NATIVE SEED COLLECTION AND USE IN ARID LAND RECLAMATION: A LOW-TECH APPROACH

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Abstract. Loss of vegetation production in arid lands has been difficult to remediate and has significant economic impacts on human populations. Restoration efforts based on non-local materials and large-scale mechanization have not been capable of efficiently reversing the trend of environmental degradation. The use of traditional knowledge and simplified methods of seed harvesting, storing, marketing and soil preparation have proven that regeneration of native species and efficient land reclamation is possible in areas that have traditionally been considered degraded beyond redemption. This paper describes a method of land reclamation that combines tradition and simple mechanics that can be applied in all arid areas that face desertification. Because the work builds on cultural practices long used in non-industrialized societies, it is particularly adapted to rural areas. The methods described have the potential to open new low-tech economic opportunities to all segments of local non-urban populations while combating desertification and creating a more ecologically sound environment.

Keywords: arid land revegetation, combating desertification, land reclamation, reclamation, seed collection, seed marketing, soil preparation, traditional knowledge

1. Introduction

Around the world many arid lands are losing productivity and stability due to overgrazing, fire, erosion, and other factors related to past management practices and environmental changes. These losses have proved difficult to remediate and have had significant economic and ecological impacts on the human populations inhabiting those regions. Experiences in South Africa have been largely analogous to those in the American west, as annual species replace perennials on degraded rangelands (Dean *et al.*, 1995). Restoration efforts based on non-local materials and large-scale mechanization have not been capable of reversing the trend of environmental degradation (Pellant and Monsen, 1993). The importance of locally adapted and collected material has become increasingly obvious (Belnap, 1995; Linhart, 1995). The problems with invasion of weeds, increasing fire frequency, mined land reclamation, soil loss, and lack of economic opportunity for rural populations are similar across many temperate and tropical arid regions. Lessons learned over the past four decades in Nevada have broad applications to other areas. Only a few years ago it was accepted that reclamation of areas with low precipitation in the American west was not technically or economically feasible. Now successful revegetation with native species is the norm; even in the hottest and driest areas of

Environmental Monitoring and Assessment **99:** 267–274, 2004.

the Great Basin it is considered routine (Richards *et al.*, 1998; Ross, 1999). The resulting plant communities generally far exceed the pre-existing vegetation in soil stabilization, biodiversity, resistance to weed invasion, wildlife habitat, and forage production. Surprisingly, success has resulted from the simplification of techniques. In Nevada, hand labor by previously untrained inmate conservation crews has been used successfully for all steps of the reclamation process. The techniques described here for the collection of native seed and its use in low-tech reclamation on a wide variety of scales in varied environments have wide applicability for arid regions worldwide.

2. Collection and Marketing of Native Seed

2.1. Selection of species

Selection of seed for harvesting is dependent on several important factors. Species to be harvested must be useful either locally or elsewhere for reclamation work. They must be capable of supporting productive post-reclamation land uses, which should be identified in the first step in the process. It is important to remember, though, that the goal of reclamation is usually to initiate a productive community that will evolve in acceptable directions of succession, not necessarily to create an instant climax community. The seeds should be of species which have simple storage and germination requirements that can be easily met locally. There must be an adequate supply of the seed stock in the area, and it must be of a type that can be collected in some quantity over a reasonable period of time. Local demand and experience will drive many of the considerations of species selection. However, there may be excellent native species which are known to be of value but have no history of use in reclamation, and therefore have unknown shelf life and germination requirements. In most cases, very small-scale, unsophisticated tests can be conducted to ensure that seed collected is viable and can be easily used under typical field conditions. The methods described below for the preparation of sites and planting of seed can be conducted as tests of the potential usefulness of species which don't have a history of reclamation use (Kleiner, personal communication).

2.2. Timing of collection

Once the useful species have been selected and collectable populations located, it is necessary to determine collection times and techniques. Timing is often critical, and may vary with aspect and elevation, among other factors. This may allow extension of collection times, as well as providing a diversity of site-adaptation in the collected material. If seed is collected too soon, it often has low viability or problems with dormancy. If it is collected too late, it may be lost as it scatters from seed heads,

or may be preyed upon by animals or pathogens before it is collected. Except with very large fruits, it is not usually desirable to collect seed from the surface of the ground, due to the likelihood of weed seed contamination and the difficulty of cleaning such seed. When seeds ripen over time, rather than all at once, it may be useful to conduct repeated collections (Young and Young, 1986). *Experience and careful record keeping are the keys to determining the proper collection times for species*, *which do not have a history of reclamation use.*

2.3. Collection methods

Many rural, agricultural, and subsistence cultures already have traditional seed collection equipment and techniques. Often these can be used on new species, or easily adapted for such use. Examples include flat woven baskets into which seed can be flailed with sticks or wicker rackets, (Fowler, 1989, 1992; Kelly, 1964; D'Azevedo, 1986) toothed baskets or plastic bottles with bottoms removed and teeth cut into the circumference for stripping seed, blankets which are spread beneath plants, and rubber or wooden paddles which are used to rub seed heads. In some cases, it is easiest to harvest the entire flowering head. In others, it may be best to cover the ripening seed heads with bags to collect the seeds as they fall (Young and Young, 1986). *Trial and error*, *combined with innovation and local traditional practices*, *will readily reveal effective collection techniques for most species*.

