Rootplowing and Seeding Arid Rangelands in the Southwest

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Highlight: *Twenty-three seedings were made across southern New Mexico following rootplowing of creosotebush or tarbush. Because of the harsh environment, equipment was used that in a single operation killed the brush, formed basin pits, planted the seed on a firm seedbed, and windrowed the dead brush over the seeded area. Good to excellent stands were obtained on 10 plots; 4 had fair stands. Many of the failures were related to highly erosive or droughty sites, or to soils that form a hard surface crust. Even under droughty conditions, there generally was a good stand of the seeded species where brush cover coincided with a low place where water was concentrated. The species most easily established on the sandy to loamy sites infested with creosotebush were Lehmann and Boer lovegrass, black and sideoats grama, yellow bluestem, blue panic, and fourwing saltbush. On heavier soils, the best species were sideoats grama, yellow bluestem, and alkali sacaton. The exact seed mixture for any site depends on management objectives.*

The desirable vegetation on some arid rangeland sites of the Southwest has been severely depleted by past grazing abuses, droughts, and brush encroachment. On some of these sites, natural recovery is slow or nonexistent, and seeding desirable species is the only hope of recovery. However, establishment of seeded species is difficult in arid areas. Sites infested with noxious shrubs must be cleared of these plants before being seeded. Droughts are frequent and unpredictable. Precipitation is more reliable in summer than in the other seasons, so seedlings must be established during hot weather. Nearly all species adapted to the area have small seed that must be planted at the 1/4- to 1/2-inch depth. Harsh environmental conditions prevail at shallow soil depths (Herbel, 1972 and Abernathy and Herbel, 1973).

Plots were seeded at several southern New Mexico locations from 1966 to 1970 with experimental seeding equipment (Abernathy and Herbel, 1973). The equipment was developed for rootplowing and seeding brush-infested ranges in one pass over the land. The depth of plowing was 9 inches. This was sufficient to kill the major shrubs encountered in these trials. The brush from an 8-ft rootplowed swath was windrowed on a 3-ft swath seeded with a press-wheel seeder. In addition, basin pits were formed. Thus, in a single operation, the brush was killed; basin pits were formed; seed was planted on a firm seedbed; and the dead brush was windrowed over the seeded area (Fig. 1)

Various accessions and species were tested. Most seeds for these trials were furnished by the Los Lunas Plant Materials

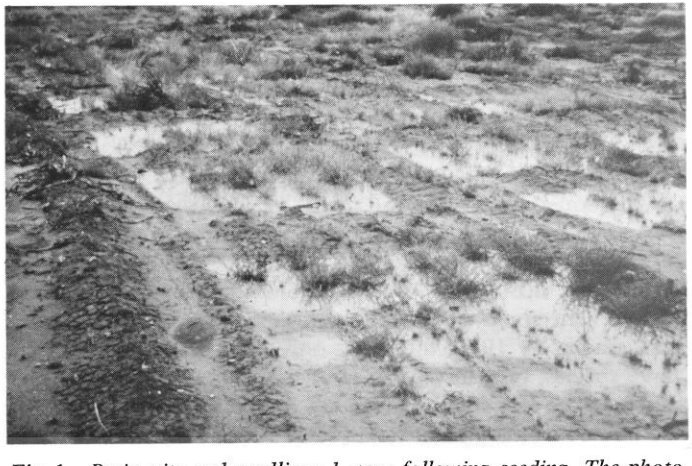

Fig. 1. *Basin pits and seedlings 1 year following seeding. The photo was taken following a thunderstorm.*

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The research is a result of cooperative investigations of Agr. Res. Serv., U. S. Dep. Agr., and the Agricultural Experiment Station, New Mexico State University, Las Cruces. (Journal article 418, Agr. Exp. Sta., New Mexico State University, Las Cruces.)

Manuscript received June 2, 1972.

Center (Soil Conservation Service, U. S. Department of Agriculture and New Mexico State University, cooperating). The seed of Marfa black grama was from a harvest of a native stand near Marfa, Texas. The seeding rate was 6 to 9 lb/acre of a mixture of chaffy seed plus 1 to 2 lb/acre of small, slick seed. Different ecotypes of the same species were seeded on separate plots, but various mixtures of species were used.

