

Sustainable approaches for rangeland management and livestock production in arid and semi arid regions of tropical countries.
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Abstract

Sustainable grazing management or land resource use is a key issue of concern in most arid and semi arid regions of the world. This challenge is particularly formidable in arid rangeland environment, because of inherent seasonal constraints, higher livestock densities and change in socio-economic conditions of pastoral communities.

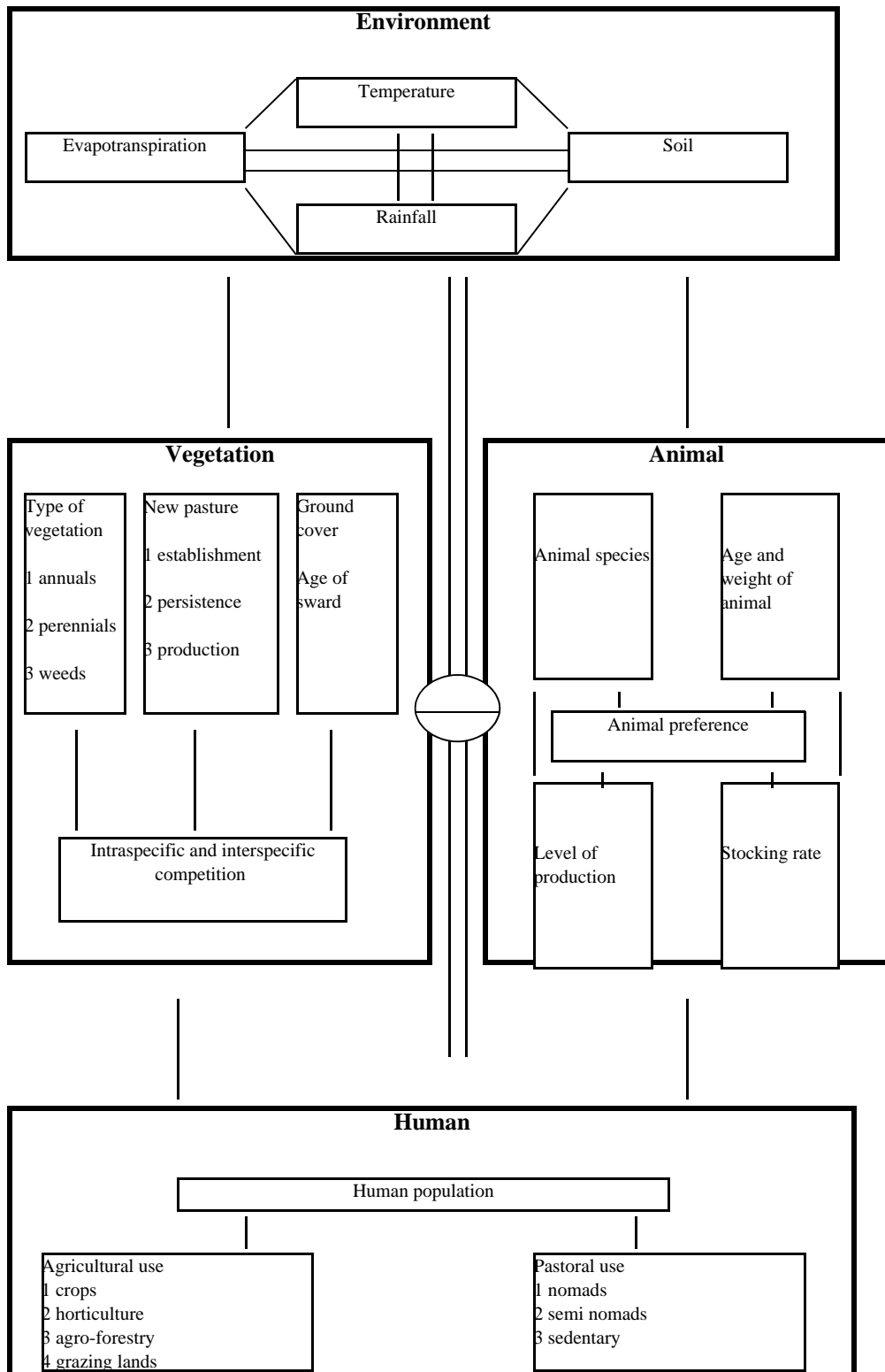
The objectives of rangeland based livestock production vary with the pastoral system employed, such as nomadic, semi nomadic and sedentary systems. Ideally, stocking rates to achieve maximum profitability should also be sustainable. Rainfall fluctuations from year to year in the arid and semi-arid rangelands, make it difficult to devise perfect stocking strategies and grazing management to cope with the variability. The light stocking rates required to match average rainfall can reduce the risk of forage deficit and financial losses due to death of animals in low and average rainfall years. Nevertheless, a major challenge lies ahead to convince pastoral people about the benefits of reducing stocking rates and improving production efficiencies, in order to achieve higher livestock production, an improvement in income and less degradation of the rangeland.

