Control of Weeds and Woody Plants on Rangelands
This publication was developed by the Extension Service, U.S. Department of Agriculture, in cooperation with other federal and state agencies for nationwide use by the State Cooperative Extension Services.

The authors of this publication are R. W. Bovey, Research Agronomist, U.S. Department of Agriculture, Agricultural Research Service, Department of Range Science, Texas A&M University, College Station, TX 77843; A. F. Wiese, Professor, Texas Agricultural Experiment Station, P.O. Drawer 10, Bushland, TX 79012; R. A. Evans, Range Scientist, U.S. Department of Agriculture, Agricultural Research Service, Renewable Resource Center, University of Nevada, 920 Valley Road, Reno, NV 89512; H. L. Morton, Plant Physiologist, U.S. Department of Agriculture, Agricultural Research Service, 2000 East Allen Road, Tucson, AZ 85719; and H. P. Alley, Professor, Plant Sciences Division, University of Wyoming, Laramie, WY 82071.

On February 28, 1979, the Environmental Protection Agency announced emergency suspension of uses of 2,4,5-T products on forests, rights-of-way, and pastures and suspension of registered uses for silvex products on forests, rights-of-way, pastures, and home, aquatic, and recreation areas. Cancellation proceedings were initiated at the same time. Decisions on these uses of products will not be known until final action has been taken. During the interim period, these uses are illegal.
Control of Weeds and Woody Plants on Rangelands

R. W. Bovey, A. F. Wiese, R. A. Evans, H. L. Morton, and H. P. Alley

Weeds and brush represent one of the most serious barriers to profitable livestock production. Of the estimated 1 billion acres of grazing land in the United States, approximately two-thirds are infested with weeds and brush. In some areas only one or two species are important; in others the problem entails a mixture of several species. Weeds and brush reduce forage quality; deplete soil water and nutrients; harbor insect vectors and predators; and may be poisonous, unpalatable, or mechanically injurious to livestock. Heavy stands of brush increase the difficulty of handling livestock and reduce land values.

Many of the weed and brush problems on grazing lands are a result of a history of mismanagement. Many weed problems exist on abandoned fields that were once in agronomic crops. Soil disturbance followed by poor management has resulted in severe soil erosion and loss of fertility. These areas could be improved by controlling the weeds and brush, providing adequate soil fertility, and reestablishing a desirable plant cover. Other reasons for encroachment of weeds and brush on rangelands include spread of seeds and plants by livestock and wild animals, poor grazing management, reduction in rangeland fires, and reduced competition from desirable vegetation. Periodic drought also contributes to weed and brush invasion and dominance by reducing competing vegetative cover. Plant diseases, insects, and rodents also may play a significant role in reducing forage cover.

Many weeds and brush provide considerable browse, forage, and protection for wildlife and livestock. Land managers need to identify desirable species and adjust control programs to retain them. For example, some oaks provide excellent browse and protection for deer and goats but are of little value for cattle. Retention of some brush may be required to maintain wildlife habitat. On areas subject to wind and water erosion, such as sand dunes, weeds and brush provide necessary cover until more desirable forage is established. Weeds and woody plants also may serve as valuable sources of useful wood and industrial products.

It is essential that problem plants be accurately identified so proper control methods can be used. If you cannot identify the species to be controlled, seek advice from a local county agent or extension specialist or from state agricultural experiment station or U.S. Department of Agriculture (USDA) personnel. Some well-illustrated USDA or state agricultural experiment station or extension circulars, bulletins, and books may be available to help you identify problem species, including poisonous plants.

Methods of Control

The first step in controlling a problem species is to identify it correctly. Plant species differ greatly in their response to fire, mechanical, chemical, or biological control measures. Selecting the proper method depends on the species, cost, type of soil and terrain, rainfall patterns, existing forage species, proximity to cropland, management objectives, and other factors.

Chemical Control

Herbicides are an important means of weed and brush control on rangelands. Compared to mechanical practices, herbicides usually are less expensive, less damaging to the environment, and often more effective. Herbicide sprays, however, are subject to drift and may damage susceptible crops or valuable vegetation on nearby areas if improperly applied. A variety of herbicides and herbicide combinations are available commercially. It is essential that you understand the properties and effects of herbicides to use them safely and effectively. Herbicides commonly used for weed and brush control include: 2,4-D, 2,4,5-T, silvex, dicamba, bromacil, picloram, triclopyr, ammonium sulfate (AMS), amitrole, and tebufluuron. Combinations of herbicides such as 2,4-D + 2,4,5-T, 2,4,5-T + picloram, 2,4,5-T + dicamba, and 2,4-D + picloram or dicamba also are used.

Herbicide Formulations

After manufacturing, technical (pure) herbicide must be formulated with other ingredients to prepare usable products that can be handled easily and to obtain the desired effects on weeds and crop plants. Since sometimes very small amounts are required per acre, uniform application is essential. Herbicides are formulated as liquid concentrates (2,4-D, 2,4,5-T, dicamba, picloram), wettable powders (bromacil, amitrole), and granules or pellets (picloram, dicamba, tebufluuron).

Solutions. Solutions are physical homogeneous mixtures of two or more substances. An example is sugar or salt (solute) dissolved in water (solvent). Most salts, such as the amine salts of 2,4-D, 2,4,5-T, and dicamba or the potassium salt of picloram, are soluble in water. They are formulated as water-soluble concentrates by the manufacturer and are mixed with water for spraying.
Emulsions. An emulsion is one liquid dispersed in another liquid, each maintaining its original identity. The mixture may separate without stirring, but it usually remixes with agitation. Esters of 2,4-D or 2,4,5-T (oil-like) are formulated with emulsifiers (a third substance) and can mix with water, oil, or oil-water carriers when spray solutions are prepared. The emulsified 2,4-D or 2,4,5-T spray solution appears milky.

Wettable Powders. Wettable powders are finely divided solid particles that can be suspended in a liquid. Wettable powders are prepared because some herbicides are nearly insoluble in both water and oils, and concentrated solutions or emulsions cannot be prepared from them. When finely ground, these herbicides can be dispersed in water or oil. Most suspensions of wettable powders require agitation. Bromacil is an example of a wettable powder.

Granules or Pellets. Granules or pellets consist of alacalay, clay, sand, vermiculite, or some other carrier impregnated with an herbicide. They are made by spraying the herbicide on the carrier or by adding a core material such as vermiculite to the dry powder by pillrolling with the appropriate binders. Tebuturon is an example of an herbicide prepared for use as an extruded pellet.

Characteristics of Herbicides

Phenoxo Herbicides. Phenoxo herbicides such as 2,4-D, 2,4-DB, 2,4,5-T, dichlorprop, MCPA, and silvex have been used for more than 30 years and are effective for controlling many weed and brush species. They are used to produce changes and shifts in plant cover that are beneficial for livestock utilization and wildlife habitat. The phenoxyo are not toxic to livestock or man at dosages labeled for weed control and they disappear rapidly from the soil, vegetation, and water. They do not accumulate in the food chain.

Ester formulations of phenoxyo herbicides are moderately toxic to certain fish. They are only slightly toxic to lower aquatic organisms, birds, and wild mammals under laboratory conditions.

Susceptible vegetation, especially cotton, can be damaged from spray drift or from volatilization (especially high volatile esters). Following label instructions and making applications during favorable weather should prevent drift and volatilization problems.

The phenoxyo herbicides selectively control broadleaf weeds in grasslands or grass crops. Low rates of 0.25 to 2 pounds per acre effectively control many broadleaf plants. High rates of phenoxyo can injure grasses.

The phenoxyo compounds are relatively inexpensive and easy to apply. They usually are marketed as liquid concentrates of salts or esters. The ester formulations, especially 2,4,5-T, often are more effective as foliar sprays on trees and brush than are the salts. Types of amine formulations commonly available include dimethyamine, triethylamine, diethanolamine, trimethylamines, and triethanolamine.

Inorganic salts of the phenoxys that have been sold include the ammonium, sodium, potassium, and lithium salts. Salts are sprayed in water carriers.

Esters are classified as high volatile or low volatile, depending on how readily they vaporize. Methyl, ethyl, isopropyl, and butyl esters of 2,4-D are examples of 2,4-D formulations that are highly volatile when sprayed on hot days. Such phenoxyo compounds are identified on the herbicide container or package label. Examples of low volatile esters of phenoxys include the propylene glycol butyl ether, butoxyethanol, and isoctyl esters. Low volatile esters should be used in areas where sensitive crops or vegetation are grown. The tendency for an herbicide to vaporize (volatilize) is important because it may be carried as fumes from the target area and damage nearby valuable vegetation, especially under windy conditions on hot days.

The concentration of the active ingredient, the "acid equivalent," is indicated on the label as pounds per gallon. Acid equivalent refers to the concentration of formulation that theoretically can be converted to the acid after removal of the ester or amine portion of the molecule. If an herbicide concentrate has an acid equivalent of 4 pounds per gallon, then 1 gallon of the concentrate contains 4 pounds by weight of the parent herbicidal acid, regardless of formulation. Usually the most concentrated formulations cost less per pound and are more economical to use than weaker concentrates. Silvex and 2,4,5-T cost more per pound than 2,4-D. Therefore, for control of both weeds and brush, it is frequently more economical to substitute 2,4-D for 2,4,5-T for at least part of the mixture. On many woody species, however, 2,4,5-T is more effective than other phenoxyo.

