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Research Priorities for Improvement of Rangelands

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Abstract : Pasture lands are major landuse systems in arid and semi-arid regions. These rangelands are being over-exploited due to increased livestock pressure leading to rapid depletion of natural vegetation. Immediate measures are, therefore, required for developing adequate location-specific management strategies for their rehabilitation and improvement in order to have sustained production. Some areas of research that need priority attention are focused.

Key words : Rangeland, range management, forage, livestock, pasture.

The rangelands are the uncultivated natural forest lands and grasslands which provide browsing and grazing grounds to the livestock and wild animals. Their management involves three important components; the soil, the vegetation and the animal component. A simultaneous improvement in all these components is necessary for optimization and sustained production of forage, fuelwood, fiber, meat, milk, etc. A multidisciplinary integrated approach is called for to achieve the desired goals.

An appropriate range management would help not only to enhance production, productivity and economic returns, but also to maintain the energy cycle in nature and desirable eco-balance. A large amount of solar energy is trapped by green vegetation on these rangelands and converted to cellulose. Grazing ruminants consume and convert this cellulose into animal food reserves which are further used by man as meat and meat products. The ruminants also provide to man a variety of other useful products like milk, animal protein, fiber (wool), leather and skin as well as draught power which helps in agricultural operations and transport. According to FAO estimates, 79% of the cattle, 86% of sheep, 95% of goats and nearly all the bufalloes of the world are found in the developing countries (FAO, 1995). This reflects their tremendous potential for export of animal products to the advanced, industrialized nations. Proper management of rangelands would also go a long way in checking the process of desertification of large stretches of land, which is too dry to be cultivated in arid and semi-arid regions of the world. Some important issues that require immediate attention and need intensive research are outlined below.

Management of Rangelands

Range ecology

An appreciation of the ecological status and ecosystem of rangelands is essential for their amelioration. The past and present opinions show that the relatively more stable rangelands in India constitute biotic climax or disclimax rather than scientifically managed sub-climax under varying combination of fire and grazing treatments. An open system comprising vegetation, plant and animal communities, soil, topography, water, temperature, atmospheric gases, organic residues, minerals, solar energy, flow of energy, circulation of matter, etc., together constitutes an ecosystem, which needs to be carefully monitored.

Possibilities of using remote sensing data for range resource evaluation and its proper utilization should be carefully scrutinized. The spectral signature of the vegetation must be standardized on eco-shed basis in different ecosystems of the country. This would provide the required thrust for systematic planning and also for monitoring the induced progression.

In order to achieve the management equilibrium in rangelands, researchers must account for the socio-economic status of native human communities who would influence and manipulate forces at work in the ecosystem for increased productivity and biological efficiency. Low cost technology for forage and pasture development would be more acceptable to the resource poor farmers of developing nations. Emphasis should be given on developing suitable models for nutrient cycling under grassed pastures in order to further work out farm management schedules and fertilizer advice (Haynes and Williams, 1993). Factors which affect competition of pasture species with weeds during the establishment phase, such as seedling vigor, aggressiveness and invasive capacity, should be explored. Studies on changes in species composition with regard to their palatability, population biology including seed availability and longevity in the soil, could be rewarding. Adaptation of exotic species, their competitiveness, relative aggressiveness, persistence and compatibility with native vegetation need intensive research.

Stocking rate

Stocking rate refers to the animals per hectare and the grazing pressure to available pasture land per head. Increased stocking rate increases the grazing pressure, resulting in decline of herbage availability. Optimum stocking rate, to match total forage resources including harvested roughage and concentrates (Jacoby, 1989), is always difficult to determine in arid and semi-arid lands due to extreme variation in primary productivity, resulting from erratic precipitation. This optimum rate may vary from year to year depending on precipitation. Stocking far in excess of the available feed is extremely destructive for a rangeland. Apart from optimum stocking rate on these rangelands, virtues of mixed herd of different animals like camels, cattle, sheep, goats also need to be explored due to their differential preferences and grazing habits.

In arid regions, droughts are quite frequent and, therefore, in such areas/period adjustment of herd size is important. Satellite imagery could be helpful in identifying those areas which have deficit or excess forage. Unpredictability of duration and severity of drought pose serious problems. Concerted efforts are needed to have well planned programs to meet such challenges. The stocking rate should be conservative during years of low rainfall, in order to prevent overgrazing. Another strategy could be to move herd from regions of scarcity to regions of plenty.

