

sometimes has actually produced less with nitrogen than without.

Near Havre, Mont., yields of hay as high as 1 thousand pounds an acre annually for 6 years were obtained when barnyard manure was applied on native range. About 80 pounds an acre was obtained from untreated range. Near Mandan, N. Dak., nitrogen has increased the production of the native range and reseeded introduced species, such as crested wheatgrass, smooth bromegrass, and Russian wild-rye.

From native grass on cleared virgin brushland at the Red Plains Conservation Experiment Station, Guthrie, Okla., 133 pounds of beef an acre were produced when phosphate and nitrogen fertilizers were applied. Only 84 pounds an acre were produced without fertilizer. This represents nearly a 60-percent increase in animal gain from fertilization at an annual rate equivalent to 100 pounds of superphosphate and 33 pounds of nitrogen to the acre.

Range grasses in some parts of southern Texas do not contain enough phosphorus to provide adequate nutrition for grazing livestock. Range fertilization is employed there to increase the yield of forage and to improve its phosphorus content. An experiment was conducted on the King Ranch near Falfurrias to determine the most practical methods of supplying phosphorus to range cattle and to determine the effect of phosphate on the yield and chemical composition of forage. Phosphate applied to such rangelands prevented phosphorus deficiency in cattle. The application of about 200 pounds of 48-percent triple superphosphate to the acre increased the yield and phosphorus content of forage for a period of 4 to 5 years.

A new band-seeding method of establishing pastures has shown promise in range seeding trials. The seed is drilled over bands of fertilizer placed 1 to 2 inches below the seed. Available fertilizer is thus made accessible to seedling plants.

Grasses

E. A. Hollowell

The most important grasses of which seed or vegetative propagating material is available in quantity are listed here.

The characterization of grass species and varieties as related to soils is not specific, because the interaction with climatic factors may greatly vary the growth responses of the plants to any set of soil conditions. Unfavorable factors such as acidity, alkalinity, salinity, and texture, which affect the adaptation of species, within limits may be compensated for by optimum conditions of other factors, such as moisture.

BEACHGRASSES (*Ammophila* species) are perennials. They grow in moderately acid to neutral soils and tolerate high salinity. They need shallow to deep, fine sand to loamy sands and moist to very moist conditions. They are benefited by applications of nitrogen. They are adapted to cool conditions and are winter hardy. They are used to control dunes and blowing soil.

American beachgrass (*A. breviligulata*)—see Beachgrasses.

European beachgrass (*A. arenaria*)—see Beachgrasses.

BERMUDA-GRASS (*Cynodon dactylon*) grows in shallow to deep, highly acid to neutral soils and is tolerant of high salinity. It likes gravelly loam to well-drained clay. It tolerates drought periods but prefers heavy moisture. Applications of nitrogen are beneficial. It is adapted to the Southern and Southwestern States.

The starred names differ from those in USDA Service and Regulatory Announcements No. 156, reprinted August 1956.

Coastal and Suwannee are better adapted to deep sands. Midland is hardier. Greenfield grows better at low nutrient levels.

BLUEGRASSES (*Poa*) comprise many perennial species, which are adapted to a wide range of soil and climatic conditions and are widely distributed throughout the United States.

Big bluegrass (*P. ampla*) grows in slightly acid to slightly alkaline soils. It is not tolerant of salinity. Soils should be of average depth or deep, gravelly loam to well-drained clay. It prefers moist conditions, although it tolerates drought. Applications of nitrogen are beneficial. A perennial, it is adapted to the Northwestern States.

Bulbous bluegrass (*P. bulbosa*) grows in moderately acid to slightly alkaline soils. It is not tolerant of salinity. Deep or moderately deep silt loam to poorly drained clay are suitable. It needs moist to very moist conditions. Applications of nitrogen are helpful. It is adapted to cool-summer temperatures. It is a perennial and is grown mostly in the coastal section of the West.

Canada bluegrass (*P. compressa*) grows in highly acid to neutral, shallow or moderately deep, loamy sand or poorly drained clay. It tolerates moist to very moist conditions but is not tolerant of salinity. Applications of nitrogen benefit it. This perennial is adapted mostly to the humid Northeastern States and grows at relatively low nutrient levels.

Kentucky bluegrass (*P. pratensis*), a perennial, grows in slightly acid to slightly alkaline soils of average depth, deep silt loam, and well-drained clay. It needs moist to very moist conditions. Available phosphorus and calcium stimulate growth. It is adapted to the Northern States and upper South, particularly in places where available phosphate is abundant. It is adversely affected by high summer temperatures.