The plots were seeded in early summer. The stand ratings shown in Tables 1 through 3 for the 1966 to 1969 seedings were taken in the fall of 1970. The 1970 seedings were evaluated in the fall of 1971.

Jal Site

A deep sandy site infested with creosotebush (*Larrea tridentata*) on the Dinwiddie Ranch 10 miles west of Jal was rootplowed and seeded in 1966, 1967, and 1968. Table 1 shows the most successful species and ecotypes seeded each year.

The soil was very wet at the time of seeding on June 24, 1966, from about 2 inches of rainfall on June 19. This was followed by about 5 inches of rainfall the latter part of August. By October, there was an excellent stand of sideoats grama, black grama, and Lehmann lovegrass. However, all seedings at this area were heavily grazed in the summer and fall each year. By 1970, only a fair stand of the above three species remained, probably due to the heavy grazing (Table 1). There were only a few scattered plants of the other seeded species. The overall stand was rated as *poor*.

Over 2 inches of rain fell within a few days after the seeding on June 20, 1967. July and August, however, were hot and dry, so that by October there was only a poor stand of the seeded species. By October, 1970, there was a fair stand of sideoats grama and Lehmann lovegrass (Table 1). The overall stand was rated as *fair*.

Good rainfall in early July followed the 1968 seeding, and light showers occurred throughout the summer. By early fall, the stand was excellent. By 1970, there was an excellent stand of NM 44 black grama; a good stand of Marfa black grama and A 130 and A 16851 blue panic (*Panicum antidotale*); and a fair stand of sideoats grama, both accessions of blue grama, and Lehmann lovegrass (Table 1). The overall rating was *good to excellent*. Only a few scattered plants of A 12751 and A 12752 Boer lovegrass (*Eragrostis chloromelas*) were obtained during the 3 years at both Jal and Carlsbad.

Carlsbad Sites

A shallow, gravelly loam site infested with creosotebush on the Hood Ranch, 17 miles south of Carlsbad, N. Mex., was rootplowed and seeded in 1966. In 1967 and 1968, a loamy site infested with creosotebush on the Ussery Ranch, 12 miles east of Carlsbad, was rootplowed and seeded. See Table 1 for part of the species and ecotypes seeded each year.

The soil on the Hood Ranch site was shallow, and the rootplow, set to plow at the 9-inch depth, turned up large blocks of caliche. About 7.6 inches of precipitation were recorded at this site in August 1966. By fall, there was a good to excellent stand of fourwing saltbush, sideoats grama, and blue grama. By 1970, there was only a fair stand of the above three species, probably because of the droughty nature of the shallow site. The stand of NM 118 blue grama was better than the NM 115 blue grama stand (Table 1). The overall stand was rated as *poor* to *fair*.

More than 3 inches of rain fell within a few days following the seeding on the Ussery Ranch on June 21, 1967. By October, however, only a poor stand of the seeded species survived because of the dry, hot conditions prevailing in July and August. An excellent stand emerged in the spring of 1968, but much of it was lost in May and June. However, by September, 1968, there was a good stand. By 1970, there was a good stand of sideoats grama, black grama, and blue grama, and a fair stand of Lehmann lovegrass. No differences in stand between accessions of the same species were observed (Table 1). The overall stand was rated as *good to excellent.*

Over 3 inches of rainfall in early July followed the 1968 seeding on the Ussery Ranch. This was followed by about 3½ inches scattered throughout August. By fall, an excellent stand of some seeded species was evident. By 1970, there was an excellent stand of NM 44 black grama, *Eragrostis atherstonei*, and Lehmann lovegrass. There was also a good stand of Marfa black grama, sideoats grama, and blue grama (Table 1). The overall stand was *excellent*. No plants of NM 184 or C 14 alkali sacaton (*Sporobolus airoides*) were obtained from the three seedings at Carlsbad.

Table 1. Part of the species seeded with stand ratings[1] for plots at Jal and Carlsbad, N. Mex.

