V. Irrigation and Fertilization

After the mined area has been seeded and planted, efforts must be concentrated to assist in seedling establishment, growth, and survival. Reclamation is not successful until the vegetation on the site can grow and reproduce under the normal management of similar undisturbed sites. In the West, native rangeland management usually consists of regulation of the number and species of animals grazing the site and regulation of the seasons of use of the land. Irrigation, fertilization, or use of herbicides and pesticides are not usually used on western rangelands. However, such cultural techniques are sometimes used to promote the establishment and growth of plant communities on mined lands. The vegetative community must meet reclamation success criterion after these cultural techniques are discontinued before the mining company can be released from its reclamation responsibility.

Use of intensive cultural techniques help establish plants. Many desirable species would not establish for many years or even decades if the techniques are not employed. By using these methods, succession is advanced. Where weedy pioneer species would occupy a site for years, intensive management techniques establish long-lived perennials that can occupy the site indefinitely. Site productivity, diversity, and stability are promoted.

Acclerating succession through irrigation, fertilization, and pest control is considered undesirable by some. Artificially induced succession may not proceed in the same direction as natural succession, possibly resulting in a vegetative community that will not be capable of maintaining itself without continued manipulation. Legal requirements state that reclamation on rangeland can only be considered successful when the vegetation community maintains itself for 5 to 10 years after the last seeding, irrigation, or fertilization. Because of this, cultural methods must be used only for establishing the community. Therefore, these cultural techniques should be used sparingly.

Irrigation

Irrigation provides plants with water they would not obtain naturally, Irrigation is controversial. While it is not always necessary or even beneficial, it is used regularly and is necessary in some cases. Different methods of irrigation have different advantages, disadvantages, and appropriate situations in which they are employed.

Irrigation should provide adequate amounts of water but should not cause undue runoff or erosion, nor should it waste water. Because water is a limited resource in much of the West, irrigation must be as efficient as possible. Techniques that allow water to penetrate deeply into the soil excessive (Fig. 103). Evaporation will occur each time the site is irrigated. If water is deep in the soil, a small percentage evaporates. Water that is all near the surface will suffer a much higher percentage evaporation. Deep moisture will last longer in the soil and will reduce the need for irrigation frequency.

