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Chapter 25

Shrub and Forb Seed Production

The success or failure of range restoration and revegetation programs depends on procurement of an adequate supply of quality grass, forb, and shrub seed. Rangeland species seed is either grown commercially or collected from wildland stands. Commercially produced seed of numerous grass species is available (Asay and Knowles 1985b; Horton and others 1990; Sours 1983). A few site-specific grass species of limited commercial demand are collected from native stands, but in general the seed of most grasses are grown under cultivation. The latter is not true for many forbs, or most shrubs. Seed of several native and introduced forbs seeded on rangelands are now commercially available. They include cultivars of alfalfa, cicer milkvetch, crownvetch, various clovers, arrowleaf balsamroot (fig. 1), flax, sainfoin, globemallow, small burnet (fig. 2), western yarrow, Utah sweetvetch (fig. 3), and several penstemon species (Rumbaugh and Townsend 1985; Stevens and others 1985c; Van Epps 1966). Seed of numerous forbs must still be collected from wildland stands. This is especially true for some site-specific forbs. Also, seeds from nearly all shrub species are collected from wildland populations.

Figure 1—Balsamroot seed production field in full bloom.

Figure 2—Seed production field of small burnet 'Delar'.

Figure 3—'Timp' Utah sweetvetch starting to flower in a seed production field.

Recently, however, specific ecotypes of several shrubs species have been released (Carlson and others 1984; Noller and others 1984) and some seed is being produced commercially (fig. 4, 5). Considerable work is being done on selection, breeding and improvement of a number of shrub species that may eventually lead to commercial seed production (McArthur and others 1985; Monsen and Davis 1985; Stevens and others 1996; Stutz and Carlson 1985; Van Epps 1966).

A prime requirement for successful restoration and revegetation of range and wildlands is the use of plant material from a seed source of proven adaptability to the planting site. Often, the amount of seed required is not available from either wildland populations or from materials previously released from breeding and selection programs. This void can be filled by encouraging development of shrub seed orchards and forb and grass seed fields. Seed production principles, procedures and techniques are fairly well established for many grass and legume species.

Figure 4—Seed orchard of 'Immigrant' forage kochia.

Figure 5—Antelope bitterbrush seed orchard.

Utah (Horton and others 1990) has developed a grass seed production guide. Wyoming and Montana have guides for grass and legume seed production (Holzworth and Wiesner 1985). Seed production information can be obtained from Agricultural Experiment Stations, the Natural Resources Conservation Service, and State Crop Improvement Associations. The technology for growing seed crops of forbs (except legumes) and shrubs is extremely limited. Researchers in Utah (Stevens and others 1996) have recently published a guide for seed production of a number of forbs and shrubs. Available cultural and management practices have been adapted from agronomic, horticultural, and forestry seed production principles and techniques, from initial studies of a few shrub and forb seed production plantations, and from years of observations.

Seed is harvested from native stands, cultivated orchards, and croplands. Seed quality and genetic identity (verification of the source) are of prime importance.

Official seed certifying agencies in every State provide third party verification of cultivar/germplasm source, identity, and purity. The parent certification organization, the Association of Official Seed Certifying Agencies, has established minimum requirements and standards, defined seed classes and generations, and developed tagging specifications for member agencies. These are explained in detail in chapter 27.

In Utah, seed certification is a service performed by the Utah Crop Improvement Association (UCIA) in cooperation with the Utah Agricultural Experiment Station at Utah State University and the Division of Plant Industry of the Utah Department of Agriculture and Food. Anyone may apply to grow certified seed, but the UCIA must be contacted before planting to consider land eligibility, germplasm/variety origin, and ensure familiarity with certification procedures. Application forms and copies of the seed certification standards may be obtained by contacting: Utah Crop Improvement Association, Utah State University, Logan, UT 84322-4855.

After planting, fields must be rogued to remove other species and off-types. Weeds, particularly noxious prohibited or restricted ones, must be controlled. Seed fields will be inspected at least once before harvest by a UCIA representative. Wildland stands are also inspected by UCIA representatives. Once inspected, seed from these stands can be certified to the appropriate class. Seed identity and freedom from contamination must be maintained during harvest and storage. Conditioning facilities are also inspected. A sample of the cleaned seed is submitted to an approved seed laboratory for analysis. If the seed sample meets the certified seed analysis standards, certification is completed by proper labeling. *Only seed produced in accordance with the regulations of the UCIA and labeled with an official tag or bulk certificate can be represented as Utah Certified Seed* (Stevens and others 1996).

