Testing New Range Forage Plants[1]

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America's wide open spaces, the range lands of the West, are beginning to receive some long deserved attention. Large areas of this country's original range lands have been diverted to uses other than grazing. They were first used by native game and native Americans, then crossed by explorers, missionaries, and livestock growers. Finally permanent settlers came to plow up and dry farm or irrigate large tracts of range land. Although some plowed areas have been abandoned, range lands are still decreasing in acreage because of new reclamation projects and the expansion of highways, cities and industrial sites.

The remaining range lands, heavily used for more than a hundred years, are still important to the economy of the West, first because of the tremendous acreage involved; second because the roughages produced on these wild lands can be profitably used by livestock; third because the range lands are adjacent to ranches producing livestock in small irrigated valleys where hay for winter feeding can be produced; and fourth range lands are often watersheds for irrigation projects and are also used for recreation and by big game animals.

Many attempts to domesticate range plants have failed, largely because the methods used were too direct. They were based on collections of seed where abundant, and direct seeding of such seeds into range areas without intermediate testing. Under the rigorous and droughty climatic conditions the seed produced on native stands and vigor of seedlings from native seed were seldom good. Cultural practices were not known. The wide variation among ecotypes of many species made improbable the selection of the right strain for optimum establishment. After heavy use almost to the extinction of some species, native grasses have finally caught the attention of plant collectors, plant breeders, conservationists and eventual users. Native American range grasses are now being developed and tested for use in reseeding depleted ranges and marginal farm lands. Figure 1 shows the physical plant and main development area of a Plant Materials Center.

Work on range reseeding has been slow in developing because of the high cost of reseeding in relation to the value of the land involved. Range reseeding has also been retarded by the lack of adapted varieties, the lack of successful cultural methods, and the general thought that forage production could be increased by range protection and a reduction in livestock numbers. Proper management and integration of domestic livestock and wild game use are still the most important hope for improvement of nonplowable acres. On many other range acres where important productive native plants are scarce, large tracts are now invaded by sagebrush, rabbitbrush and other weeds. Here manage-

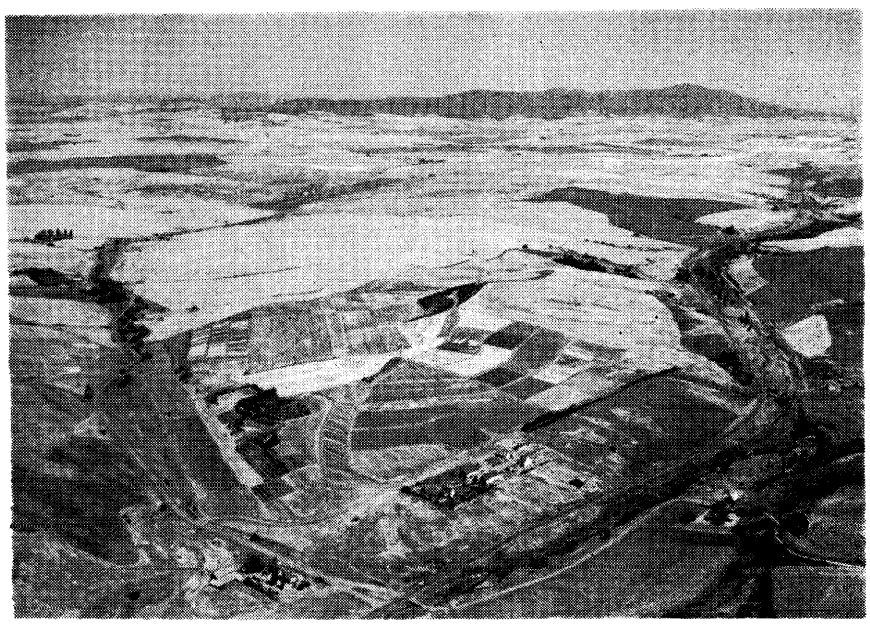

FIGURE 1. Aerial view of the U.S.D.A. Soil Conservation Service Plant Materials Center at Pullman, Washington, adjacent to and cooperating with the Washington Agricultural Experiment Station. This center is important in the introduction, domestication, testing, and increase of plant materials for use in the conservation program of the northwest. Near the left center cattle are on grazing trials, and in the lower right some foundation seed fields can be seen. The observational test areas in the center are separated by terraces and roadways.

