TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

PLANT MATERIALS No. 27

Bozeman, Montana
May 19, 1981

RE: Collecting, Processing, and Germinating Seeds of Western Wildland Plants

By: James A. Young, Raymond A. Evans, Burgess L. Kay, Richard E. Owen, and Frank L. Jurak[1]

INTRODUCTION

The demand for wildland plants for revegetation of roadsides, mine dumps, and other harsh environments has created the need to develop efficient techniques for (1) collecting, (2) threshing and cleaning, (3) storing, (4) germinating, and (5) propagating seeds of these plant species.

Our purpose is to provide individuals interested in the propagation of wildland plants with a summary of the techniques we have developed from practical experience and from the application of knowledge from related fields.

SEED COLLECTION

Timing Collections

The timing of seed collection from wildland plant species is one of the most crucial and difficult steps in propagation. Collection of immature seeds results in low seed viability or dormancy. The danger in delaying collection is that the fruits of many wildland plants dehisce (fall from the seed head[2]) very rapidly and seeds are lost if collection is delayed. Collecting seeds from the ground may be possible, but usually results in low-quality seeds and excessive cleaning costs.

Most crop plants bloom in sequence, beginning with the uppermost or central flower; therefore, these plants have a determinate inflorescence or flower arrangement. In contrast, many wildland plants have indeterminate inflorescences

[1]Range scientists, Science and Education Administration (SEA), Renewable Resource Center, 920 Valley Road, Reno, Nev.; Wildland seeding specialist and research technician, Agronomy and Range Science Department, University of California at Davis; and, formerly, agricultural research technician, SEA-FR, Reno.

[2]See glossary of technical terms, p. 36.

where the flower stalk continues to grow with prolonged flowering and many different stages of seed maturity on the same stalk. This makes uniform seed collection difficult. If the seed collector is able to selectively harvest only the ripe portions of the inflorescence, the indeterminate inflorescence is no great problem.

There is no substitute for experience in judging when to collect seeds of wildland species. To start a collection program for a species with which you have no previous experience is difficult. Guides to maturity can be obtained for regional floras. Such manuals usually provide a range in maturity (for example, late June or July). More detailed information can be obtained from the few specialty manuals or articles that deal with the collection of seeds of native plant species (*5*).[3] The original "Woody Plant Seed Manual" (*1*) and its more recent edition (*23*) provide guidelines for the woody species. The old and difficult-to-obtain bulletin "Collecting and Handling Seeds of Wild Plants" (*17*) is an excellent source of information for California collectors.

Considerable information is available concerning seed collection of the important browse species bitterbrush (*Purshia tridentata*). The seeds of this shrub are collected by personnel of land management agencies and professional seed collectors. Nord (*19*) pointed out that bitterbrush seed production may be forecast a year before the fruit develops. Because bitterbrush flowers on second-year twigs, good crops generally follow years of average or better moisture and when stem elongation averages at least 3 inches. For species that fruit on the current year's wood, this observation would not be valid.

Essentially, the novice seed collector must judge plant phenology or the sequence of plant development. Flowering is the first phenological stage of which the would-be seed collector must be cognizant. Flowering is obvious for many species with colorful petals, sepals, or bracts, but careful attention is required to note anthesis (shedding of pollen) with many grasses. After flowering, the sequence of phenology is as follows:

1. *Soft-dough stage*.--This stage is indicated by the excretion of dough from seeds when squeezed between the thumb and forefinger. Seeds collected at this stage generally have low viability if they will germinate at all.

2. *Hard-dough stage*.--The hard dough stage can be judged by biting the grain, once the milk or dough stage is completed. Once the seed is fully mature, it is usually too hard to bite. Seed collection should start with the transition from soft to hard dough. The time interval between soft and hard dough is a good indication of how soon to repeat the collection. With these first collections, the chance of obtaining plump, fully matured seeds can be increased by not stripping the seed from the plant, but rather by cutting considerable plant material. In some species, this method will continue the maturity process. Care must be taken to insure that the mass of plant material dries uniformly and does not mold.

3. *Maturity*.--Obviously, the goal of wildland seed collectors is to harvest mature seeds. Unfortunately, maturity and seed dehiscence may occur at the same time. To make sure some seeds will be obtained, repeated collections are necessary. These collections extend from the latter part of the soft-dough stage

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[3]Italic numbers in parentheses refer to Literature Cited, p. 34.

until all seeds are lost. Each collection must be clearly labeled with the collection date, location, species, and stage of phenology based on physical appearance. Descriptive notes on associated plant or site factors that may aid in reidentification of the stage of maturity are valuable.

