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Los Lunas Plant Materials Center Annual Technical Report

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'Windbreaker' big sacaton (*Sporobolus wrightii*)

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Soil Health Studies

Background

The USDA-Natural Resources Conservation Service (NRCS) staffs were involved in three meetings in the winter and spring of 2012. The attendees were:

- State Agronomist
- Area Agronomists
- State Water Quality and Soil Data Quality Specialists
- Los Lunas Plant Materials Center (LLPMC) staff

The outcome identified nine potential studies regarding the soil health benefits of using cover crops. The purpose of these proposed studies is to provide New Mexico NRCS Field Staff with practical information to employ cover crop practices in New Mexico. Such data is currently not available for Southwestern climates and soils.

Cover crops may be defined as any crop that is planted between periods of regular commodity crop production. This practice can save the producer money and provide for a more sustainable farming operation with fewer inputs (fertilizer, irrigation, cultivation, etc.) compared to traditional farming operations. Cover crops are often used in New Mexico on irrigated lands. However, cover crops are rarely used in New Mexico on dry-land farms because the limited amount of precipitation is inadequate for establishment and sustainability. The limited and irregular precipitation that does occur is often reserved for only commodity crop production.

Between cropping systems, the land is often left fallowed. The bare topsoil of fallowed land is subject to erosion by severe spring winds (some days above 50 mph) that commonly occur in New Mexico and are particularly damaging on sandy soils. This wind damage commonly occurs both on and off farm and range sites in New Mexico.

About 10 million dollars in destruction were estimated annually on site in New Mexico (Davis and Condra, 1989) and includes:

- Reduced soil productivity because of the loss of water storage capacity for plant available water
- Loss of plant nutrients
- Degradation of soil structure
- Land-reduced uniformity of soil conditions in the field

The deposition of sediment caused by wind erosion reduces water reservoir storage capacity, clogs streams and drainage channels, deteriorates aquatic habitat, muddies recreational waters, increases water treatment costs, damages water distribution systems, and carries agricultural chemicals into water systems.

Wind erosion damages offsite were estimated at 466 million dollars to occur in New Mexico annually (Huszar and Piper, 1986) and damages included:

- Exterior paint
- Landscaping
- Automotive
- Interior and Laundry
- Health
- Recreation

Sandy soils are common in New Mexico and as well as being subject to wind erosion, have limited water holding capacity because of their coarse texture (soil particle size between 0.05 and 2.0 mm). Because of their large particle size, macro-pores exist between soil particles and aggregates (PEDS) that are too large to have any significant capillary forces and are drained by gravity. Sandy soils hold very little available water, about 1-inch per 1-foot of soil. However, on sandy soils, the increase in soil organic matter provided by cover crops may improve soil water holding capacity by increasing the microspore space which holds the capillary water.

Other potential soil health improvements from cover crops include:

- Additional nitrogen, phosphorus, and sulfur
- Improvement in soil structure by supplying directly or indirectly through microbial action the major soil aggregate forming cements, particularly polysaccharides
- Increased cation exchange capacity which absorb nutrients for eventual plant use
- Increased microbial activity (i.e., free nitrogen fixers and denitrifiers) by supplying carbon as food source
- Increased buffering capacity against rapid change in acidity, alkalinity, salinity, and damage by pesticides and toxic heavy metals.

Other benefits of cover crops as described in the *NRCS Cover Crop Practice Standard's Manual* include:

- Reduce erosion from wind and water
- Increase biodiversity
- Suppress weeds
- Provide supplemental forage
- Reduce particulate emissions into the atmosphere
- Minimize and reduce soil compaction
- Attract beneficial insects (pollinators and parasitoids)

Perhaps the soil health benefits gained by using cover crops may provide for more lucrative commodity crops. After the three successive meetings, the following three studies were considered to be the most important:

1. **Study #1: Performance of Selected Cover Crops and Cover Crop Mixes Followed by a Selected Cash Crop under New Mexico Southern High Plains Conditions**

   Compare the performance including soil health benefits, ease of establishment, forage value and other agronomic characteristics of selected cover crops. After termination of the individual cover crops, a selected commodity crop will be seeded into the various cover crop treatments. The growth response of this commodity crop without the addition of fertilizers will provide the final measurement of cover crop performance in this study.

2. **Study #2: Comparison of a Cover Crop/No-till Farming Practices with Conventional Tillage Farming Methods**

   The inputs and products of a cover crop/no-till planting (using a single cover crop species) will be compared with a conventional tillage planting with the same commodity crop. A thorough analysis of economic costs and benefits of both methods will be conducted, and the ecological services provided by the practices will be quantified.

3. **Study #3: Evaluation of Uncommon Cover Crops under New Mexico Conditions**

   Uncommon legume cover crops that are tolerant of drought and alkaline soils will be evaluated under New Mexico conditions. Many of these legume cover crops have been developed in Australia and other arid countries.

Study #1 Study Plan

Performance of Selected Cover Crops and Cover Crop Mixes Followed by a Selected Commodity Crop under New Mexico Conditions

Introduction

NRCS cooperators are interested in sustainable farming practices that use cover crops to improve soil health. In the New Mexico southern high plains, dryland farming is occurring where the annual average amount of precipitation during this current drought period is only about 15 inches. This seems to be close to the threshold for the minimal amount needed for dryland farming in this hot, arid environment. Even more limiting, most of the precipitation occurs during the summer months (June to August) when the daily temperatures average above 90° F (Western Regional Climate Center, 2012). Because of the high temperatures, the limited amount of precipitation may be lost mostly to evaporation making dryland farming extremely difficult. With some success, Area Agronomist Kevin Branum explained dryland farming in this area has been limited to drought tolerant small grains. Historically local producers have sold these grain crops to dairies as silage. Using cover crops in this area may enhance both the quality and the yield of dryland grain silage crops.

Cover crop mixes are commonly used in the river valleys of northern New Mexico (such as the Rio Grande, Rio Chama, and Mora River) where the temperatures are cooler (-30° to 85° F) and precipitation is typically more abundant (12 to 26 inches annually). Irrigation water also is more available in this area. These cover crop mixes are often highly sophisticated containing both cool-season and warm-season plants, legumes, grasses, and mustards. As reported by Ana Gomes, Northwest Area Agronomist (personal communication 11/2012), some of the commonly used cover crop mixes are:

- Cowpea sorghum-sudan grass and millet
- Triticale, rye, and cowpea
- Brassica, ryegrass, sorghum-sudan, small grains and clovers
- Oregon common ryegrass, annual white sweet clover, cowpeas, millet, turnip, radish, cowpeas

Producers are using cover crop mixes because different species provide different attributes that synergistically improve soil health. Examples of plants that lead to soil health improvement include:

- Grasses provide the longest lasting residue cover because they have a higher carbon-to-nitrogen ratio in their biomass compared to non-grass species
- Legumes with their rhizobium bacteria relationship (for example clover and common vetch) fix atmospheric nitrogen which feeds into the soil system
- The deeper tap roots of forb species, especially Brassicas (mustards), penetrate and open soils reducing compaction which improves infiltration. They also provide large amounts of carbon that feed micro-organisms
- Cool-season plants (grains, mustards, vetches, and clovers) are able to grow in the fall, winter, and spring which helps to build the soil and manage soil moisture during cold periods

- Warm-season plants (Sudan grass, medics, and cowpeas) are able to grow during the hot summer months which can help to build the soil. This in turn helps to improve soil moisture retention and improves filtration during excessively warm periods

The goal of these studies is to provide NRCS Field Office staff with concrete information about the soil health benefits gained by using the recommended selection of cover crops. Cover crop single species and cover crop mixes will be grown and evaluated at the LLPMC for use in the southern high plains of New Mexico and the river valleys of northern New Mexico. Cover crops exhibiting superior performance during these field studies will be tested again in the second phase of this study at appropriate field locations in New Mexico.

Study Methods

The following cover crops treatments and commodity crop are commonly grown in New Mexico by NRCS cooperators and subsequently, were selected for testing by New Mexico NRCS State and Area agronomists:

Cover Crop	Species	Rate (PLS/lbs./acre)
Annual grain single species	Barley	Cool-season TBD
Annual legume single species	Hairy vetch	Cool-season TBD
Legume/forb/grass mix	Buckwheat	Warm-season 5
	Cowpeas	Warm-season 7.5
	Forage radish	Cool-season 2
	Foxtail millet	Warm-season 5
	Male sterile Sorgham/sudangrass	Warm-season 3
	Triticale	Cool-season 5
Commodity crop	Milo	Warm-season TBD

Control plots of bare soil will be used to evaluate the soil benefits of the cover crop treatments. Both herbicides and mowing treatments will be applied to control weeds on all treatments. There will be no tillage on any treatment during this study. Soil testing will be performed prior to sowing cover crops and the recommended fertility treatments will be applied if nutrient deficiencies are identified.

Cover crop treatments will be terminated after they become well-established in late spring, and then they will be replaced by the commodity crop. There will be no fertilizer inputs when growing the commodity crop. The resulting production of the commodity crop will be an important factor in measuring cover crop performance.

Cover crop treatments and commodity crop will be grown under the following conditions:

- **Deficit irrigation** where the crops will be allowed to temporarily wilt, and
- **Ample irrigation** sufficient enough to prevent wilting

Because the cover crop treatments selected are a mix of warm-season and cool-season species, they will be sown in early fall of 2013. The cover crops and commodity crop treatments together will be grown under 20 inches of water which includes both irrigation and precipitation at the LLPMC to simulate conditions where limited irrigation is available in the New Mexico southern high plains. The deficit irrigation treatment provides for more water than precipitation inputs found in the New Mexico southern high plains (15 inches of precipitation), so the results will be applicable to this location where some irrigation water is available. The irrigation amounts will be recorded using flow meters that will allow water inputs to be accurately determined from the flow meter data and precipitation data that will be determined from the weather station at the LLPMC. The cover crop treatments will also be grown under ample irrigation to measure their potential and simulate the conditions of the northern New

Mexico river valleys and other irrigated lands in New Mexico. The ample irrigation (the control) will simulate conditions where irrigation is possible and crop response is an expression of potential and not limited from reduced water availability.

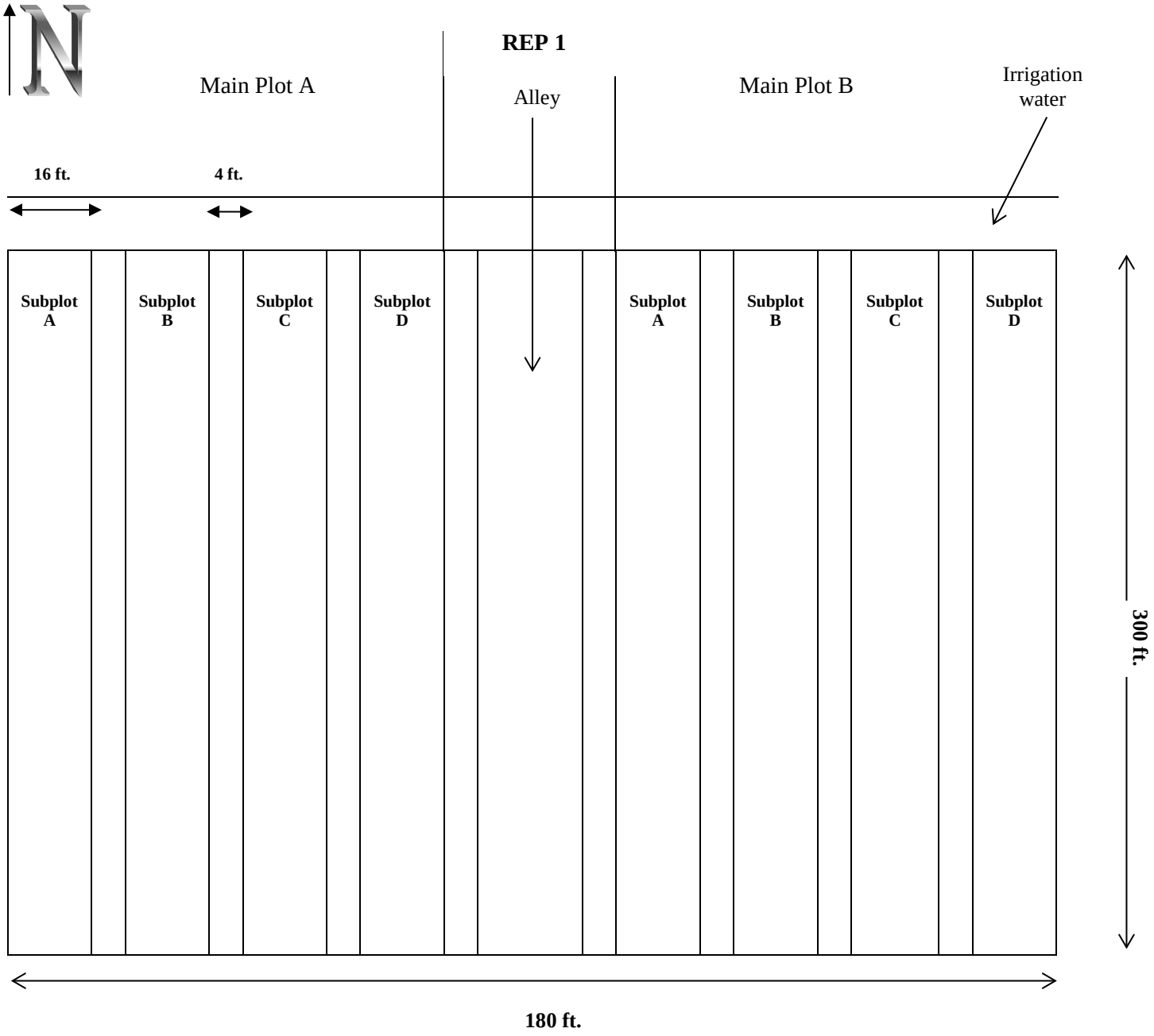
Cover crops evaluated includes both single species and a mix. Single species cover crops may be easier to establish because selective herbicides can be used, but the more difficult to manage mixes might provide enhanced soil health benefits as previously discussed. A cover crop mix will be seeded as a mix and not separated into its individual species components to allow for the evaluation of the mixes' ability to compete with weeds, and an accurate simulation of follow-up commodity crop establishment and production once the cover crop is terminated. Seeding rates will be done at the cover crop distributor's recommended rates. This rate is traditionally very heavy which is necessary to be competitive with the heavy seed bank of common farm weeds that often pre-exist on the soil surface of disturbed soil. The mix will be sown in equal percentages of all the components. The initial seeding will be done with Land Pride PSN-2096 Seeder (a two-box broadcaster with a "Brillion" like culti-packer). Seedings in future years will be done with a Great Plains No-Till Drill 3P605NT for penetration through the cover crop residue so seeds are in contact with mineral soil.

To maintain a moist surface soil during seedling germination, emergence, and establishment, the first series of irrigation treatments will occur approximately every three days for the first three weeks until seedling roots have achieved a 4-inch depth. Below a 4-inch depth is the zone considered to be below the active soil surface evaporation zone, and the seedlings are considered to be established. Because water is applied by flood irrigation, it takes a constant two-inch surface depth from the source to cover the length of the 300-ft. plots on laser leveled land with a 0.03 percent slope. However it only takes 0.4 of an inch of water to recharge the top four inches of a sandy soil to field capacity moisture. The other 1.6 inches of moisture in flood irrigation is lost to soil percolation below the seedling root zone. Because we are trying to simulate rainfall in the New Mexico southern high plains, we will consider these initial irrigation treatments during the 3-week period only at 0.4-inch application which would simulate the several 0.4-inch rainfall storms in the southern high plains of New Mexico in a 3-week period required to establish a seeding.