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[2] *All work at the Pullman Plant Material Center is in cooperation with the Agricultural Research Service and the Washington, Idaho, and Oregon Agricultural Experiment Stations.*

ment is a slow, if not impractical, method of increasing production.

When in the early 1930's this country became erosion conscious and attempts were made to reseed worn out and eroded lands to commercially available grasses and legumes, conservationists became aware of the lack of adequate plant materials for use on depleted range sites.

Assembling Plant Material

Beginning with the extensive foreign plant explorations made in 1930-34, forage plants from northern Asia began to arrive in the United States. These introductions were supplemented by collections from the native vegetation of the western United States, by strains from plant breeders and commercial seeds used as checks. Material was assembled with the thought that somewhere on the western ranges from the various site, soil and climatic conditions there could be found plants of superior performance and adaptation — plants equal to those from European countries from which some introductions have been under cultivation in this country for more than 200 years. In order to be useful any new plant would also have to be as good or better, at least in some characteristics, than presently available material. The most widely used introduced range grass was crested wheatgrass, therefore, any new dryland range forage plant had to be as good or better than crested wheat.

Testing Procedure

The large number of plants assembled, required thorough, rapid and economical methods of testing. The testing procedure used at the U.S.D.A. Plant Material Centers begins with an observational rod row of each accession established in the field, or if seed is scarce, in the greenhouse and transplanted to the field. Figure 2 shows a group of native wheatgrasses. Within each particular "use group" a standard commercial check plant is included at regular intervals so that direct visual comparisons can be made. This observational testing is based not so much on the botanical differences in the plants as upon their eventual use.

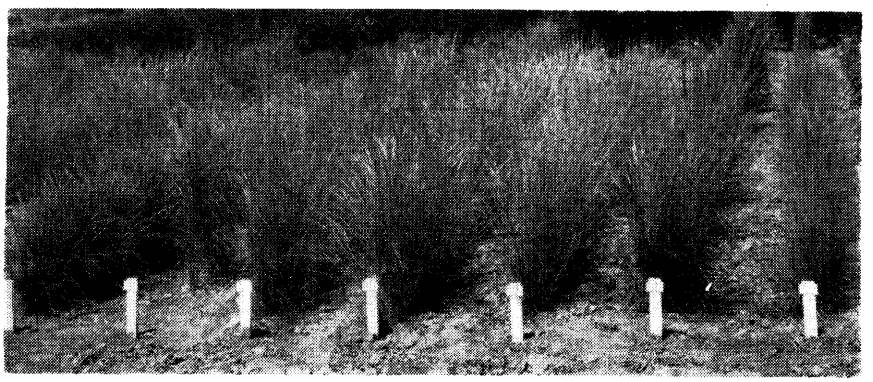


FIGURE 2. Initial observational testing of strains of beardless wheatgrass *(Agropyron inerme)* and bluebunch wheatgrass *(A. spicatum)*. These Pacific Northwest collections show a wide variation in growth habit and productivity.

In all testing procedures, grasses were compared within "use groups." A "use group" may be defined as a group of grasses having similar growth requirement, adapted to similar sites and to a large degree interchangeable with respect to conservation use. For example, two important range grass use groups are: (1) Drought tolerant, long lived bunchgrasses. Included here are crested wheatgrass, Fairway crested wheatgrass, Siberian wheatgrass, Whitmar beardless wheatgrass, bluebunch wheatgrass and Russian wildrye. (2) Vernal dominant dryland grasses, which includes Sherman big bluegrass, Nevada bluegrass, Sandberg bluegrass, prairie Junegrass (*Koeleria cristata*) and bulbous bluegrass. The "use group" concept of testing plants in groups based on their similarities in growth characteristics and possible conservation use has saved many man years of technical help by speeding up the testing procedure. Many species of only botanical interest rapidly fell by the wayside.

Individual plant performance records for each accession include such data as source, date of planting, emergence, seedling vigor, growth stages on various dates, dates of bloom, maturity, disease-resistance, cold tolerance, drought-resistance, forage characteristics, aggressiveness, production, and conservation use.

Notes taken over a period of five years resulted in a thorough acquaintance of the technician with each accession. Many plants were eliminated by rigors of the climate or simple non-performance. In 20 years of testing some 14,000 accessions were subjected to this observational procedure. About five percent have been selected for secondary testing.