The rough bluegrass (*P. trivialis*) is a perennial that grows in moderately acid to neutral soils of shallow to average depth. Sandy loams to poorly drained clays are preferred. It is adapt-

ed to cool conditions of the Northern States. It is somewhat tolerant of shade.

BLUESTEM GRASSES, of many species, differ widely in adaptation to soil conditions. They grow in slightly acid to moderately alkaline soils. They are benefited slightly by application of nitrogen. They are adapted to a wide range of climatic conditions and are grown mainly in the Great Plains.

The following are the more important perennial bluestems.

Angleton grass (*Andropogon nodosus*) grows in moderately acid to neutral soils of average depth to deep, fine sand, and poorly drained clays. It is tolerant of high salinity. It requires moist to heavy-moisture conditions, but may survive periods of drought. It is adapted to the gulf coast region. The application of nitrogen is helpful.

Australian bluestem (*A. intermedius*) grows in fine sand to sandy loam of average depth or deeper. It is drought resistant. It is adapted to the southern Great Plains. It is not hardy.

Big bluestem (*A. gerardi**) grows in slightly acid to slightly alkaline soils and in sandy loam to poorly drained clay of average depth. It tolerates dry to moist conditions. It is adapted to the central Great Plains.

Caucasian bluestem (*A. caucasicus*) is benefited by applications of nitrogen.

Little bluestem (*A. scoparius*) is more winter hardy and is better adapted to the northern Great Plains and to sandy soils on the southern high plains and to clay and sandy soils with good moisture.

Sand bluestem (*A. hallii*) grows in deep, fine sand to silt loams. It is adapted to conditions in the central and southern Great Plains.

Yellow bluestem (*A. ischaemum*) is tolerant of moderate salinity, is drought resistant, and is particularly adapted for use on eroded soils.

BROMEGRASSES (*Bromus*) include many species of perennials and annuals, which grow under widely different

conditions and are benefited by the application of nitrogen. The perennials are adapted to the Northern States. The winter annuals grow in the South and the western coastal sections.

Field bromegrass (*B. arvensis*) grows in moderately acid to neutral soils and is not tolerant of salinity. Shallow to deep, sandy loam to poorly drained clay and moist to heavy-moisture conditions are preferred. It is a winter annual in Eastern and Pacific States.

Harlan bromegrass (*B. stamineus*) is a winter annual in California. (See Mountain bromegrass.)

Meadow bromegrass (*B. erectus*), a perennial, is widely distributed in the Northern States. (See Mountain bromegrass.)

Mountain bromegrass (*B. carinatus**) grows in slightly acid to slightly alkaline soil and is not tolerant of salinity. It grows in shallow to deep, fine sand to clay and requires moist conditions. This perennial is adapted to the Rocky Mountain and Pacific coastal regions.

Rescuegrass (*B. catharticus*) is adapted to the coastal section of the Western States and the lower South. It is a winter annual or a short-lived perennial.

Smooth bromegrass (*B. inermis*) grows in moderately acid to moderately alkaline soils and is not tolerant of salinity. It does best on deep sandy loam and well-drained clays that are moist. A perennial, it is widely adapted in the Central and Northern States.

BUFFALOGRASS (*Buchloë dactyloides*) grows in slightly acid to moderately alkaline soils. It tolerates slight salinity. It needs shallow to moderately deep loam or well-drained clays and dry to moist conditions. It is drought resistant and is benefited slightly by applications of nitrogen. A warm-season perennial, it is particularly adapted to the heavy soils of the Great Plains.

BULBOUS BARLEY (*Hordeum bulbosum*) grows in neutral to moderately alkaline soil and is tolerant of slight salinity. It grows in sandy loam to clay loam of shallow or average depth. It

needs moist to very moist conditions but will tolerate drought periods. It is moderately benefited by applications of nitrogen. It grows in winter, is adapted to the central part of the coastal region of the West, and is useful for eroded soils.

CANARYGRASSES include many perennial and annual species of *Phalaris*. They grow under a wide range of soil and climatic conditions.

Hardinggrass (*P. tuberosa* var. *stenoptera*) grows in slightly acid to highly alkaline soils and tolerates moderate salinity. It thrives in moist or very moist silt loam or poorly drained clay of average or greater depth. The application of nitrogen is helpful. It grows in winter and spring; in summer it remains dormant in the tuber stage. It grows in heavy soils in Oregon and California and to a limited extent in the gulf coast section of Texas.