The cover crops will be roller crimped in mid-May after the conclusion of the severe spring winds and the soil temperature is warm enough to allow for germination. The warm season commodity crop, milo will be sown immediately after cover crop termination. At maturity, the milo crop grain from individual plots will be combined harvest and cleaned separately. Grain samples from the 32 plots will be sent to the New Mexico State University Seed Laboratory for purity and germination. A pure live seed weight (PLS) among treatment plots will be used to evaluate soil inputs provided by the cover crop treatments

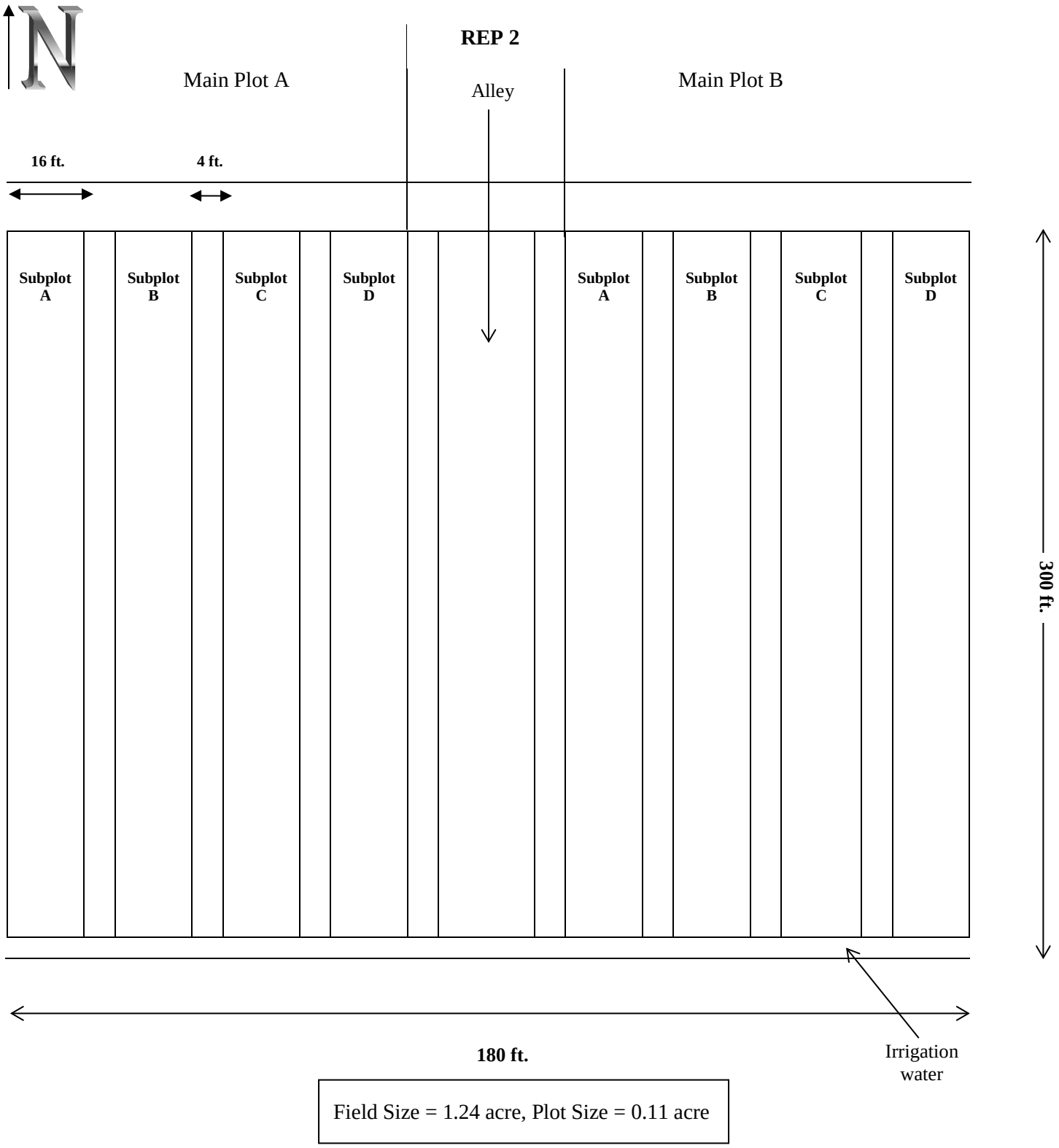
The study design is a split-plot, randomized, complete-block design with four replications (Figures 1-4) and encompasses approximately 5.0 acres. The main plots will receive irrigation treatments; either adequate water to prevent wilting or limited water, considering both precipitation and irrigation for a combined total of 20 inches. The subplots are the cover crop treatments. Each subplot is 16 ft. by 300 ft. or approximately 0.11 acre (area agronomists requested large plots). For maintenance purposes, there are 4-foot alleyways between the subplots and a 20-ft. alleyway between main plots. Each main plot is 80 ft. by 300 ft. and is composed of four subplots. The study is performed on a 'Vinton' series, loamy-fine sand. All statistical tests will be performed using 'Statistix 8' analytical software (Tallahassee FL, 2003). Analysis of Variance for a split plot study design will be used to analyze the data for this study. The Tukey HSD test will be used to examine unplanned comparisons among means.

Figure 1: Plot Plan for Cover Crop Trials: Study #1 – New Mexico Southern High Plains



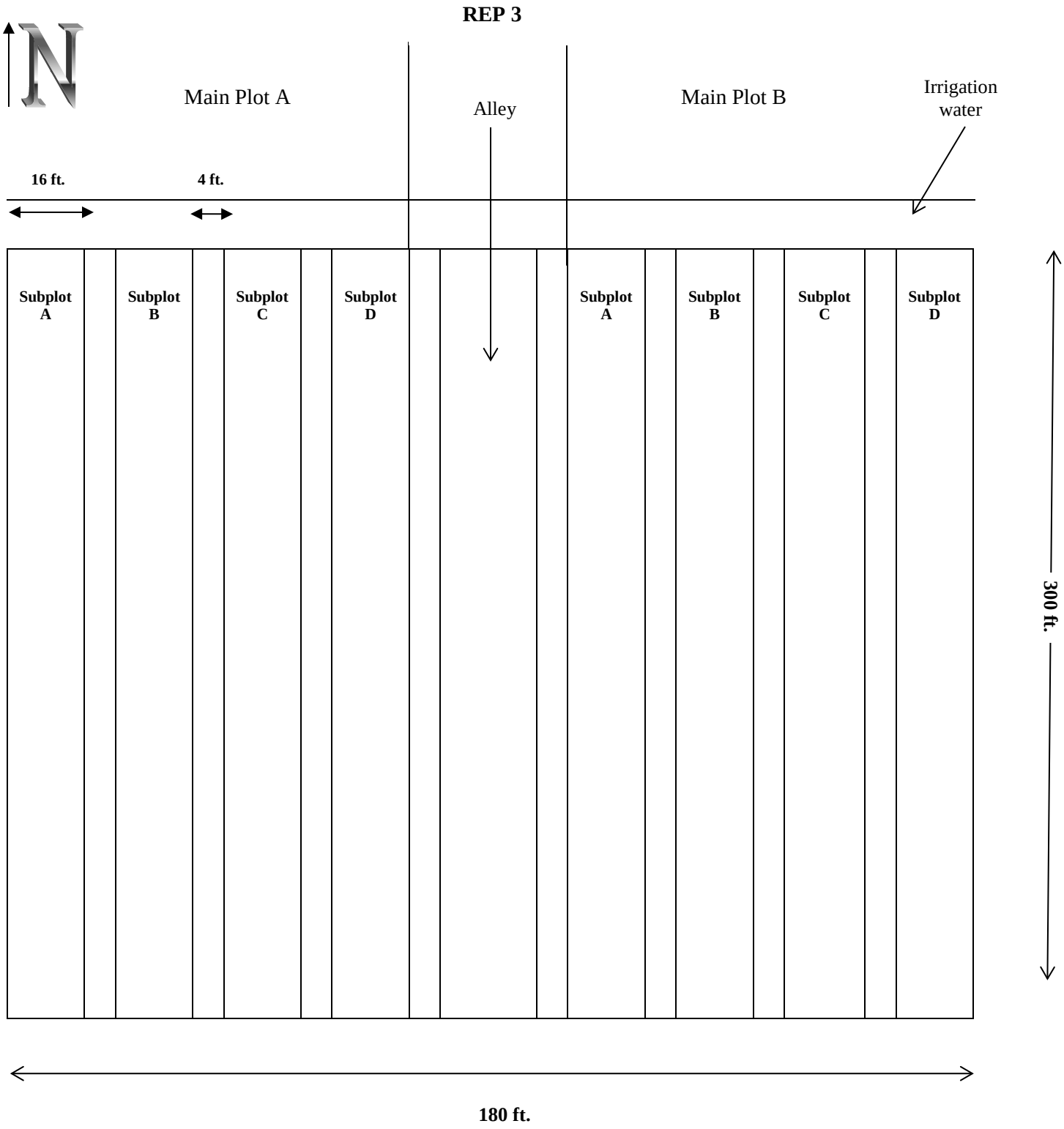
Field Size = 1.24 acre, Plot Size = 0.11 acre

Figure 2: Plot Plan for Cover Crop Trials: Study #1 – New Mexico Southern High Plains



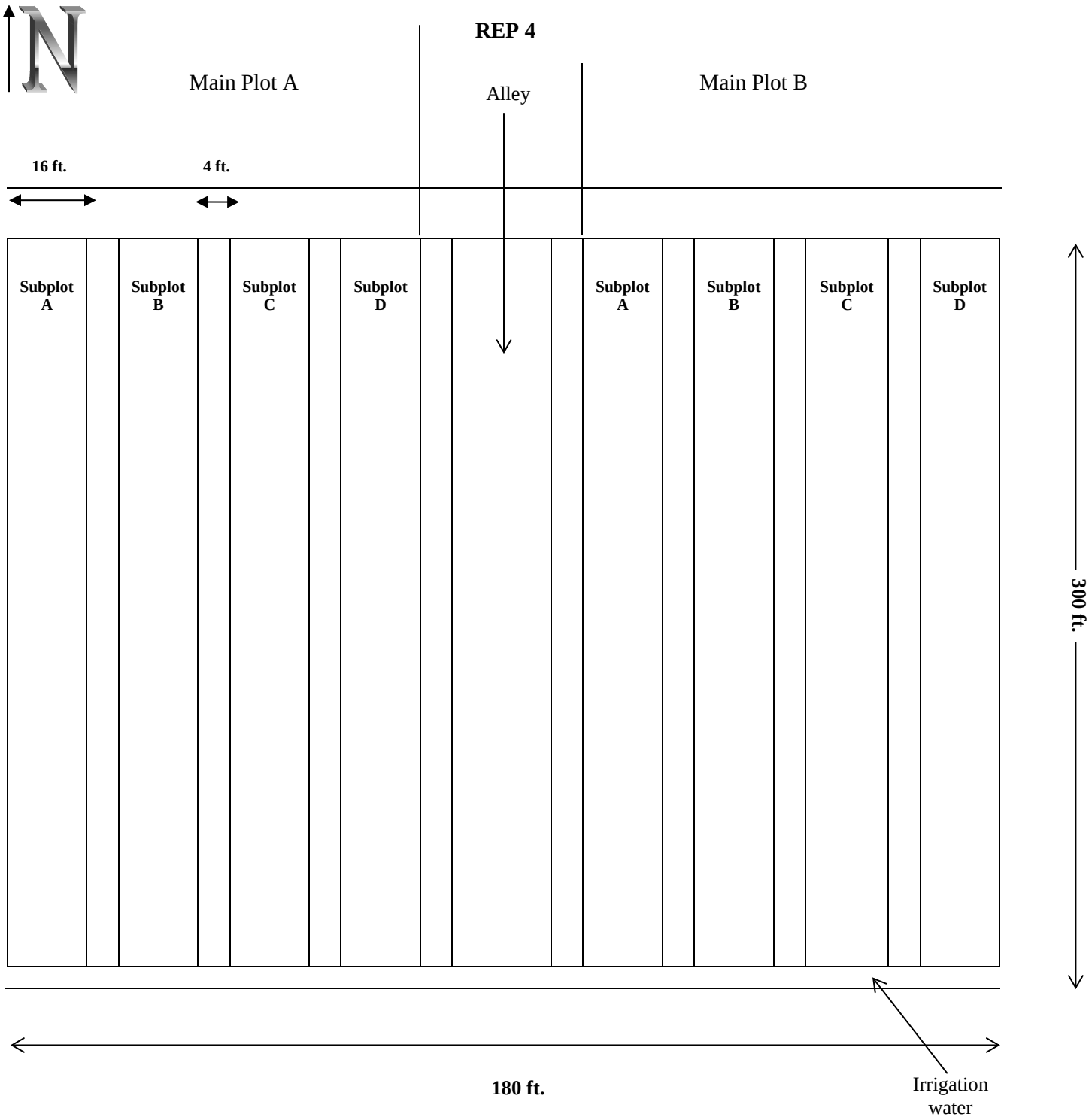
Field Size = 1.24 acre, Plot Size = 0.11 acre

Figure 3: Plot Plan for Cover Crop Trials: Study #1 – New Mexico Southern High Plains



Field Size – 1.24 acre, Plot Size = 0.11 acre

Figure 4: Plot Plan for Cover Crop Trials: Study #1 – New Mexico Southern High Plains



Field Size = 1.24 acre, Plot Size = 0.11 acre

Analyzing the Soil and Cover Crops

Soil and cover crop analysis will involve the measuring and sampling methods described in *Sampling Methods for Plant Materials Program Soil Health Study, Effects of Mixed Species Cover Crops on Soil Health* (see Appendix C). A brief summary of the methodology for the proposed measurements which includes physical, biological, and chemical indicators as described in the following sections. A list of the equipment and supplies needed to perform the study has been developed (see Appendix A) and the items that need to be purchased have been identified. A roller crimper ($4,000) and other miscellaneous items ($3,000) still need to be purchased. Appendix B contains a table that describes the sampling procedure. Currently this study requires a total of 1,920 samples which will annually produce 832 lab samples to be analyzed.

Summary of Measurement Methods

Physical Indicators

Bulk density will be determined before cover crop planting in year one, and between commodity crop harvest and planting of the cover crop in subsequent years. A total of ten random samples will be taken from each plot; five samples at 0-2 inch depth, and five samples from 2-4 inch depth. Obvious compacted areas of the plot (tire tracks, foot prints, etc.) will not be considered for sampling. Soil samples will be taken with a 3-inch, beveled, soil sampling ring following the procedure outlined in the *Soil Quality Manual* (USDA-NRCS, 2001).

Soil Moisture, Temperature, and Resistance will be determined the day of cover crop planting and the day of cover crop termination:

- **Soil moisture** – Each plot will be measured using four, soil moisture sensors with data loggers. The sensor type has not yet been determined. The sensors will be arranged in pairs: one buried shallow and the other buried deeper to capture soil moisture loss over time. Two pairs of sensors will used per plot: the first pair will be placed one-third of the plot length distance from the water source, and the second pair will be placed two-thirds of the plot length distance from the water source.
- **Soil temperature** will include ten random samples by measuring at a 3-inch depth and allowing enough time for the temperature to become constant.
- **Soil compaction** will include ten random samples and will be measured using a soil penetrometer. The procedure will include:
  - Selecting the ¾-inch instrument tip which is recommended for use on sandy soils
  - Recording the soil moisture condition at the time compaction readings are conducted; either wet, moist, or dry
  - Applying a slow, even pressure so the penetrometer advances into the soil at a rate of about 4 seconds per 6-inch depth
  - Recording the highest reading measured at a 6-inch depth
  - Continuing the same procedure as above for 6- to 12-inch depth and a 12- to 18-inch depth.

  Note: Sample size may change for any of the physical indicators which will be dependent on variability of the measurements.

Biological Indicators

Biological Assessment is a measurement of the microbial activity in the soil by using a soil microbial activity indicator. The soil will also be measured for water-extractable organic carbon and water-extractable organic N. A soil health calculation will be performed that examines the balance of soil carbon and nitrogen and their relationship to microbial activity. Sample will be assigned a soil health calculation number that will vary from 0

to over 50. A high number is desirable and will increase over time when applying good soil management practices.

Composite samples composed of ten random soil samples for each plot will be taken at a 6-inch depth using the following schedule**:**

- One-to-two weeks prior to planting the cover crop
- After cover crop termination or prior to establishment of a commodity crop
- One-to-two weeks after the commodity crop is harvested.

Soil samples will be placed in a quart size, re-sealable bag, and the resulting sample should fill the bag about two-thirds full.

Cover Crop Biomass Yield will be determined at cover crop termination by using a U-shaped sampling frame 100 x 50 cm by the method outlined by the National Soil Health Study (2012). Fresh plot clippings will be placed on tarps for an initial green weight (1/10 g). Clippings must be kept out of direct sunlight. Clippings will be then be separated by plant family or genus and placed into separate bags and includes weeds. These samples will be dried for 16 hours at 55° to 60° C. For a sample, take 6–8 bags from oven and allow them to cool to room temperature and then weigh. Place back into the oven for another 4–6 hours and reweigh. Repeat procedure until weight is constant. Record the weight to the nearest 1/10 g for each bag. After all samples have been weighed and recorded, store the sample bags in a sealed container and place in a climate controlled room to protect them from rodents and insects until they can be shipped for analysis. These samples will be used to measure plant tissue nitrogen.