Management of Native Seed Production Areas

Advantages associated with use of seed collected from wildlands are: (1) species adaptation to the seed collection site is known; (2) the plants are established and generally mature; (3) there is normally a large choice in species from which to choose; (4) ecotypes can normally be found that are adapted to most site conditions; and (5) natural biological insect controls may be present. Some disadvantages are: (1) it is sometimes difficult to acquire the right to harvest or manage for seed production; (2) distance, time, and expense is involved in traveling to check on the potential seed crop, its maturity, and in harvesting; (3) often, the seed crop is small due to unfavorable weather conditions, animal grazing, or insect damage; (4) seeds may be costly to harvest; and (5) seed sources available may not be adapted to the site intended for rehabilitation.

Several management practices have been used to improve seed production from selected wildland populations. They include: fencing to prevent game and livestock grazing, removal of undesirable plants (even from within the species being managed), and thinning to enhance seed production and facilitate harvesting. All of the above practices have the potential for increasing seed production and improving seed quality. The removal or flagging of rocks and removal of scattered plants of other species from a native stand may change a normally hand collected population to one in which machine harvesting could be used, thereby increasing harvesting efficiency and the amount of seed harvested. A good example would be the use of a head stripper or beater mounted on the front of a vehicle (see chapter 24) for harvesting arrowleaf balsamroot. Pruning some species may be advisable to improve seed harvesting. Proper and timely spraying for insect control may also increase seed yield and seed quality. Timely seed harvest is very important with some species; especially those whose seed is shed quickly after maturity.

Shrub and Forb Seed Orchard Establishment and Management

Cultivation of seed crops has a number of advantages. Management practices that can enhance seed production include: time of seeding, seedbed preparation, depth of seeding, row spacing, planting methods, fertilization, irrigation, weed and insect control,

and time and method of harvest. Utah, Wyoming, and Montana have published guides for the field production of grass and legume seeds (Holzworth and Wiesner 1985; Horton and others 1990). Shrub and forb seed production practices have been developed for a few species (Stevens and others 1996).

The prospective seed producer needs to select a species or variety, and decide whether to plant seeds, seedlings, or vegetative propagules based on plant release specifications and available resources.

Seed orchards of dioecious species such as fourwing saltbush (fig. 6) should be planted from stem cuttings to establish the proper ratio of pistillate to staminate plants.

Location of the orchard or seed field is of the utmost importance. It can be the most critical factor in determining if a seed production operation succeeds or fails. Questions that should be addressed in selecting the location of a seed orchard or seed field are: is the site suitable for the species being established with respect to soil, climatic conditions, terrain, accessibility; are: labor force and equipment available; what type of irrigation is available if needed; and what kind of isolation is there from plants of the same species? Location of the seed orchard at a slightly lower elevation and more southerly latitude than the site from which the mother plants originated could be beneficial. Selection of this type of site has the potential for providing a longer growing season and improving accessibility for performing necessary cultural practices and seed harvesting. Soil characteristics should meet the needs of the species being planted. Antelope bitterbrush, for example, can be found on both acidic and basic soils, but seed from sources originating on acid soils grow poorly on basic soils and do not produce good seed crops. Species such as bitterbrush, sagebrush, and rabbitbrush should be planted on wind-free areas to reduce seed losses during the time of seed maturity. Mature seed crops can easily be lost when a strong wind disperses the seed just prior to the planned collection dates. Species that mature late should be planted in areas with fairly open winters or late snowfall.

Seed orchards should be located near an available labor force so that cultural practices and seed harvesting can be accomplished efficiently. Availability of adequate equipment for the various cultural practices must be considered.

Plants within orchards that have been developed through hybridization or selection should be isolated from other plants of the same species to prevent undesirable crossing and to comply with seed certification isolation requirements.

The design of a seed orchard is influenced by several factors. These include: plant size, which has an influence on spacing and population density; row width, which will affect the type of mechanical equipment used and cultural treatments; row planting directions in relation to land slope, wind, snow accumulation, spraying, seed harvesting; and the sexual nature of the plant (hermaphroditic, dioecious, or monecious); adequate pollination; and the concept of including several plant species in an orchard to encourage biological insect control.