Species and ecotype	Jal			Carlsbad		
	1966	1967	1968	1966	1967	1968
Fourwing saltbush (*Atriplex canescens*)						
NM 155	vp	0	0	f-g	vp	p-f
Sideoats grama (*Bouteloua curtipendula*)						
Vaughn	f	f	f	p-f	g	–
NM 28	–	–	–	–	g	g
Black grama (*Bouteloua eriopoda*)						
NM 44	–	–	e	–	–	e
Marfa	f	p-f	g	p	g	g
Blue grama (*Bouteloua gracilis*)						
NM 115	vp	p	f	vp	g	g
NM 118	–	vp	f	f	g	g
Eragrostis atherstonei						
NM 500	vp	–	vp	–	–	e
Lehmann lovegrass (*Eragrostis lehmanniana*)						
A 14328	f	f	f	vp	f	e

[1] e = excellent; g = good; f = fair; p = poor; vp = very poor; 0 = none; – = not seeded.

Alamogordo Sites

A loamy site infested with creosotebush on the La Luz Study Site, Forest Service, 3 miles northeast of Alamogordo, N. Mex., was root-plowed and seeded in 1967 and 1968. In 1969 and 1970, a loamy site infested with creosotebush on the McGregor Range, about 25 miles south of Alamogordo, was rootplowed and seeded. Table 2 shows some of the species and ecotypes seeded.

About 2 inches of rain fell within 2 weeks after the seeding at La Luz on June 22, 1967. This was followed by about 3½ inches of rainfall reasonably well distributed throughout the remainder of the summer. By October the stand was rated as *good to excellent*, particularly under the dead brush cover and in the low places. The stand continued to persist, and by 1970 there was an excellent stand of A 68 Lehmann lovegrass; and a

good stand of fourwing saltbush, NM 45 black grama, and A 84 Boer lovegrass; a poor stand of NM 28 sideoats grama, Marfa black grama, and NM 115 blue grama; and a few scattered plants of NM 118 blue grama (Table 2). The overall stand was rated as *excellent* (Fig. 2).

About 1½ inches of rain fell within 10 days after the seeding at La Luz on June 27, 1968. This was followed by about 4 inches of rainfall from July 24 to August 12. By October the stand was excellent. By 1970, there was an excellent stand of NM 317 Lehmann lovegrass; a good stand of fourwing saltbush, NM 44 black grama, and A 84 Boer lovegrass; a fair stand of Marfa black grama and *Eragrostis atherstonei*; and a poor stand of NM 28 sideoats grama (Table 2). The overall stand was *excellent*.

Excellent moisture (about 7 inches of rainfall) occurred at the McGregor Site in late summer and early fall of 1969. By fall there was a poor to good stand on the eight plots seeded July 18-21, 1969. By fall, 1970, the stand was good to excellent on the various plots, and the species established persisted through droughty 1971. Table 2 gives the rating of some of the accessions as of the fall of 1971. One to four plots were seeded with each accession. NM 44 black grama was slightly better than Sonora, and both were superior to Marfa black grama. Only a few scattered plants of NM 115 blue grama were found, but poor to good stands were obtained with NM 118 blue grama. A 1407 yellow bluestem was more easily established than KG 495 yellow bluestem. Fair stands were obtained on plots seeded with *X* 38, *X* 11, and *X* 28 Lehmann lovegrass; a good stand was obtained with *X* 19 Lehmann lovegrass; and an excellent stand was obtained with NM 317 Lehmann lovegrass. The experimental numbers, *X* –, were breeding selections obtained from Dr. L. N. Wright, Agricultural Research Service, Tucson, Ariz. The overall rating on the eight plots was *good* to *excellent*.

Table 2. Part of the species seeded and stand ratings[1] for plots at Alamogordo.

	Alamogordo			
	La Luz		McGregor	
Species and ecotype	1967	1968	1969	1970
Fourwing saltbush				
(*Atriplex canescens*)				
NM 155	g	g	vp	vp
Sideoats grama				
(*Bouteloua curtipendula*)				
Vaughn	–	–	–	vp-p
NM 28	p	p	p-g	p
NM 368	–	–	f	p
Black grama				
(*Bouteloua eriopoda*)				
NM 44	–	g	g-e	f-g
NM 45	g	–	–	–
Marfa	p	f	f	vp-p
Sonora	–	–	g	p-g
Blue grama				
(*Bouteloua gracilis*)				
NM 115	p	0	vp	0
NM 118	vp	0	p-g	0
Yellow bluestem				
(*Bothriochloa ischaemum*)				
A 1407	–	–	g	vp-f
KG 495	–	–	vp	0
Eragrostis atherstonei				
NM 500	–	f	g	vp
Boer lovegrass				
(*Eragrostis chloromelas*)				
A 84	g	g	–	0-p
BF 66	–	–	0-f	0-p
A 12751	–	–	–	0-p
Catalina	–	–	f	0-p
Lehmann lovegrass				
(*Eragrostis lehmanniana*)				
A 68	e	–	–	g-e
A 14107	–	–	–	vp
A 14328	–	–	–	g-e
NM 317	–	e	e	g-e
X 11	–	–	f	vp
X 19	–	–	g	vp
X 28	–	–	f	f
X 38	–	–	f	vp