Use of fertilizers

Large scale application of fertilizers for herbage production from the rangelands may not be a good proposition, particularly in the arid zone, due to low benefit:cost ratio, retarded water-uptake, etc. However, application of low maintenance dose could be fetching under an intensive range management or a sustainable forage production program. Research efforts should aim at working out maintenance fertilizer doses, period and periodicity of application, minimum threshold rainfall below which fertilizer should not be applied in a particular ecosystem, nutrient cycling (N, P and S) in permanent grasslands, pathways of nitrogen losses and factors influencing these losses such as extent of volatilization and leaching to help improve nitrogen use efficiency. High nitrate accumulating plants in low rainfall areas should be identified.

The pasture management strategy should be evolved so as to optimize productivity of sward, enhance soil microbial activity, maintain nutrient cycling that does not involve large inputs, sustained pasture production under different management conditions like stocking rates, grazing pattern, etc. New/improved genotypes should be tested under location-specific environments and farming systems by using local farmers' management practices.

Biological nitrogen fixation

Legumes play a key role in soil enrichment in the absence of manuring. Their importance is two fold: they build up a high nitrogen content in the soil and they provide nutritious forage for livestock (Paroda *et al.*, 1980). Little and fragmentary information is available on the extent

of nitrogen fixed in association between bacteria and grass roots. Biological nitrogen fixation of range grasses and legumes warrant extensive studies on priority so as to meet the nitrogen requirement for augmenting productivity in relation to stress environment and cultivation of legumes, in nitrogen-hungry tropical rangelands as well as in established pastures. Studies may also be intensified on mycorrhizal associations to improve the phosphorus uptake, especially in regions where soils are inherently poor in fertility. Influence of legume trees on availability of nitrogen and other nutrients for uptake by ground vegetation should be systematically investigated (Blair *et al.*, 1990).

Integrated pest management

The development of integrated pest management schedules for rangelands should find priority. There is a need for evolving long term strategies and work plans, including cultural practices, like use of tolerant and resistant plants, biological control of pests, use of predators for pest control, etc. Studies should also be carried out on communities of invertebrate fauna and friendly microbial biomass associated with natural, unimproved pastures.

Water management

Water management in rangelands could be reviewed and researched upon from two angles: (i) diversion of occasional rain water in the years of good rainfall, from natural courses to adjacent slopes in the watershed through appropriate spreaders like small dams, gully heads, etc., and (ii) harnessing of excess rainwater in farm ponds, seepage ponds, percolation ponds or storage tanks. Such on-site water management approaches would ensure checking soil erosion besides resulting higher production of forage. On the other side, stored rain water in ponds or tanks shall also render such ranges accessible to grazing animals.

Silvipasture

In the arid areas of Rajasthan, Haryana and Gujarat fodder-cum-fuel trees like khejri (*Prosopis cineraria*), babool (*Acacia nilotica*), ardu (*Ailanthus* spp.) etc. are a common sight in the farmers' fields. Productivity of such native fodder tree species, or other suitable exotics, needs to be studied in relation to grass production in silvi-pastoral systems. There is also a need to introduce suitable fodder trees in the rangelands to provide top-feed and shade to the grazing animals and also to improve the physical conditions and fertility of the soil. Research on these aspects merits priority so as to accumulate substantial database for initiating various action plans for development.

Evaluation, Fodder Conservation and Utilization Management

Forage production

An optimum rather than maximum productivity coupled with sustainability in production as well as management equilibrium would be ideally required. The introduced species/ecotypes must be evaluated for climatic and nutritional requirements, their feeding value and various aspects related to their use in persistent productive pastures. Evaluation of potential browse species in relation to increased aridity is ideally called for. Systematic evaluation is required for grass yield under grazing, seasonal yields, winter kill of swards and sward deterioration. Effect of tree component on nutrient and water uptake by ground flora, feeding behaviour of different species or different breeds within same species must be studied in relation to different ecotypes, rangelands and improved pastures in order to substantiate various components of energy cycle.

Fodder conservation

Fodder conservation measures must be carefully adapted to enhance the productivity of animals in rangelands, especially in extreme winter months. Specific role of hay and silage making, fortification of nitrogen through incorporation of legumes or urea, need in-depth studies, particularly in relation to livestock need. Establishment of fodder banks using artificial dehydration practices, coupled with production of wafers or pellets, could result in continuous

availability of nutritious fodder to cattle. Such pilot projects must be designed and implemented to generate requisite data for large scale recommendations.