Even within "use groups" great differences within species occurred, which resulted in selection of prominent ecotypes of each important range grass to represent that species in secondary tests, called field evaluation studies. Range plants were promptly put into field evaluation studies along with appropriate checks at six outlying sites, mainly on State Agricultural Experiment Station Branch locations. At these stations the rainfall varied from approximately 9 inches to 18 inches per year, the elevation from 1,600 to 3,500 feet, the growing season from 150 to 200 days, the seasonal temperatures from -22°F. to 100°F. and the soil types from very light, deep silt loam to a medium heavy, shallow soil over basalt.

While these adaptation tests were being run at locations, studies on germination and seedling vigor, seed habits and seed production, cultural trials, mixture studies, and others were being made at the plant material centers. In this secondary testing stage experiment stations and federal research agencies assisted in randomized replicated trials involving all phases of testing. Assistance of other groups was also obtained to get the widest possible information on adaptation and performance. From limited seed stocks seed was made available to cooperating experiment stations for independent tests.

New promising species were included in standard seed packets supplied to Smith-Hughes Agricultural Instructors, 4-H clubs, and County Agents. Packets were made up on the basis of adaptation areas. For example, in Washington these areas are semi-humid, dryland, irrigated and West Coast. These nurseries served to acquaint the general public with new grasses and legumes. Some nurseries have developed into seed production studies under irrigation, others into range reseeding trials or mixture studies. At one time over 300 such small nurseries were being observed in the state of Oregon, many of them on range sites far removed from any other test locations.

The Forest Service Research Centers have provided many tests on lands and conditions not accessible to private owners. These have been effective in checking adaptation and the performance of grasses and legumes, particularly on high elevation mountain meadows and timbered sites. The Bureau of Land Management, Bureau of Reclamation and other agencies have also cooperated in testing new dryland grasses under actual use conditions.

On the basis of field evaluations plus other studies, small seed increase plantings of a limited number of range grasses are made at the plant material centers. This provides sufficient seed for field planting trials which are essentially an extension of nursery plot seedings to farms in soil conservation districts. Such field plantings are made in comparison with standard practices and species which the rancher would normally use. Figure 3 shows a good field planting. New dryland grasses have been tested alone and in mixture by grazing animals on a typical site in the semi-humid area. Field size plantings of improved range grasses are now being made on range sites where comparative grazing data can be obtained.