[1] e = excellent; g = good; f = fair; p = poor; vp = very poor; 0 = none; – = not seeded.

Fig. 2. *The foreground shows the untreated creosotebush site at La Luz, and the background shows the plot rootplowed and seeded in 1967. The photo was taken in 1968. Note the desert pavement in the untreated area. Also note the edge effects near the untreated area caused by rodents and rabbits. Soil erosion has been reduced considerably on the seeded area.*

Eleven 2-acre plots on the McGregor Range were rootplowed and seeded June 15 to 18, 1970. Precipitation was slightly above average in July, but August was hot and dry, and there were only light showers in September. Despite the droughty conditions, most plots had good to excellent stands by October. In 1971, winter, spring, and summer were very droughty. Table 2 gives the stand ratings observed during the fall of 1971. The same ranking among accessions of black grama and yellow bluestem observed on the 1969 seeding at McGregor was recorded for the 1970 seeding. Most accessions of Lehmann lovegrass were more readily established than Boer lovegrass or *Eragrostis atherstonei*. The overall rating on the eleven plots was *poor* to *good*, depending largely on the accessions seeded on a particular plot.

In addition to the results shown in Table 2, we had little or no success at Alamogordo in seeding the following: Lubbock rhodesgrass (*Chloris gayana*); A 13273 bush muhly (*Muhlenbergia porteri*); common sainfoin (*Onobrychis viciaefolia*); C 42, NM 168, or P 2575 Indian ricegrass (*Oryzopsis hymenoides*); NM 26, NM 184, or C 14 alkali sacaton; NM 164 creeping dropseed (*Sporobolus usitatus*); or A 3659 sacaton (*S. wrightii*). We had some success with blue panic; A 16851 was superior to A 130.

Jornada–Creosotebush Site

A gravelly, sandy loam site infested with creosotebush on the Jornada Experimental Range was rootplowed and seeded each year from 1966 to 1970. This site occurs on a 2% to 3% slope, and the soil is highly erosive. Essentially the same species and ecotypes seeded at Alamogordo were seeded at this

location. There were 1.9 inches of rainfall within 10 days following the seeding on August 11, 1966, and 0.8 inch in September. A fair stand was established by October. Most seedlings succumbed to drought in the winter and spring, 1966-67. The seeding on July 18, 1967, was followed by two heavy storms, each exceeding 2 inches in a short time. In all, 7.5 inches of rain fell on the seeded site from July 18 to September 30, 1967. Emergence of the seeded species was poor because of considerable erosion on the area. The summer rainfall after the seeding on July 19, 1968, was 4.5 inches. By October, there was a good stand of the seeded species, but by the fall of 1969 only a poor stand of fourwing saltbush, sideoats grama, A 84 Boer lovegrass, and NM 317 Lehmann lovegrass remained. The death loss was due to dry conditions in the winter and spring, 1968-69.

The summer rainfall after seeding on August 7, 1969, was 1.9 inches. By early fall, good emergence had occurred in spots, but most seedlings were desiccated. By 1970, there was no evidence of the seeded species.

An area was seeded on the Jornada Experimental Range on June 24 and 25, 1970. From July 1 to August 5, 2.6 inches of rainfall were recorded, but the remainder of August and all of September were hot and dry. By mid-August, some seedlings had emerged on these plots. However, by mid-September, the seedlings were dead.