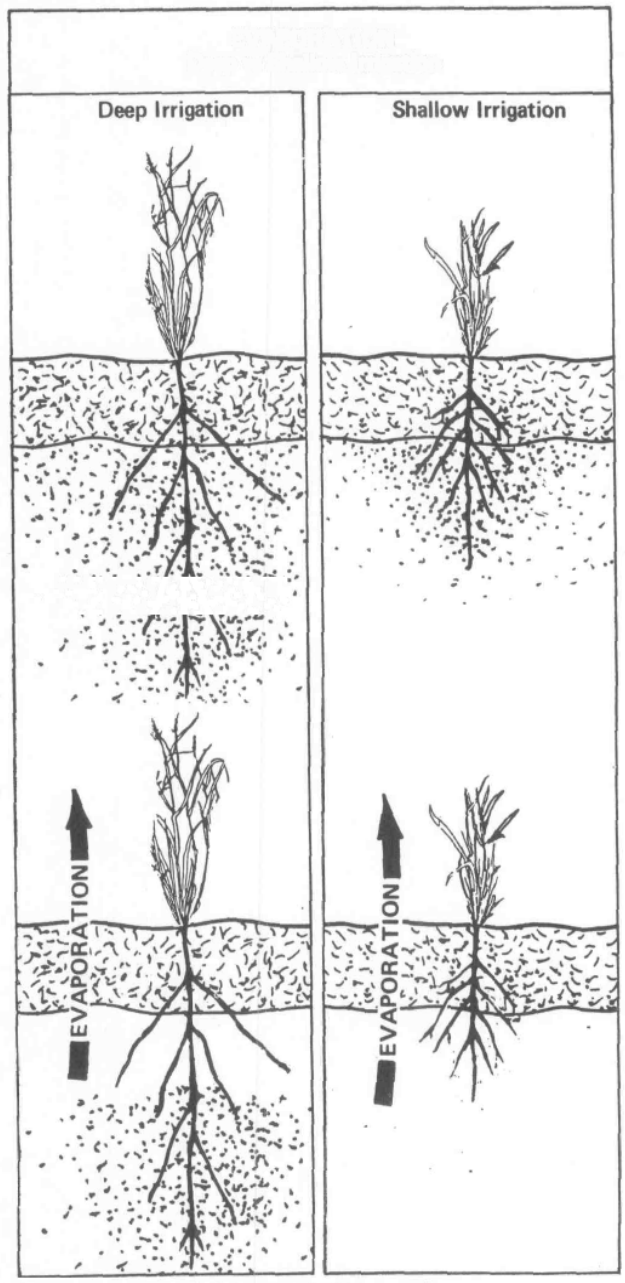

Figure 103. —Effects of deep vs. shallow irrigation

A further advantage of deep watering is the response it elicits from the plant roots. By irrigating deeply, the roots are encouraged to penetrate deeper into the soil to remove all the usable moisture. This is especially beneficial when irrigation is concluded. The plant roots will have expanded so they can obtain water out of a relatively large volume of space.

Irrigation should not cause excessive runoff. Erosion caused by irrigation is related to application rates, soil infiltration rates, and irrigation frequency.

Sprinkler

Sprinkler irrigation uses pumps to push water through metal pipes. Sprinklers spray the water over the desired area. Several sprinkler systems are available. Hand-carried, self-powered linear, and center-pivot systems are now being used. All spray water and sometimes fertilizer. Self-powered linear or center-pivot systems move with water power. Hand-carried systems are moved manually. All must be on relatively level areas. Sprinkler irrigation systems are common agricultural tools in the West so obtaining and servicing the system is relatively easy. Sprinklers can precisely meter water to the soil.

Sprinkler irrigation is inefficient when used in hot, dry, windy weather. Evaporation is very high when these conditions prevail. Because the sprinklers create a spray of relatively small drops, evaporative surface area is greatly increased by the sprinklers. Sprinkler application rates should be closely controlled to prevent surface runoff and erosion.

Flood

Flood irrigation is spreading the water over the surface of the site. If often involves a network of irrigation ditches along the ridges and benches. The ditches are dammed at intervals and the water in the ditches floods over the surface of the land below the ditch level (Fig. 104). This technique is a common method of irrigating native and domestic pastures in the West. The ditches used are seldom deeper than 2 feet and should not present a hinderance to livestock or wildlife. They often promote a land of lush growth of vegetation along their banks that can be a benefit as wildlife habitat. The ditches are a hinderance to vehicle traffic.

