La Semilla

The Seed

1996 ANNUAL REPORT
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EXECUTIVE SUMMARY

The broad objective of the Natural Resources Conservation Service (NRCS) plant materials program parallels the United States Department of Agriculture's long-term conservation objectives to protect or enhance soil, water, air, plant and animal resources.

As part of its coordinated program with America's Conservation Districts, the NRCS provides specialized activities and assistance in plant materials projects through 26 Plant Materials Centers. The Tucson PMC serves the hot desert areas of California, Nevada and Utah. It is NRCS policy to assemble, evaluate, release and distribute for commercial increase, plant materials for a broad range of resource conservation and development needs. We also develop and disseminate new techniques for plant and resource management.

Conservation districts, various federal and state agencies, and private landowners cooperate in these efforts. Cooperators with the Tucson PMC include state universities, U.S. Fish and Wildlife Service, Agricultural Research Service, Forest Service, Bureau of Land Management, Bureau of Reclamation, state natural resource agencies, the Arizona Crop Improvement Association, and others. This interagency cooperation offers many opportunities for joint development and release of plant materials and for exchange of information, seed and planting stock.

The Tucson PMC began operations in 1935. The evaluation of plants as well as cultural and management practices are carried out at the federally owned 45.5 acre farm and off-center evaluation sites. The NRCS operated the PMC from 1935-1952 when the University of Arizona assumed responsibility for operations. The NRCS (formerly the SCS) resumed control of the PMC once again in 1962. This is the 35th year of operation since the NRCS took over responsibilities in 1962.

The Tucson PMC has been conducting various studies and plantings to address resource issues in the following areas: rangeland, mineland, urban lands, cropland, natural areas, and channel stabilization.

Land Use Description: Rangeland
Fourteen rangeland related studies were conducted by Tucson PMC personnel in 1996. Five of these studies focused on individual species that are in the Tucson PMC advanced evaluation stage of the selection process. These species include desert saltbush (*Atriplex polycarpa*), cane bluestem (*Bothriochloa barbinodis*), Arizona cottontop (*Digitaria californica*), spike dropseed (*Sporobolus contractus*), and purple threeawn (*Aristida purpurea*). All of these species are native to the southwestern United States and the intended primary use for these species is in rangeland revegetation efforts.

Six off-center studies were initiated and/or evaluated in 1996; these studies included the Yuma Proving Grounds, Maggie Tank Hay Seeding - Using Grass Hay Bales, Southwestern Borderlands Savanna Grassland Ecosystem Restoration Study, Six Mile Flat Field Evaluations - Nevada Adaptation Trials, and Avra Valley Retired Farmland Revegetation Trials.

The study at Yuma Proving Grounds was initiated in 1992 to determine efficient methods of revegetating disturbed areas in the Mohave Desert. This study consisted of an experimental demonstration focusing on the potential of various container sizes and irrigation regimes in the establishment of native, desert plants on disturbed, arid sites.

The Maggie Tank Hay Seeding using grass hay bales was designed and initiated to facilitate revegetation of deteriorated rangeland. The objective was to use livestock as a tool to incorporate grass seed through trampling in areas where grass hay bales had been scattered.

The Southwestern Borderlands Savanna, Grassland Ecosystem Restoration Study was initiated in 1996 and is a cooperative effort including the USFS Rocky Mountain Experiment Station, Coronado N.F., NRCS Douglas Field Office, NRCS Tucson Plant Materials Center, Whitewater Dray NRCD, Arizona State Land Department, Malpai Borderlands Group, USFWS, Hidalgo SWCD, and the Animas Foundation. The immediate objective of this cooperative study is to work to improve the density and composition of perennial, native grasses and reduce the influence of mesquite and other woody species.

The Six Mile Flat Field Evaluations in Nevada were initiated in 1987 in order to evaluate and select the best adapted plant materials to meet the conservation needs for MLRA 29. To date, 62 accessions encompassing 17 different species have been planted on this site.

The Avra Valley Retired Farmland Revegetation Study was initiated in 1989. Identified needs for this study included: improve and expand information on plant materials having potential use in rehabilitating idled farmland; determine appropriate seeding mixes and planting methodologies which can achieve the desired land use goals; and identify species for rehabilitating idled farmland.

Field planting evaluations included the 47 Ranch Field Planting, the George Morin Ranch Field Planting and the Riggs Flat Field Planting. The 47 Ranch Field Planting was installed in May 1995 and seeded five acres of P.I. 216101 cane bluestem at a rate of 2.5 lbs/acre and was compared against Lehmanns lovegrass (standard). Site preparation included rootplowing western honey mesquite on the contour and broadcast seeding afterwards. Evaluations included percent stand and a visual estimate of percent utilization. The George Morin Ranch Field Planting was installed during the summer of 1996. This planting compared the Tucson PMC's accession of Arizona cottontop (9003705) with a commercial wild collection. Both collections were seeded at a rate of 3 PLS pounds per acre. Evaluation factors included percent stand and precipitation amounts. The Riggs Flat Field Planting was installed to promote the use of improved conservation plant materials for range seeding and to evaluate the adaptation of experimental plant lines for use in northern Arizona. This site was first planted in 1986 and again in 1994. The second planting utilized 17 grass and 4 shrub species.

Land Use Description: Mineland

The Cyprus Tohono Mine Revegetation Project was initiated in 1994. The objectives of this project are to conduct trials and evaluate methods of revegetating overburden and mine processed material using native plant materials. The information acquired from these trials will provide Cyprus Tohono Corporation with a prescription for large-scale revegetation, in accordance with agreements made with the Tohono O'Odham Nation. Information gained from this project may also aid in improving conservation practices elsewhere. The primary goal for revegetating the overburden and mine processed material is to stabilize the slopes to prevent erosion and to blend the overburden piles with the surrounding vegetated mountain sides.

The use of native plant materials will eventually promote the utilization of the overburden slopes as territorial and forage locations for native wildlife species. Animals thought to directly benefit from revegetation include mule deer, javalina, Gambel's quail, desert cottontail, and various reptiles and arthropods.

The objectives of this project are also designed to meet the concerns of North Komelik Village and the Sif Oidak Grazing District, in relation to improving the aesthetic appearance of the mine as viewed from North Komelik Village and Highway 15. Revegetation of slopes facing North Komelik Village is the desired goal for Cyprus-Tohono Corporation.

Land Use Description: Urban Lands

The Palm Springs/Desert Water Agency Adaptation Trials is a cooperative effort between the Desert Water Agency, Coachella Valley Resource Conservation District, and the Natural Resources Conservation Service. This study was initiated in 1990 to evaluate various plant species for their adaptability, water use and response to irrigation with tertiary water versus potable water. The objectives of this planting are to demonstrate the feasibility of using tertiary water on trees, shrubs and turf; provide the public an example of growing water use efficient plants with tertiary water; measure the effect of tertiary water on plant growth in comparison with potable water; measure plant nitrate nitrogen uptake and losses due to deep percolation; formulate appropriate fertilization recommendations; and use this study to educate the community on the proper use of tertiary water for irrigation.

Land Use Description: Cropland

The Tucson PMC has initiated studies and activities to determine cover crops, cropping systems, and residue management practices to optimize soil and water protection, food and fiber production, and economic returns. The objective of these studies is to identify and develop legumes having minimal water requirements for use as cover crops during summer fallow periods in MLRA 30 and during winter fallow periods in MLRA 40 and 41. The Tucson PMC will work to document and promote the benefits of using cover crops and green manure crops in cropping rotations. The Cover Crop

and Green Manure practice when implemented will: protect air quality by reducing wind erosion, improve soil tilth, improve soil moisture holding capacity, and reduce soil nutrient loss.

The Cool and Warm Season Cover Crop Trials are a joint study with Kai Umeda, Vegetable Crop Specialist with the Maricopa County Extension Service. The warm-season trials are specifically evaluating a legume that can be planted, turned under prior to winter vegetables. Factors being evaluated include biomass production and amount of nitrogen added to the soil. The cool season trial is a Tucson PMC study where various legumes for biomass production and adaptability to southern Arizona are being screened. The warm-season trial included 'Tropic Sun' sunn hemp (*Crotalaria juncea*), Iron & Clay cowpeas (*Vigna unguiculata*), sesbania (*Sesbaina exaltata*), sudangrass (*Sorghum sudanense*) and kenaf (*Hibiscus cannabinus*). The cool-season trial included purple vetch (*Vicia atropurpurea*),'Lana' woolypod vetch (*Vicia villosa* ssp. *varia*), 'Biomaster' pea (*Pisum sativum*) and Papago pea (*Pisum sativum*).

The 'Pete' Eastern Gamagrass Field Planting was installed in June 1997 north of Elfrida, Arizona in cooperation with the Douglas Field Office. This field planting was initiated to evaluate the adaptability of 'Pete' eastern gamagrass as a pasture and/or silage plant in southern Arizona. Evaluation factors to be recorded are irrigation requirements, percent stand, dormancy or frost date, yield and cooperator's comments with regard to management and suitability.

The 'Seco' Barley Field Planting was installed in January 1997 north of Elfrida, Arizona in cooperation with the Douglas Field Office. This field planting was installed to compare the performance of the 'Seco' and 'Solumn' barley cultivars. The objective of this field planting was to determine which cultivar is best adapted to the Elfrida area with regard to biomass production, use as a feed silage and/or grazing preference.

The Heaton Farms Field Planting was initiated in 1994 in cooperation with the Fredonia Field Office. This field planting was designed to evaluate two pasture and hayland grass alternatives to tall wheatgrass on saline-sodic soils. 'Newhy' hybrid wheatgrass (*Elytrigia repens* x *Pseudoroegneria spicata*) and 'RS-Hoffman' quackgrass (*Elytrigia repens*) were planted in three borders of a small irrigated field. Two alfalfa varieties, 'Spredor 3' and 'Cimarron VR', are also part of this trial.

Land Use Description: Natural Areas

Guaranteed, local, genetic ecotypes of most native species are not generally commercially available. Revegetation projects such as those done by the National Park Service require the use of indigenous genotypes which have been specifically collected from within a given geographic area. This project is designed to assist other agencies or groups with locating, propagating, or producing genetically indigenous genotypes for use in areas where non-indigenous genotypes are not desired or allowed. The objectives of this project are to develop methods or the means to produce limited quantities of genetically indigenous plant materials for specific uses in specific geographic areas. Studies developed under this project will be very specific in scope and duration and designed to meet specific, identified needs.

The objective of the Seed Production for Reseeding Disturbed Areas at Fort Bowie National Park Historic Site Project is to produce 50 bulk pounds of seed of five native, perennial grasses. The original seed for these grass species was collected on site at the Fort Bowie National Historical Site. Plants were propagated from this seed and used to establish seed production blocks at the Tucson Plant Materials Center. Seed harvested from these production blocks was processed and stored at the Tucson PMC until the 50 bulk pound objective was fulfilled.

Land Use Description: Channel Stabilization

In MLRA 41-3 many of the upland range sites have had an increase in brush species due to a decrease in herbaceous species. This has resulted in increased runoff, soil piping and the formation of gullies. Identified needs include: (1) identification of plant species that are adaptable, (2) identify cultural techniques that enhance plant establishment and (3) screen and/or identify plant species that can withstand soil deposition, flooding and resistance to herbivory.

The Fort Huachuca East Range Vegetative Gully Plug Trial was initiated in 1993 in cooperation with the Douglas Field Office. The objective of this study is to evaluate four warm season grasses for use and applicability in stabilization of small gullies in MLRA 41-3. Brush species such as creosote, whitethorn, catclaw, mesquite, and tarbush have increased due to a decrease in the herbaceous grass species. As the herbaceous component decreased less rainfall is being absorbed into the soil and more is running off. On the East Range this increased runoff is

causing soil piping and the formation of gullies on highly erodible soils that have a high gypsum and sodium content. Dirt access roads have also contributed to gully formation by concentrating and directing runoff onto these highly erodible soils. The Tucson PMC installed a gully plug trial in two small gullies. The species for this project included spike dropseed (*Sporobolus contractus*), big sacaton (*Sporobolus wrightii*), tanglehead (*Heteropogon contortus*), and vetiver grass *(Vetiveria zizanioides*). Evaluation factors included survival, vigor and height.

An important component to the success of the Tucson PMC program requires continued, close collaborative efforts with NRCS field offices and their cooperators, other governmental agencies, and local environmental organizations. This partnership is exceptionally valuable in terms of developing high quality conservation plant materials and technology. Continued cooperation and the development of new partnerships is needed in order to meet our conservation challenges. The Tucson PMC is available to assist NRCS field offices with not only plant materials but also quality technology products for use in the conservation of our natural resources in the arid southwestern United States. It is the goal of the Tucson PMC to provide ***usable*** products to our customers.

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PROJECT: RN1.7

PROJECT TITLE: **Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.**

PROBLEM STATEMENT: Current technological information as well as current plant materials information is needed to effectively implement NRCS Range Seeding practices. Up-to-date information regarding a large number of native plant species needs to be collected and made available to NRCS Field Offices.

LAND RESOURCE REGIONS:

I	Southwestern Plateaus and Plains Range and Cotton Region
J	Southwestern Prairies Cotton and Forage Region

MLRA: 29, 30, 31, 40, 41

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:

PRIMARY:	550	RANGE SEEDING
SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
TERTIARY:	342	CRITICAL AREA PLANTING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants condition, productivity.
SECONDARY:	Soil	Soil erosion from sheet and rill.

SCOPE/DESCRIPTION: Plant Materials Opportunities: Develop native plants and technology to effectively implement the NRCS Range Seeding practice in areas of MLRA's 29, 30, 31, and 40 where annual precipitation is 7 inches or less. Develop native plants for reseeding burns or reseeding into killed stands of Lehmann lovegrass in MLRA 41 and the higher precipitation zones in MLRA 40. When applied, the Range Seeding practice will: (1) Protect air quality by reduction of wind induced soil erosion, (2) Protect adjacent surface water resources by reduced water induced soil erosion, (3) Provide food and cover for wildlife, and (4) Provide food for domestic grazing animals.

OBJECTIVES: Identified needs include: (1) Improved and enhanced basic biological information on plants having rangeland applications, and (2) Development of improved plant materials for special rangeland applications. Proposed actions include: (a) Utilize Convergent-Divergent Improvement or Recurrent Restricted Phenotypic Selection methods to develop native plant populations for use in range reseeding projects, (b) Develop and release *Bothriochloa barbinodis* for use in MLRA40 and 41, (c) Develop and release *Digitaria californica* for use in MLRA 40 and 41.

STATUS OF KNOWLEDGE: Since 1934 the primary focus of plant development at the Tucson PMC has been on the development and release of native and introduced plant materials for range reseeding in the arid Southwestern U.S. Refer to past Tucson PMC annual technical reports or additional information.

PLANNED COORDINATION: University of Arizona Agricultural Experiment Station, Conservation

Districts, various Federal and State agencies, NRCS Field Offices, Malpai Borderlands Group.

COOPERATORS: Conservation Districts, Field Offices, Various Government Agencies, Local Municipalities.

PROJECT LEADER: West NTC Plant Materials Specialist, Tucson Plant Materials Center

APPROVED BY PMC STATE CONSERVATIONIST ADVISORY COMMITTEE:
AZPMC High Active

STUDIES:
TUCSON, ARIZONA PLANT MATERIALS CENTER
04C017L START: 1988 END:1997
ICST - Avra Valley Retired Farmland Revegetation Trials.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A010H START: 1987 END: 2000
Six Mile Flat Field Evaluations - Nevada Adaptation Trials, Caliente, Nevada.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A8212L START: 1982 END: 2000
Desert Saltbush for Rangeland and Abandoned Farmland Revegetation.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A8291L START: 1982 END: 2000
Arizona Cottontop for Rangeland Revegetation.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9301L START: 1993 END: 1998
Joshua Tree National Park Plant Adaptation Trials - Comparative Studies.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9302L START: 1993 END: 1997
Yuma Proving Grounds AE/Cultural Trials.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04S002U START: 1985 END: 1999
Cane Bluestem Plant Development for Rangeland Revegetation.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04I023L START: 1989 END: 2000
1989 *Sporobolus contractus* Population Development.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9501L START: 1995 END: 1999
Maggie Tank Native Hay Seeding - Using Native Grass Hay Bales.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9701L START: 1997 END: 2000
Southwestern Borderlands Savanna Grassland Ecosystem Restoration Study.

STUDY NUMBER: 04A8212L

Desert Saltbush for Rangeland and Abandoned Farmland Revegetation.

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	550	RANGE SEEDING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
	TERTIARY:	342	CRITICAL AREA PLANTING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants management; establishment, growth, and harvest.
SECONDARY:	Animals	Animals habitat, cover or shelter.

DESCRIPTION: Species: *Atriplex polycarpa* (Torrey)S.Wats. - Desert saltbush, cattle spinach, all-scale.

Plant Symbol: ATPO

Accession Number(s): P.I. 399195, A-18348.

This accession was Ccollected by Wendall Hassell near Blythe, California in November 1973.

This accession was evaluated in two Initial Evaluation Plantings (IEP): 1974 Desert Species IEP and the 1977 Tree, Shrub and Annual Forb IEP. In the 1974 IEP, P.I. 399195 was the most uniform and best-looking accession. It was also noted as the best seed producer in 1974. In the 1974 IEP, P.I. 399195 was evaluated against six native accessions over a four year period. In the 1977 IEP, P.I. 399195 was consistently rated higher for vigor and cover. In this IEP, P.I. 399195 was evaluated against eleven accessions over a five year period. Uses for P.I. 399195 desert saltbush will include revegetation of eroded rangelands, retired farmlands and critical areas. At this time, seed is harvested best by hand. This may limit production by commercial growers by not being cost-efficient. Range of adaptation is primarily MLRA's 30,31 and 40. This includes the Sonoran and Mohave deserts with elevations between 300 and 3,000 feet (91-914 meters) and annual precipitation from 3 to 10 inches (75-250 mm). Potential soils include sandy loam, loam and clay loam. Also, moderately saline soils.

DURATION OF STUDY: 1982 through 2000

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Tucson Plant Materials Center.

STATUS OF KNOWLEDGE: This information is taken from Mohave Revegetation Notes, U.C.

Davis, Agronomy and Range Science, Publication Number 18, November 1977 by K.L. Burgess, C.R. Brown, and W.L. Graves. This publication reports on work supported by the BLM - Contract # 53400-CT4-2(N), Document Obligation No. 6809.

Desert saltbush (*Atriplex polycarpa*) is a perennial, low, rounded, erect intricately branched shrub 1-2 m tall, with gray or yellowish-brown branches, the bark shed in long strips. The leaves are alternate, crowded on young twigs, oblong to spatula-shaped, 3-20 mm long, coated with small scales on both sides of the leaf. One-veined from the base. Male and female flowers are borne on separate plants; the male in leaf axiles or on terminal spike; the female crowded along the numerous divergent branches in diffuse flower clusters. Flowers are tan to greenish in color. The seed is pale brown, 1-1.5 mm long.

Desert saltbush is found on alkaline plains and occasionally rocky or gravelly slopes in desert or grassland and is limited to between 120 - 900 meters (400-3,000 feet) elevation in alkali sinks in communities with creosote bush scrub, shadscale scrub, and sagebrush scrub. It is found in scattered localities in the San Joaquin Valley and Mohave and Colorado Deserts in California, southern Nevada, southwestern Utah and Arizona, Baja California, and northwestern California (Munz 1974; Benson and Darrow 1954). It is less extensive than *Atriplex canescens* in geographic distribution (Hastings et al. 1972), and less cold tolerant and more drought hardy (Nord 1977). It is reported to flower from May to August, with fruit ripening from October to December and seed dispersal occurring from November to May (Foiles, 1974).

Atriplex polycarpa has long been noted for its excellent forage qualities (Bidwell and Wooten 1925). It is rated "good for deer; good to fair for cattle, sheep and goats; and fair for horses" (Sampson and Jesperson 1963). It is known to grow well on rangelands with soil pH varying for 6-8 (Nord 1977). It is often found in association with highly unpalatable species and may be the only shrub in areas that are too arid or saline for other species to grow (Chatterton et al. 1971b). Its greatest forage value is in the fall, when grassland species make a minimal nutritional contribution to the range. Its nutritional value in crude protein, total digestable nutrients, and fats is comparable to that of alfalfa, and late in the year it is a good source of calcium, phosphorous, and carotenoids (Chatterton 1970). Goodin and McKell (1970) have estimated maximum forage yields under cultivation to be 12,822 kg/ha and suggest that cultivation as a forage crop has considerable potential in marginal lands subject to prolonged drought in excessive salinity.

Phosphorous content in the soil is significantly correlated with yield of aerial plant parts (Lailhacar-Kind 1976). Although extremely tolerant of salt in the environment, its germination has been found to be reduced with higher salt concentrations (Chatterton and McKell 1969). Large quantities of salt are accumulated in the shoots. Salinity tolerance may be due to an accumulation of salt in the trichomes on the leaf surface from adjacent mesophyll cells, reducing salinity stress of photosynthetically active tissue (Chatterton 1970). Adult plants have been tested and found to withstand shoot water potential deficits of -69 bars (Sankary and Barbour 1972).

It does not accumulate nitrate even in high-nitrate environments (Chatterton et al. 1971a). *Atriplex polycarpa* flourishes on soils unsuitable for most other species, and is usually absent from less saline soils due to competition from more aggressive species (Lailhacar-Kind 1976).

Desert saltbush has been proposed as the best species to establish in pure stands as quail habitat (Glading et al. 1945). MacMillan (1960) found that a planting rate of 45 kg/ha was adequate to establish a thick stand of saltbush. It establishes easily if adequate moisture is present in the soil, and further care involves only protection from sheep and cattle. A satisfactory management system would allow only limited use during the summer and fall months. The species has been virtually eradicated by overgrazing in many of its original localities (Sampson and Jesperson 1963). Graves et al. (1976) found transplants to be more successful than spot seeding under western Mohave Desert conditions. A saponin content of 1.2% of dry weight has been found in the foliage of *Atriplex polycarpa*. Extracts from increasing quantities of foliage have been found to be increasingly inhibitory to germination of its own seed and that of several other species but will enhance germination of seed of California ephedra (Askham and Cornelius 1971). It is unlikely that the bracteoles of the utriculate fruiting body contain saponin (Sankary and Barbour 1972). Even so, the leaching of seeds has been found to increase germination (Cornelius and Hylton 1969). Actived carbon was the best treatment for speeding initiation of germination. It also resulted in a significantly higher 7-day and 14-day germination. Stratification in moist sand at 2 °C for 30 days, heating at 60 °C for four hours, and exposure to 100 ppm ethylene for 24 hours increased 7-day germination but were not significantly different from the control at 14 days. In addition, scarification, soaking in 6% sodium hypochlorite solution for 24 hours, and soaking in 6% hydrogen peroxide solution for 10 minutes significantly decreased germination at 14 days. Nord et al. (1971) reported best emergence in late spring from a planting depth of 1.25 cm versus 2.5 cm. Williams et al. (1974) obtained no germination of *Atriplex polycarpa* in washed plaster sand at either 1 or 2 cm. Burgess et al. (1977) obtained 13% germination in the same type of medium from a 1 cm depth, using a different seed source. Covering the seed with as little soil as possible (2-3 mm) would probably improve emergence. Chatterton and McKell (1969b) reported higher seed quality and germination from a November collection than from one made in December in 1966. They suggested percentage of seed fill was highest and germination most rapid in seed which matured early. Seeds left to ripen on the plants often germinate while still on the plant. Utricle size has been found to be significantly related to germination. Size catagories greater than 1.7 mm (1/15 inch) gave significantly better 14-day germination than unsorted control utricles. Size catagories less than 1.7 mm gave lower germination than the control. Separating utricles on the basis of size before seeding may improve seeding success.

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TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Potential cultivar release

STUDY NUMBER: 04S002U

Cane Bluestem Plant Development for Rangeland Revegetation.

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	550	RANGE SEEDING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
	TERTIARY:	342	CRITICAL AREA PLANTING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Plants	Plants management, other.

DESCRIPTION: This accession of *Bothriochloa barbinodis* (cane bluestem), P.I.216101, was selected for advanced evaluation because of its superior vigor, herbage production, and tolerance to drought and cold. It was included in two initial evaluation plantings out of which the 1981 *Andropogon barbinodis* Strain Trial was established (1981 Tucson PMC Annual Tech. Report, pp.93-96). Cane bluestem, P.I.216101, maintained its superior performance throughout all three evaluation trials. The potential use for this accession is primarily as an erosion control plant on mismanaged rangelands and critical areas such as abandoned cropland and road cuts. Potential adapted soil textural classes include: sandy loam, loam, fine sandy loam, loamy fine sand, and gravelly and rocky soils.

DURATION OF STUDY: 1985 through 1999

STUDY LEADER: Mark Pater

LOCATION: ARIZONA PMC

COOPERATORS: Tucson Plant Materials Center

METHODS AND MATERIALS: Objectives: (1) Establish a large-scale seed production block on the Tucson PMC farm for future ICST's and Field Plantings; (2) Conduct evaluations on performance and site adaptability in ICST plantings and Field Plantings. Potential off-center sites include: Avra Valley, Six-Mile Flat, Gray Ranch, Bowie; (3) Summarize data for eventual documentation and potential release of an adapted cultivar of cane bluestem.

STATUS OF KNOWLEDGE: *Bothriochloa barbinodis* (Lag.) Herter is described by Gould (1975) as

a cespitose perennial, the culms often in large clumps. CULMS erect or geniculate at the base, tending to become decumbent and much-branched below in age, mostly 60-120 cm tall; CULM NODES bearded with hairs mostly 1-3 mm long (occasionally longer), these typically erect and not widely spreading; LEAVES essentially glabrous except for few to numerous long hairs on upper sheath margins and in vicinity of ligule; LIGULE 1-2 mm long, becoming erose and lacerate; BLADES firm, linear, 2-7 mm broad, often 25-30 cm or more long but the upper culm blades greatly reduced; PANICLES mostly 7-13 cm long, often partially included in upper sheath, with a straight main axis and numerous primary branches mostly 4-9 cm long, these erect or loosely spreading at tips, the basal ones moderately rebranched; INTERNODES OF PANICLE BRANCHES AND PEDICELS more or less densely villous on the thickened margins, with a broad, membranous central region; SESSILE SPIKELET 4.5-7.3 mm long excluding awn; FIRST GLUME usually sparsely hairy below the middle; LEMMA AWN 20-30 mm or more long, geniculate and twisted. Chromosome number 2*n*=180.

Gould (1956) states that *Bothriochloa barbinodis*, with the high chromosome number of 2*n*=180, frequently has irregular meiosis but appears to produce sufficient good pollen for normal fertilization. This grass is highly cleistogamous, especially under conditions of aridity and heat when the inflorescence usually remains partially enclosed in the subtending sheath or "boot".

This species is important in the Southwest since it grows in relatively dry habitats. If supplemented by occasional flooding from heavy summer showers, this species can grow where annual precipitation ranges from 130-180 mm (Judd 1962). Although the role of *Bothriochloa barbinodis* in the original grassland associations of the Southwest may have been minor in the past, it has flourished on disturbed soils of road and railroad rights of way. From eastern Texas to southern Arizona and in northern Mexico it is consistently represented in roadside floras (Gould 1953).

Bothriochloa barbinodis is considered fair to good forage while young (Judd 1962). Humphrey (1960) classified this species as fair forage because it is coarse and nutrients tend to leach from forage when plants are dry. Although Tucson PMC personnel consider this to be a poor forage species in MLRA 41, Gay and Dwyer (1965) considered it fair to good forage for cattle and sheep. Fudge and Fraps (1945) found that *Bothriochloa barbinodis* contained more crude protein and phosphoric acid than did silver bluestem. Judd (1962) states that usually it is found as scattered plants or in small groups; seldom in dense, pure stands. It is a good indicator of proper grazing, since it tends to disappear when a range is excessively utilized. Koshi et al. (1977) compared *Bothriochloa barbinodis* under irrigated and non-irrigated conditions in Big Plains, Texas. They found that cane bluestem grown under natural rainfall made a higher proportion of their seasonal growth and made more total growth late in the season (irrigated: 1.0 tons/ha; non-irrigated: 1.5 tons/ha). They concluded that when water was adequate, *Bothriochloa barbinodis* grew most between mid-June and late August. If water was not available at that time but was available later, they grew more later in the season. This flexibility in growth patterns should be considered in the management of this species and in evaluation of its potential. They also found that *Bothriochloa barbinodis* is as well or better adapted than switchgrass (*Panicum virgatum* L.) to drought conditions.

Reardon and Merrill (1974) evaluated nonstructural carbohydrates in grazed and ungrazed *Bothriochloa barbinodis*. The trend of carbohydrate reserves, major storage carbohydrates, and primary storage locations were determined in grazed and

ungrazed cane bluestem plants. Sucrose was usually the major reserve carbohydrate, and the largest concentration of reserve carbohydrates was in the crown portion of the plant. The total nonstructural carbohydrate (TNC) levels were higher in grazed than in ungrazed plants. The ungrazed plants matured earlier, as indicated by an earlier TNC peak and had lower winter TNC levels. Their results indicate that maximum plant vigor can be maintained with a periodic June to November grazing deferment followed by moderate foliage removal. This deferment would allow the plant to synthesize and accumulate plant foods and go into dormancy with a relatively high reserve TNC level. Moderate grazing after the October peak should not be harmful.

LITERATURE CITED:

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Gay, C.W., Jr. and D.D. Dwyer. 1965. New Mexico Range Plants. New Mexico Agr. Ext. Ser. Circ. 374. 85p.

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Humphrey, R.R. 1960. Arizona Range Grasses, Their Description, Forage Values, and Management. Ariz. Agr. Exp. Sta. Bull. 298. 104p.

Judd, B.I. 1962. Principal Forage Plants of Southwestern Ranges. Rocky Mtn. For. and Range Exp. Sta., Colo. State Univ., Fort Collins, CO. P.16.

Koshi, P.T., A.V. Eck, J. Stubbendieck, and W.G. McCully. 1977. Cane Bluestem: Forage Yield, Forage Quality, and Water Use Efficiency. Jour. Range Mgmt. 30(3):190-193.

USDA. 1960. Plant Material Introduced January 1 to December 31, 1954 (Nos. 212043 to 222845). Plant Industry Publication, Washington, D.C. p.158.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Amendment to Range Seeding Specifications, Technical Note.

OTHER ACTIONS: Plant Guide Publication, Plant Release Publication.

STUDY NUMBER: 04A8291L

Arizona Cottontop for Rangeland Revegetation.

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	550	RANGE SEEDING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
	TERTIARY:	342	CRITICAL AREA PLANTING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Plants	Plants management, other.