For large-scale collections of seeds of wildland species, seed-moisture curves will be valuable guides to proper timing of harvesting. Moisture is high in immature seeds, usually about 60 percent, but drops to about 10 percent as the plants mature (*9*). The seed-moisture curve for each species will show a characteristic shape because of differences in the slope or drying rate. The rate of seed moisture change varies with climatic conditions, but averages about 3 percent per day during the seed maturity period. With above-average hot weather, the slope of the curve temporarily increases; whereas, during cooler rainy weather, the curve flattens. For many crops, the seed-moisture curves are known and are used for guides to harvesting seeds. Methods of determining seed moisture are provided in the seed storage section of this manuscript.

Germination tests on each collection, made over a period of phenological development, provide the ultimate basis for the correct time to harvest. Remember that optimum germination may occur in the most mature seeds, whereas optimum seed yield may occur at an earlier stage of maturity before seeds are lost by shattering. Because of year-to-year variation in growing conditions, no method provides an absolutely accurate prediction of the specific date for seed collection.

The period of optimum seed collection can be extended by starting seed collection at low elevations and following maturation upslope. The same procedure can be applied to species that produce tillers that mature later than the main inflorescence.

Nord (*19*) found that 74 percent of the variability in date of seed ripening for bitterbrush was accounted for by variability in latitude and altitude. Through application of Hopkins' Bioclimatic Law (*14*), adding or subtracting one day for each 100 feet of elevation or 15 minutes latitude has led to a highly significant relationship between actual and theoretical seed ripening dates.

Often the seed collector can take advantage of microenvironmental differences at a given location to aid in collecting mature seeds. If seeds are immature on north-facing slopes, plants of the desired species growing on south slopes will generally be at a more advanced stage of maturity. Plants growing in swales or along drainage bottoms may produce more seeds than the same species on arid south slopes.

Areas burned in wildfires are excellent for seed collection for several seasons after burning. This is a result of the natural plant succession following burning and the dynamic reproductive response of many species to reduction in competition and nutrient changes brought on by the fire.

Seed Caches

Rodents, birds, and insects, especially ants, are voracious collectors of some seeds. For some species, for example, juniper (berries) and pinyon pine (nuts), the seed collector must race the natural predators in order to obtain any seeds unless protective bagging or screening is used. Some seeds, especially

conifers and bitterbrush, can be obtained from rodent caches. Seeds from warm desert annuals that have ant-attracting glands can be recovered from the refuse dumps of ant nests. For some species of ants, the viable seeds are stored in the nest, and only chaff is left on the soil surface. The droppings of many animals contain viable seeds or seeds that have improved germinability after passing through the digestive tract. The difficulty with any of these collection methods from caches or droppings is that the quantity of seeds obtained is small and they are often contaminated with pathogens.

COLLECTION METHODS

Collection methods are largely hand methods because the desired wildland species do not grow in pure stands and the topography often limits use of mechanical equipment.

Grass Species

The seeds (caryopses) of grasses can often be collected by stripping. The stripper may be the collector's fingers or mechanical fingers on a truck-mounted or towed implement. The process consists of allowing the grass culms (stems) to collect between the fingers and the seeds to be scraped from the terminal inflorescence as the stripper moves forward. A simple seed stripper made from sheet metal and a gallon can may be a valuable tool for hand stripping (fig. 1). The culms of the grass plant fit between the teeth of the stripper, and the

