Seeding Pelleted and Unpelleted Seed on Four Range Types[1]

A. T. BLEAK AND A. C. HULL, JR.[2]

Range Conservationists, Field Crops Research Branch, Agricultural Research Service, U. S. Department of Agriculture, Ephraim, Utah, and Logan, Utah.

There has been a constant search for improved methods for revegetating depleted range lands. Attempts have been made to find methods which are adapted to a wide variety of conditions, easy to apply and relatively inexpensive. One of the more recent methods was seeding "compressed" pellets. These pellets consist of a mixture of soil, seed of adapted species, rodent and insect repellent, and fertilizer, compressed into small hard spheres.

The first large-scale seedings by this process were in 1946 when 10,000 acres were seeded on the Papago Indian Reservation in Arizona. Subsequently, an additional 80,000 acres were seeded on southwestern Indian reservations during 1946-48. Reports by Wagner (1949) and Wagner and Kinkor (1950) showed that the 90,000 acres seeded on Indian reservations were failures.

During 1948 and 1949, approximately 73,500 acres were broadcast with compressed pellets on Bureau of Land Management lands in the West. There was no over-all report for these areas, but a detailed report on 21,000 acres seeded in Idaho in 1947-48 records the poor results on this area which were typical of all areas (Tisdale and Platt, 1951). This and a later report (Moomaw *et al.*, 1954) indicated that lack of seed covering, competition from native vegetation and a marked reduction in seed viability as a result of pelleting were some of the major causes of failure.

In 1948 an experimental aerial broadcasting of pelleted and unpelleted seed was made on 7,510 acres on four range types on national forest land in southeastern Utah. These plantings were made to compare stand establishment from pelleted and unpelleted seed, as well as to measure the effect of several ground preparations and seed covering methods. Bleak and Phillips (1950) reported unpelleted seed was superior to pelleted seed in producing seedlings under all comparable conditions included in this study. Two major reasons were: (1) Seed was broadcast at 1.2 and 2.4 pounds per acre on pellet treatments as compared to 10 pounds per acre of unpelleted seed. Because of processing and aerial broadcasting costs it was considered too expensive to use rates of more than two pellets per square foot on range lands. (2) Laboratory tests and field trials showed that compression of seed during pelletizing resulted in mechanical seed injury and other damage. Reduced germination and seedling emergence from seed of crested wheatgrass or other species after compression pelletizing has also been reported by Allen (1948), Stevenson (1949), Tisdale and Platt (1951), and Moomaw, *et al.* (1954).

The 1950 report by Bleak and Phillips was for seedling stands only. Because later results showed no change in the value of pellets for range seeding and because of waning interest in pellet seeding, mature stand establishment and herbage production were not reported. With the recent renewed interest in pellet seeding, it was decided to reevaluate these 7-year-old stands and present additional data.