Percent live cover will be determined every 30 days after planting until complete 100% cover is obtained. Procedure will consist of photography and canopy cover measurements.

Photography procedure: (new photo taken every 15 days)

- Locate a replication representative per treatment
- Mark a permanent spot for a height post
- Place the height post in the permanent spot (avoid trampling as much a possible)
- Take photograph looking down across the canopy from the front of the plot
- Name the photograph file according to the plot id code, location, and the date
- No need to photograph snow covered plots
- Stretch a tape diagonal across length of plot. The tape should be stretched so it just touches or is slightly above the majority of the top of the cover crop canopy. Use stakes to set it in place.
- Starting from the corner, step in the plot to the 5-ft. mark on the tape and determine and record cover along transect at every 5-ft. interval.
- Record which plant is present at the transect. Options are grass, legume, rape, radish tops, weeds (identify weed species to family or genus). If two or more species occurs at the same point on the transect, then the plant that is most likely to intercept a fallen raindrop first is the only plant that is counted. The same person should read all transects for a single replication.

Plant height: (Taken on 30 day intervals)

- Plant height for RUSLE is defined as the average height of green growth of the canopy. Do not include inflorescences when making height measurements.
- Measure plant height at five random locations

It is anticipated that the cover crops will cease growth at the onset of winter at some locations; therefore, no change in canopy cover or plant height are expected until regrowth begins in the spring. If complete canopy cover was not achieved prior to winter dormancy, continue canopy cover and plant height measurements on a 30-day basis after growth resumes until 100% of canopy is obtained.

Chemical Indicators

A composite sample composed of ten soil samples will be taken for each plot at a depth of 0–2-inches and 2–4-inches prior to cover crop planting in year one, and between harvesting the commodity crop and planting the cover crops in subsequent years. Indicators include:

- Total carbon, nitrogen, and sulfur by dry combustion
- pH factor
- Extractable cations (Ca,Mg, Na, K) by NH4OAC
- Cation exchange capacity (pH 7)
- Extractable P (Melich or Olsen as appropriate)
- Permanganate organic matter C (active carbon)
- Particulate organic matter
- Beta-glucosidase
- Soil texture

Forage nitrogen analysis will be performed on plant family or genus samples (nitrogen test used by the National Study is to be determined).

Prepare a lab sample for each plant family or genus sample, per treatment, and per replication:

- Use forage samples from the biomass measurement
- Grind samples using Willey Mill with 2 mm screen
- Send a 50 g sample to lab

Equipment and Supplies Required to Perform Soil Health Study

The items highlighted in yellow currently need to be purchased or constructed.

Biological Indicators

Dry Matter Yield and Botanical Composition of Cover Crops

- 0.5 sampling frame (U-shaped)
- Forage plot clippers
- Flat or trenching shovel
- Hanging field scale – 1/10th lb. increments with tarred weighing tub or designated weighing tarp
- Small laboratory scale (> 2000g maximum weight with a minimum of 1/10th g)
- Ten harvesting tarps (minimum size 36-in. x 36-in.) for collecting harvest samples
- Paper sacks of all of one type, do not mix; sizes #20, #25 (lunch box size) or #57 (grocery bag size)

- Drying oven
- Permanent marker
- Gloves

Percent Live Cover and Plant Height of Cover Crops

- Plot map
- Data sheets
- 300 ft. tape with 5 ft. intervals
- T-post to stretch out tape
- Measuring stick with metric units; the numbers need to be visible in photographs
- Digital camera

Biological Assessment

- Plot map
- Plastic gloves
- Soil sampler (Kress etal.2003) needed to build and equipped with a depth indicator
- Re-sealable bags
- Permanent marker
- Box
- Shipping labels
- Packaging tape

Chemical Indicators

Forage Nitrogen Analysis

- Box for shipping samples
- Packaging tape
- Chest freezer (storing plant samples) ($4,000)
- Shipping labels
- Data sheet with plot id codes, PMC location, and sampling data

Soil Analysis

- Plot map soil sampler
- Gloves
- Re-sealable bags (quart size) equipped with labeling stripe (white)
- Permanent marker
- Shipping box

- Shipping labels
- Packaging tape

Physical Indicators

Soil Temperature, Soil Moisture, and Soil Compaction

- Plot map
- Data sheets
- Soil moisture probe – HydroSense II ($1,300)
- Soil thermometer – $16.00 each, one for each plot for Rep 1 (requires 48 = $768)
- Soil penetrometer – Forestry supplies, Ben Meadows two at $250 ($500)

Soil Bulk Density and Soil Moisture Measurement

- Plot map
- Soil data sheet
- 3-inch x 4-6-inch diameter bulk density ring (acquire four from the State Office)
- Hand sledge hammer
- Wood block
- Garden trowel
- Flat blade knife
- Re-sealable bags
- Minimal of 5 oz. paper or plastic cups
- Permanent marker
- Small laboratory scale (> 2000g maximum weight with a minimum of 1/10th g)
- ⅛ cup measuring scoop

Plot Maintenance Equipment

- Roller crimper ($4,000)

Sampling Procedure for the Soil Health Study

Indicator Type	Indicator	Time of Sampling (periods) & Sampling Depth	Number of Plots	Samples/ Plot	Samples/ Period	Total Number of Samples	Total Number of Lab Samples	Equipment Required	In-House	Comments
Physical	Soil Moisture	Cover crop planting and termination taken at a 7" depth	32	10	320	640	0	HydorSense 2	X	
Physical	Soil Temperature	Cover crop planting and termination. Taken at 3" depth	32	10	320	640	0	Soil Thermometer	X	
Biological	Percent live cover	Every thirty days after planting until 100% cover is obtained. Use a line transect diagonally	32	100 marks	32	192	0	Tape	X	6 months of monitoring
Biological	Plant Height	Every 30 days until winter dormancy	32	10	320	2,240	0	Height post & Digital camera	X	
Physical	Soil Resistance	Cover crop planting and termination and measured at 3 depths (1-6", 6-12", and 12-18")	32	15	1,440	2,880	0	Penetrometer	X	
Physical	Soil Bulk Density	Cover crop plantings and terminations. Taken at a 0-2" and 2-4" depths	32	10	640	1,280	0	Bulk density ring	X	
Biological	Biological assessment	One to two weeks before planting cover crops, after cover crop termination, one to two weeks after commodity crop harvest Samples taken to a 6" depth	32	30	960	1,920	64	Kress Soil Sampler only by Lincoln Soil Lab	b	Composite sample by plot
Biological	Cover crop yield	At cover crop termination Separate by species and weigh Oven temperature must not exceed 60 degrees C	32	3	96	288	0	Hanging field scale Drying oven Clippers 0.5 m sampling frame with open end	X	
Chemical	Forage N	Termination of cover crop or commodity crop (by species)	32		0	0	128	Oven heat <60° C		3 species/plot
Chemical	Soil – C,N,S,Ca,Mg,Na,K,P pH,Organic C Organic matter Betta-glucoidase Soil texture	Prior to cover crop planting in year one, and between harvesting the commodity cropland planting cover crops in subsequent years from two depths 0-2" and 2-4"	32	60	960	1,920	832	Commercial Lab Kress Soil Sampler		Composite sample by plot
Biological	Commodity crop yield (Milo)	Harvest at maturity Air and dry weigh	32	1	32	32	32	Plot combine		
						Totals=12,000	1,024			

Bureau of Land Management "Seeds of Success"

Study Number: NMPMC-S-1101-RA

The Natural Resources Conservation Service (NRCS) Los Lunas Plant Materials Center (LLPMC) entered into an Interagency Agreement with the Bureau of Land Management (BLM) "*Seeds of Success"* (SOS) Program in 2010 to establish seed production fields of BLM selected native plant populations at the LLPMC in an effort to improve the commercial availability of seed adapted to the Colorado Plateau. Under cultivation, some of the selected species are very sensitive to diseases and pests that may reduce both plant survival and seed yield. Alternative solutions for improvements for commercial production of these difficult species will be evaluated through replicated studies at the PMC. Also, demonstration plantings employing proven methodologies will also be utilized in the evaluating process.

The Colorado Plateau region is situated in the four corners area and includes portions of Arizona, Colorado, New Mexico, and Utah. It comprises approximately 130,000 square miles. This area is made up of high deserts with scattered high mountain forests and is unique with its spectacular geology that includes domes, reefs, river narrows, natural bridges, slot canyons and more. The Colorado Plateau has the greatest concentration of national parks in the United States: Grand Canyon National Park, Arches National Park, Bryce Canyon National Park, Canyonlands National Park, Capitol Reef National Park, Great Basin National Park, Zion National Park, Mesa Verde National Park, Petrified Forest National Park, and Monument Valley Navajo Tribal Park. Historically this area has been impacted by heavy off-road vehicle use, livestock grazing, mining activities, abandoned farmland, and noxious and invasive weed invasion. There is a limited amount of commercial plant materials adapted to this region available for restoration purposes.

Recommendations for LLPMC SOS activities were identified by the Colorado Plateau Native Plant Initiative Technical Committee and approved by Peggy Olwell January 26, 2012 included:

1. Cease work with bluebunch wheatgrass (*Pseudoroegneria spicata)*, desert needlegrass (*Achnatherum speciosum)*, and wild rhubarb (*Polygonum alpinum)*.

2. Begin work with James' galleta (*Pleuraphis jamesii*) and Rocky Mountain beeplant (*Cleome serrulata*) if budget permits; additional collections will be made by SOS in 2012.

3. Continue work on evening primrose (*Oenothera pallida*), but include additional accessions to add genetic diversity to the plant material before it is released to growers; additional collections will be made by SOS in 2012.

4. Continue work on scarlet gilia (*Ipomoxis aggregata*) to determine how to grow it (agronomic issues) and include additional accessions in this effort; additional collections will be made in 2012.

5. Continue work on prairie coneflower (*Ratibida columnifera*) with additional accessions added in 2013; additional collections will be made in 2012.

6. Continue work on small flower globemallow (*Sphaeralcea parvifolia*) with potentially expanding field to one-acre depending on cost.

LLPMC Progress by Activity

1. **Bluebunch wheatgrass** (*Pseudoroegneria spicata)*, **desert needlegrass** (*Achnatherum speciosum)*, and **wild rhubarb** (*Polygonum alpinum)* projects have been discontinued.

2. **James' galleta (*Pleuraphis jamesii*)** – Four collections of were received in May 2012:

BLM #	Weight
NM-930N-9	38.59g
NM-930-75	21.65g
NM-930N-87	4.89g
UT-933-209-10	100 seeds

Two of the collections required cleaning and are now ready for use. Transplants will be produced from this seed in the spring of 2013 and used to establish three, isolated seed production fields in July of 2013.

Seed of *Cleome serrulata* was not received.

3. ***Oenothera pallida* – Pale Evening Primrose (LLPMC # Number** 9066884, BLM # W6-32619)

Only 0.3 g of primrose seed was received from SOS in 2010. This primrose seed had poor germination resulting in the production of 20 containerized transplants. These plants were transplanted into a raised bed at the LLPMC in spring of 2011. In the fall of 2011, a considerable amount of seed was harvested by hand from these plants.

There was sufficient seed to sow six plug trays (341 cells each) with about 0.7 tsp seed per tray; this seed was mixed with 3/4 -cup of sifted peat moss/perlite media for each tray. This mixture was applied through a soil sieve to evenly disperse the seed over each tray on April 13, 2012.

Each tray was watered daily until April 16, 2012, and then the trays were put in clear plastic bags and placed in a walk-in cold room with minimal lighting (for species requiring light for germination) set at 40° F (4° C). The trays were removed from cold stratification and placed in a greenhouse on May 7, 2012; the greenhouse had a night temperature set-point of 55° F (13° C) and day set-point of 70° F (21° C). The seedlings were transplanted into Deepot™ 12 (2.5" x 3" [12 cubic inches]) containers in mid-June 2012. After the seedlings were well established in the D12's, they were transferred to the nursery to harden off on July 31, 2012.

Field 34S at the LLPMC was prepared by laser leveling and flood irrigating in early August 2012. The planting rows were ripped 18-inches deep with a straight shank subsoiler. Fertilizer was applied every 12-inches in the soil slits at a dose of 4g phosphorus (⅔ tbs. ammonium phosphate) and 10g potassium (1 tbs. potassium sulfate) using a Rainflo Model #1600 Series II Water Wheel Transplanter to dibble holes where the fertilizer was placed. The soil slit was ripped again to distribute the fertilizer both vertically and horizontally. The field was flood irrigated again to optimize soil moisture before planting and to partially fill the soil slits.

The seedlings were transplanted on August 23, 2012 using the Water Wheel Transplanter to place the plants 12-inches apart with a between row spacing of 76-inches. Unlike the other rows, the easternmost ¾-row of pale evening primrose was fertilized with 5g of Osmocote Plus 15-9-12 (5-6 month release) controlled release fertilizer placed in the bottom of each planting hole. The final planting contained 2.75 rows in the central portion of Field 34S and comprised about 800 plants. Figures 1 and 2 show the planting in mid-October 2012.

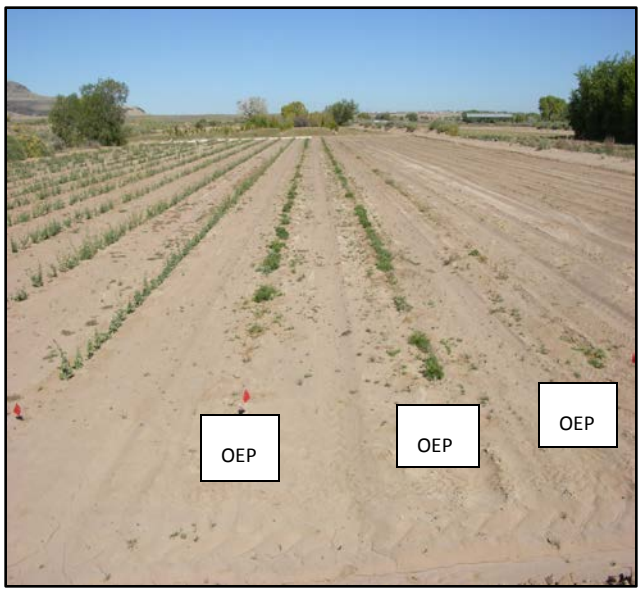


Figure 1. *Oenothera pallida* – Pale Evening Primrose planting comprising 2.75 rows in the central portion of Field 34S on October 15, 2012.

Figure 2. *Oenothera pallida* – Pale Evening Primrose plants on October 15, 2012.

4. ***Ipomopsis aggregata* – Scarlet gilia (LLPMC# 9066883, BLM # W6 32589)**

Seed was received from SOS in 2010 and a 0.25 acre field of scarlet gilia (*Ipomoxis aggregate)* was established from transplants in August 2010. By September, this field had succumbed to root-rot which was killing the plants. The field was drenched with the fungicide 'Subdue Maxx' to control this disease. The drenching seemed to be effective because only a few plants died after this treatment. Seed was hand harvested from the few remaining plants in 2011 to be used for establishing a new seed production field in 2012. Perhaps with a more controlled watering system as an alternative to flood irrigation, this species could be grown successfully under agronomic conditions.

On February 22, 2012, the seed was sown into a single 341 cell plug tray (each cell measuring 0.75" x 0.75" x 2.5") at rate of two – five seeds per cell. The seed was covered lightly with fine grit (0.02" to 0.03" [0.5–0.8mm]) and the tray was moistened. The tray then was placed in a clear plastic bag and placed into a walk-in cold room with minimal lighting (for species requiring light for germination) set at 40° F (4° C) on February 23, 2012. The tray was removed from cold stratification and placed in a greenhouse on April 12, 2012; the greenhouse had a night temperature set-point of 55° F (13° C) and day set-point of 70° F (21° C). The seedlings were transplanted into Deepot ™ 19 (2.5" x 5" [19 cubic inches]) containers between May 21 and 28, 2012. After the seedlings were well established in the D19's, they were transferred to the nursery to harden off on June 27, 2012. The seedlings were transplanted into a Weed Guard Plus Heavy Weight Creped Organic paper mulch on July 19, 2012. Holes were cut into the mulch with a 3-inch diameter sharpened steel pipe in two parallel rows with plant spacing 16-inches between rows and within rows. The holes were dug with a miniature clam shell post-hole digger and 1 tsp. (5g) of 'Osmocote' Plus 15-9-12 (5- to 6-month release) controlled release fertilizer was placed in the bottom of each hole. A row of T-tape (15 mil, 8-inch emitter spacing, 0.22 gpm/100 ft.) drip tape was placed adjacent to each row. The transplants were drenched with 'Subdue' fungicide (July 23, 2012) and 'Banrot' fungicide (July 30, 2012) with approximately 6 oz. of drench solution per plant at the labeled rate for preventative care. (The planting was irrigated for 15 hours about every 7 days). As of March 1, 2013, 135 out of the 155 plants (87%) were still alive. The planting and an individual plant are shown in Figures 3 and 4 as of October 10, 2012.