The phenoxyo compounds are readily absorbed by leaves and are translocated throughout the plant along with the products of photosynthesis. Oil soluble formulations, usually esters, applied in kerosene or diesel oil will penetrate the bark of most woody plants and can be used as basal or foliar sprays on individual plants. The phenoxyo herbicides, however, are more commonly applied broadcast to large areas containing dense stands of brush. These herbicides are sprayed on above-ground parts and foliage since they are not effective at economical rates as soil-applied herbicides.

Organic Arsenicals. The organic arsenicals include DSMA, MSMA, and cacodylic acid and are available as liquid concentrates. These compounds have limited use for woody plant control as foliar sprays. DSMA and MSMA are used for postemergence weed control in tolerant lawn grasses, cotton, citrus, and noncrop areas. Cacodylic acid is used as a general desiccant (drying agent) and defoliant (contact) spray on many crop and noncrop areas. The organic arsenicals can be used for quick dieback of woody species, but plants tend to recover. The organic arsenicals can be injected into the trunk to kill unwanted trees. As foliar sprays, they are applied in water. Complete coverage by spray is required for best results. They are inactivated by soil contact.

The organic arsenicals may injure desirable plants. Directed spraying should be used to avoid desirable plants. Organic arsenicals have a moderate to low mammalian toxicity but are highly toxic to insects such as honey bees. They are mildly corrosive to spray equipment.

Bipyridyls. Diquat and paraquat are desiccant and defoliant herbicides used for general contact activity against weeds and brush. In some situations, they are used as selective herbicides. Paraquat is water soluble and is inactivated by soil contact.

Woody species usually will resprout from foliar sprays of diquat and paraquat. Paraquat may be more effective as an injection treatment against some undesirable trees. Paraquat is registered for suppression of existing sod and emerged undesirable weeds and grasses to permit pasture and range seeding. Paraquat can be used to control winter weeds in dormant warm-
season grasses. Paraquat is highly toxic when ingested. Extreme care must be taken to avoid breathing the spray mist or getting the concentrate on the skin. Wear protective clothing and respirators when making applications. Get immediate medical care in the event of ingestion. The antidote for paraquat poisoning consists of repeated oral administration of large amounts of bentonite or fuller’s earth along with a cathartic to bind paraquat and prevent its absorption (activated charcoal may be used in place of bentonite). At the same time, forced diuresis and hemodialysis are employed to remove paraquat from the blood. If treated within 12 hours, chances of survival are excellent.

**Benzoic.** Dicamba is a selective translocated herbicide. It controls many broadleaf weeds in pastures and cropland and it controls some woody plants. It is similar to the phenoxy herbicides in activity and use. It is absorbed through roots as well as through foliage. Dicamba can be applied by either ground or aerial sprays or as granules, depending on the weed to be controlled and their proximity to susceptible crops. Dicamba can be applied in mixtures with 2,4-D or 2,4,5-T to broaden the spectrum of weed species controlled. Dicamba has a low order of toxicity to wildlife, fish, livestock, and humans. It rapidly degrades and does not accumulate in the environment. Dicamba has a low corrosion hazard to spray equipment. It is formulated as a liquid as dimethyamine or sodium salt and is sprayed in a water carrier. It also is formulated in granular form as an anhydride. Dicamba is highly water soluble; care must be taken to prevent its movement into water sources.

Spray drift of dicamba to sensitive crops, conifers, and certain woody plants should be prevented. Granular formulation may be preferred in areas where drift of sprays would present a hazard to crops.

**Ureas and Uraclis.** These compounds include bromacil, diuron, fenuron, fenuron-TCA, monuron, monuron-TCA, tebuthiuron, and hexazinone.

Ureas and uracil-type herbicides can be selective at low rates and nonselective at high rates. They usually are formulated as wettable powders for water sprays or as granules or pellets for dry application.

Bromacil (a uracil) will control a wide variety of woody species. If rates above 5 pounds per acre are used, it also will kill many desirable grasses and forbs on grazing lands.

Fenuron is no longer produced commercially, but a fenuron-TCA combination is available and is used to control certain woody plants and weeds on noncrop areas. Monuron and monuron-TCA combinations are available commercially, but they have limited use for brush control because high rates are required for effectiveness. The monuron-TCA or fenuron-TCA combinations generally are used for nonselective, temporary sterilization in noncrop areas.

Tebuthiuron shows excellent promise for control of a variety of undesirable woody plants. This herbicide is formulated as pellets and contains 20 or 40 percent active ingredient. It is commercially available for both rangeland use and weed control on noncrop areas.

Hexazinone is a relatively new compound that shows promise for weed control and for use on noncrop areas. Hexazinone is recommended for forestry site preparation and for pine release where loblolly, long leaf and short leaf, slash, and Virginia pines are grown. The pelleted product can be spread in a grid pattern for hardwood brush control. It also shows promise for total vegetation control, including control of perennial grasses. It is highly water soluble.

The ureas and uracil compounds mentioned above are absorbed primarily through the roots of plants. They can be applied in spring or fall when weeds and brush are actively growing and when adequate rainfall leaches them into the soil.

Fall, winter, and early spring applications of tebuthiuron and hexazinone can be timed to reduce injury to forage plants and eliminate hazards of drift. These compounds may kill trees at a considerable distance from the point of application, depending on the size of the root system and whether it extends into the treated area. The compounds are nonvolatile and do not corrode equipment.

Most urea and uracil herbicides can be injurious to some forage species when applied broadcast, especially as sprays. Applying herbicides as pellets or balls to confine the herbicide to a few spots in the treated area reduces exposure to desirable forage plants. Applications can be made by air or ground. Application of granules, pellets, or sprays to the soil surface or sprays applied subsurface in rows or bands spaced 6 to 10 feet apart may reduce injury to forage and may increase the kill of some woody plants.

Most of the ureas and uracil compounds persist in the soil for several months at rates used for brush control. They are low in toxicity to warm-blooded animals.

**Other Organic Herbicides**

Picloram is a selective, translocated herbicide that effectively controls many weed and brush species in grasslands. It can be applied to the soil or foliage and is effective as an injection/cut surface treatment on many undesirable trees.

Picloram can be applied in liquid sprays and as pellets to brush in the spring and fall, depending on the species to be controlled. Applied as a spray, it is absorbed by both foliage and roots. Most perennial grasses are resistant. The high activity of picloram against many woody plants at moderate rates makes it desirable for brush control.
Care must be taken to prevent drift of picloram to desirable plants. Picloram is relatively persistent in soil, especially in cool climates. Since it is water soluble, care must be taken to prevent its movement into water used for irrigation. It should not be applied where it can be leached or moved to sensitive crop areas by rainfall. Picloram has a low mammalian toxicity. It is only slightly corrosive to spray equipment.

Triclopyr is a relatively new selective postemergence herbicide for use on rights-of-way and industrial and forestry sites; it is being used experimentally for rangeland brush control. It also can be used to kill trees and brush by injection/cut surface treatments. It is readily translocated in plants and is reportedly more effective than 2,4,5-T on some species. It is moderately toxic to warm-blooded animals. It degrades rapidly in soil. Ester formulations are available.

Glyphosate is a nonselective herbicide that is effective against both grasses and broadleaf plants. It is readily translocated from leaf and stem tissue to roots, resulting in a high degree of kill on many weeds. It is inactivated by contact with the soil and should not injure newly seeded forages planted in treated soil. It is sprayed in a water carrier. Glyphosate currently is registered for use for noncrop and pre-till weed control and as a directed spray for orchards, plantations, Christmas trees, and many other crops. It is not corrosive to equipment.

Broadcast sprays over woody species will damage desirable forage plants. Applications should be made to individual plants on noncrop areas or areas to be renovated. Glyphosate has a low order of mammalian toxicity.

Amitrole is effective against poison ivy and poison oak. If amitrole is accidentally sprayed on desirable plants, it is less likely to cause severe injury than sprays of 2,4-D, 2,4,5-T, or silvex.

Amitrole is available as a powder containing 50 percent active ingredient or as a liquid formulation. Another formulation, Amitrole-T, contains 2 pounds per gallon of ammonium thiocyanate in addition to 2 pounds per gallon of amitrole. Amitrole is effective through the roots and tops of plants. Amitrole cannot be used where there is any possibility of residues on food or seed crops.

Inorganic Herbicides. Ammonium sulfamate (AMS) is a nonselective herbicide. It is used extensively to kill all plants growing on rights-of-way. AMS kills trees. It can be used as a foliage spray or in cuts through the bark. When applied to stumps, it prevents sprouting.

AMS is not poisonous to animals. It is safe to use near crops because it does not vaporize and because large amounts are needed to injure plants. AMS is not a desirable chemical to use on grazing lands. It kills or suppresses forage plants as readily as woody plants. It is corrosive. Spray equipment should be cleaned immediately and coated with diesel oil or similar light oils after use.

Oils. Diesel oil and kerosene are commonly used to control honey mesquite and huisache. One cup to 1 gallon of oil is used per tree, depending on tree size. The oil is applied around the base of the tree during dry weather when the soil is pulled away from the trunk. Application at this time enables oil to penetrate to the lower buds on the stem.

Oils alone are not very effective herbicides when applied to the foliage of woody plants. Diesel fuel is commonly used as a diluent and carrier for some oil soluble herbicides such as 2,4,5-T for individual plant treatments. It also is used as a carrier in aircraft spraying, usually as 1:4 oil-in-water emulsion with the ester of 2,4,5-T or other herbicides. The oil reduces evaporation of the herbicide in arid areas and aids in penetrating the stems and foliage of some woody plants. Water carriers, however, are equally as effective as oil carriers in some situations; for example, the use of 2,4-D on sagebrush. Due to the high cost of diesel fuel, water carrier is being substituted in aircraft spraying.

