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Los Lunas Plant Materials Center Annual Technical Report

By: Los Lunas Plant Materials Center Staff

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'Windbreaker' Big Sacaton (*Sporobolus wrightii*)

Study Number: NMPMC-S-0901-CP

Big sacaton is a native, robust, perennial warm-season bunchgrass. It is found throughout the southwestern United States, usually occurring on low alluvial flats and flood plains. It is useful forage for livestock and wildlife. Under irrigation, big sacaton may reach heights exceeding 3 m. The mature plants range in height from 1–4 m. Based upon its density and height, it has the potential as a windbreak plant for irrigated cropland.

Seed collections of big sacaton were taken from 37 locations throughout New Mexico. These collections were used to establish non-replicated, accession rows that consisted of 520 plants in a field at the Los Lunas Plant Materials Center. Based on a visual evaluation of vigor and height, ten superior plants were selected. Each selected superior plant came from a separate accession to maintain a diverse population. From these ten plants, one super selection was made.

A hybrid, cross-planting was established as an attempt to improve the height of the progeny. In 1992, clonal shoots of each selected plant were planted into a hybrid, seed-production block with the super plant as the male pollinator. In 1995, seed was hand-harvested from each female parent. In 1996, this seed was used to establish an evaluation planting that contained both parents and progeny. The progeny were derived from seed, and the parents were vegetatively propagated. Both sets of plants were grown in 6-inch square pots for eight months in an attempt to equalize carbohydrate reserves in the seed derived plants and the clones. The planting design was an 8-replicated, split-plot, randomized block design. Each replication consists of 20 plants spaced on 10-ft. centers. A plot consists of a parent and the progeny plant.

The planting is mowed in the winter to remove plant liter from the previous year. By the end of the third growing season, the leaf blades of most plants had approached 3 m in height. When the plants are flowering they may approach 4 m.

In August 2002, the planting was evaluated for leaf height, basal width, and appearance. A separate, paired, T-test statistical analysis was performed on each replication comparing the height of each parent to its progeny. The progeny and parent plants were not significantly different in height (alpha .05). However, there appears to be a difference in leaf blade width, color, and uprightness between the parents and progeny plants. The cloned parent plants remain identical to their source where the progeny plants seem to have random variation.

The August 2002 clonal big sacaton planting was removed in 2009.

NMPMC-S-0901-CP – Seed Increase of 'Windbreaker' 9066790 Big Sacaton

In 2009, big sacaton seed from the original parental selections was used to start transplants in the LLPMC greenhouse. The transplants were used to plant seed increase plantings of the big sacaton into fields at the LLPMC. The increase field plantings are on 38 row centers and use three different in row planting intervals; one foot, two feet and three feet. The three in row intervals will be harvested and cleaned separately to look for any significant affects they may have on seed production.

In 2011, the accession 9066790 was formally released by the LLPMC and the New Mexico State University as a plant materials cultivar named 'Windbreaker.' The established fields at the LLPMC will now be harvested as foundation seed of 'Windbreaker' big sacaton cultivar; seed is available for commercial production from the LLPMC.

2011 Treatment and Harvest

2011 field maintenance for the parent plantings consisted of the following activities:

Big Sacaton Parent Lines		
Field Number	**Action**	**2011 Dates**
Field 13 parent lines	Swath Weed control Fertilization and irrigation	11/19 Entire growing season As needed to maintain planting.
Field 26N parent lines	Weed control Fertilization and irrigation	Entire growing season As needed to maintain planting.

2011 field maintenance for the foundation production field consisted of the following activities:

'Windbreaker' Big Sacaton Foundation Seed Increase–Accession #9066790		
Field Number	**Action**	**2011 Dates**
Field 8	Fertilization 40lbs. Nitrogen 40 lbs. Phosphorous Irrigation 3" Application Cultivation Herbicide Application Harvest Weed control Fertilization and irrigation	 5/26 2/15 4/7, 4/29, 5/27, 6/22,7/21, 8/2 6/2 4/1 Combine 9/30 Entire growing season To be done for optimum growth in 2012
Field 14	Fertilization 40 lbs. Nitrogen 40 lbs. Phosphorous Irrigation 3" Application Cultivation Herbicide Application Harvest Weed control Fertilization and irrigation	 5/26 2/15 4/6, 4/29, 5/27, 6/27, 7/21, 8/25 6/2 3/4 Combine 9/20 Entire growing season As needed to maintain planting.

Evaluation of Big Sacaton for Use in Field Windstrip Plantings

Study Number: NMPMC-P-9801-CP

Background information on the Los Lunas Plant Materials Center's (LLPMC's) evaluation of the native grass species big sacaton (*Sporobolus wrightii*) can be found in study number NMPMC-P-9601-CP. This study details the LLPMC's efforts to develop a selected accession of big sacaton for a possible plant materials release. The study also details the efforts of producing big sacaton seed and transplants from advanced plantings grown at the LLPMC.

NRCS Field Offices in our service area continue to be very interested in using big sacaton for windstrip plantings to control or prevent existing soil erosion on various types of land uses. Distribution and planting of this native species continues to promote the use of this species as a windstrip and further defines its range of adaptability.

All windstrip plantings are no longer being evaluated. For background and evaluation information about these plantings, please see the previous *LLPMC Annual Technical Reports* detailing all evaluations and plantings of big sacaton.

'Windbreaker' big sacaton cultivar was released by the Los Lunas Plant Materials Center and New Mexico State University in 2011. This study is now inactive.

Big Sacaton Biomass Forage Production Study

Study Number: NMPMC-T-1001-BF

In 2010, the Los Lunas Plant Materials Center (LLPMC) initiated a study of big sacaton (*Sporobolus wrightii*) as to its potential as a biomass forage species. This is a three-year study. In 2009, the LLPMC established a 1.25 acre seed increase of big sacaton in Fields 8 and 14, and these areas of increased acreage are being used for this study. The plants are spaced at 1-ft., 2-ft. and 3-ft. intervals on 38-inch rows. This diverse spacing will help to determine the effect of the amount of spacing has on forage and seed production.

Big sacaton is a robust, native, warm-season perennial grass species adapted to the southwestern United States. This plant is capable of high forage production, and it has the potential as a bioenergy fuel production species. Big sacaton can grow in soils that are considered marginal for the more high-value cash crops, and where forage production is not as dependent upon high rates of supplemental water applications. These attributes make big sacaton a viable candidate for biomass forage production in the lesser rainfall areas of the Southwest.

2010 Agronomic Treatments and Forage Weights

The fields were irrigated, fertilized, and kept weed free during the 2010 growing season to produce an optimum amount of seed production. The following table describes the agronomic treatments used on the big sacaton clipping fields in 2010.

***2010* Biomass Forage Production Study – Agronomic Treatments**					
Field Number	**Fertilizer Application**	**Date**	**Pesticide Application**	**Date**	**3" Irrigation Application (2010 Dates)**
8	40 lbs. Phosphorous 40 lbs. Nitrogen	03/02/2010 07/02/2010	Pre-emergent	03/04/2010	3/5, 5/11, 6/17, 7/15, 8/13, 9/13, 10/28
14	40 lbs. Phosphorous 40 lbs. Nitrogen	03/03/ 2010 07/02 2010	Pre-emergent	03/04/ 2010	3/10, 5/10, 6/2, 6/17, 7/15, 8/13, 9/13, 10/12

The forage clippings were weighed for green forage weight, and then oven dried for 48 hours to obtain the dry forage weight. The following table shows the green and dry weights of the 2010 forage clippings.

***2010* Biomass Forage Production Study – Forage Green Weight and Dry Weight**						
Month	**Field Number**	**Plant Spacing**	**Avg. Green weight/plot[1] (lbs.)**	**Avg. Green weight/acre[1] (lbs.)**	**Avg. Dry weight/plot[2] (lbs.)**	**Avg. Dry weight/acre[2] (lbs.)**
April	8	1 ft.	0.034	85.000	0.006	14.152
	8	2 ft.	0.043	61.429	0.007	10.698
	14	3 ft.	0.008	7.273	0.001	0.741
May	8	1 ft.	0.507	1,267.500	0.195	487.500
	8	2 ft.	0.446	637.143	0.153	218.571
	14	3 ft.	0.020	18.182	0.0004	0.364
June	8	1 ft.	0.865	2,162.500	0.367	917.500
	8	2 ft.	2.201	3,144.286	0.860	1,228.571

[1] Average clipped weights of three random plots, each containing seven plants and clipping the center five plants

[2] Forage clippings oven dried for 48 hours to obtain the dry weight

2010 Biomass Forage Production Study – Forage Green Weight and Dry Weight						
Month	**Field Number**	**Plant Spacing**	**Avg. Green weight/plot[1] (lbs.)**	**Avg. Green weight/acre[1] (lbs.)**	**Avg. Dry weight/plot [2] (lbs.)**	**Avg. Dry weight/acre[2] (lbs.)**
	14	3 ft.	1.033	939.091	0.347	315.454
July	8	1 ft.	1.291	3,227.500	0.747	1,867.500
	8	2 ft.	4.180	5,971.429	1.740	2,485.714
	14	3 ft.	3.187	2,897.273	1.107	1,006.364
August	8	1 ft.	3.827	9,567.500	1.693	4,232.500
	8	2 ft.	11.587	16,552.857	4.840	6,914.286
	14	3 ft.	12.750	11,590.909	4.693	4,266.364
Sept	8	1 ft.	5.967	14,917.500	2.787	6,967.500
	8	2 ft.	7.620	10,885.714	3.660	5,228.571
	14	3 ft.	12.760	11,600.00	5.740	5,218.182
Total Yearly Average (lbs.)						
		1 ft.	2.082	5,204.583	0.966	2,414.442
		2 ft.	4.346	6,208.810	1.877	2,476.307
		3 ft.	4.960	4,508.780	1.981	1,801.244

[1] Average clipped weight of three random plots, each containing seven plants and clipping the center five plants

[2] Forage clippings oven dried for 48 hours to obtain the dry weight

2011 Agronomic Treatments and Forage Weights

The fields were irrigated, fertilized, and kept weed free during the 2011 growing seasons to produce an optimum amount of seed production. The following table describes the agronomic treatments used on the big sacaton clipping fields in 2011.

2011 Biomass Forage Production Study – Agronomic Treatments					
Field Number	**Fertilizer Application**	**Date**	**Pesticide Application**	**Date**	**3" Irrigation Application (2011 Dates)**
8	40 lbs. Phosphorous 40 lbs. Nitrogen	02/15/2011 05/26/ 2011	Pre-emergent 2,4-D	04/01/2011 04/01/2011	4/7, 4/29, 5/27, 6/22, 7/21, 8/25, 2011
14	40 lbs. Phosphorous 40 lbs. Nitrogen	02/15/2011 05/26/ 2011	Pre-emergent 2,4-D	04/01/2011 04/01/2011	4/6, 4/29, 5/27, 6/22, 7/21, 8/25, 2011

The forage clippings were weighed for green forage weight, and then oven dried for 48 hours to obtain the dry forage weight. The following table shows the green and dry weights of the 2010 forage clippings

2011 Biomass Forage Production Study – Forage Green Weight and Dry Weight						
Month	**Field Number**	**Plant Spacing**	**Avg. Green weight/plot[1] (lbs.)**	**Avg. Green weight/acre [1] (lbs.)**	**Avg. Dry weight/plot[2] (lbs.)**	**Avg. Dry weight/acre[2] (lbs.)**
April	8	1 ft.	0.273	682.500	0.160	400.000
	8	2 ft.	0.347	495.714	0.193	275.714
	14	3 ft.	0.893	811.818	0.400	363.636

2011 Biomass Forage Production Study – Forage Green Weight and Dry Weight						
Month	**Field Number**	**Plant Spacing**	**Avg. Green weight/plot[1] (lbs.)**	**Avg. Green weight/acre [1] (lbs.)**	**Avg. Dry weight/plot[2] (lbs.)**	**Avg. Dry weight/acre[2] (lbs.)**
May	8	1 ft.	0.747	1,867.500	0.340	850.000
	8	2 ft.	1.367	1,952.857	0.547	781.429
	14	3 ft.	4.667	4,242.727	1.653	1,502.727
June	8	1 ft.	1.987	4,967.500	0.867	2,167.500
	8	2 ft.	4.573	6,532.857	1.847	2,638.571
	14	3 ft.	8.713	7,920.909	3.473	3,157.273
July	8	1 ft.	2.573	6,432.500	1.267	3,167.500
	8	2 ft.	7.120	10,171.429	3.417	4,881.429
	14	3 ft.	22.367	20,333.636	8.667	7,879.091
August	8	1 ft.	3.400	8,500.000	1.768	4,420.000
	8	2 ft.	9.484	13,548.571	4.933	7,047.143
	14	3 ft.	33.800	30,727.273	17.576	15,978.181
Total Yearly Average (lbs.)						
		1 ft.	1.796	4,490.000	0.880	2,201.000
		2 ft.	4.578	6,540.286	2.187	3,124.857
		3 ft.	14.088	12,807.271	6.354	5,776.182

[1] Average clipped weights of three random plots, each containing seven plants and clipping the center five plants

[2] Forage clippings oven dried for 48 hours to obtain the dry weight

2010 – 2011 Random Sampling Scheme

During the 2010 – 2011 study periods, a random selection of seven plants per plot was used. Three random plots were clipped from each of the three separate spacing measurements for a total of nine plots. The center five plants of each plot were then clipped to a 6-inch height. The following tables describe the 2010 and 2011 random sampling schemes.

2010 Biomass Forage Production Study – Random Sampling Scheme												
	April Samples		**May Samples**		**June Samples**		**July Samples**		**August Samples**		**September Samples**	
Plant Spacing	**Row No.**	**Plant No.**	**Row No.**	**Plant No.**	**Row No.**	**Plant No.**	**Row No.**	**Plant No.**	**Row No.**	**Plant No.**	**Row No.**	**Plant No.**
1-ft.	8	14	10	129	14	112	16	159	9	6	19	227
	16	59	04	155	5	95	5	48	2	49	9	38
	15	159	03	148	11	124	4	55	4	219	16	81
2-ft.	16	125	3	102	8	20	16	100	7	33	6	23
	13	63	15	91	3	71	10	80	3	62	12	134
	2	91	17	11	17	122	8	70	14	32	14	13
3-ft.	9	39	10	46	18	12	29	2	12	42	17	6
	13	16	22	39	23	42	28	7	7	7	2	53

2010 Biomass Forage Production Study – Random Sampling Scheme												
	April Samples		May Samples		June Samples		July Samples		August Samples		September Samples	
Plant Spacing	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.
	18	39	17	49	12	8	14	16	3	23	23	28

2011 Biomass Forage Production Study – Random Sampling Scheme												
	April Samples		May Samples		June Samples		July Samples		August Samples		September Samples	
Plant Spacing	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.	Row No.	Plant No.
1-ft.	17	71	10	119	7	224	18	16	9	80	19	158
	8	126	4	29	16	74	18	211	14	143	6	107
	12	207	13	229	15	247	19	10	5	35	17	83
2-ft.	17	76	16	130	16	76	2	47	16	101	5	48
	18	128	9	108	5	90	8	14	5	113	17	71
	3	19	8	32	4	64	6	88	7	67	5	32
3-ft.	14	48	12	35	27	34	22	13	26	54	18	29
	22	19	19	28	8	41	17	26	28	48	31	34
	22	44	27	46	22	39	2	17	2	47	17	33

2010-2011 Biomass Weights

The following table shows the average biomass weight for the 2010–2011 clipping periods.

Biomass Forage Production Study – Forage Green Weight and Dry Weight Averaged Over a Two-Year Period (*2010-2011*)						
Month	Field Number	Plant Spacing	Avg. Green weight/plot[1] (lbs.)	Avg. Green weight/acre[1] (lbs.)	Avg. Dry weight/plot[2] (lbs.)	Avg. Dry weight/acre[2] (lbs.)
April	8	1 ft.	0.154	383.750	0.083	207.076
	8	2 ft.	0.195	278.571	0.100	143.206
	14	3 ft.	0.450	409.545	0.200	182.188
May	8	1 ft.	0.627	1,567.500	0.267	688.750
	8	2 ft.	0.906	1,295.000	0.350	500.000
	14	3 ft.	2.343	2,130.454	0.828	751.545
June	8	1 ft.	1.426	3,565.000	0.617	1,542.500
	8	2 ft.	3.387	4,748.571	1.353	1,933.571
	14	3 ft.	4.873	5,409.091	1.910	1,736.363
July	8	1 ft.	1.932	4,830.000	1.007	2,517.500
	8	2 ft.	5.650	8,071.429	2.578	3,683.571
	14	3 ft.	12.777	11,615.454	4.887	4,442.727

Biomass Forage Production Study – Forage Green Weight and Dry Weight Averaged Over a Two-Year Period (*2010-2011*)						
Month	**Field Number**	**Plant Spacing**	**Avg. Green weight/plot[1] (lbs.)**	**Avg. Green weight/acre[1] (lbs.)**	**Avg. Dry weight/plot [2] (lbs.)**	**Avg. Dry weight/acre[2] (lbs.)**
August	8	1 ft.	3.613	9,033.750	1.730	4,326.250
	8	2 ft.	10.535	15,050.714	4.886	6,980.714
	14	3 ft.	23.275	21,159.091	11.134	10,122.272
	14	3 ft.				
Total Yearly Average (lbs.) Over Two Year Period (2010-2011)						
		1 ft.	1.550	3,876.000	0.741	1,856.415
		2 ft.	4.135	5,888.857	1.853	2,648.212
		3 ft.	8.744	8,144.727	3.792	3,447.019

[1] Average clipped weights of three random plots, each containing seven plants and clipping the center five plants
[2] Forage clippings oven dried for 48 hours to obtain the dry weight

Summary

The big sacaton biomass forage production study ran for five months in 2011, from April to August. This was the second year of the three-year study. The intent was to cover a six month clipping schedule, but in 2011 the seed harvest was done before the scheduled September clipping. Harvesting removed some of the forage from the field which prevented the September clipping. To avoid this problem in 2012, the September clipping plots will be identified prior to seed harvest and if possible, these selected plants will not be harvested.