DESCRIPTION: Two accessions of *Digitaria californica* (9003694 AND 9003705) were selected from the 1976 Arid Land Grass IEP at the Tucson PMC. The final report on the 1976 planting was published in the 1980 Tucson PMC Annual Technical Report. The abstract in this report states that 9003694 was the superior accession. The plant performance data shows that 9003705 had the best vigor rating and the highest forage production. In addition, the remarks column shows 9003705 as the best performing accession (Tucson PMC Annual Technical Report, 1989). The potential use for this species is as an erosion control plant on degraded rangelands and critical areas such as abandoned farmland and roadway construction sites.

DURATION OF STUDY: 1982 through 2000

STUDY LEADER: Mark Pater

LOCATION: ARIZONA PMC

COOPERATORS: Tucson Plant Materials Center.

METHODS AND MATERIALS: Objectives: (1) Establish a large-scale seed production block for accession 9003705 on the Tucson PMC farm for future ICST's and Field Plantings; (2) Conduct evaluations on performance and site adaptability using ICST's and Field Plantings. Potential off-center sites include: Avra Valley, Six-Mile Flat, Gray Ranch, Bowie; (3) Summarize data for eventual documentation and potential release of an adapted cultivar of Arizona cottontop.

STATUS OF KNOWLEDGE: *Digitaria californica* (Benth.) Henr. (Arizona cottontop) is a leafy perennial bunchgrass that contributes considerable range forage in the Southwest, from southern Colorado to Texas, Arizona, and northern Mexico. This grass makes

rapid growth following winter rains and furnishes earlier forage than most associated grass species (Gould 1983).

Gould (1977) describes this species as: CULMS firm, erect from a hard base, mostly 40-100 cm tall but occasionally much less; BLADES flat or somewhat folded, usually glaucous, bluish-green, and glabrous or nearly so, 2-5 mm broad; LIGULE membranous, 2mm or more long; PANICLE contracted, 5-15, occasionally 20 cm long, with relatively few branches, these erect, usually appressed; SPIKELETS 3-4 mm long excluding the hairs; SECOND GLUME narrow, densely villous with soft, silvery or purple-tinged hairs 2-4 mm or more long; STERILE LEMMA broad, three-nerved, villous on the margins but glabrous on the internerves; GRAIN ovate-lanceolate, abruptly narrowing to a short awn-tip, mostly 2.5-3.2 mm long.

Found on open, well-drained soils, often on steep, rocky slopes, at elevations of 1,000 to 6,000 feet; reported from all counties in Arizona except Apache but much more abundant in the southern portion of the state than in the northern counties, flowering mostly August to November. Colorado to Texas, Arizona, and Mexico.

LITERATURE CITED:

Gould, F.W. 1977. Grasses of Southwestern United States. Univ. of Ariz. Press, Tucson, AZ. P.296.

Gould, F.W. and R.B. Shaw. 1983. Grass Systematics, 2nd edition. Texas A&M University Press, College Station, TX. p.213.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Amendment to Range Seeding Specifications, Technical Note.

OTHER ACTIONS: Plant Guide Publication, Plant Release Publication.

STUDY NUMBER: 04I023L

1989 Sporobolus Contractus Population Development

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Initial Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	550	RANGE SEEDING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
	TERTIARY:	342	CRITICAL AREA PLANTING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants condition, productivity.
SECONDARY:	Soil	Soil erosion, other.

DESCRIPTION: The 1989 *Sporobolus contractus* IEP consists of 44 accessions, the bulk of which were collected from various locations in southeastern Arizona. The remaining accessions were collected from other various locations in Arizona, southern Utah, and Nevada. Progressive systems to evaluate and improve plant materials are currently being applied at the Tucson PMC. One of two plant development systems will be employed for *Sporobolus contractus* (spike dropseed), depending on the method of reproduction for this species: (a) Convergent-Divergent selection method will be utilized if the species is cross-pollinated, or (b) Modified Mass Selection will be used if the species is self-pollinated. Either way, the desired end-result should be the development of a population of spike dropseed with a broad genetic base that is adapted to a wider area within its natural range than would a source-identified ecotype. Objectives of this study include: (a) Develop a genetically broad-based population for use as an alternative choice for some of the introduced lovegrass species. The primary use for this population will be for range revegetation projects. (b) Determine the method of reproduction and utilize an appropriate breeding/selection system for population development. (c) Evaluate seed production, germination and seedling establishment characteristics as well as harvesting and seed processing techniques. (d) Summarize data for eventual documentation and release of a genetically broad-based population of spike dropseed.

DURATION OF STUDY: 1989 through 2000

STUDY LEADER: Mark J. Pater

LOCATION: ARIZONA PMC

COOPERATORS: University of Arizona Agricultural Experiment Station, Agricultural Research Service.

METHODS AND MATERIALS: All of the collection sites for the accessions assembled for this

evaluation will be plotted on a map in order to determine the range of collection within the species' natural range of adaptation. The map will also aid in the development of a genetically broad-based population. The planting block was designed to allow for 3 individuals from each of the 44 accessions to be randomly placed into an 11x12 completely randomized block design. This resulted in a total of 132 plants being planted into a modified mass selection block. Seed harvested from this block is to be bulked in equal quantities to form a new population. Seed from this population is to be used to establish a small-scale seed production block at the Tucson PMC. Seed produced in this block will be used to propagate individual plants which will be used for off-center plantings at various locations from within the species natural range of adaptation. Seed will be harvested from surviving plants at these various off-center plantings and bulked together in equal amounts to form a new population. This population may then be used as breeders seed or another round of off-center plantings and seed harvesting may be conducted.

STATUS OF KNOWLEDGE: *Sporobolus contractus*, spike dropseed, is a native cespitose, perennial, warm-season bunchgrass; CULMS 40-120 cm tall and 2-4 mm in diameter at the base, in small clusters to moderately large clumps; SHEATHS rounded and glabrous on the back, usually with tufts of long hairs on either side of the collar and often ciliate pilose on the margins; LIGULE a dense fringe of short or rather long hairs; BLADES mostly 10-30 cm long, flat or involute, tapering to a slender tip, glabrous; PANICLE dense, contracted, spikelike or moderately lobed, typically 1 cm or less thick and 15-20 cm long, at least the basal portion and sometimes the entire panicle remaining enclosed in the sheaths; SPIKELETS light brownish or lead colored, 2-2.8, rarely 3 mm long; GLUMES thin, membranous, unequal, the first usually about half as long as the second, the second equaling the lemma or slightly shorter; CARYOPSIS mostly about 1 mm in length, broad and flattened (Gould 1977). This species occurs naturally on dry, open, sandy or rocky slopes and washes, frequently along roadsides, mostly at elevations from 760-1,981 meters. It flowers mostly from August to October, occasionally as early as June. Spike dropseed is found growing from Colorado to southeastern California to Texas, and Sonora, Mexico (Gould 1977).

LITERATURE CITED:

Gould, F.W. 1977. Grasses of Southwestern United States. Univ. of Ariz. Press, Tucson, AZ p.225.

Pater, M.J. 1991. 1989 *Sporobolus contractus* IEP. 1991 Report. USDA-SCS, Tucson Plant Materials Center Ann. Tech. Report. P.4-7.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Amendment to Range Seeding Specifications, Technical Note.

OTHER ACTIONS: Plant Guide Publication, Plant Release Publication.

STUDY NUMBER: 04A9101L

Purple Threeawn for Soil Protection of Arid Rangelands - Final Report

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland , Natural area

VEGETATIVE PRACTICES: **PRIMARY:** 342 CRITICAL AREA PLANTING

SECONDARY: LAND RECLAMATION, HIGHWAY TREATMENT

	RESOURCE	CONSIDERATION/PROBLEM
PRIMARY:	Soil	Soil erosion from sheet and rill.

DESCRIPTION: Species: *Aristida purpurea* Nutt. var. *purpurea*.

Common Name: Purple threeawn.

Plant Symbol: ARPU9.

Accession Number: 9055864.

This accession is a bulk harvest from the 1980 Warm Season Grass IEP. The number of accessions that contributed to this harvest was not recorded. The 1983 Annual Report indicated that T21014, T14971 and T14954 were selected for advanced testing. However, these accessions were not kept separate and it is not known if they were included in the bulk harvest.

This accession was selected from the 1980 Warm Season Grass IEP, project plan #04I943T. The 1980 IEP consisted of 80 accessions of *Aristida* spp., 8 accessions of *Muhlenbergia porteri* and 27 accessions of *Anthephora pubescens*. In 1988 all of the accessions, which were phenotypically purple threeawn, were bulked together and assigned one accession number--9055864. All of these accessions exhibited similar vigor, growth habit and flowering times. Purple threeawn was selected for Advanced Testing because it is highly desirable native cool season perennial grass that is adapted to MLRA's 30, 40 and 41. In these areas purple threeawn has high potential for use in critical area stabilization, environmental protection of abandoned or retired cropland and reduction of soil erosion on desert rangelands.

In 1996 this project was dropped from the Tucson PMC testing program due to the uncertain genetic makeup of the bulk harvested material and that this species is commercially available.

DURATION OF STUDY: 1991 through 1997

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Tucson PMC, UofA

STATUS OF KNOWLEDGE: Purple threeawn (*Aristida purpurea* var. *purpurea*) is an erect perennial bunchgrass that is mostly 30 to 60 cm. tall; leaves are fine, narrow and involute; inflorescence is a panicle 10 to 25 cm. tall with main axis and branches flexuous and curving under the weight of the maturing spikelets; inflorescence is erect before spikelet maturity and after seed has shattered; spikelets are one flowered and reddish-violet at maturity; glumes are very unequal with the second as much as twice as long as the first; lemmas are indurate with a hard sharp pointed, usually bearded, callus; awns are 3 to 4.5 cm. long, fine and delicate, deeply colored on the mature grain (Gould 1973).

Flowering occurs from March to September. Species are found on rocky or sandy plains or slopes, along roadsides at elevations of 305-1525 meters but occasionally as high as 2135 meters. Purple threeawn is found in all counties of Arizona except Navajo, Coconino, Greenlee and Yuma (Gould 1973). It is also found in southern California in the Coastal Sage Scrub and Creosote Bush Shrub vegetation zones (Munz 1968).

The basic chromosome number is X=11 (Gould 1968). Gould in 1958 found chromosome counts on n=11 for *A. purpurea* var. *purpure*a, *A. purpurea* var. *longsetia*, and *A. divaricata* (Humb. and Bonpl.). *Aristida ternipes* Cav. was recorded as a tetraploid, with n=22, and *A. wrightii* as a hexaploid, with n=33 (Gould 1958). It is generally considered that most Aristida species are C4 plants. *Aristida oligantha* (Michx.), *A. adscencionis* and numerous other threeawn species from Argentina are C4 plants (Cavagnaro 1988, Engle 1990).

Generally, threeawns are considered pioneer or primary successional species. They are considered to be of low palatability and provide low to moderate amounts of forage. Some species of threeawn, Prairie and Sixweeks, have been found to exhibit allelopathic effects on other plants (Sarma 1983, Engle 1990). Germination and pollination/seed production information is limited to non-existent (Allred 1986-Rhodora). In regards to germination Jackson (1928) found that threeawn seeds germinate just as well in light as they do in dark with best germination at 25^{o}C. Also, it was found that isopropyl-N-phenyl carbamate (IPC) at a concentration of 0.05 percent actually increased the total germination of purple threeawn at 18^{o}C (Al-Aish 1958). Germination and establishment of *A. purpurea* var. *longiseta* was improved when seed was planted under a litter or rock cover (Fowler 1968).

Seed harvesting has always been difficult. PMC personnel have had good results using the Woodward Flail-vac seed harvester. This machine is very effective in stripping the mature seed from the inflorescence. Other producers harvest the seed by hand. Conditioning the seed, removing the awns, is still difficult. At the Tucson PMC we have tried to remove the awns using a Westrup Brush Machine. Our results have been less than satisfactory. A combination of using a hammermill, brush machine and a office clipper/cleaner may provide as clean product as can be achieved.

LITERATURE CITED:

Al-Aish, M and W.V. brown, Grass Germination Responses to Isopropyl-Phenyl Carbamate and Classification, American Jour. of Botany, 45, pp. 16-23.

Allred, K.W. 1986. Studies in the Aristida (Gramineae) of the Southwestern United States. IV. Key and Conspectus. Rhodora, 88 pp. 367-387.

Cavagnaro, J.B. 1988. Distribution of C3 and C4 grasses at different altitudes in a temperate arid region of Argentina. Oecologia, 76 pp. 273-277.

Engle, D.M., T.G. Bidwell, J.F. Stritzke, and D. Rollins. 1990. Atrazine and burning in tallgrass prairie infested with prairie threeawn. Jour. of Range Mange., 43(5), pp. 424-427.

Fowler, N.L. 1986. Microsite Requirements for Germination and Establishment of Three Grass Species. The Amer. Midland Naturalist, 115(1) pp. 131-145.

Gould, F.W. 1973. Grasses of Southwestern United States. The University of Arizona Press, Tucson, Arizona. pp. 242.

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Gould, F.W. 1958. Chromosome Numbers in Southwestern Grasses. American Jour. of Botany. 45 pp. 757-767.

Jackson, C.V. 1928. Seed Germination in Certain New Mexico Range Grasses. Botanical Gazette, 86, pp. 270-294.

Munz, P.A., D.D. Keck. 1959. A California Flora. University of California Press, Berkeley and Los Angeles, California. pp. 1534-1535.

Sarma, K.K.V. 1983. Allelopathic Potential of the Phytoextracts of *Aristida adscensionis* Linn., Tropical Ecology, 24(1), pp. 19-21.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: None

OTHER ACTIONS: Plant guide

STUDY NUMBER: 04A9302L

Yuma Proving Grounds AE/Cultural Trials - Final Report

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Natural area, Rangeland

VEGETATIVE PRACTICES:	**PRIMARY:**	342	CRITICAL AREA PLANTING
	SECONDARY:	561	HEAVY USE AREA
	TERTIARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Air	Air quality, other.

DESCRIPTION: This project was initiated in late 1992 in order to determine efficient methods of revegetating disturbed areas in the Mohave Desert. Plants chosen for this project were the predominant perennial species in the Yuma Proving Ground area: big galleta, white bursage, creosote bush, and desert saltbush. In 1993 the Natural Resources Conservation Service was requested to expand the desert revegetation project currently existing with Yuma Proving Grounds (U.S. Army) and the Yuma and Laguna Conservation Districts.

The amended project was initiated in 1993 as an experimental demonstration of the potential of various container sizes and irrigation regimes in the establishment of desert plants on disturbed, arid sites. The knowledge obtained in the initial project will be applied to actual sites. Tucson PMC personnel will also prepare a literature review on additional technologies such as chemical and physical soil stabilization materials and the interactions with stabilizers and plant materials in the establishment of plant materials.

It is important to realize that many disturbed arid areas will never revegetate naturally. This is evidenced by still visible prehistoric Anasazi pueblos and roads, as well as numerous areas of more recent date such as ghost towns, historical military maneuver areas, aqueduct and power construction corridors, etc.. The need for efficient revegetation methods in these difficult areas is apparent.

The objectives of this project are: to produce short-term soil stabilization through the use of vegetation to protect air quality; to revegetate the area for long-term soil stabilization to reduce soil erosion, increase the aesthetic and wildlife habitat value of the disturbed areas, and to replace at least part of the original desert flora on actual sites; and to reestablish higher successional flora for camouflage and cosmetic purposes.

DURATION OF STUDY: 1993 through 1997

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Dept. of Defense, Yuma and Laguna NRCD's, Tucson Plant Materials Center.

METHODS AND MATERIALS: The purpose of the initial evaluation planting was to test the effect of irrigation regimes (2 regimes) and pot size (3 sizes) on the establishment of the plant materials. The design was a completely randomized design. Two separate 60'x60' plots were laid out in 10'x10' treatment blocks. Each 10'x10' treatment block had 10 plants irrigated using drip tubing. Each of the treatment blocks contained a single species in one pot size. The species and pot size were randomly distributed among the blocks.

Two 60'x60' plots were indstalled for the purpose of testing two irrigation regimes: 1) 1 gallon per hour at 1 time per week, and 2) 1 gallon per hour 1 time every two weeks. Each species was grown in three pot sizes in each plot or irrigation regime. An additional 60'x60' plot was installed to evaluate a one irrigation ("mudding in") regime. The pots used were the following three sizes: SuperCells (8.25" deep and 10 in^3), Deepots (10" deep and 40 in^3), Treepots (16" deep and 555 in^3or 2 gallons).

The species used in all of the above-mentioned plots are: creosote bush (*Larrea tridentata*), white bursage (*Ambrosia dumosa*), big galleta (*Hilaria rigida*), and desert saltbush (*Atriplex polycarpa*).

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Revegetation Fact Sheet targeted for the Mohave desert.

RESULTS:

1993

Seeds from creosote bush, white bursage and big galleta were collected in the summer of 1993 by Rhonda Beyke of the YPG Environment and Safety Department. Further collections of seed were made by TPMC and YPG staff on August 10 & 11, 1993. Collections of white bursage and creosote cuttings in the YPG area were made by Kathy Bade (TPMC) on September 21, 1993. Seeds were stored in plastic ziploc bags. Cuttings were stored in ziploc bags with damp paper towels wrapped around the base of the cuttings and put into a cooler with ice until they could be put into soil for rooting.

Seed germination experiments were conducted comparing leached and unleached seed for white bursage, creosote bush and desert saltbush under two temperature regimes (16 hours at 70 °F and 8 hours at 50 °F versus 16 hours at 80 °F and 8 hours at 60 °F). These temperatures were chosen as based on normal winter temperatures in the winter and early spring months when seed generally germinates. The results (Table 1) showed that warmer temperatures are very important for big galleta germination, and gave better results for creosote bush and white bursage also. Desert saltbush was not as affected by the temperature differences and gave comparable results at both regimes. The big galleta seed that had not germinated after 17 days at the lower temperatures proceeded to almost immediately germinate when moved to the higher temperatures and 11 out of 20 seed (55%) were germinated after 8 days at the higher temperatures.

On August 10 & 11, 1993, soil from under mature plants of creosote bush, white bursage, and big galleta was collected as mycorrhizal inoculant for the soil mix that the seeds will be grown in. This is a recommended procedure for inoculating desert plants, as most of these plants benefit greatly from mycorrhizae. Soil samples from 0-3 inches and 3-6 inches were collected from the site that the demonstration project will be installed on for future analysis for pH, texture, and possibly $CaCO_3$ and nutrients.

Potting soils used for this project were two types: the first included SuperSoil brand cactus mix, which was mixed with 1/20 part mycorrhizal inoculant (soil taken from under mature plants of the same species as the seed) and a small amount of gypsum (≈1/100), and the second soil mix made of one part sand, one part standard potting soil likewise mixed with mycorrhizal inoculant and gypsum (as above).

Several methods of seed conditioning were tried for the various types of seed. Creosote bush seed was cleaned with a Westrup Brush Machine using a #14 mantle and a speed of 7, then this seed was processed with an air seed shucker and hand screened with a #12 round mesh screen. The seed aspirator was then used to eliminate dust and small particles. The product of this process was hulled seed.

White bursage was scarified using a Forsberg scarifier for 1.5 minutes, and then processed through the seed aspirator to remove small particles and dust. This did not hull the seed, but produced a rounded seed with the majority of the spines removed. We found that these seeds appeared to imbibe and germinate more quickly than unscarified seed.

Big galleta seed was cleaned in the same way as the creosote bush seed with the Westrup Brush Machine using a #14 mantle and a motor speed of 7, next using the air seed shucker, followed by hand-screening on a #12 round mesh, and finally the seed aspirator to remove particulates. The product of the conditioning process for big galleta was hulled seed.

Desert saltbush seed was cleaned by using the Westrup Brush Machine and a #14 mantle and a speed of 10. It was then processed twice through the Office Clipper using screen sizes #9 on top and 1/22 on the bottom.

It was determined from the seed germination experiments that the hulled creosote seed germinated well without further treatment, so hulled creosote seed was planted into all pots. Scarified white bursage seed was planted, and hulled big galleta seed was planted into all pots.

The cuttings collected on September 21, 1993 were first cut down to approximately six inches in length, the bottom 1.5 - 2 inches of leaves were stripped off and leaves and small branches above this were trimmed. The cuttings were dipped in RootTone and placed in either sand or cactus mix potting soil. There were 268 cuttings of white bursage and 72 cuttings of creosote bush. These cuttings were kept under mist three times daily in the greenhouse until rooted, except for 40 of the creosote bush cuttings which were in the shadehouse at 2 minutes of sprinkling twice daily.

1994 RESULTS

Seed germination testing and results are detailed in the interim report for FY93. However, a summary of this information plus some additional observations on seedling growth and problems encountered will be presented in this report. The four species being evaluated in this project are: white bursage (*Ambrosia dumosa*), creosote bush (*Larrea tridentata*), big galleta (*Hilaria rigida*) and desert saltbush (*Atriplex polycarpa*).

Our germination experiments utilized two temperature regimes: (1) 16 hours at 70 °F, 8 hours at 50 °F and (2) 16 hours at 80 °F, 8 hours at 60 °F, based on normal winter temperatures in the winter and early spring months when this seed generally germinates. Results showed that the warmer temperature was extremely important for the big galleta to germinate, and also gave better results for creosote bush and white bursage as well. Desert saltbush performed equally well under either temperature regime.

Problems encountered in the germination of these species included very low germination rates for the white bursage seed, damping off of creosote seedlings, sensitivity of big galleta to any fungicide or insecticide used, accidental mister and sprinkler turnoffs at critical points resulting in death to quite a few seedlings, and herbivory by rabbits and insects. Larger seed collections and plantings would be indicated to offset these problems, as well as careful monitoring and transplanting of creosote so that seedlings do not receive too much water which greatly increases mortality. Literature suggests that this is due to a high oxygen requirement of the roots.

Also, starting seed in small pots and transplanting to larger ones as they grow appears to promote the health of all the plants. Larger containers planted to creosote, for example, were much less successful than the small and medium containers. It was discovered that white bursage cuttings rooted very well (50% or more of the cuttings in sand rooted) and that sand appears to be the best medium for this. The rooting of the white bursage cuttings work quite well and

showed a much higher success rate than seeding. It is important to keep the cut surface damp from the time the cuttings are made until they are planted. Creosote bush cuttings were also attempted, but although some produced new leaves, roots never appeared and eventually the cuttings died.

1995

On Tuesday February 8, 1994 the ground breaking ceremony was held for the Demonstration Planting at the Yuma Proving Grounds. Following the ceremony the irrigation system was installed. The system included three valves: valve 3 for the perimeter plantings (landscape, screening and protection), valve 2 for irrigation of the once every 14 days treatment and valve 1 for the once every seven day treatment. Valve box and timer were also installed. Signs were installed that described the project, delineated the boundaries and acted as barriers to vehicles. Plots were staked and flagged for installation of the plants. Big galleta (*Hilaria rigida*) supercells and deepots were planted. Total number of Big galleta plants installed were 60 (30 supercells and 30 deepots). Vegetative collections of White bursage (*Ambrosia dumosa*) and Creosote bush (*Larrea tridentata*) were made for plant propagation and replanting at the site.

On December 19-23, 1994 additional plants were installed in the irrigated treatments. This included Creosote bush (30 supercells & 30 treepots), Big galleta (30 treepots), Desert saltbush (*Atriplex polycarpa)* (30 deepots & 30 treepots), White bursage (30 supercells, 30 deepots & 30 treepots). A no-irrigation treatment was also installed. This included: Creosote bush (15 supercells & 15 treepots), Big galleta (15 deepots & 15 treepots), Desert saltbush (15 deepots & 15 treepots) and White bursage (15 supercells, 15 deepots & 15 treepots). The no irrigation plot followed the same statistical design and layout as the irrigated plots. A planting along the perimeter of the demonstration site was also installed which included 48 Desert saltbush and 58 Quailbush plants. Diamond cholla was previously planted along the perimeter near the signs. The perimeter planting was installed in a random fashion to simulate a natural setting.

The final planting was installed on January 23 & 24, 1995. This involved planting 30 Creosote deepots and 30 Desert saltbush supercells into the irrigated plots with an additional 15 Creosote deepots, 15 Creosote supercells, 15 Big galleta supercells and 15 Desert saltbush supercells were installed in the no-irrigation plot.

Throughout the planting process some general observations were made regarding the soil mix and plant age for the transplants. A heavier soil mix (more soil or sand) would facilitate easier root ball removal the plant container and the shrub species should have 1 to 2 additional months of growing time for each of the pot sizes. The Creosote plants were approximately 12 months old and the Desert saltbush were 5 months old. However, these species may typically have a delicate root system and additional time may not have produced a plant with a sturdier root ball.

In the no-irrigation plot the plants were installed using a process called "mudding in". Approximately 1 gallon of water was put into each hole and allowed to soak into the soil prior to planting. An additional pint of water was applied to the plant (in a small irrigation basin) after planting. Holes were approximately 8 inches deep by 6 inches in diameter for all containers except the treepots. Treepot holes were approximately 18 inches deep by 8 inches in diameter.

An additional seeding trial was installed to evaluate broadcast seeding and the use of mulch. This trial was composed of three treatments: A: applying an Aspen fiber mulch with tackifier over a seeded area (60' X 60'), B: applying Curlex aspen fiber erosion control blanket (stapled to the soil) over a seeded area (60' X 60'), and C: control area with no seeding or mulch cover. All three plots were tilled using an implement to break up the shallow (2-4") hardpan. Treatments were sprinkler irrigated (lawn sprinkler) for approximately one hour. The Aspen fiber mulch treatment was showing good grass seedling emergence. The seedlings appeared to be Needle grama (*Bouteloua aristidoides*) and Purple threeawn (*Aristida purpurea*). The curlex blanket had no visible seedling emergence. The control, as well as most of the plot, had numerous seedlings of various winter annuals such as: Spanish needle (*Palafoxia linearis*) and Sand mat (*Euphorbia polycarpa*) as a result of the early January rains.

Evaluations were started on March 15, 1994 for the Big galleta plantings and December 15, 1994 for the additonal plantings with evaluations conducted every week. Weekly evaluations were conducted until February 16, 1995 when they were stopped due to a lack of funding. Evaluations were resumed on August 24, 1995. Evaluations were then conducted once every two months with the final evaluation conducted on November 28, 1995. Evaluation factors were: plant vigor, height and survival. In addition observations were made regarding volunteer vegetation within the site. Data was summarized and analyzed using PC-SAS. Interpretation of the results are shown in figures 1 through 12. Our findings show that Creosote bush had higher survival and better growth in the larger pot size, Desert saltbush had better growth in

the larger pot size, and that all species showed no difference with regards to survival based on irrigation frequency. In other words, there was no difference in survival between the no-irrigation and once a week irrigation treatments. In addition, there was very little difference between pot sizes with regards to survival.

In summary, this demonstration planting has shown that the use of transplants is probably the best and may be the only method of revegetating a disturbed site in the very low Deserts. Also, plant survival was not dependent on any one pot size or irrigation frequency. However, if the objective of the planting is to initially have taller, vigorously growing plants, a larger pot size (older plant) and several applications of irrigation water will be required.

Table 1.

Seed Germination Test Results

Species[1]	Temp. Regime (°F)	Total Germ. on 8/23/93	Total Germ. On 9/8/93	Total Germ. From 50 Seed	Total Germ. %
white bursage (L)	50-70	0	2	2	4%
white bursage (UL)	50-70	0	0	0	0%
white bursage (L)	60-80	1	3	3	6%
white bursage (UL)	60-80	0	0	0	0%
desert saltbush (L)	50-70	16	20	20	40%
desert saltbush (UL)	50-70	16	18	18	36%
desert saltbush (L)	60-80	13	13	13	26%
desert saltbush (UL)	60-80	18	22	22	44%
hulled creosote (L)	50-70	20	25	25	50%
hulled creosote (UL)	50-70	16	23	23	46%
hulled creosote (L)	60-80	27	29	29	58%
hulled creosote (UL)	60-80	24	24	24	48%
unhulled creosote (L)	50-70	0	0	0	0%
unhulled creosote (UL)	50-70	0	0	0	0%
unhulled creosote (L)	60-80	0	1	1	2%
unhulled creosote (UL)	60-80	5	7	7	14%
big galleta (L)	50-70	0	0	0	0%
big galleta (L)	60-80	11	0	11	55%

[1] L = Leached UL = Unleached

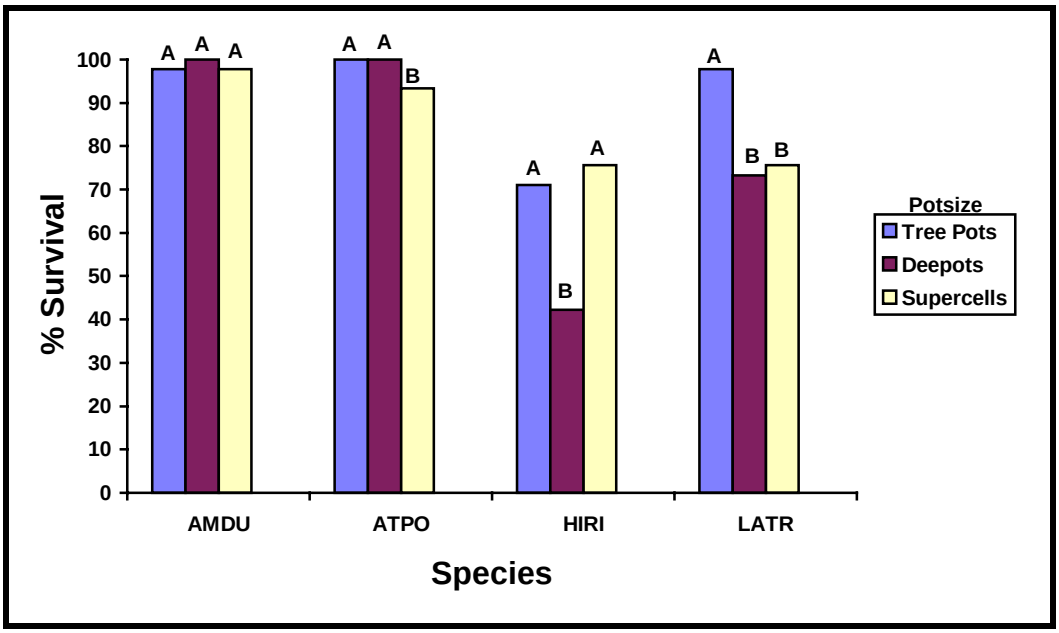

Figure 1: Percent survival for each species based on final evaluation data (11/28/95). Graph represents the means derived from the interaction between irrigation frequency and pot size. Means, by species, with the same letter are not significantly different at the 0.05 level of significance.