These first-year seedlings did not flower in 2012 which was expected. Additional field collections of scarlet gilia (*Ipomoxis aggregate*) from the Colorado Plateau were planned by SOS in 2012 and will be added to the seed production activities at the LLPMC in 2013. These collections are from targeted areas within the Colorado Plateau where there is a need for future restoration.

Figure 3. *Ipomopsis aggregata* – Scarlet gilia planting in Field 7 at the LLPMC on October 10, 2012.

Figure 4. *Ipomopsis aggregata* – Scarlet Gilia plant in Field 7 at the LLPMC on October 10,2012.

5. ***Ratibida columnifera* – Upright prairie coneflower (LLPMC# 9066882, BLM# W6-32619)**

New upright prairie coneflower seed collections were planned by SOS in 2012, and they will be added to our seed production activities in 2013. There are currently two seed fields at the LLPMC, and their areas are as follows: Field 23S 0.50 acre and Field 8 0.55 acre for a total of 1.05 acres. The planting in Field 23S was harvested in December of 2011 using a Kincade XP 2-row plot combine. The field yielded 29.4 pls/lbs. The seed had a purity of 85% and total viability of 75% for a PLS per cent of 64%. Field 8 did not produce seed in 2011 because it was the first established year. Figures 5, 6, and 7 show the plantings in mid-October 2012. In November of 2012, seed was harvested from both fields for a combined weight of 248 lbs. of cleaned seed.

Maintenance of the fields included:

- Flood irrigation monthly from October through April, biweekly from June through September
- Fertilization of Nitrogen at three applications (50lbs each); Phosphorous at three applications (50 lbs. each)
- Mechanical cultivation monthly from March through November
- Hand hoeing biweekly from March to November

Figure 5. *Ratibida columnifera* - Upright prairie coneflower planting in Field 8 on October 15, 2012

Figure 6. *Ratibida columnifera* – Upright prairie coneflower planting in Field 23S on October 15, 2012

Figure 7. *Ratibida columnifera* - Upright Prairie Coneflower plant in Field 8 on October 15, 2012.

6. ***Sphaeralcea parvifolia* – S**mallflower globemallow (Accession Number 9066885)

   With the 0.6 grams of seed that was originally obtained from SOS in 2010, 80 transplants were produced in 2011 and installed in a two-row planting at the LLPMC Field 23N. Seed was collected off of these two rows of plants in the late summer and early fall of 2011. Several collections were made because of the continuous flowering and seed maturation of the species. The seed was collected using a battery powered shop vacuum with a mesh screen made from a paint strainer bag attached to the inlet inside the tank. The seed was scarified in a MAT-OSU pneumatic scarifier for 60 seconds at 20 psi in batches of 1 tsp. per run.

We had sufficient seed to sow 23 plug trays (341 cells each) with about 0.4 tsp. seed per tray; this seed was mixed with 4 tsp. of grit (0.03” to 0.08” [0.8– 2mm]) for each tray. This mixture was applied through a soil sieve to evenly disperse the seed over each tray on February 6, 2012. Each tray was covered with one-third cup of grit (>0.08” [>2mm]) and watered daily. On February 13, 2012, the trays were put in a clear plastic bags and placed into a walk-in cold room with minimal lighting (for species requiring light for germination) set at 40° F (4° C). The trays were removed from cold stratification and placed in a greenhouse on April 5, 2012; the greenhouse had a night temperature set-point of 55° F (13° C) and day set-point of 70° F (21° C). The seedlings were transplanted into Deepot ™ 12 (2.5” x 3” deep [12 cubic inches]) containers between May 21 and 28, 2012. After the seedlings were well-established in the D12’s, they were transferred into the nursery to harden off on July 31, 2012.

Field 34S at the LLPMC was prepared by laser leveling and flood irrigating in early August 2012. The planting rows were ripped 18-inches deep with a straight shank sub-soiler. Fertilizer was applied every 12-inches in the soil slits at dose of 4g phosphorus (⅔ tbs. ammonium phosphate) and 10g potassium (1 tbs. potassium sulfate)

using a Rainflo Model #1600 Series II Water Wheel Transplanter to dibble holes where the fertilizer was placed. The soil slit was ripped again to distribute the fertilizer vertically and horizontally. The field was flood irrigated again to optimize soil moisture before planting and to partially fill the soil slits. The seedlings were transplanted on August 20 and 23, 2012 using the Water Wheel Transplanter to plant the seedlings 12 inches apart with a between row spacing of 76 inches. The final planting contained 11.75 rows on the western portion of Field 34S and comprised about 3,500 plants. Figures 8 and 9 show the planting in mid-October 2012. The plants did not have enough time to develop seed this year because a hard frost occurred (25° F) on October 27, 2012.

Figure 8. *Sphaeralcea parvifolia* – Smallflower globemallow planting on October 15, 2012.

Figure 9. *Sphaeralcea parvifolia* – Smallflower globemallow plants on October 15, 2012

Maintenance of the fields included:

- Hand hoeing every two weeks
- Mechanical cultivation every four weeks
- Weekly irrigation from August 20 to September 10; biweekly irrigation through November 20, 2012

Little Bluestem and Prairie Dropseed Seed Production for Boulder County Parks and Open Space

Study Number: NMPMC-S-0701-OT

Introduction

The Natural Resources Conservation Service (NRCS) has entered into a cooperative agreement with the Boulder County Parks and Open Space (BCPOS) for the Los Lunas Plant Material Center (LLPMC) to produce seed from populations of little bluestem (*Schizachyrium scoparium*) and prairie dropseed (*Sporobolus heterolepis*) from the Boulder area. In 2006, BCPOS had previously collected local seed from both species. This seed was sent to LLPMC for cleaning and to be used as the source for establishing two, half-acre seed production fields.

Prairie dropseed is a native, warm-season, long-lived perennial bunch grass found on prairies, dry hill and plains areas. In Colorado, prairie dropseed has been found along the foothills from the city of Boulder to Pueblo County at elevations of 5,300 to 7,200 ft. and on dry-to-medium, well-drained soils. It is slow growing and slow to establish with maturity requiring up to five years to reach its maximum height of 3 feet.

Little bluestem is a native, warm-season, long-lived perennial bunchgrass found on prairies, dry hills, fields and open wooded areas. It is found growing on the eastern half of Colorado as far west as Larimer, Chaffee and Archuleta Counties at elevations from 3,500 to 8,000 ft. The plant prefers well-drained, sunny sites and can grow up to 3 feet in height.

Methods

In June of 2011, the LLPMC began to produce 8,000 little bluestem (*Schizachyrium scoparium*) plug transplants and 8,000 prairie dropseed (*Sporobolus heterolepis*) plug transplants. The plug soil mix contained two parts of Sunshine #1 media to one part of perlite. One pound of a three-month controlled release fertilizer (17-16-12) was added per four-cubic feet of the plug soil mix.

After ten days in the greenhouse, most of the seeds of both species had germinated, and the seedlings had emerged. The seedlings were placed on a bench and kept damp with an automatic sprinkler system for three weeks. Then they were moved outside to the nursery to harden off for an additional two weeks.

In September of 2011, the little bluestem and prairie dropseed transplants were planted into Field 14 at the LLPMC using a Holland Transplanter Model # 1265. To keep the transplants' roots from drying out, they were kept in the plug trays until moments before transplanting.

The field was hand-hoed approximately once every three weeks during the active growing period (April – November). During the winter (December 2011 – March 2012) they were hoed twice to control cool-season grasses and other weeds (primarily species in the mustard plant family). The irrigation was applied by flooding and fertilizer was applied by broadcasting. Application rates for irrigation and fertilization are described in Tables 1-4.

Table 1. Little Bluestem 2011 Irrigation and Fertilization

Date	8/16	8/19	8/24	8/30	9/14	9/30	10/28
Flood Irrigation Application	1 inch	1 inch	1 inch	1 inch	2 inch	2 inch	2 inch
Fertilization*	None						

*Transplants had received 3-month application of slow release fertilizer

Table 2. Prairie Dropseed 2011 Irrigation and Fertilization							
Date	**8/17**	**8/19**	**8/24**	**8/30**	**9/14**	**9/30**	**10/28**
Flood Irrigation Application	1 inch	1 inch	1 inch	1 inch	2 inch	2 inch	2 inch
Fertilization*	None						

*Transplants had received a 3-month application of slow release fertilizer

Table 3. Little Bluestem 2012 Irrigation and Fertilization										
Date	**2/8**	**3/30**	**4/18**	**5/21**	**6/6**	**6/26**	**7/16**	**7/31**	**9/15**	**10/4**
Flood Irrigation Application	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch
Date	2/14	2/16	6/4	6/4	9/24	9/24				
Fertilization	P@40*	N@40*	P@40*	N@40*	P@40*	N@40*				

* lbs/acre

Table 4. Prairie Dropseed 2012 Irrigation and Fertilization										
Date	**2/27**	**3/28**	**4/18**	**5/21**	**6/6**	**6/26**	**7/16**	**7/31**	**9/5**	**10/5**
Flood Irrigation Application	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch	3 inch
Date	2/14	2/16	6/4	6/4	9/24	9/24				
Fertilization	P@40*	N@40*	P@40*	N@40*	P@40*	N@40*				

*lbs/acre

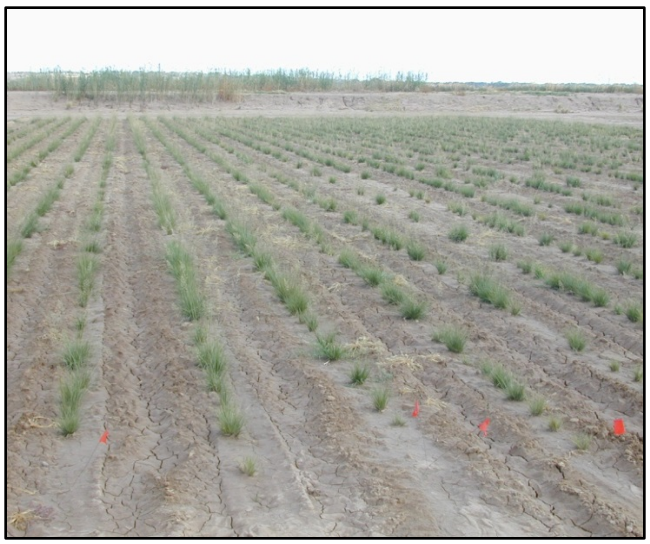
To maintain seed purity, both fields are managed by adhering to national foundation seed standards. Subsequently, the fields were inspected in July 2012 by the New Mexico State University Crop Improvement Association for the isolation requirements and absence of noxious weeds. Seed harvest was in October 2012 for both fields was done with a Kincade XP plot combine. Harvested seed is placed on an air drying table for about 4 days until the seed is dry enough to prevent molding. During the winter period, the seed is cleaned and a sample is analyzed for purity and germination by the New Mexico State University Seed Certification Laboratory in Las Cruces, New Mexico (Table 5).

Results

The little bluestem and prairie dropseed fields yielded 19 bulk pounds and 1 bulk pound respectively (Table 5). Production of the prairie dropseed was disappointing but not unexpected. The prairie dropseed plants are still very small (less than 18 inches in height) and as they mature they should produce more seed. Also, about one-third were killed during the winter of 2011 from frost heaving because the young plants of prairie dropseed grow very slowly and were consumed by soil cracking. These interspaces or row skips caused by dead plants will be filled with new transplants in July 2013 that have been grown from a 25 gram sample of the seed harvested in 2012. By planting earlier, we should have better winter survival results.

Table 5: Boulder County Little Bluestem Seed Yield and Analysis Results									
Species	**Year**	**Bulk Wt. (lbs.)**	**% Other Crop**	**% Inert Matter**	**% Weed Seed**	**% Germ.**	**% Dormant Seed**	**% Pure Live Seed**	**Pure Live Seed Wt. (lbs.)**
Little bluestem	2012	19.0							
Prairie dropseed	2012	1.0							

Little bluestem September 2012



Prairie dropseed September 2012

GRAND CANYON NATIONAL PARK

INTRODUCTION

In July 1990, the U.S. National Park Service (NPS) made an agreement with the USDA-NRCS Los Lunas Plant Materials Center (LLPMC) to collect, propagate, and increase native grasses, forbs, shrubs, and trees. This agreement states that the LLPMC will produce the plant materials for the purpose of revegetating disturbed areas and native landscaping projects in the Grand Canyon National Park (GCNP) which includes both the north and south rim areas of the park.

Date	Species	Action	Status
2006	bottlebrush squirretail	Added to agreement	Inactive
2007	sideoats grama	Added to agreement	Inactive
2009	blue grama spike muhly	Added new accession to the agreement Added to the agreement	Active
2010	Indian ricegrass needleandthread woody and herbaceous species	Added to the agreement Added to the agreement Added to the agreement	Active

The following table shows the complete list of the GCNP plant species accessions:

Common Name	Scientific Name	Plant Symbol	Accession Number
Grasses			
blue grama	*Bouteloua gracilis*	BOGR	9062875
blue grama	*Bouteloua gracilis*	BOGR	9066803
bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066659
bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9062858
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9062857
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066904
muttongrass	*Poa fendleriana*	POFE	9062861
needleandthread	*Hesperostipa comata*	HECO	9062859
needleandthread	*Hesperostipa comata*	HECO	9066797
sideoats grama	*Bouteloua curtipendula*	BOCU	9066732
spike muhly	*Muhlenbergia wrightii*	MUWR	9066802
western wheatgrass	*Pascopyrum smithii*	PASM	9062860
Trees and Shrubs			
Apache plume	*Fallugia paradoxa*	FAPA	9062865
big sagebrush	*Artemisia tridentata*	ARTR	9066056
century plant	*Agave utahensis*	AGUT	9062874
cliffrose	*Purshia mexicana*	COME	9062876
curl-leaf mountain mahogany	*Cercocarpus ledifolius*	CELE	9062867
currant	*Ribes spp.*	RI SPP.	9066057
Datil yucca	*Yucca baccata*	YUBA	9066058
desert barberry	*Berberis fremontii*	BEFE	9066059
elderberry	*Sambucus spp.*	SA SPP.	9066047
fernbush	*Chamaebatiaria millefollium*	CHMI	9062866

Common Name	Scientific Name	Plant Symbol	Accession Number
fourwing saltbush	*Atriplex canescens*	ATCA	9062873
Gambel oak	*Quercus gambelii*	QUGA	9062872
lupine	*Lupinus spp.*	LU SPP.	9062863
penstemon (blue)	*Penstemon spp.*	PE SPP.	9062862
penstemon (red)	*Penstemon spp.*	PE SPP.	9066054
pinyon (twoneedle) pine	*Pinus edulis*	PIED	9066467
ponderosa pine	*Pinus ponderosa*	PIPO	9066466
rabbitbrush	*Chrysothamnus nauseosus*	CHNA	9062877
Utah juniper	*Juniperus osteosperma*	JUOS	9066055
Utah serviceberry	*Amelanchier utahensis*	AMUT	9062869
wolfberry	*Lycium spp.*	LY SPP.	9062870

2012 ACCOMPLISHMENTS

In 2012, the LLPMC performed the following activities:

- Muttongrass – Grew plug transplants from seed harvested from the seed production fields at the LLPMC. These transplants were used to establish an additional 0.50 acre production field.

  To improve seed production of the muttongrass, a split application of 100 lbs/acre of gypsum ($CaSO_4$) was applied in 2012. The first application was completed during the early growth period. The second application was done in December of 2012 while the plants were dormant; the gypsum was placed in a band approximately 2" below the soil surface next to the plants. Calcium deficiency can suppress seed development, and the application of $CaSO_4$ could provide increased harvest of this species.

- Needleandthread – Grew plug transplants from seed harvested from the seed production field of 0.9 acres at the LLPMC. These transplants were used to establish 0.24 acre seed production field.

- Indian ricesgrass – A 0.14 acre Indian ricegrass production field was established by direct seeding in January 2012 from GCNP seed received by the LLPMC in 2011.

- Deliveries – The LLPMC delivered a total of 29,114 transplants to the GCNP on June 12, July 25, and August 28, 2012.