The big sacaton will be clipped for the final time in 2012 and this will provide three, consecutive years of forage production for analysis. The forage data gathered in the three-year study will allow the LLPMC to provide a more accurate recommendation for planting this native grass species when intended for biomass production. The three-year study also will provide more evidence in determining if this grass species has the necessary amount of forage production to make it a candidate for bioenergy fuel production.

There are no anticipated changes to the agronomic treatments for the 2012 growing season. Identifying the proper agronomic treatments for big sacaton to produce optimum amounts of forage versus seed should be investigated.

Field 8 – Biomass big sacaton 1-ft. spacing clipped 06/20/2011

Field 8 – 2-ft. spacing clipped Biomass big sacaton 08/19/2011

Field 14 – Biomass big sacaton 3-ft. spacing clipped 07/20/2011

Field 14 – 3-ft. spacing Biomass big sacaton 08/19/2011

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 Los Lunas Plant Materials Center (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 Plant Materials Program in the past, and they are currently available through commercial seed sources.

1990-1991 – In 1990, a re-collection of little bluestem accessions from the LLPMC service area was done to attempt finding an improved selection of little bluestem; one that might out-perform 'Pastura.' In 1991, these accessions were grown in a greenhouse at the LLPMC and then transplanted to an initial evaluation planting. After extensive evaluation of this collection, five accessions were identified that appeared to have improved attributes.

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. On August 2, 2006, some of these transplants were then planted into Field 28S into a replicated polycross block. Several of the transplants did not survive the initial container planting, and therefore new plants had to be grown in 2007 to complete the polycross block.

2007 –On May 1, 2007, additional culms were taken of the five accessions, placed into transplant containers, and on August 22, 2007, the new transplants were planted into the polycross block in Field 28S. Unfortunately all of the transplants did not survive until the August planting date, and as a result, we had to produce additional transplants in 2008 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 in 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 and completed the planting of the little bluestem polycross block. Seed harvest from the little bluestem will allow for new evaluations to be started on this polycross material. These evaluations along with those of the initial evaluation planting should provide the data necessary to complete the plant material release process.

Field 28S – 2011 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Field	Action	2011 Date
28S	Fertilizer	
	40 pounds Nitrogen	6/3, 7/29
	40 pounds Phosphorous	2/15
	Irrigation 3" application	4/11, 5/11, 6/8, 6/23, 7/15, 8/12, 9/22
	Herbicide application	3/31, 6/3
	Pesticide application	7/27, 8/17, 9/7
	Harvest seed	
	Flail-vac	August and September 2011

Field 28S will be irrigated and fertilized in 2012 as needed for optimum growth.

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 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 initial evaluation planting 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 initial evaluation planting 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.

2011 – We will continue to harvest seed from the polycross block, and the process will continue on developing a plant release for this species.

Field 28S – 2011 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 28S	2011 Date
Irrigation 3" application	4/11, 5/11, 6/8, 6/23, 7/15, 8/12, 9/22
Fertilizer 40 pounds Nitrogen 40 pounds Phosphorous	 6/3, 7/29 2/15
Herbicide	3/31, 6/3
Pesticide Application	8/17, 9/7
Harvest Seed Flail-Vac	 August and September 2011

Field 28S will be irrigated and fertilized in 2012 as needed for optimum growth.

National Park Service 2011 Annual Report

Grand Canyon National Park

In July 1990, an agreement was made with the LLPMC for the collection, propagation, and increase of native grasses, forbs, shrubs, and trees. The agreement states that the LLPMC will produce the plant materials for the purpose of revegetating disturbed areas and native landscaping projects in the GCNP which includes both the north and south rim areas of the park. Amendment No. 1 of 1999 and Amendment No. 2 of 2001 states that the LLPMC will produce seed of two native species (blue grama and muttongrass), and the LLPMC will grow transplants started from native tree and shrub seed collected from the park.

- In 2006 the LLPMC agreed to add bottlebrush squirreltail to the list of grass species to be grown for seed production
- In 2007 the LLPMC agreed to add sideoats grama to the list of grass species to be grown for seed production
- In 2009 the LLPMC agreed to add a new accession of blue grama. In addition, spike muhly was added to the list of grass species to be grown for seed production
- In 2010 an addendum to the GCNP agreement was finalized, and the LLPMC agreed to grow additional transplants of both woody and herbaceous species for GCNP. In addition, new accessions of Indian ricegrass and needleandthread were added to the list of grass species to be grown for seed production

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

Grand Canyon National Park 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

Grand Canyon National Park Plant Species Accessions			
Common Name	***Scientific Name***	**Plant Symbol**	**Accession Number**
Datil yucca	*Yucca baccata*	YUBA	9066058
Desert barberry	*Berberis fremontii*	BEFE	9066059
Elderberry	*Sambucus spp.*	SA SPP.	9066047
Fernbush	*Chamaebatiaria millefollium*	CHMI	9062866
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

2011 Accomplishments

In 2011 the LLPMC performed the following activities:

- Muttongrass plug transplants were grown from seed harvested from the production seed fields at the LLPMC, and these transplants were used to establish an additional 0.50 acre production field.
- Blue grama plug transplants were grown from seed harvested from the production seed fields at the LLPMC, and these transplants were used to establish an additional 0.76 acre seed production field.
- Needleandthread plug transplants were grown at the LLPMC from seed sent from the GCNP in 2010, and these transplants were used to establish a 0.09 acre seed production field.
- The LLPMC received 0.50 lbs. of Indian ricegrass seed harvested by GCNP personnel during 2010 and 2011. This seed will be used to establish a seed production field in early 2012.

The following tables describe the seed production fields established at the LLPMC, the amount of seed production, and the amount of pure live seed on inventory.

2011 Established GCNP Production Fields at the LLPMC			
Common Name	***Scientific Name***	**Agreement Acreage**	**2011 Acreage**
Blue grama	*Bouteloua gracilis*	2.00	2.60
Bottlebrush squirreltail	*Elymus elymoides*	0.50	0.00*
Indian ricesgrass	*Achnatherum hymenoides*	0.50	0.00
Muttongrass	*Poa fendleriana*	1.00	2.28
Needleandthread	*Hesperostipa comata*	0.50	.09
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.

2011 Amount of Seed Production for the GCNP

Common Name	*Scientific Name*	Pounds Cleaned
Blue grama	*Bouteloua gracilis*	13.86
Muttongrass	*Poa fendleriana*	*
Spike Muhly	*Muhlenbergia wrightii*	19.38

* Seed cleaning process not completed.

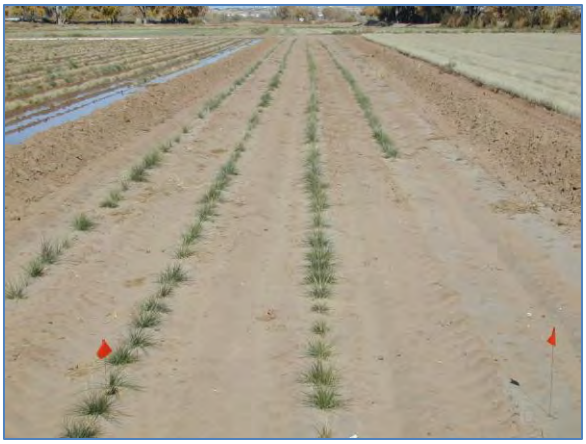
2011 Amount of Pure Live Seed on Inventory for the GCNP

Common Name	*Scientific Name*	Accession	Pure Live Seed On Inventory (lbs)	Test Date
Blue grama	*Bouteloua gracilis*	9062875	16.57 14.96 4.23	11/17/09 12/06/10 11/17/11
Blue Grama	*Bouteloua gracilis*	9066803	8.43 4.38	1/28/11 12/15/11
Muttongrass	*Poa fendleriana*	9062861	2.00	9/17/10
Sideoats grama	*Bouteloua curtipendula*	9066732	0.50	12/04/09
Spike muhly*	*Muhlenbergia wrightii*	9066802	9.31	1/25/11

* Spike muhly seed for 2011 is still being tested at the New Mexico State Seed Laboratory

Field 21S: GCNP Spike Muhly Seed Production Field

Field 33: GCNP Muttongrass Seed Production Field Established in November 2011



Field 28S: GCNP Needleandthread Seed Production Field

Pipe Spring National Monument

On September 12, 2002, an agreement was made with the LLPMC for propagating and harvesting native seed collected from the PSNM for the purpose of revegetation projects at the PSNM.

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

Pipe Spring National Monument Accessions

Common Name	Scientific Name	Plant Symbol	Accession Number
Blue grama	*Bouteloua gracilis*	BOGR	9066558
Bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066590
Galleta	*Pleuraphis jamesii*	PLJA	9066559
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066587

2011 Accomplishments

The Pipe Springs National Monument Agreement has expired. The following table describes the final shipment of seed to the PSNM from the LLPMC in 2011:

2011 Final Seed Shipment to PSNM from the LLPMC

Common Name	*Scientific Name*	Accession	Pure Live Seed Shipped (lbs.)
Indian ricegrass	*Achnatherum hymenoides*	9066587	156.80
Galleta	*Pleuraphis jamesii*	9066559	7.30 (Bulk seed)
Bottlebrush squirreltail	*Elymus elymoides*	9066590	46.30

Zion National Park

On September 12, 2002, an agreement with the Los Lunas Plant Materials Center (LLPMC) was made for the collection of native seed from the Zion National Park (ZNP), the propagation of those seeds at the LLPMC, and the increase of native grass species.

The agreement states that ZNP will use the plant materials produced by the LLPMC to revegetate disturbed areas at the park. The seed will be collected by the park staff and sent to the LLPMC for conditioning; it then will be used to establish seed production fields to satisfy 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
Blue grama	*Bouteloua gracilis*	BOGR	9066530
Bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066532
Cane bluestem	*Bothriochloa barbinodis*	BOBA	9066543
Galleta	*Pleuraphis jamesii*	PLJA	9066586
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066528
Muttongrass	*Poa fendleriana*	POFE	9066531
Sand bluestem	*Andropogon hallii*	ANHA	9066529

2011 Accomplishments

In 2011, the LLPMC added 0.06 acres to the existing 0.84 acres of bottlebrush squirreltail seed production in Field 19. This new planting increases the total bottlebrush squirreltail production acreage to 1.90.

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

2011 Established ZNP Production Fields at the LLPMC

Common Name	*Scientific Name*	Agreement Acreage	2011 Acreage
Bottlebrush squirreltail	*Elymus elymoides*	1.50	1.90
Indian ricegrass	*Achnatherum hymenoides*	0.50	0.42*
Sand bluestem	*Andropogon hallii*	0.50	0.00**

* Only 0.42 acres of Indian ricegrass was established due to the amount of seed originally received from ZNP.
** The sand bluestem field was removed prior to 2010 as per agreement with ZNP.

2011 Amount of Seed Delivered to ZNP

Common Name	*Scientific Name*	Pounds Delivered
Indian ricegrass	*Achnatherum hymenoides*	10.00
Bottlebrush squirreltail	*Elymus elymoides*	20.00

2011 Amount of Seed Production for the ZNP

Common name	*Scientific name*	Pounds Cleaned
Bottlebrush squirreltail	*Elymus elymoides*	114.64
Indian ricegrass	*Achnatherum hymenoides*	39.14

Amount of Pure Live Seed on Inventory for ZNP

Common Name	*Scientific name*	Accession	Pure Live Seed on Inventory (lbs)	Test date
Bottlebrush squirreltail	*Elymus elymoides*	9066532	4.32 18.11 0.47 14.35 62.54	8/20/09 9/17/10 8/27/07 8/06/05 8//08/11

Amount of Pure Live Seed on Inventory for ZNP

Common Name	*Scientific name*	Accession	Pure Live Seed on Inventory (lbs)	Test date
			13.83	8/08/11
Cane bluestem	*Bothriochloa barbinodis*	9066543	1.40 Bulk 1.36 2.19 1.58 0.20 Bulk	No test* 1/21/05 1/17/06 3/09/07 No test*
Galleta	*Pleuraphis jamesii*	9066586	1.51 0.58 Bulk 0.46 Bulk	1/08/07 No test* No test*
Indian ricegrass	*Achnatherum hymenoides*	9066528	15.48 44.12 76.57 33.06 22.74 27.87	10/16/06 4/28/08 10/31/08 11/11/09 12/14/10 11/30/11
Muttongrass	*Poa fendleriana*	9066531	4.55 0.70 1.84 Bulk	5/30/08 11/20/08 No test*
Sand bluestem	*Andropogon halii*	9066529	2.73 Bulk 2.80 8.89 3.26 9.84 24.78	No test* 3/20/06 3/21/07 6/14/10 7/07/10 4/19/10

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

Field 20S: ZNP Bottlebrush Squirreltail Seed Production Field

Field 35N: ZNP Indian Ricegrass Seed Production Field

Carlsbad Caverns National Park

On August 23, 2004, an agreement with the LLPMC was made for the collection, propagation, and the increase of native grass species. A new agreement was started in 2010 that provides for the propagation of transplants and seed increase by the LLPMC for CCNP native grass species.

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

2011 Accomplishments

The following tables describe the seed production fields established at the LLPMC, the amount of seed production, and the amount of CCNP pure live seed on inventory:

2011 Established CCNP Production Fields at the LLPMC

Common Name	*Scientific Name*	Agreement Acreage	2011 Acreage
Blue grama	*Bouteloua gracilis*	0.50 acre	0.50 acre
Green sprangletop	*Leptochloa dubia*	0.50 acre	0.50 acre
Plains bristlegrass	*Setaria vulpiseta*	0.50 acre	0.90 acre
Purple threeawn	*Aristida purpurea*	0.50 acre	0.50 acre
Sideoats grama	*Bouteloua curtipendula*	0.50 acre	0.50 acre

2011 Amount of CCNP Seed Production

Common Name	*Scientific Name*	Pounds Cleaned
Blue grama	*Bouteloua gracilis*	37.38
Green sprangletop	*Leptochloa dubia*	24.80
Plains bristlegrass	*Setaria vulpiseta*	64.12
Sideoats grama	*Bouteloua curtipendula*	14.76
Threeawn	*Aristida purpurea*	12.06

Recommendations for CCNP Seed Production

The LLPMC recommends that new seed production fields of green sprangletop and sideoats grama need to be established in 2012. This is based on the lack of good seed production in 2011, and the lack of vigor observed in the plantings this past growing season.

2011 Amount of 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	17.38	1/24/07
			8.12	1/09/08
			2.79	6/17/10
			2.59	12/01/09
			16.82	1/19/11
Green sprangletop	*Leptochloa dubia*	9066658	41.46	1/19/07
			82.23	1/03/08
			44.91	7/13/10
			28.10	12/10/09
			29.92	1/25/11
			14.38	12/07/11
Plains bristlegrass	*Setaria vulpiseta*	9066606	17.59	5/15/08
			146.46	7/13/10
			24.04	2/12/10
			14.53	12/08/10
			46.03	1/03/12
Purple threeawn	*Aristida purpurea*	9066607	2.99	3/21/06
			9.10	3/09/07
			7.90	4/23/08
			3.04	6/11/10
			0.54	5/18/10
			5.11	12/13/10
			10.25	1/06/12
Sideoats grama	*Bouteloua curtipendula*	9066605	63.84	1/19/06
			36.34	1/23/07
			117.14	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*
			1.02 Bulk	No test*

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

Field 13: CCNP Blue Grama Seed Production Field

Field 24S: CCNP Purple Threeawn Seed Production

Southeast Utah Group– Arches and Canyonlands National Parks

On, August 27, 2010, an agreement between the USDI, National Park Service 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 plant materials produced by the LLPMC to seed identified project areas of the two national parks. Seed of the plant species identified for the reseeding projects will be collected by the park staff and sent to the LLPMC for conditioning; it then will be used to establish seed production fields as specified in the agreement.

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

Arches National Park Accessions			
Common Name	***Scientific Name***	**Plant Symbol**	**Accession Number**
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

Arches and Canyonlands National Park Seed Received by the LLPMC

Arches National Park				
Common Name	***Scientific Name***		**Accession**	**Amount (lbs.)**
Indian ricegrass	*Achnatherum hymenoides*		9066888	4.64
Canyonlands National Park				
Common Name	Park Location	*Scientific Name*	Accession	Amount (lbs.)
Indian ricegrass	Island in the Sky	*Achnatherum hymenoides*	9066907	1.20
Indian ricegrass	Needles	*Achnatherum hymenoides*	9066908	0.34

2011 Accomplishments

The Indian ricegrass received from both Arches and Canyonlands National Parks was tested for germination by the LLPMC in 2011. The LLPMC ran treatments on the Indian ricegrass seed to accelerate the germination process on all of the accessions. These treatments included subjecting the seed to heat, cold, and mechanical scarifications and a combination of the three treatments. The results of these germination tests had rates ranging from 1 to 2 percent for the accessions.

After this low germination was found, the LLPMC decided to send the ricegrass from both Arches and Canyonlands to the New Mexico State University Seed Certification in Las Cruces, New Mexico for a tetrazolium salt stain test. This test indicates a percentage of viability or quality of the seed, but does not indicate a true germination rate. The ricegrass tetrazolium test results for the accessions were found to be between 58 and 71 percent viability.

In consultation with the NPS and with the results of tetrazolium tests, the LLPMC will use the seed received from both Arches and Canyonlands National Parks to do a direct seeding into production fields during the winter of 2011-2012. Direct seeding will allow for soil scarification of the ricegrass seed during the cold winter temperatures.

2012 Accomplishments

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

The following table shows the agreement acreage and the actual amount of acreage that was seeded at the LLPMC:

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	***Scientific Name***	**Park Location**	**Agreement Acreage**	**2012 Acreage**
Indian ricegrass	*Achnatherum hymenoides*	Island in the Sky	0.50	1.20
Indian ricegrass	*Achnatherum hymenoides*	Needles	0.50	0.34

NRCS Cover Crop Study Pecan Orchards

Study Number: NMPMC-T-1101-CP

Using cover crops in pecan orchards is an uncommon practice in the southwestern United States, even though their use is recommended in the *New Mexico NRCS Cover Crop Practice Standard's Manual*. According to the recommendations, cover crops provide the following benefits:

- Reduce erosion from wind and water
- Increase soil organic matter content
- Capture and recycle or redistribute nutrients in the soil profile
- Promote biological nitrogen fixation
- Increase biodiversity
- Suppress weeds
- Provide supplemental forage
- Manage soil moisture
- Reduce particulate emissions into the atmosphere
- Minimize and reduce soil compaction
- Attract beneficial insects (pollinators and parasitoids)

This practice can save the producer money and provide for a cleaner and more sustainable farming operation compared to traditional farming operations.

To demonstrate the value of using cover crops in pecan orchards, the New Mexico USDA Natural Resources Conservation Service (NRCS) conducted a study of three, separate plantings using four types of cover crop treatments. The three study locations are located in area of Anthony, New Mexico, and all of the study sites are owned and operated by the Victor Diaz family: Anthony Pecan Farm, Dilaso Farm, and the Los Nogales Farm.

See the following table to compare the soil type, canopy density, and age of the stand of pecan trees at the three study sites:

Study Site	Soil Type	Canopy Density	Stand Age (yrs.)
Anthony Pecan Farm	Anthony-Vinton fine sandy loam	Medium	20
Dilaso Farm	Glendale clay loam to silty clay loam	None	3
Los Nogales Farm	Harkey loam	Medium	20

Cover Crop Selection and Seeding Rates

The following variety of cover crops was selected for their potential to do well in this area:

Cover Crop Variety	Bulk Seeding Rate
'Durana' white clover	15 lbs/acre
'El Lucero' New Zealand white clover	15 lbs/acre
Foxtail prairie clover (New Mexico native)	15 lbs/acre
Cocktail Mix composed of:	
'El Lucero' New Zealand white clover	5 lbs/acre
'Lana' Woolypod vetch	5 lbs/acre
Max-Q fescue	20 lbs/acre

- 'Durana' white clover, a perennial legume, was selected because it has been successfully used as a cover crop in pecan orchards in the Las Cruces, New Mexico and the El Paso, Texas areas (Val Ryan with Pennington Seed, Inc., personal communication 2011).
- 'El Lucero' New Zealand white clover is a perennial legume and has been a persistent cover crop that was seeded under the canopy of fruit trees at the New Mexico State University Los Lunas Agricultural Science Center (LLASC).
- Foxtail prairie clover, an annual legume and a New Mexico native, was originally collected in the Silver City, New Mexico area and has been very easy to establish the NMSASC. Where it has been established, it has naturally reseeded itself annually to a solid stand.
- Cocktail Mix included a tall fescue and a woolypod vetch. Tall fescue, because of its performance, has historically been the most popular irrigated pasture and hay crop species, and it has some shade tolerance characteristics. The woolypod vetch, an annual species, has been commonly used as a cover crop in California vineyards. This annual species also aggressively reseeds itself annually.

Preparing the Soil and Seeding the Plots

To prepare the soil surface for seeding, we used three pieces of equipment: a drag-harrow, a ridged cultipacker, and a water filled lawn roller, depending upon the site's soil condition. We used the drag-harrow to break-up hard surface soil, the cultipacker to break-up dirt clods and smooth out the soil surface, and the lawn roller to firm-up the soil surface in preparation for the seeding.

We seeded all of the plots using a *Great Plains, Land Pride Solid Stand Seeder* (a Brillion-like seeder) which has a 6-ft. seeding swath. The seedbed at each location was prepared so the required ¼-inch seeding depth was consistent among the three sites (Figure 1). We took soil surface samples (6 in. depth) and subsurface samples (24 in. depth) at each location to measure the active carbon which is an indicator of soil biological activity and reflects the soil health. The plot layouts for each farm are presented (Pages 29, 30, and 31).

Figure 1: Rudy Garcia checking seeding depth after one pass with the seeder.

Anthony Pecan Farm – Seeded April 4, 2011

The pecan trees on the Anthony Pecan Farm are spaced on 30 ft. centers. Prior to seeding, the farm staff applied approximately a ½-inch of fine pecan wood chips to the soil surface. Each plot consisted of two 18 ft. wide strips centered between two 750 ft. tree rows (Figure 2). Plot size was approximately 0.62 acres. The plots were oriented in the direction of the irrigation water flow (west to east). Each plot required six passes with the seeder. After seeding, a tractor-towed lawn roller (24-in. diameter x 36-in.long) filled with water (approximately 600 lbs.) was used to compact the soil over the seeding to achieve good seed-to-soil contact. The orchard was flood irrigated on April 5, 2011(Figure 3).

Figure 2: Keith White operating the Land Pride solid stand seeder to install the seeding at the Anthony Pecan Farm (April 4, 2011).

Figure 3: Surface flood irrigation was applied on April 5, 2011 at the Anthony Pecan Farm.

Seedling emergence was observed seven days later on Monday, April 11, 2011 (Figure 4).

Figure 4: Seedling emergence at the Anthony Pecan Farm (April 11, 2011)

Dilaso Farm – Seeded April 5, 2011

The pecan trees on the Dilaso Farm are spaced on 25-ft. centers. Prior to seeding, the site was cultivated to remove the soil surface cracks that commonly form during drying on this type of soil (Glendale clay loam to silty clay loam). After cultivating, the soil was too moist to seed, and so it was allowed to dry for approximately two hours. Each study plot consisted of one 12 ft. wide strip centered between two 1,500 ft. tree rows. Plot size is approximately 0.41 acres oriented in the direction of the irrigation water flow (east to west). To prepare a firm seed bed, we used a ridged cultipacker (15 in diameter .x 72 in. long) to break up the soil clods in the plot area. The application of a lawn roller followed, which was used to compact the soil surface to create a firm seedbed. Seeding required two passes with the seeder. Next, the lawn roller was applied a second time to firm-up the soil over the seeding in order to achieve good seed-to-soil contact (Figure 5). The planting was irrigated the next day (Wednesday, April 6, 2011).

Seedling emergence was observed seven days later on Wednesday, April 13, 2011, but the seedlings were dying as quickly as they were emerging.

Figure 5: Alfred Ramos pulling the lawn roller to firm the soil after seeding to achieve good seed-to-soil contact at the Dilaso Farm (April 5, 2011).

Los Nogales Farm – Seeded April 6, 2011

The pecan trees on the Los Nogales Farm are spaced on 30-ft. centers. Prior to seeding, the farm staff applied approximately ½-inch of fine pecan wood chips to the soil surface. Beneath the wood chips, the soil surface was harder than it needed to be for a firm seedbed, so it was cultivated with a drag-harrow (Figure 6) at approximately a 2-in depth (just above very moist soil in the profile). The moisture was residue from a previous irrigation. Each study plot consisted of two 18 ft. wide strips between two 900-ft. tree rows. Plot size is approximately 0.74 acres and oriented in the direction of irrigation water flow (east to west). After cultivating, the lawn roller was applied to compact the soil surface to create a firm seedbed. Seeding required three-passes with the seeder. The lawn roller was applied a second time to achieve good seed-to-soil contact. This location, similar to the others, was irrigated the next day. It was irritated again on April 25, 2011.

Figure 6: Applying the drag-harrow to loosen the hard soil surface at the Los Nogales Farm (April 7, 2011).

Discussion

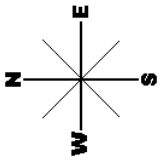
The *Great Plains, Land Pride Solid Stand Seeder* (a brillion-like seeder) is a type of surface broadcast seeder with a roller drum *without* precision depth control. Seeding depth is controlled by preparing the soil surface which needs to be firm to prevent the seed from being deeper than the recommended ¼-inch depth. To acquire the proper soil surface firmness, the pre-seeding activities (as previously described) were performed. However these activities do not necessarily provide the ideal soil firmness. To compensate for possible improper seeding depth, soil cracking, incorrect irrigation intervals, and other unforeseen problems, we tripled the seeding rate to help ensure a dense cover crop stand for our first study in this area. However, once the selected cover crop species and varieties have been shown to be successful in the Anthony area, seeding rate studies should be done with the actual equipment that will be used for seedbed preparation and seeding; both to reduce future seed cost and ensure an adequate stand of vegetation.

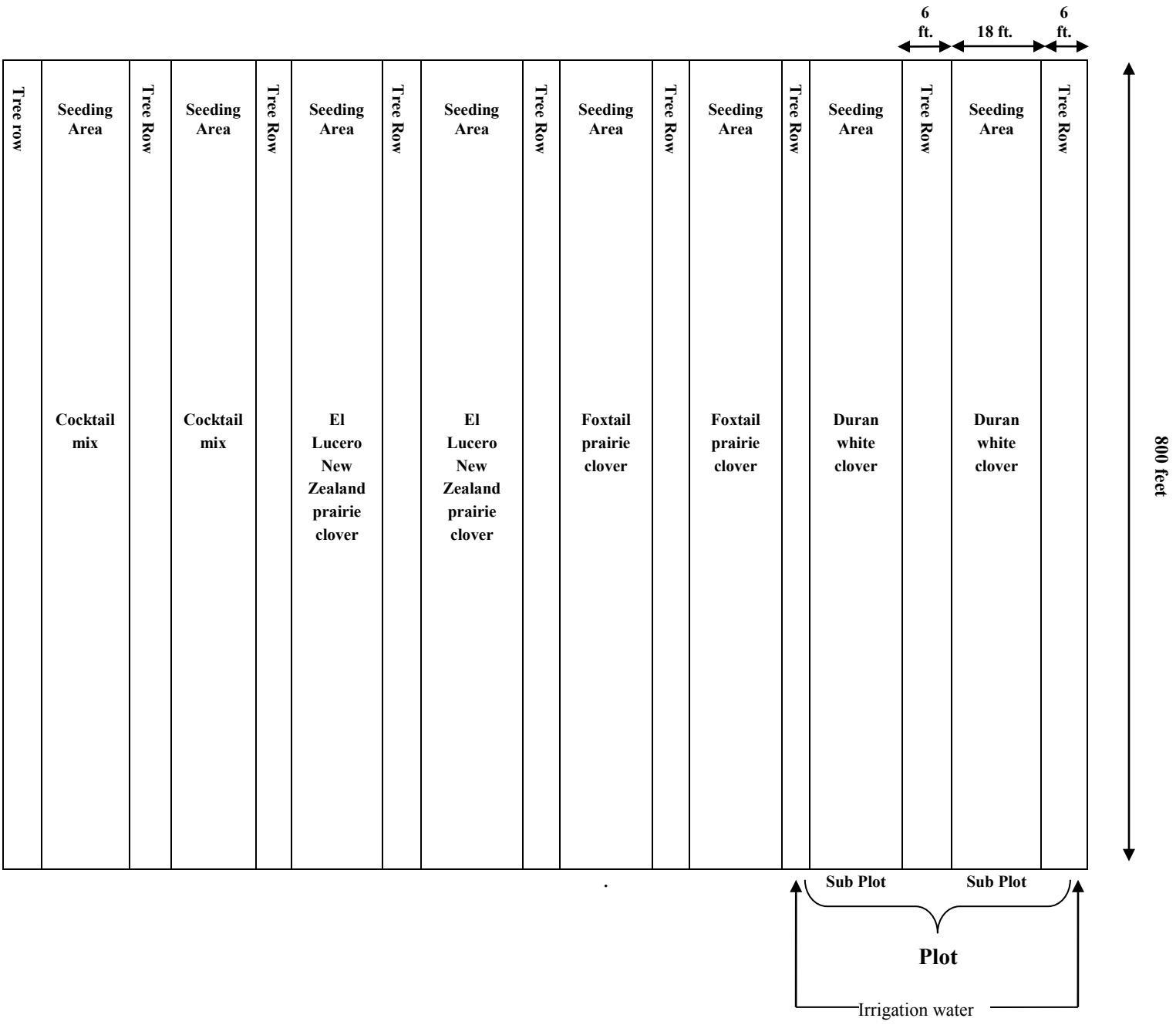
An unexpected soil condition encountered at the Dilaso Farm was the extreme surface cracking as the soil dries after an irrigation application (Figure 7). This tends to inhibit seedling establishment as the seedling roots became exposed. For the first three to four weeks, a possible solution may be to keep the planting wetter than normal to help reduce the amount and the depth of the cracking. Once the seedlings' root systems are below 4-inches (the active evaporation zone), the seedlings may be able to tolerate the cracking of the soil surface and can then receive regular irrigation intervals.

Figure 7: Cracked soil surface at the Dilaso Farm five days after irrigation (April 13, 2011).

This fine tuning needs to occur on each farm to determine the best practices to save resources.