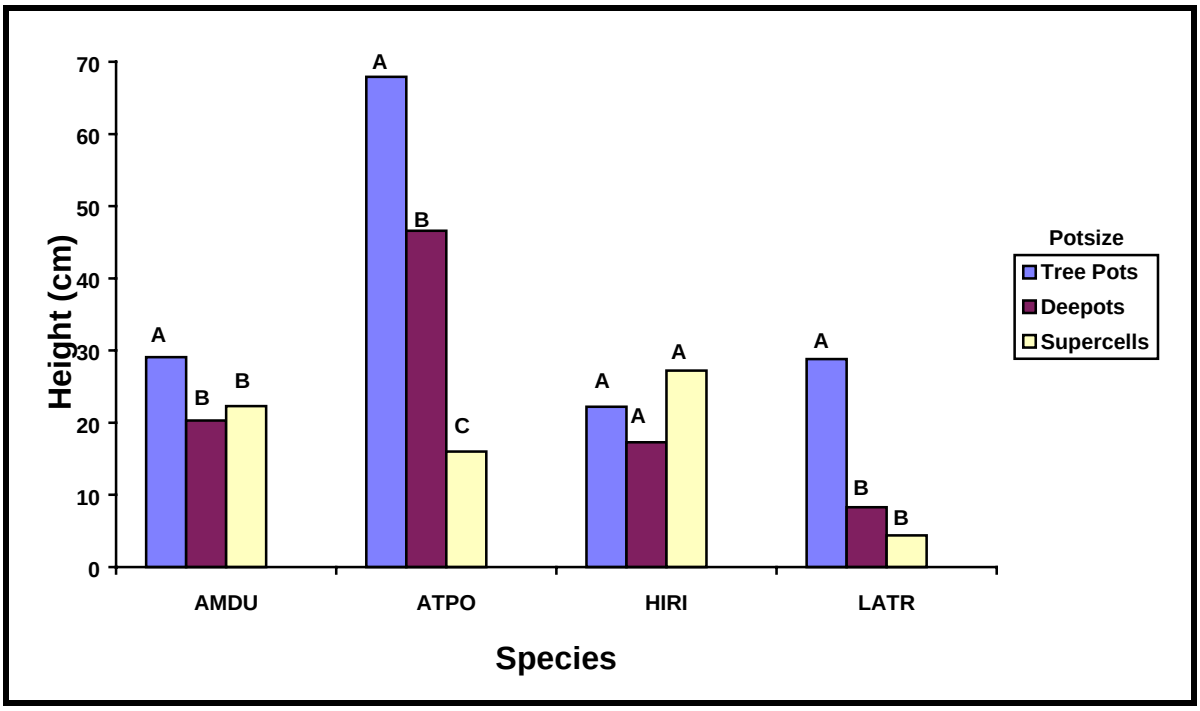

Figure 2: Height, measured in centimeters, for each species based on final evaluation data (11/28/95). Graph represents the means derived from the interaction between irrigation frequency and pot size. Means, by species, with the same letter are not significantly different at the 0.05 level of significance.

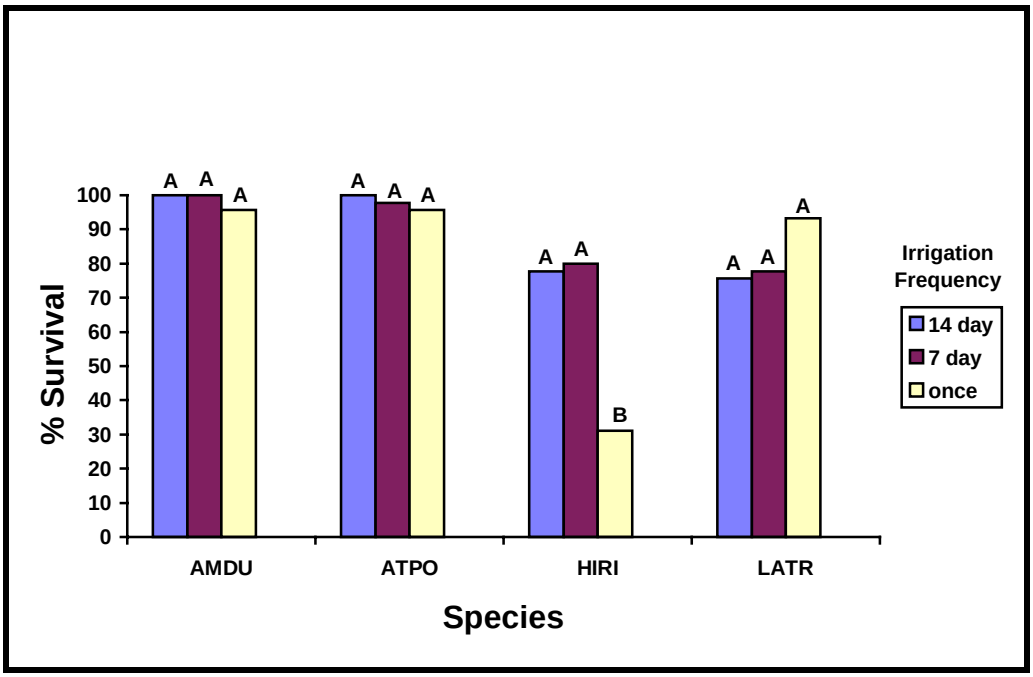

Figure 3: Percent survival based on irrigation frequency for each species. Means were calculated from the final evaluation data (11/28/95). Means, by species, with the same letter are not significantly different at the 0.05 level of significance.

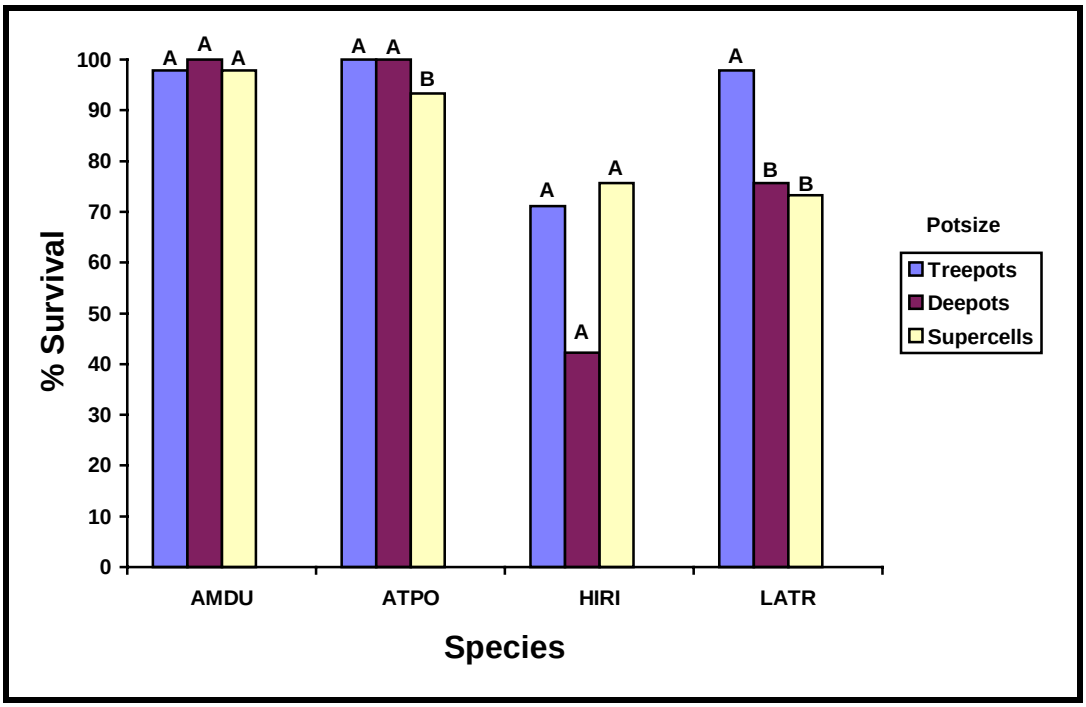

Figure 4: Percent survival based on potsize for each species. Means were calculated from the final evaluation data (11/28/95). Means, by species, with the same letter are not significantly different at the 0.05 level of significance.

Figure 5: Vigor ratings by pot size,over time, for white bursage (*Ambrosia dumosa*), averaged over three irrigation treatments.

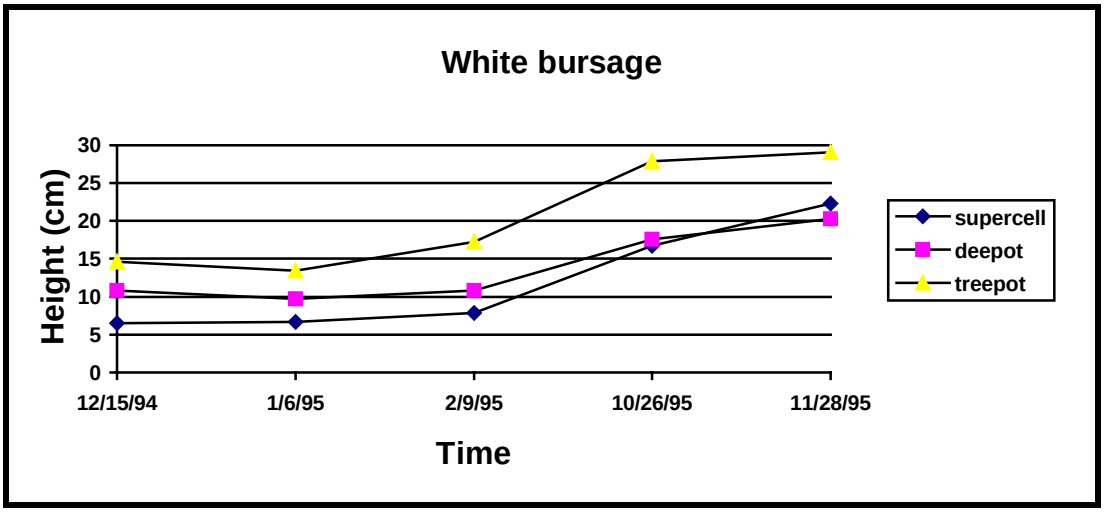

Figure 6: Height (cm), over time, by pot size for white bursage (*Ambrosia dumosa*) averaged over three irrigation treatments.

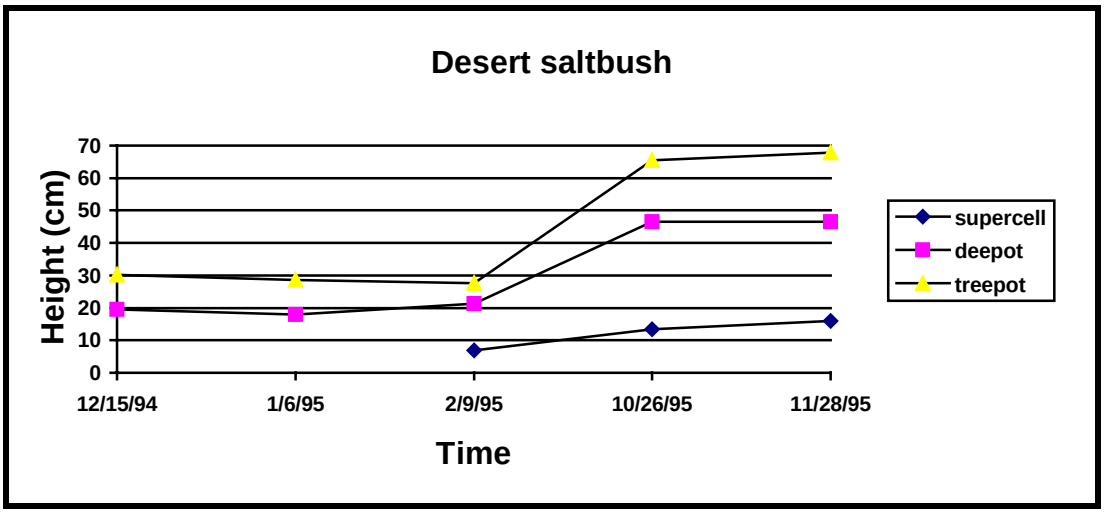

Figure 7: Height (cm), over time, by pot size for Desert saltbush (*Atriplex polycarpa*) averaged over three irrigation treatments.

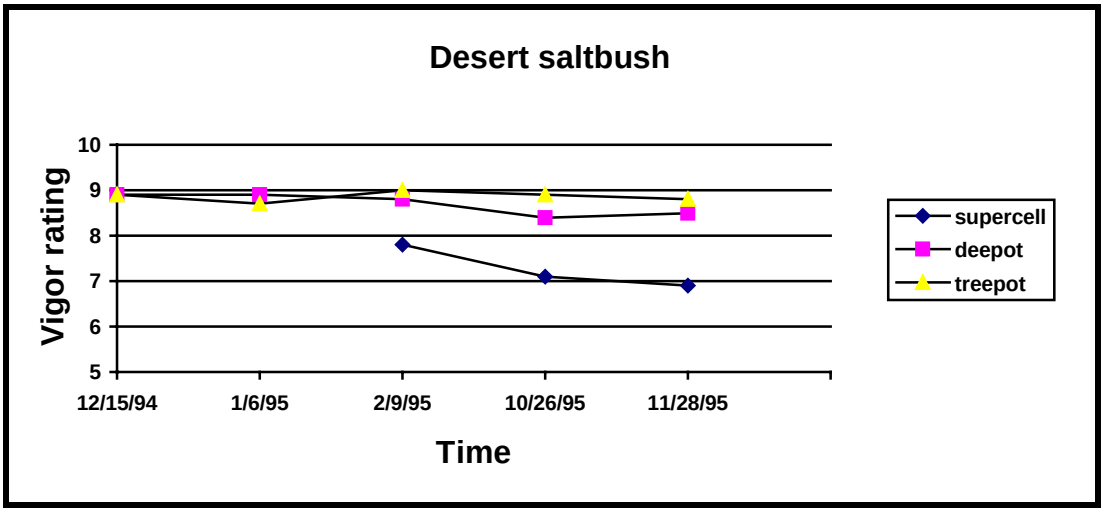

Figure 8: Vigor ratings by pot size,over time, for Desert saltbush (*Atriplex polycarpa)* averaged over three irrigation treatments.

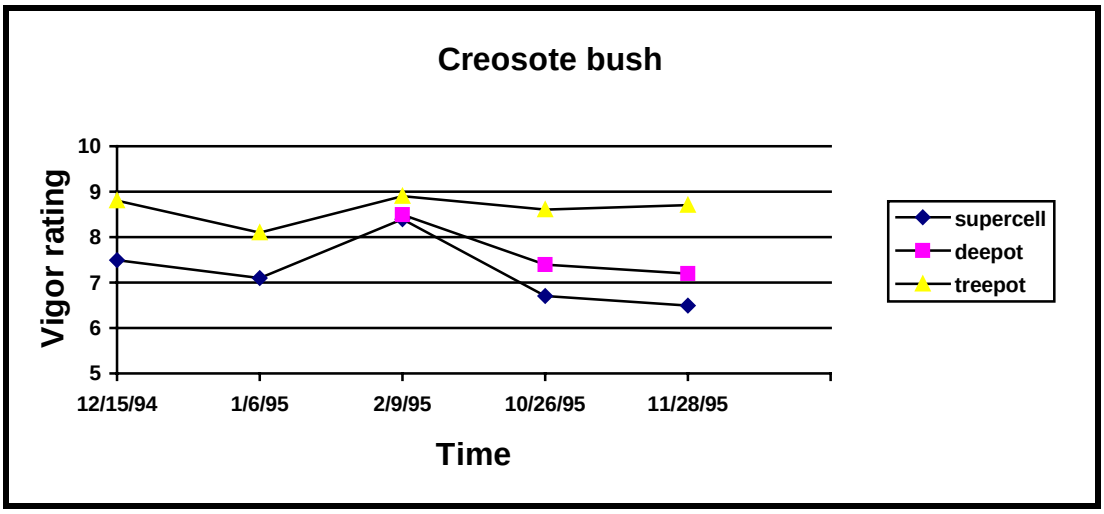

Figure 9: Vigor ratings by pot size,over time, for Creosote bush (*Larrea tridentata)* averaged over three irrigation treatments.

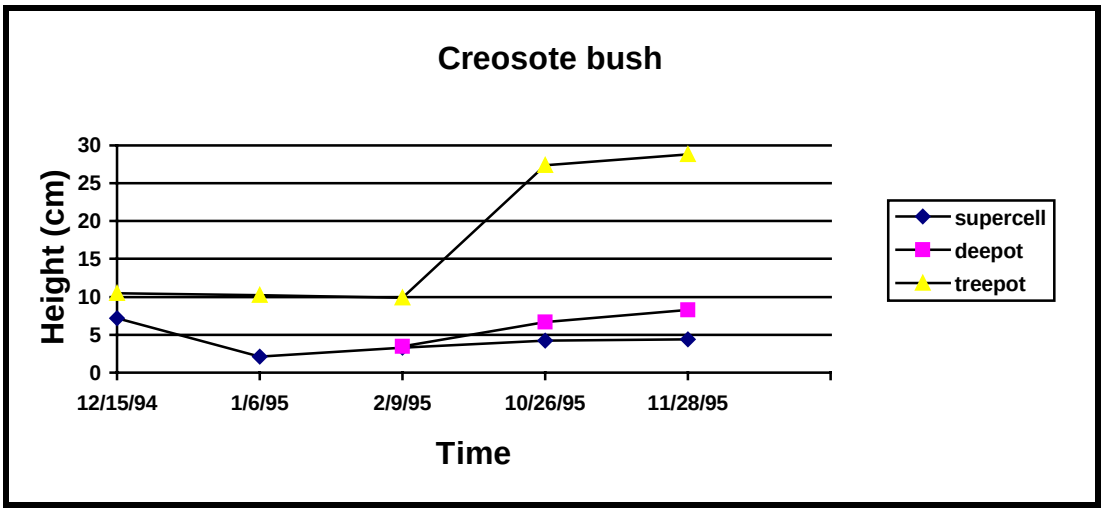

Figure 10: Height (cm), over time, by pot size for Creosote bush (*Larrea tridentata)* averaged over three irrigation treatments.

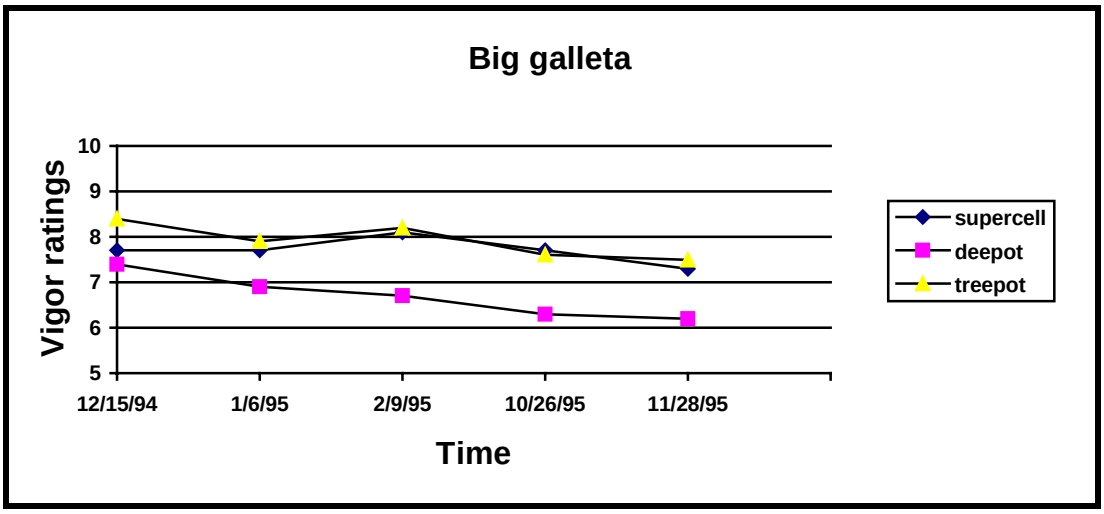

Figure11: Vigor ratings by pot size,over time, for Big galleta (*Hilaria rigida*), averaged over three irrigation treatments.

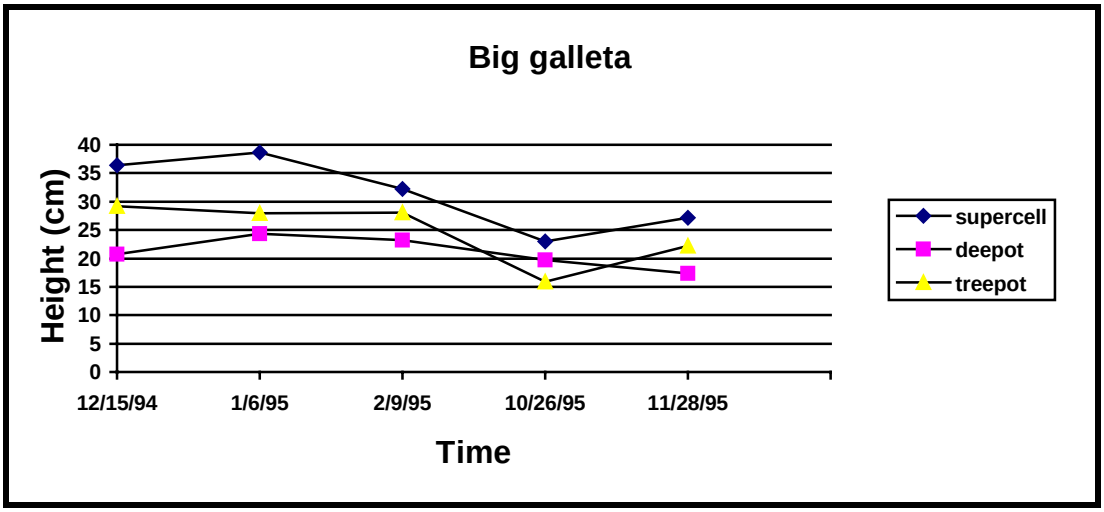

Figure12: Height (cm), over time, by pot size for Big galleta (*Hilaria rigida)* averaged over three irrigation treatments.

STUDY NUMBER: 04A9501L

Maggie Tank Hay Seeding - Using Grass Hay Bales.

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Comparative Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	550	RANGE SEEDING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
	TERTIARY:	342	CRITICAL AREA PLANTING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants management; establishment, growth, and harvest.
SECONDARY:	Soil	Soil erosion from sheet and rill.

DESCRIPTION: The Maggie Tank Hay Seeding project is located on private land within the Sheep Canyon grazing allotment. The allotment is approximately 12 miles south of Bowie, Arizona in Cochise County. The following people are involved in the project: Larry Humphrey and Ted McRae - BLM; Kim McReynolds - University of Arizona Cooperative Extension; Mark Pater - NRCS Tucson Plant Materials Center; Hugh Peterson - Ranch Manager. This project was designed to facilitate revegetation of deteriorated rangeland. Some natural revegetation had been occurring on the allotment over the past 10 years. However, there were areas that were not showing any significant response to improved grazing management. The idea was to use the cattle as a tool to plant grass seed by trampling around the area where hay was thrown out.

DURATION OF STUDY: 1995 through 1999

STUDY LEADER: Kim McReynolds, Mark Pater

LOCATION: ARIZONA PMC

COOPERATORS: Cooperative Extension Office - Willcox, Arizona (Kim McReynolds; BLM - Safford, AZ (Larry Humphrey, Ted McRae); Willcox Field Office (Don Decker); Hugh Peterson - Ranch Manager.

METHODS AND MATERIALS: In 1995, the Tucson Plant Materials Center supplied approximately 50 bales of plains bristlegrass and yellow bluestem hay for the project. On March 8, 1995 half of the hay (both species) was thrown out in a trap along a pre-set line that had been previously sampled for grass plants. Approximately 90 head of cattle (including calves) were kept in the trap for several days. The cattle had never been fed hay, so instead of picking through it to eat, they used it for bedding. The second seeding trial was conducted on September 3, 1995. Transects were established for baseline data and hay was thrown in a line similar to the first seeding. Data is being collected using the pace frequency method.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Technical Note, Amendment to Range Seeding Specifications

OTHER ACTIONS: Range Seeding Alternative Publication

RESULTS:

1995
The March 8, 1995 planting site was evaluated in October 1995 to determine if seeds did germinate and seedlings had become established. Transects were not run but 86 seedlings were counted along the line.

1996
Following a break in a severe drought, a transect for the March 8, 1995 planting was run in the fall of 1996. Significant differences in percent frequency of plains bristlegrass, yellow bluestem and burroweed were found. Plains bristlegrass showed a 42% frequency, burroweed a 20% frequency and yellow bluestem exhibited a 4% frequency (see Table 1 and Chart 1).

The September 3, 1995 trial was evaluated on October 23, 1996. Significant differences in percent frequency were found in fluffgrass, yellow bluestem, plains bristlegrass, burroweed, snakeweed and mesquite (see Table 2 and Chart 2). Observations revealed that the March 8, 1995 planting has significantly more grass than before but the plants appeared less healthy. This may be due to two factors. First, the hay may have been spread too thin which allowed the hay to break down faster and the seedlings did not have added protection and moisture. The second and obvious one is that they were greatly stressed during the drought period. It was surprising that any plants survived. The September 3, 1995 planting did not spread the hay out as thin as the first planting. At first this was thought to have been a mistake because no germination was observed. However, by the time the drought ended, the hay had decomposed enough that much better germination and survival was observed in comparison with the March 8, 1995 planting.

In addition, one buffelgrass and one pink pappusgrass plant were noted. The buffelgrass is not expected to survive the cold winters at this site. Also, with the heavier hay application, an abundance of threeawn plants had become established on the edges of the hay line where they could take advantage of the more hospitable microclimate.

MAGGIE TANK HAY SEEDING
Pace Frequency Summary
First Trial - First Line of 100

Table 1

SPECIES	% FREQUENCY 1995	% FREQUENCY 1996
fluffgrass (TRPU)	2	7
black grama (BOER)	1	0
tobosa grass (HIMU)	1	0
threeawn (ARIST)	1	0
plains bristlegrass (SEMA)	0	42*
yellow bluestem (BOIS)	0	4*
ambrosia (AMBRO)	0	3
hog potato (HODE)	0	1
burroweed (b) (HATE)	28	18*
burroweed (c) (HATE)	20	2*
snakeweed (b) (GUSA)	1	3
snakeweed (c) (GUSA)	0	2
mesquite (b) (PROSO)	2	0
mesquite (c) (PROSO)	8	7

* Significant difference at p=0.95

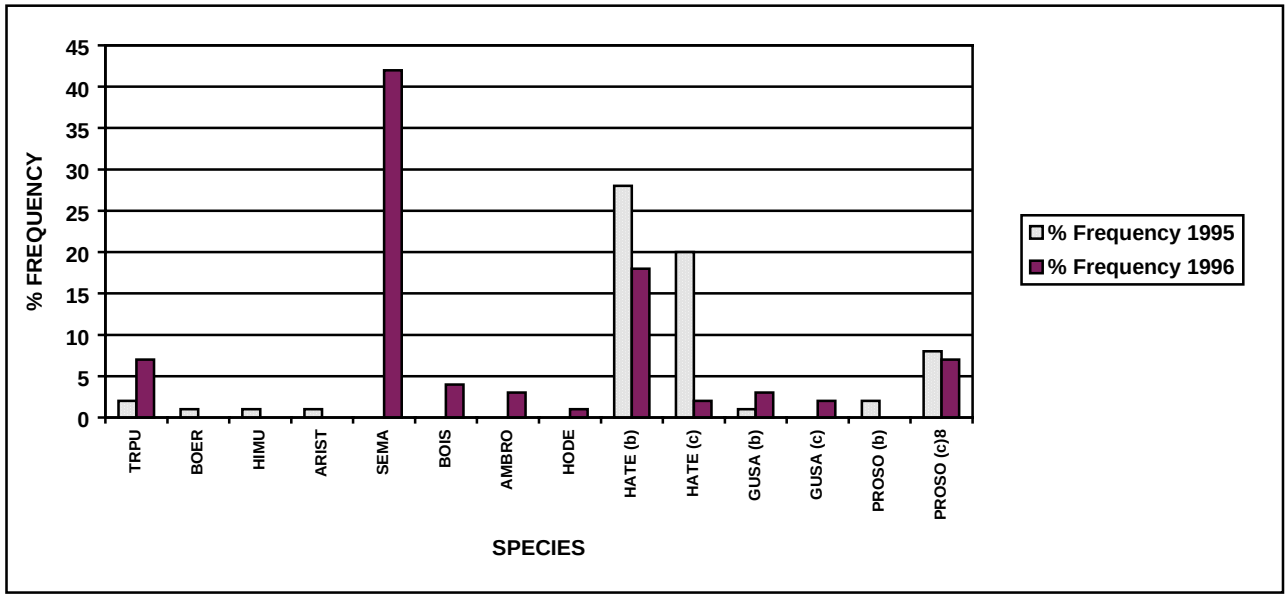

Chart 1. Comparison of percent frequency summary for all species found along the first trial transect evaluated in the fall of 1996.

MAGGIE TANK HAY SEEDING
Pace Frequency Summary
Second Trial - First Line of 100

Table 2

SPECIES	**% FREQUENCY 1995**	**% FREQUENCY 1996**
fluffgrass	20	2*
threeawn	4	10
plains bristlegrass	2	41*
yellow bluestem	0	46*
bush muhly	2	0
sand dropseed	2	0
buffelgrass	0	1
Lehmann lovegrass	0	1
hog potato	10	1*
composite spp.	4	0
soaptree yucca (b)	0	0
soaptree yucca (c)	2	0
creosote (b)	0	1 (seedling)
creosote (c)	0	0
burroweed (b)	33	6*
burroweed (c)	15	2*
snakeweed (b)	11	0
snakeweed (c)	8	1*
mesquite (b)	3	3 (seedlings)
mesquite (c)	6	0*

* Significant difference at p=0.95

MAGGIE TANK HAY SEEDING
Pace Frequency Summary
Second Trial - First Line of 100

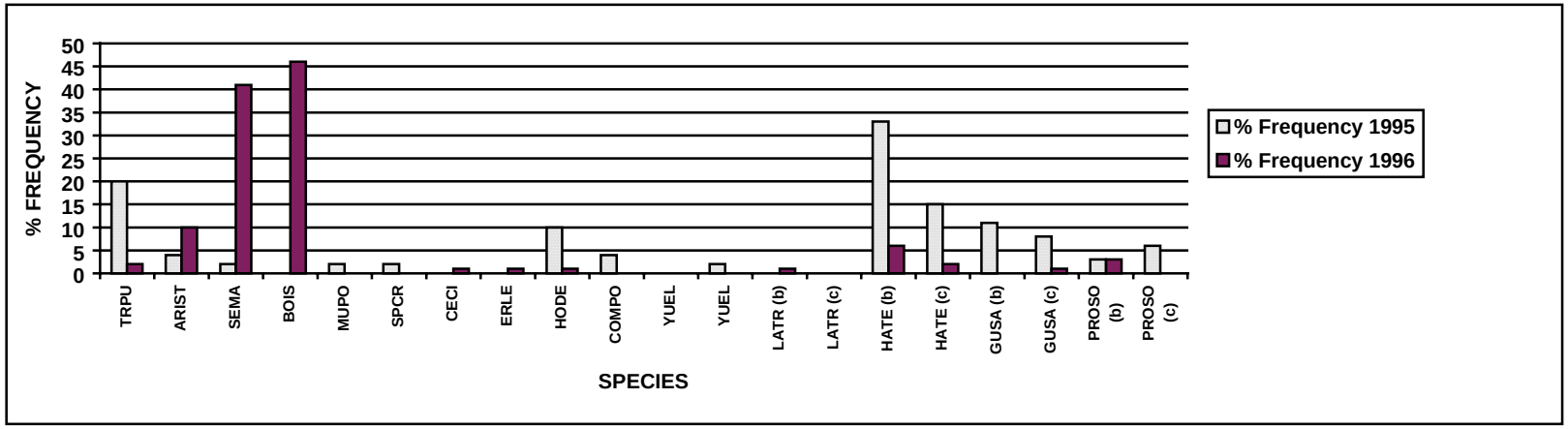

Chart 2. Comparison of percent frequency summary for all species found along the second trial transect evaluated on October 23, 1996.