Reed canarygrass (*P. arundinacea*), a perennial, grows in slightly acid to neutral, shallow to deep, silt loam to muck in moist or swampy conditions. It is not tolerant of salinity. It is widely grown in the Northern States. It will stand flooding for short periods. Nitrogen is beneficial.

CARPETGRASS (*Axonopus affinis*) grows in highly acid to slightly acid soils of shallow to average depth and of fine sand to clay loam. It requires a great deal of moisture and tolerates swampy conditions. It is benefited slightly by application of nitrogen. It is widely grown in the gulf coast section of the South. It is a perennial, warm-season grass, particularly adapted to low-lying sands. It does not tolerate salinity.

Centipedegrass (*Eremochloa ophiuroides*) grows in highly acid to neutral soils and is not tolerant of salinity. It needs shallow to deep, gravelly loam to loam and moist to very moist conditions. It is used mainly as a lawn grass and is best adapted to the sandy soils of the Southern States. It grows at low nutrient levels and is shade tolerant.

Desert saltgrass (*Distichlis stricta*) grows

in slightly acid to highly alkaline soils and will tolerate high salinity. It grows in loam or poorly drained clay of shallow to average depth and moist to swampy conditions. It will tolerate drought, however. A perennial, it is adapted to the low salty soils of the intermountain and west coast States.

DROPSEEDS include many species of *Sporobolus*, which grow in a wide range of soil and climatic conditions. They are adapted to the southern Great Plains and the Southwestern States. They are benefited slightly by the application of nitrogen.

Alkali sacaton (*S. airoides*) grows in neutral to highly alkaline soil and is tolerant of high salinity. It grows in fine sand to clay loam and is a perennial. It stands dry conditions.

Sacatongrass (*S. wrightii*) is less tolerant of alkaline and saline conditions and requires more moisture than alkali sacaton.

Sand dropseed (*S. cryptandrus*), a perennial, grows in neutral to moderately alkaline soil. It is tolerant of slight salinity and dry conditions.

FESCUE (*Festuca* species) is adapted to a wide range of soil and climatic conditions in the Northern States and in the South at higher altitudes.

Arizona fescue (*F. arizonica*) grows in slightly acid to neutral soil of shallow to average depth—silt loam to clay loam and dry to moist conditions. It is benefited slightly by applications of nitrogen. It grows in open pineland and is adapted to high altitudes of the Southwestern States.

Hard fescue (*F. ovina* var. *duriuscula*) will tolerate drier sites and lower nutrient levels than sheep fescue.

Idaho fescue (*F. idahoensis*) grows in slightly acid to slightly alkaline soil of average depth—loamy sand to well-drained clay and dry to moist conditions. It is slightly benefited by applications of nitrogen. It is adapted to cool to cold temperatures in the Central and Northern Intermountain States. It does not tolerate salinity.

Meadow fescue (*F. elatior*) grows in highly acid to neutral soil of shallow to average depth—silt loam to poorly drained clay and moist conditions. It is adapted to humid parts of the Central States and the Pacific Northwest coastal region. It is not fully hardy.

Red fescue (*F. rubra*) grows in moderately acid to neutral soils. It does not tolerate salinity. It grows in deep, sandy loam to well-drained clay. It needs moist to very moist conditions and is benefited by applications of nitrogen. It is adapted to the Northern States. It tolerates shade and is used widely in lawns.

Sheep fescue (*F. ovina*) grows in highly acid to neutral soils and is not tolerant of salinity. It prefers gravelly loam and well-drained clay. It is used mainly as a lawn grass and is adapted to shady sites in the Northern States.

Tall fescue (*F. arundinacea*) grows in highly acid to moderately alkaline soils. It needs shallow to deep, gravelly loam to poorly drained clay and moist to very moist conditions. It is widely adapted in the North, upper South, and Southwest. It will tolerate short periods of drought.

FOXTAIL MILLET (*Setaria italica*) grows in moderately acid to slightly alkaline soils. It is not tolerant of salinity. Deep, sandy loam to well-drained clay, moist to very moist are preferred. Applications of nitrogen are beneficial. It is a summer annual and is widely adapted throughout the Northern States and the Great Plains. It will tolerate short periods of drought.