Triazines. Atrazine applied at low rates (0.8 to 1 pound per acre) in the fall is a soil-active herbicide that controls downy-brome and other weeds. Perennial grasses can be seeded the following fall and will establish under much reduced weed competition. Atrazine also can be used in renovation of existing stands of certain perennial range grasses in the western region of the United States.

Herbicide Combinations

Herbicide combinations are being used on both agronomic and grazing lands. Herbicide combinations sometimes broaden the spectra of weeds controlled and reduce cost. One of the first successful combinations of herbicides for brush control was a 1:1 mixture of 2,4-D + 2,4,5-T; it is still used today.

Woody species susceptible to foliar sprays of 2,4-D + 2,4,5-T include common alder, quaking aspen, boxelder.
American chestnut, cottonwood, American hazel, American hop hornbeam, sweetbay magnolia, interior live oak, post oak, poison ivy, multiflora rose, willow, and yellow poplar. Injections of 2,4-D + 2,4,5-T through properly spaced cuts in the bark of undesirable trees also is effective on some species.

A picloram + 2,4,5-T (1:1) combination is more effective on honey mesquite and some other woody plants as a foliar spray than either herbicide alone at comparable rates. Picloram + 2,4-D (1:4) and dicamba + 2,4-D (1:2 and 1:3) combinations are available commercially for weed and brush control.

Application Methods

Formulated herbicides are of little value if application methods and equipment are not available to treat weeds in a safe and practical manner. Equipment for applying chemicals must disperse small quantities of herbicide over large areas. Spraying is the most common method of applying herbicides. Herbicides can be applied by (1) spraying onto foliage, (2) spraying basal bark or stumps, (3) injecting into the sapwood of trees by mechanical devices or through frills or notches cut into the tree, and (4) applying to the soil.

Broadcast Sprays

Spray applications can be classified according to volume. An ultra low volume application signifies a total spray volume no greater than ½ gallon per acre. An ultra low volume treatment may be undiluted herbicide. Low volume sprays are from 1 to 30 gallons of spray solution per acre. High volume sprayers apply from 30 to 500 gallons or more per acre.

Low Volume Sprays. Several herbicides control weeds and brush when applied at low volume as broadcast foliar sprays. Low volume spraying is usually quicker, easier, and less expensive than high volume spraying. Low volume sprays often are applied by aircraft. Best control of some woody or resistant species may require complete coverage of the plant with a high volume spray.

Ground equipment is practical for applying low volume sprays to low growing weeds and brush on uncleared land or to regrowth on land that has been mechanically cleared. Low volume sprays applied in swaths up to 50 feet wide with either a spray boom with several nozzles or a large, boomless nozzle have produced satisfactory coverage of plant foliage. Spray booms on ground sprayers should be mounted to clear the tallest weeds and brush by 2 to 3 feet. An operating pressure of 30 to 40 pounds per square inch (psi) generally is effective. Boomless nozzles should be mounted to clear all weeds and brush by 3 to 4 feet. Spray pressures from 30 to 60 psi are used.

Aerial spraying is most efficient for treating large areas or tall and dense stands of brush on rough terrain. Both fixed wing aircraft and helicopters are used for aerial spraying. Helicopters are particularly useful for spraying rough terrain and small, irregularly shaped areas. They often are used for spraying rights-of-way. Aerial spraying can give good coverage in most brush. Sprays applied in tall brush often are inadequate to kill understory plants. A second aerial spraying may be necessary a year or two after the first. When applying spray by aircraft, the pilot must fly as close to the top of the brush as deemed safe. Experienced flagmen or guides on the ground are used to mark individual flight swaths for the pilot’s guidance. Proper swath width should not exceed one and a half times the wingspan or bladespan of the aircraft.

High Volume Sprays. High volume sprays are used to apply herbicides to weeds and brush along roads, rights-of-way, fence rows, and other similar areas or to individual plants on pastures and rangeland. All foliage and twigs should be thoroughly wetted. High volume sprays usually are applied to foliage with power equipment. The power sprayer should be capable of maintaining pressures up to 100 pounds psi. This pressure is enough to force the spray through the foliage and to the tops of tall trees. Pressure higher than 100 pounds forms fine spray droplets that may drift and damage nearby susceptible crops.

Adjustable, hand-operated sprayers are suitable for applying sprays to low growing brush. Best coverage is obtained with a fan- or cone-type nozzle that has a spray angle of about 40 degrees. The nozzle should be attached at a 45 degree angle to an extension tube from 24 to 36 inches long. To reach the tops of tall trees or brush too far away for a wide-angle spray, the gun can be adjusted to deliver a narrow-angle stream. Adequate pressure for hand-operated equipment varies from 25 to 40 psi.

Because of the large volume of spray necessary for this method, it is impractical for treating areas where the water supply is limited, large areas, or areas where truck- or tractor-mounted spray tanks cannot be taken.

Individual Plant Treatments

Treatment of individual plants is especially useful for controlling undesirable hard-to-kill woody species that occur in scattered stands. Individual plant treatment includes foliar sprays, basal sprays, cut surface and injection, and soil treatment.

Foliar Sprays. Foliar sprays of 2,4,5-T, 2,4-D, silvex, dicamba, and picloram usually are applied in spring and summer to individual plants or groups of plants when they are actively growing and after the leaves have reached full size. Low or high volume sprays can be used. Ester formulations usually are more effective on woody species than amine formulations and are less likely to be washed off should rainfall occur soon after application. If complete coverage is necessary to kill a given weed species, high volume (drench) sprays that wet all foliage, twigs, and terminal stems may be desirable.

Basal Sprays. Basal sprays are used to treat bark at the base of individual plants. Mixtures of ester formulations of 2,4-D, 2,4,5-T, or silvex with diesel oil or kerosene carriers or oil alone commonly are used. Basal sprays can be used to kill brush and trees with main stems up to about 5 inches in diameter any time of the year. Effectiveness of the treatment may be reduced if the bark or soil is wet. The stem should be sprayed from the soil line to 18 inches above ground. One gallon of spray will treat 50 trees 2 inches in diameter. Compressed air sprayers, knapsack sprayers, or power sprayers can be used.

Cut Surface and Injection Treatments. Trees larger than 5 inches in diameter often have bark too thick for basal sprays to penetrate. Herbicide can be applied to the sapwood of trees through frills or notches cut into the bark, or it can be mechanically injected.

Frills are cuts made into the sapwood. They encircle the tree and act as cups to hold the herbicide. The frill is made by circling the trunk with ax cuts that penetrate sapwood at least ¼ of an inch. Spacing depends on the species, herbicide, and time
of year. The frill can be filled with the same solution as is used for basal sprays. Undiluted herbicide also can be used. A notch also can be cut into one side or more at the base of the tree and sprayed with the appropriate herbicide.

The same spray equipment can be used for frills and notches as is used for basal sprays. The solution also can be applied with a plastic squeeze bottle, such as a dishwashing liquid container, or with a small can that has a pouring spout or lip. Since ammonium sulfamate solutions are corrosive, plastic or discardable containers are satisfactory.

Injection treatments are very effective for killing woody plants, but the labor requirements make them expensive. Also, to be effective, the correct volume of herbicide solution must be placed in properly spaced cuts. In winter, resistant species may require higher concentrations of herbicide or closer spaced cuts with herbicide. Follow the directions on the container label. Commercial injection tools are available.

If trees are felled, the freshly cut surface of the stump should be treated with herbicide to prevent sprouting of certain species. It is more efficient to prevent sprouting than to kill the sprouts. Apply the herbicide (e.g., 2,4,5-T) in oil; undiluted; in a solution of 2 to 4 pounds of ammonium sulfamate per gallon of water; or as ammonium sulfamate crystals directly to the fresh cuts.

If oil solutions are used, apply to the cut surface and also drench the bark thoroughly from the cut to the ground.

**Soil Treatment.** Certain soil-active herbicides as pellets or as sprays can be applied broadcast to individual plants, or they can be placed in grids or bands to kill brush. Rainfall after application is required for best results; in some cases, the soil should be moist before application. There may be reduced kill during hot, dry seasons.

Dry herbicide materials commonly are formulated as extruded pellets 0.05 to 0.15 inch in diameter, spherical pellets from 0.05 to 0.5 inch in diameter, or tablets of varying size up to 1 inch long. The use of soil-active herbicides has become more common since the development of new herbicides that are effective for brush control.

The small herbicide pellets can be broadcast or applied in bands in brush-infested areas. The larger spherical pellets and tablets are effective when applied in grids spaced on 6- to 9-foot centers. Different species respond differently to a grid pattern due to differences in root systems. Gambel oak, which has a deep root system, does not respond well to grid pattern applications, but it is killed with broadcast applications. Shrub live oak and Utah juniper respond well to a grid pattern in which the herbicide pellets are spaced on 3-, 6-, or 9-foot centers because of its shallow, widespread lateral roots. Snakeweed control is best with broadcast application of granules. Damage to forage plants also is minimized using grid or band placement. Small or large pellets can readily be broadcast by aircraft. Soil- applied herbicides such as bromacil, tebuhiuron, or hexazinone can damage forage stands if broadcast sprays of wettable powders are used. Picloram, tebuhiuron, and bromacil pellets of varying size from 0.05 to 0.15 inch diameter can be applied in bands spaced at 6 to 10 feet apart.

