Revegetation of Semiarid Rangelands: Problems, Procedures, and Probabilities

J.R. Simanton

Rangelands are lands not under cultivation which are used for cattle grazing or wildlife habitats. Arid and semiarid rangelands are characterized by low amounts of erratic precipitation, high potential evapotranspiration, and limited supplies of surface and ground water. Supplies of water are often insufficient to support permanent cultivation, large numbers of people, or heavy industry. Vegetation of arid and semiarid rangelands can be either grass-, shrub-, or grass/shrub-dominated. Examples of grass-dominated rangelands are the steppes in Eurasia, the veld of Africa, and the plains of North and South America (Fig. 1). Shrublands are found in the Middle East, northeast and south central East Africa, western United States, northern Mexico, western and central Australia, and Gran Chaco of South America (Fig. 2).

Fig. 1. *Grassland prairie of the northern Great Plains of the United States.*

The economic future of most rangeland areas depends on maintaining a natural and productive vegetation cover for efficient use by grazing and browsing animals while conserving the water and soil resource. This is especially true in arid and semiarid regions where droughts are common, soils are shallow, and most vegetation is marginally resilient to major vegetative canopy losses.

Problem

There are over 235 million acres of semiarid rangeland in the United States that are classified as being in fair to very poor condition (Table 1) (U.S. Forest Service 1980). Economic losses from reduced production caused by undesirable vegetation on these western rangelands are estimated to be about 250 million dollars annually (Morton 1973) and the world-wide cost of rangeland deterioration is estimated at 6.8 billion dollars annually (Dregne 1978). These estimates do not include the indirect economic losses due to increased soil erosion and decreased water supplies. The impact on future generations of these indirect losses are very difficult to assess. The less than good range conditions found on many rangelands are a product of man's historic misuse of the range resource and the compounding effects of climatic extremes. A vicious circle of deteriorating rangeland conditions is initiated when the vegetative cover is reduced or removed through the combination of overgrazing and short-term droughts. This deteriorating condition perpetuates because there is insufficient vegetation cover to prevent soil surface sealing. Soil surface smoothing and erosion increase, which in turn decrease infiltration and soil water holding capacity—a condition very unfavorable for plant growth or establishment (Fig. 3).

In arid and semiarid regions where natural regeneration is extremely

Author is hydrologist, USDA-ARS, Aridland Watershed Manage. Research Unit, 2000 E. Allen Road, Tucson, AZ 85719.

Table 1. Condition of Rangeland Ecosystems in the United States 1976. (U.S. Forest Service 1980).

Ecosystem	Total area	Good* condition	Fair condition	Poor condition	Very poor condition
Desert grassland	25**	2	6	12	4
Sagebrush	124	16	41	46	22
Desert shrub	81	14	30	26	12
Southwest shrub steepe	43	4	6	18	14

* Good = Vegetation and soils are between 61–100% of site potential
* Fair = 41+60%, Poor = 21–40% and Very Poor = 20% or less.
**In millions of acres

slow, rangeland deterioration is increasing at an alarming rate. Many deteriorated ranges have been "invaded" by low forage value, high water-using shrubs that are up to three times less water-use-efficient than grasses. Lack of vegetative cover and the corresponding increase in bare soil increase the portion of annual precipitation lost as runoff and evaporation. The net result is that less of the total precipitation is available for supporting vegetation and biomass production (Fig. 4).

Fig. 2. *Semiarid shrublands of the southwestern United States.*

The social, economic, and political problems associated with deteriorating rangelands are perhaps the limiting variables in the process of rangeland rehabilitation. The rangeland revegetation and utilization problem is complex and involves a multitude of entangled ecological, cultural, economic, and political factors that may be impossible to unravel. This is especially true in Africa and the Mid-East where nomad tribesman are not constrained by political boundaries. Governments in these areas are not prepared to address the management programs that must accompany revegetation projects. Also, many of the developing countries have more demanding social problems and are limited in their financial and political ability to begin large-scale revegetation projects. In the United States and Mexico many ranchers are reluctant to change their ranching practices—practices that have pushed many ranchers into a position of economic hardship and possibly into another cycle of continuing vegetation deterioration. Today, the opportunities and technologies are available to increase rangeland productivity and decrease soil and water loss. Decisions not to invest in rangeland improvement are based more on economic and political problems than on technological deficencies. If revegetation practices were annually applied to 10 million acres of the fair to very poor rangeland, it would take over 20 years to treat these rangelands in the western United States. However, there are no known revegetation practices that, if applied once, will assure maximum production for 20 years. Proper livestock and wildlife management after establishment of a desirable vegetative cover is the key to the longevity of any revegetation program.

