

MANAGEMENT OF RANGE RESOURCES IN THE INDIAN ARID ZONE WITH REFERENCE TO RODENT CONTROL

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The rangelands of Indian arid zone support a few highly palatable and nutritive perennial grasses which along with annuals constitute a rich native pasture. Recent adoption of range management practices claim improvement of pastures but the fact remains that the pastures are able to support the livestock only for five months in a year. For rest of the period the animals migrate out of arid region for grazing. One of the main reasons of deterioration of pastures is the damage done by a large number of rodents which inhabit the Indian arid zone. The range resources of the Indian arid zone are discussed with respect to three ecosystems: Rocky, sandy and saline ecosystems. Rodents damaging the grasses and other shrub and tree species, which provide top feed for the livestock, are also described under each ecosystem. The rodents inflict losses by their debarking activity, due to their tunnelling propensity and by eating and cutting the grasses. The rodents prefer to feed upon the grass species like *Cenchrus ciliaris*, *Panicum antidotale* and *Lasiurus indicus*, which are the most nutritive fodder species for livestock as well. The rodents, particularly *Tatera indica indica*, *Meriones hurrianae*, and *Gerbillus gleadowi*, when they occur above 400 per hectare level of population, can consume the entire grass produce in the arid land, leaving nothing for the livestock to thrive upon. It is, therefore, desirable that rodent control should be an essential attribute to the range management.

Two methods of rodent control are described. One is based on baiting the rodents with berries of *Zizyphus nummularia* (vern. *Bordi*) impregnated with compound 1080.

INTRODUCTION

The rangelands of the Indian arid zone support a few highly palatable and nutritive perennial grasses like *Lasiurus indicus*, *Panicum antidotale*, *Dichanthium annulatum*, *Eleusine compressa*, *Cenchrus ciliaris* and *C. setigerus*. These grasses along with the annuals constitute a very rich native pasture. About 60% of the land is either a wasteland or fallowland and supports about 10% of the total livestock population of the country. This landuse pattern forces a reader to think very high about the grasslands of the Indian arid zone, and the return through milk, wool and meat production could be expected to be of a high order. Actually, however, the situation is just the reverse.

Lately, fencing and adoption of other range management practices like soil and water conservation measures, fertilization of the range, seeding and introduction of pro-

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ductive and nutritive grasses and legumes are recorded to substantially increase the productivity of the land but still 50% of the livestock is forced to migrate out of the arid regions after October-November and return only in July when it has rained. The main reason being insufficient fodder and water supply to sustain the livestock on a year-long basis. This is chiefly on account of extreme arid conditions of the climate, over-grazing and pests. Among the pests, by far the most important are the rodents which are distributed in very large numbers in each and every ecosystem of the desert. They inflict severe damage to grasses and to the tree and shrub species, the latter being also important as they provide top-feed to livestock. In the present communication, we have tried to centralise the idea that for growing improved pastures rodent control is an essential attribute.

THE RANGE RESOURCES AND RODENT POPULATION

A reconnaissance of the Indian grasslands (Dabadghao, 1957) has revealed that *Dichanthium-Cenchrus-Elyionurus* type is the dominant grass cover in the region. Satyanarayan and Shankarnarayan (1964) described 5 grassland types from the alluvial plains of the Central Luni Basin while Raheja and Sen (1964) recognised 12 types from Rajasthan. From the Central Luni Basin Satyanarayan and Shankarnarayan (1963) described 10 types while Nanda and Gupta (1968) considered 12 types from Rajasthan. Gupta and Saxena (1972), based on their detailed surveys, grouped various grassland communities into 7 types, viz., *Sehima nervosum* type on the hills and piedmont regions, *Dichanthium* type on older alluvium with sandy clay loam to clay soils, *Cenchrus* type on well drained alluvial sandy to sandy loam soils, *Lasiurus* type on loose sandy soil, *Desmostachya bipinata* type on younger alluvium, *Sporobolus-Dichanthium* type on lowlying heavy saline soils and *Panicum turgidum* type on sand dunes. Kaul and Chakravarty (1968) recognised 13 grassland communities from 24 rangelands in western Rajasthan.

For range management, with respect to rodent control, the range resources can broadly be classified under the following ecosystems:

1. Rocky ecosystem, including all the rugged hilly projections, folds of hillocks, scattered isolated outcrops of rocks and gravel formations.
2. Sandy ecosystem, including vast stretches of loose sandy plains, sand sheets and dunes of various types.
3. Saline ecosystem, including salt lakes, salt basins, depressional saline areas and ranns.