**Wipers and Special Techniques.** Herbicides also can be applied directly to weeds and brush using specially designed tractor-mounted rope wick or carpet applicators. Herbicide solutions are conducted through the porous medium and wiped onto the unwanted plants. Present designs allow treatment of weeds and brush not exceeding 6 to 7 feet tall. The rope wick or carpet applicators are saturated with undiluted or diluted herbicide (e.g., 1 part herbicide to 1 part water) and wiped on the unwanted plants as the tractor passes through the field. Hand-carried wipers for small jobs also have been constructed. These wiping devices are available commercially and enable better placement of the herbicide on weeds with less exposure to valuable plants. The devices reduce total herbicide and carrier used per acre compared to broadcast sprays. Although costs may be reduced, wiping treatments may be less effective than other methods on some species.

### Preparation of Broadcast Sprays

High volume or low volume spray preparations can be made with selective or nonselective herbicides. Always double check the herbicide label on the container or package for instructions. See [table 1](#).

**Low Volume Sprays.** Low volume spray preparations can be made with 2,4-D, 2,4,5-T, dicamba, picloram, triclopyr, etc., or certain mixtures of these herbicides. [Table 1](#) shows the amount of various herbicide concentrates to be used for a 2-pound-per-acre application.

To prepare the spray, mix the concentrate with the carrier (water, oil, oil-in-water emulsion) in the proper proportions. Since rate of treatment is 2 pounds per acre, the per acre discharge rate of the sprayer must be known. For example: If the sprayer output is 10 gallons per acre, and if the acid equivalent of the concentrate is 2 pounds per gallon, then mix 1 gallon of concentrate with enough carrier to make 10 gallons of spray. (See the Calibration section later in this bulletin.)

<table>
<thead>
<tr>
<th>Acid equivalent of concentrate, pounds per gallon</th>
<th>Amount (fluid measure) of concentrate</th>
<th>Basal spray (mix with 1 gallon kerosene or diesel fuel)</th>
<th>Herbicide drench (add to each 10 gallons water)</th>
<th>Low volume spray (to use for 2-pound-per-acre application)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>10 ounces</td>
<td>1 pint</td>
<td>1 gallon</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>8 ounces</td>
<td>12 ounces</td>
<td>3 quarts</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>6 ounces</td>
<td>10 ounces</td>
<td>5 pints</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>5 ounces</td>
<td>5 ounces</td>
<td>2 quarts</td>
<td></td>
</tr>
</tbody>
</table>

When preparing oil-in-water emulsions for low volume spraying:

- Use an ester formulation that is designated on the label as compatible with oil-in-water emulsion carriers.
- Add about half the required volume of water to a clean spray tank.
- In a separate tank, mix and agitate the required volumes of herbicide and oil.
- Add the herbicide-oil mixture while agitating the water.
- With continued agitation, add the remaining water.
- During use, agitate the emulsion frequently to prevent separation of the oil and water.

**High Volume or Drench.** To prepare high volume sprays containing 2,4-D, for example, mix spray concentrate with water in the proportions shown in table 1. To prepare a drench containing amitrole, mix 1½ pounds of 50 percent amitrole powder with each 25 gallons of water. To prepare a drench containing ammonium sulfate (AMS), mix 0.6 to 1 pound of the chemical with each gallon of water.

Other wettable powders such as bromacil or hexazinone can be prepared similarly to amitrole.

If increased wetting and penetration of the spray is desired, add 4 ounces of surfactant to each 100 gallons of solution.

**Basal Sprays.** Basal sprays are prepared by mixing esters of 2,4-D, 2,4,5-T, silvex, or similar herbicides with either kerosene or diesel fuel. For most species, 2,4,5-T is best. Mix basal sprays in the proportions shown in table 1 or follow the directions on the herbicide label.

**Injections or Cut Surface Treatments.** Preparations for injection or cut surface treatments can be made from amines and esters of 2,4-D, 2,4,5-T, silvex, or other herbicides. Treatments can be made with concentrated formulations of the herbicides. For best results, follow the directions on the herbicide label.

Ammonium sulfate, in solutions or as crystals, can be used for cut surface treatments. The solution is prepared by mixing 2 to 4 pounds of AMS into 1 gallon of water.

Research has shown that the amine salts of 2,4-D or 2,4,5-T are more readily translocated from injection or cut surface treatments than esters. The amine can be applied undiluted or they can be diluted in water.

**Soil Treatments.** Some herbicides are formulated as granules, pellets, spheres, tablets, or wettable powders for application to the soil. Pelleted materials can be spread by hand, by tractor-drawn equipment, or by aerial equipment. Wettable powders usually are mixed with water and sprayed directly on foliage or on the soil under or near the plants. If individual plant treatment is made, the amount of chemical needed will depend on the size and kind of plant to be killed. Do not apply within 100 feet of desirable trees. The herbicide concentration is indicated on the label as percentage of active ingredient in the formulation.

The granule or powder formulations of different herbicides vary in percentage of active ingredient from 2 to 90 percent. Therefore, the amount of formulation used per acre must be determined. For instance, if a 2-pound-per-acre herbicide application is desired with a formulation containing 10 percent active ingredient, the required amount of product per acre would be 20 pounds.

**Special Carriers for Drift Control.** Invert emulsions are thick, viscous mixtures like mayonnaise and are useful for dispersing herbicides in areas where drift control is important.

In invert or water-in-oil emulsions, oil is the continuous phase and water droplets are the discontinuous phase. Spray droplets produced are larger than those of conventional sprays and are less subject to evaporation and movement by air currents. Reduced weed control may result from inadequate spray coverage due to the large spray droplets, however. Cost of operation may be increased due to special spray equipment and handling. Mixing instructions on the herbicide label should be followed closely.

Some commercial preparations added to the spray solution are available to control herbicidal spray drift. Check with local agricultural chemical dealers or agricultural authorities if you want to use special drift control agents.

**Application Equipment**

**Ground Equipment.** Of the hand-operated sprayers, the backpack sprayer is most popular. It employs compressed air to force liquid out of the tank through a single or multiple nozzle hand-carried boom. Tank capacity of hand-operated sprayers varies from 0.5 to 5 gallons. These sprayers are most useful in treating small areas or individual plants that may be inaccessible to power equipment.

Power-driven sprayers range from small wheel-mounted sprayers used in home gardens and lawns to large field sprayers. Field sprayers can be mounted on trailers, tractors, or trucks or they are self-propelled. Special heavy duty sprayers with foam marker systems for use on rough, brush covered rangeland can be constructed by modifying conventional farm sprayers. Sprayers can be classified by output volume. Spray output may range from less than a gallon to several hundred gallons per acre when saturation of a large mass of vegetation is required. Most weed sprayers, however, are low volume, with 30 gallons per acre or less of total spray output.

Basic components of a power sprayer consist of a liquid holding tank, nozzle(s) to direct the spray, and a pump to force the spray through the nozzles. In addition, there must be a pressure regulator, a pressure gauge on the boom, a shut-off valve, and a filter and strainer (figure 1). Agitation is provided by bypass at the pressure regulator or by a mechanical agitator. Details about sprayer components, spraying systems, and operation can be obtained from several manufacturers and from local agricultural authorities.

Power-driven or ground sprayers may consist of hand guns, wands, or a boom of one or more nozzles to treat individual plants, or boom sprayers that apply swaths up to 50 feet wide in a single pass. Boomless sprayers with a cluster of flat spray nozzles mounted in the proper assembly produce relatively uniform spray patterns in swath widths up to 30 feet. Potential drift for all types of sprayers is reduced at spray pressures of 10 to 30 psi. Hooded sprayers are designed for low volume applications and control of spray drift. Mist blow sprayers can be used in some areas that are remote from crops; they provide excellent coverage and weed control. These sprayers consist of nozzles placed in a high speed blast of air that propels the herbicide onto the weeds or brush. Such sprayers are effective in applying insecticides in orchards, but in many situations the drift potential is too great for applying herbicides.

**Aerial Equipment.** The components of aircraft sprayers are similar to those of ground equipment. Spray pumps on aircraft are driven by a V-belt drive from the main engine, a small direct-connected propeller, or an electric motor. Agitation
usually is provided by a hydraulic bypass from the centrifugal pump. Most boom are positioned behind the trailing edge of the wing for improved visibility and accessibility. Booms generally are shorter than the length of the wings to prevent drift from the wing tip vortices.

Hydraulic pressure spray nozzles are the most popular, but various atomizing devices including spinning brushes, disks, and screens also are used. Spray systems include the Ziegler nozzle system, which is operated at low pressure and employs a manually controlled cap for positive shutoff. A hole drilled through a brass plug positioned along the boom forms the nozzle tip. The spray stream formed by the nozzle strikes the flat cap, aiding in spray formation.

Another boom system uses diaphragm check valve nozzles. Spring tension closes the diaphragm check valve when spray pressure drops below about 7 psi to insure a positive shutoff. The nozzle pressure is usually set at 30 psi during spraying. Nozzles can be spaced along the boom to give the most desirable spray pattern. Nozzle tips, orifice disks, and cores can be changed to vary sprayer output and droplet size.

The spinning or centrifugal atomizer, powered by air (propellers) or electric motors, can produce either coarse or fine sprays. Atomization is accomplished when centrifugal force pushes liquid through the rotating screen or disk. Usually four units are used per aircraft, with two atomizers properly spaced at the trailing edge of each wing.

The bifluid nozzle system was developed to apply invert emulsions (water-in-oil). Although the system is not widely used, it provides a well-metered system for applying invert emulsions.

The number of nozzles (17 to 32) used with the various types of spray systems depends mainly on the type of aircraft and on operator preference. Biwing planes usually use fewer nozzles than low wing monoplanes. The use of fewer but higher flow rate nozzles produces larger spray droplets. Large droplets reduce drift potential but increase the probability of uneven spray coverage. Using the fewest number of nozzles that will provide uniform spray coverage has been most satisfactory. The distance between nozzles usually is equal. Some operators place additional nozzles on the right boom to adjust for the spray pattern distortions caused by the propeller slipstream.

Control of spray drift is especially important with aircraft since drift of growth regulator herbicides, such as 2,4-D or 2,4,5-T, can cause damage to nearby susceptible vegetation and reduce the effectiveness of treatments. Spraying should be done under proper weather conditions (low wind velocity and stable air) to deposit the chemical on the target area. Droplet size of the released spray is very important. Small droplets (10 micron in diameter) can drift up to 1 mile when released 10 feet high in a 3 mile per hour wind. Large droplets (300 to 400 microns in diameter) are less subject to drift but may not provide uniform coverage. Spray systems designed to produce a mean droplet diameter of about 200 microns are a compromise between drift control and adequate coverage. Absolute drift control is difficult because present-day techniques do not always eliminate all small droplets. Drift control agents sometimes are useful near ecologically sensitive areas to minimize the small droplets.

Granular Applicators. The application of herbicides in granular, pellet, and tablet form is gaining much popularity for weed and brush control on grazing lands. Granular or pelleted herbicides have advantages compared to sprays in that they eliminate drift and volatility hazards and may be applied almost any time of year. One disadvantage of herbicide pellets and granules is that they are less effective on some species than sprays of the same herbicide. Uniform application and proper amounts of herbicide are important for good results. For application to small areas or individual weeds and brush, the herbicides can be applied by hand. For large areas, broadcast application may be necessary. Reliable commercial applicators that accurately meter small amounts of pelleted herbicides may be difficult to obtain. Land managers must insist on accurate applications. Application equipment is calibrated similarly to spray equipment. The hopper is filled with the desired amount of pelleted herbicide and the applicator is driven over a predetermined area before the output is weighed. If it is undesirable to drop the granules on the soil, a catching device can be used. An aircraft simulated application can be done on the ground if the airplane is equipped with a positive feed mechanism driven by electric or hydraulic motors; otherwise, actual flight tests must be conducted.

Calibration of Equipment

Accurate application of herbicides is extremely important in obtaining maximum weed control and preventing environmental damage. A typical field boom sprayer can be calibrated by several methods. The most accurate method is to actually spray an area of known size as follows:

- Fill the spray tank with a known quantity of spray solution (water).
- Refill the tank after spraying an area of known size.
- Calculate gallons of spray used and determine sprayer output in gallons per acre.

For example: If the swath width of the sprayer was 20 feet and 2 gallons of spray were used after traveling 218 feet (20 × 218 = 4.360 square feet or 0.1 acre), sprayer output would be 20 gallons per acre. Spray volume per acre can be changed by
varying spray pressure, the type of nozzles, or the speed of the spray vehicle. Hand-carried or aerial sprayers can be calibrated in a similar manner.

Cleaning Application Equipment

Clean the sprayer immediately after use. Emptying the spray tank and rinsing it with water may be sufficient for short-time storage. Rinsing the tank with kerosene or fuel oil will protect most metal parts from corrosion and help remove oil-soluble herbicides such as 2,4-D ester. Experience has shown that the tank is by far the most important source of contamination, probably followed by hose contamination. Other sources of contamination include the pump, boom, nozzles, and sprayer tires. By thoroughly rinsing and cleaning all parts, little or no damage to herbicide sensitive crops should be encountered. For greater safety with sensitive crops, fungicides or insecticides should not be applied with equipment that has been used for applying herbicides.

Spray equipment can be cleaned with household ammonia. First rinse the sprayer thoroughly with water. If an ester formulation has been used, use a small quantity of kerosene or diesel oil for rinsing. Follow with a rinse of clean water containing 1 teaspoon of laundry detergent per gallon. If a salt formulation of an herbicide has been used, omit the fuel oil rinse.

After rinsing the sprayer, fill it with a solution of 1 part household ammonia to 99 parts water (1 quart ammonia in 25 gallons of solution). Leave the solution in the tank; booms, and hoses for 12 to 24 hours. Then remove it and rinse the equipment with clean water. Other commercial preparations also are available for cleaning spray equipment.

Factors Affecting Results

When herbicides are applied as foliar sprays, they usually are effective only during certain periods of the year, commonly in the spring after the leaves of woody plants have fully expanded and plants are growing actively. Also, weeds may be susceptible for only a short time during their life cycle (seedling stage); they may be virtually unaffected later. Foliar damage from insects, hail, or drought also may render the treatment unsuccessful due to poor absorption and translocation of the chemical. Consequently, foliar sprays of herbicides should be applied when plants have developed under favorable soil moisture and temperature and environmental conditions. Each weed or brush species, however, may respond differently. Consult the proper reference or agricultural authority before wasting money on an improper treatment.

Spraying the proper rate of herbicide onto the foliage at the right time is the first step in successful application. Proper application equipment is essential. One of the most important factors is application at low wind velocity—below 10 miles per hour (mph) for ground equipment and below 6 mph for aerial equipment. Applying herbicide when winds are above these velocities may result in loss of chemical from the target area and damage to adjacent areas from spray drift. If some wind is encountered, be certain the wind direction is away from susceptible crops or valuable vegetation.

Good spray coverage of 72 droplets psi or more on vegetation is essential for satisfactory weed control. Good coverage results from using proper spray equipment, making applications under low wind conditions, and eliminating skips between passes.

Once on the stems and leaves, the herbicide must be absorbed in large enough amounts to be translocated throughout the plant. Barriers to absorption include the waxy outer covering of leaf surfaces and the bark on woody plants. Absorption of plant surfaces sometimes can be improved by oil-in-water carriers or by the use of surfactants or wetting or penetrating agents in water carriers. Plants differ in their ability to absorb herbicides. Absorption usually is more rapid in young plants.

Translocation of the herbicide throughout the plant or to the site of action (stem and root tissue) is necessary for control. Most herbicides move best within plants during favorable environmental conditions when the plant is growing actively. Too high rates of some foliar applied herbicides such as the phenoxyis may reduce translocation and overall control. These herbicides can disrupt the tissues responsible for transport in the plant.

Timing of picloram applications and, in some cases, dicamba applications, on brush may not be as critical as with the phenoxyis since the period when brush is susceptible to these herbicides sometimes is longer. Spring, summer, and fall treatments sometimes are equally effective on some species, providing weather and plant growth conditions are favorable. The fact that picloram and dicamba are absorbed by roots as well as foliage may be partly responsible for their extended effectiveness. Applying picloram and dicamba in the fall for weed control in pastures and rangeland makes treatment safer because susceptible crops cannot be grown during this period.

Good coverage of foliage with other herbicides is essential for satisfactory results. Small spray droplets of 100 microns in diameter or less give better coverage and results than do large spray droplets of 300 to 400 microns. Small droplets are subject to drift; therefore, a balance between small and large droplets is desired. Spray droplet size can be increased by modifying spray solution viscosity, nozzle type, and spray pressure.

Sprays of urea, uracil, and AMS herbicides can be applied at the same time as pelleted formulations. Sprays of these herbicides are prepared by mixing wettable powders with water. Sufficient water must be added to suspend the herbicide and prevent stoppage of the spray nozzles during application. These materials are primarily active by root uptake, although some foliar uptake may occur. Adequate coverage of the target plant is necessary. If increased wetting and penetration of the brush is desired, a surfactant can be added.

Rainfall before and soon after treatment is desirable to leach pelleted herbicides such as picloram, dicamba, and tebuthiuron into the root zone of the weeds and brush. They are absorbed by the roots and move up through the plant to kill it. Tebuthiuron applied to the soil as pellets can be applied in the Southwest at any time of year for control of certain woody species. Tebuthiuron is not readily broken down by sunlight and will remain intact on the soil surface until adequate rainfall leaches it into the soil. Picloram and dicamba are broken down by sunlight; avoid application during hot, dry months.

Esters of 2,4,5-T or similar herbicides in diesel oil carrier commonly are used as basal sprays. These treatments kill trees up to 5 inches in diameter. Treatments can be applied any time of the year. If the bark or soil is wet, effectiveness is reduced. For trees larger than 5 inches in diameter, bark often is too thick to penetrate with sprays; therefore, the herbicide can be applied to the sapwood through frills or notches cut into the bark. In winter, difficult to control species may require higher herbicide concentrations or closer spacings of cuts around the tree.
Nonchemical Control

Mechanical Control

Hand Methods. Hand methods of weed and brush control probably have been practiced since antiquity. Although effective, they are slow, costly, and laborious. They are practical on small areas or in scattered stands. Hand methods include grubbing, cutting, girdling, and burning. Grubbing consists of using a grubbing hoe, shovel, or similar tool to dig enough of the root system out of the soil to kill the plant. The operation is difficult and time consuming, but it is effective if properly done. Axes or saws are used widely to cut down brush. They are most effective on woody species that are killed when the top growth is removed, such as eastern redcedar and blueberry juniper. On species that resprout, which includes most brush, stumps and cut surfaces can be treated with herbicides to prevent resprouting.