Jornada–Tarbush Site

A heavy loam site infested with tarbush (*Flourensia cernua*) on the Jornada Experimental Range was rootplowed and seeded each year from 1967 through 1970. The soil on this site crusts heavily after a rainstorm. The seeding on August 8, 1967, was followed by 2.3 inches of rainfall during the remainder of the summer. Poor to fair stands of fourwing saltbush, NM 28 sideoats grama, tobosa (*Hilaria mutica*), NM 184 alkali sacaton, and A 3659 sacaton were obtained. Nearly all those plants were growing under the dead brush cover. This initial stand persisted through the years. After the seeding on July 23, 1968, 6.2 inches of rain fell the remainder of the summer. By October, there was an excellent stand in the bottom of the basin pits. By 1970, the ratings for those accessions that grew were: fourwing saltbush, *very poor*; NM 28 sideoats grama, *fair*; A 1407 and KG 495 yellow bluestem, *good*; NM 184 alkali sacaton, *fair*; and A 3659 sacaton, *poor*. The overall stand was rated *fair to good.*

The summer rainfall following seeding on August 7, 1969, was 2.3 inches. Fair emergence was observed on the area in early September, but by October, most seedlings were desiccated. By fall, 1970, all plants had died.

Virtually the same accessions seeded in 1969 at the heavy loam site were also seeded on June 25, 1970. The rainfall between July 1 and August 5 was 5.6 inches. By mid-August, there was good emergence on these plots, but the remainder of the summer was hot and dry. By early fall, most seedlings were desiccated.

We had no success in seeding the following on the Jornada-tarbush site: Vaughn or NM 368 sideoats grama; KG 40 Caucasian bluestem (*Bothriochloa caucasica*); NM 500 *Eragrostis atherstonei*; BF 66 or Catalina Boer lovegrass;

Fig. 3. *Fourwing saltbush plant the year following seeding. There were enough of these plants to outgrow the competition due to browsing by rabbits and rodents.*

Table 3. Species seeded and stand ratings[1] for plots at Deming and Lordsburg, N. Mex., seeded in 1967 and 1968.

Species and ecotype	Deming		Lordsburg	
	1967	1968	1967	1968
Fourwing saltbush (*Atriplex canescens*)				
NM 155	g	g	p	vp
Sideoats grama (*Bouteloua curtipendula*)				
NM 28	vp-f	vp-f	f	f-g
Black grama (*Bouteloua eriopoda*)				
A 3730	p	–	p	–
NM 44	–	g	–	g
Marfa	p	p	p	vp
Eragrostis atherstonei				
NM 500	–	0	–	p
Boer lovegrass (*Eragrostis chloromelas*)				
A 84	g	g	vp	f
BF 66	–	0	–	p
A 12751	0	–	p	–
Lehmann lovegrass (*Eragrostis lehmanniana*)				
A 68	e	g	f	f
NM 317	g	e	f	g
Bush muhly (*Muhlenbergia porteri*)				
A 13273	0	0	vp	vp
Alkali sacaton (*Sporobolus airoides*)				
NM 184	vp	p	0	vp
C 14	p	vp	vp	0

[1] e = excellent; g = good; f = fair; p = poor; vp = very poor; 0 = none; – = not seeded.

Lubbock rhodesgrass; C 42, NM 168, or P 2575 Indian ricegrass; A 130 or A 16851 blue panic; vinemesquite (*Panicum obtusum*); NM 26 or C 14 alkali sacaton; or NM 164 creeping dropseed.

Deming Site

A loamy site infested with creosotebush on the Smith Ranch, 11 miles northeast of Deming, N. Mex. was rootplowed and seeded in 1967 and 1968. The species and ecotypes seeded are shown in Table 3. Following the seeding on June 27, 1967, dry conditions prevailed until July 29. From then until September 25, about 4.9 inches of rain fell at this site. By October, the stand on the plot was excellent, particularly Lehmann lovegrass. Following the seeding on June 20, 1968, the rainfall during the summer was above average. By October, the stands on both the 1967 and 1968 seedings were excellent. The rating on both plots decreased to *good* by 1970 because of droughty conditions. The individual accessions seeded in both 1967 and 1968 had the same rating in 1970 (Table 3).

Lordsburg Site

A loamy (limy) site infested with creosotebush on the Rouse Ranch, two miles south of Lordsburg, N. Mex., was rootplowed and seeded in 1967 and 1968. The same species used each year at Deming were also used at this location. After the seeding on June 26, 1967, 2.9 inches of rain fell during the summer. By October, the stand was poor, probably because the storms were too light to moisten the soil adequately. Following the seeding on June 19, 1968, the summer rainfall was slightly above average. By October 1968, the stand of the seeded species was excellent under the dead brush cover but poor elsewhere. The 1967 seeding was poor except in the drainages. The overall ratings on both plots were slightly higher in 1970 than previously–*poor to fair* for the 1967 plot and *fair* for the 1968 plot. The individual accessions seeded in both 1967 and 1968 had about the same rating in 1970 (Table 3).