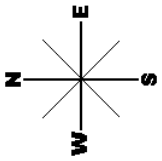
Anthony Pecan Farm Plot Plan

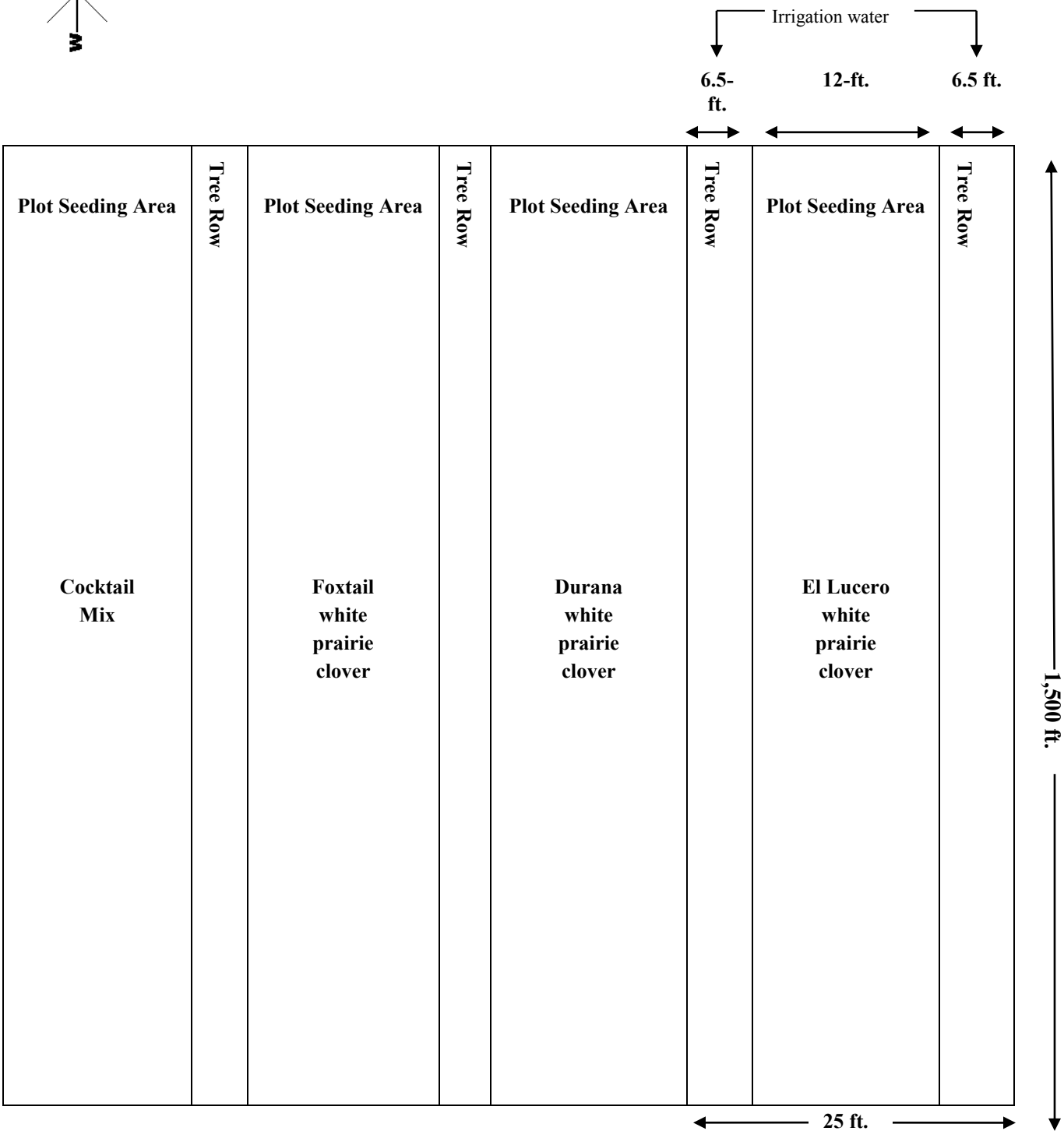




Each sub plot received three passes with the seed drill

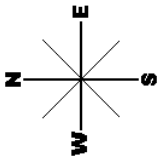
Dilaso Farm Plot Plan

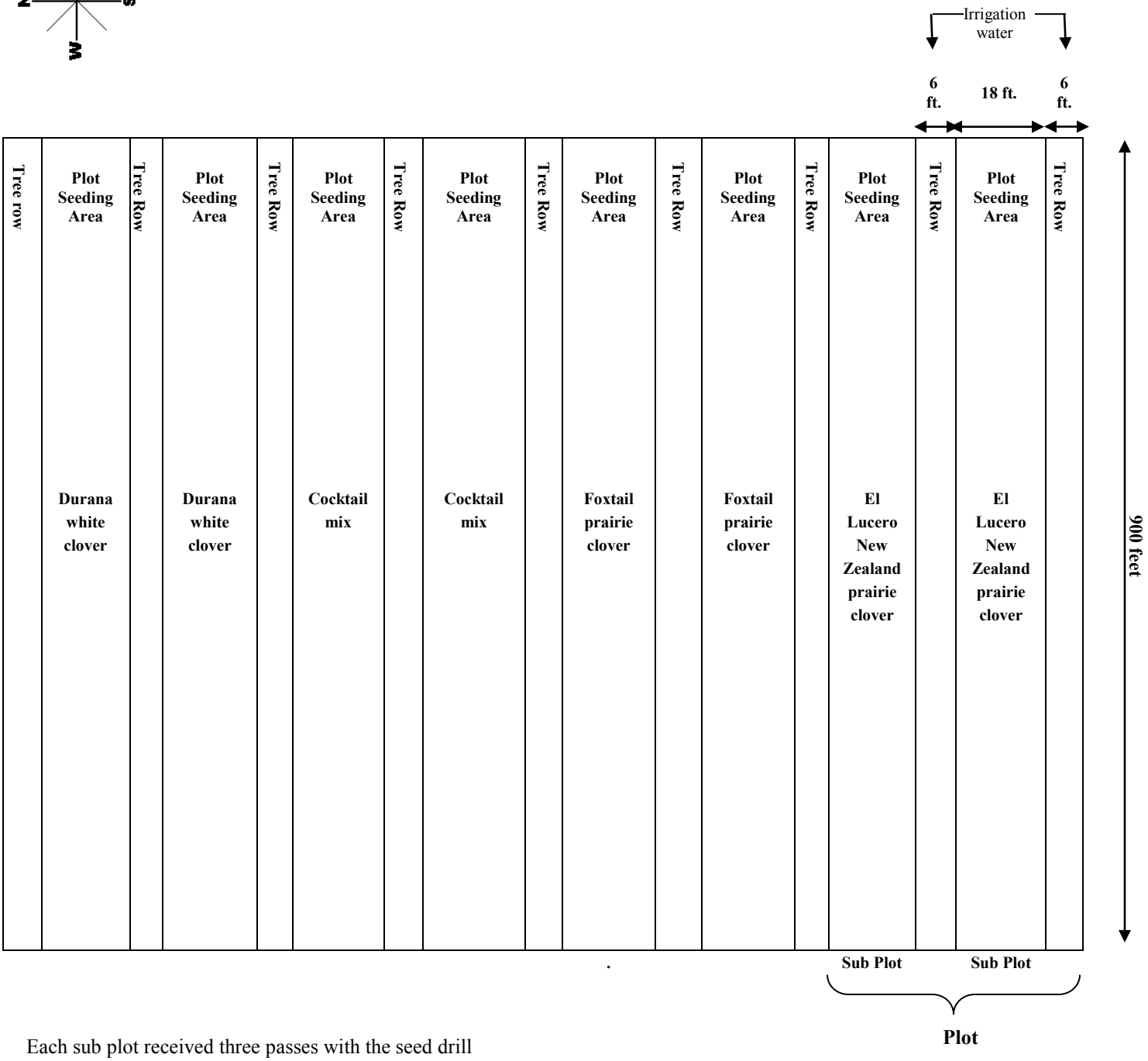




Each plot received two passes with the seed drill

Los Nogales Farm Plot Plan





Each sub plot received three passes with the seed drill

Bureau of Land Management Evaluation of Priority Native Species for Restoration Purposes

Study Number: NMPMC-S-1101-RA

The BLM and other land management agencies are in need of native species for restoration purposes in the Desert Southwest. The availability of desired species in the commercial market is negligible. When available species are found in the market, they are extremely expensive, and the source or origin is often unknown. It is the goal of the NRCS and BLM to determine the potential for commercialization of various priority species (grasses, forbs, shrubs) by conducting seed production studies. These studies are conducted under agronomic conditions to improve the availability of native species in the commercial market for restoration purposes.

Seed of several species was provided by BLM to NRCS as part of a 2009 agreement:

- 1.9 g of prairie coneflower (*Ratibida columnifera*)
- 0.3 g of primrose (*Oenothera pallid*)
- 6.1 g of scarlet gilia (*Ipomopsis aggregate*)
- 0.6 g of scarlet globemallow (*Sphaeralcea parviflora*)

Additionally, the BLM and the LLPMC collected seed of wild rhubarb (*Rumex hymenosepalus*). The LLPMC also collected bluebunch wheatgrass (*Pseudoroegnaria spicata*), and desert needlegrass (*Achnatherum speciosum*) for potential application within the same region of interest.

Status and Strategies

Prairie Cone Flower

In 2010, the prairie coneflower seed from Coconino County, Arizona was harvested using a combine (0.44 lbs. bulk lbs.) from the ½ -acre seed production field at the LLPMC. In September 2011, an additional ½ -acre seed production field was established. We expect to harvest more than 20 lbs. of seed in December 2011. The seed does not shatter upon ripening, but it is held in the floral capsules, and is very easy to clean. At of the end of 2011, the prairie coneflower has been found to be well adapted to commercial production.

There should be a sufficient amount of the prairie coneflower seed for the single source collection, from Coconino County, Arizona to be moved into commercial channels in FY 2013. Moving material into commercial production would consist of a focused outreach to all potential growers, the provision of enough seed to establish a minimum of a ½ -acre block, and offer technical assistance by the LLPMC to those growers. In addition to seed harvest, we will need to conduct additional studies to evaluate the effect of fertilization on seed yields.

Options:

1. Proceed with no expansion of production field
2. Proceed with expansion of production field
3. Stop seed production activity and begin multi-accession common garden study
4. Select options 1 and 3
5. Select options 2 and 3
6. Cease further work with the species

Newly planted ½-acre prairie coneflower seed production field.

Second-year prairie coneflower ½-acre seed production field

Primrose

No seed was produced in 2010. Currently there are 30 plants in production which were harvested for seed in early October 2011. This seed may be used to produce transplants for a new seed production field.

Options:

1. Proceed with seed production field
2. Stop seed production activity and begin multi-accession common garden study
3. Both, or
4. Cease further work with the species

Second-year primrose plants (30) grown in raised beds at the LLPMC.

Scarlet gilia

These plants are in poor condition with only 40 plants remaining in the ⅓-acre seed production field. The plants produce very small seed capsules with very tiny seed that shatters as it ripens. This species does not seem to be adapted to farm production. When applying the standard type of flood irrigation in sandy soils, it easily succumbs to root-rot as it did at the LLPMC.

Second-year scarlet gilia plants (⅓-acre)

The scarlet gilia was less successful becoming established than the other species. Additional work is needed to determine propagation and production protocols.

Options:

1. Perform extensive literature review on establishment and propagation protocols, apply protocols, evaluate agronomic potential, and then decide next steps
2. Stop working with species at this time

Scarlet globemallow

Two, 300 ft. rows of plants from Kane County, Utah were harvested for seed in November 2011. Only a few grams of seed were achieved from the cleaning process. Seed production may be meager since these were first year seedling plants.

Second-year scarlet globemallow plants (two 300 ft. rows)

This single-source collection of scarlet globemallow from Kane County, Utah, appears to be well adapted to commercial production. A sufficient amount of seed could be ready for commercial production by 2014 if we expand this field to ½-acre in 2012. Moving material into commercial production would consist of a focused outreach to all potential growers, the provision of enough seed to establish a minimum of a ½-acre block, and offer technical assistance by the LLPMC to those growers. In addition to seed harvest, we would need to conduct additional studies to evaluate the effect of fertilization on seed yields. Interest was expressed by BLM representatives in developing multi-accession populations for both the Colorado Plateau and the Chihuahuan desert region.

Options:

1. Proceed with field increase
2. Stop seed production activity and begin multi-accession common garden study
3. Both
4. Cease further work with the species

Wild Rhubarb

In May 2010, together the BLM and the LLPMC collected seed of this species in San Juan County, New Mexico. Transplants propagated from this seed were grown at the LLPMC and then established into two separate, ⅓-acre seed production fields. The plants had begun to produce heavy seed stalks by fall of 2011.

Based on seed production in the fall of 2011, this species has shown itself to have a potential for commercial production.

Options:

1. Proceed
2. Stop seed production activity and begin multi-accession common garden study
3. Both options 1 and 2
4. Cease further work with the species

Second-year wild rhubarb (*Rumex hymenosepalus*) seed production field (shown is ⅓-acre of the ⅔-acre seed production field).

Wild rhubarb (*Rumex hymenosepalus*) seed stalks are developing by fall of the second year after planting at the LLPMC

Desert Needlegrass and Bluebunch Wheatgrass

Seed of both species was originally collected in the Farmington, New Mexico area in 2008. Currently there are 20 lbs. of desert needlgrass seed and 7 lbs. of bluebunch wheatgrass seed. We currently have a ½-acre seed production field for each of these species.

Fourth-year desert needlegrass on the ½-acre seed production field

Second-year bluebunch wheatgrass ½-acre seed production field

The desert needlegrass and bluebunch wheatgrass, both collected from Farmington, New Mexico, should have a sufficient amount of seed available for their potential release to commercial growers by 2013.

Options:

1. Proceed
2. Stop seed production activity and begin multi-accession common garden study
3. Both
4. Cease further work with the species

Cottonwood (populous angustifolia)

Cottonwood seedlings (900) were produced at the LLPMC to establish a cutting production field. Germplasm from San Juan, La Plata and Tularosa counties was used to produce 300 seedlings of each.

First-year cottonwood seedlings from San Juan, and Otero counties in New Mexico.

Boulder County Big Bluestem

Study Number: NMPMC-S-0701-OT

Big bluestem is a native, warm-season, perennial bunchgrass commonly found in prairies, dry soils, open wooded areas in the southwest, and in zones that receive more than 14 inches of annual precipitation. This species is an excellent forage species that is highly palatable to all classes of livestock and elk. It does however, become coarse in texture late in the season.

In September of 2006, big bluestem (*Andropogon gerardii*), Accession number 9066730 seed was collected by the Boulder County Parks Department and sent to the NRCS Los Lunas Plant Materials Center (LLPMC). The intent was to establish a one-third acre seed production field.

On June 21, 2007, the LLPMC began to produce big bluestem transplants by hand seeding 5,000 plug cells (¾" x ¾" x 2 ½"). 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 (17-6-12) was added per four-cubic feet of the plug soil mix.

After nine days, most of the seed had germinated and seedlings had emerged. The seedlings were placed on a bench and kept damp with an automated sprinkler system for three weeks. They were then moved to the nursery to harden off and continue growing for an additional four weeks.

On August 2, 2007, the transplants were planted into the one-third-acre seed production field (Field 16) at the LLPMC.

Boulder County big bluestem with seed in dough state (August 2008)

Boulder County big bluestem initiating flowering (July 2011)

Field Maintenance

The seed production field was hand-hoed approximately once every three weeks during the growing season (April – November). Other field maintenance activities for 2007, 2008, 2009, and 2010 are described in the following tables:

2007 Activities					
Activity	**08/02**	**08/10**	**08/23**	**09/10**	**10/26**
Irrigation	2"application	2"application	2"application	2"application	2"application
Fertilized	70 lbs. Nitrogen 40 lbs. Phosphorus				

2008 Activities						
Activity	**02/19**	**04/01**	**05/05**	**06/07**	**07/02**	**07/25**
Irrigation		2”application	2”application	2”application		2”application
Fertilized	40 lbs. Nitrogen 40 lbs. Phosphorus					40 lbs. Nitrogen
Herbicide					2,4-D	

2009 Activities					
Activity	**03/25**	**04/25**	**06/01**	**06/26**	**07/29**
Irrigation	2”application		2”application	2”application	2” application
Fertilized		40 lbs. Nitrogen 40 lbs. Phosphorus			
Herbicide	2,4-D + Pendulum				

2010 Activities					
Activity	**03/25**	**April**	**05/04**	**06/02**	**July**
Irrigation	3”application		3” application	3” application	
Fertilized	40 lbs. Phosphorus			40 lbs. Nitrogen	
Herbicide	None applied				
Activity	**August**	**09/07**	**October**	**November**	**December**
Irrigation		3” application			
Fertilized			40 lbs. Nitrogen		
Herbicide	None applied				

To maintain seed purity, the seed production field is managed by adhering to foundation seed standards. Subsequently, the field is inspected in July by New Mexico State University Crop Improvement Association for the isolation and absence of noxious weeds.

The seed is harvested using a combine in August or September depending on the year. The seed is then placed on an air drying table for processing and to prevent molding. During the winter the seed is cleaned and tested for purity and viability by New Mexico State University Seed Certification in Las Cruces, NM.

Results

The seed yield and lab results are listed for years 2008 – 2010 in the following table. The very low harvest in 2010 was primarily due to the indeterminate ripening of the seed. As the seed ripens unevenly, it shatters from the inflorescence. Consequently, most of the seed that is harvested is often immature and is lost in the cleaning process. The 2011 crop had extreme indeterminate ripening as well, and subsequently, the seed was harvested biweekly in August and September with a Flail-Vac seed harvester. This harvester only removes ripe seed and leaves the immature seed intact. The very last harvest was done with a combine. Even with this effort, only 4.6 bulk pounds of clean seed was harvested. Consequently and at the request of the cooperator, this planting has been terminated.

Boulder County Big Bluestem Seed Yield and Analysis							
Year	**Bulk Wt. (lbs.)**	**% Other Crop**	**% Inert Matter**	**% Weed Seed**	**% Germination**	**% Pure Live Seed**	**Pure Live Seed Wt. (lbs.)**
2008	58.2	0	7.5	0	68	63.2	36.8
2009	37.3	0	27.9	0	94	67.8	25.3
2010	11	0	35.2	0	64	41.5	4.6
2011	4.6	6.2	7.6	0	74	86.1	63.7

The National Hispanic Cultural Center
'Longstem' Deep Planting Methodology

Study Number: NMPMC-T-1001-RI

The Natural Resources Conservation Service (NRCS) Los Lunas Plant Materials Center (LLPMC) and the Ciudad Soil and Water Conservation District (SWCD) planted 380 'longstem' understory native shrubs in the Rio Grande Bosque directly behind the National Hispanic Cultural Center (NHCC) located at 1701 4th St. SW, Albuquerque, New Mexico. The study site is owned by the Middle Rio Grande Conservancy and managed by the City of Albuquerque Open Space. This location serves as a study area for students from Environmental Sciences classes conducted by the NHCC. The project received funding from Senator Bingaman's program for the control of non-native phreatophytes and Rio Grande Bosque watershed restoration.