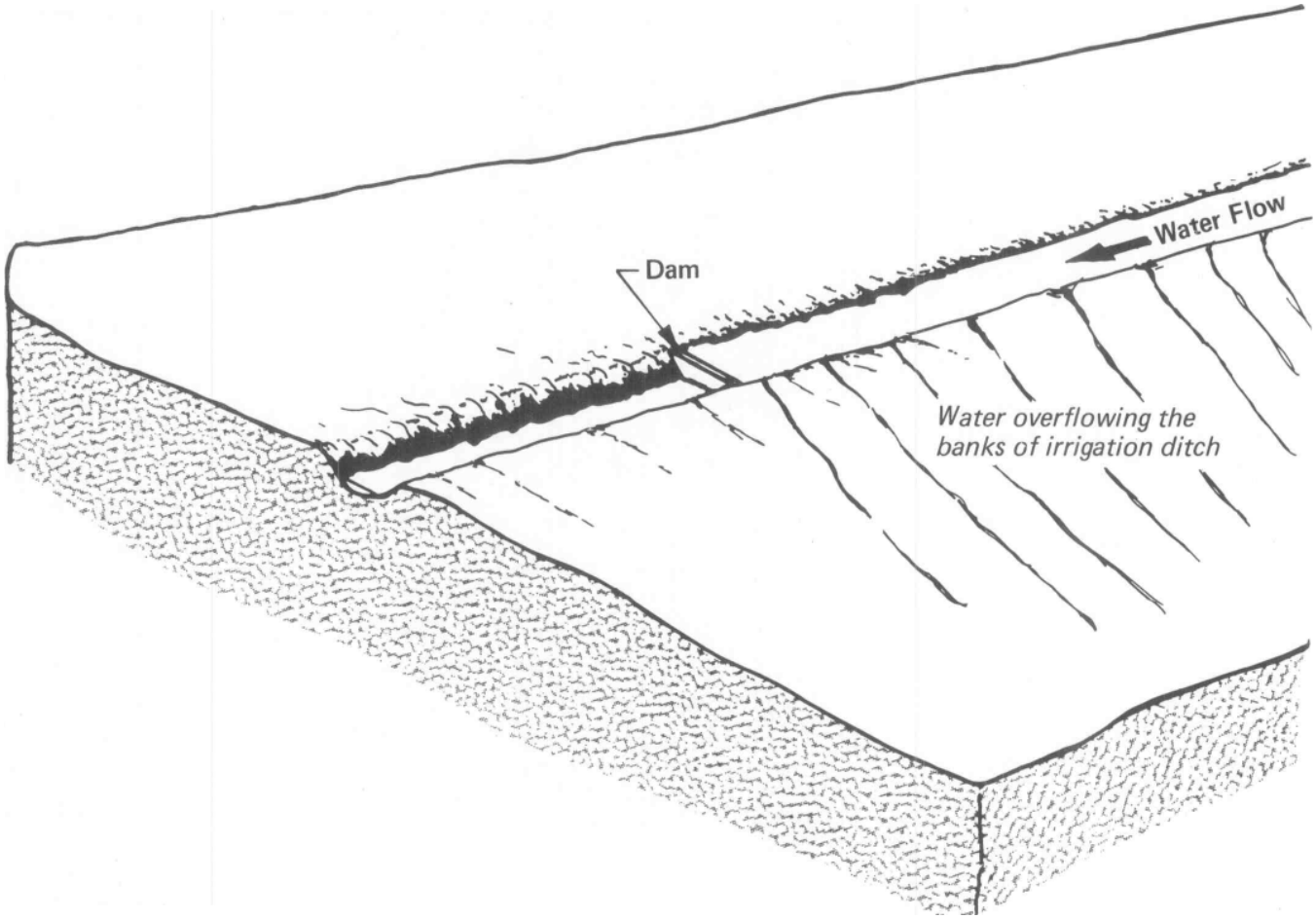

Figure 104.—Ditch irrigation

Ridge and furrow irrigation techniques are appropriate for flood irrigating rows of plants, such as windbreaks. The plants are located on the ridges, and the furrows on each side of the plant now irrigate the plants (Fig. 105). This technique usually will not be used for irrigating a large area, but is very effective to irrigate specific plants. The water is not flooded over the plants as in ditch irrigation. Rather, the water percolates under the furrows and is carried by capillary action under the ridge to where the plant roots can reach it.

Overland flow irrigation is using sprinklers to spray water faster than it can be absorbed into the soil. The excess water runs downhill, flooding areas below the sprinkler (Fig. 106). The runoff is collected at the base of slope in a small furrow. Overland flow is not acceptable on easily eroded slopes before the vegetation has begun to grow. Overland flow on bare slopes will erode and create hills and gullies. This irrigation technique should only be used after the site has been vegetated.