2.4. Seed cleaning

Most seeds, especially those of grasses and grasslike plants, will require more or less cleaning after collection. Mechanical cleaning equipment is widely available, even in the most non-industrialized areas, but the process can also be done by hand. The first step is to break loose the inflorescence or outer covering. Grain threshers, if properly adjusted, can be used for many types of native seed. Hammer mills, commonly used to grind grain for domestic stock, can be adjusted to rub seeds loose and remove outer covers. Hand threshing techniques, in use since ancient times, include rubbing seeds against coarse screens, or trampling seed material with oxen or other livestock against a hard floor. Following threshing, the seed must be separated from the non-viable material which has been removed from it. Again, a wide variety of traditional practices may be employed, based on local needs and desires (Kelly, 1964). Screening may be done in two steps—first with a large screen to remove large material, then with a small screen which retains the seed while dirt and fine material falls through. Winnowing, either by means of natural breezes, or with a powered air source, has long been used. The seed is tossed into or dropped through moving air, which carries away chaff while the seed drops to a collection surface, or vice versa. Some types of seed can be easily cleaned by

means of vibrating an inclined pan or sheet of paper or cloth, so that the seed rolls to the lower edge while trash remains above (Young and Young, 1986).

2.5. SEED STORAGE

Proper storage of seed is absolutely vital to the maintenance of seed viability. After seed has been properly cleaned, it should be dried to at least 14% moisture, preferably 5–6%. Simple oven drying can be used to determine seed moisture content. A sample of seed is weighed, then dried in an oven, then reweighed. The weight of the dried sample divided by the original undried weight gives the moisture content of the original sample. Seed should be dried for storage under cool temperatures if possible, in a dark and well-ventilated environment, since heat and light are enemies of viability. Of course, seed must be protected from bird, rodent, and insect predators during this time, so it may be necessary to construct special facilities which bar such predators while maintaining the environmental conditions listed above. Again, many rural cultures have traditional practices and/or facilities which can be examined for these characteristics and modified as needed. For long term storage, the temperature should be kept as low as possible in most cases, with low relative humidity and good air circulation (Young and Young, 1986). Once the seed is well dried, it can be stored in a wide variety of airtight containers for later use or sale (Monsen, personal communication; Kleiner, personal communication).

2.6. SEED TESTING

A great variety of seed tests exist, many of considerable complexity and expense. For relatively unsophisticated collectors and users, there is no substitute for simple field testing and proper record keeping. Test plots can be established with careful plot marking and exclusion of grazing, traffic, and other disturbance. The plot conditions should match actual projected use situations as much as possible, and should be established using the basic planting prescription presented below. While it may not be possible to conduct tests quickly enough to gauge the viability of specific collection lots, tests are useful to determine which species are most likely to succeed, and the conditions which favor their survival. In some cases it may be useful to conduct very small tests, even in pots, to determine seed viability and ideal conditions of use.

2.7. MARKETING

While seed is often used locally for specific reclamation projects, it is also often sold for use on other sites. Ideally, a market is established for the seed before it is collected, since this avoids problems with storage. Operations which are subject to reclamation should be encouraged to commission seed collection in advance, so that collectors have a known destination for their product, and purchasers are

not as vulnerable to the vagaries of availability. In other cases, seed distributors purchase seed from collectors, storing it under controlled conditions and marketing it across wider geographic and economic ranges than local collectors can access. This has become a major industry in the western U.S. in recent years, and has been of great help in increasing supply and stabilizing prices as demands fluctuate in synchrony with wild fire rehabilitation needs. In some cases, it may be well worth it for local communities to establish cooperatives similar to those which are used in the marketing of agricultural products (Kleiner, personal communication).

2.8. Record keeping

Regardless of whether seed will be used locally or marketed for use elsewhere, complete and accurate record keeping is essential to ensure that full benefit of experience is obtained, to increase the marketability of material and the likelihood of ultimate successful use. At a minimum, data recorded for each seed batch should include:

- Common name and local synonyms, if any, along with scientific name and subspecies or variety
- site of collection including upper and lower elevation limits
- name and location of collector, date(s) of collection
- collection and cleaning methods.

Seeds for use in commerce will often require additional information, such as results of germination and purity tests, certification of weed seed compliance, etc., but these tests are beyond the scope of local collectors and would probably have been conducted by cooperatives or distributors if needed.