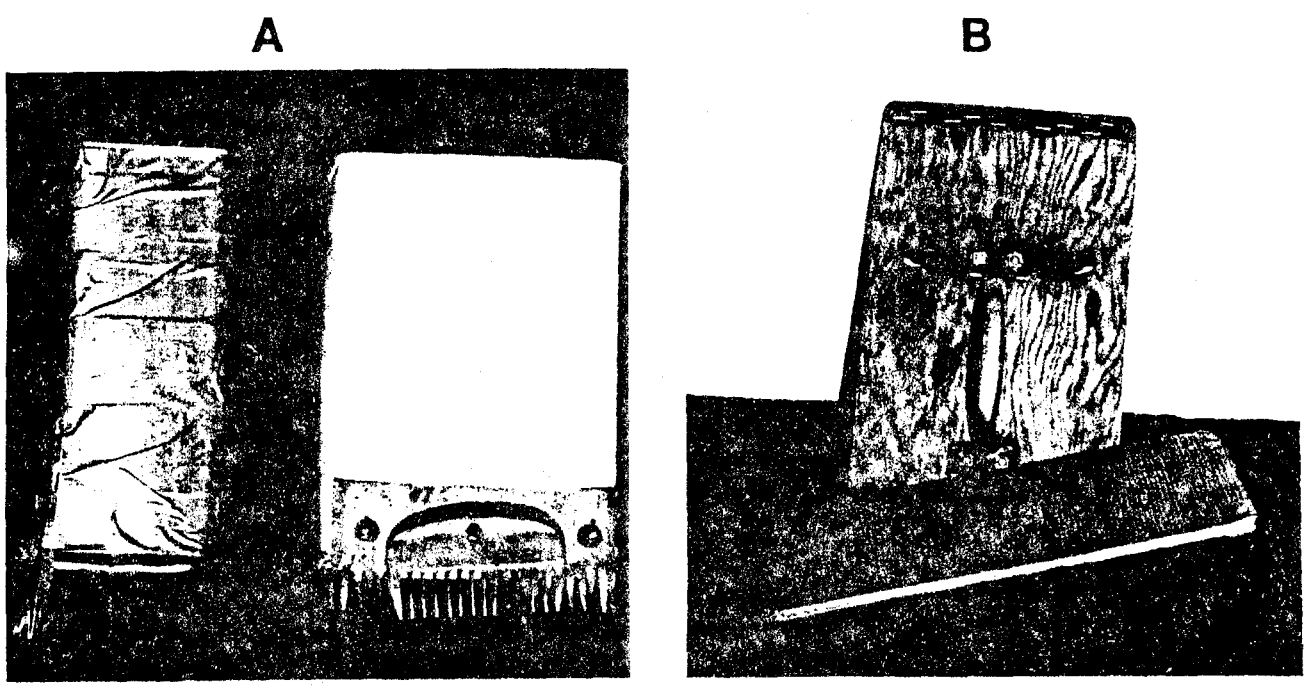

Figure 1.--Seed collecting and threshing equipment: *A*, Simple seed stripper made from gallon can and sheet metal; and *B*, rubber-mat covered paddles for threshing.

inflorescences are pulled loose to drop into the container. In dense stands of annual grasses, a garden rake can be used to strip the seeds of some species. For large-scale mechanical harvesting, the seed stripper is a very inefficient way of collecting the seeds. A number of native grass species cannot be harvested satisfactorily by any of the conventional mechanical means, such as field combines, making it necessary to strip. A flow diagram for Thurber's needlegrass (*Stipa thurberiana*) seed collection is shown in figure 2. If wildland grass species occur in large enough stands or on topography that permits use of mechanical equipment, it is far more efficient to use a header or a forage harvester to collect the material for threshing than to attempt to strip the seeds. Headers are machines that clip the plants just under the seed head. Seeds are cured in piles and later threshed.