Individual plants, when allowed to grow without competition, are often much larger than anticipated. In wildland situations, they are normally observed growing where they are in equilibrium with the environment. This should be considered for each species and ecotype when designing a seed orchard. Rows must be wide enough to operate cultivation, spraying, and harvesting equipment. Plant density will affect the amount of seed produced. However, distances between plants need to be such as to lessen the stress for moisture and space as the plants grow to maturity. Planting of rows along the contour should be considered for better erosion control, equipment use, and more effective seed harvest on slopes. Where plant size allows close spacing in the rows, consideration might be given to running the rows in the direction that will make the most effective use of moisture from precipitation, especially snow. The method of seed harvesting must also be considered when designing a seed orchard, as some orchards may be in production for 25 years or longer.

In areas receiving 11 to 13 inches (280 to 330 mm) of annual precipitation, large varieties of fourwing saltbush should have a minimum spacing of 10 ft (3.0 m) by 16 ft (4.9 m) (fig. 6). This is more than the 8 ft (2.4 m) by 10 ft (3.0 m) spacing suggested by McArthur and others (1978c), 15 ft (4.6 m) by 5 ft (1.5 m) suggested by Briggs (1984), and 9 ft (2.7 m) by 12 ft (3.7 m) suggested by Noller and others (1984)

Figure 6—Seed orchard of 'Rincon' fourwing saltbush.

working with medium-sized plants. Plant spacing of 12 to 16 ft (3.7 to 4.9 m) has been used successfully with an upright type of bitterbrush. However, on a per-unit of ground basis, wide spacing may not equal ideal spacing, for example, more plants may produce less seed per plant but more seed per unit of ground than will fewer, larger, higher producing plants. Recommended plants and row spacing for 22 forbs and 8 shrubs have been developed by Stevens and others (1996).

The sex of individual plants of dioecious species such as fourwing saltbush should be considered prior to orchard planting (Briggs 1984; Noller and others 1984). The greater the number of pistillate plants per unit area that can be planted and still obtain optimum pollination, the greater will be the seed yield for the area. One suggested design consists of several rows of pistillate plants alternating with a single row of staminate plants, with the rows running at right angles to the prevailing wind (McArthur and others 1978c). The outer rows should be staminate plants. Source of the staminate plants should be the same as the pistillate plants to ensure compatibility and uniformity in anthesis, and to maximize seed yields. It is possible to use clonal material from several sources grown under similar environments to prevent inbreeding, and also to increase the gene pool of desirable characteristics in the progeny. McArthur and others (1978c), recommend that monecious plants of a primarily dioecious species not be used in seed orchards because they usually produce fewer seeds.

The concept of including several plant species, including grasses and forbs, in a shrub seed orchard for biological insect control has not been adequately studied. A single species seed orchard can create an unnatural condition that can encourage a population explosion of injurious insects (Moore and Stevens 1984; Moore and others 1982). This was pointed out by a case of walnut spanworm infestation in an antelope bitterbrush seed orchard in central Utah, on the Nephi Experimental Farm (Furniss and Van Epps 1981). If planting more than one species proves to be a useful control measure, then the idea of including several species in an orchard for maximum benefit while still maintaining the primary purpose of the orchard for seed production would require careful planning.

The planting design for forbs and small shrubs will depend on mature plant size, type of material used for planting, equipment needs, seed harvesting techniques, and method of irrigation. Some species such as cicer milkvetch may develop a dense stand, while others such as Lewis flax, small burnet, or winterfat should be maintained in rows. Row width will vary, depending on plant size, growth habit, and equipment used.

Items to Consider When Establishing a Forb Seed Field

A forb seed field should be planted with seed prepared similarly to a field being prepared for a field crop. The seedbed for transplants, however, will not need the same preparation. One or more years fallowing of the land for soil moisture accumulation and weed control prior to planting is an excellent management practice that can pay big dividends, especially in direct seeded stand establishment and future labor requirements. Competition from weeds must be controlled through pre-cultivation or through the use of herbicides prior to planting. Weed control is a must in seed production for several reasons: (1) weeds compete for soil moisture, nutrients, and space; (2) weeds can become rodent habitats; (3) weeds can interfere with harvesting; and (4) weed seed can cause seed crop contamination at harvest time and may prevent the sale of seed or its certification.