1 Introduction

Sustainable grazing management or land resource use is a key issue of concern in most arid and semi arid regions of the world. However, many complexities are involved in assessing the sustainable use of these drought prone rangelands. For example, at government level, decision makers face a problem of inadequate and inappropriate data or in some cases data is unobtainable, which is largely a function of the complexity and uncertainty regarding the interactions of the different components of natural rangeland ecosystems. To progress towards the achievement of sustainable rangeland management systems, requires an adaptive and integrated approach to decision making process. This challenge is particularly formidable in arid rangeland environment, because of the following inherent seasonal constraints (Figure 1).

- a) the first constraint is that primary productivity is generally low, because the rangeland environment seldom provides an optimum plant growth environment. In this case the most common constraints are limited water and nutrient supplies, excessive temperature and unfavourable topography. As a result, rangeland herbage densities are low and thereby capable of supporting only low animal densities.
- b) the second constraint is herbage quality and quantity, varying over time and space levels due to climatic conditions. For example, seasonal and annual droughts are common in most arid and semi arid rangelands. These uncertainties impose major challenges to utilise opportunities in a sustainable way.
- c) the third constraint focuses on the process of selective grazing. During the grazing period, livestock select between the plant species, which imposes stress on the selected species and if this stress is continuous for an indefinite time then it may eliminate the selected plant species from the sward.

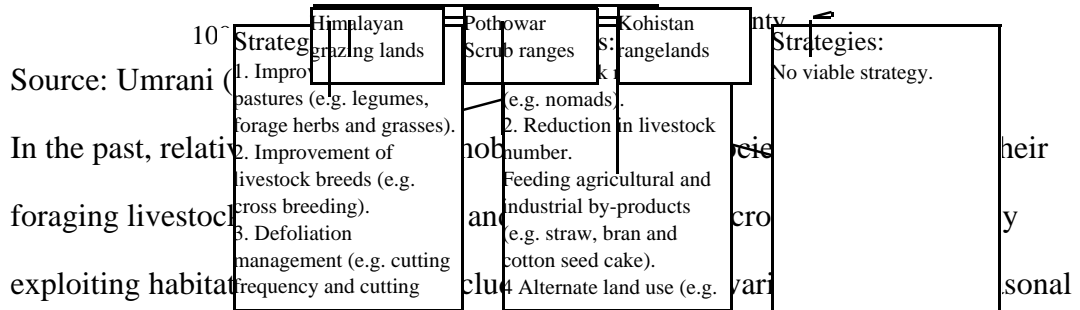
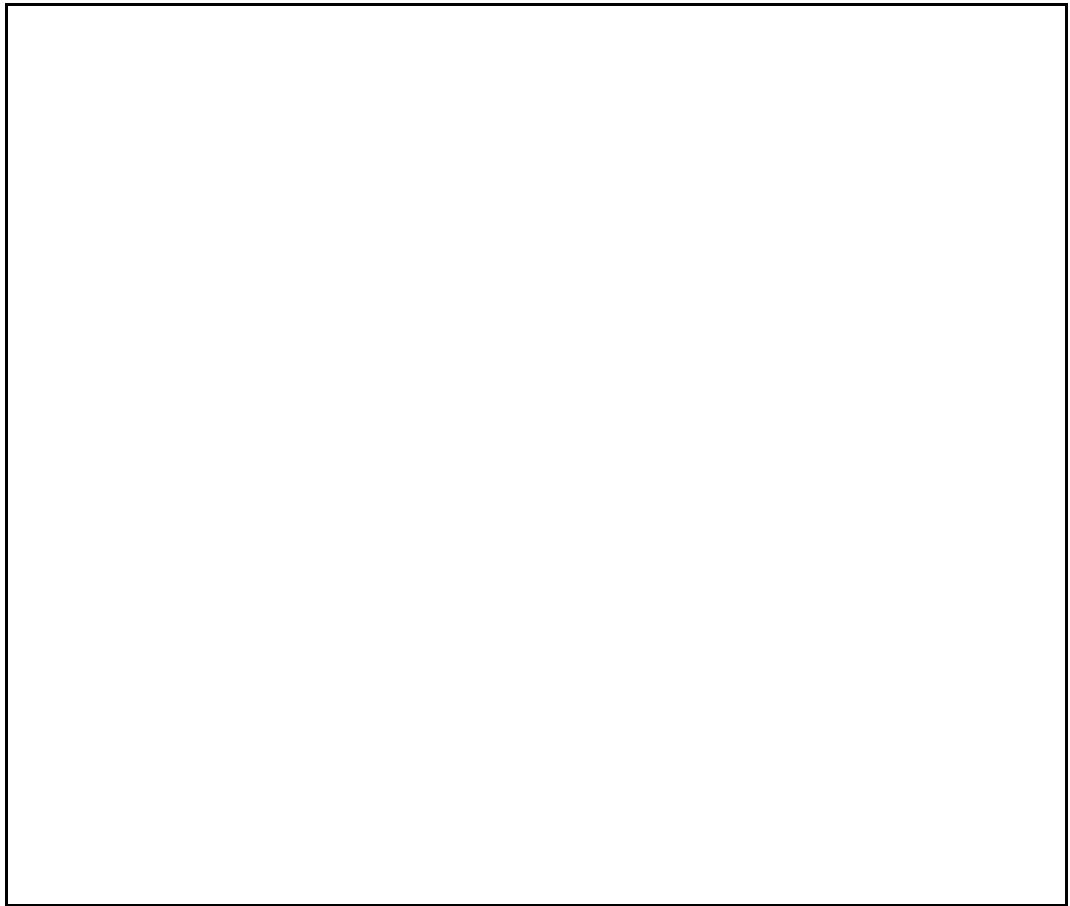
Figure 1 Factors affecting a rangeland ecosystem.