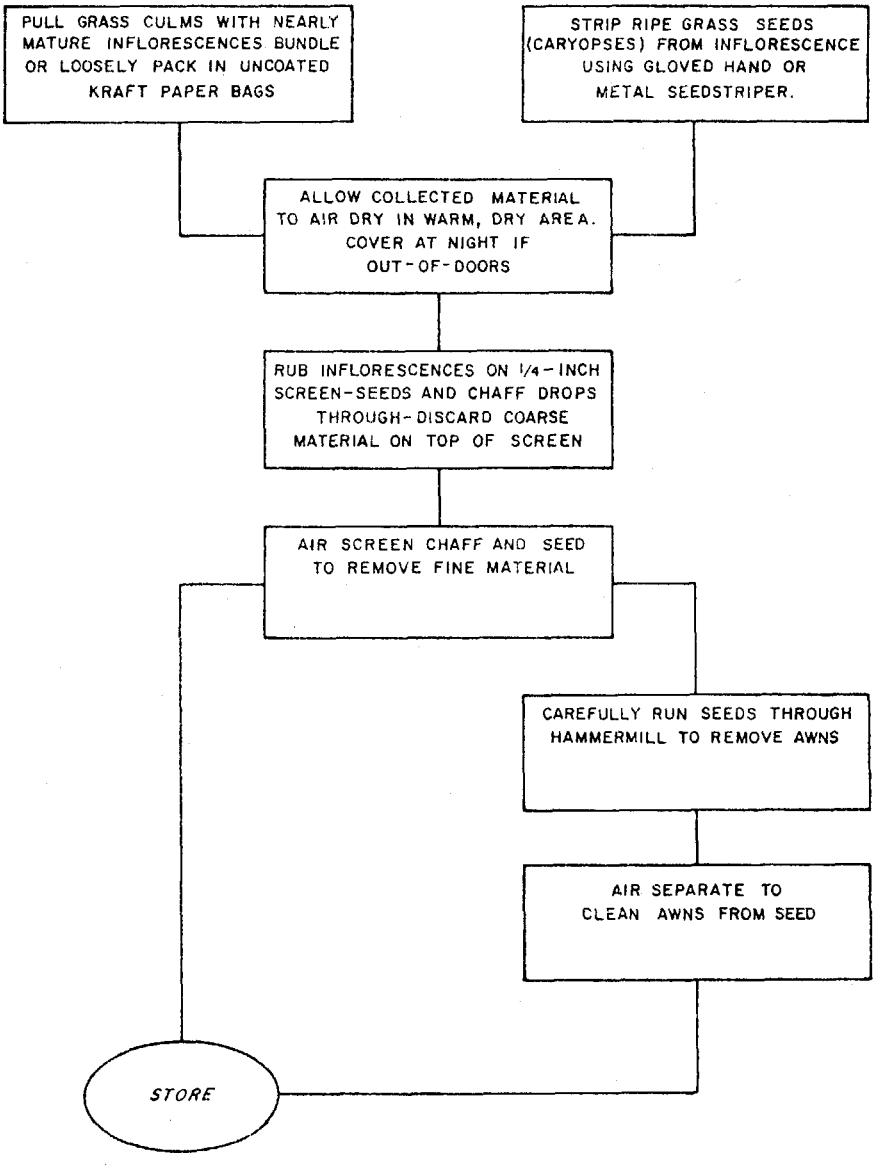

Figure 2.--Steps in collecting, threshing, and cleaning seeds of Thurber's needlegrass (*Stipa thurberiana*).

Forage harvesters can be used to chop mature grass stands. The chopped material is either cured for later threshing or the herbage and seeds are broadcast together at time of planting. This can be a highly satisfactory technique in local areas where long distance transportation is not involved. The herbage provides a mulch to help establish the desired seedlings.

Grass fields can be repeatedly harvested the same growing season by simple modification of a standard combine (*12*). The cutter bar is covered with a section of split tubing or pipe so the grass stems are not cut, but slide under the combine. Before the grass stems slide under the covered cutter bar, extra large bats on the combine reel swat the seed heads, knocking mature seeds into the combine. Immature seeds remain in the seed heads and pass under the combine. The speed of the rotation of the reels should be increased four or five times over normal operating speeds for this sytem to work.

Many highly specialized harvesters, such as pneumatic-type strippers, bluegrass cylinder strippers, and suction seed reclaimers, are used commercially in the crop seed industry. If large-scale collection of a suitably abundant wildland species is being contemplated, it may be worthwhile investigating this sophisticated equipment. A good source of information is Harmond et al. (*9*).

McKenzie (*16*) compiled the available literature on high-production grass seed collectors. This publication provides domestic and foreign sources of small combines and grass strippers. It also lists research organizations active in research and development of grass seed collection equipment and has a reference section for pertinent literature.

Broadleaf Herbaceous Species

The seeds of many herbaceous species can be collected by holding a tray or box under the inflorescence while shaking or flailing the mature seeds into the receptacle. For very small herbaceous annuals, the simplest method may be pulling the entire plant and bagging the material in paper sacks. Some herbaceous species have capsules or fruits that dehisce explosively. For these species, the entire inflorescence must be cut before maturity and allowed to dry on tarps or in mesh bags.

Collecting the entire plant is the only way to harvest seeds from spiny annuals such as Russian thistle (*Salsola iberica*), where seeds are produced axillarly over all of the plant (fig. 3). When the entire plant is harvested, care must be taken to insure that the material dries without molding.