Injurious insects can damage plants and seed, and present one of the most serious obstacles to profitable seed production. Serious infestations of seed insects in seed fields require aggressive pest management to prevent loss of the seed crop.

Rodents may become a problem in seed fields. They can eat or cache large quantities of seed, and kill plants by girdling the stems or damaging roots during winter periods.

If irrigation is used, the particular irrigation system chosen may have to be installed prior to planting, and should be considered in the overall design. Optimum rates of irrigation or fertilizer application, and their effects on plant growth and seed production, have not yet been determined for most forb and shrub species.

Several low-growing shrubs and forbs such as cicer milkvetch, penstemon, Lewis flax, small burnet, forage kochia, and winterfat can be successfully combine-harvested. There are some problems with cylinders clogging when combining cicer milkvetch and winterfat, and this may also occur with other species. The leaves and stems of cicer milkvetch can be killed in late September or early October, using a defoliant followed by direct combining with the header being placed on the ground. A defoliant can reduce the amount of green forage, and facilitate threshing.

Various suction-type seed harvesting machines have been used experimentally in seed fields. These include backpack units, as well as those mounted on trailers, tractors, and trucks. Under wildland conditions, the most successful method has been hand harvesting with the use of a hopper (see chapter 24) or other containers, though mechanical harvesting of seed from a few species shows promise.

Items to Consider When Establishing a Shrub Seed Orchard

1. Selecting planting material (if not a released variety)
   a. Select plant materials according to orchard objectives.
   b. Use rooted stem cuttings or other types of vegetative propagules from selected clones possessing the desired characteristics.
   c. Plant seed from plants possessing desirable characteristics.
   d. Plant quality seeds and plants to assure maximum survival. A good seed orchard may be in production for 25 years or longer.

2. Location
   a. Plant within the area of adaptation. Many ecotypes of species are site-specific. Elevation, temperature, precipitation, and soil characteristics must be considered.
   b. For ease in cultivating, spraying, harvesting, and to reduce erosion under clean cultivation, plant on level or minimal slope.
   c. For species whose seeds are easily shattered or disseminated, plant in wind-sheltered areas.
   d. To facilitate seed harvesting, species that mature seed late in the year (sagebrushes, rabbitbrushes, and saltbushes) should be planted in areas with open winters or with late snowfall.

3. Design
   a. Design the row width and plant spacing within rows according to: mature plant size and plant status; whether a plant is dioecious, monecious or hermaphroditic; and the intended method of seed harvest.
   b. Plant rows on contour for erosion control.
   c. When practical, plant rows east and west to maximize soil moisture benefits from precipitation and snow accumulation.
   d. Plant wind pollinated species with rows at right angles to prevailing winds.

4. Management
   a. Lead time and timeliness in operation are of extreme importance. Lead time is required for seed or clone selection, propagation of stem cuttings, site preparation, and planting design. Timeliness in the practices of planting, spraying, and seed harvesting is necessary.
   b. Seedbed preparation should be similar to that prepared for small grain crops.
   c. Mechanical and herbicide fallowing of the soil for a year or more prior to planting will help control undesirable plants and improve moisture accumulation.
   d. Fence orchards for protection from livestock and wildlife.
   e. Clean cultivate within and around seed producing areas. This will decrease the likelihood of destruction by wildfire.
   f. Prune for more effective seed production and harvesting and for removal of broken or dead branches.
   g. Weekly observations and sweeping are necessary to assess status of destructive insects. Identify insects causing problems and develop a control program. Care must be taken to minimize harm to pollinator, parasite, and predator insects that may be present.
   h. For bee pollinated species, introduce bees for more effective pollination.

5. Seed Harvesting
   a. The collector must discern between good viable seed, and poor seed that may be insect-damaged or underdeveloped. He must know when seed is ripe and ready for harvesting.
   b. Consider the use of combines or head and seed strippers where possible.
   c. Seed harvesting with various beaters, hoppers, and hand strippers are presently the most efficient and fastest methods for some species. Precautions must be taken to ensure that seed is not mechanically injured during harvest or subsequent processing.