GRAMAGRASSES include many species of *Bouteloua*. The most important are perennials. They grow in neutral to moderately alkaline soil and are not tolerant of salinity. They require soil of average depth—silt loam to well-drained clay—and dry to moist conditions. They are adapted to the Great Plains and intermountain regions. They are drought resistant and are benefited slightly by the application of nitrogen.

Black grama (*B. eriopoda*) tolerates

slight salinity and is more drought resistant than other gramagrasses.

Blue grama (*B. gracilis*) is widely adapted from relatively moist to dry conditions and to sandy and hard lands.

Hairy grama (*B. hirsuta*) is particularly adapted to sandy, rocky, caliche soils.

Side-oats grama (*B. curtipendula*) requires more moisture than blue grama.

INDIANGRASS, YELLOW (*Sorghastrum nutans*) requires fairly deep soils and reasonable moisture.

JAPANESE LAWNGRASS (*Zoysia japonica*) grows in acid to neutral soils. It is not tolerant of salinity. Shallow to deep, gravelly loam to poorly drained clay and moist to very moist conditions are preferred. It is tolerant of short droughts. It is benefited by applications of nitrogen, although it grows at relatively low nutrient level. It is a summer-growing perennial and is used for lawns. It is adapted to the humid Eastern States that have high summer temperatures.

JAPANESE MILLET (*Echinochloa crusgalli* var. *frumentacea*) grows in moderately acid to neutral soils and is not tolerant of salinity. Soils should be of shallow to average depth and sandy loam to well-drained clay. It needs heavy moisture and is benefited by applications of nitrogen. A summer annual, it is adapted to the Northeastern States.

JOHNSONGRASS (*Sorghum halepense*) grows in slightly acid to slightly alkaline soils. It is not tolerant of salinity. Soils should be of average to deep silt loam to poorly drained clay, moist to very moist. Applications of nitrogen are beneficial. It is adapted to the Southern States. A perennial, it grows well in fertile soils.

LOVEGRASS (*Eragrostis*) has many annual and perennial species, few of which have agricultural value. Some species are adapted to sands to clay loams and dry or moist conditions.

Boer lovegrass (*E. chloromelas*), a per-

ennial, grows in slightly acid to moderately alkaline soils and is not tolerant of salinity. It likes gravelly loam to clay soils. It is adapted to the Southwestern States. It is drought resistant but not cold tolerant.

Lehmann lovegrass (*E. lehmanniana*) (see Boer lovegrass).

Sand lovegrass (*E. trichodes*) is particularly adapted to sandy soils and to the central and southern Great Plains.

Weeping lovegrass (*E. curvula*) is most widely adapted, especially on dry, sandy soils and is used in the dry regions in the South and Southwest.

MANILA LAWNGRASS* (*Zoysia matrella*) is adapted to conditions of the Southeastern States. (See Japanese lawngrass.)

MEADOW FOXTAIL (*Alopecurus pratensis*) grows in moderately acid to neutral soils. It will tolerate slight salinity. It needs soil of average depth to deep, silt loam and clay loam and moist to very moist conditions. It tolerates flooding and is benefited by applications of nitrogen. It is a perennial, cool-season grass, particularly adapted to the Pacific Northwest.

MESQUITEGRASSES (*Hilaria*) include several species that grow in neutral to moderately alkaline soils and are tolerant of moderate salinity. They grow in shallow to deep sandy loam to clay loam in very dry or dry conditions. They are perennials and are adapted to dry conditions of the Southwest.

Curly-mesquite (*H. belangeri*) is more abundant in low desertlike sites.

Galleta (*H. jamesii*) will tolerate drier sites.

Tobosa (*H. mutica*) (see *Galleta*.)

NEEDLEGRASS (*Stipa*) has many species that are adapted to a wide range of soil and climatic conditions. They are generally adapted to the northern Great Plains and the intermountain and Pacific coast regions.

Green needlegrass (*S. viridula*) is a perennial, adapted to the northern Great

Plains. It is benefited by applications of nitrogen.

Needle-and-thread grass (*S. comata*) grows in neutral soils to moderately alkaline soils and are not tolerant of salinity. Soils should be shallow to moderately deep, sandy loam to well-drained clay. They stand dry to moist conditions and are benefited slightly by applications of nitrogen. They are adapted to the northern Great Plains and intermountain regions.

Purple needlegrass (*S. pulchra*) is adapted to coastal ranges of the West.