For herbaceous species that have spike-type inflorescences, pods can be stripped from the spike as with grasses. Lupines are a good example of a broadleaf plant where stripping is possible. The pappused seeds (achenes) of many of the species of the Compositae (sunflower) family can be lightly brushed or swept into bags if the collector times dehiscence perfectly. Some of the Compositae have large heads for inflorescence that are subtended by armed bracts or spines. These heads can be clipped and bagged for later threshing.

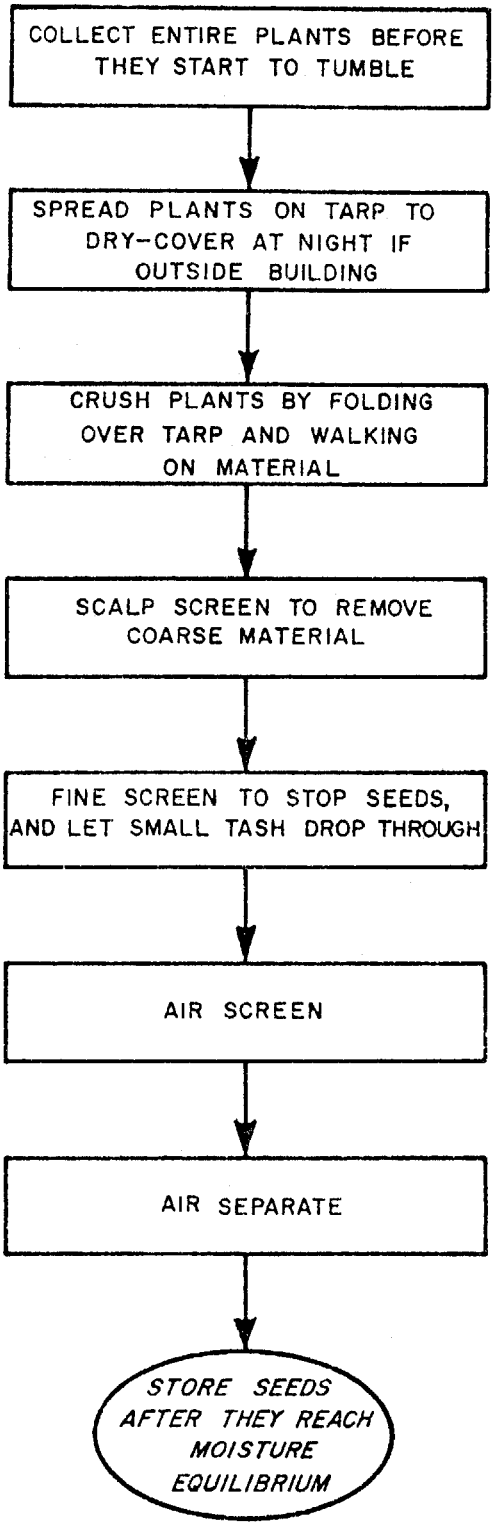

Figure 3.--Steps in collecting, threshing, and cleaning seeds of Russian thistle (*Salsola iberica*).

Shrub Species

The seeds of many shrubby species can be collected by holding a tray or box under the out-stretched branches while flailing the bushes with a stick or paddle or by sweeping the arms across the upper branches to loosen the seeds, which then shower into the receptacle. For collecting bitterbrush seeds by hand, the Inyo tray was developed (*20*). It consists of an aluminum tray 20 inches long, 30 inches wide, and rounded at the bottom to a depth of 8 inches. A handle is inserted along the long axis. For limited collections, a cardboard box serves the same purpose as will baskets and canvas bags. A lightweight, 20-gallon barrel provides a ridged lip over which to bend shrub branches for removing fruits. This procedure is effective with spiny shrubs, such as desert peach, where the fruit must be physically stripped from the branches (fig. 4).

Shrubby species with explosive capsules, such as *Ceanothus*, must have the capsules stripped before maturity and ripened in mesh bags or on tarps to avoid seed loss. Canvas or plastic sheeting spread on the ground to collect seeds loosened from branches is of limited value because of the time and difficulty required to spread the sheeting under low branches and over rocks.