Procedures

The term *revegetation* usually implies that an existing vegetation type will be replaced by a new type through the efforts of man. It is usually considered in terms of brush removal and grass reseeding, but could also be envisioned in terms of replacing grass with trees for fuelwood or wildlife habitat. Revegetation practices should be directed toward reversing the trend of deteriorating rangeland resources and toward increasing productive and protective vegetative cover. This improvement process should decrease surface evaporation, runoff, and erosion. Beneficial revegetation practices should also be directed toward holding soil and water

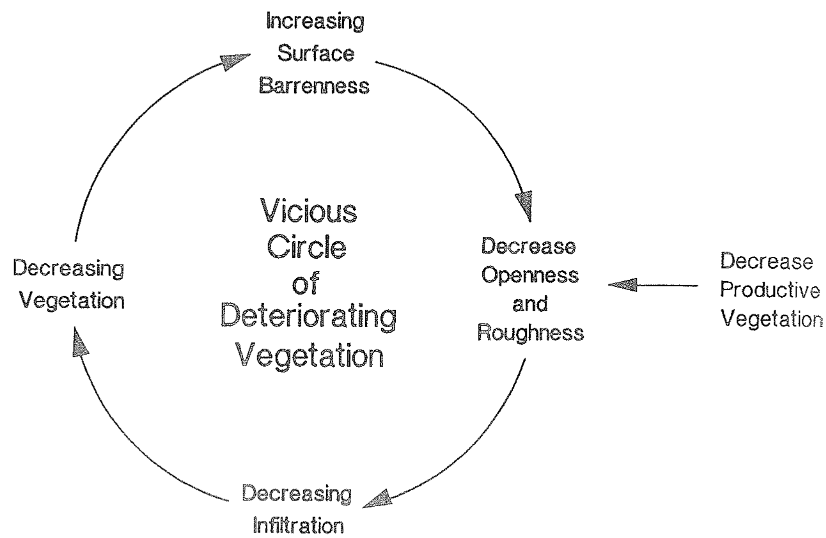

Fig. 3. *Vicious circle of deteriorating rangeland vegetation.*

resources in place so establishment of productive vegetation can be expedited.

Besides the social and economic problems associated with rangeland revegetation is the problem of selecting the best procedure for a particular result. Revegetation techniques should provide microenvironments most likely to achieve cost effective vegetative cover under the existing set of environmental conditions. In most cases, this means suppression of vegetation competition accompanied with a suitable seedbed.

Revegetation methods used to improve rangelands include mechanical renovation and seeding; chemical control of undesirable vegetation; burning for removal of undesirable vegetation or for stimulation of desirable vegetation; good grazing management; and combinations of these methods.

Mechanical treatments improve semiarid rangelands in three ways: (1) improve the soil-water regime, (2) improve species composition, and (3) improve soil fertility. Mechanical renovation ranges from hand removal of undesirable vegetation to removal of vegetation by elaborate specially designed machines (Fig. 5). Though expensive, mechanical treatment is the most positive method of vegetation removal and soil surface manipulation. Plows, pitters, rippers, furrowers, cutters, imprinters etc., are a few of the implements used in rangeland renovation. These implements are designed and strengthened to withstand the rough rangeland terrain. However, most rangeland implements are limited to nearly level, rock-free areas. Because of the wide range of topographic, soil and vegetative conditions, no single implement works well on all rangeland. Further, some implements control the existing vegetation but do not prepare a satisfactory seedbed. Other implements can prepare the seedbed but are ineffective in vegetation control.

Land-forming techniques such as terracing, forming level benches, water spreading, and basin formation are used to hold runoff water on the watershed to increase soil water available to vegetation. These techniques are different from the mechanical treatments because there is usually a much longer time frame needed to produce a positive economic and environmental effect.