Key:						
	TRPU	fluffgrass	ERLE	Lehmanns lovegrass	PROSO	mesquite
	ARIST	threeawn species	HODE	hog potato		
	SEMA	plains bristlegrass	COMPO	composite species		
	BOIS	yellow bluestem	YUEL	soaptree yucca		
	MUPO	bush muhly	LATR	creosote bush		
	SPCR	sand dropseed	HATE	burroweed		
	CECI	buffelgrass	GUSA	snakeweed		

MAGGIE TANK HAY SEEDING
Species List (1995-1996)

Table 3

COMMON NAME	SCIENTIFIC NAME
black grama	*Bouteloua eriopoda*
buffelgrass	*Cenchrus ciliaris*
bush muhly	*Muhlenbergia porteri*
fluffgrass	*Tridens pulchellus*
Lehmann lovegrass	*Eragrostis lehmanniana*
plains bristlegrass	*Setaria macrostachya*
sand dropseed	*Sporobolus cryptandrus*
threeawn	*Aristida spp.*
tobosa	*Hilaria mutica*
yellow bluestem	*Bothriochloa ischaemum*
pink pappusgrass	*Pappophorum bicolor*
ambrosia	*Ambrosia spp.*
composite	*Composite family*
hog potato	*Hoffmanseggia densiflora*
burroweed	*Haplopappus tenuisectus*
creosote	*Larrea tridentata*
mesquite	*Prosopis juliflora*
snakeweed	*Gutierrezia sarothrae*
soaptree yucca	*Yucca elata*

STUDY NUMBER: 04A9701L

Southwestern Borderlands Savanna Grassland Ecosystem Restoration Study

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Comparative Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES: **PRIMARY:** RANGE SEEDING

SECONDARY: WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	CONSIDERATION/PROBLEM
PRIMARY:	Plants	Plants management; establishment, growth, and harvest.
SECONDARY:	Soil	Soil erosion from sheet and rill.

DESCRIPTION: The Borderlands Ecosystem Project area covers nearly 1 million acres in southeastern Arizona and southwestern New Mexico and includes the San Bernardino, southern San Simon and Animas Valleys. Much of the region supports semi-desert grass-shrub ranges and woodlands that are vital for livestock growers and local economies. This vegetation type occupies a strip of 50 to 100 miles along the United States-Mexico border in Arizona, New Mexico, and west Texas (Martin 1975). Elevations generally are from 3,000 to 6,000 feet. Precipitation, depending on geographic location along a northwest to southeast axis, ranges from 8 to 20 inches annually. In order to better understand and quantify the effects of different management practices on encroachment of woody species in grasslands and savannas, a multiple year research study is being implemented that considers the effect of several management strategies on ecosystem processes, function and composition. Other partners, in addition to the Rocky Mountain Experiment Station and Coronado National Forest included the Natural Resources Conservation Service (NRCS), the Whitewater Draw Natural Resource Conservation District, Arizona State Land Department, Malpai Borderlands Group, Hidalgo Soil and Water Conservation District, Animas Foundation, and U.S. Fish and Wildlife Service at the San Bernardino National Wildlife Refuge. The objective of the research study is to evaluate the impacts of a number of management treatments on components of the rangeland ecosystem: soils, vegetation, wildlife, and livestock. In Arizona, study locations include the San Bernardino National Wildlife Refuge (NWR), the Malpai Ranch, and the Sycamore Ranch. Locations on both the Malpai Ranch and the Sycamore Ranch include land leased from the State of Arizona. In New Mexico, the locations include the George Wright pasture of the Gray Ranch and a location north of Rodeo on the Roos Ranch. Study areas are easily accessible for logistical reasons and enhanced value for demonstration and learning. The focus of this study is not eradication of woody species, but rather a reduction of woody species density to

improve range and watershed condition and promote development of a viable and productive perennial grass component. A successful treatment would be expected to produce a savanna condition with more widely scattered woody species and improved herbaceous cover, condition and productivity. Past efforts to mechanically control mesquite in the area have focused on either lifting of individual plants and root systems or root plowing and shearing. These treatments result in significant soil disturbance. An alternative mechanical treatment using a Marden duplex drum brush cutter (roller chopper) is being proposed for much of this study. While the brush cutter will not kill plants, it should be effective in breaking down crowns and breaking up the soil surface while incorporating some of the crown organic material into the upper soil layer and minimizing further soil disturbance. The treatment also reduces the transpiring leaf surface area of the mesquite plants. Mechanical treatment will be combined with and without native species seeding appropriate to each site. Sprouting of woody species is expected, however, establishment of an herbaceous layer should allow effective use of prescribed fire to control sprouts in the near future. Herbicides will not be used as part of this study.

DURATION OF STUDY: 1997 through 2000

STUDY LEADER: C. Edminster, R. Bemis, M. Pater

LOCATION: ARIZONA PMC

COOPERATORS: Rocky Mountain. Experiment Station, Coronado N.F., Douglas F.O., Whitewater Draw NRCD, AZ State Land Dept., Malpai Borderlands Group, USFWS, Hidalgo SWCD, Animas Foundation.

METHODS AND MATERIALS: Treatments planned for the locations at the San Bernardino NWR, the Malpai Ranch, the George Wright pasture at Gray Ranch, and the Roos Ranch include (1) Control (no treatment), (2) Congregating livestock into small area for a few days and feeding hay, and (3) Hand cutting mesquite to reduce transpiration while increasing coarse organic material on the soil, congregating livestock and feeding hay. Native species hay for this portion of the study is being provided by the NRCS Tucson Plant Materials Center. The Borderlands research project currently has two years (1997 and 1998) remaining onn its original charter. Plans are to implement the treatments in the spring of 1997 and monitor results for a minimum of two growing seasons. Hopefully the project charter will be extended to allow for continued monitoring and implementation of future prescribed burning treatments.

STATUS OF KNOWLEDGE: One of the persistent concerns in many ecosystems in the Southwest is the increase in density of shrubs and trees during the past century years (Martin 1975; Dahl et al. 1978; Branson 1985; Ruyle et al. 1988; Brown and Archer 1989; Grover and Musick 1990; Bahre 1991). Of particular interest in the Borderlands Project area are increases of velvet mesquite in Arizona and honey mesquite in New Mexico (Little 1980). At higher elevations in the region, concern focuses on one-seed juniper and alligator juniper. Traditional explanations for this increase have focused on changes in climate, livestock grazing, and fire regimes. Recently an alternative hypothesis that encroachment of

woody plants into grass dominated communities is driven by increases in atmospheric CO_2 has been proposed (Mayeux et al. 1991; Polley et

al. 1994; Idso 1992; Johnson et al. 1993). While atmospheric CO_2 increases and possible climate change may have facilitated shifts to woody plant domination, numerous case studies have established a strong link between effects of changes in fire regimes and livestock grazing management on encroachment of woody plants into grasslands and savannas (Archer et al. in press). The goal of public land managers and ranchers in the Borderlands area is to manage the semi-desert grasslands and savannas according to the concepts of ecosystem management with emphasis on sustaining, and where needed, restoring ecological function and production and health of the entire ecosytem, from soils to humans. Goals in the region are to improve and rehabilitate rangelands to the benefit of a majority of components. This is anticipated to support rural livelihoods and, in turn, protect to open space nature and biodiversity of the landscape. An objective of the proposed study is to determine if and how the shrub and tree components can be managed for the ecological and economic benefit of the system. Improved composition and density of perennial grasses, preferably native species, and reduced influence of mesquite and other woody species are immediate objectives. The eventual return of fire, a natural component of the ecosystem and management tool, is of particular interest.

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TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Technical Note

OTHER ACTIONS: Publication on using native grass hay for range reseeding.

STUDY NUMBER: 04A010H

Six Mile Flat Field Evaluations - Nevada Adaptation Trials, Caliente, Nevada.

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland, Wildlife

VEGETATIVE PRACTICES:

PRIMARY:	550	RANGE SEEDING
SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants management; establishment, growth, and harvest.
SECONDARY:	Animals	Animals habitat, food.

DESCRIPTION: The Six Mile Flat planting site is located 31 miles west of Caliente, Nevada on Highway. To date, Tucson PMC personnel have conducted 6 plantings on this site.

The planting design on the site is a completely randomized block design using four replications for each accession being evaluated. A cultural treatment planting was also installed on this site in 1989 to evaluate plant/stand establishment using furrows and pitting.

To date, 62 accessions encompassing 17 different species have been planted on the Six Mile Flat site. The planting site is located in MLRA 29. The soils are classified as Toyken series with a coarse sandy loam texture. Average annual precipitation for this area is 178 mm and the elevation is 1,495 meters.

Indigenous species found on this site include: budsage (*Artemesia spinescens*), spiny hopsage (*Grayia spinosa*), spiny horsebrush (*Tetradymia axillaris*), snakeweed (*Gutierrezia sarothrae*), Mormon tea (*Ephedra* spp.), squirreltail (*Sitanion hystrix*), indian ricegrass (*Oryzopsis hymenoides*), big galleta (*Hilaria jamesii*), and fluffgrass (*Tridens pulchellus*).

Cooperating agencies and groups include: BLM, Lincoln County Conservation District, Nevada State Land Department - Division of Forestry, NRCS - Caliente Field Office and the Tucson Plant Materials Center. The purpose of this planting is to evaluate and select the best adapted plant materials to meet the conservation needs for MLRA 29.

The ten acre site is primarily used for replicated testing of selected plant materials (released cultivars as well as materials in Advanced Evaluation) received from various plant materials centers located in the western United

States. The site is also used to evaluate cultural treatments which may aid in plant establishment. Another objective is to use this site as a demonstration site to show cooperators and interested groups which plant materials are most successful in establishing vegetative cover in MLRA 29.

DURATION OF STUDY: 1987 through 2000

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Caliente NRCD, BLM, Tucson Plant Materials Center.

METHODS AND MATERIALS: The replicated plantings were installed using a randomized complete blocks design with each accession being replicated four times. Each planting block for each replication measured 1.83 x 15.24 m (6 x 50 feet) and was cleared of all existing vegetation using a rear-mounted undercutter knife on a Case 275 tractor (see Project Plan Map). Since 1987, the seed has been planted using either a Planet Junior (hand-operated or tractor-mounted), hand broadcasting, a rangeland drill, and a Kincaid No-Till Plot Drill. Seed was planted directly into the cleared evaluation blocks. Seeding depth and rate varied but followed NRCS recommendations for species and seed size.

The first planting was conducted in November, 1987. This planting included the following list of plant species:

SPECIES	CULTIVAR/ACCESSION
fourwing saltbush	478837
	9003134
	478838
	9003136
	9003126
	'Rincon'
	'Santa Rita'
	'Marana'
	'Wytana'
indian ricegrass	478833
	9035287
	'Nezpar'
	'Paloma'
basin wildrye	478831
	'Magnar'
	'Prairieland'
lovegrass species	'A-67'
	'Cochise'
mediterranean ricegrass	253339
smilograss	198091

The second planting was conducted in November, 1988. This planting was installed using the following species:

SPECIES	CULTIVAR/ACCESSION
alkali sacaton	421071

	421069
	‘Saltalk’
	‘Salado’
penstemon	9004621
	9007036
	‘Cedar’
	‘Bandera’
russian wildrye	‘Bozoisky-select’
	‘Vinall’
bush muhly	9003824
	‘El Vado’
streambank wheatgrass	9021076
	‘Critana’
slender wheatgrass	‘Primar’
	‘Pryor’
	‘San Luis’
mammoth wildrye	‘ND-691’
	‘Volga’
western wheatgrass	‘Rodan’
crested wheatgrass	‘Nordan’
	Standard Syn. 1
	‘Fairway’
	‘Hycrest’
	‘Ephraim’
	‘P-27’

The third planting was conducted on July 25, 1989. The following is a list of the species that were planted:

SPECIES	**CULTIVAR/ACCESSION**
black grama	‘Nogal’
	‘Sonora’
blue grama	‘Hachita’
	‘Lovington’
sideoats grama	‘Haskell’
	‘El Reno’
	‘Vaughn’
	‘Niner’
buffelgrass	9003686
	T-4464
yellow bluestem	P.I. 237110
	‘Ganada’
lovegrass species	‘A-67’
	‘Catalina’
	‘Cochise’

July 25, 1989 planting list (continued):

SPECIES	**CULTIVAR/ACCESSION**
western wheatgrass	‘Arriba’
	‘Barton’
	‘Rosana’
	‘Rodan’

mediterranean ricegrass	253339
smilograss	198091

The 1989 cultural treatment planting objective was to evaluate the use of pits and furrows and their ability to assist in the establishment of perennial vegetation. This particular planting site borders the east side of the replicated planting area. The total area for the cultural treatment planting encompasses 2.5 acres. The area was divided into 3 blocks of equal size: the pitted area located in the south 1/3, the control area located in the center, and the furrowed area was located in the north 1/3 of the site. Furrowing shovels, mounted on a tool bar, spaced four feet apart, were used to create the furrows and pits. The pits are approximately 12-16 feet long, 6 inches deep, and 20 inches wide. The pits follow the natural contour of the ground and were spaced alternately on each pass with the tractor. The furrows are 6 inches deep and 20 inches wide, continuous, and following the contour of the slope. Both the pitted and furrowed areas were seeded after the treatments were installed. The control area was seeded prior to the treatment installation using the tractor tire tread as a simulated imprinter. Each treatment was seeded to 1.33 bulk pounds of 'Cochise' lovegrass.

The fourth planting was installed on July 31 - August 1, 1990. Most of the warm-season species were replanted at this time. The following is a list of the species that were planted:

SPECIES	**CULTIVAR/ACCESSION**
alkali sacaton	421071
	421069
	‘Salado’
lovegrass species	‘Catalina’
	‘Cochise’
mediterranean ricegrass	253339
smilograss	198091
yellow bluestem	P.I. 237110
	‘Ganada’
black grama	‘Nogal’
	‘Sonora’
blue grama	‘Hachita’
	‘Lovington’
sideoats grama	‘Haskell’
	‘El Reno’
	‘Niner’
	‘Vaughn’
big galleta	‘Viva’

The cultural treatment area was replanted with 'Viva' galleta grass seed using the rangeland drill and disk weights in order to plant the seed as deep as possible. The seed was planted at a depth of 0.5 to 1.0 inches.

The fifth planting was installed in November 1990. Due to the apparent failures of the previous replicated plot plantings, it was decided to try to establish a cover crop using annual grain species: 'Seco' barley and 'Aroostock' rye. The objective was to see if a dead litter cover would facilitate the establishment of perennial vegetation on this planting site.

Each grain species was replicated one time for each perennial species being tested. On November 6, 1990 Tucson PMC personnel planted 29.8 bulk pounds of 'Seco' barley and 20 bulk pounds of 'Aroostock' rye. Four rows were planted into each selected planting block at an average depth of 1 inch. The total area planted for each grain species was 0.33 acres at a seeding rate of 29.8 pounds per 0.33 acres for 'Seco' (90 lbs/acre) and 20 pounds per 0.33 acres for 'Aroostock' rye (60 lbs/acre). to help reduce rodent predation, Tucson PMC personnel broadcast wheat seed over the tops of the drill-seeded plots.

The sixth planting was installed on March 24-25, 1992. Most of the cool-season species were planted back into their original plots using the Kincaid No-Till Plot Drill. All species were seeded at a depth of 1.5 inches. After planting, bales of oat straw mulch was applied to the first three replications for all species except the russian wildrye and western wheatgrass plots. In those plots, the first replication was not mulched. The actual mulch application rate was 2,100 lbs of straw per 0.62 acres (total area mulched). The straw was anchored into the soil using a mulch tucker (crimper). The site had received over 8 inches of precipitation since October of 1991 and the Tucson PMC personnel observed excellent soil moisture during the planting.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Technical Note, Possible amendment to NRCS range seeding specifications

RESULTS:

1988

The 1987 planting was first evaluated in June of 1988. Overall, the results were judged as poor to fair. This planting was evaluated again in November, 1988 and it was observed that the status of the fourwing saltbush seedlings was holding steady but the indian ricegrass, western wheatgrass and basin wildrye plants had all dessicated and died. This was primarily due to the lack of summer moisture and low amount of winter moisture.

1989

The November 1988 and July 1989 plantings were evaluated during the course of the year following each planting and it was noted that no seedling emergence was observed. It was noted that the site had received little to no summer moisture and very low winter precipitation. Considerable rodent activity was observed in the newly seeded plots. The rodents tended to first retrieve the seed in all of the 'Barton' western wheatgrass plots. They would then systematically retreive the seed from each freshly seeded plot in order

of preference. There were also no visible signs of seed germination or seedling establishment of the 'Cochise' lovegrass which was seeded in the cultural treatment plots.

1990

This planting was reviewed in November of 1990. There were no visible signs of seed germination or seedling establishment of the 'Viva' galleta grass which was planted in the cultural treatment area. We did find 3-4 individual plants of 'Nordan' crested wheatgrass in replication plot #3. We also found evidence of fair to good emergence of 'Catalina' and 'Cochise' lovegrass in each of the replicated plots. Plant emergence was most evident in shallow depressions where there was a light gravel mulch. These grass seedlings were

very small and showing signs of stress. Due to their small size, we were very doubtful that they would survive the 1990-91 winter.

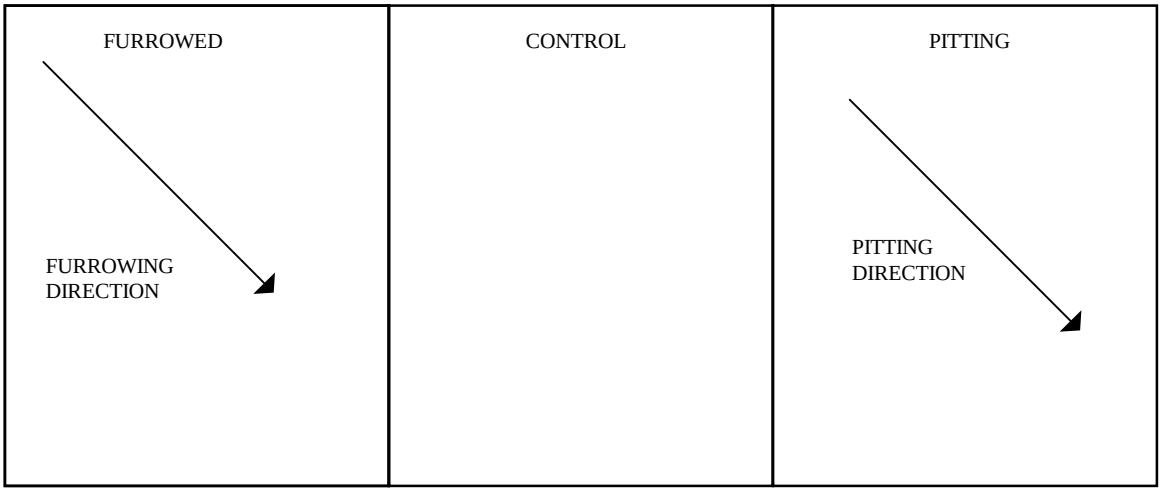
1992

This planting was first evaluated on April 14, 1992. It was reported that seedling emergence was evident in the unmulched plots. The seedlings were reported to be 1-1.5 inches in height and good soil moisture was evident below 2 inches. No seedlings were visibly evident in the unmulched plots. The site was evaluated again on June 25, 1992. It was noted that the seedlings in the unmulched plots had appeared to have gone dormant and some additional new seedlings were also evident. It was also noted that a significant number of seedlings were lost due to dessication. The mulched plots were still difficult to evaluate. Precipitation on the site to date since planting was 1.47 inches.

SIX-MILE FLAT, NEVADA EVALUATION SITE
PROJECT PLAN MAP
(Not to Scale)

NORTH ➨

	A	B	C	D	E	F	G	H	I
1	478837	9003134	Rincon	Santa Rita	9003126	Wytana	478838	Marana	9003136
2	Santa Rita	9003136	Marana	9003134	Wytana	478838	478837	9003126	Rincon
3	478837	Marana	9003126	9003136	9003134	Rincon	478838	Santa Rita	Wytana
4	9003126	Santa Rita	Rincon	Marana	478838	9003134	9003136	Wytana	438837
5	Paloma	Nezpar	9035287	478833	Magnar	478831	271893	253339	198091
6	Nezpar	9035287	Paloma	478833	478831	Magnar	271893	198091	253339
7	478833	Paloma	Nezpar	9035287	271893	478831	Magnar	253339	198091
8	Paloma	478833	9035287	Nezpar	271893	Magnar	478831	198091	253339
9	Cochise	A-67	Catalina	Arriba	Barton	Rosana	Rodan	Bozoisky	Vinall
10	Catalina	Cochise	A-67	Barton	Rosana	Arriba	Rodan	Bozoisky	Vinall
11	Cochise	A-67	Catalina	Rosana	Arriba	Barton	Rodan	Vinall	Bozoisky
12	Catalina	Cochise	A-67	Arriba	Rodan	Barton	Rosana	Vinall	Bozoisky
13	Ephraim	Fairway	Standard	P-27	Hycrest	Nordan	San Luis	Primar	Pryor
14	Hycrest	Nordan	Standard	P-27	Fairway	Ephraim	Primar	Pryor	San Luis
15	Nordan	Standard	Ephraim	P-27	Fairway	Hycrest	San Luis	Pryor	Primar
16	Hycrest	Standard	Ephraim	Nordan	P-27	Fairway	Primar	San Luis	Pryor
17	El Vado	9003824	Saltalk	421071	421069	Salado	ND-691	Volga	
18	9003824	El Vado	421071	Salado	Saltalk	421069	Volga	ND-691	
19	9003824	El Vado	421069	Salado	Saltalk	421071	Volga	ND-691	
20	El Vado	9003824	Saltalk	421069	Salado	421071	ND-691	Volga	
21	9004621	9007036	Bandera	Cedar	Haskell	Vaughn	Niner	El Reno	
22	Cedar	9004621	9007036	Bandera	Vaughn	Niner	Haskell	El Reno	
23	Bandera	9004621	9007036	Cedar	Niner	Vaughn	Haskell	El Reno	
24	Bandera	9004621	Cedar	9007036	Vaughn	Niner	Haskell	El Reno	
25	Critana	9021076	Hachita	Lovington	Nogal	Sonora			
26	Critana	9021076	Hachita	Lovington	Sonora	Nogal			
27	Critana	9021076	Lovington	Hachita	Sonora	Nogal			
28	9021076	Critana	Hachita	Lovington	Sonora	Nogal			
29	237110	Ganada	Ganada	237110	Ganada	237110	237110	Ganada	
30	9003686	T-4464	T-4464	9003686	T-4464	9003686	9003686	T-4464	



2.5 ACRE CULTURAL TREATMENT AREA
07/26/89 - Seeded to 'Cochise' lovegrass (hand-broadcast seeded)
07/30/90 - Seeded to 'Viva' galleta grass using the "baby" rangeland drill (#2 setting with all disk weights)

STUDY NUMBER: 04C017L

Avra Valley Retired Farmland Revegetation Trials - Final Report

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Intercenter

LAND USES: Cropland, Rangeland

VEGETATIVE PRACTICES:	**PRIMARY:**	327	CONSERVATION COVER
	SECONDARY:	342	CRITICAL AREA PLANTING
	TERTIARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil erosion, wind.
SECONDARY:	Plants	Plants management, pests (brush, weeds, insects, diseases.)

DESCRIPTION: Retired and/or abandoned farmlands are a conservation concern in southern Arizona primarily due to blowing dust problems and secondarily due to weed problems. If the site can be stabilized with a productive plant community, the problems of blowing dust and weed species dominance may be minimized or prevented. There is a need to develop plant materials and technology to implement, in an effective and economical manner, the NRCS practice of Conservation Cover on lands retired from active agricultural production. When applied, this practice will:

1. Protect air quality by reducing wind erosion;
2. Serve to protect the quality of surface water resources by reducing offsite sedimentation;
3. Improve local groundwater recharge by reducing water runoff, and
4. Provide enhanced wildlife habitat in terms of food and cover.

Identified needs include:

1. Improve and expand information on plant materials having potential use in rehabilitating idled farmland;
2. Determine appropriate seeding mixes and planting methodologies which can achieve the desired goals, i.e. livestock grazing, wildlife habitat enhancement, or restoration of a natural plant community;
3. Identify species for rehabilitating idled farmland which:
    - provide cover,
    - weed suppression,
    - provide and economic return i.e. through livestock grazing, or
    - adaptability to fine textured, saline, sodic, or saline-sodic soils.

The Natural Resources Conservation Service (NRCS) assists clients to achieve both the client's objectives and those of society as represented by NRCS for

sustained use of soil, water, air, plant, and animal resources. NRCS planning and assistance is based on technical, cultural, and sociological knowledge about the resources (General Manual, NRCS Policy, Part 409 - Planning Policy, Subpart A. - Policy, paragraph 409.03[a]).

DURATION OF STUDY: 1988 through 1997

STUDY LEADER: Mark Pater

LOCATION: ARIZONA PMC

COOPERATORS: Bureau of Reclamation, Tucson Plant Materials Center.

METHODS AND MATERIALS: This project site was originally established in January of 1988. The objectives at this site are to evaluate cultural treatments and adapted species which may be used in the revegetation/restoration of abandoned and retired farmland in southern Arizona.

SITE LOCATION: The Avra Valley planting site is located in MLRA 40-1 and consists of 19 acres of retired farmland. It is located approximately 4 miles west of Interstate 10 on the north side of Avra Valley Road and approximately 1 mile east of the Central Arizona Project canal. The legal description for this site is T12S, R11E, Sec. 11.

SITE DESCRIPTION: Approximately 10 acres located in the northeast corner of the acre site have been utilized for cultural treatment evaluations. The cultural treatments were completed in July, 1989. These treatments involved ripping the east half (5 acres) of the plot to a depth of 18-24 inches to break up a hardpan layer situated approximately 6-18 inches below the soil surface. The site was ripped from north to south and was then disked afterward. Furrows were then installed in an east to west direction on a 40 inch spacing in the north one-half of the 10 acre block. This plot design resulted in four 2.5 acre-sized treatment blocks: (Quadrant 1) furrowing only, (Quadrant 2) furrowing combined with ripping, (Quadrant 3) control area [no treatment], and (Quadrant 4) ripping only.

DATES AND ACTIVITIES:

1. June 8, 1989: Soils were identified as Mohave clay loam and Sonoita sandy loam. Both soils have a hardpan located approximately 6-18 inches below the soil surface.
2. July 18-19, 1989: Ripping and furrowing completed on the site, all four treatment areas are planted to a drought-tolerant sorghum (*Sorghum bicolor* [L.]Moench) - supplied by Dr. Voigt [ret.] from the University of Arizona farm in Marana.
3. January 8, 1990: Planted one-half of each treatment block to 'Seco' barley (Hordeum vulgare L.).
4. July 27, 1990: Planted sorghum, 'Seco' barley and mediterranean ricegrass (*Oryzopsis coerulescens* [Desf.]Hack.).
5. December 12, 1990: Planted one-half of each treatment block to a cool-season mixture of 'Santa Rita' fourwing saltbush (*Atriplex canescens* [Pursh]Nutt.), quailbush (*Atriplex lentiformis* [Torr.]S.Wats.), 'Catalina' lovegrass (*Eragrostis curvula* var.

conferta Stapf.), mediterranean ricegrass and plains bristlegrass. The remaining one-half of the treatment blocks were planted to 'Seco' barley.

6. November 21, 1991: Tucson PMC personnel, utilizing a Kincaid No-Till Plot Drill, planted into the standing mulch sites and the non-mulch sites to evaluate whether the standing mulch would enhance stand establishment. Species planted included: 'Santa Rita' fourwing saltbush, 'Casa' quailbush, and P.I. 399195 desert saltbush (*Atriplex polycarpa* [Torr.]S.Wats.).
7. August 12, 1993: Tucson PMC personnel, utilizing the Kincaid No-Till Plot Drill, planted six grass species. Species planted included: plains bristlegrass (2 accessions), Arizona cottontop, cane bluestem, yellow bluestem (*Bothriochloa ischaemum* [L.]Keng.) and 'A-130' blue panic (*Panicum antidotale* Retz.). The objectives of this planting were to evaluate these species for their ability to germinate and become established at various planting depths as well as to observe how well these species perform despite competition from weedy species which are well established on this site.

STATUS OF KNOWLEDGE: Retired and/or abandoned farmlands are a conservation concern in southern Arizona primarily due to blowing dust problems and secondarily due to weed problems. If the site can be stabilized with a productive plant community, the problems of blowing dust and weed species dominance may be minimized or prevented.

From the early 1950's until the mid-1970's, farmland in southern Arizona went out of production primarily due to hydrologic and economic reasons. Groundwater pumping increased and continued pumping became economically prohibitive for crop irrigation (Cox and Thacker 1992; Jackson, McAuliffe and Roundy 1991).

Since the mid-1970's, other factors have added to the reduction of agricultural irrigation. Cities, mines, and other municipal and industrial water users have purchased farmland to acquire the rights to pump groundwater. Through these purchases the water is transferred to another use and location, and the farmland is retired from agricultural production. Because Arizona's 1980 Groundwater Management Act restricts future groundwater pumping, these water transfers will cause more farmland to be retired in the future. A study on the water transfer process in Arizona identified over one-half million acres of land that are or could become involved in water transfers (Cox and Thacker 1992; Woodard et al. 1988).

LITERATURE CITED:

Cox, J.R. and G.W. Thacker. 1992. How to Establish a Permanent Vegetation Cover on Farmland. Cooperative Extension, College of Agriculture, The University of Arizona, Tucson, Arizona.