2 Challenges to sustainability

Sustainability of arid and semi-arid lands require constant adaptation to change, not only utilising the opportunities, but also using resources at a sustainable rate, so that they remain available year after year. Although grazing has a heavy disturbing effect on herbage species of arid rangelands, compared to fire, cultivation, deforestation, mining and urban development, it has far less devastating effects on the vegetation and habitats (Behnke and Scoones, 1993; Bayer, 1995). However, in some places livestock grazing has reached a point where the sustainability of the rangeland is at risk due to disruption of traditional systems (Aleem, 1980; Mohammad, 1989; Umrani et al., 1995; Umrani et al., 1996).

Figure 2 Level of climatic uncertainty and change in strategies for sustainable rangeland utilisation of Pakistan.



migrations. These movements of livestock were recognised as biological and socio-economic ‘servo-mechanisms’ (Behnke and Scoones, 1993; Scoones, 1996). However, concern for the sustainability of arid rangelands derives from the fear that these historical servo-mechanisms which were absorbing environmental fluctuations, are no longer functioning adequately, thus there is a need for other strategies (Figure 2).

Many arid and semi-arid rangelands have a large livestock population. There is now general recognition of many aspects of ecological and economic rationale in the

traditional land use of grazing lands, for example, movement of livestock, manipulation of herd structure and livestock species composition. These are all part of a coherent and adaptive response by pastoral people of arid rangelands towards a fluctuating and moisture-deficient environment. However, various social, political and economical processes have disturbed such adaptive strategies. In most countries, productive grazing lands are converted into crop lands and allocated to non-pastoral communities. Many migratory routes of livestock have been challenged by agricultural communities and other government departments (Mohammad, 1989). Such actions and policies have contributed to the demise of traditional sustainable land use systems, which evolved over centuries to fit within the constraints of the environment. Therefore there is a great need to review existing pastoral systems in arid and semi-arid rangelands. On the one hand, pastoralists and ranchers living in arid regions have had to cope with wide fluctuations in forage availability, and on the other hand they have had to face changes in social and political structure around them.

3 Effect of stocking rate on sustainability

The objectives of rangeland based livestock production vary with the pastoral system employed, such as nomadic, semi nomadic and sedentary systems. In these systems the objectives are usually not to maximise profits per animal, but to keep more animals to exploit time and space variation in availability of herbage. In these systems, grazing management other than through the control of stock numbers and animal species combination, is difficult to implement.