The following tables describe the seed production fields established at the LLPMC, the amount of seed production, seed and transplant deliveries, and the amount of pure live seed (PLS) currently in our inventory:

2012 Established GCNP Production Fields at the LLPMC			
Common Name	Scientific Name	**Agreement Acreage**	**2012 Acreage**
blue grama	*Bouteloua gracilis*	2.00	2.60
bottlebrush squirreltail	*Elymus elymoides*	0.50	0.00*
Indian ricegrass	*Achnatherum hymenoides*	0.50	0.14
muttongrass	*Poa fendleriana*	1.00	2.63
needleandthread	*Hesperostipa comata*	0.50	0.33
sideoats grama	*Bouteloua curtipendula*	0.50	0.00*
spike muhly	*Muhlenbergia wrightii*	0.50	0.70

* The bottlebrush squirreltail and sideoats grama fields were removed prior to 2011 as per agreement with GCNP.

2012 Seed Production for the GCNP		
Common Name	**Scientific Name**	**Pounds Cleaned (Bulk)**
blue grama	*Bouteloua gracilis*	72.42
muttongrass	*Poa fendleriana*	111.75
spike muhly	*Muhlenbergia wrightii*	1.50
needleandthread	*Hesperostipa comata*	4.70
Indian ricegrass	*Achnatherum hymenoides*	No harvest

2012 Transplant Delivery to the GCNP by the LLPMC				
Common Name	**Scientific Name**	**Accession**	**Container Size**	**Amount delivered**
sideoats grama	*Bouteloua curtipendula*	9066732	SC10[1]	3,234
pinyon pine	*Pinus edulis*	9066765	D25[2]	268
needleandthread	*Hesperostipa comata*	9066797	D25[2] and SC10[1]	93
fernbush	*Chamaebatiaria millefollium*	9066903	D25[2]	400
Utah serviceberry	*Amelanchier utahensis*	9066912	D25[2]	21
threeawn spp.	*Aristida spp.*	9066913	SC10[1]	165
big sagebrush	*Artemisia tridentata*	9066914	D25[2]	850
Fremont's mahonia	*Mahonia fremontii*	9066915	D25[2]	680
rose heath	*Chaetopappa ericoides*	9066916	SC10[1]	21
Mormon tea	*Ephedra viridis*	9066917	D25[2]	390
James' buckwheat	*Eriogonum jamesii*	9066918	D25[2]	539
rubber rabbitbrush	*Ericameria nauseosa*	9066919	SC10[1] and D25[2]	1,477
Arizona spinyaster	*Escobaria vivipara var. arizonica*	9066920	SC10[1] and D25[2]	447
Gray aster	*Eurybia glauca*	9066921	D25[2]	1,100
threadleaf snakeweed	*Gutierrezia microcephala*	9066922	D25[2] and SC10[1]	40
false goldenaster	*Heterotheca villosa*	9066923	SC10[1]	1,460
fineleaf hymenopappus	*Hymenopappus filifolius*	9066924	SC10[1]	98
threadleaf ragwort	*Senecio flaccidus*	9066926	D25[2]	343
threenerve goldenrod	*Solidago velutina*	9066927	SC10[1]	947
globemallow	*Sphaeralcea ambigua*	9066928	SC10[1]	2,708
sand dropseed	*Sporobolus cryptandrus*	9066929	SC10[1] and PC4[3]	7,986
MacDougal verbena	*Verbena macdougalii*	9066930	D25[2]	1,317
banana yucca	*Yucca baccata*	9066931	D25[2]	186

[1] Super Cell 10 cubic-inch

[2] Dee Pot 25 cubic-inch

[1] Super Cell 10 cubic-inch

[2] Dee Pot 25 cubic-inch

[3] Pine Cell 4 cubic-inch

GCNP Pure Live Seed on Inventory at the LLPMC				
Common Name	**Scientific Name**	**Accession**	**Pure Live Seed On Inventory (lbs.)**	**Test Date**
blue grama	*Bouteloua gracilis*	9062875	2.07 14.96 4.23 28.93	11/17/2009 12/6/2010 11/17/2011 2/13/2013
blue grama	*Bouteloua gracilis*	9066803	8.43 4.38 23.66	1/28/2011 12/15/2011 2/13/2013
muttongrass	*Poa fendleriana*	9062861	2.00 0.14 66.86	9/17/2010 3/13/2012 12/21/2012
sideoats grama	*Bouteloua curtipendula*	9066732	0.50	12/04/09
spike muhly	*Muhlenbergia wrightii*	9066802	9.31 12.29 0.40	1/25/2011 1/24/2012 2/15/2013
needleandthread	*Hesperostipa comata*	9066655	3.97	3/28/2013

Grand Canyon National Park spike muhly seed production field 21S

Grand Canyon National Park muttongrass seed production field 35S

Grand Canyon National park needleandthread seed production field 24N

Grand Canyon National Park Indian ricegrass seed production field 14

June 2012 – Transplant delivery to the Grand Canyon National Park

ZION NATIONAL PARK

INTRODUCTION

In June 2009, an agreement was made between Los Lunas Plant Materials Center (LLPMC) and Zion National Park (ZNP) to propagate 800 PLS pounds of bottlebrush squirreltail (*Elymus elymoides*) and 200 PLS lbs. of Indian ricegrass (*Achnatherum hymenoides*).

The agreement states that ZNP will use this seed to revegetate disturbed areas at the park. The seed of these two species was collected by the park staff and sent to the LLPMC for conditioning; it then was used to establish seed production fields according to the agreement.

The following table shows a complete list of the accessions involved in the ZNP agreement:

Zion National Park Accessions			
Common Name	**Scientific Name**	**Plant Symbol**	**Accession Number**
bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066532
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066528

2012 ACCOMPLISHMENTS

See the following four tables for the established ZNP seed production fields at the LLPMC, the amount of seed delivered to ZNP, the amount of seed production, and pure live seed on inventory for the ZNP:

2012 Established ZNP Production Fields at the LLPMC			
Common Name	**Scientific Name**	**Agreement Acreage**	**2012 Acreage**
bottlebrush squirreltail	*Elymus elymoides*	1.50	1.00
Indian ricegrass	*Achnatherum hymenoides*	0.50	0.42*

* Only 0.42 acres of Indian ricegrass was established due to the amount of seed originally received from ZNP.

2012 Seed Delivered to the ZNP by the LLPMC		
Common Name	**Scientific Name**	**Pure Live Seed Pounds Delivered**
Indian ricegrass	*Achnatherum hymenoides*	50.0 Lot# SFP-08-F35NZ10

2012 ZNP Seed Production at the LLPMC		
Common name	**Scientific name**	**Pounds Cleaned (Bulk)**
bottlebrush squirreltail	*Elymus elymoides*	76.10
Indian ricegrass	*Achnatherum hymenoides*	56.00

ZNP Pure Live Seed on Inventory at the LLPMC				
Common Name	**Scientific name**	**Accession**	**Pure Live Seed on Inventory (lbs)**	**Test Date**
bottlebrush squirreltail	*Elymus elymoides*	9066532	2.65 13.74 0.47 14.35 12.54 13.83 46.57	8/20/09 9/17/10 8/27/07 8/06/05 8//08/11 8/08/11 1/17/13
cane bluestem	*Bothriochloa barbinodis*	9066543	0.60 (bulk) 1.36 2.19 1.58 0.20 (bulk)	No test[4] 1/21/05 1/17/06 3/09/07 No test[4]
galleta	*Pleuraphis jamesii*	9066586	1.51 0.58 (bulk) 0.46 (bulk)	1/08/07 No test[4] No test[4]
Indian ricegrass	*Achnatherum hymenoides*	9066528	15.48 44.12 26.57 33.06 22.74 27.87 49.97	10/16/06 4/28/08 10/31/08 11/11/09 12/14/10 11/30/11 2/19/13
muttongrass	*Poa fendleriana*	9066531	4.55 0.70 1.84 (bulk)	5/30/08 11/20/08 No test[4]
sand bluestem	*Andropogon halii*	9066529	2.73 (bulk) 2.80 8.89 3.26 9.84 19.48	No test[4] 3/20/06 3/21/07 6/14/10 7/07/10 4/19/10

[4] Seed was not sent for testing due to an insufficient amount of seed or seed was from the collections made at the ZNP.

Zion National Park bottlebrush squirreltail seed production field 19

Zion National Park Indian ricegrass seed production field 35N

CARLSBAD CAVERNS NATIONAL PARK

INTRODUCTION

On August 23, 2004, an agreement was made between the Los Lunas Plant Materials Center (LLPMC) and the Carlsbad Caverns National Park (CCNP) for the collection, propagation, and the increase of native grass species. A new agreement began in 2010 that provides for the propagation of transplants and seed increase by the LLPMC for CCNP native grass species. There was no seed production in 2012, and all CCNP fields have been removed after discussion with the park and NPS/NRCS liaison.

The following table shows a complete list of the accessions involved in the CCNP agreement:

Carlsbad Caverns National Park Accessions			
Common Name	**Scientific Name**	**Plant Symbol**	**Accession Number**
blue grama	*Bouteloua gracilis*	BOGR	9066604
curlyleaf muhly	*Muhlenbergia setifolia*	MUSE	9066608
green sprangletop	*Leptochloa dubia*	LEDU	9066658
plains bristlegrass	*Setaria vulpiseta*	SEVU2	9066606
purple threeawn	*Aristida purpurea*	ARPU9	9066607
sideoats grama	*Bouteloua curtipendula*	BOCU	9066605

2012 ACCOMPLISHMENTS

The following tables describe the CCNP seed shipped to the NPS from the LLPMC in 2012 and the pure live seed on inventory:

Seed Shipment to the CCNP by the LLPMC			
Common Name	**Scientific Name**	**Accession**	**PLS lbs. shipped**
blue grama	*Bouteloua gracilis*	9066604	3.50
green sprangletop	*Leptochloa dubia*	9066658	30.60
plains bristlegrass	*Setaria vulpiseta*	9066606	57.40
purple threeawn	*Aristida purpurea*	9066607	12.00
sideoats grama	*Bouteloua curtipendula*	9066605	22.50

CCNP Seed Shipment to Guadalupe Mountains National Park by the LLPMC			
Common Name	**Scientific Name**	**Accession**	**PLS lbs. shipped**
green sprangletop	*Leptochloa dubia*	9066658	168.50
plains bristlegrass	*Setaria vulpiseta*	9066606	17.00
sideoats grama	*Bouteloua curtipendula*	9066605	50.00

CCNP Seed Shipment to Capulin Volcano National Monument by the LLPMC			
Common Name	**Scientific Name**	**Accession**	**PLS lbs. shipped**
blue grama	*Bouteloua gracilis*	9066604	25.00
purple threeawn	*Aristida purpurea*	9066607	12.00
sideoats grama	*Bouteloua curtipendula*	9066605	50.00

CCNP Pure Live Seed on Inventory at the LLPMC				
Common Name	**Scientific Name**	**Accession**	**Pure Live Seed on Inventory (lbs.)**	**Test Date**
blue grama	*Bouteloua gracilis*	9066604	13.85	1/24/07
			8.12	1/09/08
			2.79	6/17/10
			2.59	12/01/09
			8.60	12/15/11
green sprangletop	*Leptochloa dubia*	9066658	27.40	1/25/11
			14.38	12/07/11
plains bristlegrass	*Setaria vulpiseta*	9066606	17.37	5/15/08
			71.99	7/13/10
			24.04	2/12/10
			14.53	12/08/10
			46.03	1/03/12
purple threeawn	*Aristida purpurea*	9066607	7.90	4/23/08
			3.04	6/11/10
			0.54	5/18/10
			3.36	1/06/12
sideoats grama	*Bouteloua curtipendula*	9066605	41.29	1/19/06
			36.34	1/23/07
			17.14	3/10/08
			40.08	6/29/10
			13.54	12/23/09
			9.72	12/15/10
			0.74	1/03/12
			3.00 (bulk)	No test[5]
			1.02 (bulk)	No test[5]
			0.40 (bulk)	No test[5]

[5] Seed not sent for testing due to an insufficient amount of seed or seed was from the collections made at the CCNP.

SOUTHEAST UTAH GROUP
ARCHES AND CANYONLANDS NATIONAL PARKS

INTRODUCTION

On, August 27, 2010, an agreement between the US Department of Interior, National Park Service (NPS) Southeast Utah Group (Arches and Canyonlands National Parks) and the USDA Natural Resources Conservation Service's Los Lunas Plant Materials Center (LLPMC) was made for the collection of native seed, the propagation of those seeds, and the increase of native grass species at the LLPMC.

The agreement states that NPS will use the seed produced by the LLPMC for identified project areas in the two national parks. Populations of Indian ricegrass (*Achnatherum hymenoides*) was identified and collected by the park staff and then sent to the LLPMC for conditioning and to be used for future seed production.

The following tables show a complete list of the accessions involved in this agreement and the seed received by the LLPMC:

Arches and Canyonlands National Parks Accessions			
Common Name	**Scientific Name**	**Plant Symbol**	**Accession Number**
Arches National Park Accessions			
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066888

Canyonlands National Park Accessions				
Common Name	**Park Location**	**Scientific Name**	**Plant Symbol**	**Accession Number**
Indian ricegrass	Island in the Sky	*Achnatherum hymenoides*	ACHY	9066907
Indian ricegrass	Needles	*Achnatherum hymenoides*	ACHY	9066908
Indian ricegrass	Island in the Sky and Needles mix	*Achnatherum hymenoides*	ACHY	9066887

2012 ACCOMPLISHMENTS

On January 4 and 6, 2012, the Indian ricegrass seed received from both Arches and Canyonlands Nationals Parks was planted by direct seeding into production fields at the LLPMC.

The following table shows the agreement acreage and the actual amount of acreage that was established in 2012:

Arches and Canyonlands National Park Seed Production Fields at the Los Lunas PMC			
Arches National Park			
Common Name	**Scientific Name**	**Agreement acreage**	**2012 Acreage**
Indian ricegrass	*Achnatherum hymenoides*	1.00	1.00

Canyonlands National Park				
Common Name	**Park Location**	**Scientific Name**	**Agreement Acreage**	**2012 Acreage**
Indian ricegrass	Island in the Sky	*Achnatherum hymenoides*	0.50	0.26
Indian ricegrass	Needles	*Achnatherum hymenoides*	0.50	0.09

The direct seeding of Indian ricegrass was moderately successful for both Canyonlands accessions averaging approximately 30 percent stand establishment in their respective production fields The Arches planting averaged 70 percent stand establishment on only about half of the planted acreage. The remaining half of the Arches

planting had less than a 20 percent stand establishment in 2012. The low stand establishment of the Indian ricegrass fields is a result of the high dormancy found in this particular species. It may take up to three years for seed to break dormancy and germinate after the direct seeding of the Arches and Canyonlands fields. The following table shows the results of seed testing of the previous seed collected at Canyonlands and Arches show this dormancy and low seed germination. Scarification, cold stratification and other after-ripening techniques to induce germination had little or no effect on the seed received by the LLPMC. The direct seeding of the Indian ricegrass was determined to be a viable solution by the LLPMC for establishing the seed fields.

Seed Test Results for Original Seed Lots Prior to 2012		
Seed Test Lab Results for…	**Canyonlands Mixed Seed Lot**	**Arches Original Large Seed Lot**
Purity	96.73	97.06
Germination	2%	0%
Dormant	56%	71%
Total Value	58%	71%
TZ Test	56%	71%

Seed will be harvested from the established Indian ricegrass fields in 2013, and this seed will be used to complete the amount of acreage specified in the agreement.

It should be noted the seed previously collected at Canyonlands National Park and Arches National Park prior to 2012 is available and also could be used to establish seed production fields. One of the seed lots from Canyonlands has two sites mixed together, but both this lot and one from Arches have a substantial amount of seed.