ORCHARDGRASS (*Dactylis glomerata*) grows in moderately acid to neutral soils. It is not tolerant of salinity and likes shallow to deep gravelly loam to poorly drained clay and moist to very moist conditions. It is benefited by applications of nitrogen. It is a perennial and is widely adapted in the Northern States and the upper South.

PANGOLAGRASS (*Digitaria decumbens*) grows in highly acid to neutral soils and is not tolerant of salinity. It needs moist to very moist conditions but will tolerate periods of drought. It is adapted to the sandy soils of Florida but requires added fertility. It is a perennial. It is not winter hardy.

PANICUM GRASSES (*Panicum*) include many annual and perennial species, which are adapted to a wide range of soil and climatic conditions. They are widely distributed, mainly in the warmer climates.

Blue panicgrass (*P. antidotale*) grows in moderately acid to slightly alkaline soils. It is not tolerant of salinity. Sandy loam to well-drained, fertile clay of average depth or deep are preferred. It is adapted to southern parts of the Great Plains and the Southwest. It is drought resistant but not winter hardy.

Guineagrass (*P. maximum*) grows in highly acid to slightly acid soils and is not tolerant of salinity. A perennial, it is adapted to subtropical and tropical conditions and requires applications of nitrogen.

Paragrass (*P. purpurascens*) grows in highly acid to neutral soils and is not tolerant of salinity. It requires moist to very moist conditions and tolerates some flooding. It is benefited by applications of nitrogen. It is subtropical to tropical in adaptation. It is a perennial and is propagated vegetatively.

Proso millet (*P. miliaceum*) grows in moderately acid or neutral and shallow or deep, sandy loam in dry to moist conditions. It is benefited by an application of nitrogen. A summer annual, it is cultivated for seed in the central and northern Great Plains.

Switchgrass (*P. virgatum*), a perennial, is adapted mainly to the central and southern parts of the Great Plains. It prefers sandy loams that are reasonably well supplied with moisture.

Vine mesquitegrass (*P. obtusum*) grows in neutral to moderately alkaline soils. It tolerates slight salinity. Soils should be of shallow to average depth and sandy loam to well-drained clay. It prefers dry conditions. A perennial, it grows in the Southwestern States and is drought resistant.

PASPALUM GRASSES (*Paspalum*) include many perennial species, which grow in highly acid to neutral soils—shallow to deep, gravelly loam to poorly drained clay and moist to swampy conditions. They are adapted principally to the Gulf Coast States and California. They are not hardy. Some species grow when nutrient levels are relatively low.

Bahiagrass (*P. notatum*) is adapted to drier sites and low nutrient levels.

Dallisgrass (*P. dilatatum*) requires higher nutrient levels than other species and is less adapted to fine sand and loam sand.

PENNISETUM GRASSES (*Pennisetum*) include many annual and perennial species, which grow in a wide range of soil and moisture conditions. They are adapted to climates in the South.

Buffelgrass (*P. ciliare*), a perennial, grows in slightly acid to slightly alkaline soils and is tolerant of slight salinity. Soils should be of average depth—

fine sand to well-drained clay. It stands dry to moist conditions and is moderately drought resistant. It grows in southern Texas and is particularly adapted to sandy soils. It requires applications of nitrogen. It is not hardy. Blue buffel is better on heavy soils.

Kikuyugrass (*P. clandestinum*) is a perennial that grows in neutral to moderately alkaline soils. It is tolerant of moderate salinity. Shallow to deep, fine sand to well-drained clay are preferred. It is adapted to subtropical and tropical conditions. It grows in California.

Napiergress (*P. purpureum*) grows in highly acid to neutral soils. It does not tolerate salinity. Its preferred soils are of average depth or deep, fine sand or clay loam. This perennial requires moist or very moist conditions. It is benefited by an application of nitrogen. It is adapted to subtropical or tropical conditions. It grows in Florida.

Pearl millet (*P. glaucum*) grows in highly acid to neutral soils and is not tolerant of salinity. Deep, fine sand or loam are best. It requires a great deal of moisture and is benefited by nitrogen. It is a summer annual adapted to the South.

PERENNIAL VELDTGRASS* (*Ehrhartacalycina*) grows in neutral to moderately alkaline soil. It is tolerant of slight salinity and likes shallow to deep loam and well-drained clay and dry to moist conditions. It is benefited slightly by an application of nitrogen. It is adapted to central and coastal areas of California. It is a drought-resistant perennial.