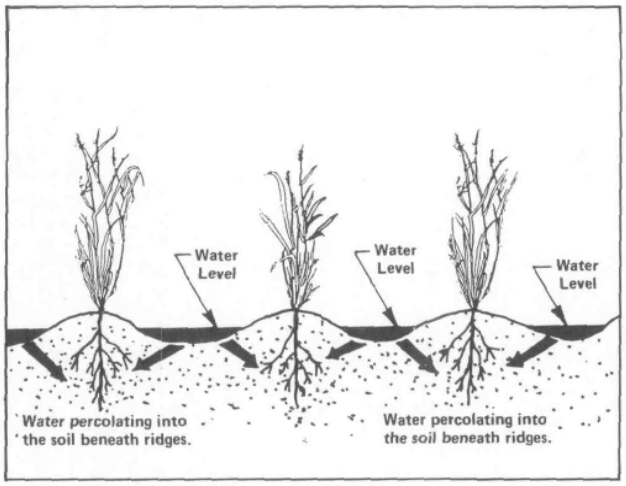

Figure 105.—Ridge and furrow irrigation

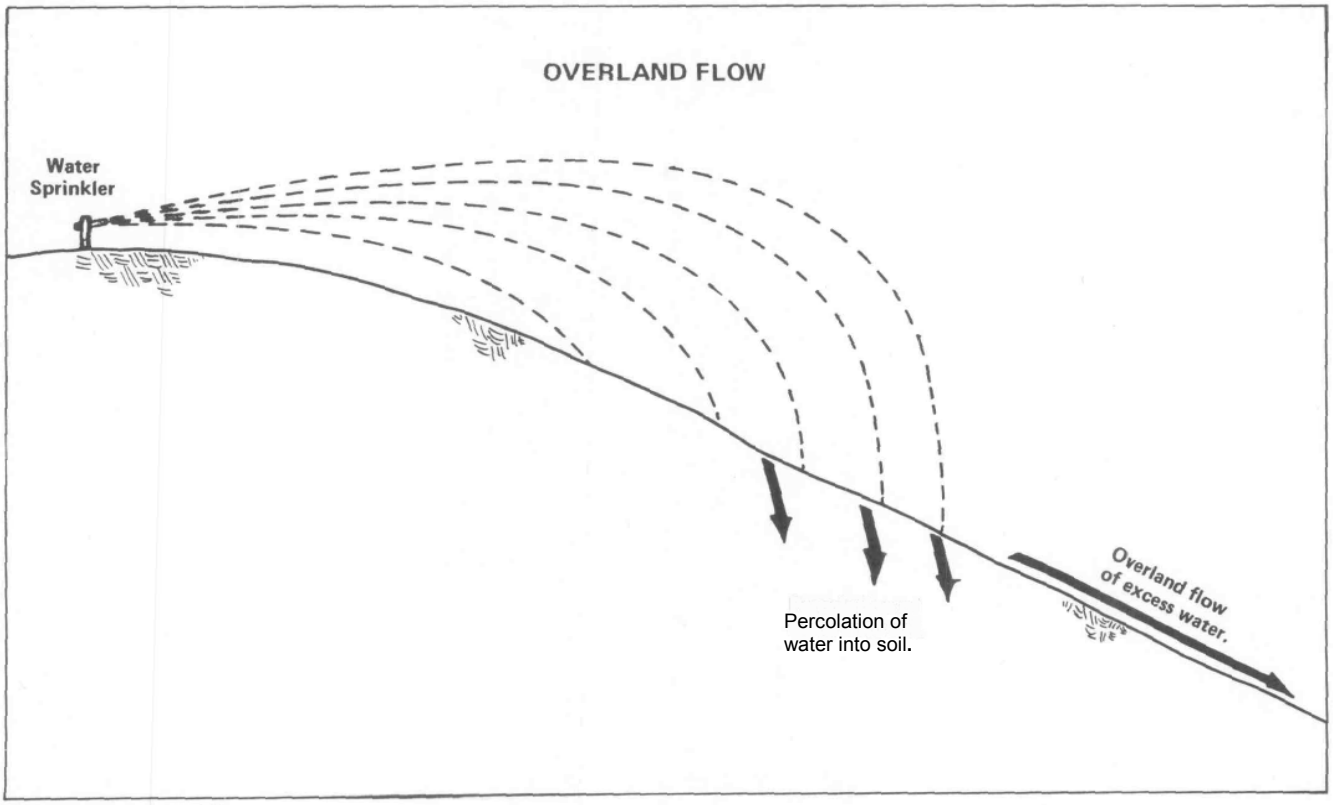

Figure 106.—Overland flow

Drip Irrigation

Drip irrigation is an intensive irrigation system that waters individual plants or small clumps of plants. Small diameter tubes carry water to selected site. They are often used on moderate to steep slopes, where horizontal tubes with variously placed water outlets irrigate individual plants. Watering rates must be regulated to prevent runoff and erosion, especially since most of these systems are on slopes.

A major advantage drip irrigation has over flood or sprinkler irrigation is that drip irrigation can be regulated to maintain soil moisture at an optimum level. Irrigating with sprinklers or flood systems provides moisture levels from saturation to near wilting point. At the time of irrigation, saturation levels, which exclude oxygen from the root zone, occur; between irrigations, soil moisture often becomes limiting. Drip irrigation can be done as often as necessary to keep soil moist and can be done slow enough to avoid saturation (DeKemer and Back, 1977). Drip irrigation uses water efficiently. The watering rate can be regulated so it is absorbed into the soil as quickly as it is emitted from the tube. Since it is carried to the plant in a tube it cannot evaporate or be lost into the soil where it is not desired. Other forms of irrigation expose water to the air and therefore have much more evaporative loss. Drip irrigation can leach soluble salts or other soluble toxic materials before planting an area.

Drip systems are not appropriate for full coverage of an area. The cost of achieving total coverage would be prohibitive. Adequate filtration is essential to prevent clogging in the tubes and emitters.

Fertilization

Most fertilization is done before or concurrently with seeding. After an area is seeded and the soil is susceptible to damage from vehicular travel, fertilization is done through the irrigation system. Where the water is pumped onto the area, in sprinklers or drip systems, fertilizer is added to the water at the pump. A solution of fertilizer dissolved or suspended in water is added at a regulated, uniform rate to the water supply pumped through the system.