Canyonlands National Park 'Island in the Sky' Indian ricegrass seed production field F33N

Cayonlands National Park 'Needles' Indian ricegrass seed production field F33N

Arches National Park Indian ricegrass seed production field F27N

2012 Activities for Bureau of Land Management New Mexico

Propagation and Planting of the Cottonwood Pole Production Field

The Rio Grande cottonwood seed that was received from the Bureau of Land Management (BLM) New Mexico in late June 2011 was cleaned immediately after receipt. The catkins were placed between soil sieves which allowed the cotton to be removed using compressed air. On June 28 and 30, 2012, Super Cells (1.5" dia. and 8" tall) were sown with the cleaned seed in the following amounts:

BLM No.	Origin	Latitude	Longitude	Elevation (feet)	Seed Collection Date	Total Cleaned Seed Volume (ml)	Seed Volume Sown per Super Cell Tray (ml)	No. of 98 Cell Trays Sown
930N-46	La Plata River	36°46'55.74"N	108°13'07.22"W	5278	6/23/11	30	5	7
930-154	Tularosa Creek	33°09'3.25"N	105°53'15.26"W	5465	6/23/11	90	5	8
930N-44	San Juan River	36°49'22.89"N	107°39'35.82"W	5626	6/20/11	50	3	8

The seed was processed as follows:

What	Action
The Super Cells were filled with a mix…	Containing two parts Sunshine No. 1 Mix (sphagnum peat moss and perlite) to one part horticultural perlite with Osmocote Plus 15-9-12 Controlled Release Fertilizer (3-4 month release) at a rate of 100g per cubic foot.
The seed was…	Lightly covered with the same mix and the cells were kept moist with daily irrigations.
The plants were…	Graded and culled in the fall of 2011 and placed in a coldframe to overwinter.
The plants were…	Graded again In the early spring, fertilized with 2.5 g/cell of the same fertilizer, and placed in the greenhouse until mid-May.
The seedlings were…	Hardened off in the nursery during late May and June of 2012 and sub-irrigated on a daily basis.
Field 25N at the Los Lunas Plant Materials Center (LLPMC)…	Was prepared for the seedlings in June 2012 by: • Laser leveling and flood irrigating the field • Ripping the planting rows to a depth of 18-inches using a single parabolic shank subsoiler • Applying fertilizer at one-foot intervals in the soil slits at a dose of 10g phosphorus (3 TBS ammonium phosphate) and 10g potassium (1 TBS potassium sulfate) using a Rainflo Model #1600 Series II Water Wheel Transplanter to dibble holes where the fertilizer was placed. • Cultivating the soil slit to a depth of 6 inches with sweeps to distribute the fertilizer horizontally. The field was flood irrigated again to optimize soil moisture before planting, and to partially fill the soil slits. • Planting the Super Cell (1.5-in. diameter and 8-in. tall) seedlings of *Populus deltoides* ssp. *wislizen (*Rio Grande cottonwood) at approximate 2-foot

What	Action
	spacing within the row and a between-row spacing of 10 feet.

The planting in Field25N contained eight rows and comprised about 1,200 plants. The layout was as follows:

- Western two rows – La Plata River, Accession No. 9066956, ≈300 plants
- Middle three rows – Tularosa Creek, Accession No. 9066957, ≈450 plants
- Eastern three rows – San Juan River, Accession No. 9066958, ≈450 plants

Figure 1 shows the pole planting production field in early September 2012.

Figure 1. BLM pole production planting in Field 25N at the LLPMC on September 7, 2012.

In 2012, the LLPMC received additional cottonwood and willow seed collections from BLM New Mexico. Table 1 describes these accessions and the number of seedlings propagated in 2012:

Table 1. Accessions and number of seedlings propagated in 2012

BLM No.	NM930-172	NM930-173	NM930-174	NM930-170	NM930-168
Genus	*Salix*	*Populus*	*Populus*	*Populus*	*Populus*
Species	*gooddingi*	*deltoides ssp. wislizeni*	*deltoides ssp. wislizeni*	*deltoides ssp. wislizeni*	*fremontii ssp. fremontii*
Origin	Santa Fe River	Santa Fe River	Rio Grande (Old Buckman Road)	Rio Grande (BLM Boat Launch, Pilar)	Gila River (Nichols Canyon)
Latitude	E398652	E398792	E395483	E422360	32°39’15.9”
Longitude	N3940794	N3940972	N3967515	N4008812	108°50’5.3”
Elevation (feet)	6172	6172	5500	6110	3820
Seed Collection Date	6/9/12	6/9/12	6/9/12	6/3/12	4/17/12
No. of 98 Cell Trays Sown	2	4	Seed combined with 9066953	8	8
LLPMC Accession	9066952	9066953		9066954	9066958

Table 1. Accessions and number of seedlings propagated in 2012					
BLM No.	NM930-172	NM930-173	NM930-174	NM930-170	NM930-168
No.					

These seedlings will be planted out in 2013 adjacent to the existing pole production area. There are only enough Gooddings willow seedlings for one row. The remaining eight rows will be allotted to germplasm from Santa Fe/Buckman, Pilar, Gila River, as well as future collections from the Pecos River.

Propagation of *Arctostaphylos pungens* - Pointleaf Manzanita for the BLM Kasha-Katuwe Tent Rocks National Monument

The propagation of manzanita is fraught with difficulties. The *US Forest Service Woody Plant Seed Manual* describes the manzanita drupe as having a hard, bony endocarp enclosing multiple seeds with each seed borne in a nutlet-like section. The nutlets can be completely coalesced or broken in one- to several- seeded segments. Each seed has a channel or periole at its basal (radical) end. In nature, the seed is considered refractory and requiring fire-related environmental cues for germination. Even though the seeds are said to be water permeable, they require sulfuric acid scarification to allow germination under nursery conditions. This may mean that the endocarp needs to be thinned to lessen its physical restriction on endosperm imbibition and swelling. But the acid must not be allowed to dissolve the periole plug completely and damage the endosperm and embryo. Coalesced nutlets seem to require longer acid treatment times probably because the perioles are on the interior of the drupe where the nutlets are sealed together and thus better protected from the acid.

Over the years we have conducted numerous types of treatments on Arctostaphylos seed to try to enhance germination. These include concentrated sulfuric acid scarification, mechanical scarification, and exposure to smoke, exposure to water soluble char compounds (charate), and exposure to heat.

The latest batch of Kasha-Katuwe Tent Rocks (KKTR) seed was included in an experiment testing the effect of smoke and charate on acid scarified seed. This experiment was designed to vary the duration of acid scarification based on seed size (a rough approximation of degree of nutlet coalescence – smaller size implies one or a few nutlets per seed unit). This experiment investigated KKTR germplasm as well as pointleaf manzanita seed from Washington County, Utah collected at an elevation of 4,800 feet by a commercial collector. The acid scarification times varied from 120 minutes for the smallest seed units to 150 minutes for the most coalesced nutlets. The seeds were planted into plug trays with multiple seed per cell with each seed size in a random section of the tray. The trays were moist stratified at 40° F in a refrigerator. The seeded trays were removed from the refrigerator after 18 weeks when significant germination was observed in some treatments in late December 2011.

The bottom line conclusions were:

- Charate prevented germination
- Smoke reduced germination relative to the control (for example, no treatment other than acid scarification).

The longer acid scarification treatments on the larger seed units had germination percentage of about 15% germinating seed per seed unit. The smallest seed units had much lower germination percentages indicating possible acid destruction of some of the seed units.

The germinating seed were transplanted in early February 2012 into Accelerator® pots (3-inches top diameter and 4-inches high) containing a nursery canning media (composted wood chips and bark and pumice). These pots are designed to provide air-pruning of the roots via slits in the side of the pots (see Figure 2). The pots were covered with spun-bonded fabric to prevent the media from washing out through the slits (see Figure 3). The seedlings were grown in a greenhouse with a night temperature set-point of 55° F (13° C) and day set-point of 70° F (21° C). By mid-June the plants were starting to grow rapidly (see Figure 4). By October, the seedlings had well-consolidated rootballs and were ready for transplanting (see Figure 5). Because of the expense in purchasing air-

pruning pots in larger sizes, we fabricated our own using inexpensive one gallon nursery pots which were slit with a thin copper plate heated by a soldering iron to sufficient temperature to melt slits in the pots (see Figure 6). The original drain holes in these pots were covered with spun-bonded fabric to prevent the media from washing out (see Figure 7). The media for these pots consisted of a mix of one part nursery canning media (composted wood chips and bark and pumice) and one part horticultural perlite. Figure 8 shows *Arctostaphylos pungens* (Pointleaf Manzanita) plants grown from the KKTR seed after transplanting in air-pruning pots in early October 2012. The number of KKTR seedlings transplanted into air-pruning pots was 49 compared with 59 for the Utah seedlings.

Conducted solely on the Washington County Utah seed, the last experiment tested new acid scarification times as well as potential smoke-like cues. Because it appeared that 120 minutes of acid treatment was damaging, the smallest seed was scarified for only 90 minutes. The largest seed might need longer treatment times, so the scarification time was increased to 175 minutes. The treatment times, seed sizes and seed batch weights are described in Table 2.

Table 2. Seed size classes, acid scarification times, and post–scarification weights for *Arctostaphylos pungens* – Pointleaf Manzanita seed from Washington County, Utah

Seed Size (mm)	Acid Scarification Duration (min)	Seed Batch Mass for Smoke Cue Treatments(g)
2.1 - 2.8	90	0.4
2.8 - 3.2	115	0.5
3.2 - 4.0	140	0.4
> 4.0	175	1.1

Each seed batch was treated to one of the following chemical cues:

- Gibberelic acid (GA_3 at 500 mg/l) 20 ml for each seed batch
- Colgin Liquid Smoke Mesquite (8 years old) 10% (v/v) diluted with tap water, 25 ml per batch
- Colgin Liquid Smoke Hickory (new) 10% (v/v) diluted with tap water, 25 ml per batch
- Tap water 25 ml per batch

The chemical treatments lasted 24 hours as the seed and solutes were continuously stirred. The seed were planted into plug trays with one seed per cell with each seed size in a random section of the tray. The trays were moist stratified at 40° F in a refrigerator. The seeded trays were removed from the refrigerator after 12 weeks in early May 2012 when significant germination was observed in some of the treatments. The germination percentages for each seed treatment and size are shown in Table 3.

Table 3. Germination percentages of the four seed sizes and four chemical-cue treatments for *Arctostaphylos pungens* – Pointleaf Manzanita seed from Washington County, Utah. Percentages based on germinating seed per seed unit.

Seed Size (mm)	Acid Scarification Duration (min)	Colgin Liquid Smoke Mesquite	Colgin Liquid Smoke Hickory	Gibberelic acid (GA_3)	Tap Water	Mean
2.1 - 2.8	90	20%	32%	20%	13%	21%
2.8 - 3.2	115	33%	37%	33%	9%	28%
3.2 - 4.0	140	21%	29%	33%	0%	21%
> 4.0	175	21%	23%	24%	0%	17%
	Mean	**24%**	**30%**	**27%**	**5%**	

The improved germination due to the Liquid Smokes and GA_3 are readily apparent. The relative equality of the scarification treatments indicates that the acid treatment times may be approaching optimal. When KKTR seed

are available, it will be important to see if these results can be duplicated. If sufficient seed are available, a more comprehensive test of scarification times and chemical-cue concentrations could be conducted.

Figure 2. Accelerator® pot with *Arctostaphylos pungens* (Pointleaf Manzanita) seedling.

Figure 3. Accelerator® pot with spunbonded fabric cover to prevent media loss.

Figure 4. *Arctostaphylos pungens* (Pointleaf Manzanita) grown from seed from BLM Kasha-Katuwe Tent Rocks (KKTR) National Monument, mid June 2012.

Figure 5. *Arctostaphylos pungens* (Pointleaf Manzanita) seedling grown from BLM KKTR National Monument seed, early October 2012.

Figure 6. Air-pruning pot fabricated from a one-gallon nursery pot which was slit with a thin copper plate heated by a soldering iron to sufficient temperature to melt slots.

Figure 7. The original drain holes in the air-pruning pots were covered with spun-bonded fabric to prevent the media from washing out.

Figure 8. *Arctostaphylos pungens* (Pointleaf Manzanita) plants grown from BLM KKTR National Monument seed after transplanting in air-pruning pots, early October 2012.

Revised Pollinator Plant Recommendations for New Mexico

In recent years, domesticated honey bee populations and beekeepers have been faced with many new challenges. These include introduced diseases and parasites, as well as a new phenomenon known as Colony Collapse Disorder, which is thought to be caused by a complex combination of habitat loss, pathogens, pests, exposure to insecticides, and other stresses. The decline in honey bee populations has stimulated an increasing interest in providing habitat for both domesticated (hive) bees and for native wild bees. In nature, native pollinators perform most of the pollination of wild plants, whereas domesticated honey bees provide the primary pollination service for many crop plants.

To help enhance these pollinator populations, the Natural Resources Conservation Service (NRCS) Plant Materials Program is conducting field trials to develop recommendations on the plants that will sustain bees throughout the growing season. Funding for on-farm pollinator plantings is now available under the cost-share programs administered by the NRCS (e.g., the EQIP program for both organic and conventional producers). Wildflowers, trees, shrubs, and grasses are an integral part of the conservation practices that landowners, farmers and ranchers can install as part of their conservation plan. However, advice on suitable plants is currently based on broad regional guides, with little research-based information on the best choices for New Mexico. The aim of this project is to meet this need by testing a variety of (mostly native) plants for their ability to attract and sustain pollinators and other beneficial insects under a range of New Mexico conditions.

The Los Lunas NRCS Plant Materials Center (LLPMC) installed plantings in 2010, 2011, and 2012 to evaluate native and introduced species for pollinator activity (abundance and diversity); the combined plant species totals included 170 herbaceous perennials, 60 annuals and biennials, and 40 shrubs. We are evaluating these different plant species for pollinator use, plant survival, plant vigor, and duration and timing of flowering. The insects collected in 2011 and 2012 are being identified to genus for native bees and to family for flies and wasps (predatory and parasitic). The results describing the insects collected on particular plant species will be published at a later date.

In addition to the plantings at Los Lunas, in 2011 three pollinator plantings were installed at NMSU's Farmington and Tucumcari Agricultural Science Centers as well as at a demonstration farm for beginning farmers at Chaparral (south of Las Cruces), NM. In 2010, limited plantings were also installed at a rural high school in Reserve, NM and at the Whitfield Wildlife Conservation Area near Belen, NM.

In 2011, weekly pollinator observations and collections were made at the LLPMC from early March to early November, and these data were combined with those from monthly visits to all four sites made in 2012, yielding qualitative pollinator abundance and diversity information for each plant species. Considerable variability in pollinator activity on particular plant species was observed from week to week as the sources of pollen and nectar were continuously changing as other species came into bloom. Differences in pollinator activity on various plant species were also noted between morning and afternoon observations, which may have been partly due to differences in timing of nectar secretion, as well as diurnal variation in the activity of different insects.

Bloom periods were recorded for all species. It became apparent that the bloom periods were not consistent between years (2010 to 2012) due to a number of factors including:

- above average March and April maximum temperatures in 2011 and 2012
- extreme cold in February 2011 (-15° F)
- influence of planting date and degree of establishment (i.e., whether the species had overwintered versus having been planted out as a seedling in the spring)

The following tables summarize the recommended annual, herbaceous perennial, and shrub species which attracted appreciable pollinator activity at the LLPMC or in at least one of the other sites. In each table, the order of species is based on estimated start of the bloom period.