REDTOP AND BENTGRASSES (*Agrostis*) include many species that grow in highly acid to neutral soils and are not tolerant of salinity. Shallow, moist, gravelly loam to muck are preferred. They tolerate swampy conditions and benefit from the application of nitrogen. They grow when nutrient levels are relatively low. They are cool-season grasses and are suited to humid sections of the Northern States.

Colonial bentgrass (*A. tenuis*), *creeping bentgrass* (*A. palustris*), and *redtop* (*A. alba*) are important perennials.

RHODESGRASS (*Chloris gayana*) grows in moderately acid to highly alkaline soils. It tolerates moderate salinity. Soils of average depth to deep, loam and well-drained clay are preferred. It tolerates dry conditions. Applications of nitrogen are beneficial in the Southwestern States. It is a perennial but is not hardy.

RICEGRASSES (*Oryzopsis*) comprise many species, which grow in slightly acid to moderately alkaline soils and are tolerant of slight salinity. They thrive in sandy loam to clay loam that is of average depth or deeper. They stand very dry to dry conditions and are tolerant of wide ranges of temperature. They are mainly adapted to the western intermountain region. They are benefited slightly by application of nitrogen.

Indian ricegrass (*O. hymenoides*) is drought resistant. It is a perennial.

Smilo (*O. miliacea*) tolerates dry or moist conditions. It is grown in California in places that have wet winters and dry summers.

RYEGRASSES are annual and short-lived perennial species of *Lolium*. They grow in highly acid to neutral soils and are not tolerant of salinity. Shallow to deep, fine sand to poorly drained clay are suitable, as are moist to very moist conditions. They are benefited by the application of nitrogen. Some species are widely adapted in most States.

Italian ryegrass (*L. multiflorum*) is adapted as a winter annual in the South and as a summer annual in the North.

Perennial ryegrass (*L. perenne*) is a short-lived perennial. It is adapted to conditions of the Pacific Northwest and limited areas of the Northeast.

ST. AUGUSTINEGRASS (*Stenotaphrum secundatum*) grows in highly acid to slightly alkaline soils. It is not tolerant of salinity. It grows in shallow to deep, gravelly loam to muck in wet or swampy conditions. It is benefited by applications of nitrogen. It is adapted

to the gulf coast region. It is used mostly for shady lawns. It is a perennial.

SUDANGRASS (*Sorghum sudanense**) grows in moderately acid to neutral soils of average depth or deep, loamy sand to well-drained clay. It requires moist conditions although it tolerates drought periods after it is established. It is benefited by the application of nitrogen under moist conditions. It is a summer annual adapted to localities of high summer temperatures.

TALL OATGRASS (*Arrhenatherum elatius*) is a short-lived perennial that grows in moderately acid to neutral soils and is moderately tolerant of salinity. Soils should be of shallow to average depth and loam to poorly drained clay. It requires moist to very moist conditions but thrives in rich, well-drained soils. It is adapted to the Northern States.

TIMOTHY (*Phleum pratense*) grows in highly acid to neutral soils. It is not tolerant of salinity. It is benefited by applications of nitrogen. It is widely adapted in the Northern States in sandy loam or poorly drained clay.

VELVETGRASS (*Holcus lanatus*) grows in highly acid to slightly acid soils. It is not tolerant of salinity. Soils should be of shallow to average depth and fine sand to poorly drained clay. It requires heavy moisture. It is benefited by applications of nitrogen, although it grows at a low nutrient level. It is adapted to the Northern States and the upper South. It will tolerate swampy sites. It is mostly a weed.

WHEATGRASSES (*Agropyron*) include many native and introduced species. They grow under a wide range of soil conditions but are not adapted to acid soils. Some species tolerate salinity and are adapted to the drier sites. They are benefited by applications of nitrogenous fertilizers when the shortage of moisture is not acute. They are widely distributed in the Western States.

Beardless wheatgrass (*A. inerme*) is slightly more tolerant of drought in the Pacific Northwest, where it is best adapted, than crested wheatgrass.

Bluebunch wheatgrass (*A. spicatum*) requires semihumid conditions and a higher nutrient level.

Crested wheatgrass (*A. desertorum*) grows in neutral to slightly alkaline soils. It is tolerant of moderate salinity, gravelly loam or well-drained clay of average depth, and dry to moist conditions.

Fairway wheatgrass (*A. cristatum*) is better adapted to extreme northern conditions than crested wheatgrass.