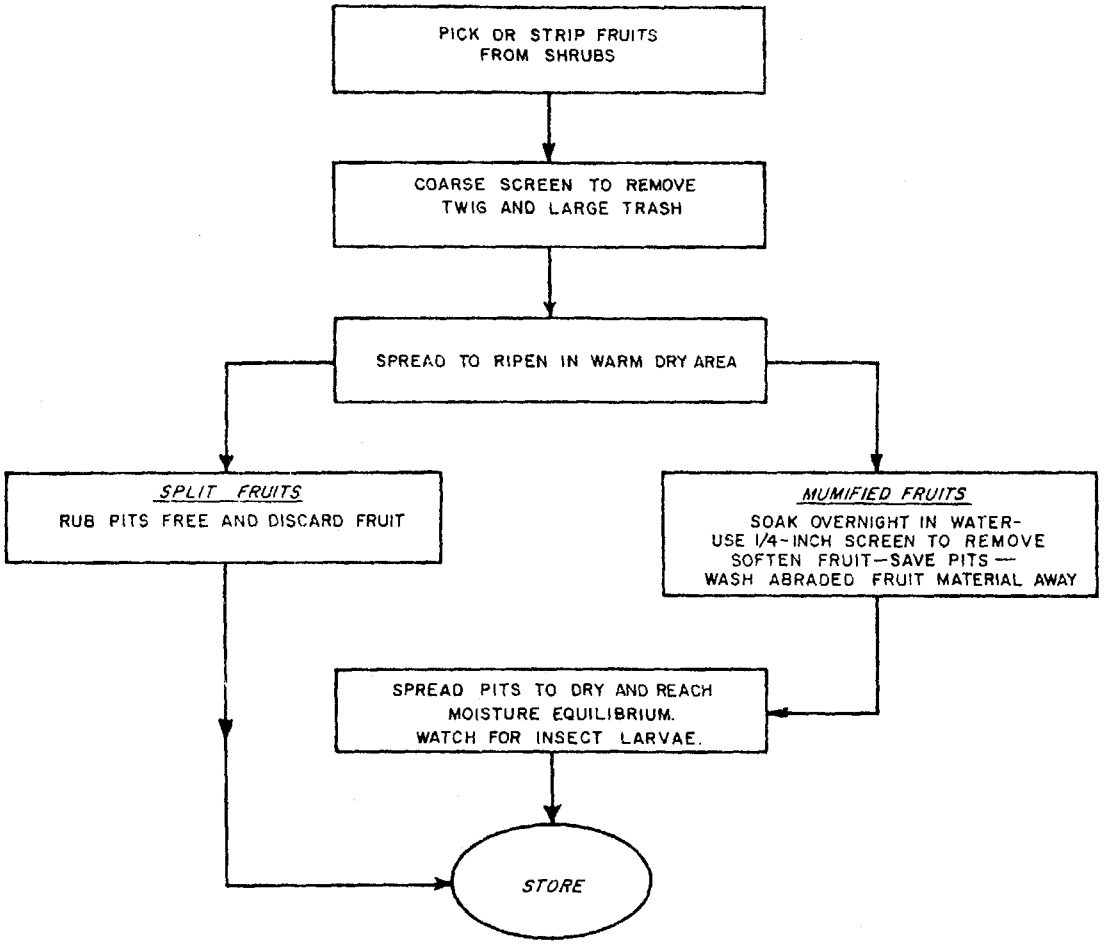

Figure 4.--Steps in collecting and cleaning pits of desert peach (*Prunus andersonii*).

Trees

The coniferous trees are the most important wildland species whose seed is extensively collected and sold in commerce. The specialized techniques for collecting and threshing conifer cones are explained in depth in the recent edition of the "Woody Plant Seed Manual" (*23*).

Species of *Populus* are important revegetation tree species in the Western United States. They are often propagated vegetatively rather than by seed. Seed collections require special techniques where branches with nearly mature fruits are cut and brought into a warm room or greenhouse and placed in water to allow the capsules to open.

Mechanical Harvesting of Tree Seeds

Mechanical tree shakers have been used to shake cones or fruits to the ground for later collection. Correct timing is necessary to limit damage to the trees.

Mechanical Harvesting of Shrub Seeds

Seeds of some semiherbaceous shrubs, such as fourwing saltbrush (*Atriplex canescens*), can be stripped by tractor-drawn seed strippers. Combines (combination of headers and thresher) have been used to harvest winterfat (*Eurotia lanata*) seeds (*22*). Field trials of vacuum harvesting, either vehicle mounted or a backpack model, have shown promise for harvesting seeds of several western shrubs. Nord et al. (*20*) provide a comparison of hand and vacuum harvested bitterbrush seed collection efficiency and cost.