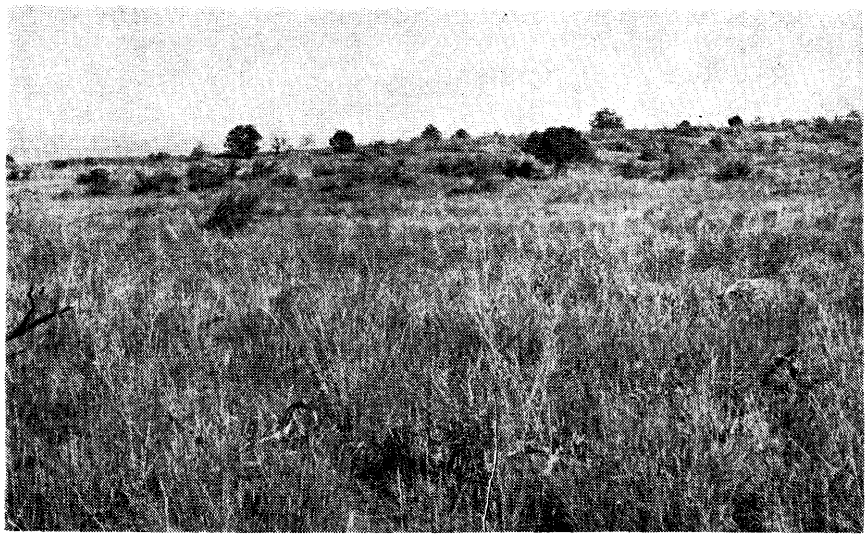

FIGURE 1. This dense two-year-old grass stand, obtained by plowing and drilling in 1953 after the 1948 aerial broadcasting of one-pellet-per-square-foot failed to produce a stand, is yielding 1,220 pounds of air-dry forage per acre.

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They provide information from mature stands on the relative merits of broadcasting pelleted and unpelleted seed and show how certain tillage methods affected establishment of mature stands.

Location and Methods

Aerial broadcastings were made in four vegetation types on the Monticello district of the Manti-LaSal National Forest in southeastern Utah. These types ascend in elevation from the lower limits of the juniper-pinyon type at about 6,500 feet, through the mountain brush and ponderosa pine types, to the upper limits of aspen type at about 8,400 feet. Estimated annual precipitation varies from about 15 inches in the juniper-pinyon to 28 inches in the aspen. Precipitation is predominately of the winter pattern although thunderstorms characteristically occur in July and August. A light, sandy loam soil is general throughout the area.

The juniper-pinyon type (mainly *Juniperus osteosperma and Pinus edulis)* has a sparse mountain brush and herbaceous understory. Openings in the stand usually have a well-developed erosion pavement. The mountain brush type consists of dense stands of big sagebrush *(Artemisia tridentata)* with frequently interspersed clumps of serviceberry *(Amelanchier alnifolia)* and gambel oak *(Quercus gambeli)*. The ponderosa pine type consists of an open stand of ponderosa pine *(Pinus ponderosa)* with a sparse mountain brush understory. Trailing fleabane *(Erigeron flagellaris)* and hairy goldaster *(Chrysopsis villosa)* occur in the openings. The aspen type consists of alternate stands of aspen trees *(Populus tremuloides)* and openings which are usually covered with moderate to heavy stands of trailing fleabane and hairy goldaster.

Pelleted and unpelleted seed was broadcast by airplane on large seedings where there was no seedbed preparation. Experimental areas, with different methods of seedbed preparation, were broadcast to pelleted and unpelleted seed by airplane and by hand.

Seeding rates for pellets were one and two pellets per square foot or 1.2 and 2.4 pounds of seed per acre. Unpelleted seed was broadcast at 10 pounds per acre. One pellet per square foot was recommended by the pellet manufacturer as a proper seeding rate. The two-pellets-per-square-foot treatment was included to see what pellets would do at double the recommended rate. Ten pounds per acre was the established rate for broadcasting normal seed without covering. In processing pellets, an attempt was made to process different kinds of seed separately and the size of the pellets was adjusted for size of seed. Seed mixtures of pelleted and unpelleted seed broadcast on the various types are as follows:

Juniper-pinyon — four parts smooth brome *(Bromus inermis);* four parts crested wheatgrass *(Agropyron desertorum);* two parts bulbous bluegrass *(Poa bulbosa);* and one part yellow sweetclover *(Melilotus officinalis).*

Mountain brush — five parts smooth brome; two parts crested wheatgrass; one part slender wheatgrass *(Agropyron trachycaulum);* two parts orchardgrass *(Dactylis glomerata);* and one part yellow sweetclover.

Aspen and ponderosa pine — four parts smooth brome; two parts orchardgrass; and one part timothy *(Phleum pratense).*

Large-Scale Seedings

Pelleted and unpelleted seed was aerial broadcast in September, 1948. Good distribution of unpelleted seed was obtained by broadcasting during the early morning and in the evening when the air was calm. Satisfactory distribution of pellets was obtained with moderate winds and they were broadcast whenever the pilot considered it safe to fly. Unpelleted seed and both rates of pellet broadcasting were applied in the juniper-pinyon, mountain brush, and ponderosa pine. In the aspen, the two-pellets-per-square-foot intensity was omitted. A total of 7,510 acres were seeded within the four vegetative types.