Fertilization during flood-irrigating is less precise and is not often attempted. Since the water is usually free-flowing, there is no convenient place to add fertilizer. Furthermore, the water is not as well controlled as it is with sprinkler or drip irrigation, so fertilizer may be applied too heavily in some areas and not applied to others. This problem seldom occurs with drip or sprinkler irrigation systems.

Water Harvesting

Water harvesting is catching or concentrating natural moisture to increase moisture in desired areas. The techniques range from spreading impervious materials over the soil surface and channeling the subsequent runoff to a desired site to placing snowfences that catch blowing snow.

Impervious materials can be used on a large scale to seal off large areas and direct the runoff to a pond or a lower area where stands of trees or shrubs can use the water. If the runoff is directed to a pond, water is usually used for irrigation when needed. In cases where the water is desired to stands of vegetation, the runoff is used by the plants as it occurs (Fig. 107a and b).

Impervious materials that cover large areas and create runoff include latex emulsions, paraffin wax, emulsions, butyl rubber, sheet metal, and plastic film. They range from relatively inexpensive to extremely expensive, with

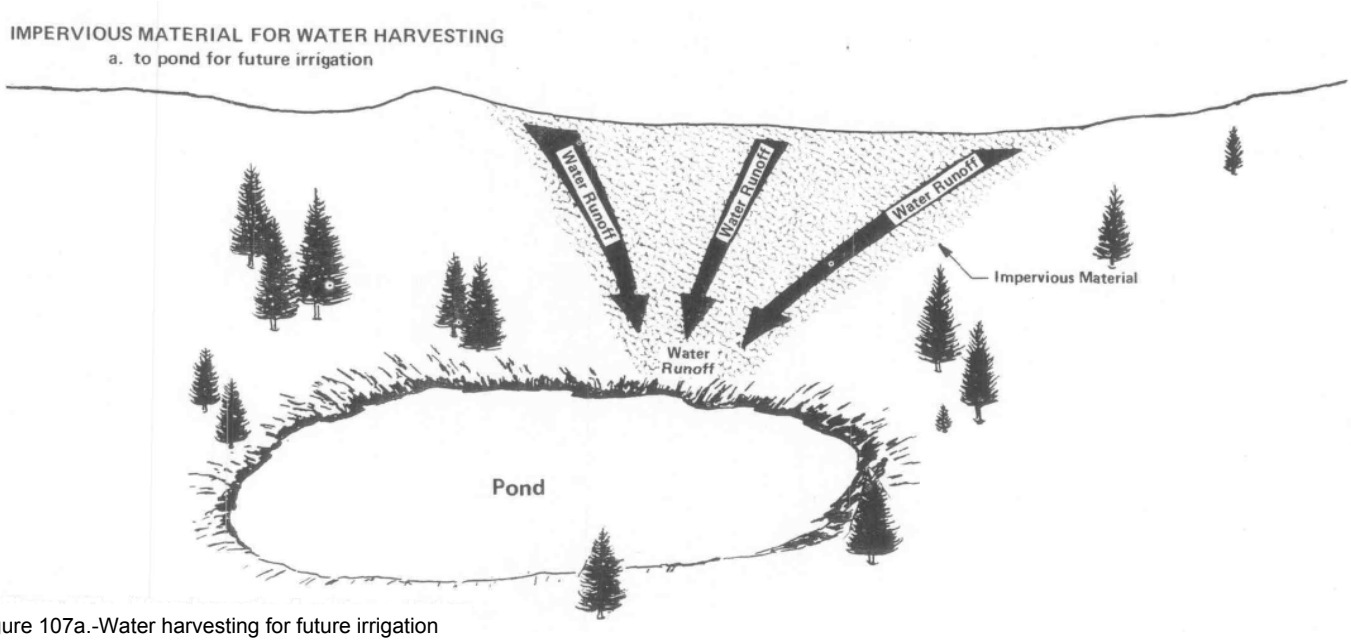

Figure 107a.-Water harvesting for future irrigation

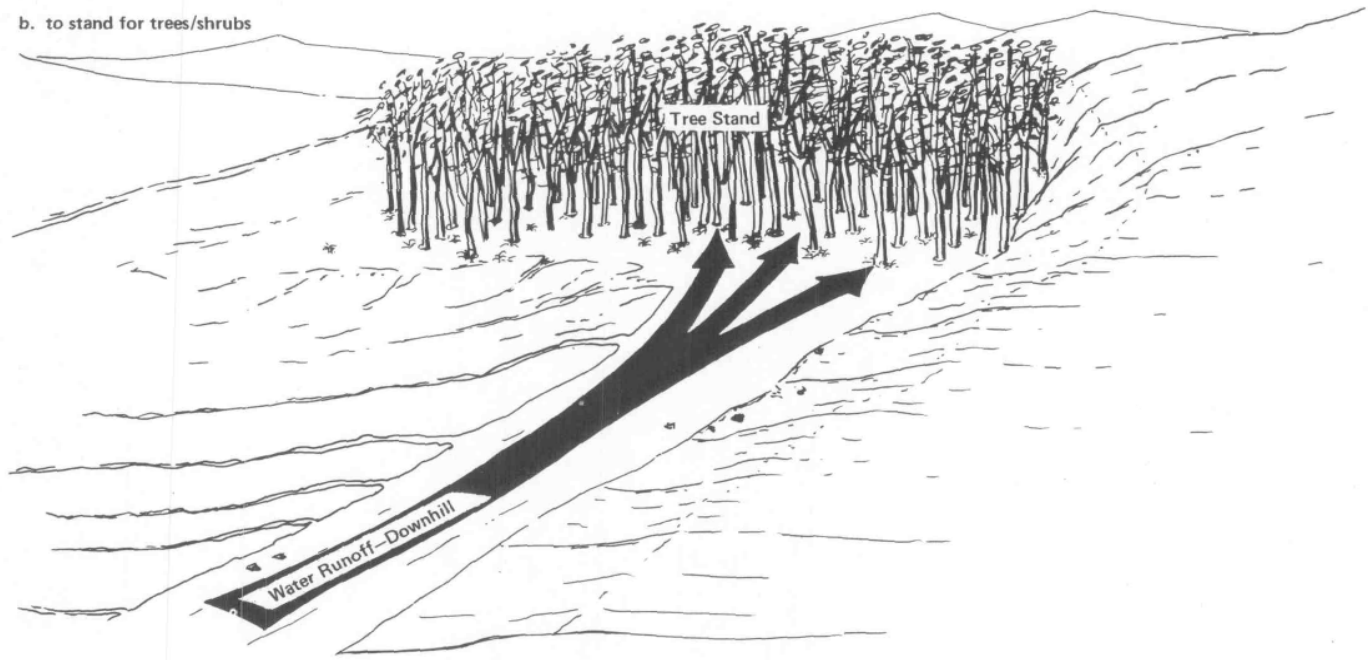

Figure 107b.—Water harvesting for runoff to tree stand

the lifespan of the materials often inversely proportional to its cost. The various materials must be carefully applied to the soil. Any that rest on the soil must be well anchored from wind; those that bind the soil surface (such as the latex or wax) are easily broken up by animals or vehicles and therefore must be carefully protected from disturbance.