This study planting will improve wildlife habitat and recreational opportunities by increasing the native plant diversity; thereby creating a healthier, native, phreatophyte understory plant community. The existing understory species of Siberian elm, tree of heaven, Russian olive and saltcedar are all on the New Mexico "Class C" noxious weed list according to the *National Plant Board 2007*. In addition, this study planting provides the LLPMC with an opportunity to test the types of plant materials used, and test a new modification to the *'Longstem' Planting Method*. This modification was our first attempt to plant 'longstems' while they were actively growing in September instead of waiting for dormancy in November. There are many higher-elevation locations in New Mexico where by November there can be a significant amount of snowfall which can make it difficult to access and plant at higher-elevation areas.

The NHCC study site has a 4- to 8-foot water table that can support established, native riparian pheatophytic vegetation. But because of flood control structures and flow regulation, the surface water hydrology has been altered, and as a result, has disconnected this site from the flood plain eliminating overbank flooding. For the recruitment of new seedling stands of common native obligate riparian species such as cottonwoods, willows, New Mexico olive, indigo bush, false willow, and golden currant, supplemental water from overbank flooding is critical. These species require more than twice the amount of water than can be naturally provided in this hot, desert climate.

Methodology

The establishment of obligate, riparian woody plants requires either lengthy irrigation until the transplant's root system can extend into the permanent soil moisture above the water table (capillary fringe), or by using planting techniques that allow immediate or rapid root extension into the water source by utilizing deep planting methods such as the '*Longstem' Planting Methodology* developed by NRCS New Mexico. This method allows for planting riparian woody species with minimal or no follow-up irrigation, improving survival rates, and reducing long-term revegetation costs.

The '*Longstem' Planting Methodology* involves placing the lower portion of the root ball of a 'longstem' transplant in contact with the capillary fringe of the water table. This should be done in the fall when the evapotransporation demands for plants are reduced. Often this requires that the root crown of a transplant be buried as deep as 4 to 6 feet. By spring, new adventitious root growth will be initiated on the main stem of the plant, just below the soil surface providing oxygen to the root system. At time of planting, a 40-inch long x 1-inch in diameter watering tube is embedded with each plant. If the capillary water drops beneath the rootball, supplemental water can be provided until the root system once again becomes in contact with capillary water. When a root system becomes disconnected from capillary water, the leaves of the plant will show immediate symptoms of drought as they wilt and desiccate. If a plant is placed too deep in the soil and the water table submerges the entire root ball, the leaves of the plant will display yellowing or chlorosis. If this soaking persists longer than 3 to 4 weeks, it may kill the plant.

Site Preparation and Planting

The NHCC planting area totals approximately 7 acres. In the winter of 2009, a private contractor first cleared the area using a Hydro Ax to masticate the standing exotic preatophytes of Russian olive, tree of heaven, Siberian elm, and saltcedar. The stumps of these tree species were treated with Garlon®4 herbicide immediately after mastication to control resprouting of the vegetation. In July 2009, the LLPMC staff retreated the resprouting of the exotic phreatophytes with a basal stem application consisting of 61% triclopyr (Garlon®4 herbicide) mixed with a 75% dilution of vegetable oil. By the end of August 2009, the standing dead trees were chipped mechanically and left in place as a surface mulch.

All of the 380 longstem transplants were grown in one-gallon, 14-inch treepots. Producing these transplants from linear stock takes 2–3 years, or 3– 4 years from seed. To achieve a 6–to 9-foot height, the plants were kept well-fertilized and irrigated during the growing process.

A riparian restoration workshop was hosted by the SWCD to provide exposure and training of this new, inexpensive, and very effective planting methodology. The participants of the riparian workshop did the majority of the planting. The planting holes were prepared using a 9-inch by 8-foot auger attached to a front-end loader on a 65-hp farm tractor (Figure 1). The longstem transplants were then were placed into 5- to 8-ft. deep holes depending upon the depth to capillary water (Figure 2). The holes were then backfilled and packed with hand shovels. A 40-inch section of scheduled 20 PVC, thin-walled, perforated pipe (perforated along the bottom one-third of the pipe) was inserted into the hole next to the transplant. The pipe was used as a flag to locate the transplants to distinguish them from any volunteer plants, and to provide irrigation at root crown depth in the event watering was needed. Single species transplants were planted in groups of 5 to 20 to simulate how they would be found in the natural landscape (Figure 3). They were also planted in areas that were cleared of the exotic woody vegetation to reduce the competition of already established vegetation. This planting never received any supplemental irrigation.

Figure 1: A 9-inch by 8-foot auger attached to a front-end loader on a 65-hp farm tractor. LLPMC planting staff Keith White (seated in tractor), and (left to right) Bobby Harris, Joe Aragon, Greg Fenchel and Alex Taylor.

Figure 2: Indigobush (center) as with other species, are planted in groups of 5–20 plants to simulate how they naturally occur.

Figure 3: Volunteer George Duda deep planting indigobush 'longstem' treepot 6 feet below the soil surface.

Results and Discussion

The planting was evaluated for survival on October 8, 2010. Rainfall for the site during the 14-month establishment period was almost normal (approximately 11 inches). Precipitation information was obtained approximately 10 miles northwest of the planting site from the National Weather Service Forecast Office at the Albuquerque International Airport (see the following table).

Monthly Precipitation for the Time Period Ending of Planting to Evaluation (inches) [3]				
Year	**Month**	**Accrual**	**Normal**	**Deviation from Normal**
2009	September	1.42	1.07	+0.35
2009	October	1.51	1.00	+0.51
2009	November	0.04	0.62	-0.58
2009	December	0.15	0.49	-0.34
2010	January	0.64	0.49	+0.15
2010	February	0.17	0.44	-0.27
2010	March	0.40	0.61	-0.21
2010	April	0.58	0.50	-0.08
2010	May	0.04	0.60	-0.56
2010	June	0.76	0.65	+0.11
2010	July	2.19	1.27	+0.92
2010	August	0.95	1.73	-0.78
2010	September	1.88	1.07	+0.81
2010	October	0.26	0.74	-0.48

[3] From the National Weather Forecast Office, 2341 Clark Carr Loop SE, Albuquerque, NM

Monthly Precipitation for the Time Period Ending of Planting to Evaluation (inches) [3]				
Year	**Month**	**Accrual**	**Normal**	**Deviation from Normal**
Total		**10.99**	**11.28**	**-0.29**
Normal Annual Rainfall	**9.88**			

Of the original 380 transplants, we located 336 of them or 88 percent (see the following table). Many of the transplants were difficult to locate because their watering tubes had been removed by an unknown source. Of those located, there was a 97 percent survival rate, and because they were planted in a very dry environment, it is probable that the capillary water enabled them to survive and quickly grow.

Survival of 'Longstem' Transplants after Two Growing Seasons –National Hispanic Cultural Center, Albuquerque, New Mexico				
Common Name	**Scientific Name**	**Alive**	**Dead**	**Percent Survival Rate**
Emory baccharis	*Baccharis emoryi*	66	4	94
Golden Current	*Ribes aureum*	11	0	100
Indigo Bush	*Amorpha fruiticosa*	66	2	97
New Mexico Olive	*Forestiera pubescens*	150	3	98
Skunkbush Sumac	*Rhus trilobata*	19	2	90
Wolfberry	*Lycium torreyi*	13	0	100
Total		**325**	**11**	**97**

More than two feet of new annual growth was observed on many of the New Mexico olives and the *Emory baccharis* (Figures 4 and 5). The early September planting did not affect the survival of the longstem shrubs (97%). The planting will be evaluated for survival once more in 2012.

Figure 4: New Mexico olive (center) displayed more than 2 feet of current year's growth on its main stem.

Figure 5: Emory's baccharis displayed more than 2 feet of current year's growth on its main stem.

Additionally, a New Mexico olive was found under a mature, fallen cottonwood tree, but it still displayed aggressive vigor with more than 3 feet of growth measured on many of its new branches as it grew out from under the tree (Figure 6).

Figure 6: New Mexico olive transplant (center) crushed by fallen cottonwood is resprouting from base of the log.

Figure 7: Russian olive resprouts are beginning to dominate some areas of the planting

A future treatment with herbicide may be necessary in the south area of the planting site to control the resprouting of exotic understory species that are competing with the newly established native plants for light, water, and nutrients (Figure 7).

NMDOT Cooperative Agreement Project Planting Specifications for Sites Disturbed by Roadside Construction Projects in Region 6

Study Number: NM-PMC-T-0502-OT

The *1992 NMDOT Roadside Revegetation and Maintenance Handbook* was a result of a Joint Powers Agreement between the NMDOT and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), and it contains all of the elements required to produce a high-quality, revegetation project. In 2005, the NMDOT reviewed the planting specifications outlined in the handbook to determine if any revisions were needed. As a result, an update to the agreement was deemed appropriate and in 2005, the NMDOT initiated a new agreement with the USDA-NRCS Los Lunas Plant Materials Center (LLPMC) to complete the update.

The 2005 Cooperative Agreement between the LLPMC and the NMDOT includes three phases of operation:

- **Phase One***:* Research. Review the existing planting specifications and the proposed planting specifications outlined in the *1992 NMDOT Roadside Revegetation and Maintenance Handbook* in order to recommend the correct revegetation methods for sites that have been disturbed by roadside construction projects.
- **Phase Two**: Methods. Monitor the project sites and install the recommended species of seed and seed mixes, and apply the recommended fertilizing and mulching techniques.
- **Phase Three:** Results. Evaluate the seeding and mulching trials; produce summary and progress reports.

Phase One – Review the Existing Planting Specifications

The planting specifications currently being used by the NMDOT for revegetation projects on sites that were disturbed by roadside construction projects contains all of the elements to produce average or above-average results. The recommended species and seed mixes in the *1992 NMDOT Roadside Revegetation and Maintenance Handbook* are adapted to the project sites' soil and climatic conditions.

Species selection is based on where they naturally occur across ecological land units referred to as "ecological sites." An ecological site is an area of land having a combination of soil, climate, topographic, and natural biotic factors that is significantly different from adjacent areas. Individual plant species have different but overlapping environment requirements for establishment and growth, and occupy specific ecological sites across New Mexico.

Land Resource Units (LRAs) are geographic areas, usually of several thousand acres that are characterized by a particular pattern of soil, climate, water resources and land uses, and they are composed of several similar ecological sites. LRAs that are geographically associated are grouped and referred to as Major Land Resource Areas by the USDA, Natural Resources Conservation Service (NRCS). The USDA-NRCS has categorized New Mexico into nine Major Land Resource Areas (MLRAs). The *Handbook* outlines seven MLRAs in New Mexico and recommends a seed mix for each MLRA with consideration to soil and climatic conditions. Seven seed mixes for a diverse state like New Mexico (composed of mountains, valleys and deserts) is few, but for practical application, compromises must be made. Once a seed mix is planted, species will become established where they are the most viable. For example, Indian ricegrass will perform the best on sandy soils; alkali sacaton will do best on salty soils; galleta is the best on clay soils, and so forth. The species recommended in the handbook were modeled from *NRCS Standards and Specifications for Critical Area Plantings*. They can be reviewed at http://www.nm.usda.gov/technical/fotg/section-4/std-spec.html.

The recommended seed mixes for the different MLRAs contain many of the same species, but they are composed with different proportions of species depending on the species suitability to the MLRA. For example, if a site is located in the southern New Mexico desert MLRA, xeric species would be recommended at a higher seeding rate (such as galleta, Indian ricegrass, and alkali sacaton). In the MLRA for the northern mountains of New Mexico,

mesic species would be favored in the seed mix (such as western wheatgrass, mountain brome, and Arizona fescue).

For the project sites detailed in this report, NRCS recommended the following:

- Exclude all of the non-native species from the seed mixes (such as smooth brome, yellow bluestem, Lehmans lovegrass, and Kentucky bluegrass). Even though these species are included in the *NRCS Standards and Specifications for Critical Area Plantings*, they are recommended because they are relatively easy to establish and provide good forage to livestock and wildlife. NRCS plantings are typically located on isolated, private property where there is less of a concern for spreading seed of invasive species. However, when seeding on a right-of-way adjacent to private property, there is a possibility that these species will volunteer on adjacent private lands.
- Fertilize during seeding. This is a recommended practice and is specified in the *Handbook* and in the *NRCS Standards and Specifications for Critical Area Plantings*. It has however, been our experience that fast-growing, pioneer weed species (such as Kochia and Russian thistle) will be the primary beneficiary from this treatment and will be more competitive for light, nutrients, and water than the seeded vegetation. But once seedlings are in the third and fourth leaf stage, then fertilization may be appropriate depending on the results of a soil test. Commonly, water is the limiting factor for growth rather than nutrients in the Southwest. Native grasses seem to tolerate low fertility and may grow slow with or without fertilizer.
- Mulch the seeding project sites. The *Handbook* discusses the use of mulch in seeding and further states "that without mulch, a seeding has a less than 50% chance of success." The application of mulch to a seeding extends the duration of adequate soil surface moisture between rainfall events which is critical when seeding in the desert and semi-desert areas. It can take 15 to 25 days of moist soil surface conditions to establish seedlings. Generally, once seedling roots get below a 4-inch depth, they are no longer affected by surface evaporation and can become established. Mulching materials may include hay, straw, wood fibers (hydro-mulching), erosion control mats and wood chips which we are currently testing.

Cooperative Planning

The LLPMC in cooperation with the NMDOT planned the revegetation projects by:

- Selecting projects sites that were at least one acre in size
- Providing clear and distinguishable markings for the project sites
- Completing the planting of the project sites
- Mulching all of the planting sites as part of the revegetation process. The NMDOT agreed to provide mulch thereby fulfilling the obligations of the 2005 Cooperative Agreement.
- Providing the NMDOT with reports on the inspection of planting trials, site location documentation, before and after site conditions, and weather conditions at the time of planting.

Selecting the Project Sites

On March 7, 2006 and March 16, 2006, the LLPMC and NMDOT personnel investigated several possible project sites. The following two sites were selected:

- State Highway 602 just south of Gallup, New Mexico
- Highway 550 northeast of San Ysidro, New Mexico

Highway 602 Project Site, Gallup, New Mexico

This site had the characteristics needed for a planting as outlined in the 2005 Cooperative Agreement. It is located near mile post 24 south of Gallup, New Mexico, and situated along the 602 right-of-way where part of the acreage

overlaps the Navajo reservation. The site is one-acre in size at an elevation of 6,750 feet. It is located in Major Land Resource Area 36, New Mexico and Arizona Plateaus and Mesas, Common Resource Area, Western Plateau (WP-1).

Highway 602 Site Pre-Treatment-Conditions:

Road construction at the site had been completed, and the site was immediately available for installation of the planting. The site was completely void of any vegetation as a result of the NMDOT replacing and extending a drainage pipe to protect the roadway. Soils on the site were compacted and had been left in a fairly level condition. The LLPMC collected soil samples for each site and sent them to the New Mexico State University (NMSU) Soil and Water Analysis Laboratory. This site has the typical soil found in Region 6 and considered adequate for revegetation. The soil had:

- High water-holding capacity (sandy clay loam texture), good nutrient availability (Ph 7.63)
- Low amounts of sodium and other salts.
- Unusually high concentrations of iron and zinc for the Southwest.

Highway 550 Project Site, San Ysidro, New Mexico

On March 16, 2006, the LLPMC and NMDOT looked at a road construction site located at mile post 30 on Highway 550 just northwest of San Ysidro. The site was located on the Highway 550 right-of-way and was the result of an erosion control construction project on the Arroyo Penasco that flows alongside the highway. In a discussion with Region 6 NMDOT employees, this site became the second project site.

Highway 550 Site Pre-Treatment Conditions:

The site is approximately two-acres in size. After sending soil samples to the NMSU Soil and Water Analysis Laboratory, this site was found to contain a high concentration of salt.

Phase II: Methods

Monitoring Precipitation

For 2007, the NMDOT monitored the monthly precipitation at the Highway 602 project site. For 2008, precipitation information was obtained from the Gallup Municipal Airport.

Precipitation information for the Highway 550 project site was obtained from the Cuba, New Mexico and the Rio Rancho, New Mexico National Climate Weather Stations.

Preparing and Seeding the Project Sites

Prior to mulching and due to the compaction of the soil at the project sites, the soils were conditioned using a drag-harrow. Compost mulch was spread over the project sites using a tractor-mounted, front-end loader and leveled to a three-inch depth over the entire site.

Following the mulching application, the plots were measured and staked for both the grass-mix and single-species planting sites.

The study treatments consisted of three different seed mixes planted at three different seasons of the year. The grass type was matched to the appropriate season for seeding. Therefore, warm-season grasses were seeded in the summer; cool-season grasses were seeded in the fall; and both warm- and cool-season grasses were seeded in the winter (see the following tables).