Rocky Ecosystem

The rocky outcrops are usually steep and the slope varies from 40-60 per cent. Except the upper slopes the flanks are thinly covered with talus creeps, and skeletal soil is formed in pockets where accumulation is fairly good for plant establishment. The soils are light brown coarse textured to brown loamy sand. The existing rangelands on such areas are very poor on account of root zone limitations. The development of deep rooted perennials does not take place except in pockets where some soil has been deposited. The grasses mostly consist of annuals like *Aristida*, *Tragus biflorus* along

with a few perennials like *Oropetium thomaeum*, *Digitaria adscendens*, *Enneapogon elegans* and *Cymbopogon jawarancusa*. *Sehima nervosum*, a palatable and nutritive drought evading perennial, is very rare since it is browsed as soon as it comes up after the rains and hence cannot be seen on the ranges subjected to heavy grazing. Under protection this has been recorded to have a basal cover of 11.5% while the average cover may not exceed 2% during the monsoon which is reduced to 0.1-0.2% after the monsoons. *Cymbopogon jawarancusa* is also subjected to heavy grazing though not much palatable, and browsed clumps can be seen. The total basal cover occupied by grasses on over-grazed ranges hardly exceeds 3.4%. Trees and shrubs like *Acacia senegal*, *Commiphora wightii* and *Zizyphus nummularia* are present but provide very little leaf fodder on account of their low density. *Euphorbia caducifolia* occurs at many places and is hardly of any use to the livestock but because of its thorny nature it provides protection to the saplings and grasses growing in or near the clumps.

On rocky ranges where some sand or soil has been deposited, a few clumps of *Lasiurus indicus* or *Dichanthium annulatum* can be observed, but these two species do not cover appreciably the major part of these ranges. The carrying capacity of such ranges is very low, not exceeding 25 sheep per 100 hect. and the average dry forage production ranges from 2.5 to 3.8 quintals per hectare.

The gravelly plains cover extensive areas in the rocky desert and support grasses like *Eleusine compressa*, *Dactyloctenium indicum*, *Eragrostis ciliaris*, *Cymbopogon jawarancusa* and *Aristida* sp. The percentage of basal cover occupied by grasses hardly exceeds 3% of the total area. *Eleusine compressa*, a palatable perennial, throws out stolons on all sides which work as sensors for the soil depth and moisture in the range, bearing roots and holding the ground wherever suitable conditions exist. The density of trees and shrubs is very low consisting mostly of stunted trees of *Prosopis cineraria*, *Capparis decidua*, *Zizyphus nummularia* and *Acacia nilotica* ssp. *indica* which provide top feed to the livestock during the scarcity period. Such areas are largely suitable for goat and sheep grazing and may be protected as woodlots. The dry forage yield from such areas hardly ranges from 6.5-7.0 quintals per hect. (Raheja, 1963).

On account of the hard rocky surface rodents do not find it convenient to inhabit such ranges and are recorded to inhabit only the rock crevices and make burrows in the clumps of *Euphorbia* bushes where some soil has been deposited. The CutchRat, *Rattus cutchicus*, is the main species recorded from this habitat. From 66% of the rodents of various species collected in a reconnaissance rodent survey carried out at 12 quarry points in Rajasthan desert, *M.p. sadhu*, *Funambulus pennanti* and *Mus cervicolor phillipsi* were next in order in the frequency of occurrence. Relatively the damage done to the ranges is less as compared to other habitats.

Sandy Ecosystem

The sandy plains cover vast stretches of loose sand transported by high velocity of wind in the region, sometimes forming hummocks and sand sheets on the alluvial plains. On medium heavy soils with a good moisture holding capacity *Dichanthium annulatum*, a tussocky drought evading perennial, is the main species showing its optimum expression in areas merging with the foothills. In enclosed areas the basal cover

is about 24% while in areas open for grazing a basal cover as low as 3–4% has been recorded. The less nutritive and unpalatable species associated with this type of grass are *Digitaria adscendens*, *Urochloa panicoides*, *Brachiaria ramosa*, *Tetrapogon tenellus*, *Aristida mutabilis* and *funiculata*, *Heteropogon contortus*, *Cymbopogon jawarancusa* and *Eragrostis* sp., but all these species are browsed during the scarcity period. *Cenchrus ciliaris* and *Cenchrus setigerus* are perennial tussocky grasses on well drained alluvial sandy to sandy loam soils. