The stocking rates depicted by the graph represent a basis for conservative stocking rates over a period of years. In a year of high precipitation and consequently high forage yield, additional livestock numbers may be grazed during the summer and fall, or the grazing season may be extended to a greater length than usual. In event of drought, livestock numbers may be reduced to cope with reduced forage production. The proposed graph may serve the purpose of adjusting stocking rates as deemed necessary.

A regression equation \( Y = 27.17 + 78.48X \), where \( Y \) = estimated yield of forage in pounds per acre, and \( X \) = inches of precipitation in May plus June, was developed. This equation may be used to estimate forage production as early as July 1 each year. Assuming that a mature beef cow (1,000 pounds) requires 660 pounds of forage (air-dry basis) per month an estimate of carrying capacity is determined for the varying amounts of forage production estimated.

The data presented may be of considerable value in forecasting range production and stocking rates within certain limits. In years of high precipitation, the forage production may be high and the carrying capacity may consequently be increased. In event of drought, livestock numbers may be decreased to cope with reduced production.

**LITERATURE CITED**


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**Improvement of Native Range through New Grass Introduction**

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The search for superior grasses and legumes for reseeding eroded sites and range lands received a great stimulus with the interest in conservation work in the early 30's. Since then new grasses have steadily been introduced or developed for special conservation jobs. The grasses introduced prior to this time were mostly brought over from Europe by immigrants. They were not particularly adapted for range use.

Since 1935, when the Soil Conservation Service nurseries were organized, some 14,000 grass, legume, tree and shrub introductions have been tested in Western range states. Improved varieties developed from foreign introductions and native collections are now becoming generally available from this work. Some new grasses have been adequately tested, named and released. They are now in large scale production and are being widely used. Others are in various stages of development, testing and release.

**Testing and Selecting Improved Varieties**

Introduced or newly collected plants in Soil Conservation Service nurseries are first tested in a single 20-foot row of each. (Fig. 1) Rows are three feet apart. These seedings are made in the field. If the seed is scarce or appears to be low in viability, plants are started in the greenhouse and later placed in proper sequence in the nursery by transplanting. Species are planted alphabetically and by use groups including appropriate check strains. Each row is observed over a 5-year period using an individual 5 x 8 inch card on which to record observations. Seed is harvested only from the outstanding plants. Over a period of years only five percent have been carried into secondary tests. If plants are self-pollinated, the harvested seed is used for further increase. If plants are cross-pollinated, production plantings under isolated conditions are made using original seed.

Seed increased from selections or original sources is used for replicated plantings which also include standards. Secondary plantings include grasses alone as well as alternate-row mixtures with an appropriate legume. After these trials further reduce the number of strains, the outstanding ones are put into field plots, also replicated. These may include alfalfa-grass mixtures for the long-lived grasses, sweetclover or red clover-grass mixtures for the rapid-developing grasses, irrigated pasture mixtures or dryland grass trials. In this stage of testing, grasses are made available to cooperating experiment stations. Plantings are made in outlying trials in problem areas representative of the probable range of adaptation of specific grasses.

Standard seed sets of new grass and legume varieties are also made available by crop zones to county agents and vocational agricultural instructors so local people may observe newly developed varieties compared with standards under local growing conditions. Such plantings have been very effective
in keeping the public informed and acquainted with new grass and legume developments. They serve as a source of plant materials for study and a focusing point for tours and field days.

Results from mixture trials indicate locations and mixtures which appear to be outstanding. At this stage the best grasses are put into larger increase blocks from the original increase plantings to supply seed for field trials on farms in Soil Conservation Districts.

A field trial is the extension of nursery or Experiment Station findings concerning new species, mixtures or techniques onto farms under actual use conditions. Sites and cooperators are carefully chosen to compare the new trial or practice with the standards in the area where the field trial is to be made.

When the new plant finds ready acceptance and compares favorably with the standards being used, the data are summarized and proposals are made for the release of the new variety.

**Seed Production**

If the new variety is accepted, foundation seed from the original increase fields is made available through Crop Improvement Associations and Soil Conservation Districts to cooperators and members for certified and registered seed production. Seed increase is rapid and soon finds its way into commercial channels.

Ranchers and farmers have long been aware of registered livestock and improved wheat varieties. Today they are also becoming aware of improved grass and legume varieties, many of which can be purchased in leading seed and farm supply stores. This was not possible 20 years ago.

Some of the leading improved grasses adapted to range use, developed and released as a result of Soil Conservation Service nurseries working with Experiment Stations in the West, are Greenar intermediate wheatgrass (*Agropyron intermedium*), Whitmar beardless wheatgrass (*Agropyron inermis*), Primar slender wheatgrass (*Agropyron trachycaulum*), Topar pubescent wheatgrass (*Agropyron trichophorum*), tall wheatgrass (*Agropyron elongatum*), Sodar streambank wheatgrass (*Agropyron riparium*), Siberian wheatgrass (*Agropyron sibiricum*), Bromar mountain bromegrass (*Bromus marginatus*), Manchur smooth bromegrass (*Bromus inermis*), hard fescue (*Festuca ovina var. durieuscula*) and Sherman big bluegrass (*Poa ampla*) (Fig. 2).

Of these improved grasses, the total annual seed production in the Northwest amounts to more than 2,000,000 pounds—a sufficient amount to plant each year more than 350,000 acres of land.

**Requirements for Establishing Improved Grasses on Range**

Whether ranges can best be improved through management of existing vegetation or through reseeding is a problem which confronts many ranchers. It is primarily a technical and economic
problem. Aside from the economics of getting returns greater than the investment within a short period of time, other considerations such as watershed protection, control of erosion, and reduction of weed invasion may be important. These are long term benefits seldom credited to range seedings.

If the range conditions, site, soil, climatic and economic factors indicate that range improvement through reseeding is feasible, improved introduced or domesticated grass varieties are now available to do the job (Fig. 3). It becomes a matter of choosing a variety adapted to the particular site, season of use and management plan. Every well planned seeding will be preceded by a range site and condition survey, a soil survey including land capability determinations and a complete ranch plan for the protection and integrated use of the proposed seeding in connection with other available range both during the establishment period and following years.

New grasses for range improvement should be established only in blocks large enough to warrant separate management. A small seeding, for example, of crested wheatgrass (Agropyron desertorum) in a native range area creates utilization and management problems.

There is no substitute for good farming in the establishment of new grasses. Good farming includes:

1. The elimination of existing vegetation
2. A good firm seedbed
3. Proper date and method of seeding
4. The use of seed protectants and fertilizer.
5. Protection of the seeding after emergence, including rodent control

Cultural techniques are generally well known. In critical marginal or low rainfall areas, known cultural practices must be carefully followed to achieve success in establishment of new varieties.

**Individual Grasses**

*Crested wheatgrass (Agropyron desertorum).—*Has become the standard with which anything new for range use must be compared. First introduced in 1898, it attracted some attention in 1916 but was not widely used until the drought years of the early 30's. It is one of the most cussed and discussed range grasses. There was a long interval from the time of its introduction to widespread use. Some of the new grasses are being brought into use more rapidly. They are being critically compared with crested wheatgrass, and will be widely used only to the extent that they can either supplement or replace it. In addition to the Fairway variety which is generally less productive on range sites than Standard crested, a recent new variety “Nordan”, has been released by the North Dakota Agricultural Experiment Station.

*Siberian wheatgrass (Agropyron sibiricum).—*This is essentially an awnless form of crested wheatgrass. It was introduced from the same general area in Northern Asia. It has narrow seed heads and somewhat narrower leaves and finer stems. On dry sites and in dry years it equals or exceeds crested wheatgrass in production. It is being certified in Oregon, Washington and Idaho. The annual seed production is approximately 10,000 pounds.

**Whitmar beardless wheatgrass (Agropyron inerme).—**This strain was selected from more than 200 beardless and bluebunch wheatgrass selections from many locations in the Northwest (Fig. 1). One of four ecotypes, Whitmar came from a climax area in Whitman County, Washington. In comparative trials with other types and strains over wide areas, it was outstanding. On properly managed range sites it exceeds crested wheatgrass in production. It will not stand the mismanagement and overgrazing that often occurs with crested wheatgrass. It has a later season of use. When a small range seeding is to be made in a native

![FIGURE 3. A range seeding of Whitmar beardless wheatgrass near Prosser, Washington, under 8 inches of rainfall at an elevation of less than 2,000 feet. This was established in wide rows and some seed harvested the first year. The field on the left is a range planting of Sherman big bluegrass.](image)

![FIGURE 4. Whitmar beardless wheatgrass. Selected and developed from native western range lands, it is now available for range seedings.](image)
Tall wheatgrass (Agropyron elongatum).—Tall wheatgrass was also introduced from Asia and is the foreign counterpart of our own giant wildrye. It is remarkably alkali tolerant and productive where subsoil moisture is available. Some of the original tests were on an outlying nursery at Union, Oregon where over seven tons of air-dry forage were produced per acre. At the Aberdeen, Idaho nursery at 5,000 feet elevation with less than 10 inches rainfall, it produced as much as crested wheatgrass on abandoned farm land and stayed green two or more weeks later into the summer than crested wheatgrass. Tall wheatgrass is being most extensively used in Utah and Nevada. There are also large areas in central Washington and southeast Oregon where tall wheatgrass is just beginning to be used. Several hundred thousand pounds of seed are available annually. Certified seed stocks are available.

Greenman intermediate wheatgrass (Agropyron intermedium).—This is not strictly a range grass but is being used alone with alfalfa on abandoned farm lands on favorable sites in rainfall areas of 14 inches or more annually. It will grow wherever alfalfa will grow. It is often planted in alternate rows with alfalfa. Intermediate wheatgrass is one of the most widely used grasses in mixtures with dryland alfalfa in the northern half of the United States. Nearly 1,000,000 pounds of seed are being produced annually in the three Northwest states.

Topar pubescent wheatgrass (Agropyron trichophorum).—Very similar to intermediate wheatgrass, this species has a high percentage of pubescent heads and leaves. It is more drought resistant than intermediate and spreads by rhizomes rapidly. It is adapted to shallow soils and dry sites in rainfall areas of 10 to 14 inches. A very drought resistant sod-forming grass, its late maturity makes it valuable as a range species. Annual production of Toper approximates 20,000 pounds. Sufficient seed to meet the demand is not yet available.

Amur wheatgrass (Agropyron amurense).—Amur wheatgrass is also similar to intermediate wheatgrass in growth habit and late maturity. In pure stands it is coarser, more vigorous and more productive than intermediate wheatgrass. In mixtures with alfalfa it produces less. A selected strain is in limited production.

Sodar streambank wheatgrass (Agropyron riparium).—This native sod grass makes a dense turf, is easy to establish and can be effectively used as an understory grass. In mixtures with other grasses at Aberdeen, Idaho, it increased the density and ground cover but did not affect the total production of associated grasses in mixtures. Most seed has been used for ditchbank and roadside seedings in the Columbia Basin. Foundation seed is available.

Sheep fescue (Festuca ovina var. durivscula).—This introduction from Australia is the original material from which chewings fescue was selected. It is very close to Idaho fescue in growth and adaptation but is much higher in seed production and easier to propagate. Although primarily used for root production in alfalfa-grass mixtures, it has a place as an understory grass in range seedings on good soils where rainfall is 12 inches or more. Hard fescue is in commercial production.

Bulbous bluegrass (Poa bulbosa).—One superior strain is about ready for release. It is leafier, more productive and stays green longer than most strains tested. When used as an understory grass it gives cheatgrass (Bromus tectorum) some competition. Bulbous bluegrass has been most successfully used at elevations below 5,000 feet. It does well where the winters are not too severe. Its large seeds are very attractive to rodents, and many plants have disappeared because of rodent damage to the seed crop and to the bulbs. Seed of common strains is available.

Canby bluegrass (Poa canbyi).—Essentially a large form of Sandberg bluegrass. This understory grass is more productive but is less widely distributed. Superior selections are available. Some field tests have been made. To date no one has become interested in seed production. It could be widely used as an understory grass in range seedings.

Hybrid bluegrasses (Poa spp.).—The hybrids resulting from various crosses of American and European bluegrasses include many promising strains for range use (Fig. 5).
RANGE IMPROVEMENT THROUGH GRASS INTRODUCTIONS

This project, under the leadership of Dr. Jens Clausen of the Carnegie Institution of Washington, began in 1945. Hundreds of crosses were made involving a wide range of species and selections. More than 10,000 hybrid progeny are being grown at Pullman and other nursery locations. Some of the more promising crosses resulting from big bluegrass × Kentucky bluegrass combine the winter growth habit of big bluegrass with the rhizomatous character of Kentucky blue. This work has progressed far enough for extensive trials to be made of the outstanding new hybrids.

Russian wild ryegrass (Elymus junceus).—This grass has been widely tested and found adapted in northwest nursery plantings, but it has not yet come into use for range reseeding. It is slow to establish. It begins growth and matures later than crested. Russian wild ryegrass is densely tufted, and after seed matures, its basal foliage remains green and palatable all summer. Its total herbage production is fairly low. Seed production is low and the high cost has restricted wider use of this promising grass.

Manchar smooth bromegrass (Bromus inermis).—Manchar is a northern type brome, well adapted for range seedings in mountain meadows in northern latitudes. It forms sod slowly, is very leafy, productive and easy to establish because of its good seedling vigor. Seed is widely available. In 1952 there were more pounds of certified Manchar seed grown than any other smooth brome grass in America.

Erect brome grass (Bromus erectus).—Is a bunch-type, pubescent-leaved brome, similar in many characteristics to smooth brome. It is very productive but its exact area of adaptation is not yet known.

Red brome grass (Bromus tomentellus).—Is an early maturing, leafy, bunch-type brome. It is perennial but has some of the seed characteristics of annual bromes. Seed matures and shatters early. It reseeds readily. After seed maturity the foliage remains green all summer. Seed is just now available for field planting trials.

Many new grasses such as Harding-grass (Phalaris tuberosa), Sunol-grass (Phalaris coerulescens), Lomas-grass (Elymus glaucus), and others are being tested and used in California by Soil Conservation Service nurseries, Experiment Stations, and others. Superior new strains of northern introduced or domesticated grasses such as bulbous barley (Hordeum bulbosum), Boehmer timothy (Phleum boehmeri), Pacific giant wild rye (Elymus cinereus), bearded wheatgrass (Agropyron subsecundum) and others are being developed.

New grasses are not a cure-all for overgrazed or depleted ranges. Where reseeding is necessary, new grasses with the proper cultural practices and correct use can do their share toward putting conservation on the land and increasing our range forage resources.

CALL FOR PAPERS FOR ANNUAL MEETING

Members who wish to present papers at the next annual meeting of the Society to be held at Great Falls, Montana, in January, 1957, are requested to submit titles and short abstracts to the Program Committee.—Melvin S. Morris, Chairman, Program Committee, School of Forestry, Montana State University, Missoula, Montana.