Chemical treatment includes the use of herbicides and fertilizers. Chemical treatments may be used in combination with one or more of the mechanical treatments. The intensity of the overall range treatment depends on the potential for increased forage production. Chemicals may be aerially

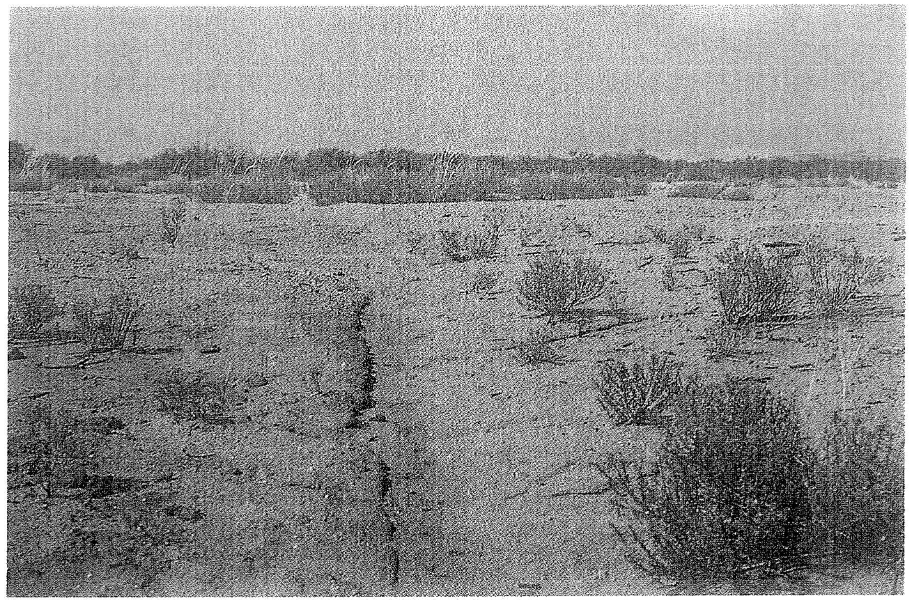

Fig. 4. *Semiarid rangeland caught in the vicious circle of deteriorating rangeland vegetation.*

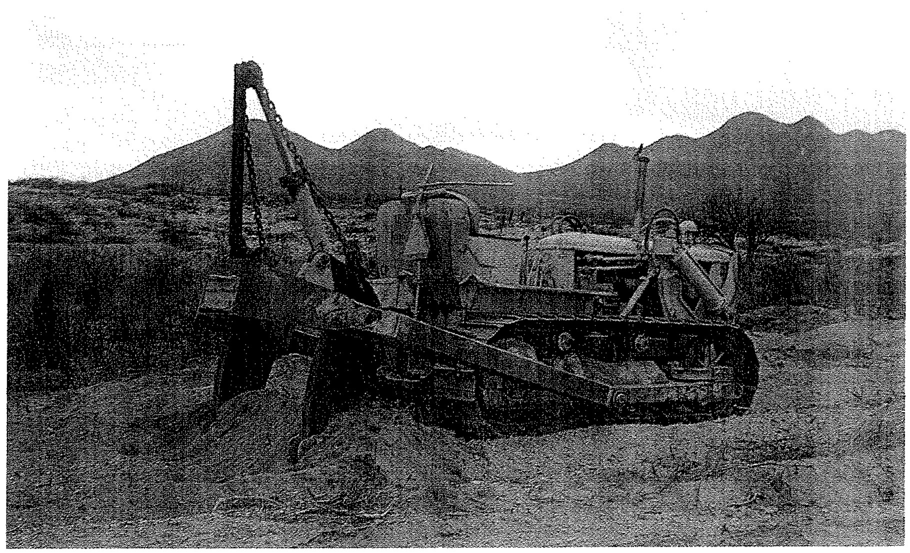

Fig. 5. *Root-plow behind a bulldozer is an effective mechanical treatment for killing semiarid rangeland shrubs.*

applied to areas too rugged for mechanical treatment. However, the greatest forage response occurs in nearly level to gently sloping rangeland where rainwater infiltration can be high and runoff and erosion negligible. Use of herbicides in steeply sloping areas, where low infiltration rates may limit soil moisture, may further aggravate the deteriorated condition because the semi-protective shrub cover will be reduced thus increasing runoff and erosion. Herbicides also have the potential for damaging downslope or downwind vegetation and the pollution of surface and ground waters. Also, establishment of desirable vegetation may take an extremely long time or not occur at all if there is not an adequate seed source in the chemically treated area. Vegetation response to fertilizers is greatest where soil moisture conditions are not a limiting growth factor. In areas where soil moisture severely limits forage production, rangeland fertilization can result in grass stand reduction where short-term droughts follow fertilization.