Summer Seeding Mix

Cultivar	Common Name	Scientific Name	Lot Number	Lbs/acre	% Mix
El Vado	spike muhly	*Muhlenbergia wrightii*	SCD-06-SWSEED	1.0	5
Grant	cane bluestem	*Bothriochloa barbinodis*	SFD-05-F9	2.0	5

Summer Seeding Mix					
Cultivar	**Common Name**	**Scientific Name**	**Lot Number**	**Lbs/acre**	**% Mix**
Hachita	blue grama	*Bouteloua gracilis*	SFD-05-F16	1.5	25
Loetta	Arizona cottontop	*Digitaria californica*	SCO-04-7036	1.0	5
Nogal	black grama	*Bouteloua eriopoda*	SFD-04-F21N	2.0	10
Pastura	little bluestem	*Schizachyrium scoparium*	SFD-05-F19	3.5	10
Salado	alkali sacaton	*Sporobolus airoides*	SFD-03-F15	1.0	5
Vaughn	sideoats grama	*Bouteloua curtipendula*	SFD-05-F19	4.5	25
Viva	galleta	*Pleuraphis jamesii*	SFD-04-F19	2.5	10

Fall Seeding Mix					
Cultivar	**Common Name**	**Scientific Name**	**Lot Number**	**Lbs/acre**	**% Mix**
Arriba	western wheatgrass	*Pascopyrum smithii*	SFD-02-GA	8.0	25
Bannock	streambank wheatgrass	*Elymus lanceolatus*	SCO-04-22W	5.5	5
Garnet	mountain brome	*Bromus marginatus*	SG1-04-UC	4.0	10
Goldar	bluebunch wheatgrass	*Pseudoroegneria spicata*	SCO-05-22E	9.5	10
Paloma	Indian ricegrass	*Achnatherum hymenoides*	SPD-03-f8-f25N	6.0	20
Redondo	Arizona fescue	*Festuca arizonica*	SCO-02-SWSEED	4.0	10
San Luis	slender wheatgrass	*Elymus trachycaulus*	SFD-99-UC3	6.0	10
Tusas	bottlebrush squirreltail	*Elymus elymoides*	SFD-04-F13	12.0	10

Winter Seeding Mix					
Cultivar	**Common Name**	**Scientific Name**	**Lot Number**	**Lbs/acre**	**% Mix**
Arriba	western wheatgrass	*Pascopyrum smithii*	SFD-02-GA	8.0	20
Hachita	blue grama	*Bouteloua gracilis*	SFD-05-F16	1.5	20
Paloma	Indian ricegrass	*Achnatherum hymenoides*	SPD-03-f8-f25N	6.0	20
Redondo	Arizona fescue	*Festuca arizonica*	SCO-02-SWSEED	4.0	10
Salado	alkali sacaton	*Sporobolus airoides*	SFD-03-F15	1.0	5
Tusas	bottlebrush squirreltail	*Elymus elymoides*	SFD-04-F13	4.0	10
Vaughn	sideoats grama	*Bouteloua curtipendula*	SFD-05-F19	4.5	15

The seeding for the mixed-grass plots was done through the 3-inch layer of surface mulch with a Great Plains No-Till Drill and replicated on four 24x30ft plots for each of the seasonal treatments. The coulter discs (cutting disc) of the seed drill penetrated through the light surface mulch down to the mineral soil where the seed was planted at about ½ inch depth in the mineral soil. The seeding rate was 20 pure live seed per sq. ft.

The single species plots were also seeded through the 3-inch layer of surface mulch with a Kincaid Plot Drill. The coulter discs of this seed drill also penetrated through the light surface mulch down to the mineral soil where the seed was planted at a ½ in depth in the mineral soil. Plot size was 5-ft. x 20 ft. and contained four, seeded rows spaced on 16-inch centers of 25 accessions, cultivars or a wildflower seed mix (see the following table). The seeding was arranged into a four, replicated randomized complete block design. The seeding rate was 20 pure live seeds per sq. ft.

Species Selected for the Single Species Plots					
Cultivar or Accession #	**Scientific Name**	**Common Name**	**Cultivar or Accession #**	**Scientific Name**	**Common Name**
Arriba	*Pascopyrum smithii*	western wheatgrass	Quickbloom		wildflower mix
Bandera	*Penstemon strictus*	Rocky Mountain penstemon	Redondo	*Festuca arizonica*	Arizona fescue
Bannock	*Elymus lanceolatus*	thickspike wheatgrass	Rosana	*Pascopyrum smithii*	western wheatgrass
Bromar	*Bromus marginatus*	mountain brome	Salado	*Sporobolus airoides*	alkali sacaton
El Vado	*Muhlenbergia wrightii*	spike muhly	Saltillo	*Muhlenbergia wrightii*	cane bluestem
Garnet	*Bromus marginatus*	mountain brome	San Juan	*Penstemon angustifolius*	narrowleaf penstemon
Goldar	*Pseudoroegneria spicata*	bluebunch wheatgrass	San Luis	*Elymus trachycaulus*	slender wheatgrass
Grant	*Bothriochloa barbinodis*	cane bluestem	Showy plains		wildflower mix
Hachita	*Bouteloua gracilis*	blue grama	Sodar	*Elymus lanceolatus*	streambank wheatgrass
Llano Estacado		wildflower mix	Southwest mix		wildflower mix
Loetta	*Digitaria californica*	Arizona cottontop	Tusas	*Elymus elymoides*	bottlebrush squirreltail
Nezpar	*Achnatherum hymenoides*	Indian ricegrass	Vaughn	*Bouteloua curtipendula*	sideoats grama
Paloma	*Achnatherum hymenoides*	Indian ricegrass	Viva	*Pleuraphis jamesii*	galleta
Pryor	*Elymus trachycaulus*	slender wheatgrass			

Highway 602 Project Site Seeding

Summer Seeding

- August 7, 2006 –Grass-mix plots. The disturbed areas of the project site outside of the research plots were also seeded at this time to control surface erosion.
- August 8, 2006 – Single-species plots.

Fall Seeding

September 18, 2006 –Grass-mix plots. The soil condition was moist from recent rains, and the surrounding rangeland vegetation appeared to be in good condition.

Winter Seeding

December 7, 2006 – Grass-mix plots. Some snow was visible on parts of the site, and subsequently the plots were moist and not frozen at the time of the planting. However, the shady areas in and around the project site were frozen to approximately a 4-inch depth.

To obtain an accurate account of precipitation at the site, NMDOT in 2007 installed a rain gauge at the Highway 602 project site. Monthly precipitation was recorded by NMDOT personnel.

Highway 550 Project Site Seeding

On December 14-15, 2006, work began on the Highway 550 project site; the site was devoid of volunteer vegetation and the soil was compacted, but it was left in a smooth, level condition. The construction area along the Arroyo Penasco was sloped from the edge of the right-of-way down to the arroyo bed. Because of the slope, this area could not be mulched or seeded at that time.

After the slope was repaired by NMDOT, the mulching applications were done on April 3, 2007 and May 17, 2007. Prior to mulching, the site was conditioned using a disc to prepare for the seeding. The construction site, which included a sloped arroyo bank area and the area inside the right-of-way boundary fence on reservation property, was covered with approximately 3-inches of mulching material. Most of the sloped bank had to be hand-mulched using shovels and hand rakes. A small area of the slope located inside the right-of-way boundary fence was not mulched, and this area was used as an untreated control plot.

Summer Seeding

- June 26, 2007 – Grass-mix plots. The disturbed area outside of the project plots was also seeded to control erosion. This included the construction area along Highway 550 and inside of the highway right-of-way fence on reservation property.
- June 26 -27, 2007 – Single species plots.

Fall Seeding

September 17, 2007 – Grass-mix plots. The soil had good moisture content from recent rains. The vegetation near the site was in good growing condition, and it appeared the area had been receiving a fair amount of precipitation since the June seeding.

Winter Seeding

December 4, 2007 – Grass-mix plots. The LLPMC used its Great Plains No-Till drill to seed the plots. The surface soil had good moisture content and was not frozen at the time of seeding.

The mixed grass plots were evaluated using one diagonal transect placed corner to corner in each plot. A one-meter square frame was used to sample vegetation at five predetermined random locations along this transect (Figure 3). Inside each frame, species composition was determined and canopy cover was estimated using the Daubenmire[4] Cover Class Method (see the following table) with one modification. If there was no established seedling of a seeded species in a plot, no cover class value was assigned and received a value of 0 (zero).

The mulch depth of the two project sites was measured in 2008 to determine its persistence.

Daubenmire Cover Class Method - Percent of Coverage

Class	Range of Coverage	Midpoint of Range
1	0-5%	2.5%
2	5-25%	15.0%
3	25-50%	37.5%
4	50-75%	62.5%
5	75-95%	85.0%
6	95-100%	97.5%

[4] (1968, P. 43 *Plant Communities, a Textbook of Plant Synecology*, Harper Row Publisher, New Your, NY)

Phase III: Results – Evaluating the Project Sites

Highway 602 Project Site

Replication 1 and some of Replication 2 was found damaged on May 8, 2008. The single-species and grass-mix plots were impacted; at least half of the grass-mix seedings were completely destroyed (Figures 1 and 2). The single-species plots had less damage.

Figure 1: Highway 602, May 8, 2008. Tire track damage to the right-of-way plots.

Figure 2: Highway 602 on May 8, 2008. Tire track damage to the right-of-way plots.

The plots were evaluated on September 19, 2008. The depth of the mulch had been reduced to 1¼-inches from its original 3-inch depth. Bare soil was found in the plots, and water erosion caused some minor riling. The mulch appeared to have deteriorated from weathering or has floated away, with that remaining being generally larger pieces. Even with this reduction, the mulch is still providing the relative cool moist conditions required for some new grass seedling establishment.

Grass-Mix Plots:

The summer, fall, and winter grass-mix seedings had failed to establish by 2008. However, western wheatgrass had the best performance in replication 4 for summer, fall, and winter seeding with values of 15 – 37.5 percent cover. Only traces (2.5 percent cover) of a few other seeded species were found. Plots with the best vegetation stands were sown in the summer or fall, with as many as four species showing presence in some of the study plots. However, many volunteer native and non-native plants were also found in the plots such as rabbitbrush, mat muhly, and sand dropseed. Figures 4 – 6 show the condition of the grass-mix plots in the fall of 2007.

Figure 3: One-meter square frame used to sample the grass-mix plots.

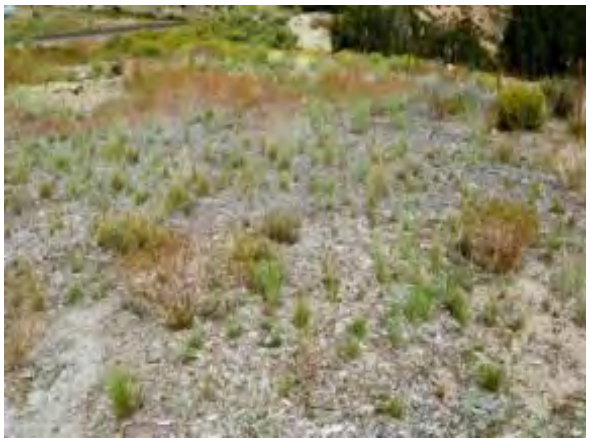


Figure 4: Highway 602 October 11, 2007. Grass-mix plots on roadside with good establishment of seeded species.

Figure 5: Highway 602 on Sept. 19, 2008. Grass-mix plots on roadside with limited establishment of seeded species.

Figure 6: Highway 602 on Sept. 19, 2008. Grass mix plots with volunteer rabbitbrush (*Ericameria nauseosa*) inside boundary fence.

Single Species Plots:

Outstanding performance by many of the cool-season species was observed. Cultivars, accessions, or mixes with the highest mean cover values were, 'Sodar' streambank wheatgrass (79.4%), 'Pryor' western wheat (73.1%), 'Tusas' bottlebrush squirreltail (47%), 'San Luis' slender wheatgrass (45.8%), 'Rosana' western wheatgrass (45.8%), 'Llano Estacado' wildflower mix (38.3%), and 'Arriba' western wheatgrass (29.4%). The warm-season entry with the best cover was 'Hachita' blue grama at 20%. Other warm-season entry cover values ranged from 7 to 0 percent

Figure 7 shows the condition of the Highway 602 single species plots 2007.

Figure 7: Highway 602 September 19, 2008. Single-species plots of cool-season grasses inside boundary fence.

Highway 550 Project Site

The plots were evaluated September 26, 2008. The mulch at the Highway 550 site had been reduced to a 1- to 1-½ inch from its original 3 inch depth. Bare soil can be seen in patches of the mulched area caused by water and wind and erosion, and is particularly thin on the sloped ground.

Grass-Mix Plots:

Cover values for mixed grass plots were very low and ranged from 0 to 2.5 percent cover for seasonal seeding treatments. The site was generally bare; even volunteer weeds were absent with cover values of 0 – 15 percent.

The following photos show the condition of the mixed-grass plots at the Highway 550 project site.

Figure 8: Highway 550 September 26, 2008. Sampling native grass-mix plots with a one-meter square frame.

Figure 9: Highway 550 September 26, 2008. Native grass-mix plots void of seed species and weeds.

Figure 10: Highway 500 September 25, 2008. Some emergence of native grass species in the grass-mix plots.

Single Species Plots:

The best performing **warm-season species** with the greatest mean cover were:

- 'Alma' blue grama (20%)
- 'Niner' sideoats grama (10.6%)

The best performing **cool-season grasses** include:

- 'Pryor' slender wheatgrass (20%)
- 'Tusas' bottlebrush squirreltail (13.8%).

The other entries had only a few established plants or had failed to establish.

The following photos show the conditions of the Highway 550 single-species plots.

Figure 11: Highway 550 September 26, 2008 – Established grasses in the single species plots.

Figure 12: Highway 550 September 26, 2008 – Limited emergence of the rowed grasses in the single species plots.

Discussion

Only the single-species plots at the Highway 602 project site had successful results. Unfortunately, the Highway 602 mixed-grass plots, Highway 550 mixed-grass plots, and Highway 550 single-species plots had only traces of established seeded species.

The Highway 602 seeding of single-species plots showed a good portion of the species were able to emerge and become established. The best performing species were cool-season grasses and wildflower mixes. The five (5) best-performing cool-season grass species were:

- 'Sodar' streambank wheatgrass
- 'Pryor' slender wheatgrass
- 'Arriba' western wheatgrass
- 'Redondo' Arizona fescue
- 'Tusas' bottlebrush squirreltail

All of the above species had good germination, and by the end of the first season had become well established. After their establishment, they had produced a good amount of forage and should be considered in any seed mix used to revegetate disturbed areas with similar conditions.

The Highway 602 seeding had three (3) best-performing single-species, warm-season grasses:

- 'Hatchita' blue grama
- 'Viva' galleta grass
- 'El Vado' spike muhly

These warm-season species had emerged and become established, and also had produced some forage; these species are common at this location and should be included in seed mixes used on disturbed sites with similar environmental conditions.

The Highway 602 seeding also had a wildflower mix; 'Llano Estacado' was used in the single-species planting performed very well. Several individual wildflower species became established, and one plot had an 85% canopy cover. Colorful wildflowers are always favored by the public and should be considered in seed mixes where they can be successfully established.

Understanding the factors that reduced the seedling survival in the mixed-grass plots for Highway 550 and Highway 602, and the single-species plots for Highway 550 is necessary to improve survival of future seedings.

A common cause of seeding failures in the Southwest is the absence of rain during the establishment period. However, both areas seemed to have received an adequate amount of rain. The area surrounding the Highway 550 project site received an average of 1.7 inches per month of precipitation from June to September 2007, which is one-third above the normal amount for the Cuba, New Mexico area during this time period. The Highway 602 project site received a near 30 year average precipitation in 2007. However, during periods of intense summer monsoonal rain showers, the surface topsoil containing seed may be washed away which did occur to some extent at both locations.

Another common cause for seeding failures in the Southwest are the use of non-adapted species which cannot survive the arid conditions resulting in seedling or adult plant desiccation. However, the species used at both sites were adapted to the arid conditions. The majority of the cultivars and species entries are typically the species suggested in the USDA-NRCS Ecological Range Site for seeding in that area, and they are also listed in the *New Mexico NRCS Range Seeding Standards and Specifications*. Subsequently, we know they are adapted and have been used successfully in previous plantings in the area of the two study locations.

Often the species selected for a project are not adapted to the soil chemistry, particularly salinity which is a common occurrence in the soils of the Southwest. The soils of the Highway 602 project site (2.05 mmhos/cm and SAR of 2.31) did not contain high salts. However, the soils of the Highway 550 project site were shown to be saline by the Soils Laboratory at New Mexico State University (Electrical Conductivity of 6.8 mmhos/cm and SAR of 7.41). Consequently, seeded species that have low or no tolerance to salts may have been impacted by osmotic drought or a nutrient deficiency and therefore die. The species installed at the Highway 550 project site that may have been sensitive to salt included white prairie clover, Rocky Mountain penstemon, spike muhly, little bluestem, Arizona fescue, cane bluestem, bluebunch wheatgrass, Indian ricegrass, black grama, and sideoats grama. Those species that did become established included slender wheatgrass, bottlebrush squirreltail, blue grama, and sideoats grama. These species (other than sideoats grama) are known to be tolerant of some salts. Therefore, sideoats grama is a contradiction in its superior performance on the saline soil of the Highway 550 project site. It is an example of how complex these ecosystems can be. The measured saline soil conditions may not be consistent throughout the entire site. However, when seeding saline soils, the use of salt tolerant species should be highly considered.