Covering large areas with impervious materials is seldom desirable. The land covered with the material will not support vegetation and is susceptible to massive wind and water erosion. The covering, if maintained for a long period, is quite expensive. This technique is more applicable for providing water for domestic animals or wildlife than as a common revegetation technique.

Condensation Traps

Small scale use of impervious materials has more applicability for revegetation on arid and semi-arid sites. Condensation traps made with polyfilm have been used to collect and concentrate moisture for individual plants, especially to help individual plants become established (Jensen & Hodder, 1979).

The condensation traps catch soil moisture as it evaporates. The moisture condenses on the underside of a plastic sheet and then runs down the sheet to the base of a plant. The basic design (Fig. 108) has an excavated basin, approximately 5 feet in diameter and 1 foot deep. A tree or shrub is planted in a small mound in the center of the basin. Plastic film is placed over the basin, with the edges anchored with dirt along the edge of the basin. A hole is cut in the center of the plastic so the plant can poke through. Finally, rocks are placed around the plant at the base of the small mound. The rocks keep the plastic taut, with the plastic at an angle adequate to make the water run down to the mound around the plant.

Traps increase available moisture for the plants, are relatively inexpensive, and can be easily modified to handle bareroot or containerized seedlings, trees, shrubs, or grasses. The plastic film breaks down after several years. Colored film, especially black film, breaks down faster than clear plastic. Weed growth is inhibited by black plastic.

These traps must be well built. The plastic should be at a minimum of 25 degrees from the horizontal so that the moisture travels all the way to the plant. If the plastic is not taut it will be susceptible to tearing. Traps built on open slopes may fill with eroded soil which destroys the trap and covers the plant. They should not be built on slopes where erosion will be a problem.