Girdling is cutting a ring through the bark and cambium layer to prevent movement of water and nutrients to top growth. Girdling is practical in scattered stands of large trees of 6 inches in diameter or greater. It is most effective during the summer months. Herbicides can be applied to the cut ring for improved kill. Portable chain or power saws and girdlers are available for woody plant control. They reduce labor, time, and cost in brush removal but have limited use in dense stands or large areas.

Large Equipment

Dozing. Dozing is a widely used method of brush control. Much clearing is done with straight dozer blades; however, many modifications and attachments are available for specialized clearing jobs. Ideally, dozing removes brush and large trees by pushing or pulling the plants out with as much of the roots intact as possible. Special attachments to the straight blade include teeth or U-shaped “stingers” to allow cutting the plant off below the ground line and lifting out the roots.

Dozing is most commonly practiced in open stands of large trees and brush or on rocky soils where other mechanical control methods are limited. It is not desirable in dense stands of brush that sprout from the roots after top removal. Dozed trees should be windrowed or stacked so the brush can be burned or left to decay. If the seeding of the dozed area is desired, brush piles can be left in place or removed for easier seeding, fertilizing, mowing, or spraying of the newly established pasture. Followup brush control treatments probably will be necessary to control missed plants, resprouts, and new seedlings within 2 to 5 years after dozing, depending on the type of brush and how well the job was done.

The equipment and fuel required for dozing are costly. Soil is disturbed and compacted. Forage stands and wildlife habitat may be partially or heavily damaged. The soil may be subjected to wind and water erosion, depending on how well the job was done. Under some circumstances, leaving alternate undisturbed strips, particularly on steep or erodible lands or where wildlife is important, may be justified. Grubber attachments and stacker blades minimize soil disturbance.

Chaining. Chaining is a relatively inexpensive means of mechanically clearing brush. Chaining does not remove all brush and its major effect is temporary. Naval anchor chains are pulled behind two large crawler tractors of equal horsepower across brush to be crushed or pulled out. The chains may be 90 feet long or longer with links weighing 80 pounds or more. Cables of 1 inch or more in diameter have been used, but they are not as effective as chains. Many adaptations have been made to chains such as welding on of short lengths of angle iron, rails, or disks to make them more efficient. Chaining is most effective on single stemmed brush and trees growing on sandy, shallow, or moist soils where many of the plants can be pulled out. Two-way chaining (chaining in opposite directions) increases effectiveness. In many situations, the tops of the brush bend over or are sheared off at the ground level before being removed, and root sprouting occurs. In heavy stands the chain may also fail to uproot brush by pulling over large masses of it.

Chaining can be used to advantage as a pretreatment to raking, root plowing, or grazing of goats by knocking down dense brush to make it more accessible. Chaining of brush infested with pricklypear, cholla, and tasajillo may scatter the cactus, making it an undesirable treatment. Chaining results in a poor seedbed and leaves brush in the path of the seeder. Broadcast seeding can be done between the first and second chaining of a two-way operation. Radio communication between tractor drivers is recommended.

Railning. Railning is a practice developed for control of pricklypear and tasajillo in south Texas. Three to nine railroad rails or heavy angle irons are welded or chained together and dragged behind a tractor in tandem in two or three sets. The rails are dragged over the area in one direction, then a second time in the opposite direction. The operation crushes the stems and pads of the cactus. Grazing cattle sometimes are used to clean up newly railed areas. Railning is most effective in hot, dry weather. Repeated railning, several weeks or months after the original treatment, removes new sprouts or missed plants. The operation destroys existing forage stands. Reseeding is recommended after railning.

Chopping. Roller chopping is a quick method of knocking down and crushing brush. Like chaining, it is a temporary measure and kills few plants. Resprouting will follow soon. Equipment consists of a steel drum or cylinder around which cutter blades are attached. Weight can be added by filling the roller drum with water or by adding steel or concrete ballast to the frame. Choppers vary in size, depending on the size of brush. A weight of about 1,500 to 2,000 pounds per linear foot of cutter blade is suitable for small and medium size brush such
as catclaw and blackbrush. Larger choppers are needed for average size honey mesquite and similar trees.

Chopping is useful only where repeated treatment is planned or where other methods will supplement brush kill. Chopping has not improved brush kill with soil-applied herbicides. Chopping removes top growth of brush and makes the working and handling of livestock easier. Chopping may be useful where goats are grazed by allowing them to reach the leaves. Chopping can be used for seedbed preparation. Chopping is relatively inexpensive and may be useful where dense brush can be knocked down quietly and burned when dry.

**Mowing and Shredding.** Mowing and shredding are temporary control methods for herbaceous weeds and small brush on pastures and rangeland. Repeated mowing, once or twice a year, is needed for maintenance on most weed-infested areas. Mower types vary, but most consist of sharp rotary blades. Heavy duty shredders can be used on large brush and small trees (3 to 4 inches in diameter). Commercially available self-propelled cutters will cut mesquite stumps 14 to 17 inches in diameter. Brush should be mowed in spring and early summer. Mowing after July 1 may damage native grasses. Stands of grasses such as bermudagrass can be mowed for weed control at any time during the growing season. In humid areas, the principal benefit of mowing is removal of old growth, which promotes regrowth, increases forage quality, and reduces the tendency of livestock to island graze. Weeds and brush become established in the ungrazed islands. Normally, two to three mowings per year limit the spread of herbaceous or woody perennials in pastures but do not eliminate established stands.

**Root Plowing.** Root plowing consists of pulling a horizontal blade through the soil behind a large tractor at depths up to 18 inches to cut off roots of brush. Blades must be 14 to 16 inches deep to kill large honey mesquite. Some brush species may be root-plowed at shallower depths. Root plowing originally was developed for land clearing. Blades of root plows vary from 6 to 14 feet wide. Fins welded to the top of the blade lift roots out of the soil to kill the plant. Fins also break up clods for a smoother seedbed.

Root plowing is useful in dense brush containing species that are resistant to herbicides or other control methods. Root plowing kills a high percentage of the brush unless rainfall occurs soon after treatment. Root plowing should not be done where a good forage stand is present, since it probably will destroy it.

Root plowing is most effective during hot summer months; however, if seeding is needed, it should be done during optimum seeding time in the spring or fall. After root plowing, the seedbed can be improved by further tillage, such as rolling or roller chopping to break up large clods. Most root plows can be equipped with a grass seeder, so plowing and seeding is done in one operation. Root plowing is an effective brush control treatment, but it is expensive, it destroys the grass stand, and it may subject the soil to wind and water erosion. Some areas of brush should be left for wildlife habitat.

**Disking.** Large disk plows or tandem disks will destroy stands of the smaller brush. They also destroy the grass stand. Disking is limited to tillable soils. Disking prepares a good seedbed, although compaction by a cultipacker, roller, or other implement may be desired. Like root plowing, the operation is expensive. The brushland disk is an adaptation of standard agricultural implements. It is a heavy duty implement and is effective in uprooting, chopping, and mulching brush, even in dense stands. Commercial seeding attachments are available.

The cost of mechanical treatment usually is closely correlated with the degree of soil disturbance and the size and density of brush to be removed. Dozing, diskin, grubbing, and root plowing are among the most effective mechanical brush control treatments, but they are the most costly to perform; chaining, roller chopping, and mowing are less expensive. Hand methods, such as sawing, axing, or grubbing sometimes are effective, but they are slow, costly, and laborious.

**Biological Control**

**Selective Grazing.** Selective grazing for control of undesirable weeds and brush is a widespread practice. Cattle, sheep, goats, horses, poultry, and certain wildlife species control many weeds by grazing. In other cases, weeds may be so unpalatable, poisonous, or vigorous that management by grazing is not practical.

In central Texas, California, Arizona, and other areas, goats use browse as a large part of their diet. Woody plants, such as live oak, post oak, blackjack oak, shin oak, sumac, greenbrier, hawthorn, American beauty berry, yaupon, sweetgum, retama, and many others can be controlled by goats. If the brush and trees are too tall for the animals to reach the leaves, they can be cut, chained, roller chopped, and dozed down within reach.

Good management of vegetation with goats is to force two to five animals per acre to browse an area rapidly in a suitable rotation grazing system. This allows brush control but prevents excessive damage to other forage species in the pasture. Three years usually are required for this system to reduce the brush to a manageable level. Lighter stocking can then be used to maintain brush control. The use of goats, where practiced, is the most effective means of biological control of brush.

The use of goats is not a simple operation since special goatproof fences and protection from adverse weather and predators are required. In some areas green foliage is not available year-round and the animals must be sold or moved. Predators, such as bobcats, coyotes, and occasionally dogs, may damage or kill the animals, resulting in severe economic loss.

**Insects and Plant Pathogens.** The best known examples of effective biological control by insects involve control of prick-
lypear in Australia by the Argentine moth borer (Cactoblastus cactorum) and St. Johnswort in the western United States by the leaf beetle (Chrysolina spp.). Other examples of biological control of weed species using insects are being tested. Development of biological control measures sometimes is slow and expensive and it presents the risk of the control organism becoming a pest. In addition, these control measures are very specific, usually involving one weed species and one insect feeder. Mixtures of weed species are most common on pastures and rangeland; removing one problem may have no impact on forage production or may allow the replacement of the weed with another weed problem. Despite these problems with biological control measures, they should be investigated and, when determined effective and safe, they should be used whenever possible.