Fire has been used to control vegetation for thousands of years. It is usually ineffective on deteriorated rangelands because there is usually insufficient fuel to carry the fire. Burning seldom increases total perennial grass production, may temporarily reduce production, and can reduce perennial grass species. Burning must be coordinated with rainfall to control fire temperature and ensure the burned rangeland will not be devoid of vegetative cover during intense rainstorms.

Management is usually a relatively slow process for range improvement or renovation and is accomplished mainly through intensively managed systems involving different grazing intensities and duration. Use of browsing livestock (such as goats and antelopes) in combination with grazing cattle appears to have potential in maintaining a desirable brush-to-grass ratio on many rangelands. Costs of fencing and water supply often limit the use of managerial or biological approaches to range renovation. In areas where vegetation deterioration is extreme and soil erosion is severe, improvement in existing vegetation may be too slow or impossible using grazing management alone.

No single control treatment is considered capable of completely solving the problem of deteriorated rangeland vegetation. Repeated treatments, together with sound range management practices are necessary to develop and maintain a productive range resource.

Probabilities

Probabilities of successful revegetation programs are frequently based on economic and social considerations rather than scientific analytical and technical procedures. In many revegetation feasibility economic analyses, short-term results are justifiably the main consideration due to the initial outlay of money and high interest rates. Most economic analyses emphasize benefit/cost ratios and the time between incurring costs and realizing benefits as major decision-making factors. Risk, uncertainty, failure to get vegetation established, forage response, and even fluctuations in the livestock market are other considerations.

The probability of successful revegetation programs is greater in the United States than in most other parts of the world. This is due to technological superiority, relative economic stability, and cultural systems of individual grazing units or ranches rather than nomadic grazing. Also, through the many federal resource conservation programs in the United States, the government can and will, take an active role in both financial and technical assistance.

Even though many developing countries of the world depend almost totally on their native rangelands for grazing, they are less likely to initiate any large-scale revegetation programs. Some reasons are: (1) lack of basic and technical knowledge, (2) deficiency of governmental organization, (3) deeply ingrained social and cultural customs, (4) shortage of skilled manpower or modern equipment, and (5) shortage of financial resources.

Another deterrent to range revegetation and conservation is a common misunderstanding of the biological laws of plant perpetuation. Removal of an undesirable species does not necessarily ensure a more desirable species will be its replacement. The undesirable species were successful at the site for a reason. Environmental conditions, species adaptation, seed availability, and management goals and programs must all be included in any revegetation planning process. Because of the vastness of semiarid rangelands throughout the world, a small increase in their productivity per unit area could mean a tremendous increase in world-wide food production. Other benefits of productive rangelands include: (1) soil and water conservation, (2) increased fiber and fuel, (3) improved wildlife habitat, and (4) a perpetuating resource of soil and forage reserve that potentially could be better utilized as technology and management improves. There needs to be coordination among technologists, policy makers, financiers, planners, and legislators before wide-ranging, long-term improvement of our rangeland resources can become a reality. The future productivity of most range areas depends on maintaining a desirable vegetation resource that will not lead to the continuing cycle of rangeland misuse and deterioration. The economic and and social problems; the renovative and management procedures to improve the resource; and the probabilities of maintaining the resource and issues that must be considered and coordinated if rangelands of the world are to be continually fully and correctly utilized.

Literature Cited

Dixon, R.M., and J.R. Simanton. 1980. Land imprinting for better watershed management. Watershed Management Proceedings. Amer. Soc. of Civil Engineers, Boise, Idaho. 809-826.

Dregne, H.E. 1978. Desertification: Man's abuse of the land. J. of Soil and Water Conserv. 33:11-14.

Morton, H.L. 1973. Weed and Brush Control for Range Improvement. Range Research and Range Problems. USDA-ARS. Washington, DC. 178 p.

U.S. Forest Service. 1980. An Assessment of the Forest and Rangeland Situation in the United States. Jan. 631 p.