Suitable harvesting devices are required to accelerate the process of grass harvesting for conservation at a right maturity stage, particularly during the year of abundance. There are considerable opportunities for reducing dry matter losses in conserved forage, which needs to be further investigated. Fodder conservation practices should be accelerated/improved so as to minimize the storage losses and for use of fodder in confined feeding of livestock. Renewed efforts are called for to enhance forage digestibility, persistence and quality retention.

Animal nutrition

There is a need to develop low-cost chemical (alkali) treatments to improve the digestibility of low quality, high lignin roughage. Likewise, possibility of using non-protein nitrogen in supplying ruminants with their nitrogen requirements could be explored. Extensive research data should be generated on animal nutrition, quantum of forage intake and its digestibility. More knowledge is required to be gained on the role of plant constituents affecting intake and digestibility of forage, availability of nutrients to the animal, protein nutrition, mineral nutrition, range vegetation high in micronutrients content, etc. Simpler, rapid and efficient laboratory techniques should be developed for predicting intake, energy value and protein value of forage. Research efforts must include studies on relationship of pasture consumption with sward characteristics and live body gain/weight change.

Genetic Improvement and Germplasm Conservation

Little genetic improvement work has been carried out on range species because (i) much needed priority was given to the cultivated forage crop species, (ii) characteristics and objectives required for breeding of grass and legume species suited to swards have not been clearly defined, and (iii) the extent of demand for improved types is uncertain. There is need to explore natural variability. In addition, breeding work for resistance to drought, pests and diseases should be streamlined; breeding for prolific seed producing types and seed quality should be included; mutation breeding may be taken up in species like *Lasiurus sindicus* (Sewan grass) which grows deep in the Thar desert, in order to improve seed production and persistence. Similarly, improvement of buffel grass (*Cenchrus ciliaris*) should take into consideration objectives such as better stock intake, late flowering, improved seedling vigor, wider nutritional adaptation and better cool season growth.

The genetic resources of range species should be conserved without fail, due to fear of loss of species on rangeland deterioration over persistent grazing or other pressing land use demands. Research may be carried out on convenient low-cost methods for genetic conservation of range species which could vary at length, in approaches, from conservation of cultivated crop species.

Seed Production and Technology

Limited research efforts have been done on seed production and technology of range species. Increased productivity and seeds of improved quality may together go a long way in development of sown pastures. Seed pelleting coupled with controlled release of fertilizer, balanced and superior seed material, etc., may help in production of vigorous seedlings and, thereby, eventually in establishment of better stands. Concerted efforts in this direction may be rewarding. In fact, seedling establishment period is always considered to be critical and, therefore, should be intensively studied. Seedlings possessing a rapid root growth system stand a better chance of successful establishment due to (i) proper utilization of moisture, and (ii) uptake of nutrients from greater soil volume. More information on seedling morphology and physiology responsible for greater tolerance to stress including soil moisture deficit and early defoliation, is needed. Suitable techniques of aerial reseeding of grasses and legumes may go a long way in pasture establishment. Well planned studies need to be undertaken to

find out the factors responsible for poor seed production in different range species and to devise suitable technologies for enhanced seed production, better processing and storage.

Basic Studies

Basic studies on plant physiology, genetics and pathology have to be undertaken to better understand the basis of adaptation of range vegetation to biotic and abiotic stresses. The gaps in available information on processes involved with the productivity, longevity, nutrient and water use efficiency have to be narrowed down for improved management of rangelands. Studies on dynamics of below-ground biomass, under biotic and abiotic stresses, need emphasis so as to fully exploit total biomass production in rangelands. Root growth behaviour under different grazing stresses should be studied.

Research on forage management, improvement and utilization warrants well organized efforts cutting across disciplines like genetics, breeding, physiology, agronomy, pathology, entomology, biochemistry and engineering. Our knowledge on forage-animal system is inadequate because such experiments are complex and expensive to conduct. It is imperative to plan long term research projects because of the complex nature of rangeland management, changing social and ecological characteristics of rangeland and changing priorities over time. Researchers and administrators should not try to formulate final recommendations midway through the long term studies. In order to improve the rangelands in totality, there is a need to conduct separate mission oriented experiments on soils, plants and livestock. Findings from these experiments should be integrated and systems analysis approach adopted. There is a need to use holistic approaches during project planning, implementation and evaluation so that not only interdisciplinary research team work is encouraged, but their findings become integral part of the program. Both applied and fundamental researches have to be integrated into economically viable management packages.

An effective and viable management of rangelands could be achieved through community approach which may require social and political will. Considering immediate and long term benefits of these programs, involvement of village panchayats under the guidance of government agencies/departments would accelerate the process of adoption of technology and rangeland management.

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