POSTHARVEST HANDLING OF SEEDS

There is often a delay between collecting and threshing. This delay is necessary to allow fruits to mature and inflorescences to dry. The pressure of maximum collection during a short time period before dehiscence also delays threshing.

This delay period is important for seed yield and quality. We have stressed the use of mesh or paper bags for collection of seeds. Plastic bags or wax coated paper should never be used. The moisture content of the freshly collected seeds is quite high and plastic or other nonporous bags will trap this moisture and cause spoilage of the seeds.

A ventilated greenhouse room is an excellent postharvest drying area for seed samples to be threshed. If the collected material is dried outdoors, provisions must be made to cover the seeds at night and in the event of winds, rain, or dew.

One method of reducing the amount of plant material to store and dry before threshing is to coarse screen the collected seed or fruit in the field. This simple process consists of screening the collected material through a screen with large enough openings to allow the seeds or fruits to pass through. Coarse trash and waste are left on top of the screen to be discarded. A second screening is

made with a screen too small to allow the desired seed to pass through. The seeds are kept on top and fine waste passes through for discarding. Screens can be constructed from hardware cloth or fine wire mesh mounted on wooden frames.

THRESHING

Modern agronomic threshing machines are called combines because they are a combination of a feeding section (consisting of reel, divider, cutterbar, and feeding mechanism) and a threshing section. In harvesting seeds of wildland species, we rarely have the opportunity to use a combine. The processes inherent in the threshing section of a combine are worthwhile to review because these same processes are necessary in hand or mechanical threshing.

Mechanical threshers consist of a threshing cylinder and fixed concave bars. The turning cylinder bars rub the herbage (straw) and seeds against the fixed concave bars. This action breaks the seeds or fruit bases from the inflorescences and often removes the glumes, bracts, pods, or fruits covering the seeds. The adjustment of the clearance between cylinder and concave bars is of the utmost importance in mechanical threshing. A general rule is to have a clearance of one and one-half times the thickness of long seeds or one and one-half times the diameter of round seeds (*9*).

There are versatile small plot threshers that are adapted to threshing small lots of seeds of wildland species (*8*). Special rubber-coated concave bars are available for these small threshers to reduce damage to fragile seeds.

Hand Threshing

Hand threshing duplicates the action of concave bars in the mechanical threshing cylinders. The object is to rub the seeds to break loose the inflorescences or fruit covering.

A simple threshing method is to rub the collected material against a coarse screen. A more efficient method is to cover two wooden paddles with rough rubber matting (fig. 1). Rubbing the collected material between the paddles or on top of a coarse screen threshes the seeds. If a large volume of material is to be threshed, this is a very time- and energy-consuming operation. A simple threshing cylinder can be made by cutting a tire innertube. The collected material is poured into the cut end of the tube, and the tube is rubbed by hand or foot until the seed is threshed clean. Another simple threshing device involves the use of two clay bricks or the halves of a single brick. This technique is especially applicable to seeds borne in capsules or nonsplitting pods. Place the fruits, capsules, and pods between the bricks and press with a grinding action. Leaving a few stems in the sample with the fruits insures ample spacing so the seeds are not crushed.

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GLOSSARY

Achene.--A small, dry, hard, indehiscent, one-seed fruit.

Afterripening.--The collective changes that occur in a dormant seed that makes it capable of germination. It is usually considered to denote physiological change.

Air-screen cleaner.--The basic piece of equipment for cleaning seed, utilizing airflow and perforated screens. Also called a fanning mill.

Anthesis.--Strictly, the time of expansion of the flower but also the period during which the flower is open and functional.

AOSA.--Association of Official Seed Analysts.

Aril.--A portion of the placenta adhering about the hilum of a seed.

Aspirator.--An airblast seed separator.

Awn.--A terminal, slender bristle on an organ, such as a grass caryopsis.

Beard.--Strong, stiff hair. Often used for awn.

Berry.--A simple, fleshy or pulpy and, usually, many-seeded fruit.

Bract.--A reduced leaf subtending a flower, usually associated with an inflorescence.

Callus.--A hard or thickened layer at the base of certain grass florets.