Seedling counts were made in all treatment areas during June-July of 1949 and plant counts plus herbage production estimates were made on seeded species in July of 1955. Herbage production estimates were converted to oven-dry weights from samples taken in each area. Plant counts were determined on 10-square-foot samples located on random transects. Herbage production was obtained by the weight-estimate technique of Frischknecht and Plummer (1949). For sampling purposes, major treatment areas were subdivided into openings, drainages and canopy. Thirty-five plots were sampled in each of these subdivisions but only the average for the treatment area has been presented here. Sample counts on the one-pellet mountain brush area in 1955 were restricted to the east portion of the original treatment area. This was necessary because the west 2,000 acres was rated a failure and was plowed and drilled to grass in 1953 and 1954.

Intensive Studies

Intensive studies were established in representative areas in the juniper-pinyon, mountain brush, and ponderosa pine types in September and October of 1948. Treatments were applied in randomized block design, each with two replications.

Each block in the mountain brush study contained 24 acres, with twelve separate treatments. Each 24 acres was first divided into three 8-acre strips to which

the following treatments were applied:

1. Wheatland plowing
2. Pipe harrowing
3. No cultural treatment

The four following seeding treatments were applied at right angles across the three treatments shown above:

1. Unpelleted seed hand broadcast at 10 pounds per acre—harrowed
2. Unpelleted seed aerial broadcast at 10 pounds per acre
3. Aerial broadcast of one pellet per square foot
4. Aerial broadcast of two pellets per square foot

Each 4½-acre burned sagebrush area within the mountain brush type was divided into four 1⅛-acre plots to which the treatments listed below were assigned at random. All seeding treatments were hand broadcast.

1. Unpelleted seed at 10 pounds per acre—harrowed
2. Unpelleted seed at 10 pounds per acre
3. One pellet per square foot
4. Two pellets per square foot

Each 4-acre area in the ponderosa pine and in the juniper-pinyon types was divided into four one-acre plots which received the treatments listed below. All seeding treatments were hand broadcast.

1. Unpelleted seed at 10 pounds per acre—dragged
2. One pellet per square foot —dragged
3. One pellet per square foot
4. Two pellets per square foot

Livestock exclosures were constructed around one replication of the small plots in the juniper-pinyon, ponderosa pine, and the burned sagebrush in the mountain brush. Both replications were fenced on the larger mountain brush study area. All plots were sampled in 1949. Only the plots within livestock exclosures were sampled in 1955. Thirty 10-square-foot random samples were taken in each separate treatment sampled.

Table 1. Average number of plants per square foot in 1949 and 1955 and estimated dry herbage per acre on four range types.

Location and Treatment	Acres Seeded	Plants per sq. ft. 1949	Plants per sq. ft. 1955	Dry herbage (lbs. per A.) 1955
Juniper-Pinyon type:				
1 pellet per sq. ft.	450	0.08	Trace	1.5
2 pellets per sq. ft.	300	0.11	0.01	3.4
Unpelleted seed (10 lbs./A.)	160	2.57	0.02	9.2
Mountain Brush type:				
1 pellet per sq. ft.	3000	0.01	Trace	0.1
2 pellets per sq. ft.	1560	0.01	Trace	0.4
Unpelleted seed (10 lbs./A.)	640	1.18	0.07	61.5
Ponderosa Pine type:				
1 pellet per sq. ft.	588	0.20	Trace	0.3
2 pellets per sq. ft.	458	0.29	Trace	1.3
Unpelleted seed (10 lbs./A.)	164	8.91	0.18	12.5
Aspen type:				
1 pellet per sq. ft.	30	0.38	0.23	134.2
Unpelleted seed (10 lbs./A)	160	9.46	0.68	251.0

Results and Discussion

Bleak and Phillips (1950) reported that favorable temperatures and moisture following seed broadcasting resulted in numerous seedlings in the fall of 1948 in the unpelleted seed treatments and a few seedlings in the pellet seeded areas. Although the 1949 growing season began late, climatic conditions were favorable for sprouting and for seedling establishment on all pelleted and unpelleted areas.