Jackson, L.L., J.R. McAuliffe, and B.A. Roundy. 1991. Desert Restoration and Management Notes 9(2):71-80.

Woodard, G.C., E. Checchio, G.W. Thacker, and B.G. Colby. 1988. The Water Transfer Process in Arizona: Analysis of Impacts and Legislative Options. Division of Economic and Business Research, College of Business and Public Administration, The University of Arizona, Tucson, Arizona.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Document for insertion into the Arizona Field Office Technical Guide pertaining to revegetation of abandoned/retired farmlands in southern Arizona.

OTHER ACTIONS: Possible publication for use by the general public.

RESULTS:

1989
The July 1989 planting was not successful due to the site having received very little precipitation. Subsequent evaluations of this planting revealed very little to no evidence of seed germination or seedling establishment.

1990
The January 1990 planting was not successful due to the site having received very little precipitation. Subsequent evaluations of this planting revealed very little to no evidence of seed germination or seedling establishment.

1990
The July, 1990 planting received good summer moisture. Mixed results were recorded on October 10, 1990: No emergence was observed for the mediterranean ricegrass (*Oryzopsis coerulescens*) in any of the treatment blocks (Control, ripped, ripped & furrowed, furrowed); the sorghum exhibited a 50-60% stand establishment and best weed control in the ripped and ripped & furrowed treatment blocks; the sorghum exhibited a 40-50% stand establishment in the furrowed only treatment block; the sorghum exhibited a less than 5% stand establishment in the control block (no treatment); the 'Seco' barley exhibited less than 1% emergence in all treatment blocks.

1991
The December, 1990 planting received very good precipitation through the winter months of 1990-1991. This planting was evaluated on March 18, 1991. An excellent stand of 'Seco' barley was observed in the ripped as well as the ripped & furrowed treatment blocks. The control treatment block had some seedlings but the stand in this treatment block was estimated at less than 5% in terms of seedling emergence and stand establishment.

In the cool-season mixture planting, a good stand of fourwing saltbush was noted in the control block. The other three treatment blocks revealed only a poor showing of fourwing saltbush seedlings. A few scattered plants of mediterranean ricegrass were observed in each treatment block. The poor performance of the fourwing saltbush in the three treatment blocks other than the control may be due to improper planting depth: it is felt that the seed may have been planted too deep.

The December, 1990 planting was evaluated again on June 9, 1991. The fourwing saltbush and quailbush that had been observed to be performing well during the March 18, 1991 evaluation, appeared to be suffering from severe moisture stress (wilted appearance). However, a good stand of fourwing saltbush was observed in the ripped only treatment area. A scattered, well-established stand of 'Catalina' lovegrass as well as scattered plants of mediterranean ricegrass were located in the ripped-furrowed treatment block. The furrowed-only treatment block was determined to have had the poorest response to the seed mix planting.

1993

The replicated shrub planting which was installed on November 21, 1991 was evaluated on February 4, 1993. Due to high amounts of precipitation in December 1992 - January 1993, all four treatment areas had dense stands of cool-season weeds. Results are as follows:

- QUADRANT 1 (Furrowed Only) had a dense stand of desert broom. The November 1991 planting resulted in no plants being found growing in any of the replicated plots. One group of four fourwing saltbush plants was found in this quadrant. These plants were the result of the December 12, 1990 planting, they were all less than 1 meter in height and appeared healthy.
- QUADRANT 2 (Furrowed and Ripped) had a few desert broom plants scattered throughout this block. They appeared to be invading the planting site from the west. The November 21, 1991 planting resulted in one quailbush plant (80 cm tall) being located in replication 1 of the No Stubble section. No plants were found growing in any of the other replications. A moderate number of fourwing saltbush plants from the December 12, 1991 planting were found scattered throughout this treatment block. These plants ranged in height from 40 to 100 cm and appeared to be quite healthy. Some light browsing by rabbits was evident.
- QUADRANT 3 (No Treatment) had a dense stand of desert broom. No plants were found in any of the November 21, 1991 replicated planting blocks. Very few fourwing saltbush plants (2-3 individuals) from the December 12, 1990 planting were found within this quadrant.
- QUADRANT 4 (Ripped Only) had a few desert broom plants scattered throughout and they appeared to be invading from the west. In the November 21, 1991 planting, four 'Santa Rita' fourwing saltbush plants were found in replication 1 of the No Stubble section. They were an average of 60 cm in height and appeared to be quite vigorous. No other plants were found in any of the other replications.

The December 12, 1990 planting resulted in a very large and healthy population of fourwing saltbush and quailbush plants in the southern 1/3 of this quadrant. The majority of the shrubs are 'Santa Rita' fourwing saltbush and all plants ranged in size from new seedlings to 150 cm in height.

1993

This replicated planting was installed on August 12, 1993. The species planted for this evaluation included yellow bluestem, cane bluestem, Arizona cottontop, two accessions of plains bristlegrass, and 'A-130' blue panic

The planting was evlauated on August 25 and 30, September 13 and 21, and October 7, 1993. The specific objectives of this planting were (1) evaluate species in advanced testing for their ability to germinate and become established on abandoned cropland, (2) evaluate these species for their ability to germinate and become established using various planting depths, and (3) evaluate these species for their ability to germinate and become established despite competition from various weedy species.

The planting design was set up as a randomized complete blocks design. Each complete block contained one replication of each of the six species to be planted. Each randomized complete block was replicated four times. Each replicated plot was planted using a Kincaid No-Till Plot Drill. Three of the four belt cone distributors on the drill were designated to a particular planting depth which were regulated with depth bands on the double disk openers. All species, except for the plains bristlegrass, were planted at depths of 0.25, 0.5 and 1.0 inches. The plains bristlegrass was planted at depths of 0.5, 1.0 and 1.5 inches. Each of the three planted rows for each replicated plot was 100 feet in length. Each planted row within each plot was spaced 18 inches apart. NRCS guidelines recommend seeding rates of 20 PLS. per linear foot. The actual planting rate for this evaluation planting was set at 60 PLS. per linear foot.

The planting was installed following two summer rainfall events to ensure a moist seedbed. After planting, the site was monitored for seedling emergence and establishment. Seedling emergence was recorded on a

percent stand per row basis, seedling establishment was recorded on an average number of plants per linear foot basis. The average percent emergence for all accessions at each planting depth is shown in Table 1:

Species	0.25" Planting Depth	0.5" Planting Depth	1.0" Planting Depth
Cane bluestem	85%	82.5%	87.5%
'A-130' blue panic	80%	72.5%	73.75%
yellow bluestem	82.5%	72.5%	57.5%
Arizona cottontop	55%	45%	45%
	0.5" Planting Depth	**1.0" Planting Depth**	**1.5" Planting Depth**
Plains bristlegrass 9003939	32.75%	50%	65%
Plains bristlegrass common	3%	0.25%	0%

The average percent emergence, regardless of planting depth, for cane bluestem (85%) was significantly higher than that of the yellow bluestem (70.38%), 9003939 plains bristlegrass (49.25%), common plains bristlegrass (1.08%) and the Arizona cottontop (48.33%). There was no significant difference between the three planting depths and the average percent emergence for the cane bluestem. Regardless of planting depth, the cane bluestem exhibited a significantly higher average number of seedlings per linear foot (26.45) than the other five species (Fig. 1). The average number of seedlings per linear foot for cane bluestem did not differ significantly between the three different planting depths of 0.25, 0.5 and 1.0 inches (Fig. 2).

There was no significant difference between the three planting depths and the average percent emergence for the yellow bluestem. Yellow bluestem averaged 18.52 seedlings per linear foot regardless of planting depth. Although this was significantly lower than that of the cane bluestem at the 0.05 level of significance, this species exhibited a significantly higher difference than the other four species. However, the average number of seedlings per linear foot for yellow bluestem did not differ significantly between the three different planting depths (Fig. 3).

There was no significant difference between the three planting depths and the average percent emergence for the 'A-130' blue panic. The 'A-130' did average 12.15 seedlings per linear foot over all planting depths. This was significantly greater than the Arizona cottontop and the two plains bristlegrass accessions. The average number of seedlings per linear foot did not differ significantly between the three planting depths (Fig.4).

There was no significant difference between the three planting depths and the average percent emergence for the Arizona cottontop. The Arizona cottontop averaged 5.6 seedlings per linear foot over all planting depths. The shallowest planting depth, 0.25 inches, had significantly more seedlings per linear foot, 6.95 seedlings, than the deepest planting depth of 1 inch which had 3.5 seedlings per linear foot (Fig.5).

There was no significant difference between the three planting depths and the average percent emergence for the 9003939 plains bristlegrass. The 9003939 plains bristlegrass averaged 4.67 seedlings per linear foot over all planting depths. The average number of seedlings per linear foot did not differ significantly between the three planting depths (Fig. 6).

The common plains bristlegrass exhibited very low germination. There was no significant difference between the three planting depths and the average percent emergence for this accession. This accession also performed less favorably averaging less than one seedling per linear foot. The average number of seedlings per linear foot did not differ significantly between the three planting depths. The average number of seedlings per linear foot for all species did not differ significantly between any of the seeding depths (Fig. 7).

Observations by Tucson PMC personnel revealed that the year following retirement, the site was dominated by tumbleweeds (*Salsola kali* L.); the following year the dominant weeds were pigweed (*Amaranthus* spp.) and common purslane (*Portulaca oleracea* L.). The following years revealed a decrease in the weed populations, an initial increase in mediterraneangrass (*Schismus barbatus* [L.] Thell.) and a gradual increase in native vegetation such as desert broom (*Baccharis sarothroides* Gray), mesquite (*Prosopis juliflora* [Swartz] DC.), burroweed (*Isocoma tennuisecta* Greene), and scattered plants of purple threeawn (*Aristida purpurea* Nutt). This site is bordered on two sides (north and west) by non-cultivated, desert land which provided a seed source for the establishment of native species. On sites which are not bordered by native vegetation, reseeding efforts will be required.

Sites with heavier textured soils do not appear to revegetate themselves as readily and will need to be revegetated mechanically. Seeding recommendations and species selection can be found in the NRCS Technical Guides along with assistance from Tucson PMC personnel.

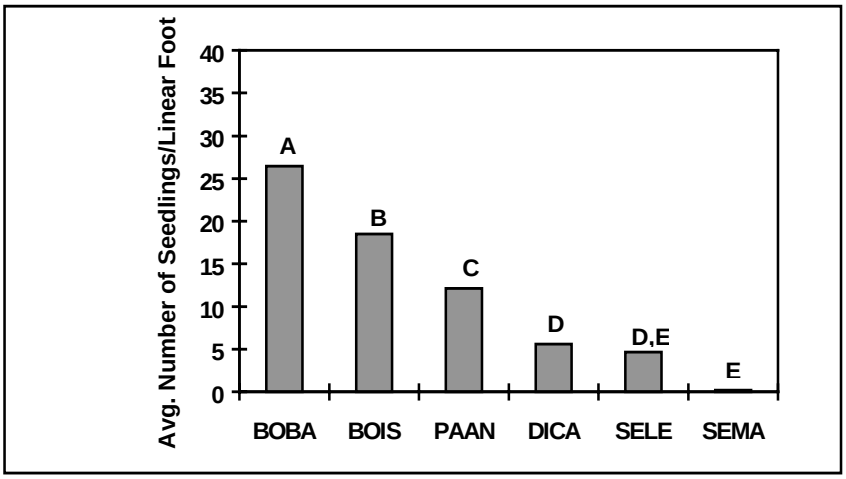


Fig. 1. Average number of seedlings per linear foot for all species regardless of planting depth. BOBA: cane bluestem, BOIS: yellow bluestem, PAAN: 'A-130' blue panic grass, DICA: Arizona cottontop, SELE: 9003939 plains bristlegrass, SEMA: common plains bristlegrass. Means with different letters are significant at the 0.05 level of significance.

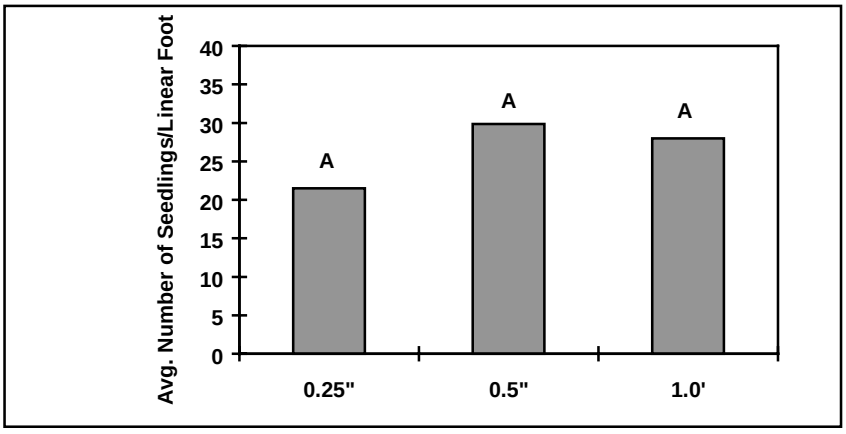


Fig. 2. Average number of seedlings per linear foot for cane bluestem at three planting depths. Means with the same letter are not significantly different at the 0.05 level of significance.

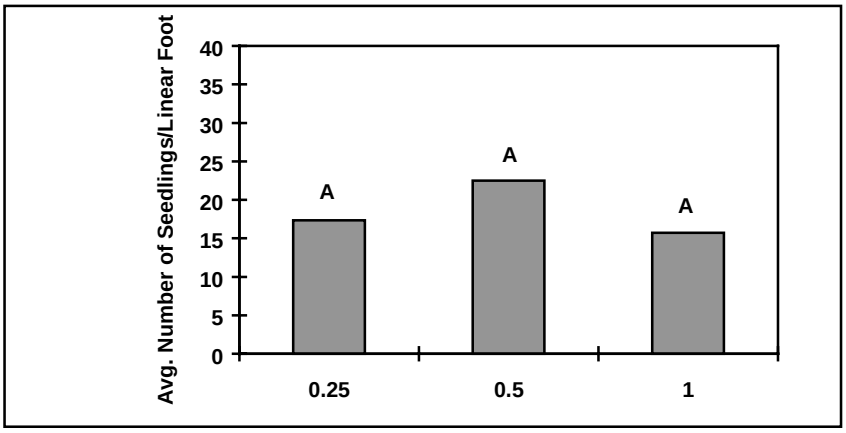


Fig. 3. Average number of seedlings per linear foot for yellow bluestem at three planting depths. Means with the same letter are not significantly different at the 0.05 level of significance.

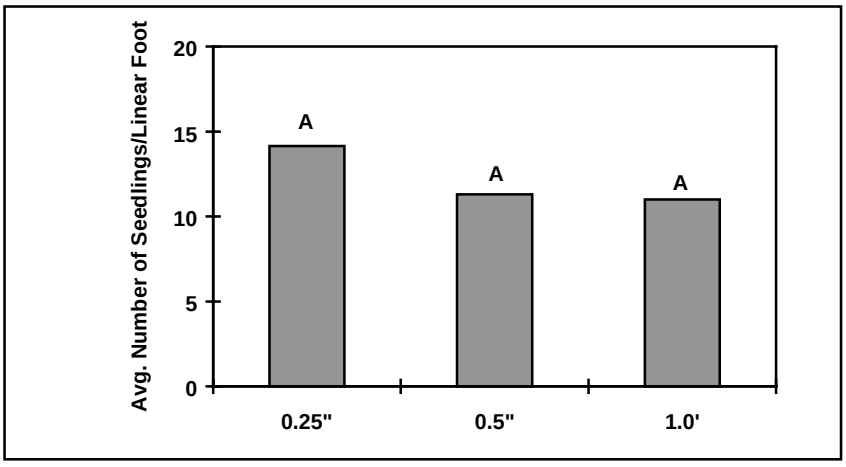


Fig. 4. Average number of seedlings per linear foot for 'A-130' blue panic grass at three planting depths. Means with the same letter are not significantly different at the 0.05 level of significance.

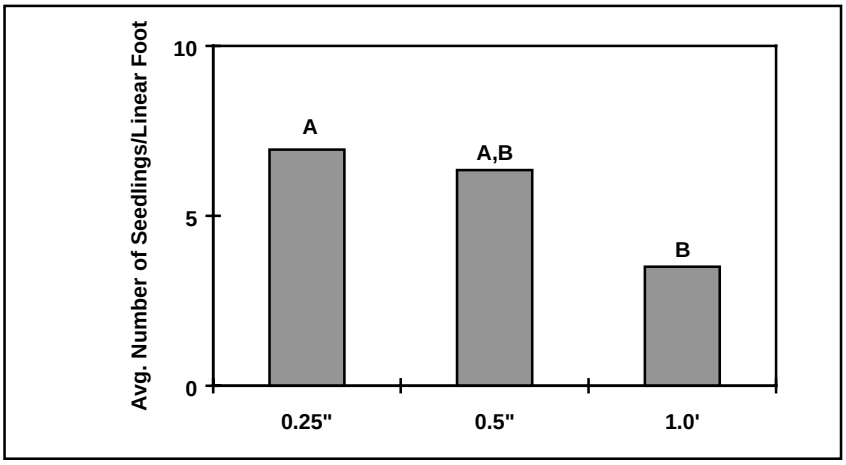


Fig. 5. Average number of seedlings per linear foot for Arizona cottontop at three planting depths. Means with different letters are significantly different at the 0.05 level of significance.

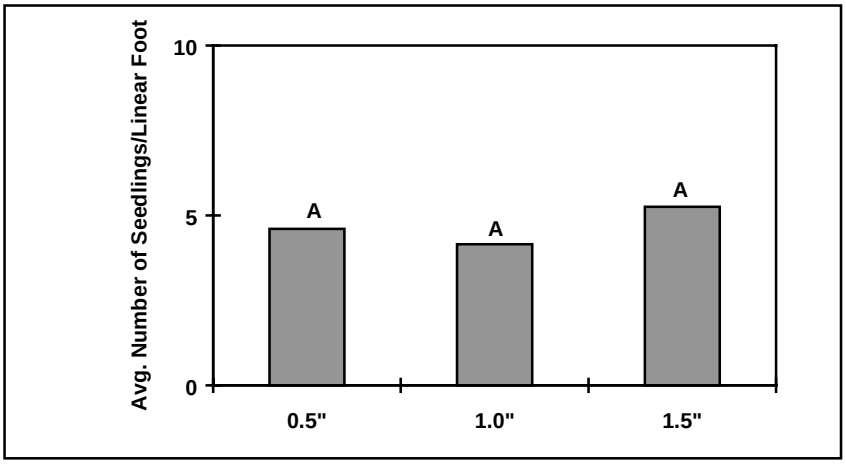


Fig. 6. Average number of seedlings per linear foot for 9003939 plains bristlegrass at three planting depths. Means with the same letter are not significantly different at the 0.05 level of significance.

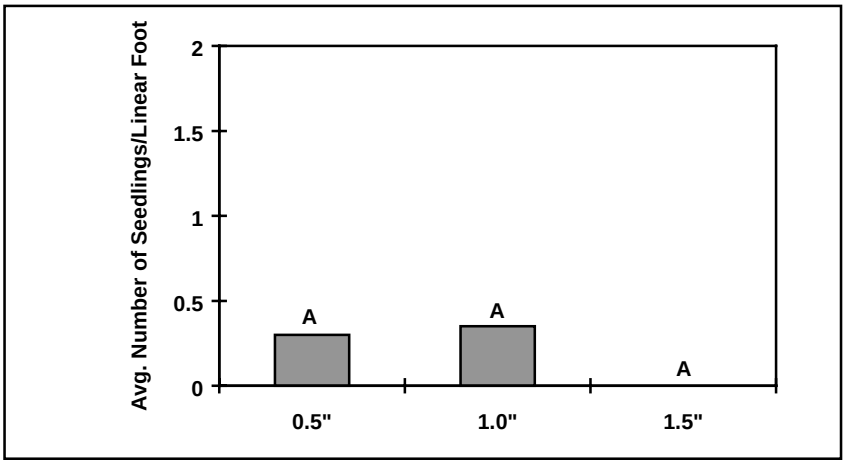


Fig. 7. Average number of seedlings per linear foot for the common plains bristlegrass at three planting depths. Means with the same letter are not significantly different at the 0.05 level of significance.

STUDY NUMBER: 04A9301L

Joshua Tree National Park Plant Adaptation Trials - Comparative Studies.

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Natural area, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY**:	342	CRITICAL AREA PLANTING
	SECONDARY:	561	HEAVY USE AREA
	TERTIARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Soil	Soil erosion, other.

DESCRIPTION: This study was initiated to evaluate two native shrubs which are found growing in the Mohave desert: creosote bush (*Larrea tridentata*) and desert saltbush (*Atriplex polycarpa*). This study will evaluate local and non-local ecotypes for each species at two planting locations: Joshua Tree National Monument Headquarters, Twenty-nine Palms, California, and a Tucson PMC test site located at Avra Valley, Arizona. Evaluation factors include ecotypic variation and transplant size with regards to growth and survival. This information may help in determining optimum pot size in relation to plant survival after transplanting.

DURATION OF STUDY: 1993 through 1998

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: National Park Service - Joshua Tree National Park, RC&D

EXPERIMENTAL DESIGN:

METHODS AND MATERIALS: Seed was collected by Joshua Tree National Monument personnel near the monument headquarters. Avra Valley seed collections were conducted by Tucson PMC personnel near the Tucson PMC's Avra Valley Advanced Evaluation site. Populations were collected from a minimum of 50+ plants within a 5 acre area. Seed harvested from each

individual plant was kept separate so that equal amounts of seed could be blended to form the bulk population.

The transplant evaluation will be conducted using Joshua Tree and Avra Valley ecotypes and three pot sizes: a) two-gallon round pots, b) Citrus pots (171 in^3), c) Joshua Tree "Tall Pots" (848 in^3, 30" deep).

Seed sowing dates should be staggered to allow well developed transplants to be planted to the field at the same time. Tall pots require 2 years for proper root development. Therefore, the citrus and one-gallon pots should be sown 12-14 months after the tall pots.

The ecotype evaluation will compare the Avra Valley and Joshua Tree collections using only the citrus pot size. A split-split plot design with three replications will be used at the two locations. Treatments will be the three pot sizes and two ecotypes. Five plants per replication will be used. To maintain a workable number of plants, the Avra Valley ecotypes will be grown in one pot size (citrus pots).

The number of plants to be propagated: Joshua Tree ecotypes = 2 species x 3 replications x 2 sites x 5 plants/replication x 3 pot sizes = 180. This breaks down to 60 Tall Pots, 60 Citrus Pots, and 60 2-gallon pots. Avra Valley ecotypes = 2 species x 3 replications x 2 sites x 5 plants/replication x 1 pot size = 60 citrus pots.

A split-split design will be used for both the Joshua Tree planting site and the Avra Valley materials. The first analysis will compare variation due to pot size, at both locations, for only Joshua Tree plants. The second analysis will compare ecotype variation between Avra Valley plants and Joshua Tree plants for citrus pots only and at both locations.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS:

OTHER ACTIONS: Develop information relative to the collection and processing of seed, propagation, and transplanting techniques for native species in the southwestern United States.

RESULTS:

1995

Plant height data was collected at both evaluation sites in 1995 to track growth rates for both ecotypes and the different container sizes (Fig's. 1 and 2). The Citrus Pot containers show a positive growth rate at both sites for both ecotypes. The Tall Pot and 2-gallon containers with the Joshua Tree National Park (JTNP) ecotype show a positive growth rate at the JTNP site but a negative growth rate at the Avra Valley evaluation site. This may be due to an adaptability or a transplant shock problem.

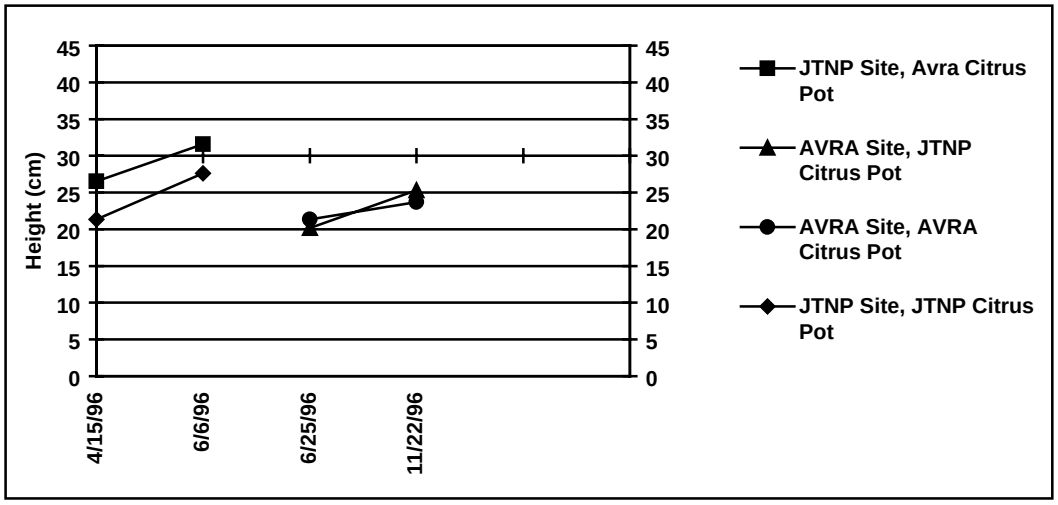


Fig. 1. Desert saltbush (*Atriplex polycarpa*) transplant growth rates (height - cm) using Citrus Pot containers and two ecotypes (Johua Tree N.P. and Avra Valley ecotypes) at the Joshua Tree National Park (JTNP) and Avra Valley (AVRA) evaluation sites.

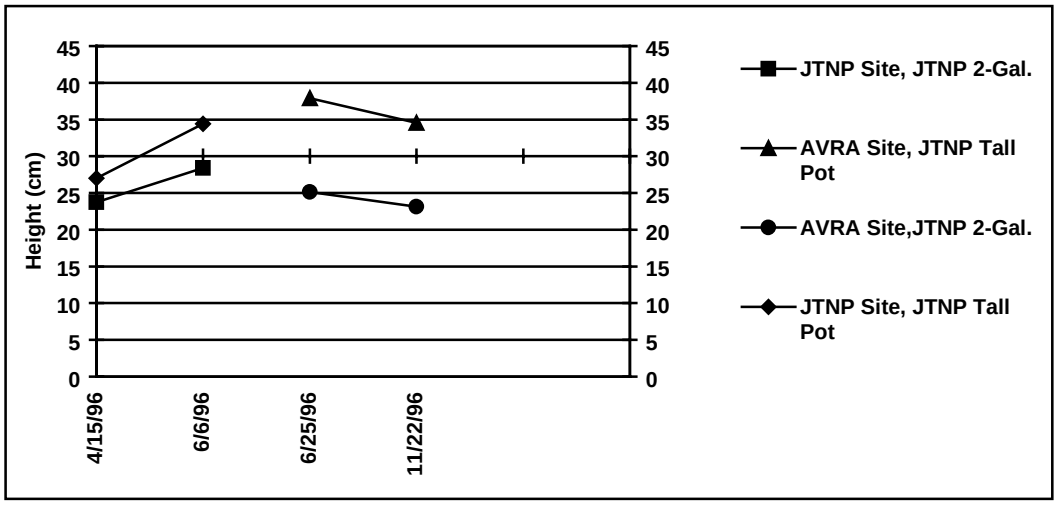


Fig. 2. Desert saltbush (*Atriplex polycarpa*) transplant growth rates (height - cm) using Tall Pot and 2-gallon containers and one ecotype (Joshua Tree N.P. ecotype), at the Joshua Tree National Park (JTNP) and Avra Valley (AVRA) evaluation sites.

STUDY NUMBER: 04F9601H

47 Ranch Field Planting

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland

VEGETATIVE PRACTICES: **PRIMARY:** 550 RANGE SEEDING

	RESOURCE	CONSIDERATION/PROBLEM
PRIMARY:	Soil	Soil erosion from sheet and rill.

DESCRIPTION: Approximately four sections of private rangeland below 47 Ranch headquarters on the south side of Davis Road were heavily overgrazed in the early 1900's. The area has been heavily invaded by western honey mesquite and there is little to no perennial grass cover. Approximately 500 acres were rootplowed on the contour and then broadcast seeded to Lehmanns lovegrass as the standard of comparison and approximately 5 acres were seeded to P.I. 216101 cane beardgrass, an accession in advanced testing at the Tucson PMC.

DURATION OF STUDY: 1995 through 1998

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Douglas Field Office, Whitewater Draw NRCD, Howard Harshbarger-Ranch owner

METHODS AND MATERIALS: This planting was installed in May 1995. The location is T21S, R24E, Sec 21 just south of Davis Road and approximately 1 mile east of the 47 Ranch headquarters. P.I. 216101 cane beardgrass was seeded on 5 acres at a rate of 2.5 lbs per acre and was compared against Lehmanns lovegrass (standard). Site preparation included rootplowing western honey mesquite on the contour and broadcast seeding afterwards. Evaluations will include percent stand and a visual estimate of percent grazing.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Update FOTG range seeding practice.

OTHER ACTIONS: Evaluations will provide documentation for release of P.I .216101 for commercial production.

STUDY NUMBER: 04F9501H

George Morin Ranch

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the U.S.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland

VEGETATIVE PRACTICES: **PRIMARY:** 550 RANGE SEEDING

	RESOURCE	CONSIDERATION/PROBLEM
PRIMARY:	Soil	Soil erosion from sheet and rill.

DESCRIPTION: This field planting was installed on George Morin's ranch during the summer of 1996 to evaluate Arizona cottontop. Comparing the PMC's accession 9003705 to a commercial wild collection. The planting site in located at T23S, R26E, Sec 7. The site was brushed and then broadcast seeded at a rate of 3 PLS pounds per acre for both collections.

DURATION OF STUDY: 1996 through 1998

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Douglas Field Office, Whitewater Draw NRCD, George Morin (owner)

METHODS AND MATERIALS: The Tucson PMC provided 60 PLS pounds of Arizona cottontop, 9003705, to be compared against a commercial wild collection of cottontop. 9003705 is in advanced testing at the PMC. Seeding rate was 3 PLS pounds per acre and seed was broadcast seeded following a brushing operation. Twenty acres was seeded to 9003705 next to a control of 2 acres which was planted to commercial wild collection of Arizona cottontop. Evaluation factors are: percent stand, rainfall amounts and timing, planting date.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Update FOTG range planting practice.

OTHER ACTIONS: Information will help provide documentation for a cultivar release.

STUDY NUMBER: 04F9407H

Riggs Flat Field Planting

PROJECT NUMBER: RN1.7

Improving the production and soil protection of rangeland in the arid, semi-arid and deserts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland & Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	550	RANGE SEEDING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants management, pests (brush, weeds, insects, diseases.)
SECONDARY:	Soil	Soil erosion from sheet and rill.