Intermediate wheatgrass (*A. intermedium*) is less drought tolerant and requires a higher nutrient level. It is adapted to well-drained, sandy loam to clay loam. It is less hardy.

Pubescent wheatgrass (*A. trichophorum*) tolerates a lower nutrient level than intermediate wheatgrass.

Quackgrass (*A. repens*) grows in highly acid to neutral soils. It is not tolerant of salinity. Soils should be of average depth to deep, fine sand to clay loam. It demands moist to very moist conditions. It is benefited by applications of nitrogen. It is adapted to the humid Northern States. It is weedy.

Siberian wheatgrass (*A. sibiricum*) is better adapted to sandy soils having hardpans than crested wheatgrass.

Slender wheatgrass (*A. trachycaulum*) requires more moisture than crested wheatgrass.

Streambank wheatgrass (*A. riparium*) is tolerant of heavy moisture. It forms dense sod for waterways.

Tall wheatgrass (*A. elongatum*) tolerates poor drainage and high salinity.

Thickspike wheatgrass (*A. dasystachyum*) (see Crested wheatgrass).

Western wheatgrass (*A. smithii*) is better adapted to moist swales and has a wider range of climatic adaptation.

WILDRYE includes many perennial species of *Elymus*. They grow in a wide range of soil and climatic conditions. Some are benefited by the application of nitrogen. At least one species is found in nearly every State.

Blue wildrye (*E. glaucus*) grows on drier sites than Siberian wildrye.

Canada wildrye (*E. canadensis*) grows in highly acid to moderately alkaline soils and tolerates moderate salinity. It requires shallow to deep, gravelly loam to clay and moist to very moist conditions. It is benefited by the application of nitrogen. It is a widely adapted species.

Giant wildrye (*E. condensatus*) grows in neutral to moderately alkaline soils. It is tolerant to moderate salinity. A perennial, it needs shallow to deep, stony loam to well-drained clay and very dry to moist conditions. It is benefited slightly by the application of nitrogen. It is moderately drought resistant and is widely distributed throughout the dry areas of the West.

Russian wildrye (*E. junceus*) grows in neutral to moderately alkaline soils. It tolerates high salinity. It requires soil of average depth to deep, sandy loam to clay loam and dry to moist conditions. It requires a high nutrient level and is benefited by applications of nitrogen. It is particularly adapted to the northern parts of the Great Plains and farther west.

Siberian wildrye (*E. giganteus*) grows in slightly acid to moderately alkaline soil. It is not tolerant of salinity. It tolerates dry to moist conditions and is benefited slightly by applications of nitrogen. It is particularly useful for the stabilization of inland sand dunes but is not adapted to coastal conditions.

Legumes

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The legumes listed here are those of which seed is available and which are of greatest importance in agriculture.

All of those I list here are benefited by applications of calcium, phospho-

rus, or potassium when the supply in the soil is exhausted or unavailable.

Trace elements may have to be supplied to the plants for high yield of forage and seed and for persistence. Such needs are mostly of local occurrence and are related to soils of specific texture and origin.

Legumes vary in their ability to make growth at different levels of soil acidity and alkalinity, but slightly acid to neutral soils are generally best.

Nitrogen is an essential nutrient for all legumes. Inoculated legumes can get the nitrogen they require from the air through the interaction of compatible symbiotic nitrogen-fixing bacteria, which infect the roots and cause nodules to form on them.

Soil texture is an important factor among the water and temperature relationships that different species require for maximum growth. High yields of forage and seed and the persistence of plants reflect the interaction of favorable climatic and soil factors. Within limits, if the other factors are favorable, plants can tolerate one or more unfavorable conditions, which, however, cause variations in the range of responses.

ALFALFA (*Medicago sativa*) grows in slightly alkaline soils of average depth to deep, sandy loam to well-drained clay. It tolerates slight salinity, but it will not tolerate wet, poorly drained soil. Moist conditions are needed for seedling establishment.

Alfalfa tolerates periods of drought if moisture is available to the roots. It is benefited by applications of mineral nutrients when needed. Its requirements of available minerals are high. It is widely adapted to different climates if proper varieties are used.

ALYCECLOVER (*Alysicarpus vaginalis*) grows in highly acid to neutral soils. It is not tolerant of salinity. The soils may be of shallow to average depth

The starred names differ from those in USDA Service and Regulatory Announcements No. 156, reprinted August 1956.