Large-Scale Seedings

There was a marked decline in plant numbers from 1949 to 1955 on all areas which had been aerial broadcast with pelleted or unpelleted seed (Table 1). The counts made in 1955 confirmed the 1950 report that in all four vegetation types the areas broadcast to unpelleted seed at 10 pounds per acre contained more plants per square foot than comparable areas broadcast to pellets at rates of one or two pellets per square foot. Doubling the pellet seeding rate to two pellets per square foot in the ponderosa pine, mountain brush or juniper-pinyon did not result in a material increase of plants either in 1949 or 1955. Doubling the pellet seeding rate on these types resulted in an herbage increase but this increase was less than 2.0 pounds per acre in 1955.

In considering costs, the principal expense for the unpelleted seed treatment was cost of seed, while processing pellets was the principal cost incurred in pellet plantings. Unpelleted seed at 10 pounds per acre cost $3.47 as compared to $2.40 per acre for one pellet per square foot and $4.80 per acre for two pellets per square foot.

In the aspen type where successful stands from broadcasting unpelleted seed have been reported (Stewart and Plummer, 1947), pelleted seed made its best showing. Also, the decrease in plant numbers from 1949 to 1955 was less pronounced than in other types, especially on the pellet seeded area. The numbers and distribution of seeded plants under the aspen canopy were adequate for fair stands on both treatment areas.

In the openings between the aspen stands, the trailing fleabane, hairy goldaster and other

native species provided severe competition for the seeded grass plants. Seeded species were generally found in the openings only where native species were sparse or absent, but established plants of smooth brome were spreading vegetatively into stands of native grasses and forbs. The high mortality of seeded plants in these openings accounted for a large portion of the decrease in plant numbers shown for this vegetation type.

In the other vegetation types, most of the seedling plants present in 1949 had disappeared by 1955. Number of plants and herbage production on the areas seeded with unpelleted seed was greater than on the comparable areas seeded to pellets at one or two pellets per square foot, but the sparse stands on these unpelleted areas must also be considered failures. In the ponderosa pine most of the existing plants were in the openings between the trees; in the mountain brush, under gambel oak and serviceberry canopy; and in the juniper-pinyon, about equally divided between canopy and openings. Generally speaking, size and apparent vigor of seeded plants were closely but inversely correlated to relative abundance of native grasses, forbs, and big sagebrush in the immediate vicinity.

Herbage production per acre on a dry weight basis on these large seedings in 1955 ranged from 134 pounds to 251 pounds per acre in the aspen; from only 0.3 to 12.5 pounds per acre in the ponderosa pine; from a trace to 61.5 pounds per acre in the mountain brush and from 1.5 to 9.2 pounds per acre in the juniper-pinyon.

The species seeded in each type were used because they had shown adaptability to the respective type in previous seedings on similar areas. In the aspen type, smooth brome appeared to be the best adapted species under the canopy and also in the openings. Orchardgrass and timothy plants were usually vigorous under the aspen canopy but were usually small and spindly in the openings. Smooth brome also appeared to be the best suited species in the ponderosa pine on this site. Timothy and orchardgrass plants were usually small and spindly. In the mountain brush type smooth brome and crested wheatgrass appeared about equally well adapted to the type with the smooth brome superior under the canopy and crested wheatgrass superior in the openings. Very few plants of yellow sweetclover, the relatively short-lived slender wheatgrass, or orchardgrass could be found. In the juniper-pinyon, crested wheatgrass and bulbous bluegrass were the most numerous. The bulbous bluegrass plants dried early and produced very little forage. Very few plants of yellow sweetclover, of smooth brome could be found in this type.