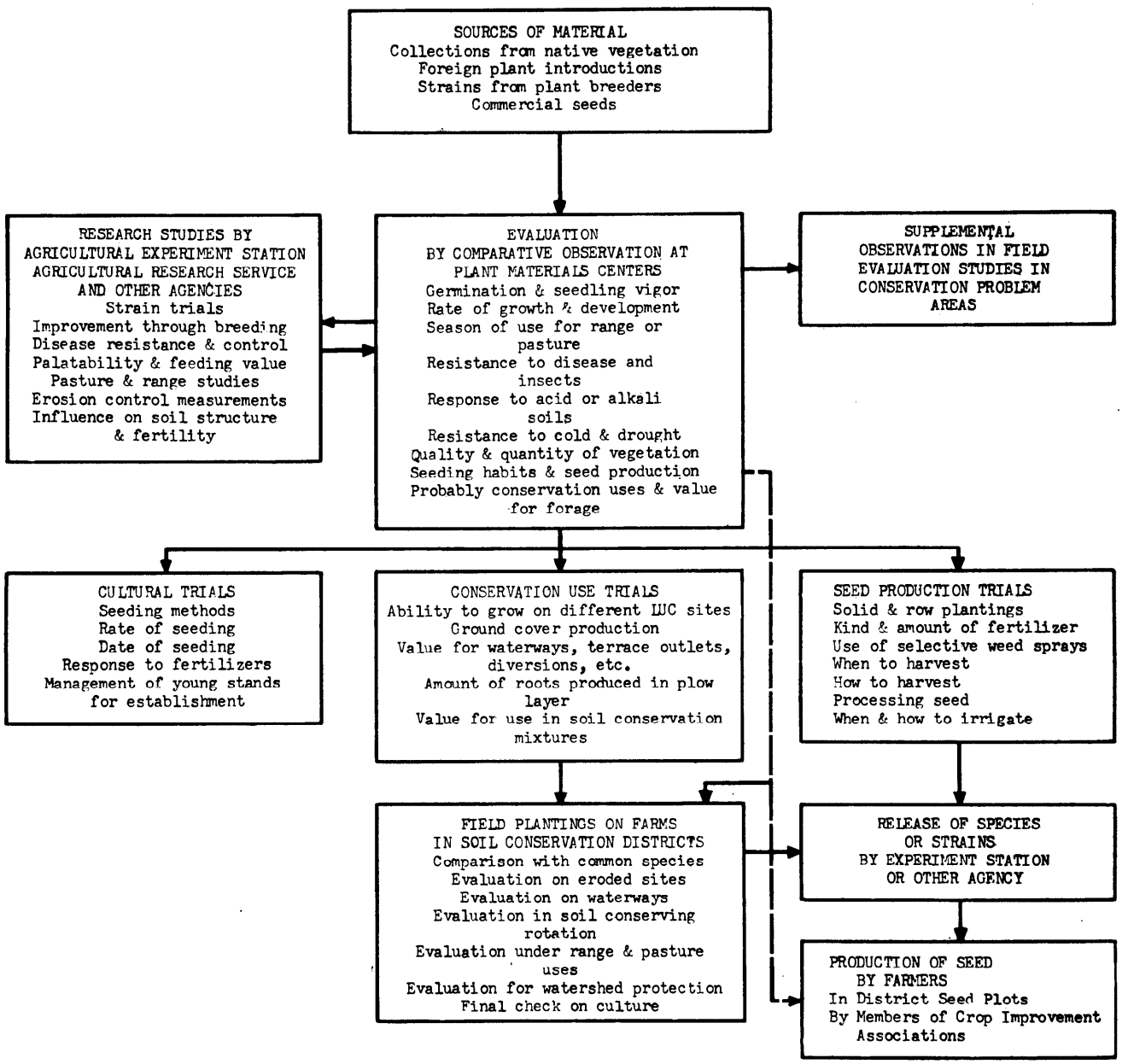
The participation of district supervisors in selecting cooperators and in choosing sites from variable land conditions has helped in making these trials effective. Grasses, legumes, trees, shrubs, and other materials have been widely used in these trials in comparison with common materials or practices. To date there have been 856 grass or legume trials and 280 woody plant trials in the Pullman Plant Materials Center zone. About one-third of these are still active. These trials allow new things to speak for themselves. Results are used in modifying and keeping technical standards for use of plant materials up to date.

When results from the field scale trials and the various cooperative research studies are summarized, an excellent cross section of the performance under various testing conditions is available. This summary provides data for decisions on the possible release of new varieties.

Release of New Varieties

New varieties are released through state experiment stations after the performance data have been presented and an agreement has been reached both on the value of the variety and on a designated name. Upon release the plant material centers make foundation seed available to state experiment stations and crop improvement associations as well as to soil conservation district seed producers. The seed bears an official foundation seed tag and is for the purpose of registered and certified seed production. This is the way improved varieties get into commercial production. Thereafter the plant materials center is responsible for the continued maintenance of foundation seed. Limited seed production is also maintained with which to continue the field

FIGURE 3. A good field planting of Whitmar beardless wheatgrass on the Mont Johnson farm in the Wood River Soil Conservation District of Southern Idaho. Ranchers are intensely interested in this two year old range seeding.



Procedure for evaluating and domesticating grasses for conservation uses at the U.S.D.A.- S.C.S. plant material centers

planting trial program until the areas of adaptation, and the culture and management of the variety are well known. The effectiveness of this combination testing procedure developed by the plant material centers is attested by the relatively abundant seed supply of improved range grasses in the Pacific Northwest.

The procedure for evaluating grasses, leading to the release of new varieties, is summarized and the relationship of the various steps is shown in the chart.

Whitmar Beardless Wheatgrass —a Case History

During the years of 1934-38 more than 1,000 field collections of beardless wheatgrass and related bluebunch wheatgrasses were made in the Pacific Northwest states. These were planted in observational rod rows. Seed in quantity was collected from a native bluebunch wheatgrass field near Shaniko, Oregon, and beardless wheatgrass from Fort George Wright Military Reservation near Spokane, Washington. These two strains were used as checks in all observational plantings.