The successful control of pricklypear cactus can be partially attributed to secondary attack by microorganisms associated with the insect Cactoblastus cactorum. Gloeosporium lunatum E&E and bacterial soft-rot organisms are primary invaders following C. cactorum attacks. Apparently a number of fungi cause disease in cactus, but their importance in the decline of various cactus species has not been fully assessed.

Research indicates that oak wilt fungus is effective in killing inoculated red oaks and preventing subsequent sprouting from cut stumps. The oak wilt fungus is not hazardous to tree species other than those in the red oak group and may be useful as a selective silviclude since it is not spread by root grafts to untreated trees.

In Texas, a fungus (Cephalosporium spp.) has been identified as the major component of this disease complex. It causes a vascular wilt that apparently is transmitted by root graft. Since live oak in many situations is considered a desirable tree for shade and for production of acorns for wildlife, it is unlikely that live oak decline can be used as a means of control for this species.

**Plant Competition.** Herbaceous weeds sometimes can be effectively eliminated by encouraging growth of competing vegetation. For example, broomsedge (Andropogon virginicus) can be controlled on unproductive pastures in Virginia with an annual application of nitrogen fertilizer for 5 years. Neither burning nor mowing controls the weed, which may make up 75 percent of the vegetation. The control of woody plants by fertilization usually has been unsuccessful since fertilization encourages rapid growth of the overstory and dominant brush, as well as forage species. In some situations where woody plants are used as browse, fertilization may increase production and palatability, but the cost of such treatments may not be warranted on rangelands.

A vigorous and dense stand of desirable grasses and forbs discourages encroachment of weeds and brush into rangelands, especially seedling weeds. Once woody plants become established and dominant, however, they usually cannot be controlled or eliminated by other competitive plants.

**Fire and Heat**

Fire is an age-old method of suppressing vegetation. In the past, it has been a natural event in many areas. Whether manmade or natural, fire probably has had a strong influence on the type of vegetation that has developed in many areas. There is still great diversity of opinion and inconclusive data about the validity of fire as a weed control practice. It has been used with great benefit in some grassland situations, but it can have disastrous effects if not controlled.

Fire can be used to stimulate regrowth and to increase forage production and the quality of permanent grasslands where thatch has accumulated. Burning helps control pricklypear, tasajillo, cholla, sagebrush, juniper, mixed chaparral brush, and others. Fire may adversely affect wildlife by altering their habitat. Consequently, a patchy burn (about 20 percent unburned) is most desirable for wildlife. A thorough understanding of the diverse habitats required by livestock and wildlife and of the changes that occur in vegetation following burning is necessary before fire can be used effectively for brush control. Moreover, the user must be familiar with burning techniques, fire behavior, and weather before attempting to use controlled burning as a management tool. Never burn when it is windy or excessively dry.

**Combinations of Control Methods**

Combinations of methods used in weed and brush control are based on effectiveness and cost. Using two or more control methods is referred to as an integrated weed or brush management system. Goats successfully control a large number of brush species. If brush is too tall, it can be cut, chained, or dozed within reach of the goats. Gambel oak control, important on several million acres in foothill rangelands in Arizona, Colorado, New Mexico, and Utah, can be attained with mechanical treatment followed by goat grazing. Repeated annual defolia-
On page 13, table 2, replace entry for downy brome with the following:

| Downy brome (Bromus tectorum) | Paraquat and surfactant, disking | Early spring or late fall. | Apply paraquat with ground rig or disk after weeds and grasses have emerged and immediately before seeding. Use 2,4-D with paraquat to control broadleaf weeds. |
| Atrazine | Fall. | Seed perennial grasses the following fall after atrazine application. On some sites seeding with deep-furrow drill is preferable. |

On page 14, table 3, replace entries for rabbitbrush and sagebrush with the following:

<p>| Rabbitbrush (Chryothamnus spp.) | 2,4-D ester, picloram, picloram + 2,4-D | Foliar spray on new growth in spring. | Timing critical with 2,4-D. |
| Sagebrush (Artemisia spp.) | 2,4-D ester; burning or plowing also effective for some species | Foliar spray during rapid spring growth. |  |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Method of control</th>
<th>Type and time of application</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitterweed <em>Hymenoxys odorata</em></td>
<td>2.4-D</td>
<td>Foliar spray in spring.</td>
<td></td>
</tr>
<tr>
<td>Burroweed <em>Haplopappus tenuisectus</em></td>
<td>2.4-D, 2.4,5-T, dicamba, picloram</td>
<td>Foliar spray in spring.</td>
<td></td>
</tr>
<tr>
<td>Canada thistle <em>Cirsium arvense</em></td>
<td>2.4-D, dicamba, picloram</td>
<td>Foliar spray in bud stage, fall, or any time during growing season.</td>
<td></td>
</tr>
<tr>
<td>Downy brome <em>Bromus tectorum</em></td>
<td>Paraquat + surfactant atrazine</td>
<td>Early spring.</td>
<td>Apply with ground rig after weeds and grasses have emerged and immediately before seeding. Use 2.4-D with paraquat to control broadleaf weeds. With 2.4-D, wait 1 year before seeding perennial grasses.</td>
</tr>
<tr>
<td>Cocklebur <em>Xanthium spp.</em></td>
<td>2.4-D, 2.4,5-T, dicamba, picloram, amitrole, glyphosate</td>
<td>Early spring.</td>
<td></td>
</tr>
<tr>
<td>Deathcamas <em>Zigadenus spp.</em></td>
<td>2.4-D, dicamba, picloram, amitrole, glyphosate</td>
<td>Foliar spray at three- to five-leaf stage.</td>
<td>Spray when necessary to prevent livestock poisoning.</td>
</tr>
<tr>
<td>Goatweed (St. Johnswort) <em>Hypericum perforatum</em></td>
<td>Biological</td>
<td></td>
<td><em>Chrysomela</em> beetles.</td>
</tr>
<tr>
<td>Halogeton <em>Halogeton glomeratus</em></td>
<td>2.4-D ester</td>
<td>Foliar spray, early branching, prebloom stage.</td>
<td>Treat patches to prevent livestock poisoning. Grub out isolated plants.</td>
</tr>
<tr>
<td>Larkspur <em>Delphinium spp.</em></td>
<td>2.4,5-T, 2.4-D, picloram</td>
<td>Foliar spray in late vegetative stage before flowering; repeat application the following year.</td>
<td>Spray to prevent livestock poisoning.</td>
</tr>
<tr>
<td>Loco <em>Astragalus spp.</em></td>
<td>2.4-D ester, 2.4,5-T, silvex, dicamba, picloram, amitrole, glyphosate</td>
<td>Foliar spray in bud to early bloom stage.</td>
<td>Repeat treatment when necessary.</td>
</tr>
<tr>
<td>Lupine <em>Lupinus spp.</em></td>
<td>2.4-D ester, 2.4,5-T, silvex, 2.4-D, dicamba, amitrole, glyphosate</td>
<td>Foliar spray in early bud stage.</td>
<td></td>
</tr>
<tr>
<td>Musk thistle <em>Carduus nutans</em></td>
<td>2.4-D, dicamba, picloram, amitrole, glyphosate, 2.4,5-T</td>
<td>Foliar spray in spring or fall.</td>
<td>Do not graze for 3 weeks (until foliage has dried).</td>
</tr>
<tr>
<td>Russian thistle <em>Salsola spp.</em></td>
<td>2.4-D, dicamba, picloram, amitrole, glyphosate, 2.4,5-T, atrazine</td>
<td>Foliar spray in early spring; atrazine in fall.</td>
<td></td>
</tr>
</tbody>
</table>

Chaining is an inexpensive method of knocking down brush previously treated with herbicide. The brush will then decay or can be burned.

In some situations, burning may help remove woody plants in the understory that are only partially killed by herbicide sprays. In other areas, individual plant treatments, such as grubbing, cutting, or applying herbicide pellets or sprays, are used for controlling plants missed by dozing or other mechanical methods.