The west portion of the 1948 one-pellet treatment in the mountain brush type provided additional information on how tillage methods affected establishment of planted grasses. This area of approximately 2,000 acres, which failed to produce a satisfactory stand following aerial broadcasting of pellets in 1948, was plowed to remove the native vegetation and drilled to provide seed covering in 1953 or 1954. In 1955, a high yielding grass stand was growing on the portion of the area plowed and drilled in 1953 (Fig. 1) and a good seedling stand was growing on the area treated in 1954. The stands produced on this area by plowing and drilling in 1953 or 1954 were similar to the stands produced on plowed plots broadcast with unpelleted seed in 1948 on the adjoining experimental study area in this type.

Intensive Studies

The average number of seedlings in 1949, the number of established plants, and the estimated herbage production in 1955 for plot studies in the mountain brush, ponderosa pine, and juniper-pinyon is shown in Table 2. All plots sown to unpelleted seed at 10 pounds per acre had a greater number of established plants in 1949 and 1955 and produced more herbage per acre in

FIGURE 2. Aerial broadcasting of one-pellet-per-square-foot was made on plowed land *(left)* and harrowed land *(right)* in September, 1948. Large plants of smooth bromegrass and crested wheatgrass can be seen in the foreground, but vigorous sagebrush plants and native grasses and forbs dominate both plots.

1955 than did the plots seeded at a rate of one pellet or two pellets per square foot. These results agree with those on the large-scale seedings.

Herbage yields per acre on the mountain brush plots increased in proportion to the amount that tillage reduced competition from native plants and provided seed coverage. For example, yields were higher when unpelleted or pelleted seed was broadcast on a plowed or harrowed seedbed than when the respective seeding treatments were applied without prior tillage treatments. Where pipe harrowing followed broadcasting, this further reduced plant competition and resulted in even greater forage yields.

Broadcasting of unpelleted seed on the plowed and harrowed plots with no later cultural treatment produced more seedlings in 1949 than broadcasting followed by harrowing. It appeared that the loose soil covered the broadcast seed by sloughing but that harrowing the loose soil covered some of the seed too deep. By 1955 this difference in plant numbers on comparable plots had largely disappeared.

On these mountain brush plots, herbage production on plots broadcast with unpelleted seed at 10 pounds per acre was markedly greater than on plots broadcast with pelleted seed at rates of one or two pellets per square foot. Where tillage treatments had been applied, the invasion of big sagebrush, native grasses, and native weeds was more pronounced on pellet-seeded areas (Fig. 2) than on areas seeded with unpelleted seed because of a sparser stand of seeded grass. Good grass stands allowed but few sagebrush or other plants to invade the area.

On the burned sagebrush plots in the mountain brush type, removal of competition by burning followed by broadcasting unpelleted seed produced good grass stands and herbage yields. These results were similar to the success reported by Christ (1934), Friedrich (1947), Pickford and Jackman (1944), and Hull and Stewart (1948) from broadcasting unpelleted seed where ash from burns provided seed covering. These good grass stands prevented reinvasion of big sagebrush (Fig. 3). The increase in plant numbers from 1949 to 1955 in the one-pellet area is largely attributed to reseeding and filling in from established crested wheatgrass plants. Eighty-five percent of the crested wheatgrass plants on this area were less than two inches in diameter and were generally scattered around the larger plants.

In the ponderosa pine, number of plants present on all treatments in 1955 was much lower than in 1949. Unpelleted seed produced significantly more plants and higher yields than pelleted seed. The higher yields on the one-pellet-harrowed, and the unpelleted-harrowed plots are considered to be due to reduction in competition from native herbaceous plants by harrowing. Ponderosa pine and the understory plants afford severe competition for the planted grasses as evidenced by relatively low yields of planted grasses; 141.1 pounds per acre was the highest yield even with an average of slightly more than one plant per square foot.

In the juniper-pinyon plots the unpelletd seed treatment was superior to the pelleted seed treatment in both number of plants and herbage production. Competition from juniper-pinyon and

Table 2. Average number of seedling plants in 1949, established plants in 1955 and estimated dry herbage production in 1955 on experimental plots.