DESCRIPTION: The goals of this field planting are: promote the use of improved conservation plants for range seeding, evaluate the adaptation of experimental plant lines for use in northern Arizona, and obtain data to update FOTG. Riggs flat is located on the Kaibab Paiute Indian Reservation approximately 6 miles west of Fredonia, Arizona and is immediately adjacent to highway 389. Elevation is 4600 feet and is within Major Land Resource Area 35-4. Annual precipitation is 9.4 inches with 27% received during July through October and 42% received from January through May. Soil is classified as Jocity clay loam, deep and well drained, and the range site is a clay loam bottom. This site was first planted in 1986 and then replanted in 1994. The 1986 planting was a complete failure due to lack of moisture and competition from weeds, primarily cheatgrass. The site was replanted in November, 1994 using 17 grass and 4 shrub species. Evaluations will be conducted through 2000.

DURATION OF STUDY: 1994 through 2000

STUDY LEADER: Fredonia Field Office and Tucson PMC

LOCATION: ARIZONA PMC

COOPERATORS: Fredonia Field Office and the Kaibab-Paiute Tribe

EXPERIMENTAL DESIGN: Randomized Complete Block Design

METHODS AND MATERIALS: The 1986 planting involved 16 species. These were: 'Ephraim' crested wheatgrass, 'Secar' bluebunch wheatgrass, 9002950 bluebunch wheatgrass, 478838 fourwing saltbush, 'Niner' sideoats grama, 'Hachita' blue grama, 421036 yellow bluestem, 'Ganada' yellow bluestem, 478840 winterfat, 'Paiute' orchardgrass, 478831 basin wildrye, 'Magnar' basin wildrye, 'Viva' galleta grass, 9035287 Indian ricegrass, 'Salado'

alkali sacaton and 9003963 sand dropseed. The 1994 planting incorporated 21 species in a randomized complete block design with three replications. Each replication is 200 feet long by 6 feet wide with a 10 foot unseeded area separating each block. Sixteen of the twenty-one species were seeded on November 15 with the remaining species seeded by the field office on 12/3/94 and the forage Kochia seeded on 2/24/95. A Kincaid plot drill was used to seed 12 of 16 grass species. The remaining four species were hand broadcasted and then raked to incorporate the seed into the soil surface, except winterfat. Winterfat seed was broadcast and left on top of the soil surface. All drill seeded species were planted to a depth of 0.5 inches except for Indian ricegrass which was planted to a depth of 1.5 inches. See attachment one for listing of species, planting rates and depth.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Update Range Seeding Specifications

OTHER ACTIONS: If appropriate, prepare or update plant guides

RESULTS

1995

This field trial was designed to evaluate a wide range of native and introduced grasses and shrubs for use in conservation planning. Thirteen species were planted on November 15, 1994 with the Tucson PMC plot drill. Seven others were planted on December 2, 1994 using either the Fredonia NRCD range drill or broadcasting. The final species, 'Immigrant' forage kochia, was broadcast seeded on February 2, 1995. The area received excellent precipitation, 16.22 inches, from October 1994 through September 1995. With 13.13 inches received from October 1994 through May 1995. This moisture, combined with unusually warm winter temperatures, allowed the cool-season annuals to germinate and establish earlier and heavier than normal. Cheatgrass (*Bromus tectorum*), filaree (*Erodium cicutarium*), and blue mustard (*Chorispora tenella*) have all provided heavy competition for the seeded species, as well as emergence evaluations difficult. Late spring and summer moisture germinated a lot of Russian thistle (Salsola kali) as well. The field trial was evaluated 5 times during this first growing season - March 8, March 28, April 26, May 30 and September 14. 'Hycrest 2' crested wheatgrass came up quicker than any of the other cool-season species planted. by March 8 there were fairly solid rows of young seedlings. It appeared to be very vigorous at that early stage. By March 28 the plants were in the 3-4 leaf stage and by May 30 were well established. On September 14 the rows were visible through the mat of dead annuals. This species appears to have had a very successful first year. 'Douglas broadleaf' crested wheatgrass also had many seedlings by March 8 and appears to be doing quite well based on subsequent evaluations. It has not established as uniformly as 'Hycrest 2' but must be considered quite successful to date. 'Hycrest' crested wheatgrass, 'Ephraim' crested wheatgrass and 'Vavilov' Siberian wheatgrass have followed a similar pattern. 'Mankota' and 'Bozoisky' Russian wildrye have had a patchy first year establishment. Established plants are healthy and vigorous but there are lots of bare ground in the seeded area. Both varieties were visible by March 8. There were a few 'P-27' Siberian wheatgrass seedlings found in March, but by May 30 they were difficult to find. The few seedlings found were small and exhibited poor vigor. By September 14 no seedlings could be found. On March 8 the '9052861 and 478833 Indian ricegrass were just beginning to emerge, while the '9035287' and 'Paloma' could not be found. On March 28 all four varieties had a few plants up. By April 26 the seedlings were in the 2-3 leaf stage, and did not look healthy. At the end of May there were only a few seedlings found of each variety, and all looked poor. In September no seedlings could be found. A few seedlings could be found of both 'Pamirian' and common winterfat on March 28, but none have been found since. Several 'Immigrant' forage kochia plants were observed in each replication during the September evaluation. They are 2-3 inches tall and appear to be healthy. There has been no observations of any galleta, blue grama, fourwing saltbush, or alkali sacaton. There is quite a lot of pocket gopher and ant activity within the

plot. Most of the cool-season grasses have been grazed, some severely. This grazing does not appear to be by rabbits as there are no pellets within the area. September rains have started some of the cool-season annuals, and many of the cool-season species show new late-summer growth.

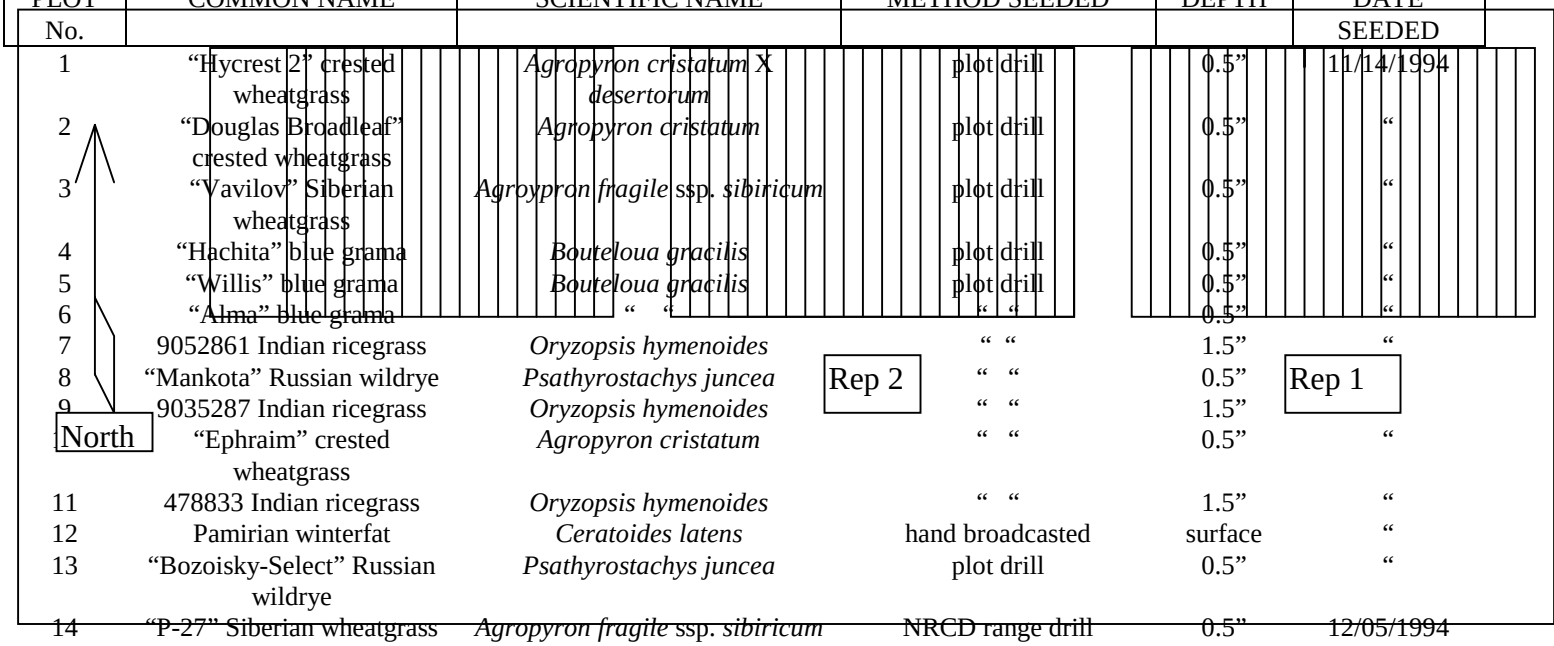
1996 RESULTS

There is no sign of the warm-season grasses like blue grama and galleta. Indian ricegrass had some germination in 1995 but never looked healthy. None can be found this spring. The few winterfat seedlings observed last year have not survived. No fourwing saltbush plants have been seen yet. Several cool-season grasses, including 'Ephraim' and 'Hycrest' crested wheatgrasses and two varieties of Russian wildrye, can be found. There are only a few plants and they are small, dry and hard to find. 'Vavilov' Siberian wheatgrass has done very well so far. The plants are numerous enough that the drill rows can be seen through the cover of dead annuals. So far this species looks very promising for this type of tough site. 'Hycrest 2' crested wheatgrass has also done very well for this tough site. This is not actually a new variety, but a pure type of the original 'Hycrest' variety which was released in 1985. Crested wheatgrass cross-fertilizes quite readily if grown too closely together, and over the years the characteristics for which 'Hycrest' was originally selected for - seedling vigor, quick establishment, greater productivity- have been watered down in the seed which is commercially available.

ATTACHMENT 1

RIGGS FLAT FIELD PLANTING
STUDY/FIELD PLANTING No. 04F9407H

PLOT No.	COMMON NAME	SCIENTIFIC NAME	METHOD SEEDED	DEPTH	DATE SEEDED
1	"Hycrest 2" crested wheatgrass	*Agropyron cristatum* X *desertorum*	plot drill	0.5"	11/14/1994
2	"Douglas Broadleaf" crested wheatgrass	*Agropyron cristatum*	plot drill	0.5"	"
3	"Vavilov" Siberian wheatgrass	*Agroypron fragile* ssp. *sibiricum*	plot drill	0.5"	"
4	"Hachita" blue grama	*Bouteloua gracilis*	plot drill	0.5"	"
5	"Willis" blue grama	*Bouteloua gracilis*	plot drill	0.5"	"
6	"Alma" blue grama	" "	" "	0.5"	"
7	9052861 Indian ricegrass	*Oryzopsis hymenoides*	" "	1.5"	"
8	"Mankota" Russian wildrye	*Psathyrostachys juncea*	" "	0.5"	"
9	9035287 Indian ricegrass	*Oryzopsis hymenoides*	" "	1.5"	"
10	"Ephraim" crested wheatgrass	*Agropyron cristatum*	" "	0.5"	"
11	478833 Indian ricegrass	*Oryzopsis hymenoides*	" "	1.5"	"
12	Pamirian winterfat	*Ceratoides latens*	hand broadcasted	surface	"
13	"Bozoisky-Select" Russian wildrye	*Psathyrostachys juncea*	plot drill	0.5"	"
14	"P-27" Siberian wheatgrass	*Agropyron fragile* ssp. *sibiricum*	NRCD range drill	0.5"	12/05/1994
15	"Hycrest" crested wheatgrass	*Agropyron cristatum* X *desertorum*	" " "	0.5"	12/05/1994
16	Common winterfat	*Krascheninnikovia lanata*	hand broadcasted	surface	12/01/1994
17	"Paloma" ricegrass	*Oryzopsis hymenoides*	NRCD range drill	0.5"	12/05/1994
18	Alkali sacaton	*Sporobolus airoides*	hand broadcasted	surface	12/01/1994
19	"Viva" galleta	*Hilaria jamesii*	hand broadcasted	0.25"	12/05/1994
20	Fourwing saltbush	*Atriplex canescens*	NRCD range drill	0.5"	12/05/1994
21	"Immigrant" forage kochia	*Kochia prostrata*	hand broadcasted	surface	02/24/1995



PROJECT: ML1.2

PROJECT TITLE: **Improve erosion control and the quality of water leaving mined land and other disturbed sites in the western US.**

PROBLEM STATEMENT: Current information on technology and plant materials is needed to assist customers in the rehabilitation of mined lands in the arid areas of the southwestern United States.

LAND RESOURCE REGIONS:

I	Southwestern Plateaus and Plains Range and Cotton Region
J	Southwestern Prairies Cotton and Forage Region

MLRA: 29, 30, 40, 41

LAND USES: Mined lands, Rangeland

VEGETATIVE PRACTICES:

PRIMARY:	342	CRITICAL AREA PLANTING
SECONDARY:	550	RANGE SEEDING
TERTIARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Water	Water quality, surface water contaminants suspended sediment
SECONDARY:	Soil	Soil erosion from sheet and rill.

SCOPE/DESCRIPTION: Develop native plants and technology to effectively implement the NRCS Critical Area Planting practice in areas of MLRA 30 and 40 with less than 7 inch annual rainfall and where mine spoil is highly acidic. When applied, the Critical Area practice will: (1) Protect air quality by reduction of wind induced soil erosion, (2) Protect adjacent surface water resources by reduced water induced soil erosion, (3) Provide food and cover for wildlife, and (4) Provide plant resources for other economic uses, i.e. grazing.

OBJECTIVES: Identified needs include: (1) Salvaging and establishment technology for Mojave desert conditions, (2) Identify acid pH tolerant plants for hot desert areas, (3) Develop management and maintenance methods for rehabilitated sites, (4) Define rehabilitation success for bond release (in Nevada), (5) Improve interagency efforts. Proposed actions include: (1) Develop funding sources to initiate on-center screening of plant material for use in acid tailing and other mined lands within arid environments, (2) Develop funding sources to evaluate and demonstrate rehabilitation requirements in arid environments, (3) Develop and maintain interagency relationships that impact mineland rehabilitation technology, i.e. ADEQ and their development of Best Management Practices for mineland rehabilitation, (4) Assist in developing a publication for use by field office customers which summarizes the current state of knowledge and recommended practices in arid areas.

STATUS OF KNOWLEDGE: The Tucson PMC has, in the past, worked with various agencies and

companies to develop information on reclamation of mined lands in the arid southwestern United States. Refer to past Tucson PMC annual technical reports for more information.

PLANNED COORDINATION: Bureau of Reclamation, Cyprus, Phelps-Dodge, BHP, Tohono O'Odham Nation, Navajo Nation, Arizona NRCS Field Offices.

COOPERATORS: Tucson Plant Materials Center, NRCS Field Offices.

PROJECT LEADER: West NTC Plant Materials Specialist, Tucson Plant Materials Center

APPROVED BY PMC STATE CONSERVATIONIST ADVISORY COMMITTEE:
AZPMC High active

LITERATURE CITED: Tucson Plant Materials Center Annual Technical Reports, Tucson PMC Long Range Plan - 1994-2000.

STUDIES:
TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9406D START: 1994 END: 2000
Cyprus-Tohono Mine Revegetation Trials (Reimbursable Project).

STUDY NUMBER: 04A9406D

Cyprus-Tohono Mine Revegetation Trials

PROJECT NUMBER: ML1.2

Improve erosion control and the quality of water leaving mined land and other disturbed sites in the western US.

STUDY TYPE: Advanced Evaluation

LAND USES: Mined lands, Rangeland

VEGETATIVE PRACTICES:			
	PRIMARY:	544	LAND RECONSTRUCTION, CURRENTLY MINED LAND
	SECONDARY:	342	CRITICAL AREA PLANTING
	TERTIARY:	550	RANGE SEEDING

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil condition, contaminants; excess chemical content.
SECONDARY:	Plants	Plants management; establishment, growth, and harvest.

DESCRIPTION: The site is located in the Phoenix Desert Shrub, Major Land Resource Area 40-2, between 1,800-2,252 feet in elevation. The mine is located approximately 32 miles southwest of Casa Grande, Arizona on Highway 15 and on the southwestern side of the Slate Mountains.

The objectives of this project are to conduct trials and evaluate methods of revegetating overburden and mine processed material using native plant materials. The information acquired from these trials will provide Cyprus-Tohono Corporation with a prescription for large-scale revegetation, in accordance with agreements made with the Tohono O'Odham Nation. Information gained from this project may also aid in improving conservation practices elsewhere. The primary goal for revegetating the overburden and mine processed material is to stabilize the slopes to prevent erosion and to blend the overburden piles with the surrounding vegetated mountain sides.

The use of native plant materials will eventually promote the utilization of the overburden slopes as territorial and forage locations for native wildlife species. Animals thought to directly benefit from revegetation include mule deer, javalina, Gambel's quail, desert cottontail, and various reptiles and arthropods.

The objectives of this project are also designed to meet the concerns of North Komelik Village and the Sif Oidak Grazing District, in relation to improving the aesthetic appearance of the mine as viewed from North Komelik Village and Highway 15. Revegetation of slopes facing North Komelik Village is the desired goal for Cyprus-Tohono Corporation.

The soils and bedrock were analyzed and found to be calcareous. Soils in the disturbed areas will be affected by the removal of vegetation, excavation and the storage of topsoil. The potential for erosion is high on the non-vegetated 4:1 slopes. Some evidence of rill erosion is apparent on newly created and exposed slopes. Potential for gully formation is great once the summer monsoon season begins. Sheet and rill erosion is also a concern during medium to heavy precipitation events. Wind and water erosion can be evaluated using RWEQ (Revised Wind Erosion Equation) and RUSLE (Revised Universal Soil Loss Equation). There is no evidence of compacted layers that will restrict water or root penetration. No evidence of crusting has been observed. No excess of natural or applied chemicals and elements such as selenium, boron, and heavy metals has been found. The potential for surface water quality impact is low due to the ephemeral nature of surface water at the site. There are no aquatic organisms observed near the site. Groundwater quality is monitored by the mine on a recurring basis. The air quality at this site may be affected by the activities at the mine. Strong winds are common and airborne particulates can obstruct vision. The planting site does not significantly contribute to air quality problems due to its small size and low amount of fine particulate matter in the soil substrate.

Dominant plants currently surrounding the site include: little-leaf palo-verde, ironwood, triangle-leaf bursage, white ratany, creosote bush, ocotillo, saguaro cactus, and hedgehog cactus. Plant species needed to stabilize the site must be native to the Sonoran Desert ecosystem with emphasis on species occurring in the USDA NRCS Range Site Description for MLRA 40-2. Plant species may include triangle-leaf bursage, creosote bush, little-leaf palo-verde, purple threeawn, brittlebush, white ratany, and fourwing saltbush.

DURATION OF STUDY: 1994 through 2000

STUDY LEADER: Mark Pater

LOCATION: ARIZONA PMC

COOPERATORS: Cyprus-Tohono Mine, Sells Field Office, Tohono O'Odham Tribe, Tucson PMC.

METHODS AND MATERIALS: The March 18-29, 1996 planting was installed using 1,374 containerized plants which were propagated at the Tucson PMC. The three container sizes were: treepots (532 cubic inches), deepots (40 cubic inches), and conetainers (15 cubic inches). Approximately 2 gallons of water was poured into each hole immediately prior to transplanting each containerized plant.

Plant height and canopy cover data was collected on a monthly basis beginning in April 1996 and ending in August 1996. Survival data was collected in September 1996.

The 1997 spring and summer plantings are organized as Two-Way Randomized Complete Blocks design. Each treatment area will have 4 randomized complete blocks (planting plots) containing each of the 5 species to be planted. Each randomized complete block will be

replicated 4 times: 4 randomized complete blocks x 2 treatment areas x 2 planting times = 16 total plots. Each plot will contain 5 species, 10

individuals per species = 50 plants per plot; 16 total plots at 50 plants per plot = 800 plants.

The plants for each species will be propagated at the Tucson PMC. At the evaluation site, the plants in each replicated plot will be transplanted by hand. Each planted row for all replicated plots will be 50 feet in length and spaced 10 feet apart. Each plant within each row within all replicated plots will be spaced 15 feet apart. The plants will be evaluated on a monthly basis for growth and survival.

STATUS OF KNOWLEDGE: Surface mining removes vegetation that protects soil against erosion. Surface mined areas that have not been reclaimed usually become a wasteland of rubble and waste dumps. Runoff erodes these areas, carrying sediment, and in some places chemical pollutants to surface and groundwater. In addition, unprotected sites are sources for blowing dust, thereby degrading the quality of air (USDA 1973). The visual aesthetics of the mined areas have a negative effect upon urban and recreation areas. Over 80% of surface mines in the U.S. are within 10 miles of population centers and 60% are visible from public use areas (Copeland 1973).

LITERATURE CITED:

Copeland, O.L. 1973. Mining impacts and resource management. Transactions of the 38th N. American Wildlife and Natural Resources Conference, Mar., Wildl. Manag. Institute, Washington D.C. p.111-120.

U.S. Department of Agriculture, SCS. 1973. Technical notes. Guidelines for reclamation of surface mined lands in Arizona. Environment Note No. 2. Phoenix, Arizona.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Technical Note, Amendment to Field Office Technical Guide, Update SWAPA information.

OTHER ACTIONS: Publication on using native species for mineland revegetation.

RESULTS:

1996

The white bursage was propagated in both deepots and treepots. Declining plant heights and canopy cover was observed during the months of June and July and was most likely attributed to a lack of precipitation and high summer temperatures. The plants appeared to begin to recover with the arrival of summer moisture during the month of August (Fig. 1). The plants propagated in the deepots were smaller in size as compared to the plants propagated in the treepots. However, with time, the plants transplanted from the deepots will attain the same heights as the treepot materials. Survival evaluations following six months after transplanting showed white bursage from the treepot containers to have a 91% survival and the white bursage from the deepot containers exhibited a 71% survival.

Fourwing saltbush was also propagated in both treepots and deepots. Despite a lack of substantial precipitation during the months of June and July, the plant height measurements did not show a decline. However, a decline in canopy cover was noted during this period in the plants that were propagated in the treepots (Fig. 2). Survival evaluations following six months after transplanting revealed the fourwing

saltbush from the treepots to have a 100% survival and the fourwing saltbush from the deepot containers exhibited a 96% survival.

Brittlebush was also propagated in both treepots and deepots. This species usually drops most of its leaves during hot, dry periods in order to better tolerate dry conditions (Fig. 3). Survival evaluations following six months after transplanting revealed the brittlebush from the treepot containers to have a 100% survival and the brittlebush from the deepot containers displayed a 91% survival.

Creosote bush was propagated in treepots, deepots, and conetainers. This species responded most favorably to the transplanting despite the hot, dry period during June and July (Fig. 4). Survival evaluations following six months after transplanting revealed the creosote bush from the treepot containers to have a 94% survival, the creosote bush from the deepot containers displayed a 100% survival and the creosote bush propagated in the conetainers exhibited a survival of 80%.

Mesquite was propagated in treepot containers. Survival evaluations following six months after transplanting revealed the mesquite to have a 78% transplant survival.

Whitethorn acacia was propagated in treepot containers. Survival evaluations following six months after transplanting revealed a 97% transplant survival rate.

Little-leaf palo-verde plants propagated in treepot containers revealed a 72% transplant survival rate.

Purple threeawn transplants propagated in the treepots have also performed well at this site. Survival evaluations following six months after transplanting revealed an 87% survival rate.

The desert marigold and desert globemallow were propagated in treepot containers. Initially both species appeared to react negatively to the transplant process which was followed by an extended period with very little to no measurable precipitation. However, during the August 1996 evaluations, these species appeared to be recovering well. Survival percentages following six months after transplanting showed the desert globemallow to have a 95% survival rate and the desert marigold an 82% survival rate. Despite the hot, dry period during June and July, most of the plants are performing well in terms of growth and survival.

The Arizona lupine was the only species not to survive past the transplant period. This was primarily due to damage by rabbits.

The creosote bush appears to be performing most favorably to the transplant process. Despite damage by rabbits, the mesquite, whitethorn acacia and palo-verde are also exhibiting vigorous growth (Fig. 5). The purple threeawn, white bursage, brittlebush, fourwing saltbush, desert marigold and desert globemallow also appear to be performing well (Fig.6). Overall plant survival percentage for this planting is 83%. The plants transplanted from the treepot containers have exhibited a 90% survival versus a 73% survival percentage for the plants transplanted from the deepot containers.

From an economic standpoint, it appears to be more cost-effective to propagate plant materials in the deepot containers. The treepot containers require more time to prepare for propagation, more potting mix and more water to maintain the plants growing in them prior to transplanting. Therefore, a 73% survival percentage seems to be an acceptable level of success.

Other studies by Tucson PMC personnel using different-sized containers for transplant projects reveal the plants grown in deepots to attain similar growth rates and size as plants grown in treepot containers. Plants propagated in conetainers do not appear to produce sufficient root mass to allow for successful transplanting in arid conditions without supplemental irrigation. Another point to consider is the plants grown in treepots weigh approximately 23-25 pounds each versus an approximate weight of 3 pounds for plants in a deepot container. The deepot containers are easier to handle and also require a much shallower hole when transplanting thereby reducing time and labor during installation.

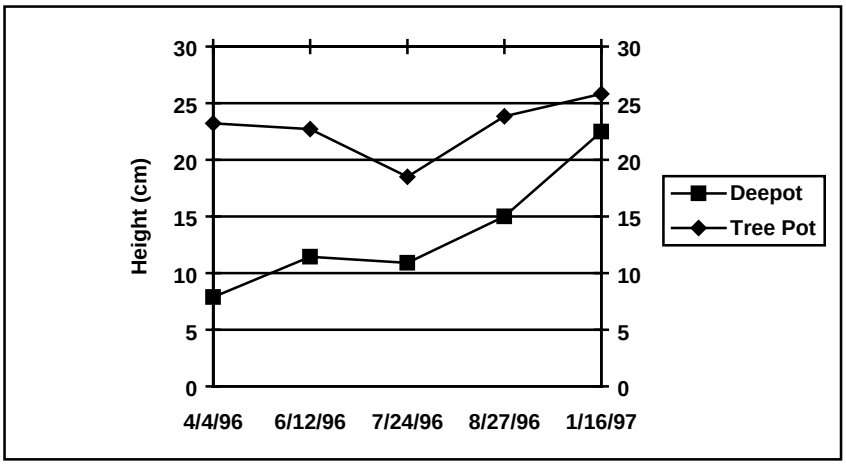


Fig. 1. Comparison of growth rates (height - cm) with two plant container sizes for *Ambrosia dumosa*.

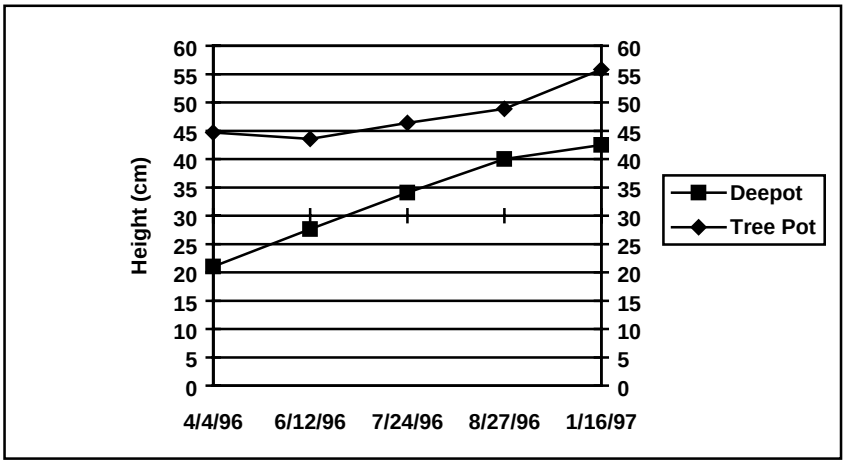


Fig. 2. Comparison of growth rates (height - cm) with two plant container sizes for *Artriplex canescens*.

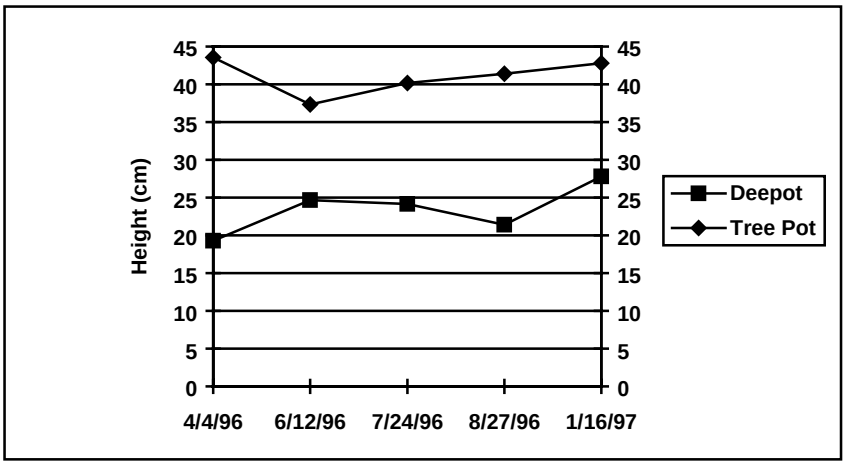


Fig. 3. Comparison of growth rates (height - cm) with two plant container sizes for *Encelia farinosa*.

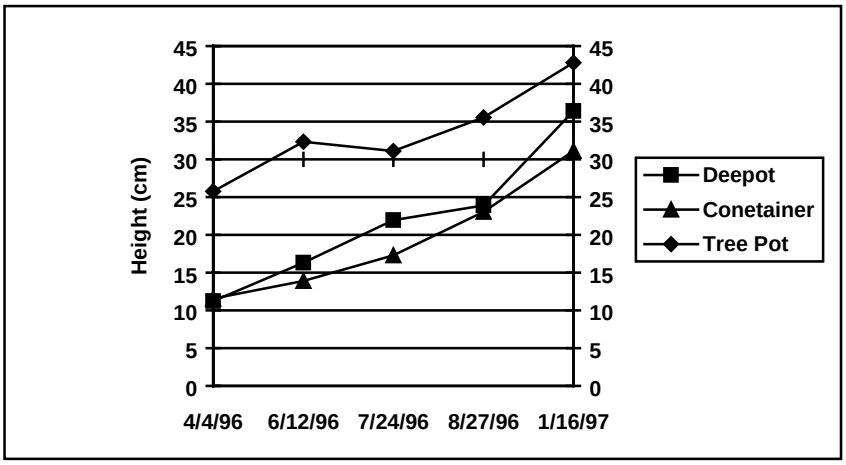


Fig. 4. Comparison of growth rates (height - cm) with three plant container sizes for *Larrea tridentata*.