Failed plantings may be caused by seeding too deep, particularly when using Southwestern warm-season grass species which often have very small caryopsis. This could have reduced the survival of the seeded species at both the Highway 550 and Highway 602 project sites. A small caryopsis often correlates to small endosperm, the part of the seed morphology that contains the required energy for the developing seedling to grow in the soil and emerge to sunlight. If the endosperm is not completely consumed by the developing seedling, it will reach sunlight where it will begin photosynthetic processes and grow. The optimum planting depth for most Southwest grass species is often considered to be shallow at ½ inch. The seedling may not be able to emerge after being buried with the 3-inches of surface mulch compounded with a ½ inch of mineral soil. A treatment for a future study may include a surface broadcast seeding with a follow-up application of a 2 inch layer of surface mulch, all in an effort to reduce the depth of the seeding.

During the Highway 602 road construction project by NMDOT, all of the existing above-ground vegetation was removed. Perennial vegetation that existed prior to the site's disturbance repopulated from roots that remained below the soil surface thus reducing the survival of the seeded species at highway 602 project site. The two, most abundant existing species were western wheatgrass (*Pascopyrum smithii*) and rubber rabbitbrush (*Ericameria nauseosa*), as evidenced by the abundance of the two species on the surrounding, undisturbed areas. The first evaluation following the seeding (2006) showed volunteer rabbitbrush and western wheatgrass growing in the seeded plots. The vegetative re-establishment of these species may have been a factor in the lack of establishment of the seeded species plots because they were in competition for light, water, and nutrients. In areas where vegetation is to be cleared and is known to be a vegetative re-sprouting species, an application of herbicide during the growing season before clearing may be necessary.

Only one of the locations (Highway 602) showed good, replicated survival data for single-species plots. Having only two-year's worth of data makes it difficult to recommend a reliable seed mix for either of these locations other than to include the five (5) best-performing cool-season grasses and the three (3) best performing warm-season grasses. For saline soils such as sampled on Highway 550, 'Pryor' slender wheatgrass and 'Tusas' bottlebrush squirreltail should be included.

Proposed Future NMDOT and LLPMC Activities

- Continue to evaluate the Highway 602 project site for species persistence
- Select new sites for future studies
- Install a depth of mulching study over seeding treatments of 0-, 2-, and 4-inches.

Preliminary Pollinator Plant Recommendations for New Mexico

Study Number: NMPMC-T-1001-CP

In recent years, domesticated honey bee populations and beekeepers have had to endure 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 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 to 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 provide the most abundant pollen and nectar for 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); these wildflowers, trees, shrubs, and grasses are an integral part of the conservation practices that landowners, farmers and ranchers install as part of their conservation plan. However, advice on suitable plants is currently developed from broad-based 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 NM conditions.

The Los Lunas NRCS Plant Materials Center (LLPMC) installed plantings in 2010 and 2011 to evaluate native and introduced species for pollinator activity; the combined species totals included 136 herbaceous perennials, 50 annuals and biennials, and 34 shrubs. We are evaluating different plant species for pollinator use (abundance and diversity), plant survival, plant vigor, and duration and timing of flowering. The insects collected in 2011 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, fairly comprehensive pollinator plantings were installed at NMSU's Farmington and Tucumcari Agricultural Science Centers as well as at a demonstration farm for disadvantaged beginning farmers at Vado (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 were compiled to yield qualitative pollinator abundance and diversity data 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 at least partly due to differences in timing of nectar secretion.

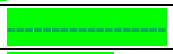
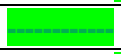
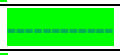
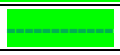
Bloom periods were recorded for all species. It became apparent that the bloom periods were not consistent between 2010 and 2011 due to a number of factors including:

- extreme cold in February 2011 (-13° F), followed by a very warm spring
- 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)

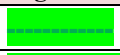
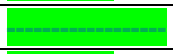
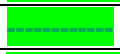
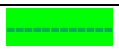
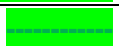
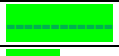
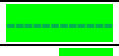
The following tables summarize the recommended annual, herbaceous perennial, and shrub species which attracted appreciable pollinator activity at the LLPMC. In each table, the order of species is based on descending

insect visitor abundance. The commercial availability of seed of the recommended species is also noted; some species may only be available in small quantities. More comprehensive information can be found in the tables in Appendix A for all species which flowered at the LLPMC during 2011 and had some insect activity; the tables list activity by insect group (i.e., predatory and parasitic wasps, (e.g. hover flies and tachinid flies), domesticated honey bees, bumble bees, other native bees, butterflies, and beetles).

Recommended Native Annuals

Species Name	Common Name	Commercially Available	Bloom Season Spring Summer Fall
Verbesina encelioides	golden crownbeard	Yes	
Phacelia integrifolia	gypsum phacelia	Not Currently	
Monarda citriodora	lemon beebalm	Yes	
Cleome serrulata	Rocky Mountain beeplant	Yes	
Dimorphocarpa wislizeni	touristplant	Not Currently	
Helianthus petiolaris	prairie sunflower	Yes	
Argemone polyanthemos	crested pricklypoppy	Occasionally	
Baileya multiradiata	desert marigold	Yes	
Gaillardia pulchella	firewheel (wild annual)	Yes	
Gilia capitata	Bluehead gilia	Yes	

Recommended Native Perennials (Native to NM, AZ, CO, UT *except two species noted in common name column*)

Species Name	Common Name	Commercially Available	Bloom Season Spring Summer Fall
Achillea millefolium	common yarrow	Yes	
Dalea candida	white prairie clover	Yes	
Gaillardia pinnatifida	red dome blanketflower	Yes	
Gaillardia pulchella	firewheel	Yes	
Helenium autumnale	common sneezeweed	Yes	
Helianthus maximiliani	Maximilian sunflower	Yes	
Heliomeris multiflora var. multiflora	showy goldeneye	Yes	
Pycnanthemum verticillatum var. pilosum	whorled mountainmint *(Midwest Native)*	Yes	
Ratibida columnifera	mexican hat (brown)		
Scrophularia californica	California figwort *(California Native)*	Yes	
Solidago nemoralis	gray goldenrod	Yes	
Solidago petiolaris	downy ragged goldenrod	Yes	
Solidago speciosa	showy goldenrod	Yes	
Symphyotrichum oblongifolium	aromatic aster	Yes	
Thelesperma filifolium	stiff greenthread	Yes	

Recommended Native Perennials (Native to NM, AZ, CO, UT *except two species noted in common name column*)

Species Name	Common Name	Commercially Available	Bloom Season Spring Summer Fall
Coreopsis lanceolata	lanceleaf tickseed	Yes	
Dalea purpurea	purple prairie clover	Yes	
Gaillardia aristata	common gaillardia	Yes	
Sphaeralcea laxa	caliche globemallow	Occasionally	
Agastache pallidiflora ssp. neomexicana	Bill Williams Mountain giant hyssop	Occasionally	
Melampodium leucanthum	plains blackfoot	Yes	
Physaria newberryi	Newberry's twinpod	Occasionally	
Ratibida columnifera	upright prairie coneflower (yellow)	Yes	
Symphyotrichum laeve var. geyeri	Geyer's aster	Yes	
Thelesperma subnudum	Navajo tea	Yes	

Recommended Native Shrubs

Species Name	Common Name	Seed Commercially Available	Bloom Season Spring Summer Fall
Baccharis emoryi	Emory's baccharis (male plant in particular)	Occasionally	
Dalea bicolor var. argyrea	silver prairie clover	Occasionally	
Ericameria nauseosa	rubber rabbitbrush	Yes	
Eriogonum corymbosum	crispleaf buckwheat	Occasionally	
Parthenium incanum	mariola	Not Currently	
Poliomintha incana	frosted mint	Not Currently	
Salix irrorata	dewystem willow	Not Currently	
Salix lasiolepis	arroyo willow	Not Currently	
Chamaebatiaria millefolium	desert sweet	Yes	
Rhus trilobata	skunkbush sumac	Yes	
Forestiera pubescens var. pubescens	stretchberry (New Mexico olive)	Yes	
Lycium torreyi	Torrey wolfberry	Not Currently	
Ribes aureum	golden currant	Yes	

Recommended Introduced Annuals and Perennials

Species Name	Common Name	Annual or Perennial	Commercially Available	Bloom Season Spring Summer Fall
Cosmos bipinnatus	garden cosmos	Annual	Yes	
Ocimum basilicum	basil	Annual	Yes	
Tithonia rotundifolia	clavel de muerto	Annual	Yes	
Foeniculum vulgare var. azoricum	sweet fennel	Perennial	Yes	
Nepeta cataria	catnip	Perennial	Yes	
Scabiosa atropurpurea	mourningbride	Perennial	Yes	
Origanum marjorana	sweet marjoram	Perennial	Yes	

The following tables record the predominant insect groups observed on each plant species during 2011 as well as a qualitative rating of pollinator abundance and diversity at the family level. The plant species in each table are listed in order of relative pollinator abundance, and within each abundance category the species are ordered by relative diversity. The bloom periods are presented in broad categories of semi-seasons because of the inconsistencies in flowering time described above and because some had repeat bloom periods. The species are grouped by native status.

Native Annuals and Biennials							**Bloom Period**					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Verbesina encelioides	golden crownbeard	**X**	NB, F, W	High	High					**X**	**X**	
Phacelia integrifolia	gypsum phacelia	**X**	NB	Medium	High				**X**			
Monarda citriodora	lemon beebalm	**X**	BB, NB	Low	High					**X**	**X**	**X**
Cleome serrulata	Rocky Mountain beeplant	**X**	NB, HB, W, BT	Medium - High	Medium - High					**X**	**X**	
Dimorphocarpa wislizeni	touristplant	**X**	F, W, BT	High	Medium			**X**	**X**			
Helianthus petiolaris	prairie sunflower	**X**	NB, HB, F, W, BT	High	Medium					**X**	**X**	
Argemone polyanthemos	crested pricklypoppy	**X**	NB, HB	Medium	Medium				**X**			
Baileya multiradiata	desert marigold	**X**	NB, W, F	Medium	Medium					**X**	**X**	**X**
Gaillardia pulchella	firewheel (wild annual)	**X**	NB, HB, BB, W	Medium	Medium			**X**	**X**	**X**	**X**	**X**
Gilia capitata	bluehead gilia	**X**	NB, HB,	Medium	Medium	Blue pollen			**X**	**X**		
Layia platyglossa	coastal tidytips		NB, W, F	Medium	Medium	Difficult from seedlings			**X**			
*Machaeranthera bigelovii***	Bigelow's tansyaster		NB, F	Medium	Medium						**X**	**X**
Oenothera albicaulis	whitest evening primrose		HB, NB, F	Medium	Low					**X**		
Eschscholzia californica ssp. mexicana	California poppy		HB, W	Low	Low				**X**			
*Phacelia heterophylla***	varileaf phacelia		NB	Low	Low				**X**			

***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**
**** Biennial Natives**

Native Perennials with High Pollinator Abundance (native to NM, AZ, CO, or UT)							**Bloom Period**					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Achillea millefolium	common yarrow	**X**	W, F	High	High				**X**	**X**		
Dalea candida	white prairie clover	**X**	W, NB, HB, BB	High	High				**X**	**X**	**X**	
Gaillardia pinnatifida	red dome blanketflower	**X**	NB, F, W	High	High	Unusual native bees			**X**	**X**		
Gaillardia pulchella	firewheel	**X**	NB, HB, W,BB	High	High				**X**	**X**	**X**	**X**
Helianthus maximiliani	Maximilian sunflower	**X**	NB	High	High	Very large, spreads					**X**	
Heliomeris multiflora var. multiflora	showy goldeneye	**X**	NB, HB, F, BT	High	High				**X**			
Ratibida columnifera	mexican hat	**X**	W, NB	High	High					**X**	**X**	**X**
Rudbeckia hirta	blackeyed Susan	**X**	NB, W, F	High	High				**X**	**X**	**X**	**X**
Solidago nemoralis	gray goldenrod	**X**	W, NB, F, BT, BF	High	High						**X**	**X**
Solidago petiolaris	downy ragged goldenrod	**X**	W, NB, BF, F	High	High						**X**	
Solidago speciosa	showy goldenrod	**X**	BB, NB, HB, F, W	High	High						**X**	**X**
Symphyotrichum oblongifolium	aromatic aster	**X**	NB, W, F, HB	High	High							**X**
Thelesperma filifolium	stiff greenthread	**X**	F, NB, W, BT	High	High				**X**	**X**	**X**	**X**
Helenium autumnale	common sneezeweed	**X**	NB, HB, W, F, BF	Medium	High							**X**
***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**												

Native Perennials with Medium Pollinator Abundance (native to NM, AZ, CO, or UT)							**Bloom Period**					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Asclepias subverticillata	horsetail milkweed		W, F, NB, BF	High	Medium - High	Toxic to livestock					**X**	
Coreopsis lanceolata	lanceleaf tickseed	**X**	NB, W, HB	High	Medium - High				**X**	**X**	**X**	**X**
Dalea purpurea	purple prairie clover	**X**	NB, HB, W, BB, F	High	Medium - High				**X**	**X**	**X**	
Gaillardia aristata	common gaillardia	**X**	NB, W, HB	Medium	Medium - High				**X**			
Sphaeralcea laxa	caliche globemallow	**X**	NB, HB, F, BB, W, BT	High	Medium - High					**X**	**X**	**X**
Melampodium leucanthum	plains blackfoot	**X**	NB, F, W	High	Medium				**X**	**X**	**X**	**X**
Ratibida columnifera	upright prairie coneflower	**X**	W, NB, F	High	Medium					**X**	**X**	**X**
Symphyotrichum laeve var. geyeri	Geyer's aster	**X**	NB, W, HB	High	Medium						**X**	**X**
Thelesperma subnudum	Navajo tea	**X**	NB, F, W	High	Medium				**X**	**X**	**X**	
Thymophylla pentachaeta	fiveneedle pricklyleaf		NB, F, W	Medium - High	Medium	Attracted some unusual native bees					**X**	**X**
Agastache rupestris	threadleaf giant hyssop		BB, HB	Medium	Medium						**X**	**X**
Lesquerella fendleri	Fendler's bladderpod		NB, HB, F	Medium	Medium					**X**		
Machaeranthera pinnatifida	lacy tansyaster		NB, W, F	Medium	Medium						**X**	**X**
Psilostrophe cooperi	whitestem paperflower		NB, F, W	Medium	Medium	Difficult to keep alive			**X**	**X**		
Symphyotrichum ericoides	white heath aster		NB, F, W	Medium	Medium						**X**	
Symphyotrichum novae-angliae	New England aster		NB	Medium	Medium						**X**	**X**
Symphyotrichum	western silver		NB	Medium	Medium						**X**	**X**

Native Perennials with Medium Pollinator Abundance (native to NM, AZ, CO, or UT)							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
sericeum	aster											
Sphaeralcea ambigua	desert globemallow (Orange)		NB, BT	Medium	Medium							**X**
Verbena macdougalii	Mac Dougal verbena		NB	Medium	Medium						**X**	
Agastache pallidiflora ssp. neomexicana	Bill Williams Mountain giant hyssop	**X**	BB, NB	Low	Medium	Very good for BB's					**X**	
Monarda fistulosa	wild bergamot		BB, NB	Low	Medium				**X**	**X**		
Physaria newberryi	Newberry's twinpod	**X**	NB	Low	Medium	Early bloomer		**X**				
Oenothera organensis	Organ Mountain evening primrose		NB	Medium	Medium - Low					**X**		
Vernonia missurica	Missouri ironweed		BB, NB	Medium	Medium - Low						**X**	
Vicia americana	American vetch		BB	Low	Medium - Low						**X**	**X**
***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**												

Native Perennials with Low Pollinator Abundance (native to NM, AZ, CO, or UT)							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Berlandiera lyrata	lyreleaf greeneyes		NB, F,W, HB	High	Low - Medium			**X**	**X**	**X**		
Coreopsis tinctoria	golden tickseed		NB, W, F	Medium	Low - Medium					**X**	**X**	**X**
Penstemon virgatus	upright blue beardtongue		BB, F, W	Medium	Low - Medium				**X**			
Silphium integrifolium	wholeleaf rosinweed		NB	Low - Medium	Low - Medium						**X**	
Verbena stricta	hoary verbena		NB, HB	Low - Medium	Low - Medium				**X**			

Native Perennials with Low Pollinator Abundance (native to NM, AZ, CO, or UT)							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Agastache cana	mosquito plant		BB	Low	Low							X
Calylophus tubicula	Texas sundrops		HB	Low	Low					X	X	X
Oenothera pallida	pale evening primrose		NB, BB	Medium	Low					X	X	
Sphaeralcea gierischii	Gierisch's globemallow		NB	Low	Low					X	X	X
Conoclinium greggii	palmleaf thoroughwort		BF	Very Low	Very Low						X	X
Senecio flaccidus var. flaccidus	threadleaf ragwort		NB	Very Low	Very Low				X			
***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**												