Location and Treatment*	Plants per sq. ft. 1949	Plants per sq. ft. 1955	Weight (lbs./A.) 1955
Mountain Brush			
Plowed—1 pellet	0.15	0.06	116.3
Plowed—2 pellets	0.22	0.11	136.2
Plowed—Unpelleted	6.16	1.06	652.1
Plowed—Unpelleted (harrowed)	2.88	1.00	812.6
Harrowed—1 pellet	0.08	0.05	76.7
Harrowed—2 pellets	0.10	0.09	77.0
Harrowed—Unpelleted	4.40	0.69	578.6
Harrowed—Unpelleted (harrowed)	3.36	0.79	648.0
No tillage—1 pellet	0.05	0.01	5.7
No tillage—2 pellets	0.06	0.01	1.4
No tillage—Unpelleted	2.26	0.08	77.3
No tillage—Unpelleted (harrowed)	3.32	0.46	373.8
Burned Sagebrush			
1 pellet	0.06	0.57	183.1
2 pellets	0.25	0.15	181.9
Unpelleted	1.58	1.01	710.3
Unpelleted (harrowed)	2.01	0.94	551.9
Ponderosa pine			
1 pellet	0.20	0.01	5.4
1 pellet (harrowed)	0.29	0.07	29.2
2 pellets	0.36	0.03	10.8
Unpelleted (harrowed)	19.99	1.07	141.1
Juniper-pinyon			
1 pellet	0.12	0.00	0.0
1 pellet (dragged)	0.18	0.02	1.2
2 pellets	0.30	0.01	0.7
Unpelleted (dragged)	2.80	0.08	8.4

* Treatments were one pellet per square foot, two pellets per square foot, and unpelleted seed at 10 pounds per acre.

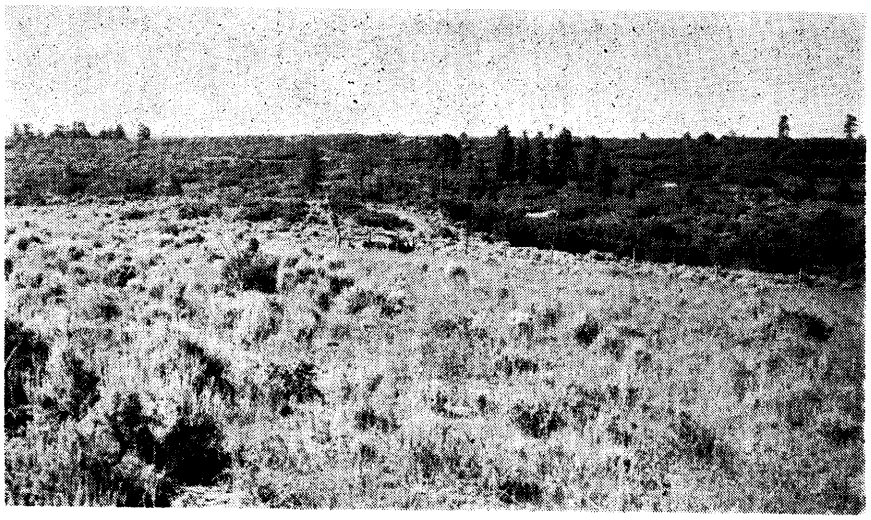

FIGURE 3. Unpelleted seed of crested wheatgrass and smooth brome broadcast and harrowed on a sagebrush burn produced a good stand which kept out most of the sagebrush *(right)*. Plot on the left was broadcast to pelleted seed with no seed covering. A thick stand of sagebrush soon invaded the area.

native herbaceous species was severe in this type. Crested wheatgrass plants were normally small with few or no seedheads, but where trees, brush and herbs had been removed from fence lines in the fall of 1948, plants were large and vigorous.

The results from both the large-scale planting and the intensive plot studies are in agreement with Robertson and Pearse (1945), Moomaw *et al.* (1954), and Plummer *et al.* (1955) that full stands of competing vegetation must be reduced for successful establishment of planted species.