Recommended Native Annuals						
Genus Species	**Common Name**	**Commercially Available**	**Bloom Season** **Spring Summer Fall**	**Self* Seeds**	**GH** Prop.**	**Notes*****
Lesquerella gordonii	Gordon's bladderpod	Yes		++	++	(NM), Dry, host of beet leafhopper?
Dimorphocarpa wislizeni	touristplant (spectacle pod)	Occasionally		++	-	(NM), Dry, host of beet leafhopper?
Gaillardia pulchella	firewheel (wild annual)	Yes		++	++	(NM), Dry
Phacelia integrifolia	gypsum phacelia	Not Currently		++	-	(NM), Dry
Gilia capitata	bluehead gilia	Yes		+	+	(NM)
Nama hispidum	bristly nama	Not Currently		+	+	(NM), Dry
Machaeranthera tanacetifolia	tanseyleaf tansyaster	Occasionally		++	+	(NM), Dry
Baileya multiradiata	desert marigold	Yes		+	^	(NM), Dry
Cleome serrulata	Rocky Mountain beeplant	Yes		++	++	(NM), Weedy?, host of harlequin bug
Helianthus petiolaris	prairie sunflower	Yes		++	++	(NM), Weedy?
Monarda citriodora	lemon beebalm	Yes		++	+	(NM)
Verbesina encelioides	golden crownbeard	Yes		++	+	(NM)

* Self-seeds: ++ very easily, + easily, ^ occasionally,

** Greenhouse propagation: ++ very easy, + easy, ^fairly easy, - difficult, -- very difficult

***Notes: (native state – NM or closest state), Weedy = probably invasive, Dry = probably suitable for dry land situations, and ? = possibly instead of probably

Recommended Native Perennials						
Species Name	**Common Name**	**Commercially Available**	**Bloom Season** Spring Summer Fall	**Self* Seeds**	**GH** Prop.**	**Notes*****
Physaria newberryi	Newberry's twinpod	Occasionally			-	(NM), Dry, host of beet leafhopper?
Erigeron pulcherrimus	basin fleabane	Yes			^	(NM)
Penstemon eatonii	firecracker penstemon	Yes			-	(NM)
Zizia aptera	meadow zizia	Yes			^	(CO)
Hedysarum boreale	Utah sweetvetch	Yes			^	(NM)
Achillea millefolium	common yarrow	Yes		^	++	(NM), Intro.
Gaillardia aristata	common gaillardia	Yes		+	+	(NM)
Gaillardia pinnatifida	red dome blanketflower	Yes		++	++	(NM)
Heliomeris multiflora var. multiflora	showy goldeneye	Yes		+	^	(NM), Dry?
Dalea candida	white prairie clover	Yes		^	^	(NM)
Dalea purpurea	purple prairie clover	Yes		^	^	(NM)
Thelesperma subnudum	Navajo tea	Yes			^	(NM), Dry
Psilostrophe cooperi	whitestem paperflower	Yes			^	(NM), Dry
Symphyotrichum laeve var. geyeri	Geyer's aster	Yes			^	(NM)
Sphaeralcea ambigua	desert globemallow	Yes		^	-	(AZ), Dry
Machaeranthera pinnatifida	lacy tansyaster	Occasionally			^	(NM), Dry
Senecio flaccidus	threadleaf ragwort	Yes		^	^	(NM), Dry?
Coreopsis lanceolata	lanceleaf tickseed	Yes		+	+	(NM)
Melampodium leucanthum	plains blackfoot	Yes			^	(NM), Dry
Gaillardia pulchella	firewheel	Yes		+	++	(NM)
Thelesperma filifolium	stiff greenthread	Yes		+	^	(NM)
Monarda fistulosa	wild bergamot	Yes		^	^	(NM), Weedy?
Penstemon	Rocky	Yes			-	(NM)

Recommended Native Perennials						
Species Name	**Common Name**	**Commercially Available**	**Bloom Season** Spring Summer Fall	**Self* Seeds**	**GH** Prop.**	**Notes*****
strictus	Mountain penstemon					
Scrophularia lanceolata	lanceleaf figwort	Occasionally			-	(NM)
Agastache pallidiflora ssp. neomexicana	Bill Williams Mountain giant hyssop	Occasionally			^	(NM)
Heterotheca camporum	lemonyellow false goldenaster	Yes			^	(MO)
Silphium integrifolium	wholeleaf rosinweed	Yes			^	(NM)
Silphium laciniatum	compassplant	Yes			^	(NM)
Argemone pleiacantha	southwestern pricklypoppy	Occasionally		+	^	(NM)
Eupatorium altissimum	tall thoroughwort	Yes			^	(TX)
Verbena macdougalii	MacDougal verbena	Yes			+	(NM)
Verbena stricta	hoary verbena	Yes			+	(NM), Weedy?
Agastache rupestris	threadleaf giant hyssop	Yes			^	(NM)
Oligoneuron rigidum	stiff goldenrod	Yes			^	(NM)
Symphyotrichum ericoides	white heath aster	Yes				(NM)
Scrophularia californica	California figwort	Yes			-	(CA)
Ratibida columnifera	upright prairie coneflower (yellow)	Yes		^	+	(NM), Dry?
Ratibida columnifera	mexican hat (brown)	Yes		+	+	(NM), Dry?
Sphaeralcea laxa	caliche globemallow	Occasionally		^	-	(NM), Dry
Thymophylla pentachaeta	fiveneedle pricklyleaf	Occasionally			^	(NM), Hardy?
Helianthus maximiliani	Maximilian sunflower	Yes		++	+	(NM), Large!
Solidago petiolaris	downy ragged goldenrod	Yes			^	(NM)
Pycnanthemum verticillatum var.	whorled mountainmint	Yes			^	(OK)

Recommended Native Perennials						
Species Name	**Common Name**	**Commercially Available**	**Bloom Season** Spring Summer Fall	**Self* Seeds**	**GH** Prop.**	**Notes*****
pilosum						
Solidago nemoralis	gray goldenrod	Yes			^	(NM)
Solidago speciosa	showy goldenrod	Yes			^	(NM)
Helenium autumnale	common sneezeweed	Yes			+	(NM), Weedy?
Symphyotrichum oblongifolium	aromatic aster	Yes			^	(NM)

* Self-seeds: ++ very easily, + easily, ^ occasionally,
** Greenhouse propagation: ++ very easy, + easy, ^ fairly easy, - difficult, -- very difficult
***Notes: (native state – NM or closest state), Weedy = probably invasive, Dry = probably suitable for dry land situations, ? = possibly instead of probably, Intro. = some varieties introduced

Recommended Native Shrubs					
Species Name	**Common Name**	**Seed Commercially Available**	**Bloom Season** Spring Summer Fall	**GH* Prop.**	**Notes****
Salix irrorata	dewystem willow	Not Currently		^	(NM)
Salix lasiolepis	arroyo willow	Not Currently		^	(NM)
Forestiera pubescens var. pubescens	stretchberry (New Mexico olive)	Yes		^	(NM), Dry?
Prunus americana	American plum	Yes		-	(NM)
Prunus pumila L. var. *besseyi*	western sandcherry	Yes		-	(NM)
Rhus trilobata	skunkbush sumac	Yes		-	(NM), Dry?
Lycium torreyi	Torrey wolfberry	Not Currently		^	(NM), Dry?
Ribes aureum	golden currant	Yes		^	(NM)
Purshia stansburiana	Stansbury cliffrose	Yes		-	(NM), Dry
Amorpha canescens	leadplant	Yes		^	(NM), Dry?
Poliomintha incana	frosted mint	Occasionally		-	(NM), Dry
Fallugia paradoxa	Apache plume	Yes		^	(NM), Dry
Chamaebatiaria millefolium	desert sweet	Yes		^	(AZ), Dry?
Parthenium incanum	mariola	Not Currently		^	(NM), Dry
Eriogonum corymbosum	crispleaf buckwheat	Occasionally		-	(NM), Dry
Ericameria	rubber rabbitbrush	Yes		+	(NM), Dry, Weedy

Recommended Native Shrubs					
Species Name	**Common Name**	**Seed Commercially Available**	**Bloom Season** Spring Summer Fall	**GH* Prop.**	**Notes****
nauseosa					
Baccharis emoryi	Emory's baccharis (male plant in particular)	Occasionally		+	(NM)
Dalea bicolor var. argyrea	silver prairie clover	Occasionally		^	(NM), Dry

*Greenhouse propagation: ++ very easy, + easy, ^ fairly easy, - difficult, -- very difficult
**Notes: (native state – NM or closest state), Weedy = probably invasive, Dry = probably suitable for dry land situations, and ? = possibly instead of probably

Recommended Introduced Annuals, Biennials, and Perennials						
Species Name	**Common Name**	**Annual or Perennial**	**Commercially Available**	**Bloom Season** Spring Summer Fall	**Self* Seeds**	**Notes****
Linum perenne	blue flax	Perennial	Yes		^	
Salvia officinalis	kitchen sage	Perennial	Yes			
Melilotus officinalis	sweetclover	Biennial	Yes		+	Weedy
Origanum marjorana	sweet marjoram	Perennial	Yes			
Origanum vulgare	oregano	Perennial	Yes			
Lavandula angustifolia	English lavender	Shrub	Yes			
Anethum graveolens	Dill	Annual	Yes		^	
Foeniculum vulgare var. azoricum	sweet fennel	Annual	Yes		^	Weedy?
Scabiosa atropurpurea	mourningbride	Perennial	Yes			
Tithonia rotundifolia	clavel de muerto	Annual	Yes		^	
Cosmos bipinnatus	garden cosmos	Annual	Yes		++	Weedy?
Nepeta cataria	catnip	Perennial	Yes			Weedy?
Ocimum basilicum	basil	Annual	Yes		^	

* Self-seeds: ++ very easily, + easily, ^occasionally
*****Notes: Weedy = probably invasive, and ? = possibly instead of probably

Aslepias Seed Production for the Xerces Society

Study Number: NMPMC-T-1301-WL

The Xerces Society sponsored a trial planting of three milkweed species in FY 2012. The species chosen were *Asclepias speciosa* (ASSP), *Asclepias latifolia* (ASLA), and *Ascelpias asperula* (ASAS). Seedlings were produced in Jiffy Strip peat pots. After seeding, the flats were imbibed for four days before the flats were placed in a 40° F walk-in cooler. ASAS and ASLA were in cold from January 27, 2012 to March 21, 2012, and ASSP was in cold from January 27, 2012 to April 5, 2012.

The plants were grown in the greenhouse until mid-June, and then they were moved into the outdoor nursery to harden off. On July 11, 2012, the seedlings were hand transplanted into Dewitt Weed Barrier Pro–White with holes cut in the weed barrier with a sharpened steel pipe (similar to a cookie-cutter). The planting holes were made with a rectangular cross-section dibble which was moved to-and-fro to make a square hole of appropriate depth for the peat pot. Before the seedlings were planted, one teaspoon of Osmocote Plus 15-9-12 with Minors was placed in the bottom of each planting hole. *Asclepias speciosa* Accession No. 9066949 was comprised of two 380-foot rows (approximately 1,000 plants), *Asclepias latifolia* Accession No. 9066950 was comprised of two 380- foot rows (approximately 1,000 plants), and *Ascelpias asperula* Accession No. 9066951 was comprised of two 300-foot rows (approximately 600 plants).

Asclepias asperula (ASAS) in field 35N on July 24, 2012

Ascelpias speciosa (ASSP) in field 35N on Sept. 7, 2012

Asclepias latifolia (ASLA) in field 35N on Sept. 7, 2012

Little Bluestem Polycross Increase Block and Advance Evaluation

Study Number: NMPMC-P-0604-RA

Little bluestem is a native, warm-season bunch grass and is recognized as an important species for revegetation seeding in its area of adaptation. The LLPMC has released the variety 'Pastura' little bluestem, and it has been used extensively in revegetation efforts throughout the LLPMC service area. There are several little bluestem varieties that have been developed by the Natural Resources Conservation Service (NRCS) Plant Materials Program that are are currently available through commercial seed sources.

Background

1990 –1991 – A re-collection of little bluestem accessions from the LLPMC service was completed in an attempt to find an improved selection of little bluestem that may out-perform 'Pastura.' These accessions were grown in the LLPMC greenhouse and transplanted to an initial evaluation planting in 1991. After extensive evaluation of these accessions by the LLPMC, five collections were identified that appeared to have better attributes when compared to the 'Pastura' release.

2006 – On March 8, 2006, culms of these five accessions were dug from the parent plants and placed into containers to produce new transplant material. All transplants were then planted into a replicated, polycross block in Field 28S on August 2, 2006. Several of these transplants did not survive the initial container planting, and new plants were grown in 2007 to complete the polycross block.

2007 – On May 1, 2007 additional culms were taken of the five accessions and placed into transplant containers. On August 22, 2007, these transplants were planted into the polycross block in Field 28S. All the transplants did not survive until the August date, and additional transplants were produced in to complete the polycross planting.

2008 – On April 25, 2008 more culms of the five accessions of little bluestem were dug from the initial evaluation planting in Field 6 and placed into transplant containers. On August 7, 2008 these transplants were then planted into the crossing block in Field 28S. All of the transplants of 2008 survived completing the planting of the little bluestem polycross block.

2012 – We will continue to harvest seed from the polycross block, and we will continue to develop a plant release for this species.

2012 Treatment and Harvest

Action – Field 28S	2012 Date
Fertilizer	
40 pounds Nitrogen	4/16
40 pounds Phosphorous	3/6
Irrigation 3" application	3/14, 4/17, 5/22, 6/11, 6/29, 7/27, 8/29, 10/29
Herbicide application	3/13
Pesticide application	9/17
Harvest seed	
Forage harvester	10/24

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

Tobosa Polycross Increase Block

Study Number: NMPMC-P-0602-RA

Tobosagrass (*Pleuraphis mutica* Buckley) is an important, warm-season, bunchgrass that grows in the Los Lunas Plant Materials Center's (LLPMC) service area. There has been a high-priority need to develop an improved selection of tobosagrass, and to provide this selection to commercial seed sources. Since the initial evaluation collections were done in the late 1970s, the LLPMC has been in the process of selecting a plant material release of this species. This species of bunchgrass is in high-demand for seeding efforts in the low rainfall, southern desert areas of the LLPMC service area.

2006 – In 2006, culms were taken from six accessions in the initial evaluation planting (IEP) in Field 6 at the LLPMC, which were identified as having the potential for a plant material release. The vegetative material was used to start transplants for inclusion in a polycross block to be established in Field 28S at the LLPMC.

The transplants of the six accessions were planted into Field 28S on August 2, 2006. Several of the transplants from the six accessions had died prior to the August planting, and this required new plants to be harvested in 2007 to complete the polycross block.

2007 – On May 1, 2007, culms were taken again from the IEP in Field 6 and potted in containers to grow transplants for the polycross block in Field 28S. On August 22, 2007, the transplants were planted in the polycross block in Field 28S. Several transplants had died prior to this planting, and as a result, new culms had to be dug and transplanted in 2008 to complete the polycross block.

2008 – On April 25, 2008, culms were taken again from the IEP in Field 6 and potted in containers to grow transplants for the polycross block in Field 28S. On August 8, 2008, the transplants were planted in the polycross block in Field 28S. All of the transplants survived, and the tobosograss polycross block was complete.

2012 – We will continue to harvest seed from the polycross block, and we will continue to develop a plant release for this species.

2012 Treatment and Harvest

Action – Field 28S	2012 Date
Fertilizer	
40 pounds Nitrogen	4/16
40 pounds Phosphorous	3/6
Irrigation 3" application	3/14, 4/17, 5/22, 6/11, 6/29, 7/27, 8/29, 10/29
Herbicide	3/13
Pesticide application	9/17
Harvest seed	
Flail-Vac	7/16

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

Active Field Studies

Propagation of Autumn Amber

Study Number: NMPMC-P-9803-UR

Evaluation of propagation techniques will be performed in 2013 as required.

2012 Treatment and Harvest

Action - Field 26S	2012 Date
Irrigation 3" application	4/11, 6/27, 10/9

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated for optimum growth in 2013.

Hope Desert Willow Stock Plant Production

Study Number: NMPMC-P-0102-UR

2012Treatment and Harvest

Action - Field 26S	2012 Date
Irrigation 3" application	2/23, 3/30, 4/26, 5/24, 6/18, 7/5, 7/19, 8/17, 9/24, 10/19

Weed control was performed throughout the growing season to keep the field clean and to promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

Regal Desert Willow Stock Plant Production

Study Number: NMPMC-P-0101-UR

2012 Treatment and Harvest

Action Field 26S	2012 Date
Irrigation 3" application	2/23, 3/30, 4/26, 5/24, 6/18, 7/5, 7/19, 8/17, 9/24, 10/19

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

Species from Four Corners Region

Study Number: NMPMC-P-9505-CR

The plantings of different shrub species collected in the Four Corners region of New Mexico continue to be grown for possible plant material release in the future. The desert needlegrass and bluebunch wheatgrass collections that were part of these original collections have been placed into seed increase for a possible plant release in cooperation with the Bureau of Land Management. Evaluations will be completed as needed on the remaining collections of this study as needed.

2012 Treatment and Harvest

Action Field 35N	2012 Date
Shrub collections	
Irrigations 3” water application	2/22, 3/29, 4/26, 5/30, 6/26, 7/31, 9/19

Weed control was performed throughout the growing season to keep the fields clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

Mexican Whitesage

Study Number: NMPMC-9801-WL

This Mexican whitesage collection is being evaluated for its potential use as a conservation plant release. No evaluations were completed in 2012.

2012Treatment and Harvest

Action Field 26N	2012 Date
Irrigation (3” application)	None

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013. No seed was harvested in 2012.

Single Leaf Ash and Fragrant Ash

Study Number: NMPMC-P-9804-UR

Evaluation of these accessions of ash will continue in 2013 for possible conservation plant materials release.

2012 Treatment and Harvest

Action Field 26S	2012 Date
Irrigation 3” application	2/23, 3/30, 4/26, 5/24, 6/18, 7/5, 7/19, 8/17, 9/24, 10/19

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

Alkali Sacaton - Tucson PMC - ICST

Study Number: NMPMC-P-0801-RA

In 2008, seed of alkali sacaton from three plant material releases, Salado, Saltalk and Vegas, along with one collection from California, were sent by the Tucson Plant Materials Center to the LLPMC to establish an intercenter strain trial (ICST). The seed was planted into replicated plots on August 13, 2008 in Field 18 at the LLPMC. Each accession will be evaluated for its performance.