Ideally, stocking rates to achieve maximum profitability should also be sustainable.

Where profit maximisation is not the objective and instead a greater number of animals is the objective, it will be more difficult to achieve sustainability, because more than twice as many animals can be kept at maintenance level, than the number of animals

required to achieve maximum profitability. At this high stocking rate, feed availability is markedly lower than at stocking rates required for higher livestock production. Thus it is surprising that system dynamics in arid and semi-arid ecosystems are said to be affected only by climatic factors such as rainfall, rather than by animal numbers (Behnke and Scoones, 1993; Bayer, 1995; Scoones, 1996). The options of moving livestock to new areas to relieve grazing stress during dry periods are restricted and this trend is going to continue in arid regions of developing countries due to their increasing human population. Therefore stocking rate is going to become the determining factor for the sustainability of rangelands.

Rainfall fluctuations from year to year in the arid and semi-arid rangelands, make it difficult to devise perfect stocking strategies and grazing management to cope with the variability. The light stocking rates required to match average rainfall can reduce the risk of forage deficit and financial losses due to death of animals in low and average rainfall years. However, profit potential could be lost in years with higher rainfall, although conserving the forage, or fattening of bought-in young animals may overcome this shortfall. On the other hand, the current high stocking rate strategy is posing a risk of high financial losses in poor and average rainfall years, due to low productivity of livestock and degradation of rangelands, although it provides a higher return in high rainfall years.

4 Balancing herbage growth with defoliation

A fuller understanding of the effect of plant competition on plant size and plant number per unit area, also the effect of defoliation on vigour, competitive ability, longevity and production of individual plant species, may help to develop sustainable grazing strategies to maintain productive and restore degraded rangelands. There are differences in the seasonal growth patterns of grass, legumes and shrub species. This knowledge can be used for grasslands of northern areas of Pakistan, to encourage the

growth of one species at the expense of other. For example, in arid rangelands the seasonal growth pattern of annual, perennial species and shrubs is different, and there are also differences between desirable and undesirable species (Archibold, 1995). Therefore increasing grazing pressure on actively growing undesirable species will give a chance for desirable species to grow better.

However, there is a problem in putting this improved understanding to practical use, particularly in arid rangelands. There are difficulties in relating pot trials and small scale field trials to the landscape level of rangelands, where there are many more factors operating simultaneously. There is also a difficulty in identifying the degradation process of rangelands, until it crosses the threshold, for example, from perennial rangeland to annual rangeland or from annual rangeland to bare-land. However, modelling will have an increasing role to play in rangeland science, to indicate the availability of herbage resources, and provide an opportunity to match livestock numbers to herbage availability.

5 Policy alternatives

On arid grasslands, technical interventions such as reseeded and fertiliser applications are constrained by risk of failure and expense, with limited potential financial returns. However, government policy can influence all stake holders in arid rangelands either directly through taxation on higher stocking rates, by providing improved veterinary services and insurance services for pastoralists who keep sustainable stocking rates, or indirectly by improvement in road services, marketing facilities and extension facilities.

Forage non-availability can be alleviated by supplementation with external feed inputs or extending the growing season by including legumes, forage herbs, shrubs and trees,

provided it does not allow pastoral people to increase their stocking rate beyond the existing sustainable capacity of rangelands. Many rangelands, which are not very far from large cities have potential to become large animal production centres, to fulfil some of the need for animal products of those cities. For example, improved transport, convenient markets and provision of feed supplies, such as agricultural and industrial by-products (wheat straw, wheat bran and cotton seed cake) can encourage pastoral people to increase production from individual animals rather than keeping large numbers of unproductive animals.

In developing countries policies are generally based on political considerations and economical benefits, so strengthening the political representation of local pastoral communities will also transfer the benefits of development projects to local pastoral people.

6 Conclusions

In conclusion, the main factor influencing sustainable rangeland management is the number of plants per unit area, their longevity, palatability and resistance to grazing, and stocking rate of livestock. In many arid and semi-arid rangelands of the tropics with large variations in rainfall from year to year, the stocking rates of livestock cannot be constant. However, a conservative stocking rate can reduce the risks of degradation of rangelands and give better production per animal compared to higher stocking rates. Nevertheless, a major challenge lies ahead to convince pastoral people about the benefits of reducing stocking rates and improving production efficiencies, in order to achieve higher livestock production, an improvement in income and less degradation of the rangeland.

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