Calyx.--The external, usually green, whorl of a flower, contrasted with the inner showy corolla.

Capsule.--A dry, dehiscent fruit composed of more than one carpel.

Caryopsis.--The grain or fruit of grasses.

Chaff.--The seed covering and other debris separated from the seed during threshing.

Corolla.--The inner perianth of a flower, composed of colored petals.

Corymb.--An indeterminant inflorescence in which the lower pedicels arising from the peduncle are successively longer than the upper ones, giving a rounded or flat-topped appearance.

Cotyledon.--Seed leaf of the embryo.

Culm.--The type of hollow or pithy, slender stem found in grasses and sedges.

Cyme.--A type of inflorescence in which the main axis ends in a flower.

Dehiscence.--The splitting open at maturity of pods of capsules along definite lines or sutures.

Dormancy.--A physical or physiological condition of a viable seed that prevents germination even in the presence of otherwise favorable germination conditions.

Embryo.--The beginning of a plant or apparent plantlet in a seed.

Endocarp.--Inner layer of the fruit wall or pericarp.

Endosperm.--The tissue of seeds that develop from sexual fusion of the polar nuclei of the ovule and the second male sperm cell.

Far-red light.--The radiant energy in the long wavelength range of the visible spectrum between 700 and 760 nanometers.

Florets.--The individual flowers of the sunflower and grass families.

Fruit.--A mature ovary and any associated parts.

Gibberellic acids.--A group of growth-promoting substances first discovered in the *Gibberella* spp. They regulate growth responses and appear to be a universal component of seeds.

Glumes.--The pair of bracts that occur at the base of a grass spikelet.

Hard seed.--A seed that is dormant because of its seedcoat and is impervious to either water or oxygen.

Hilum.--The scar remaining on the seed at the place of its detachment from the seedstalk.

Imbibition.--The initial step in seed germination involving the uptake of moisture by absorption of the seed tissue from the germination media.

Indehiscent.--Pods or capsules that do not split open at maturity along definite lines or sutures.

Indeterminate flower.--A flower that terminates in a bud, which continues to be meristematic throughout the growing season, resulting in flowers of different maturity within the same inflorescence.

Inflorescence.--The flowering structure of a plant; for example, the umbel, spike, or panicle.

ISTA.--International Seed Testing Association.

Lemma.--One of two bracts of the grass floret.

Meristematic.--A formative plant tissue made up of cells capable of dividing indefinitely and giving rise to new cells.

Noxious weed.--A weed species that is defined by law as being a threat to agriculture, to living beings, or to the general public.

Palea.--One of the thin bracts of grass floret enclosing the caryopsis and located on the side opposite the embryo.

Pappus.--The modified calyx-limb in Compositae, consisting of a crown of bristles or scales on the summit of the achene.

Pedicel.--The stalk of a single flower in a flower cluster or of a spikelet in grasses.

Peduncle.--The general term for the stalk of a flower or a cluster of flowers.

Pericarp.--The ripened walls of the ovary, referring to a fruit.

Phenology.--The study of growth stages of plants.

Raceme.--A simple, elongated inflorescence with each flower of nearly equal length stalks.

Rachis.--The central stem or axis of a spike, raceme, or compound leaf.

Scarification.--The process of mechanically or chemically abrading a seedcoat to make it more permeable to water.

Second-year twig.--Twig produced during previous growing season in contrast to current annual growth, which is produced in the same season as flowering occurs.

Seedcoat.--The protective covering of a seed.

Sepal.--A leaf or segment of the calyx.

Sessile.--Attached directly by the base, not stalked.

Spike.--A basic type of inflorescence in which the flowers arise along the rachis and are essentially sessile.

Spikelet.--The unit of the grass flower that includes the two basal glumes and one or more florets.

Stratification.--The practice of exposing imbibed seeds to cool (5° to 10° C) (sometimes warm) temperatures prior to germination in order to break dormancy.

Tetrazolium.--A class of chemicals that have the ability to accept hydrogen atoms from dehydrogenase enzymes during the respiration process in viable seeds.

Urticle.--A small, thin-walled, one-seeded fruit in which the seed is only loosely attached to the pericarp.

Viable.--Alive. In seeds, viable indicates that a seed contains structures and substances, including enzyme systems, that give it the capacity to germinate under favorable conditions in the absence of dormancy.

Van K Haderlie
State Conservationist

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