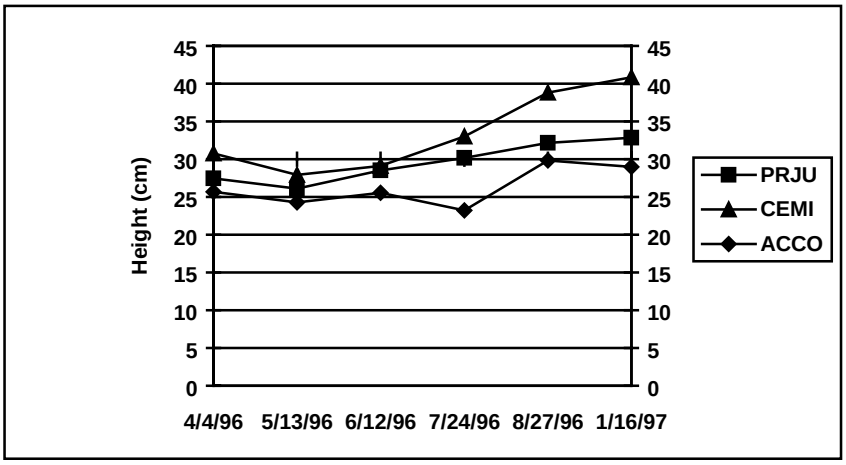


Fig. 5. . Comparison of growth rates (height - cm) for *Acacia constricta* (ACCO), *Prosopis juliflora* (PRJU), *Cercidium microphyllum* (CEMI) after transplanting from Tree Pot-sized containers.

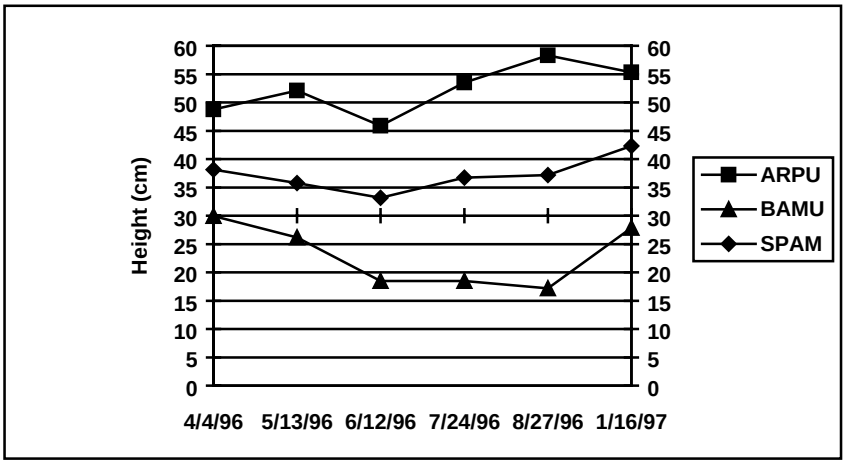


Fig. 6. . Comparison of growth rates (height - cm) for *Sphaerlacea ambigua* (SPAM), *Aristida purpurea* (ARPU), *Baileya multiradiata* (BAMU) after transplanting from Tree Pot-sized containers.

PROJECT: UR1.2

PROJECT TITLE: **Plant and technology development for urban areas to control erosion and protect water quality in semi-arid and arid areas of the United States.**

PROBLEM STATEMENT: Identify and develop plant materials and technology to effectively implement the NRCS Recreation Area Improvement practice in the 2-4 inch precipitation zone of MLRA's 30 and 31. When applied, the practice will (1) conserve water resources by reducing irrigation requirements, (2) protect adjacent surface water resources by reducing water induced soil erosion and sedimentation, and (3) improve air quality by reducing wind induced soil erosion. Plant materials and technological information is also needed to effectively implement the NRCS Streambank Protection practice in MLRA's 30 and 31.

LAND RESOURCE REGIONS:

J	Southwestern Prairies Cotton and Forage Region
I	Southwestern Plateaus and Plains Range and Cotton Region

MLRA: 6-13, 14-51

LAND USES: Urban, Recreation

VEGETATIVE PRACTICES:

PRIMARY:	342	CRITICAL AREA PLANTING
SECONDARY:	380	WINDBREAK/SHELTERBELT ESTABLISHMENT
TERTIARY:	570	RUNOFF MANAGEMENT SYSTEM

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Water	Water quality, surface water contaminants suspended sediment
SECONDARY:	Plants	Plants management, other.

SCOPE/DESCRIPTION: Identified needs include: (1) Acquiring information on water consumption of plants used in landscape situations to improve the design of irrigation systems and reduce water usage, (2) Acquiring information on plant responses of native species to typical management practices such as pruning, fertilizing, etc. To provide customers with the best information and reduce unnecessary inputs, (3) Identify plant materials that can withstand periodic immersions yet provide good cover during dry periods, (4) Identify plant materials for dry wash stabilization and beneficial wildlife applications.

OBJECTIVES: Proposed actions include: (1) Screen existing plant materials for applicability to stormwater management and constructed wetlands; evaluate, document and select new plant materials for their ability to withstand periodic immersion followed by severe drought while maintaining good soil erosion control and positive impacts on water quality. (2) Conduct a review of the literature relative to water use characteristics and develop a Technical Note. (3) Identify and evaluate transplant establishment

methodologies. (4) Evaluate plant materials adapted to the Mohave desert, currently used in the landscape trade, to determine growth rates and overall performance under various watering regimes.

COOPERATORS: Tucson Plant Materials Center, Plant Resource Specialist

PROJECT LEADER: Tucson Plant Materials Center, Arizona Plant Resource Specialist

STUDIES:

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A184L START: 1984 END:1992
Page Ranch - Desert Adaptation Planting Trials.

TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9007K START: 1990 END: 1997
FE-Palm Springs/Desert Water Agency Adaptation Trials.

STUDY NUMBER: 04A9007K

Palm Springs/Desert Water Agency Adaptation Trials - Final Report

PROJECT NUMBER: UR1.2

Plant and technology development for urban areas to control erosion and protect water quality in semi-arid and arid areas of the United States.

STUDY TYPE: Advanced Evaluation

LAND USES: Urban, Recreation

VEGETATIVE PRACTICES:	**PRIMARY:**	612	TREE AND/OR SHRUB ESTABLISHMENT
	SECONDARY:	380	WINDBREAK/SHELTERBELT ESTABLISHMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Water	Water quality, ground water contaminants, nutrients, organics.

DESCRIPTION: This is a cooperative project between the Desert Water Agency, Resource Conservation District, and the Natural Resources Conservation Service to evaluate various plant species for their adaptability, water use and response to irrigation with tertiary water versus potable water.

The planting design consists of twenty species of trees, twenty species of shrubs and a turf area planted to common bermuda grass. The trees and shrubs are replicated into six replications with each replication consisting of two water treatments, tertiary versus potable water. Irrigation will be provided by two micro systems with scheduling based on weather data obtained from the California Irrigation Management Information Systems (CIMIS). Twelve individual plants will be randomly selected to monitor nitrate nitrogen uptake. Soil samples at various depths will be taken to monitor any leaching of nitrogen.

The objectives of this planting are:

1. To demonstrate the feasibility of using tertiary water on trees, shrubs and turf.
2. Provide the public an example of growing water use efficient plants with tertiary water.
3. Measure the effect of tertiary water on plant growth in comparison with potable water.
4. Measure plant nitrate nitrogen uptake and losses due to deep percolation.
5. Formulate appropriate fertilization recommendations
6. Use this study to educate the community on the proper use of tertiary water for irrigation.

DURATION OF STUDY: 1990 through 1997

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Desert Water Agency, NRCD, Tucson Plant Materials Center.

METHODS AND MATERIALS: The role of the Tucson PMC in this study is to conduct evaluations on plant performance and, as needed, install appropriate plant materials that is in the Tucson PMC testing program. Evaluation data will be made available to the Indio Field Office on a regular basis.

Plant spacing for the tree plot is ten feet between plants within the replication and fifteen feet between each replication. Spacing for the shrub plot is fifteen feet between each replication and six feet between plants within the replication.

Plant materials from the Tucson PMC were included in this study during two plantings: November 1990 and January 1991. Installed in this planting were 12 *Eucalyptus websterana*, 12 *Eucalyptus foecunda*, 12 *Acacia victoria*, 12 *Acacia victoriae*, 12 *Acacia microbotrya*, 12 *Acacia notabilis*, 12 *Acacia salicina*, and 12 Vetiver grass plants. All of these were transplanted from one-gallon containers.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS:

OTHER ACTIONS: Technology transfer using an informational brochure.

RESULTS:

1991
The site was evaluated on January 2, 1991. Three species, *Acacia victoriae* (five plants), *Acacia salicina* (three plants), and *Acacia microbotrya* (one plant) were replanted. Evaluations included height, width, cold tolerance, and vigor. The site received an excellent cold tolerance test the last week of December 1990. The area had temperatures below 32 °F for 14 hours with a reported low temperature of 14 °F. Most of the plants received some damage, especially the *Acacia notabilis* and the *Acacia microbotrya*. In a general comparison between the two water treatments, the tertiary treatment appeared to have less frost damage. The best performing species for the shrub plot are: rosemary, Texas ranger, and desert willow. The best performing species for the tree plot include: smooth Arizona cypress, river she-oak, and African sumac. See Tables 1 and 2 for planting dates.

1992
Evaluations were conducted on March 3, 1992. No plants were replanted. African olive and desert olive may be added in 1993. This planting will be evaluated for growth and vigor once a year. This is one full year after the hard freeze and many of the plants have recovered quite well (Table 3.). The best performing species for the shrub plot are: rosemary, Texas ranger, *Acacia salicina* (Cooba wattle), desert willow, and firethorn. The resembles the 1991 performance list. Vetiver grass has grown well and has had good vigor ratings. Examination of the root structure in March 1993 has shown that it had grown below four feet with little lateral expansion. The best performing tree species are: Mexican fan palm, African sumac, California pepper tree, smooth Arizona cypress, and bottle tree.

1995
Evaluation factors for the shrub species in 1995 included cold tolerance, vigor, height, and survival. Significant differences in cold tolerance for the shrub species (Table 4) were noted for the red bird of

paradise which showed a greater cold tolerance with the domestic water treatment, and the dwarf oleander which exhibited a greater cold tolerance with the tertiary water treatment. Significant differences in vigor were exhibited by the desert willow and red bird of paradise both of which showed a significantly greater vigor rating with the domestic water treatment, and the desert olive which exhibited a significantly greater vigor rating with the tertiary water treatment (Table 4). Significant differences in height for the shrub species were exhibited by the dwarf oleander which was significantly greater with the tertiary water treatment and the rosemary which was significantly taller with the domestic water treatment (Table 4).

Evaluation factors for the tree species in 1995 included cold tolerance, vigor, height, and survival. Significant differences in cold tolerance for the tree species (Table 5) were noted for the Arizona cypress and sweet acacia both of which showed a greater cold tolerance with the tertiary water treatment. Significant differences in vigor were exhibited by the bottle tree, Arizona cypress and sweet acacia, all of which showed higher vigor ratings with the tertiary water treatment (Table 5). Significant differences in height were exhibited by the river she-oak and Mexican fan palm which were taller in the tertiary water treatment block, and the weeping bottlebrush tree which was taller in the potable water treatment block (Table 5).

Percent survival for 1995 for both shrub and tree species is shown in Tables 6 and 7. Survival data between water treatments by factor and species could not be statistically analyzed with an acceptable level of accuracy due to low numbers of plant replicates.

Table 1.

SHRUB LIST

PLANT NO.	COMMON NAME	SCIENTIFIC NAME	PLANTING DATES
1	Desert willow	*Chilopsis linearis*	June 1990
2	Yellow Bird of Paradise	*Caesalpinia gilliensii*	June 1990
3	Tiny Tim Dwarf Olive	*Olea europa*	June 1990
4	Red Bird of Paradise	*Caesalpinia pulcherrima*	June 1989
5	Wooly Senna	*Cassia tomentosa*	June 1990
6	Twin Peaks	*Baccharis pilularis*	June 1990
7	Prickly Wattle	*Acacia victoria*	Feb. 1990
			Jan. 1991 (5 plants)
8	Bush Lantana	*Lantana camara*	June 1990
9	Texas Ranger	*Leucophyllum frutescens*	June 1990
10	Blue Ranger	*Leucophyllum zygophyllum*	June 1990
11	Heavenly Bamboo	*Nandina domestica*	June 1989
12	Dwarf Oleander	*Nerium oleander petite*	June 1989
13	Vetiver Grass	*Vetiveria zizanioides*	Nov. 1990
14	Firethorn	*Pyracantha spp.*	June 1989
15	Notabilis Wattle	*Acacia notabilis*	Feb. 1990
			Nov. 1990 (4 plants)
16	Rosemary	*Rosmarinus officinalis*	June 1989
17	Compact Myrtle	*Myrtus communis-compacta*	June 1990
18	Red Salvia	*Salvia greggii*	June 1989
19	Manna Wattle	*Acacia microbotrya*	Feb. 1990
			Jan. 1991 (1 plant)
20	Cooba Wattle	*Acacia salicina*	Feb. 1990
			Jan. 1991 (3 plants)

Table 2.

TREE LIST

PLANT NO.	COMMON NAME	SCIENTIFIC NAME	PLANTING DATES
1	Shoe String Acacia	*Acacia stenophylla*	June 1990
2	Bottle Tree	*Crachychiton populneus*	June 1990
3	Mediterranean Fan Palm	*Chamaerops humilis*	June 1990
4	Weeping Bottlebrush	*Callistemon viminalis*	June 1989
5	River She-Oak	*Casuarina cunninghamiana*	June 1990
6	Feather Bush	*Lysiloma thornberi*	June 1990
7	Narrow-Leaved Red Mallee	*Eucalyptus foecunda*	Nov. 1990
8	Swamp Mallee	*Eucalyptus spathulata*	June 1990
9	Desert Ironwood	*Olneya tesota*	June 1989
10	Shamel Ash	*Fraxinus uhdei*	June 1989
11	Websters Mallee	*Eucalyptus websterana*	Nov. 1990
12	Smooth Arizona Cypress	*Cupressus glabra 'arizonica'*	June 1989
13	Sweet Acacia	*Acacia farnesiana*	June 1989
14	Hybrid Mesquite	*Prosopis chilensis*	June 1990
15	Philippine Lime	*Citrus calamondin*	June 1990
16	Cork Oak	*Quercus suber*	June 1990
17	African Sumac	*Rhus lancea*	June 1989
18	California Pepper Tree	*Schinus molle*	June 1989
19	Open		
20	Mexican Fan Palm	*Washingtonia robusta*	June 1989

Table 3.

Plants Killed or Damaged by the December, 1990 Frost:

A). Irrigated by POTABLE water:

Acacia notabilis	Notabilis wattle
Acacia victoriae	Prickly wattle
Acacia microbotrya	Manna wattle
Cassia tomentosa	Wooly senna
Chamaerops humilis	Mediterranean fan palm
Eucalyptus foecunda	Narrow leaved red mallee
Eucalyptus websterana	Websters mallee
Lantana camara	Bush lantana

B) Irrigated by TERTIARY Water:

Acacia notabilis	Notabilis wattle
Acacia victoriae	Prickly wattle
Acacia microbotrya	Manna wattle
Cassia tomentosa	Wooly senna
Chamaerops humilis	Mediterranean fan palm
Eucalyptus foecunda	Narrow leaved red mallee
Eucalyptus websterana	Websters mallee
Myrtus communis	Compact myrtle
Nandina domestica	Heavenly bamboo
Pyracantha sp.	Firethorn

Table 4.

Mean Values
for
1995 Shrub Evaluations[2]

Species	Water Treatment	Cold Tolerance	Vigor	Height (ft)
Desert willow	domestic	8.0 (A)	7.83 (A)	12.4 (A)
	tertiary	8.0 (A)	7.8 (B)	11.5 (A)
Yellow bird of paradise	domestic	7.33 (A)	5.67 (A)	4.58 (A)
	tertiary	7.67 (A)	5.67 (A)	5.83 (A)
Tiny Tim dwarf olive	domestic	9.0 (A)	8.0 (A)	3.2 (B)
	tertiary	8.67 (A)	6.67 (A)	4.0 (A)
Red bird of paradise	domestic	5.5 (A)	4.0 (A)	5.75 (A)
	tertiary	5.0 (B)	3.83 (B)	5.75 (A)
Desert olive	domestic	8.5 (A)	6.67 (B)	2.83 (A)
	tertiary	8.83 (A)	8.0 (A)	3.58 (A)
Twin peaks baccharis	domestic	DEAD		
	tertiary	DEAD		
Prickly wattle	domestic	4.0 (1)	3.0 (1)	6.08 (1)
	tertiary	7.5 (1)	7.0 (1)	9.0 (1)
Bush lantana	domestic	5.0 (1)	4.0 (1)	2.0 (1)
	tertiary	6.33 (1)	6.67 (1)	5.5 (1)
Texas ranger	domestic	8.33 (A)	6.5 (A)	5.83 (A)
	tertiary	8.6 (A)	7.4 (A)	7.1 (A)
Blue ranger	domestic	8.67 (A)	6.83 (A)	6.98 (A)
	tertiary	8.67 (A)	6.67 (A)	7.26 (A)

[2] Means, by specie and evaluation factor, followed by the same letter are not significantly different. Means, by specie and evaluation factor, followed by different letters are significantly different ($P<0.05$). Means followed by (1) could not be analyzed due to low numbers of replicates.

Table 4. (continued)

Mean Values for 1995 Shrub Evaluations[3]

Species	Water treatment	Cold Tolerance	Vigor	Height (ft)
Heavenly bamboo	domestic	7.67 (1)	6.0 (1)	3.11 (1)
	tertiary	6.0 (1)	3.0 (1)	2.5 (1)
Dwarf oleander	domestic	7.0 (B)	6.0 (A)	3.75 (B)
	tertiary	8.0 (A)	5.67 (A)	5.3 (A)
Vetiver grass	domestic	6.33 (A)	5.67 (A)	5.75 (A)
	tertiary	6.33 (A)	5.17 (A)	5.17 (A)
Firethorn	domestic	8.17 (A)	6.5 (A)	5.75 (A)
	tertiary	8.0 (A)	6.0 (A)	5.67 (A)
Notabilis wattle	domestic	DEAD		
	tertiary	DEAD		
Rosemary	domestic	8.67 (A)	7.83 (A)	3.16 (A)
	tertiary	8.6 (A)	7.0 (A)	2.6 (B)
Compact myrtle	domestic	8.0 (A)	5.67 (A)	4.16 (A)
	tertiary	7.5 (A)	4.5 (A)	3.5 (A)
Red salvia	domestic	8.0 (1)	7.5 (1)	2.5 (1)
	tertiary	6.0 (1)	4.0 (1)	2.5 (1)
Manna wattle	domestic	8.5 (1)	7.5 (1)	8.5 (1)
	tertiary	8.0 (1)	7.33 (1)	10.33 (1)
Cooba wattle	domestic	8.17 (A)	7.5 (A)	19.5 (A)
	tertiary	8.0 (A)	6.83 (A)	22.08 (A)

[3] Means, by specie and evaluation factor, followed by the same letter are not significantly different. Means, by specie and evaluation factor, followed by different letters are significantly different ($P<0.05$). Means followed by (1) could not be analyzed due to low numbers of replicates.

Table 5.

Mean Values
for
1995 Tree Evaluations[4]

Species	Water Treatment	Cold Tolerance	Vigor	Height (ft)
Shoe string acacia	potable	8.0 (1)	6.0 (1)	18.0 (1)
	tertiary	8.0 (1)	6.0 (1)	20.30 (1)
Bottle tree	potable	7.8 (A)	4.6 (B)	11.3 (A)
	tertiary	8.6 (A)	7.2 (A)	16.8 (A)
Mediterranean fan palm	potable	8.0 (1)	4.0 (1)	3.0 (1)
	tertiary	DEAD		
Weeping bottlebrush tree	potable	9.0 (A)	6.8 (A)	12.9 (A)
	tertiary	9.0 (A)	6.8 (A)	11.1 (B)
River she-oak	potable	8.6 (A)	5.0 (A)	11.8 (B)
	tertiary	8.8 (A)	7.0 (A)	23.3 (A)
Featherbush	potable	8.0 (1)	7.0 (1)	8.25 (1)
	tertiary	7.5 (1)	5.5 (1)	8.63 (1)
Narrow leaved red mallee	potable	DEAD		
	tertiary	DEAD		
Swamp mallee	potable	8.25 (1)	5.75 (1)	14.5 (1)
	tertiary	8.0 (1)	5.5 (1)	18.75 (1)
Desert ironwood	potable	8.0 (1)	6.0 (1)	10.33 (1)
	tertiary	8.0 (1)	6.0 (1)	13.0 (1)
Shamel ash	potable	9.0 (A)	7.6 (A)	9.2 (A)
	tertiary	8.6 (A)	5.8 (A)	8.2 (A)

[4] Means, by specie and evaluation factor, followed by the same letter are not significantly different. Means,by specie and evaluation factor, followed by different letters are significantly different ($P<0.05$). Means followed by (1) could not be analyzed due to low numbers of replicates.

Table 5 (continued).

Mean Values
for
1995 Tree Evaluations[5]

Species	Water Treatment	Cold Tolerance	Vigor	Height (ft)
Websters mallee	potable	DEAD		
	tertiary	DEAD		
Arizona cypress	potable	8.75 (B)	6.75 (B)	15.38 (A)
	tertiary	9.0 (A)	4.0 (A)	11.25 (A)
Sweet acacia	potable	7.7 (B)	4.7 (B)	7.0 (A)
	tertiary	9.0 (A)	8.0 (A)	12.67 (A)
Hybrid mesquite	potable	8.25 (1)	7.0 (1)	9.88 (1)
	tertiary	7.5 (1)	6.0 (1)	7.5 (1)
Philippine lime	potable	8.5 (1)	4.5 (1)	5.75 (1)
	tertiary	9.0 (1)	7.0 (1)	8.5 (1)
Cork oak	potable	4.7 (1)	2.0 (1)	2.5 (1)
	tertiary	DEAD		
African sumac	potable	9.0 (A)	7.3 (A)	13.25 (A)
	tertiary	9.0 (A)	7.33 (A)	13.33 (A)
California pepper tree	potable	9.0 (A)	7.4 (A)	14.8 (A)
	tertiary	9.0 (A)	7.5 (A)	15.42 (A)
Ball athel	potable	not planted		
	tertiary	not planted		
Mexican fan palm	potable	9.0 (A)	5.83 (A)	8.33 (B)
	tertiary	9.0 (A)	7.0 (A)	11.08 (A)

[5] Means, by specie and evaluation factor, followed by the same letter are not significantly different. Means,by specie and evaluation factor, followed by different letters are significantly different ($P<0.05$). Means followed by (1) could not be analyzed due to low numbers of replicates.

Table 6.

Percent Survival
for
Shrub Planting[6]
April 20, 1995

Species	Water Treatment	# Planted	# Alive	% Survival
Desert willow	domestic	6	6	100
	tertiary	6	5	83
Yellow bird	domestic	6	6	100
of paradise	tertiary	6	6	100
Tiny tim dwarf olive	domestic	6	5	83
	tertiary	6	3	50
Red bird of paradise	domestic	6	2	33
	tertiary	6	6	100
Desert olive	domestic	6	6	100
	tertiary	6	6	100
Twin peaks	domestic	6	0	0
baccharis	tertiary	6	0	0
Prickly wattle	domestic	6	2	33
	tertiary	6	2	33
Bush lantana	domestic	6	1	16
	tertiary	6	3	50
Texas ranger	domestic	6	6	100
	tertiary	6	5	83
Blue ranger	domestic	6	6	100
	tertiary	6	6	100
Heavenly bamboo	domestic	6	3	50
	tertiary	6	1	16

Table 6. (continued)

[6] Survival data, between water treatments by factor and specie, could not be statistically analyzed with an acceptable level of accuracy due to low numbers of plant replicates

Percent Survival
for
Shrub Planting[7]
April 20, 1995

Species	Water Treatment	# Planted	# Alive	% Survival
Dwarf oleander	domestic	6	4	66
	tertiary	6	3	50
Vetiver grass	domestic	6	6	100
	tertiary	6	6	100
Firethorn	domestic	6	6	100
	tertiary	6	3	50
Notabilis wattle	domestic	6	0	0
	tertiary	6	0	0
Rosemary	domestic	6	6	100
	tertiary	6	5	83
Compact myrtle	domestic	6	6	100
	tertiary	6	2	33
Red salvia	domestic	6	2	33
	tertiary	6	1	16
Manna wattle	domestic	6	2	33
	tertiary	6	3	50
Cooba wattle	domestic	6	6	100
	tertiary	6	6	100

[7] Survival data, between water treatments by factor and specie, could not be statistically analyzed with an acceptable level of accuracy due to low numbers of plant replicates

Table 7.

Percent Survival
for
Tree Planting[8]
April 20, 1995

Species	Water Treatment	# Planted	# Alive	% Survival
Shoe string acacia	potable	6	2	33
	tertiary	6	4	66
Bottle tree	potable	6	5	83
	tertiary	6	5	83
Mediterranean fan palm	potable	6	1	16
	tertiary	6	0	0
Weeping bottlebrush tree	potable	6	5	83
	tertiary	6	5	83
River she-oak	potable	6	5	83
	tertiary	6	5	83
Featherbush	potable	6	2	33
	tertiary	6	4	66
Narrow leaved red mallee	potable	6	0	0
	tertiary	6	0	0
Swamp mallee	potable	6	4	66
	tertiary	6	2	33
Desert ironwood	potable	6	3	50
	tertiary	6	1	16
Shamel ash	potable	6	5	83
	tertiary	6	5	83
Websters mallee	potable	6	0	0
	tertiary	6	0	0

Table 7. (continued)

[8] Survival data, between water treatments by factor and specie, could not be statistically analyzed with an acceptable level of accuracy due to low numbers of plant replicates

Percent Survival
for
Tree Planting[9]
April 20, 1995

Species	Water Treatment	# Planted	# Alive	% Survival
Arizona cypress	potable	6	4	66
	tertiary	6	2	33
Sweet acacia	potable	6	3	50
	tertiary	6	3	50
Hybrid mesquite	potable	6	4	66
	tertiary	6	2	33
Philippine lime	potable	6	2	33
	tertiary	6	1	16
Cork oak	potable	6	3	50
	tertiary	6	0	0
African sumac	potable	6	6	100
	tertiary	6	6	100
California pepper	potable	6	5	83
	tertiary	6	6	100
Ball athel	potable	not planted	-	--
	tertiary	not planted	-	--
Mexican fan palm	potable	6	6	100
	tertiary	6	6	100

[9] Survival data, between water treatments by factor and specie, could not be statistically analyzed with an acceptable level of accuracy due to low numbers of plant replicates

PROJECT: CP1.5

PROJECT TITLE: **Controlling erosion on cropland with cover cropping and residue management systems in the arid, semiarid and summer dry parts of the US**

PROBLEM STATEMENT: Cropland in arid regions experiences soil erosion from water and wind. The land is degraded and water quality is affected. Better covercropping and residue management techniques are needed.

LAND RESOURCE REGIONS: D Western Range and Irrigated Region
J Southwestern Prairies Cotton and Forage Region

MLRA: 14-51, 58-70

LAND USES: Cropland

VEGETATIVE PRACTICES:

PRIMARY:	327	CONSERVATION COVER
SECONDARY:	340	COVER AND GREEN MANURE CROP
TERTIARY:	328	CONSERVATION CROP ROTATION

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil condition; tilth, crusting, water infiltration, organic
SECONDARY:	Plants	Plants suitability, other.

SCOPE/DESCRIPTION: Studies and activities to determine cover crops, cropping systems, and residue management practices to optimize soil and water protection, food and fiber production, and economic returns. Identify and develop legumes having minimal water requirements for use as cover crops during summer fallow periods in MLRA 30 and during winter fallow periods in MLRA 40 and 41. Document and promote the benefits of using cover crops and green manure crops in cropping rotations. The Cover Crop and Green Manure practice when implemented will: protect air quality by reducing wind erosion, improve soil tilth, improve soil moisture holding capacity, and reduce soil nutrient loss.

OBJECTIVES: Develop and/or identify summer legumes for use as a cover crop in MLRA 30. Develop and/or identify low water use cover crops. Evaluate and document the benefits associated with cover crop use in hot desert areas. Identify legumes that are adapted for use under Arizona conditions. Develop an interdisciplinary/interoffice teams based upon similarity of problems and MLRA's. Teams will identify, demonstrate and promote opportunities through Field Plantings, Tech Guide updates and other activities. Western Arizona - Yuma and Parker Field Offices, SE California - El Centro, Blythe and Indio. Northwestern Arizona - Kingman, California - Apple Valley.

STATUS OF KNOWLEDGE: Cover crops and residue management are well documented. New plant materials from breeders and foreign research programs need to be tested and their performance documented. University and other researchers often develop new treatments and uses for crop residues. the application of these new techniques need to be tested.

PLANNED COORDINATION: TPMC is working with Maricopa County Extension Service (Kai

Umeda) in conducting joint trials on warm season legumes. These legumes are used as a cover crop/green manure crop for winter vegetables. We are also providing seed of Tropic sunn hemp (via the Hawaii PMC) and cowpeas to the Indio Field Office. The Indio FIELD OFFICE is working with Dr. Baki in identifying warm season legumes and using Dr. Baki's soybean variety for use as a green manure crop for winter vegetables.

COOPERATORS: Universities in affected states, USDA ARS, Cooperative Extension Service and others as needed.

PROJECT LEADER: TUCSON, ARIZONA PLANT MATERIALS CENTER & Arizona Plant Resource Specialist

STUDIES:

TUCSON, ARIZONA PLANT MATERIALS CENTER
04C9602M START: 1996 END: 2000
Cover Crop trials at TPMC and in cooperation with Maricopa County Extension Service.

STUDY NUMBER: 04C9602M

Cool Season & Warm Season Cover Crop Trials

PROJECT NUMBER: CP1.5

Controlling erosion on cropland with cover cropping and residue management systems in the arid, semiarid and summer dry parts of the US.

STUDY TYPE: Comparative Evaluation

LAND USES: Cropland

VEGETATIVE PRACTICES:

PRIMARY:	340	COVER AND GREEN MANURE CROP
SECONDARY:	328	CONSERVATION CROP ROTATION
TERTIARY:	327	CONSERVATION COVER

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil condition; tilth, crusting, water infiltration, organic
SECONDARY:	Air	Air quality, other.