3. Use of Seed in Reclamation Activities

3.1. The basic prescription

Success in arid land restoration in harsh regions of the western United States has primarily resulted from simplification of techniques and elimination of most soil amendments, fertilizers, etc. The keys to successful revegetation are site preparation, species choice, and timing. Site preparation consists of reduction of slopes to 2.5 or 3:1, application of suitable growth medium if the original soil surface has been removed, and creation of a roughened seeding surface. Because extremely arid soils rarely have significant A and B horizons, topsoil may be either unavailable or too salty and/or silty to be useful. Mines may have ample supplies of Tertiary or Quaternary alluvial overburden material which can be salvaged as growth medium. Because the nutritional requirements of native plants are rarely known, and because

the growth medium may be quite variable, soil chemical testing is not indicated unless problems with excessive salt or boron are anticipated. It is only necessary to assure that the medium contains a mix of coarse and fine material that will allow creation of an uneven surface with adequate safe sites for seedling establishment (Ross, 1999).

3.2. Surface preparation

If growth media from elsewhere are being applied, the surface should be shallowly ripped by hand or with equipment to roughen it. Numerous observers have concluded that smooth surfaces are the leading cause of failed revegetation efforts in arid areas. This is consistent with much experience with desert seeds that suggests that "safe sites", which provide a good microclimate and ensure seed-to-soil contact, and perhaps water harvest, are vital to germination.

3.3. Selection of seed and timing

Depending on the seed available and the projected end land use, typically a diverse mix of site-adapted native shrubs, forbs, and grasses is then broadcast at a rate of 20–30 seeds per square foot. Observation of the surrounding terrain may suggest suitable species, although fire and grazing regimes may have degraded these areas so severely that they are dominated by annuals or undesired perennial. In such cases, consultation with local managers and observations of past successful revegetation efforts can guide species choice. It is usually important that seeding be done shortly before the anticipated arrival of seasonal precipitation—for example, summer seedings are rarely successful in Nevada except at higher elevations. However, this may depend on local climate patterns and the seed stock itself. While seeding too early only exposes seeds to detrimental heat and light, and to the possibility of animal predation, many seeds also have specific germination and dormancy-breaking regimes which may be most easily met in the ground (Ross, 1999).

3.4. Application of seed

Once the surface has been properly prepared, seed should be spread by broadcasting. Again, there may be local agricultural equipment and practices which can be adapted for use with native seed. Where mechanical equipment is available, it may require modification to adjust for seed size and rate. Even with the simplest hand operated spreaders some sort of agitator is often required if fluffy or clumpy seeds are present in the mix. In extreme cases, these may need to be seeded separately. Seed may be hand scattered if no mechanical assistance is available. The initial goal should be to apply about 20–30 seeds per square foot, although this may vary with species. If good records are maintained, it is easy to adjust the seeding rate based on earlier results, with resulting increased success and often reduced seed use. Calibration of

seeding rate is typically by trial and error, even in highly sophisticated operations in the U.S. Shallow trays or tarps may be placed in order to calculate rate of seed fall, or small areas may be delineated and seeded with known quantities in order to adjust rates.

After seeding, the surface should be immediately hand raked or dragged with some device to cover the seed. A piece of chainlink fence weighted with scrap iron or large tires is often used. This can be drawn by stock or almost any sort of agricultural equipment or vehicle. In many cases, this step can be combined with the seeding process, either by mounting a mechanical seeder on a vehicle or by stationing hand broadcasters on the back of a truck or wagon which draws the drag at the same time. After dragging, the only follow-up necessary is to maintain fences or continue management in such a way that the site is not subject to livestock grazing or disruptive human activity (Ross, 1999).

3.5. Evaluation of success

The success of revegetation efforts should be carefully monitored, especially in early projects where the parameters which contribute to success and failure have yet to be established. At the very least, small plots should be established on different parts of the site, representing all the variation in slope, aspect, soil type, and seeding type and technique. In the first two years, it is most practical to simply count the number of seedlings which appear, using standard density hoops or any sort of homemade plot polygon of a known area. A coat hanger bent into a rough square is often useful. In later years, cover, as measured by line intercept, provides the most useful information about reclamation success. The method is easily used and can be adapted to any sort of linear measurement scale in local use. This information should be recorded so that it is linked to the original seeding data as listed above (Ross, 1999).

3.6. Management of established reclamation

Management of reclaimed areas is usually not complicated, unless there is political or economic pressure to continue the management practices which led to initial degradation. Overgrazing by livestock is a real threat, especially since the reclaimed areas are typically of higher productivity and palatability than adjacent disturbed areas. Therefore some form of livestock management is essential in grazed areas. Excessive traffic or other anthropogenic disturbances are also threats to reclamation. Once the plant community is established, some weed control may be desirable, especially in early stages before the perennial plants are dominant. Later, the site may serve as a production source for more seed collection.

4. Conclusion

Restoration activities include seed collection, cleaning, and marketing, growing of nursery or transplant stock, planting, and reclamation of disturbances. These activities provide economic opportunities for both local and regional communities and benefit individuals of either gender with nearly any level of education and physical ability. Seed collection is particularly lucrative, either for direct use in restoration projects, or for sale to distributors or end users. Contract seed collectors are operating in many areas of the world, using either simple machinery or hand collection. Because the work builds on cultural practices long used in non-industrialized societies, it is particularly adapted to such rural areas. The methods described here have the potential to open new low-tech economic opportunities to all segments of local non-urban populations while combating desertification and creating a more ecologically sound environment.

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