques like protection by fencing, soil conservation measures, reseeding of improved strains and suitable agronomic practices. Discussion is also based on variation in productivity as influenced by grass cover, soil and climatic factors, and management practices. Animal grazing studies on these rangelands, on a yearlong basis, have further indicated that a stocking rate of 2-4 ha/heifer in arid areas was almost comparable to that of 1-3 ha/heifer in seim-arid areas having high forage productivity. Body weight gain of 230-270 gm/day/heifer was achieved in both arid and semi-arid rangelands which was 2-4 times higher than the local animals used as controls comparing different systems of grazing, continuous controlled grazing appeared to be economical as well as equally effective as deferred rotational grazing. Results are discussed from the point of view of the future scope for rangeland management in the Indian arid zone, keeping in mind the phenomenon of rational utilization of available reangeland resources for sustained as well as increased primary and secondary productivity.

REGENERATION STRATEGIES OF MIXED PRAIRIE PLANTS

Lee E. Eddleman
Professor of Range Management
School of Forestry
University of Montana
Missoula, Montana 59812

The demand for understanding the basic biology of indigenous plant species in southeastern Montana has been spurred by the rapid expansion of coal stripmining throughout the Fort Union Basin. The necessity of restoring these disturbed lands back to some semblance of their former selves is recognized by conservationists as well as state and federal government. Research is being carried out to determine factors necessary for initial establishment and follow-up regeneration of many indigenous species.

Surface disturbed land frequently presents more arid conditions than the typical semi-arid mixed-prairie environment so that successful regeneration is dependent on the strategy employed by the species in its life cycle. Regeneration was broken down into four phases: 1) reproductive, 2) seed, 3) seedling, and 4) juvenile. The strengths and weaknesses of each phase were examined. General strategies are best characterized by weak points in the regeneration cycle and by factors which compensate for them. Sitanion hystrix could suffer high seedling mortality by germination soon after seed dispersal, however the highly vigorous seed and drought resistance help compensate. The establishment and seedling vigor of Artemisia tridentata wyomingensis is poor but is compensated for by high seed production and germination.

ORNAMENTAL POTENTIAL OF THE CREOSOTEBUSH

J. L. Tipton
Texas A&M University Research Center at El Paso
1380 A&M Circle
El Paso, Texas 79927
and
E. L. McWilliams
Texas A&M University
College Station, Texas 77843

The creosotebush (Larrea tridentata or L. divaricata), has been widely recommended as an ornamental for landscaping highways and urban areas. Increased use as such would result in a decrease in water demand for irrigation, a concern in the increasingly urban southern deserts of North America. Difficulties in transplanting and propagating Larrea has inhibited its use as an ornamental. The effect of season, prior root pruning, and desiccation reduction techniques on the per cent survival and rank of Larrea transplanted from a native stand was studied. Neither prior root pruning nor the desiccation reduction techniques had significant effects on survival, but mortality was significantly higher for shrubs transplanted during the winter. Significant interaction effects on the shrub rank six months after transplanting occurred. Analysis of the interaction effects indicate that there was no advantage over the most economical method of not prior root pruned -- foliage pruned and a slight advantage in the spring and fall over winter with summer intermediate. Various vegetative propagation techniques were evaluated. Larrea could not be propagated by mature stem tip cuttings under mist, by hardwood stem cuttings, or by root cuttings. Preliminary results appear promising for induced juvenile stem tip cuttings rooted under mist and layering techniques.

ESTABLISHMENT OF USEFUL SHRUBS IN A 100 MM WINTER RAINFALL AREA

Y. Orev
Ministry of Agriculture
Beer-Sheva, Israel

Field trials repeated over several years have shown the feasibility of establishment of browse shurbs of the Atriplex spp. (saltbushes) on bare soil in an area of somewhat less than 100 mm winter rainfall.

The method of establishment is simple and inexpensive and based on the utilization of runoff to ensure first year survival. Thereafter the shrubs can utilize also sources of atmospheric moisture other than rainfall.

Preliminary clipping trials point to an initial carrying capacity, after improvement, of 5 ha/sheep.

Observation in drier areas gives promise that it would be possible to extend the shrub establishment to areas of 40-50 mm rainfall and start an upward, environment improving, trend.

STATUS OF PLANT RESOURCE USE AND DEVELOPMENT: NORTH AMERICA

C. M. McKell, Director
Institute for Land Rehabilitation
Utah State University
Logan, Utah 84321

Arid lands have given man numerous species of plants for his use. Notable among these uses are shrubs for fuel and livestock fodder, sisal for fiber, juniper for posts and pine seeds for food. Primitive people tested most, if not all, plants for their daily needs and we still follow much of the conventional knowledge they gained through trial and error.

Present needs are not clearly preceived in our complex modern society. Opportunities for synthesis of materials has led man to believe in his self-sufficiency from natural products. Yet, there is room and a necessity to explore the potentials yet existing in nature for useful plant resources. Such exploration must utilize a logical and scientific approach and not continue by trial and error. Plant resource development must be compatible with existing land uses and must avoid significant environmental damage.

Some searching questions need to be answered in relation to exploitation of arid land plant resources. Have changing needs and new industrial processes made obsolete some of our brightest hopes for use of certain plant products? Are arid lands capable of supporting the production of desired plant products or should lands of higher potential be considered? Could arid lands sustain the environmental impact of production? Are arid lands too unpredictable climatically to encourage people to depend on their livelihood from them?

Some examples of products from arid lands have been presented in the conference. A general look at some of these plant materials in relation to the foregoing questions appears necessary.

Future research needs are difficult if not dangerous to predict but some obvious areas will be suggested. A final point is that research and development of arid land plant resources should be innovative but at the same time realistic.