The 2012 forage production for theses accessions was clipped and measured for dry weight at the LLPMC. The forage weight results were sent to the West Regional Plant Materials Specialist for inclusion into ICST project report.

2012 Treatment and Harvest

Action – Field 18	2012 Date
Mowed planting	3/12

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. This planting will not be irrigated in 2013.

Mesa Dropseed Initial Evaluation Planting

Study Number: NMPMC-P-0702-RA

In 2006, 18 collections were made in the LLPMC service area of the warm-season, native bunchgrass, mesa dropseed (*Sporobolus flexuosus*) for inclusion into an initial evaluation study. These collections were used to start the evaluation process to produce a conservation plant release of mesa dropseed.

In 2007, seed from each of these collections was used to start transplants in the LLPMC greenhouse. The transplants were planted into replicated plots in field 31S at the LLPMC on 8/21/2008. The replicated initial evaluation planting will be evaluated annually to provide data for a possible conservation plant material release from the LLPMC of mesa dropseed.

2012 Treatment and Harvest

Action – Field 31S	2012 Date
Irrigation 3” application	3/23, 5/18, 6/8, 6/26, 7/27, 10/3
Herbicide	3/13
Fertilizer	
40 lbs. Phosphorous	3/6

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

CSU-10/Paloma Indian Ricegrass Comparison Trial

Study Number: NMPMC-P-0903-RA

On October 27, 2009, transplants of two accessions of Indian ricegrass, 9065428 (CSU-10) and Paloma were transplanted into Field 23N of the LLPMC. The planting consists of two 38” spaced rows with groups of 10 plants of the Paloma and CSU-10, randomly located in the rows. The 10 plants in each group are spaced at one foot intervals with a 2 feet spacing between the groups. This study will be evaluating the forage and seed production of the CSU-10 accession against that of Paloma, in order to determine the possibility of a future plant material release of CSU-10.

2012 Treatment and Harvest

Action – Field 23N	2012 Date
Irrigation 3” application	3/1, 3/29, 4/17, 5/7, 6/4, 6/17, 7/16, 8/17, 9/28, 10/19
Fertilization	
40 lbs. Nitrogen	4/16, 9/24
40 lbs. Phosphorous	6/18, 9/24

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. The field will be irrigated and fertilized for optimum growth in 2013.

2012 Annual Seed Production Report

Project Study Number/Name	Field #	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest (Cleaned Wt. lbs.)
NMPMC-S-1101-RA BLM "Seed for Success" prairie coneflower	8	0.50	9/26/2011	40 lbs/ac N 3/26, 6/18, 8/16	2/9, 3/14, 4/13, 5/1, 5/21, 6/6, 6/25, 7/10, 8/2, 8/17, 10/2	11/8, 11/15	249.00
	23S	0.30	2010	40 lbs/ac P 3/6, 6/4, 9/24	3/7, 4/12, 5/3, 5/21, 6/4, 6/19, 7/2, 7/19, 8/7, 8/17, 9/10, 9/28, 10/23		
NMPMC-S-0901-CP **Windbreaker** SPWR seed increase	8	0.85	8/2009	40 lbs/ac N 5/9	4/11, 5/18, 6/11, 7/2, 7/31, 10/22	9/11, 10/1	100.45
	14	0.40	8/2009	40 lbs/ac N 5/9	4/11, 5/18, 6/11, 7/2, 7/31, 10/22	9/11, 10/1	
NMPMC-S-0302-RA **Salado** alkali sacaton Foundation seed field	11	1.0	2003	40 lbs/ac N 5/9	4/11, 5/18, 6/11, 7/2, 7/31, 10/22	No harvest	
NMPMC-S-0402-RI **Westwater germplasm** alkali muhly Foundation seed field	11	1.0	2004	40 lbs/ac N 6/4 40 lbs/ac P 6/4	4/11, 5/14, 6/8, 6/29, 7/25, 10/18	10/2	2.1
NMPMC-00701-OT 906609 Boulder County CO little bluestem seed production	14	0.48	8/16/2011	40 lbs/ac N 2/16, 6/4, 9/24 40 lbs/ac P 2/14, 6/4, 9/24	2/28, 3/30, 4/18, 5/21, 6/6, 6/26, 7/16, 7/31, 9/5, 10/4	9/19	19.00
NMPMC-0701-OT 9066910 Boulder County CO prairie dropseed seed production	14	0.48	8/17/2011	40 lbs/ac N 2/16, 6/4, 9/24 40 lbs/ac P 2/14, 6/4, 9/24	2/27, 3/28, 4/18, 5/21, 6/6, 6/26, 7/16, 7/31, 9/5, 10/5	9/17	1.10
NMPMC-S-0703-PA **Grenville** switchgrass seed production	14	0.14	2007	40 lbs/ac N 5/9	4/11, 5/15, 6/8, 7/9, 8/10, 10/3	9/21	Not yet cleaned
NMPMC-S-0503-RI 9066589 Composite vine mesquite seed increase field	14	1.0	2005	40 lbs/ac N 6/14	4/12, 5/25, 6/15, 7/25, 9/6	10/16	Not yet cleaned
NMPMC-S-7801-RA **Hachita** blue grama Foundation seed field	16	2.0	1978	40 lbs/ac N 7/9 40 lbs/ac P 3/6, 7/9	5/7, 6/11, 7/13, 8/1	10/19	5.80
NMPMC-S-0801-PA	18	1.0	2008	40 lbs/ac N 3/26, 5/29	3/30, 4/26, 5/30, 6/22, 7/24,	9/7	168.00

Project Study Number/Name	Field #	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest (Cleaned Wt. lbs.)
Jose tall wheatgrass Foundation seed production					9/21		
NMPMC-S-0402-RA **Vaughn** sideoats grama Foundation seed field	19	1.20	7/22-28/2004	40 lbs/ac N 6/14 40 lbs/ac P 3/6	4/11, 5/22, 6/14, 7/5, 8/3	8/6	84.0
NMPMC-S-0401-RA **Pastura** little bluestem Foundation seed field	19	0.86	2004	40 lbs/ac N 5/29, 7/9 40 lbs/ac P 3/6	5/7, 5/30, 6/15, 7/10, 8/3	No harvest	
NMPMC-S-0301-RA **Viva** galleta Foundation Seed field	19	2.4	2003	40 lbs/ac N 6/14, 7/9 40 lbs/ac P 7/9	4/16, 5/22, 6/14, 7/16, 8/10	6/26, 8/30	16.80
NMPMC-S-1001-WO 9062861 Grand Canyon National Park muttongrass seed production	28S	1.00	2010	40 lbs/ac N 2/16, 5/9, 6/4, 9/24 40 lbs/ac P 2/14, 6/5, 9/27 50 lbs/ac Gypsum 3/23 40 lbs/ac Gypsum 12/7	3/1, 3/23, 4/12, 5/9, 5/24, 6/7, 6/25, 7/12, 7/30, 8/15, 10/4, 10/22, 11/20	5/2	114.80
	35S	0.50	2010	40 lbs/ac N 5/9, 6/5 40 lbs/ac P 2/14, 6/5, 9/24 50 lbs/ac Gypsum 3/23	3/1, 3/23, 4/12, 5/9, 5/25, 6/6, 6/22, 7/13, 7/27, 8/15, 9/28, 10/19	5/2	
	33N	0.50	2011	40 lbs/ac N 4/16, 6/5 40 lbs/ac P 6/5, 9/24 50 lbs/ac Gypsum 3/23	2/3, 2/21, 3/7, 3/23, 4/16, 5/7, 5/25, 6/6, 6/21, 7/2, 7/13, 7/27, 8/15, 8/29, 9/10, 10/1, 10/17, 11/20	No harvest	
	21S	0.12	2012	40 lbs/ac Gypsum 12/13	10/25, 11/9, 11/29	No harvest	
	24S	0.50	2012	40 lbs/ac Gypsum 12/13	10/18, 10/29, 11/20	No harvest	
NMPMC-S-1101-RA 9062875 Grand Canyon National Park blue grama seed production	20N	0.76	2011	40 lbs/ac N 4/16, 5/29, 6/18 40 lbs/ac P 3/6 40 lbs/ac Gypsum 12/7	2/9, 3/7, 3/30, 4/17, 5/7, 5/30, 6/19, 7/19, 8/1, 9/11, 10/16	10/9	52.50
	28S	0.50	2006	40 lbs/ac N 6/18 40 lbs/ac P 3/6 40 lbs/ac Gypsum	3/14, 5/7, 6/1, 6/21, 7/19, 8/8, 8/29, 10/17 12/7	10/10	
	20N	0.75	2010	40 lbs/ac N 2/16, 6/4 40 lbs/ac P 2/14, 6/4	2/27, 3/30, 5/14, 6/6, 6/26, 7/23, 8/30, 11/29	11/2	

Project Study Number/Name	Field #	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest (Cleaned Wt. lbs.)
NMPMC-S-0901-WO 9066802 Grand Canyon NP spike muhly seed production	20S	0.70	2009	40 lbs/ac N 5/29, 7/9, 8/16 40 lbs/ac P 3/6 40 lbs/ac Gypsum 12/13	3/12, 5/8, 6/1, 6/20, 7/10, 8/1, 8/17, 10/5	10/19	1.50
NMPMC-S-9701-RA **Nogal** black grama Foundation seed field	21N	1.3	1997	40 lbs/ac N 6/5, 8/16	3/14, 5/15, 6/8, 7/2, 7/24, 8/17	10/31	39.92
NMPMC-S-0904-RA 9066803 Grand Canyon NP blue grama seed production	21S	0.60	2009	40 lbs/ac N 5/29, 7/9, 8/16 40 lbs/ac P 6/18 40 lbs/ac Gypsum 12/13	3/14, 5/9, 5/30, 6/19, 7/10, 8/2, 8/17, 10/16	10/9	54.00
NMPMC-S-1101-RA 9066885 BLM Seeds for Success Species seed increase globemallow	23N	0.06	2011		2/9, 3/14, 3/23, 4/12, 5/3, 5/21, 6/1, 6/19, 7/2, 7/16, 8/7, 8/17, 9/28, 10/17	8/8, 9/7	Not yet cleaned
	34S	0.54	2012		8/20, 8/28, 9/4, 9/10, 9/24, 10/9, 10/16, 10/31, 11/20	No harvest	
NMPMC-S-1101-RA 9066884 BLM Seeds for Success Species seed increase primrose	34S	0.	2012		8/21, 8/28, 9/4, 9/10, 9/24, 10/9, 10/16, 10/31, 11/20	No harvest	
NMPMC-S-0802-RA 9066330 desert needlegrass seed production	23N	0.45	2008	40 lbs/ac N 4/16, 9/24 40 lbs/ac P 6/18, 9/24	3/1, 3/29, 4/17, 5/7, 6/4, 6/19, 7/16, 8/17, 9/18, 10/19	5/24, 6/1	Not yet cleaned
NMPMC-S-1101-RA 9066882-9066883BLM Seeds of Success Species seed increase dock	24S	0.50	2010	40 lbs/ac N 9/24 40 lbs/ac P 6/18, 9/24	3/2, 4/12, 5/1, 5/24, 6/11, 6/19, 7/19, 8/10, 9/19, 10/1, 10/19	7/25	10.60
	27N	0.50	2010	40 lbs/ac N 9/24 40 lbs/ac P 9/24	3/1, 3/28, 5/7, 6/1, 6/21, 7/16, 8/10, 10/1, 10/19	7/25	
NMPMC-S-1301-WO 9066888 Arches National Park Indian ricegrass seed production	26N	0.45	2012	40 lbs/ac N 9/24 40 lbs/ac P 9/24 40 lbs/ac Gypsum 12/13	1/12, 2/3, 2/21, 3/7, 3/23, 4/12, 4/26, 5/16, 5/25, 6/1, 6/15, 6/29, 7/13, 7/27, 8/17, 10/9, 10/22, 11/29	No harvest	
	27N	0.50	2012	40 lbs/ac N 6/18, 9/24 40 lbs/ac P 6/18, 9/24	1/12, 2/1, 2/23, 3/7, 3/28, 4/16, 5/1, 5/18, 6/1, 6/21, 7/13, 7/31, 8/28, 10/5, 10/22, 11/20	No harvest	
NMPMC-S-1301-WO 9066907 Canyonlands National Park Indian ricegrass seed production	24N	0.26	2012	40 lbs/ac N 6/4, 9/24 40 lbs/ac P 6/4, 9/24 40 lbs/ac Gypsum 12/13	1/12, 2/3, 2/21, 3/7, 3/23, 3/28, 4/12, 5/1, 5/18, 6/4, 6/15, 6/29, 7/13, 7/27, 8/10, 10/1, 10/23	No harvest	

Project Study Number/Name	Field #	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest (Cleaned Wt. lbs.)
NMPMC-S-1301-WO 9066904 Canyonlands National Park Indian ricegrass seed production	14	0.14	2012	40 lbs/ac N 6/4, 9/24 40 lbs/ac P 6/4, 9/24	1/12, 2/3, 2/27, 3/14, 3/28, 4/20, 5/18, 6/7, 6/26, 7/16, 7/31, 9/5, 10/5, 118/29	No harvest	
NMPMC-S-1301-WO 9066908 Canyonlands National Park Indian ricegrass seed production	33N	0.09	2012	40 lbs/ac P 9/24	1/12, 2/1, 2/21, 3/7, 3/30, 4/12, 5/1, 5/15, 6/1, 6/15, 7/2, 7/13, 7/27, 8/15, 10/3, 10/17, 11/8	No harvest	
NMPMC-S-9401-RA **Paloma** Indian ricegrass Foundation seed field	20N	0.37	2009	40 lbs/ac N 2/16, 3/26, 4/16, 6/4, 9/24 40 lbs/ac P 2/16, 6/4, 9/27	2/2, 2/27, 3/28, 4/17, 5/7, 6/8, 6/29, 7/27, 10/5	5/18, 5/22, 5/25, 6/1, 6/4	85.0
	20N	0.52	2011 2012	40 lbs/ac N 4/16, 6/4, 6/18, 7/9 40 lbs/ac P 6/4, 9/27	1/12, 2/2, 2/13, 3/1, 3/28, 4/17, 5/3, 5/21, 6/7, 6/20, 7/10, 8/15, 10/9	No harvest	
NMPMC-S-1301-RA **Niner** sideoats grama	25S	0.90	2012		9/18, 9/24, 10/1, 10/16, 10/29, 11/29	No harvest	
	35N	0.20	2012		9/20, 9/24, 10/3, 10/16, 11/1	No harvest	
NMPMC-S-1102-WO 9066797 Grand Canyon National Park needleandthread seed production	28S	0.09	2011	40 lbs/ac N 2/16, 5/9, 6/4 40 lbs/ac P 2/14, 6/5, 9/27 40 lbs/ac Gypsum 12/7	2/27, 3/29, 4/12, 5/3, 5/24, 6/6, 6/26, 7/16, 7/31, 8/15, 10/18, 11/21	5/16	Not yet cleaned
	24N	0.24	2012	40 lbs/ac N 9/24 40 lbs/ac Gypsum 12/13	7/5, 7/9, 7/13, 7/17, 7/23, 7/27, 8/3, 8/8, 8/13, 8/20, 8/28, 9/11, 9/24, 10/9, 10/16, 11/8	No harvest	
NMPMC-S-0301-WO 9066532 Zion National Park bottlebrush squirreltail seed production	19	1.00	2010 2011	40 lbs/ac N 2/16, 3/26, 9/24 40 lbs/ac P 2/14, 9/27	2/27, 3/28, 4/18, 5/11, 6/7, 6/26, 7/19, 8/8, 9/5, 10/4	5/23, 5/29, 6/5	76.1
NMPMC-S-0801-RA 9066431 bluebunch wheatgrass seed production	35N	0.30	2008	40 lbs/ac N 2/16, 3/26, 7/24 40 lbs/ac P 6/18, 9/24	3/1, 3/29, 4/12, 5/9, 6/1, 6/22, 7/17, 7/27, 8/15, 9/28, 10/22	5/30	Not yet cleaned
	18	0.65	2012	40 lbs/ac N 2/16, 9/24 40 lbs/ac P 2/14, 9/27	2/27, 3/30, 4/20, 5/14, 6/6, 6/26, 7/24, 8/17, 8/30, 10/1, 11/20	5/30	Not yet cleaned
NMPMC-S-0301-WO 9066528 Zion National Park Indian ricegrass seed production	35N	0.50	2004 2005	40 lbs/ac N 2/16, 3/26, 9/24	3/1, 3/28, 4/26, 5/14, 6/1, 6/22, 7/19, 8/24, 10/9	5/18, 5/22, 5/25	56.0

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