DESCRIPTION: This is a joint study with Kai Umeda, Vegetable Crop Specialist with the Maricopa County Extension Service. The warm-season trials are specifically evaluating a legume that can be planted, turned under prior to winter vegetables. Factors we are evaluating are biomass production and amount of nitrogen added to the soil. The cool season trial is basically a TPMC study where we are screening various legumes for biomass production and adaptability to southern Arizona. The warm-season trial included 'Tropic Sun' sunn hemp(*Crotalaria juncea*),Iron & Clay cowpeas (*Vigna unguiculata*), sesbania (*Sesbaina exaltata*), sudangrass (*Sorghum sudanense*) and kenaf (*Hibiscus cannabinus*). The cool-season trial included Purple vetch (*Vicia atropurpurea*),'Lana' woolypod vetch (*Vicia villosa* ssp. *varia*), 'Biomaster' pea (*Pisum sativum*) and Papago pea (*Pisum sativum*).

DURATION OF STUDY: 1996 through 2000

STUDY LEADER: Bruce Munda & Kai Umeda

COOPERATORS: Maricopa County Extension, NRCS

METHODS AND MATERIALS: Warm-season cover crop trial was conducted in field 9. Soil in this field is a Grabe loam. All species were planted June 26, 1996 using a John Deere grain drill and at a depth of 1 to 1.5 inches deep. Each border is 0.45 acres in size. Sesbania was planted in borders 1 & 2 at a planting rate of 50 lb./ac (actual amount used = 50 lb.). Seed was inoculated with ISE600 Rhizobium inoculant or you can use "Sesbania Spec. 1" from Nirtagin company. Four irrigation's were applied to each border. The first irrigation was a pre-plant irrigation with the second irrigation following about one week after planting. Due to poor

plant establishment the Sesbania was irrigated only twice, for a total application of 9 acre inches of water, and then disked out. The third and fourth irrigation's were applied 20 days apart. The sunn hemp was planted in border 15 and 16 at a rate of 50 lb./ac and was inoculated with 'cowpea' or ISE200 type inoculant. Cowpeas were planted in borders 17 and 18 at a rate of 60 lb./ac and were inoculated with 'cowpea' or ISE200 type inoculant. Total amount of water applied was 24 acre inches for the cowpeas and sunn hemp. Cool-Season Cover Crop Trial. This trial was installed on December 10, 1996. Biomaster peas were planted in field 9 borders 1 & 2 and field 4 border 16 at a rate of 100 lb./ac. Papago peas were planted in field 9 border 17 & field 4 borders 13,14,&15 at a rate of 100 lb./ac. Both peas were inoculated with pea/vetch or ISE500 type inoculant. Lana vetch was planted in field 9 border 3 & 4, field 5 borders 1 & 2 and field 3 borders 10 and 11. Purple vetch was planted in field 9 border 18 & 19, field 3 borders 6,7,8 & 9. Planting rate was 80 lb./ac and the inoculant used was the pea/vetch type or ISE500. A John Deere grain drill was used to plant the cool-season species at a depth of 1/2 to 3/4 inches deep. All species were planted dry and irrigated up. Parameters measured for both legume trials are number of plants established, height and biomass production. 1997 observations will include length of flowering.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Amendment to cover crop standards and specifications, Technical Note.

OTHER ACTIONS: Plant Guide and/or fact sheet.

1996 RESULTS:

WARM SEASON LEGUMES

Results from Extension Service trials: Stand--sesbania was 2.25 plants/3 ft of drill row, sunnhemp was 20 plants/3 ft of drill row and cowpeas were 6.8 plants/ 3 ft of drill row; Yield(fresh weight)--sudangrass 19,816 lb/A, sunnhemp was 10,551 lb/A, sesbania was 7,794 lb/A, cowpeas was 5,184 lb/A and kenaf was 2,390 lb/A. The above yields were from trials at the MAC farm. Following the harvest of these crops cabbage, broccoli, and barley were planted. Visual observations of these crops indicated that sudangrass inhibited growth of all three crops. The three vegetable crops planted after the leguminous cover crops and kenaf did not exhibit measurable differences in growth. No supplemental fertilizers were applied to the fall planted crops at planting time. The leguminous cover crops had all exhibited growth of nitrogen-fixing nodules at the time of harvest and presumably provided nitrogen to the vegetable crops.

Results from TPMC trial: Stand--(7/29/1997) Sesbania was 0.21 plants/ft^2, sunnhemp was 3.5 plants/ft^2 and cowpeas was 1.8 plants/ft2; Yield--(9/06/1996) Sesbania was disked out due to poor plant establishment, Cowpea was 9,255 lb/A, Sunnhemp was 7,002 lb/A; Height--(9/06/1996) Cowpea was 27.2 inches, Sunnhemp was 63.7 inches. Approximately 1 in 5 cowpeas plants were observed to have nitrogen-fixing nodules while only 1 in 17 plants for sunnhemp were observed to have nodules. Cowpeas were observed to have slight insect, whitefly and leafhopper, activity while sunnhemp was observed to little to no whitefly and leafhopper activity. Quantity of irrigation water applied to the sunnhemp and cowpeas trials was 24 acre inches.

TPMC RESULTS

SPECIES	DENSITY* (PLTS/FT^2)	PLANT HT (IN) 33 DAP	PLANT HT (IN) 102 DAP	YIELD (LB/A) 102 DAP

	33 DAP			
SESBANIA	0.21	5.75	disked out	disked out
SUNNHEMP	3.5	7.5	63.7	7,002
COWPEA	1.8	9.1	27.2	9,255

* Density and first height measurements taken from an average of seven 5 ft^2 subplots within each replicate.

** Yield and final height measurements taken from an average of three m^2 plots within each replicate.

MAC RESULTS (Extension Service)

Date	Crop	Observation	
01 Jul 1996	sesbania	plant at 60 lb/A	
	cowpea	plant at 80 lb/A	
	sunnhemp	plant at 80 lb/A	
	kenaf	plant at 80 lb/A	
	sudangrass	plant at 80 lb/A	
29 Jul (28 DAP)	sesbania	12-in height*	2.2 plants/3 ft row**
	cowpea	5.1-in height	8.5 plants/3 ft row
	sunnhemp	8.8-in height	23.7 plants/3 ft row
	kenaf	3.6-in height	23 plants/3 ft row
	sudangrass	23.4-in height	47.8 plants/3 ft row
03 Sep (70 DAP)	sesbania	6-8 ft height	7,794 lb/A***
	cowpea	1-2 ft height	5,184 lb/A
	sunnhemp	4-5 ft height	10,551 lb/A
	kenaf	1-3 ft height	2,390 lb/A
	sudangrass	6 ft height	19,816 lb/A

Irrigation dates: 01, 22 Jul and 20 Aug.

***** Height measurements taken from average of 10 plants of each replicate

**Stand counts taken from 10 subplots of each replicate

***Yields taken from 3 ft X 50 ft area within each replicate

COOL SEASON LEGUMES

Papago peas and the Biomaster peas were planted on December 10 while the purple and Lana vetch were planted on December 16. Plants germinated within 2 weeks after planting. Due to the cool temperatures all of the plantings exhibited very slow growth. A more appropriate planting time would be October.

STUDY NUMBER: 04F9707R

'Pete' Eastern Gamagrass Field Planting

PROJECT NUMBER: CP1.5

Controlling erosion on cropland with cover cropping and residue management systems in the arid, semiarid and summer dry parts of the U.S..

STUDY TYPE: Comparative Evaluation

LAND USES: Cropland, Pastureland

VEGETATIVE PRACTICES:

	PRIMARY:	512	PASTURE AND HAYLAND PLANTING
	SECONDARY:	327	CONSERVATION COVER

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Animals	Animals habitat, food.

DESCRIPTION: This field planting is being conducted to evaluate the adaptability of 'Pete' Eastern gamagrass as a pasture and/or silage plant in southern Arizona. Evaluation factors to be recorded are: soil type, irrigation frequnecy & amount, percent stand, dormancy or frost date, yield and cooperators comments with regards to management and suitability.

DURATION OF STUDY: 1997 through 2000

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Paul Palmer, Farmer; Douglas Field Office and Manhatten PMC.

METHODS AND MATERIALS: We provided 95 lbs of Pete which will be seeded in early June at a rate of 10 pounds per acre and at a depth of 1 inch. Seed will be drill planted and irrigated up using a center pivot irrigation system. Seed quality is 99.82 pure seed, germination = 21 5 with 47% other viability and PLS = 67.88 %. Dormancy is a problem with eastern gamagrass seed. We followed Manhatten PMC stratification procedures which are: presoak the seed for 20 minutes in a 10:1 water/chlorox solution, rinse, presoak seed (in a burlap sack) with a 0.5% thiram mixture for a minimum of 12 hours, rinse, and store in a cold environment for a minimum of 6 weeks. We stored our seed in the PMC cooler which maintains the temperature at 35 °F and the RH at 35%. Seed lot information--Lot# SFD-93-0&0, pure seed = 99.8%, grem = 21%, other viability = 47%, PLS = 67.88%. Evaluation factors will include: planting date, percent stand, height at end of growing season, dormancy date and yield.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Update FOTG with regards to the pasture/hayland practice.

OTHER ACTIONS: Fact Sheet

STUDY NUMBER: 04F9708M

'Seco' Barley Field Planting

PROJECT NUMBER: CP1.5

Controlling erosion on cropland with cover cropping and residue management systems in the arid, semiarid and summer dry parts of the U.S..

STUDY TYPE: Comparative Evaluation

LAND USES: Cropland

VEGETATIVE PRACTICES:	**PRIMARY:**	340	COVER AND GREEN MANURE CROP
	SECONDARY:	327	CONSERVATION COVER

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil condition, other.
SECONDARY:	Soil	Soil condition; tilth, crusting, water infiltration, organic

DESCRIPTION: This field planting will compare 'Seco' against 'Solumn' with the objective to see which cultivar is best adapted to the Elfrida area with regards to biomass production, silage and/or grazing.

DURATION OF STUDY: 1996 through 1997

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Paul Palmer, Douglas Field Office

METHODS AND MATERIALS: January 17, 1997 approximately 350 lbs. of seco was delivered to Mr. Palmer. Seeding rate was 60 lbs. per acre with seed drill seeded to a depth of 3/4 to 1 inch deep. Planting will be evaluated of stand, irrigation frequency and quantity, and production.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Update FOTG on cover crop practice.

STUDY NUMBER: 04F9408R

Heaton Farms Field Planting

PROJECT NUMBER: CP7.1

Improving plant production on saline soils in the western states

STUDY TYPE: Comparative Evaluation

LAND USES: Pastureland, Hayland

VEGETATIVE PRACTICES: **PRIMARY:** 512 PASTURE AND HAYLAND PLANTING

	RESOURCE	CONSIDERATION/PROBLEM
PRIMARY:	Plants	Plants suitability, plants are not well adapted to site.
SECONDARY:	Soil	Soil condition, other.

DESCRIPTION: The field planting was designed to evaluate 2 pasture and hayland grass alternatives to tall wheatgrass on saline-sodic soils. "Newhy" hybrid wheatgrass (*Elytrigia repens* x *Pseudoroegneria spicata*) and "RS-Hoffman" quackgrass (*Elytrigia repens*) were planted on November 1, 1994 in three borders of a small irrigated field. "Spredor 3" and "Cimarron VR" alfalfa varieties are also part of the trial.

DURATION OF STUDY: 1994 through 1999

STUDY LEADER: Fredonia Field Office & Tucson PMC

LOCATION: ARIZONA PMC

COOPERATORS: Fredonia Field Office, Gene Heaton (farmer), Tucson PMC

METHODS AND MATERIALS: Study is evaluating three seeding strategies. First is seeding "Newhy" hybrid wheatgrass and "RS-Hoffman" quackgrass individually, second is seeding the two grasses after seeding the alfalfa varieties "Spredor 3" and "Cimarron VR" and third is seeding the grasses prior to seeding the alfalfa. Border A is split with half seeded to "Newhy" and half to "RS-Hoffman". Border D is split with half seeded to "Spredor 3" and "Newhy" and half seeded to "Spredor 3" and "RS-Hoffman". Border E is split between Newhy with Cimarron VR and RS-Hoffman with Cimarron VR. The grasses were seeded at a rate of 7-8 #/acre and were drill seeded using a rangeland drill. Seeding depth was 1/2 to 3/4 inches deep. The alfalfa was broadcast seeded at a rate of 10-12 #/acre. Soil has a clay loam texture. Two soil samples were analyzed one from borders D and E and the second from border A. The first sample has a pH of 8.6, electrical conductivity (EC) was 11.0 mmhos/cm and exchangeable sodium percentage (ESP) was 12.2 %. This sample places borders D and E on the break between saline and saline-sodic. Alfalfa is considered moderately sensitive to salts, and

germination is reduced by 50% when EC is 8-13 mmhos/cm. The second sample had a pH of 8.6, EC of 12. mmhos/cm, and ESP of 16%. This sample places border A well into the saline-sodic category. This will be a good test for these alternative grasses. Even tall wheatgrass, with yield reduction threshold of 7.5 mmhos/cm for EC, loses some productivity on these sites.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Update pasture planting practice, especially for saline-sodic soils

OTHER ACTIONS: Fact sheet on planting recommendations for saline-sodic soils.

RESULTS:

1995

This trial was initiated during one of the wettest years on record. From October 1994 through September 1995 the area received 16.22 inches of precipitation. The planting area was also irrigated lightly in early April with a heavier irrigation applied in early May 1995.

The first evaluation was conducted on March 8, 1995. Both grasses were emerging with the alfalfa just starting to germinate. By March 28 the grass seedlings were up and appeared to be well established. There were a few scattered alfalfa seedlings in the 2-leaf stage.

The third evaluation was on April 26, 1995. Border A had a fairly consistent stand of both grasses, with no apparent difference between the two species. In borders D and E the grasses appeared to be a little spotty. This was attributed to the difficulty of evenly planting a small amount of seed through a range drill. There were very few Spredor 3 seedlings in Border D, where the weed competition was very heavy. There were a few more Cimarron VR seedlings in Border E, but alfalfa emergence was very disappointing.

By June 21, 1995 the trial grasses had begun to seed out and the alfalfa, although still pretty thin, was growing well. There was a lot of competition in all borders from annuals, desert saltgrass, perennial Hordeum, and tall wheatgrass. Border A also had a lot of black greasewood coming up.

The final evaluation was conducted on September 14, 1995. Both varieties of grass have established well, with no apparent difference between them. Many of the plants have flowered and produced seed. The alfalfa stands are better than originally thought. There are still many bare patches, with the Cimarron VR established itself better than the Spredor 3. There are some new seedlings which have germinated with late summer rains. Some of the mature plants have produced seed. Gene Heaton plans to graze the field in November. Utilization levels will be kept light. It is hoped that we can get some seed trampled in the soil surface. The field trial will be monitored during grazing to see if the cattle have any species preference.

1996

Many of the fields in the Fredonia area are alkaline, severely limiting the type of pasture or crops which can be grown. Officially, these soils are called saline or saline-sodic. Tall wheatgrass grows fairly well on these soils and is used extensively as a pasture grass. However, it can be hard to manage with mature forage being relatively unpalatable to livestock, and makes only fair hay. The purpose of this field trial is to try "Newhy" hybrid wheatgrass and "RS-Hoffmann" quackgrass on these soils, to see if they will perform well enough to be considered as alternatives to tall wheatgrass. Both species are very palatable for grazing and make excellent hay. Two alfalfa varieties, "Cimarron VR" and "Spredor 3", were also planted to see if they would establish under saline conditions. All species were planted in the fall of 1994, to germinate in the spring of 1995. "Cimarron VR" alfalfa is looking promising. The stand is poor in places but very good in others. This variety has excellent pest and disease resistance, and is also tolerant to prolonged periods of wet soils. "Spredor 3" does not appear to well adapted to saline-wet soils. It is a low-growing variety

developed for grazing, and hopefully will start to spread by rhizomes. Both grass species appear to doing well. The saline soils have a good stand on the upper end of the field, and a fair stand at the bottom. This difference is partly due to more water available at the top end of the field. There appears to be a limit to the level of salts these grasses can withstand. On the truly saline-sodic soils both grass species have had poor establishment. The grasses are starting to spread by rhizomes, and it will be interesting to see how well they compete with weeds and other undesirable plants that are starting to grow on these soils. "Newhy" hybrid wheatgrass is available from commercial sources.

PROJECT TITLE: **Maintaining plant diversity and and cover to control soil erosion on natural areas.**

PROBLEM STATEMENT: Guaranteed, local, genetic ecotypes of most native species are not generally commercially available. Revegetation projects such as those done by the National Park Service require the use of indigenous genotypes which have been specifically collected from within a given geographic area.

LAND RESOURCE REGIONS:

MLRA: 1-273

LAND USES: Natural area, Wildlife

VEGETATIVE PRACTICES:	**PRIMARY:**	342	CRITICAL AREA PLANTING
	SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT
	TERTIARY:	568	RECREATION TRAIL AND WALKWAY

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants suitability, other.
SECONDARY:	Soil	Soil deposition, damage, offsite.

SCOPE/DESCRIPTION: This project is designed to assist other agencies or groups with locating, propagating, or producing genetically indigenous genotypes for use in areas where nonindigenous genotypes are not desired or allowed

OBJECTIVES: The objectives of this project are to develop methods or the means to produce limited quantities of genetically indigenous plant materials for specific uses in specific geographic areas. Studies developed under this project will be very specific in scope and duration and designed to meet specific, identified needs.

PLANNED COORDINATION: Planned cooperators for this project include the National Park Service - Fort Bowie National Park and the Natural Resources Conservation Service - TucsonPlant Materials Center.

COOPERATORS: National Park Service, Natural Resources Conservation Service

PROJECT LEADER: Plant Materials Technical Advisor-NPS, Tucson, Arizona Plant Materials Center.

LITERATURE CITED:

STUDIES:
TUCSON, ARIZONA PLANT MATERIALS CENTER
04S9304B START: 1993 END: 1997
Seed Production for Reseeding Disturbed Areas at Ft. Bowie National Park Historic Site.

STUDY NUMBER: 04S9304B

Seed Production for Reseeding Disturbed Areas at Ft. Bowie National Park Historic Site - Final Report

PROJECT NUMBER: NA1.1

Maintaining plant diversity and controlling soil erosion on natural areas.

STUDY TYPE: Advanced Evaluation

LAND USES: Natural area, Wildlife

VEGETATIVE PRACTICES:

PRIMARY:	342	CRITICAL AREA PLANTING
SECONDARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Plants	Plants management, other.
SECONDARY:	Soil	Soil erosion, other.

DESCRIPTION: The objective of this project is to produce 50 bulk pounds of seed of five native, perennial grasses. The original seed for these grass species was collected on site at the Fort Bowie National Historical Site. Plants were propagated from this seed and used to establish seed production blocks at the Tucson Plant Materials Center. Seed harvested from these production blocks was processed and stored at the Tucson PMC until the 50 bulk pound objective was fulfilled.

DURATION OF STUDY: 1993 through 1997

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: National Park Service, Tucson Plant Materials Center

METHODS AND MATERIALS: Seed collection trips were conducted in September 1993. Tucson PMC personnel collected seed from five native species: sideoats grama, green sprangletop, sand dropseed, plains bristlegrass, and plains lovegrass. All seed was hand harvested from the plants.

This bulk material was conditioned at the Tucson PMC using hand rubbing blocks and an air/seed aspirator. In addition, an Air Seed Shucker was used on the sideoats grama to remove the caryopsis from the glumes in order to speed up the germination process.

Seed was planted into "Super Soil" potting mix using Jiffy trays (2" x 2" compartments) in October 1993. These seedlings were then transplanted into Field 9, Border 9 (Field 1, Border 1 for the sand dropseed) at the Tucson PMC on May 5, 1994. A mechanical, tractor-

mounted transplanter was used to transplant the seedlings into the fields.

Initially, rabbits caused problems in the sideoats grama production block. However, as the plants grew larger, the grazing by the rabbits decreased. The production block received four irrigations (approximately 9" of water). Surflan (pre-emergent herbicide) was applied on March 9, 1995 to help reduce competition from weeds.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Fact sheet pertaining to seed production methods for native grass species.

RESULTS:

1994

The plains bristlegrass and sand dropseed plots were hand harvested on September 21, 1994 and October 3, 1994. The plains bristlegrass was hammermilled and cleaned using an Office Clipper. The sand dropseed was conditioned using a rubbing block and then an air/seed aspirator. The plains lovegrass, green sprangletop and sideoats grama were harvested on October 20, 1994. The plains lovegrass seed was conditioned using a rubbing block followed by the air/seed aspirator. The sideoats grama was hammermilled and then cleaned with the Office Clipper. The hammermilling resulted in too much seed damage. The Westrup Brush Machine is more efficient and results in much less damage to the seed. The green sprangletop did not produce any seed due to a very hot and dry summer in 1994. The bulk quantities of clean seed for 1994 were: 1 lb 7 oz of sideoats grama; 28 lbs 8 oz of plains bristlegrass; 5 oz of sand dropseed, and 2 oz of plains lovegrass.

1995

The seed production fields are in their second year of production. To date a total of 26 pounds of processed seed has been produced; production by species is: sideoats grama - 11 lbs 14 oz; green sprangletop - 11 lbs 4 oz; plains lovegrass - 2 lbs; sand dropseed - 1 lb. As expected, seed production in the first year was minimal with the second year showing significant increases. In April 1996 the plains bristlegrass will be replanted.

At the beginning of this project it was felt that 1/8 acre production blocks would be sufficient to meet the production goals for these species. However, based on our actual seed yields, 1/4 to 1/2 acre production fields would have been more appropriate and probably would have allowed us to meet our estimated yields. Also, larger fields would have lessened the herbivory impact from our local rabbit population.

The Flail-Vac seed harvester is very efficient for harvesting sideoats grama, green sprangletop and plains bristlegrass. Seed production for the plains bristlegrass appears to be inherently low. Flowering is indeterminate with filled florets being produced in the lower 2/3 area of the inflorescence. Seed shatters easily to timing of harvest is critical. We generally conduct our harvest when the inflorescence is still green.

1996

Seed production fields are in their final year for production for this project. Since we produced only 49.3 pounds of the agreed-to 50 bulk pounds, we will maintain the plains bristlegrass and sideoats grama production fields through 1997. We will conduct a final fall harvest in 1997. With this quantity of seed we

will be able to exceed our contract amount. Current seed production by species is: sideoats grama - 23.4 lbs; green sprangletop - 15.5 lbs; plains lovegrass - 2 lbs; sand dropseed - 1 lb, and plains bristlegrass - 7.4 lbs.

Plains bristlegrass is a low seed producer. Combined with Tucson's hot, dry summers, which greatly reduces pollen viability resulting in poor seed production, we have eliminated our summer harvest. Our fall harvest that normally occurs in October has consistently proudced higher yields. We feel this is due to our rainy season, usually August through September, when air temperatures are lower and the humidity is higher. These climatic conditions help extend the viability of the grass's pollen resulting in higher floret fertilization.

PROJECT: WA3.2

PROJECT TITLE: **Develop the technology for stabilizing channels for soil erosion control in arid and semi-arid parts of the US.**

PROBLEM STATEMENT: In MLRA 41-3 many of the upland range sites have had an increase in brush species due to a decrease in herbaceous species. This has resulted in increased runoff, soil piping and the formation of gullies.

LAND RESOURCE REGIONS: Western Range and Irrigated Region

MLRA: 41, 40-1

LAND USES: Rangeland, Natural area

VEGETATIVE PRACTICES:

PRIMARY:	550	RANGE SEEDING
SECONDARY:	314	BRUSH MANAGEMENT
TERTIARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil erosion from concentrated flow, ephemeral gully.
SECONDARY:	Water	Water quality, other.

SCOPE/DESCRIPTION: Identifed needs include: (1) identification of plant species that are adaptable, (2) identify cultural techniques that enhance plant establishment and (3) screen and/or identify plant species that can withstand soil deposition, flooding andresistance to herbivory.

OBJECTIVES: Actions include: identify plant species that can be successfully established, resist grazing, and retain soil sediments.

PLANNED COORDINATION: Cooperators with the Fort Huachuca project are: DOD Fort Huachuca, Douglas Field Office, and Tucson PMC

COOPERATORS: Dept. of Defense-Fort Huachuca, NRCS-Tucson PMC, Douglas Field Office

PROJECT LEADER: Tucson, Arizona Plant Materials Center, Arizona Plant Resource Specialist

APROVED BY PMC STATE CONSERVATIONIST ADVISORY COMMITTEE:

AZPMC	High	Active

STUDIES:
TUCSON, ARIZONA PLANT MATERIALS CENTER
04A9410S START: 1993 & END: 1995
Fort Huachuca East Range Vegetative Gully Plug Trial

STUDY NUMBER: 04A9410S

Fort Huachuca East Range Vegetative Gully Plug Trial - Final Report

PROJECT NUMBER: WA3.2

Develop the technology for stabilizing channels for soil erosion control in arid and semi-arid parts of the US.

STUDY TYPE: Advanced Evaluation

LAND USES: Rangeland, Natural area

VEGETATIVE PRACTICES:

PRIMARY:	550	RANGE SEEDING
SECONDARY:	314	BRUSH MANAGEMENT
TERTIARY:	645	WILDLIFE UPLAND HABITAT MANAGEMENT

	RESOURCE	**CONSIDERATION/PROBLEM**
PRIMARY:	Soil	Soil erosion from concentrated flow, ephemeral gully.
SECONDARY:	Water	Water quality, other.

DESCRIPTION: The objective of this study is to evaluate four warm season grasses for use and applicability in stabilization of small gullies in MLRA 41-3. Brush species such as creosote, whitethorn, catclaw, mesquite, and tarbush have increased due to a decrease in the herbaceous grass species. As the herbaceous component decreased less rainfall is being absorbed into the soil and more is running off. On the East Range this increased runoff is causing soil piping and the formation of gullies on highly erodible soils that have a high gypsum and sodium content. Dirt access roads have also contributed to gully formation by concentrating and directing runoff onto these highly erodible soils. To reduce these conditions approximately 450 acres were brushed and reseeded to warm season native grasses. As a component of the this brushing project the Tucson Plant materials Center installed a gully plug trial in two small gullies that crossed the treated (brushed & seeded) and untreated areas within the project. On September 27-29, 1993 approximately 500 plants were planted in two gullies and their respective tributaries. The vegetative plugs were spaced approximately 20 to 30 feet apart. Species used were: Spike dropseed (*Sporobolus contractus*), Big sacaton (*Sporobolus Wrightii*), tanglehead (*Heteropogon contortus*), and vetiver grass *(Vetiveria zizanioides*). The planting procedure involved digging a trench perpendicular to the gully and transplanting containerized plants into the trench. All work was done by hand. Number of plants per gully plug varied between 6 to 15 plants depending on plant size and width of the gully. All plants were watered immediately after planting and one additional watering the day after transplanting. Watering the plants was achieved by using a 100 gallon trailer mounted water tank and 300 feet of garden hose. Selected gully plugs were watered again on 10/19/93. Evaluations included survival, vigor and height.

DURATION OF STUDY: 1993 through 1995

STUDY LEADER: Bruce Munda

LOCATION: ARIZONA PMC

COOPERATORS: Fort Huachuca, Douglas Field Office, Tucson Plant Materials Center

METHODS AND MATERIALS: All grass transplants were grown from seed except for the Vetiver grass. Vetiver grass was increased by clonal propagation using 'slips'. The vetiver variety used was "Sunshine" which does not produce viable seed. Seeds were germinated and grown in Ray Leach "conetainers" (soil volume 10 in^3) for a period of 2 months. All transplants, including vetiver grass, were grown in Deepots (soil volume 40 in^3) for several months prior to field installation. Soil mix used was 'Supersoil' which is a steam sterilized organic mix with no native soil.

TECHNOLOGY TRANSFER PRODUCTS:

FOTG ACTIONS: Information from this trial could be referenced as a vegetative component for grade stabilization structures and gully erosion control.

OTHER ACTIONS: Fact sheet

RESULTS:

1995

Of the four species tested tanglehead and vetiver had the highest survival rates and were grazed the least by the indigenous fauna. Tanglehead had the highest overall survival rate at 54% with 63% for theno additional water treatment and 48% for the one additional water treatment. Vetiver grass had the second highest overall survival rate at 38% with 50% for the no additional water treatment and 31% for the one additional watering. Big sacaton had an overall survival rate of 18% with 23% and 8% survival rates for the one and no additional water treatment, respectively. Spike dropseed had the lowest overall survival rate at 6.5% with 10% and 3% survival rates for the one and no additional water treatments, respectively. See table one for more information. Transplant/gully plug location was a significant factor with regards to plant survivability and growth. Vetiver, that did not receive the additional water treatment, did not survive in the middle reaches (unbrushed) of the site. Whereas, vetiver plants, that did receive the additional watering, had a survival rate of 37.5% in the upper (brushed) and middle (unbrushed) reaches of the site. Vetiver and tanglehead had higher survival rates in the lower or downstream reaches of the trial site due to receiving additional moisture from runoff. Number of irrigation's required to ensure plant survival is still not known. However, results from this trial suggest that mudding the plants in during transplanting and planting in a location where they can receive additional moisture should provide survival rates of 30 to 60 percent. One additional watering does help ensure plant survival but only if the plant is located in such a position that it receives supplemental moisture from runoff. Timing is also important. Transplanting should be conducted when the high temperatures are below 100^{o}F but the days are warm enough to promote plant growth. Based on results of this trial a late August through September is a desirable planting window. If summer rainfall is normal there should be residual soil moisture which will help minimize transplant shock. Like water, herbivory was limiting factor to transplant success. Most of the spike dropseed and big sacaton plants were grazed out. To ensure success, transplanted materials need to be protected and/or select those species that are unpalatable or resistant to grazing. Screening native plant materials for their lack of palatability would be necessary if this type of practice becomes a useful tool. The vetiver grass has been monitored from 1993 through 1996 for movement downstream. We have seen no evidence of plant movement or re-establishment. However, due to the location of this trial, in the watershed of the San Pedro River, we removed all of the vetiver grass plants from the site on November 26, 1996.

FORT HUACHUCA - GULLY PLUG TRIAL
AUGUST 29, 1995
TABLE ONE

SPECIES	No. Planted	No. Surviving	% Survival	Vigor [1]	Height (in)

Big sacaton					
watered 2X	79	18	23	4.2	14.5
watered 1X	38	3	8	3.8	14.5
subtotal	**117**	**21**	**18**		
Spike dropseed					
watered 2X	114	11	10	3.7	17.2
watered 1X	100	3	3	3.5	14.0
subtotal	**214**	**14**	**6.5**		
Tanglehead					
watered 2X	40	19	48	3.0	26.8
watered 1X	27	17	63	2.0	31.0
subtotal	**67**	**36**	**54**		
Vetiver grass					
watered 2X	67	21	31	2.9	21.9
watered 1X	38	19	50	1.5	47.5
subtotal	**105**	**40**	**38**		
OVERALL AVERAGE	**503**	**111**	**22**	**----**	**-----**

1 = vigor, where 1 is best and 9 is worst