Summary and Conclusions

1. Seeds in compressed pellets did not have any advantage over unpelleted seeds in producing stands of planted species under all comparable conditions in the four range types.

2. In the aspen type where successful stands from broadcasting unpelleted seed have been previously reported, pelleted seed made its best showing, but even here the number of plants per square foot resulting from broadcasting one pellet per square foot was less than from broadcasting unpelleted seed at 10 pounds per acre.

3. Broadcasting pellets at twice the recommended rate did not materially improve established grass stands or increase herbage production in the ponderosa pine, mountain brush or juniper-pinyon types.

4. Grass stands and herbage production from broadcasting unpelleted seed were considered successful in the ponderosa pine, mountain brush, or juniper-pinyon types only where competing vegetation was reduced and some seed covering provided. Herbage yields were increased in proportion to reduction of competition from native plants.

5. The major factors which limited plant numbers and forage yields from planted species in this study were reduced seed germination from pelleting, unfavorable conditions for seed germination or plant establishment and competition by native vegetation.

LITERATURE CITED

ALLEN, C. E. 1948. Some notes on "pelleted" crested wheatgrass seed. News Letter, Assn. Official seed Analysts. 22:39-40.

BLEAK, A. T. AND T. A. PHILLIPS. 1950. Seedling stands from airplane broadcasting of pelleted and unpelleted seed in southeastern Utah. Intermtn. Forest and Range Exp. Sta. Res. Paper 22, 14 pp.

CHRIST, J. H. 1934. Reseeding burned-over lands in northern Idaho. Univ. Idaho Bull. 201. 28 pp.

FRIEDRICH, C. ALLAN. 1947. Seeding grass by airplane on western Montana's burned-over timberlands. Northern Rocky Mtn. Forest and Range Exp. Sta. Res. Note 52. 5 pp.

FRISCHKNECHT, NEIL C. AND A. PERRY PLUMMER. 1949. A simplified technique for determining herbage production on range and pasture land. Agron. Jour. 41:63-65.

HULL, A. C. JR., AND GEORGE STEWART. 1948. Seeding southern Idaho rangelands by airplane. Intermtn. Forest and Range Exp. Sta. Res. Paper 16. 14 pp.

MOOMAW, J. C., E. W. TISDALE, L. A. SHARP AND K. B. PLATT. 1954. Studies of pelletized seed for range reseeding. Univ. Idaho Forest, Wildlife and Range Exp. Sta. Res. Note 11. 10 pp.

PICKFORD, G. D. AND E. R. JACKMAN. 1944. Reseeding eastern Oregon summer ranges. Ore. Agr. Exp. Sta. Circ. 159. 48 pp.

PLUMMER, A. P., A. C. HULL, JR., GEORGE STEWART AND J. H. ROBERTSON. 1955. Seeding rangelands in Utah, Nevada, southern Idaho and western Wyoming. U. S. Dept. Agr. Handbook 71. 73 pp.

ROBERTSON, J. H. AND C. K. PEARSE. 1945. Artificial reseeding and the closed community. Northwest Sci. 19:58-66.

STEWART, GEORGE AND A. P. PLUMMER. 1947. Reseeding range lands by airplane in Utah. Utah Acad. Sci., Arts and Letters, Proc. 24:35-39.

STEVENSON, E. W. 1949. Results of preliminary tests of pelletized crested wheatgrass seed. Pacific Northwest Forest and Range Exp. Sta. Res. Paper 53. 7 pp.

TISDALE, E. W. AND K. B. PLATT. 1951. Pellet reseeding trials on southern Idaho range lands. Univ. Idaho and Bur. Land Mangt. Spec. Res. Report, Proj. 16. 23 pp.

WAGNER, J. A. 1949. Results of airplane seedings on Indian reservations. Jour. Forestry 47:632-635.

WAGNER, J. A., AND C. P. KINKOR. 1950. Will pellet seeding work? American Forests 56:25, 44-45.