West and Midwest Native Perennials (not native to NM, AZ, CO, or UT)							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Pycnanthemum verticillatum var. pilosum	whorled mountainmint	X	W, NB, BB, HB, F	High	High						X	X
Scrophularia californica	California figwort	X	HB, NB, F, W	Medium	High	Attracted some unusual native bees					X	X
Eupatorium altissimum	tall thoroughwort		W, NB, F	Medium	Medium							X
Heterotheca camporum	lemonyellow false goldenaster		NB	Medium	Medium						X	X
Oligoneuron rigidum	stiff goldenrod		NB, BF	Medium	Medium						X	X
Echinacea paradoxa	Bush's purple coneflower		NB, HB	Medium	Low				X	X		
Rudbeckia fulgida	orange coneflower		NB, W, F	Medium	Low							X

West and Midwest Native Perennials (not native to NM, AZ, CO, or UT)							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Rudbeckia subtomentosa	sweet coneflower		NB, F, HB	Medium	Low						**X**	**X**
Coreopsis tripteris	tall tickseed		HB, W	Low	Low							**X**
***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**												

Native Shrubs (native to NM, AZ, CO, or UT)							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Baccharis emoryi	Emory's baccharis	**X**	W, F, NB, HB, BT, BF	High	High	Male plants more attractive to pollinators						**X**
Ericameria nauseosa	rubber rabbitbrush	**X**	NB, W, HB, F, BB, BF	High	High						**X**	**X**
Eriogonum corymbosum	crispleaf buckwheat	**X**	W, F, NB	High	High						**X**	
Parthenium incanum	mariola	**X**	W, F, NB	High	High						**X**	
Poliomintha incana	frosted mint	**X**	NB, W, F, HB	High	High				**X**	**X**	**X**	**X**
Salix irrorata	dewystem willow	**X**	NB, HB, F	Medium	High	Earliest bloomer, good for hoverflies	**X**					
Salix lasiolepis	arroyo willow	**X**	NB, HB, F	Medium	High	Earliest bloomer, good for hoverflies	**X**					
Dalea bicolor var. argyrea	silver prairie clover	**X**	HB	Low	High							**X**
Chamaebatiaria millefolium	desert sweet	**X**	W, F, NB, HB	High	Medium - High	Good for tachinids			**X**			
Rhus trilobata	skunkbush	**X**	W, F, NB, HB,	Medium -	Medium -	Early bloomer	**X**	**X**				

Native Shrubs (native to NM, AZ, CO, or UT)							**Bloom Period**					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
	sumac		BF	High	High							
Forestiera pubescens var. pubescens	stretchberry (New Mexico olive)	**X**	NB, F	Medium	Medium	Early bloomer	**X**	**X**				
Lycium torreyi	Torrey wolfberry	**X**	NB, W	Medium	Medium	Early bloomer; edible fruits		**X**				
Ribes aureum	golden currant	**X**	NB	Medium	Medium	Early bloomer; edible fruits		**X**				
Eriogonum jamesii	James' buckwheat		W	Medium - Low	Medium - Low					**X**		
Fallugia paradoxa	Apache plume		NB, F, HB, W	Medium - Low	Medium - Low				**X**	**X**	**X**	**X**
W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles												

Introduced Annuals							**Bloom Period**					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Cosmos bipinnatus	garden cosmos	**X**	NB, W, BB, HB, BT, F	Medium - High	Medium - High						**X**	**X**
Ammi majus	large bullwort		W, F	Medium	Medium					**X**		
Brassica sp.	mustard (cover crop)		NB, F,W	High	Medium				**X**			
Ocimum basilicum	basil	**X**	NB, HB	Medium	Medium	Attracted some unusual native bees					**X**	**X**
Tithonia rotundifolia	clavel de muerto	**X**	BB, NB, BF	Medium - Low	Medium	Very good for BBs and BFs					**X**	**X**
Anethum graveolens	dill		F, W	Low - Medium	Low - Medium	Good for beneficial flies & wasps				**X**		

Introduced Annuals							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Cosmos sulphureus	sulphur cosmos		NB, BB	Low - Medium	Low - Medium					**X**	**X**	**X**
***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**												

Introduced Perennials							Bloom Period					
Species Name	**Common Name**	**Recommended Pollinator Plant**	**Predominant Insect Groups***	**Pollinator Diversity**	**Pollinator Abundance**	**Notes**	**Early Feb. - Mid Mar.**	**Mid Mar. - Early May**	**Early May - Mid June**	**Mid June - Early Aug.**	**Early Aug. - Mid Sept.**	**Mid Sept. - Early Nov.**
Foeniculum vulgare var. azoricum	sweet fennel	**X**	W, F	High	High	Good for beneficial flies & wasps					**X**	**X**
Nepeta cataria	catnip	**X**	NB, BB, HB, W, F	High	High						**X**	**X**
Scabiosa atropurpurea	mourningbride		NB, HB, BB, W, F	High	High						**X**	**X**
Teucrium orientale	Oriental germander		NB, HB, W	High	Medium					**X**	**X**	**X**
Origanum marjorana	sweet marjoram	**X**	W, NB, F	Medium - High	Medium - High						**X**	**X**
Trifolium pratense	red clover (double cut)		NB, BB, HB	Medium	Medium				**X**	**X**	**X**	**X**
Origanum vulgare	oregano		NB, HB, F	Medium	Low						**X**	
***W = Predatory and Parasitic Wasps, F = Flies (e.g. Hover Flies and Tachinids), HB = Domesticated Honey Bees, BB = Bumble Bees, NB = Other Native Bees, BF = Butterflies, BT = Beetles**												

2011 Annual Seed Production

Project Number/Name	Field Number	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest Weight (Cleaned Wt. lbs.)
BLM 'Seeds for Success' Project	8	0.50	9/26/2011	No treatment	9/26, 9/30, 10/17, 11/29		No harvest
NMPMC-S-0901-CP Windbreaker SPWR seed increase	8 14	0.85 0.40	8/2009	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous 40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/7, 4/29, 5/27, 6/22, 7/21, 8/25 4/6, 4/29, 5/27, 6/22, 7/21, 8/25	9/30 9/20	72.60 167.50
NMPMC-S-0302-RA **Salado** alkali sacaton foundation seed field	11	1.0	2003	80 lbs./ac. Nitrogen	4/21, 5/16, 6/8, 6/23, 7/18	9/6	1.50
NMPMC-S-0402-RI **Westwater germplasm** alkali muhly foundation seed field	11	1.0	2004	80 lbs./ac. Nitrogen	4/21, 5/16, 6/7, 6/22, 7/15, 8/3, 8/30	10/14	83.04
NMPMC-S-0403-RA 9066604 Carlsbad Caverns NP blue grama seed production	13	0.50	7/6/2005	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/7, 5/31, 6/13, 7/18, 8/3, 8/30	11/3	37.38
NMPMC-00701-OT 906609 Boulder County, CO little bluestem seed production	14	0.48	8/16/2011	No treatment	8/16, 8/19, 8/24, 8/30, 9/14, 9/30, 10/28	No harvest	No harvest
NMPMC-0701-OT 9066910 Boulder County, CO prairie dropseed seed production	14	0.48	8/17/2011	No treatment	8/17, 8/19, 8/24, 8/30, 9/14, 9/30, 10/28	No harvest	No harvest
NMPMC-S-0703-PA **Grenville** switchgrass seed production	14	0.14	2007	40 lbs./ac. Phosphorous	4/6, 4/29, 5/27, 6/22, 7/21, 8/25	8/25	N/A
NMPMC-S-0503-RI 9066589 Composite vine mesquite seed increase field	14	1.0	2005	40 lbs./ac. Nitrogen	6/1, 6/29, 8/12	10/11	15.4
NMPMC-S-7801-RA **Hachita** blue grama foundation seed field	16	2.0	1963	80 lbs./ac. Nitrogen	6/1, 6/6, 7/5, 8/24	10/26	117.60

Project Number/Name	Field Number	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest Weight (Cleaned Wt. lbs.)
NMPMC-S-0701-OT 9066730 Boulder County, CO big bluestem seed production	16	0.33	2007	40 lbs./ac. Nitrogen	4/11, 5/16, 6/20, 7/13, 8/10	9/27	4.64
NMPMC-S-0801-PA **Jose** tall wheatgrass foundation seed production	18	1.0	2008	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	3/1, 4/13, 5/4, 6/9, 7/13	9/13	344.50
NMPMC-S-0402-RA **Vaughn** sideoats grama foundation seed field	19	1.20	7/22-28/2004	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/20, 5/17, 6/9, 7/5	9/1	137.00
NMPMC-S-0401-RA **Pastura** little bluestem foundation seed field	19	0.86	2004	80 lbs./ac. Nitrogen	4/12, 5/17, 6/8, 6/29, 7/18, 8/30	No harvest	No harvest
NMPMC-S-0301-RA **Viva** galleta foundation seed field	19	2.4	2003	80 lbs./ac. Nitrogen	6/6, 7/1, 8/16	No harvest	26.50
NMPMC-S-0004-WO 9062861 Grand Canyon NP muttongrass seed production	21S	0.28	2008	120 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	1/19, 3/10, 3/24, 4/8, 4/29, 5/24, 6/8, 6/23, 7/6, 7/21, 8/10, 9/9, 10/31	5/12	0.25
NMPMC-S-1001-WO 9062861 Grand Canyon NP muttongrass seed production	28S	1.00	2010	200 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	1/18, 2/23, 3/10, 3/22, 4/18, 4/25, 5/12, 58/24, 6/6, 6/16, 6/29, 7/13, 8/3, 8/16, 8/30, 9/28, 10/21, 11/18	No harvest	No harvest
	35S	0.50	2010	120 lbs./ac. Nitrogen	1/19, 2/23, 3/23, 4/7, 4/21, 5/9, 5/24, 6/7, 6/23, 7/6, 8/3, 8/19, 9/8, 9/28, 10/21		No harvest
	33N	0.50	2011		10/12, 10/17, 10/28, 11/10		No harvest
NMPMC-S-0003-RA 9062875 Grand Canyon NP blue grama seed production	20N	0.76	2011		8/30, 9/2, 9/8, 9/20, 10/19, 11/10		No harvest
	28S	0.50	2006	120 lbs./ac. Nitrogen	4/11, 5/9, 6/8, 6/23,	9/28	7.40

Project Number/Name	Field Number	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest Weight (Cleaned Wt. lbs.)
	18	0.75	2010	40 lbs./ac. Phosphorous 120 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	7/8, 8/10, 8/30 1/18, 2/24, 3/28, 4/20, 5/5, 5/27, 6/8, 6/23, 7/13, 8/12, 9/22, 10/28	9/28	
NMPMC-S-0901-WO 9066802 Grand Canyon NP spike muhly seed production	20S	0.70	2009	80 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	4/6, 5/10, 6/9, 6/23, 7/15, 8/16	11/7	19.38
NMPMC-S-0403-RA 9066606 Carlsbad Caverns NP bristlegrass seed production	20S	.50	2006	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/8, 5/11, 6/9, 6/22, 7/8, 8/10, 8/24, 10/21	8/5, 10/3	64.12
	28S	0.17	2007	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/8, 5/11, 6/7, 6/22, 7/5, 8/10	8/5, 10/3	
NMPMC-S-9701-RA **Nogal** black grama foundation seed field	21N	1.3	1997	80 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/13, 5/12, 6/10, 7/1, 8/10	11/14	1.50
NMPMC-S-0904-RA 9066803 Grand Canyon NP blue grama seed production	21S	0.60	2009	80 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/6, 5/11, 6/9, 6/29, 7/15, 8/12	10/20	6.46
9066885 BLM '*Seeds for Success'* globemallow species seed increase	23N	0.06	2011	No treatment	8/10, 8/11, 8/15, 8/19, 8/24, 8/30, 9/8, 9/27, 10/21		No harvest
NMPMC-S-0802-RA 9066330 desert needlegrass seed production	23N	0.45	2008 2010	200 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	1/19, 2/24, 3/24, 4/20, 5/10, 6/9, 6/24, 7/6, 8/3, 8/16, 9/9, 10/28	6/1, 6/8	13.82
	23S	0.50	2010	160 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	1/18, 2/23, 3/22, 4/7, 4/21, 5/9, 5/24, 6/7, 6/22, 7/5, 8/10, 10/17		No harvest
NMPMC-S-0403-RA 9066605 Carlsbad Caverns NP sideoats grama seed production	23N	0.50	6/8/2005 6/29/2006	40 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	3/29, 5/12, 6/10, 6/29, 7/18, 8/10	9/29	14.76
9066882- 9066883 BLM '*Seeds for Success*' species seed increase	23S	0.30	2010	80 lbs./ac. Nitrogen	1/18, 2/23, 3/22, 4/7, 4/21, 5/9, 5/27, 6/14, 6/29, 7/18, 8/3, 8/16,	No harvest	No harvest

Project Number/Name	Field Number	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest Weight (Cleaned Wt. lbs.)
	24S	0.50	2010	80 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	8/30, 9/21 1/19, 2/23, 3/22, 4/8, 4/25, 5/9, 5/27, 6/14, 6/29, 7/18, 8/12, 8/30, 9/21, 10/17, 11/29		No harvest
	27N	0.50	2010	80 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	1/19, 2/24, 3/23, 4/8, 4/25, 5/10, 5/27, 6/14, 7/5, 8/3, 8/15, 9/20, 10/17		No harvest
NMPMC-S-0403-RA 9066658 Carlsbad Caverns NP green sprangletop seed production	24N	0.50	2006	80 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	4/6, 5/11, 6/9, 6/22, 7/5, 7/21, 8/3, 8/16, 8/30	10/4	24.80
NMPMC-S-0403-RA 9066607 Carlsbad Caverns NP threeawn seed production	24S	0.50	6/2/2005 6/22/2006	80 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	3/28, 5/10, 6/8, 6/22, 7/6, 7/21, 8/19, 8/30	6/27, 8/15	12.06
NMPMC-S-9401-RA **Paloma** Indian ricegrass foundation seed field	25N	0.89	2000	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	3/1, 3/23, 4/21, 5/9	5/18, 5/27, 6/7, 6/14	139.82
	20N	0.37	2009	200 lbs./ac Nitrogen 80 lbs./ac. Phosphorous	3/10, 3/28, 4/20, 5/9, 6/10, 6/29, 7/18, 8/19, 9/28, 11/3		
	20N	0.52	2011		10/19, 10/28, 11/10, 11/29		No harvest
NMPMC-S-0801-CR US Army Fort Bliss mesa dropseed seed production	25S	0.90	2008	80 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	4/7, 5/10, 6/10, 7/1, 8/3	9/16	n/a
	34S	0.13		80 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	3/24, 5/10, 6/7, 6/22, 7/18, 9/8	9/16	
NMPMC-S-1102-WO 9066797 Grand Canyon NP needleandthread seed production	28S	0.09	2011	40 lbs./ac. Nitrogen	8/9, 8/12, 8/15, 8/19, 8/24, 8/30, 9/8, 9/27, 10/28	No harvest	No harvest
NMPMC-S-0301-WO 9066532 Zion NP bottlebrush squirreltail	20S	0.40	2009	160 lbs./ac. Nitrogen	1/19, 3/10, 3/24, 4/8, 4/21, 5/9, 6/10, 6/29,	5/31, 6/7, 6/13, 7/1	114.64

Project Number/Name	Field Number	Acres	Planting Date	Fertilizer Applications	Irrigation Dates (3" Application)	Harvest Date	Harvest Weight (Cleaned Wt. lbs.)
seed production	34S	0.44	2009	160 lbs./ac. Nitrogen 80 lbs./ac. Phosphorous	7/18, 8/16, 9/28, 10/31 1/18, 3/10, 3/24, 4/8, 4/21, 5/10, 5/24, 6/7, 6/22, 7/6, 8/3, 8/30, 9/29, 10/19	5/31, 6/7, 6/13, 7/1	
	19	1.00	2010, 2011	120 lbs./ac. Nitrogen 120 lbs./ac. Phosporous	1/18, 2/24, 3/15, 4/11, 4/25, 6/8, 7/15, 8/24, 9/22, 10/17, 11/10	5/31, 6/7, 6/13, 7/1	
NMPMC-S-0801-RA 9066431 bluebunch wheatgrass seed production	35N	0.30	2008	80 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	1/18, 3/10, 3/24, 4/8, 4/21, 5/10, 5/24, 6/7, 6/22, 7/6, 8/3, 8/30, 9/28, 10/19	No harvest	No harvest
	18	0.65	2010	160 lbs./ac. Nitrogen 120 lbs./ac. Phosphorous	1/18, 2/24, 3/15, 4/6, 4/20, 5/4, 5/16, 6/7, 6/22, 7/5, 8/16, 9/22, 10/28	No harvest	No harvest
NMPMC-S-0802-CR US Army Fort Bliss spike dropseed seed production	35N	0.30	2008	40 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	3/28, 5/11, 6/7, 6/22, 7/18, 8/3, 8/30	10/28	N/A
NMPMC-S-0301-WO 9066528 Zion NP Indian ricegrass seed production	35N	0.50	2004 2005	120 lbs./ac. Nitrogen 40 lbs./ac. Phosphorous	3/10, 3/29, 4/20, 5/11, 6/16, 7/21, 11/3	5/27, 6/7	39.14