Control methods for specific plants are given in tables 2 and 3.
<table>
<thead>
<tr>
<th>Name</th>
<th>Method of control</th>
<th>Type and time of application</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cactus (Opuntia spp.)</td>
<td>2,4,5-T ester, silvex, picloram + 2,4,5-T, burning, chaining, or cabling</td>
<td>Wetting spray when temperature exceeds 60° F.</td>
<td>Mechanical bruising (railing) aids effectiveness of 2,4,5-T or silvex.</td>
</tr>
<tr>
<td></td>
<td>Prescribed burning: use propane torches for individual plants</td>
<td></td>
<td>Picloram spray or granules are effective.</td>
</tr>
<tr>
<td>Creosotebush (Larrea spp.)</td>
<td>2,4,5-T, picloram, tebuthiuron pellets, root plowing</td>
<td>Picloram and 2,4,5-T as sprays (full flower to fruiting); tebuthiuron pellets before summer or winter rainfall.</td>
<td>Root plowing may not be feasible and may require reseeding the range with adapted grasses.</td>
</tr>
<tr>
<td>Chamise (Adenostoma fasciculatum)</td>
<td>2,4-D + 2,4,5-T, picloram</td>
<td>Foliar spray in early spring or individual plant spray.</td>
<td>2,4-D ester effective on sprouts first or second spring after fire or mechanical top removal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chaining or burning effective on dense, extensive, mature stands except <em>J. deppeana</em> or <em>pinchotii</em>.</td>
</tr>
<tr>
<td>Juniper (Juniperus spp.)</td>
<td>Picloram or tebuthiuron pellets, cabling, chaining, or dozing</td>
<td>Dicamba or picloram trunk basal spray. Picloram applied under canopy as pellets or spray to individual plants. Tebuthiuron applied as pellets.</td>
<td>Any time. Cordwood is a commercial product. Retreat when necessary to kill sprouts.</td>
</tr>
<tr>
<td>Manzanita (Arctostaphylos spp.)</td>
<td>2,4-D amine</td>
<td>Foliar spray during rapid spring growth. Burn in June.</td>
<td>Diesel oil effective as a basal pour or spray. Cut surface or frill treatments can be made any time of year but are best during summer or dry periods. Treat stump with diesel oil.</td>
</tr>
<tr>
<td>Mesquite (Prosopis spp.)</td>
<td>Prescribed burning 2,4,5-T, picloram + 2,4,5-T, dicamba + 2,4,5-T, silvex, AMS, triclopyr</td>
<td>Foliar spray in spring (full leaf stage).</td>
<td>Any time. Silvex effective on some species.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oaks (Quercus spp.)</td>
<td>2,4,5-T, picloram, 2,4,5-T + picloram, tebuthiuron pellets</td>
<td>Foliar sprays of 2,4,5-T and picloram in spring, tebuthiuron pellets any time or before heavy rainfall.</td>
<td></td>
</tr>
<tr>
<td>Rabbitbrush (Chrysothamnus spp.)</td>
<td>2,4-D ester, picloram, picloram + 2,4-D</td>
<td>Foliar spray when new growth appears.</td>
<td></td>
</tr>
<tr>
<td>Sagebrush (Artemisia spp.)</td>
<td>2,4-D ester, burning or plowing also effective for some species Mowing, chaining, prescribed burning</td>
<td>Foliar spray during rapid spring growth.</td>
<td></td>
</tr>
</tbody>
</table>
Table 3 (continued). Control of woody range plants

<table>
<thead>
<tr>
<th>Name</th>
<th>Method of control</th>
<th>Type and time of application</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snakeweed or broomweed</td>
<td>2,4-D ester, picloram,</td>
<td>Foliar spray in early spring.</td>
<td>Timing critical with 2,4-D. May treat in late summer or fall with picloram.</td>
</tr>
<tr>
<td>(Gutierrezia spp.)</td>
<td>picloram + 2,4,5-T</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prescribed burning if fuel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>adequate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tarbush</td>
<td>2,4,5-T, ester, tebuthiuron</td>
<td>Foliar spray in spring</td>
<td>Also controlled by soil treatment of dicamba, picloram, bromacil, and tebuthiuron.</td>
</tr>
<tr>
<td>(Flourensia cernua)</td>
<td>pellets</td>
<td>40-90 days after bud breaks.</td>
<td></td>
</tr>
<tr>
<td>Whitebrush</td>
<td>Tebuthiuron or picloram</td>
<td>Any time except during hot</td>
<td></td>
</tr>
<tr>
<td>(Aloysia lycoides)</td>
<td>pellets</td>
<td>periods.</td>
<td></td>
</tr>
<tr>
<td>Whitehorn acacia</td>
<td>Pelleted picloram or</td>
<td>Must be followed by seeding</td>
<td></td>
</tr>
<tr>
<td>(Acacia constricta)</td>
<td>tebuthiuron, root plowing</td>
<td>appropriate grasses.</td>
<td></td>
</tr>
</tbody>
</table>

**When to Control Weeds and Brush**

What density or kind of weed infestation warrants control? This question is extremely important and requires serious thought and calculation by land managers. No rule of thumb is available. The decision to initiate brush control depends on climate, especially rainfall; terrain, particularly erosion potential; the composition of the range vegetation, including the densities of forages, weeds, and brush; the livestock production system; the available brush control alternatives; and the costs of treatment. At some level, weeds and brush can become severe enough to limit economic forage production on any range. Land managers must then choose the most economical strategy of brush control to continue livestock production. Once efforts are made to control heavy infestations, continued efforts are necessary to control resprouts and scattered plants before they again become a costly problem. Recognizing potential weed problems and controlling them promptly before they become an expensive, serious problem is good management. Weeds or brush left in strips or in strategic areas helps maintain wildlife and prevents wind and water erosion. Proper use of herbicides, fire, or mechanical methods can control unwanted plants and greatly increase forage production. Improper use of chemicals or mechanical treatments such as dozing or root plowing also can destroy desirable vegetation. Where poor stands or low quality forages occur, revegetation may be warranted. Land managers must use their knowledge and experience to select weed control treatments that will give the desired results and an adequate return on their investment.

As shown in figure 2, forage production decreases as weeds increase. Managers must decide what level of weeds and brush they are willing to tolerate for economical forage production.

![Figure 2. Forage production declines as weed and brush encroachment increases.](image)

**Maintenance Control**

Once an effective weed and brush control method has been used, a maintenance program is required to prevent reinfestation of the same species or invasion by different species. This commonly involves mowing or an application of 2,4-D during spring and summer when weeds are actively growing. For woody plants and perennial weeds, some benefit may occur from mowing or from 2,4-D treatments, but due to the persistence and rapid recovery of these weeds, individual plant treatments may be necessary. Depending on the species, sprays or pellets with the appropriate herbicides are used. Hand or power grubbers also are used to remove individual brush plants.

Sheep or goats and sometimes cattle may be effective in suppressing some weed and brush species, including big sagebrush, honey mesquite, pricklypear, Russian thistle, and several oak species. Goats are especially effective against certain woody plants, whereas sheep prefer forbs (weeds) in their diet. Consult local agricultural authorities if you have questions, since some of these plants may be poisonous or may mechanically injure grazing livestock.
Forage Production and Revegetation

Some depleted ranges and pastures can be restored by improved management of natural vegetation already present. Improved management, particularly better control of grazing to allow recovery of desirable forage plants, may be all that is necessary to restore forage production. In cases where undesirable vegetation limits forage production, removing weeds with appropriate methods restores grazing potential. Where residual desirable native vegetation is lacking, revegetation by seeding may be necessary.

Natural revegetation is inexpensive compared to artificial revegetation. The rate of range recovery under natural vegetation depends on many factors, including the kinds and amount of residual plants, seed sources, soil condition, and fertility. First determine whether native vegetation with controlled grazing, weed control, fertilization, or other cultural practices will restore grazing capacity. If revegetation is needed, consult local agricultural authorities for the best forage species for your area and the cost to establish them. See the references at the end of this bulletin for additional information on weed and brush control and forage production.

Summary

Weeds and brush are one of the most serious barriers to economic livestock production. A majority of grazing land in the United States is infested with them. Weeds and brush reduce desirable forages; harbor insect vectors and predators; make handling of livestock difficult; reduce land values; and increase production costs. Many unpalatable, mechanically injurious, and poisonous plants reduce available grazing.

Identification of the problem species is necessary to apply proper management and control measures. Current control methods include chemical, mechanical, biological, and fire. Selecting the proper treatment is important for optimum weed control, minimal impact on the environment, and maximum forage production.

Several herbicides are available for controlling most weed and brush problems. Herbicides are applied to foliage (sprays) or roots (sprays or pellets), depending on the species to be controlled and the herbicide used. Sprays are applied broadcast at ultra low, low, or high volumes to weeds and brush with hand-carried equipment, power equipment, or aircraft. Selection of application equipment depends on the density of weeds and brush, the types of species, and the acreage to be covered. In many cases, rough terrain and tall vegetation limit the use of ground or hand-carried equipment, especially on large areas.

Where stands are scattered, individual plants can be treated with herbicides by foliar sprays, cut surface and injection treatment, and soil treatment. Special wiping devices also are used to treat individual plants in small or scattered stands of weeds and brush in noncrop areas around buildings, vacant lots, roadways, and similar areas or for maintenance of control following other practices.

All equipment, including hand-carried guns, booms, and pellet applicators and aerial and power equipment, must be calibrated to deliver the proper amount of herbicide. Too little herbicide will result in poor results and too much will be costly and may injure desirable vegetation. The user must know the most favorable time for treatment.

Mechanical control includes hand methods such as sawing, axing, girdling, and grubbing woody plants. Practices requiring large equipment include dozing, chaining, raking, chopping, mowing, root plowing, and diskng. Selection of method is determined by available equipment, species and density, type of land, and terrain. Hand methods are costly and laborious and can be used only for small areas.

Biological control is possible with selective grazing by cattle, sheep, goats, horses, poultry, and certain wildlife species. Insects and plant pathogens have use for some species.

For safety and to obtain good results, burning should be done by an expert.

Combinations of two or more control measures may be less costly and more effective than a single method. Deciding when to control weeds or brush sometimes is difficult because many factors must be considered. Recognizing a potential weed problem and controlling it before it spreads and becomes a serious pest is the best approach. Reseeding may be necessary after controlling weeds and brush, since native forage plants may be too sparse to produce adequate forage for livestock production.

References


June 1984

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Norman A. Brown, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Agricultural Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, or veteran status.

Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture; the University of Minnesota Agricultural Extension Service; or the Universities of Arizona, Nevada, or Wyoming, or Texas A&M University, and does not imply its approval to the exclusion of other products that may also be suitable.