In the Spokane area 1,000 to 5,000 pounds of native wheat-

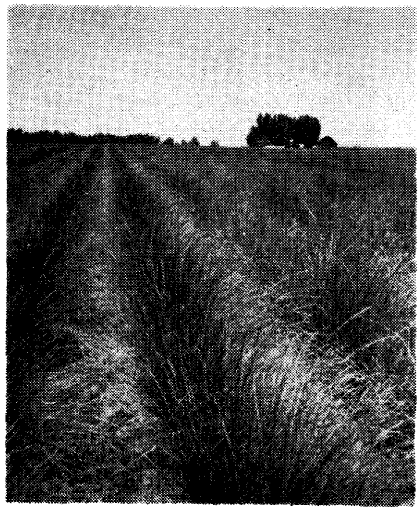


FIGURE 4. A registered Whitmar beardless wheatgrass seed field on the Ernest Egan farm in the North Side Soil Conservation District, Kimberly, Idaho. Good seed of an adapted strain is essential to successful range seedings. Foundation seed came from a Plant Materials Center.

grass seed were collected each year during 1937-40. Seed varied by seasons in germinative capacity, abundance and quality. Results from field plantings in which this seed was used were only fair. It was found that the strains occurring in greatest abundance and available for large scale seed collection were not the most desirable or productive strains. This accelerated the work of testing to find a superior strain.

The various ecotypes of beardless wheatgrass were studied in the field and in observational plantings. Representative strains of each major ecotype were selected for secondary testing and included in plantings at outlying stations. The sites which most nearly provided dryland range testing conditions were at Moro, Pendleton, and Condon, Oregon, and at Lind and Goldendale, Washington.

Results of tests showed that strains most productive at Pullman were also the most productive at the outlying dryland test sites.

Bluebunch wheatgrass was found generally more robust and vigorous than beardless wheatgrass, but it had the disadvantage of awned seeds. A method of de-awning was developed as a stop-gap measure, while further testing for a suitable awnless strain continued.

The most vigorous disease resistant productive strain of beardless wheatgrass was one found in a strip of the native Palouse prairie at Colton, Whitman County, Washington. On the basis of its performance in field evaluation studies a small seed field was established in 1938 to obtain seed for plot trials, additional plantings, and exchange purposes.

A 1941 summary of data showed this strain was more productive, by 130 to 1000 pounds of dry matter per acre, than crested wheatgrass at all six dryland test locations. In 1942 an eight acre seed field was established. Resulting seed was used for field planting trials on range and abandoned farm lands in soil conservation districts.

In 1947 accumulated data were reviewed and the name "Whitmar" was recommended and accepted by cooperating experiment stations. Foundation seed was released to district seed producers and through crop improvement associations for registered and certified seed production. The new improved range grass was on its way to commercial production. Figure 4 shows a seed production field of Registered Whitmar.

The Plant Materials Center continues to produce a small foundation seed field from which authentic seed stocks are obtained. Some seed is also produced for use in field planting trials in new areas and for management studies. This will continue until adequate commercial seed is available, and Whitmar has been either accepted or rejected as a standard grass for range seeding in areas of its adaptation using good cultural techniques and under good management practices. Present commercial production is about 20,000 pounds annually. The demand for seed is greater than the supply. Whitmar does not replace crested wheatgrass in range seedings. It supplements crested. Results from large range seedings indicate that Whitmar has a great future on western range lands that need reseeding.

Range Grasses Cooperatively Developed

Some of the range grasses developed in the West that have been through this testing procedure now available commercially for use in range reseeding are:

Native Grasses

Whitmar beardless wheatgrass *(Agropyron inerme)* selected from the native vegetation of the Palouse climax prairie is a vigorous, productive, leafy, highly awnless type. Figure 5 is a portrait of Whitmar. It is a perennial bunchgrass with good seed production. It matures uniformly but shatters readily. It is adapted to use on class IV and VI lands in the Pacific North-