To facilitate construction of the traps, Jensen and Hodder (1979) designed prefabricated traps using wooden sides and plastic sheets. These proved to be easier to install and more reliable than the original basins when relatively unskilled personnel installed the traps. Jensen and Hodder also described variations of the

basic trap designed for ease of installation or longer life (Fig, 109a and b).

Snow Traps

In much of the arid and semi-arid West, snow is a major component of the annual precipitation. However, much of the snow blows off and is trapped in areas where it is not needed. Snow traps are designed to catch the snow on specific areas where it is needed for reclamation purposes.

Snow traps are snow fences, standing mulch, or wind-breaks that reduce wind velocity and cause snow build-up. These will increase moisture from snow-melt by catching snow and reducing the snow that is blown away.

As winds blow the snow, snow traps reduce the velocity near the ground. Snow falls and drifts against the trap. When snowmelt occurs, increased snow cover will increase available moisture.

Snow traps should be constructed or grown perpendicular to the prevailing winter wind. They should be on the windward side of the area to be affected. Snow traps are usually long-lived and a low maintenance means of water harvesting.

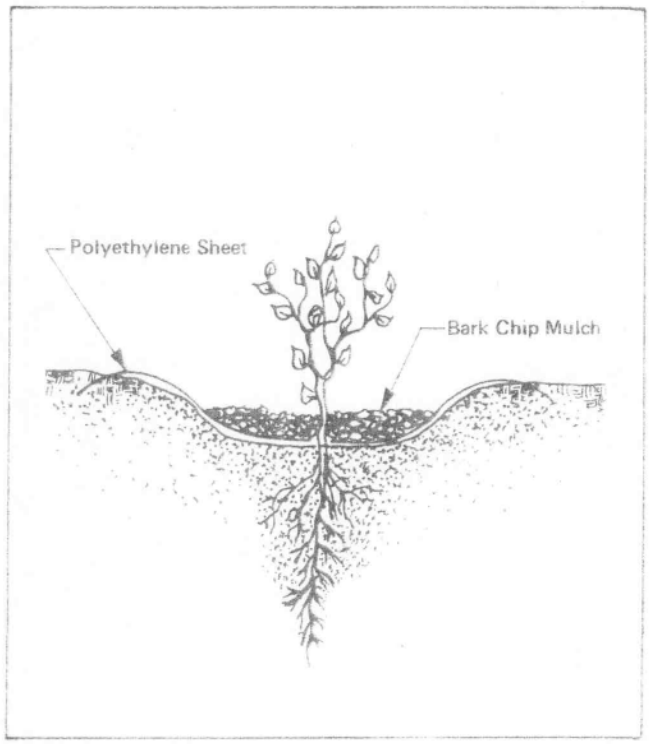

Figure 109a.—condensation trap design for ease of installation

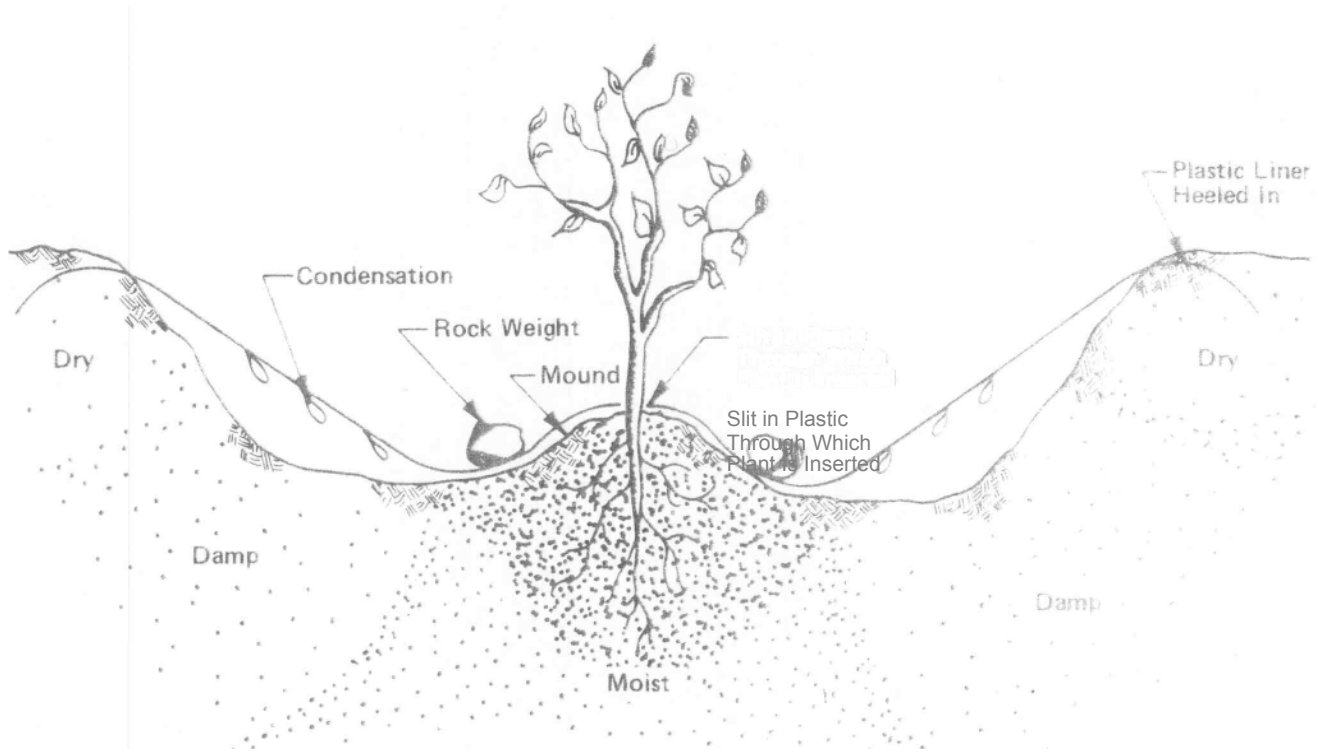

Figure 108.—Condensation trap

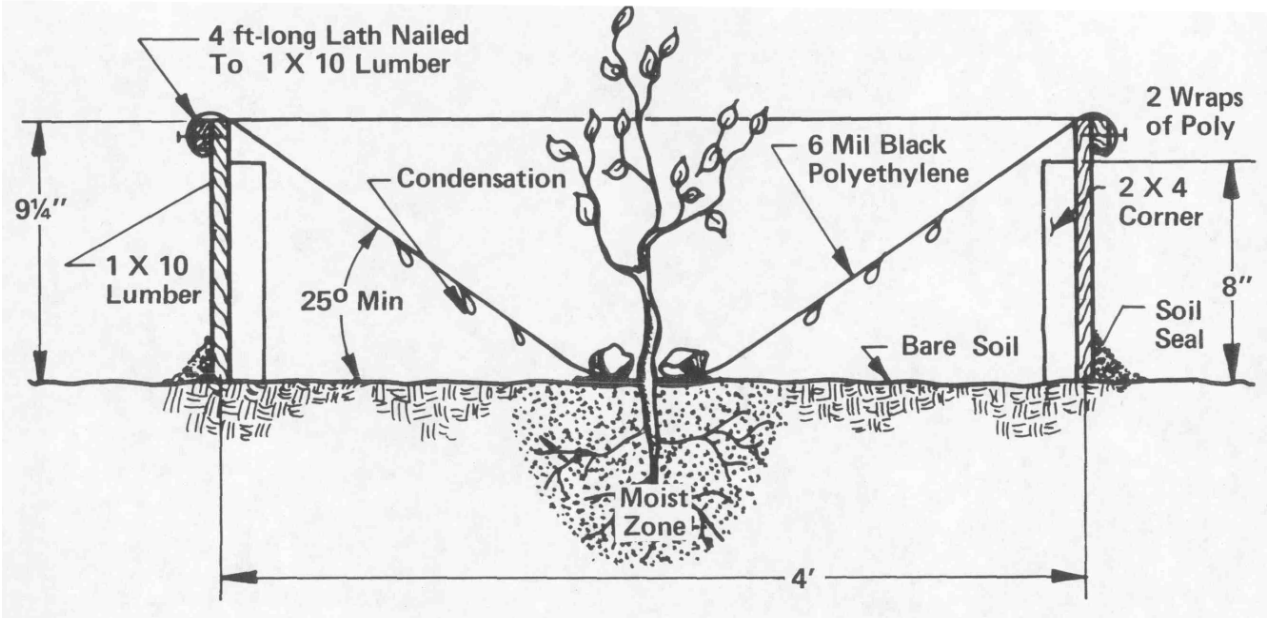

Figure 109b.—Pre-built condensation trap