Discussions and Conclusions

Twenty-three seedings were made across southern New Mexico from 1966 to 1970. At the final rating, 10 of these had good to excellent stands, and 4 had fair stands. Many of the failures were related to site conditions. We had no success in seeding the gravelly, sandy loam site on the Jornada. This site has a 2 to 3% slope, and it is highly erosive. Rootplowing and seeding on this site must be accompanied by erosion control measures. We had little success on the heavy loam site on the Jornada. After the first significant rainfall following seeding, the soil surface becomes heavily crusted. This reduces infiltration and makes it virtually impossible for the small-seeded species to emerge.

Droughty sites are also difficult to seed successfully. Very shallow sites, such as on the Hood Ranch, have a limited water-holding capacity. Even though a good to excellent stand was obtained initially, this was thinned considerably during droughty periods. Soils high in lime, such as at Lordsburg, also tend to be droughty.

At Jal, one seeding failed because of grazing pressure shortly after the seedlings emerged. Seedlings must be protected from heavy grazing during the year of establishment. Deferment from grazing during the growing season for 1 to 3 years aids in establishment of seeded stands.

Even under droughty conditions, there generally was a good stand of the seeded species under the brush cover, particularly when the brush covered a low place where water was concentrated. Virtually all established seedlings of fourwing saltbush were located on such sites.

Fourwing saltbush requires moister, cooler conditions than most grass species used in these trials, and it was often browsed by rabbits and rodents. In some instances, browsing prevented the saltbush plants from growing more than 6 or 8 inches tall. It is also likely that some seedlings were killed by rabbits and rodents. In at least one instance, the 1967 seeding at Alamogordo, the saltbush plants outgrew this damage and attained a height of 36 to 42 inches within a year of seeding (Fig. 3). Close grazing by rabbits and rodents has also been observed on the grasses. Some control measures would undoubtedly assist stand establishment.

The plants established under the brush cover were generally two to three times taller than those established on the areas without brush cover. These plants were more likely to survive droughty periods and winters. The basin pits also increased stand density, but it was important for the pit to be structurally sound. There often was a seeding failure in those pits that did not hold water.

It is also important to seed ecotypes that are easily established. In these trials, Lehmann lovegrass was more readily established than the other species. The best accessions were A 68 and NM 317. Good stands of fourwing saltbush were established on several plots. It was generally difficult to establish *Eragrostis atherstonei* and Boer lovegrass; A 84 Boer lovegrass was superior to the other accessions.

In seedings at Carlsbad, Vaughn sideoats grama was equal to NM 28. In limited comparisons at Alamogordo and the Jornada, NM 28 was superior to NM 368.

In direct comparisons, NM 44 and Sonora black grama were superior to Marfa black grama. Generally, NM 115 and NM 118 blue grama were about equal.

Of the Asiatic bluestems, A 1407 yellow bluestem was better than the others. In limited trials, we were unable to establish rhodesgrass or vinemesquite. The viability of vinemesquite seed is very low. Tobosa, bush muhly, creeping dropseed, sacaton, and Indian ricegrass were also difficult to establish. Generally, there was little establishment of alkali sacaton; NM 184 was slightly superior to C 14. Good stands of blue panic were established on some plots; A 130 and A 16851 were about equal.

The ecotypes most easily established on the sandy to loamy sites infested with creosotebush were NM 155 fourwing saltbush, sideoats grama (Vaughn or NM 28 in the eastern part of New Mexico and NM 28 for the areas further west), NM 44 or possibly Sonora black grama, NM 115 or NM 118 blue grama (at Carlsbad only), A 1407 yellow bluestem, A 84 Boer lovegrass, A 68 or NM 317 Lehmann lovegrass, and A 130 or A 16851 blue panic. On heavier soils, such as the tarbush site on the Jornada, the best ecotypes were NM 28 sideoats grama, A 1407 yellow bluestem, and NM 184 alkali sacaton. The exact seed mixture for any site depends on management objectives.

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