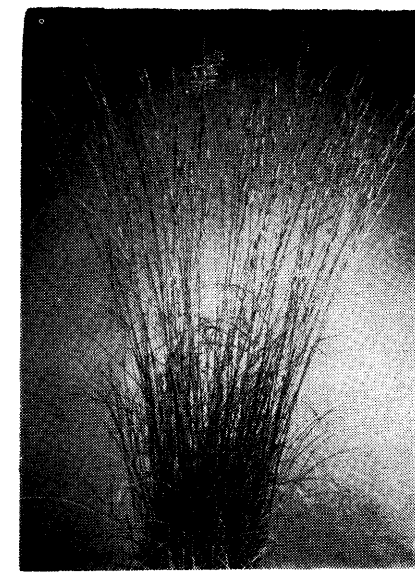


FIGURE 5. Portrait of Whitmar beardless wheatgrass, one of the important improved named varieties resulting from extensive testing and intensive work with the native range grasses of the West. Certified Whitmar seed is grown in Washington, Oregon, and Idaho.

west dryland areas of 8-15 inches average annual precipitation. When properly managed, it exceeds crested wheatgrass in forage and root production. It has a later season of use and is slower in becoming established.

Sodar streambank wheatgrass *(Agropyron riparium)* is drought-resistant, alkali-tolerant, low-growing and produces a good ground cover. "Sodar" refers to its rapid sod-forming ability. It is easy to establish, aggresive, spreads rapidly, suppresses weeds and forms a smooth, long-lived protective sod. In range seedings Sodar serves as an understory cover when used with large wheatgrasses. When mixtures are grazed, the percentage of Sodar may increase, since it is relatively low in palatability.

Sherman big bluegrass *(Poa ampla)* is a selection from a collection made near Moro, Sherman County, Oregon. It is early in spring growth, early maturing, drought escaping, tall, erect-growing, fine stemmed. It has blue, moderately abundant leaves and a large compact purplish seedhead. It is a long-lived productive perennial bunchgrass adapted to range use in semi-humid and dryland areas of the Northwest. It is superior to crested wheatgrass in earliness and amount of spring growth. In low rainfall areas of light soil it should always be fall seeded. It must be well established before grazing, otherwise it is easily uprooted, especially on sandy soils.

Introduced Grasses

Greenar intermediate wheatgrass *(Agropyron intermedium)* is a vigorous growing, mild-sod-forming, late-maturing, leafy, dark green, high producing variety. Plants are variable. It grows best on well drained soils in the rainfall areas of 15 to 30 inches at elevations of 1,000 to 3,500 feet. It produces well in the Northwest, wherever dryland alfalfa is adapted.

FIGURE 6. Topar pubescent wheatgrass is a representative improved named grass variety resulting from selection and testing among the many foreign plant introductions of recent years.

Topar pubescent wheatgrass *(Agropyron trichophorum)* is a drought-resistant, sod-forming, late-maturing wheatgrass. Figure 6 is a portrait of Topar. It resembles intermediate wheatgrass but has pubescence on the leaves, stems and seed. It spreads more rapidly by rhizomes. It is better adapted than intermediate wheat to rainfall areas of 10 to 15 inches and low fertility, to eroded and alkaline soils, and to high elevations.

Siberian wheatgrass *(Agropyron sibiricum)* is essentially an awnless form of crested wheatgrass. It has narrow leaves, narrow heads and blunt glumes. It is a little lower in seedling vigor, but on dry sites and light soils or in dry years it is better adapted and more productive than crested wheatgrass.

Hard fescue *(Festuca ovina* var. *duriuscula)* is similar to Idaho fescue in growth and adaptation but is much higher in seed production and easier to establish. It is a bunch-type, fine-leaved fescue with long, narrow, rolled, lax leaves. It is being used in rainfall areas of 12 to 30 inches annually pending the development of a superior Idaho fescue. It is a very abundant root producer.

All of the above grasses are in commercial production. Their total annual production is nearing 1,000,000 pounds of clean seed. Foundation seed is available for certified seed production.

Other promising range grasses in various stages of development and testing include sheep fescue *(Festuca ovina)*, a dwarf, more densely tufted, drought-resistant grass than hard fescue; a superior strain of bulbous bluegrass *(Poa bulbosa)*, which is more productive and stays green longer than commercial types; Canby bluegrass *(Poa canbyi)* for use in understory seedings, and several hybrid bluegrasses resulting from cooperative work of the Carnegie Institution of Washington.

The system of finding superior range grasses used at the Soil Conservation Service Plant Materials Center at Pullman, Washington, has been effective in getting them into seed production and into use on range lands.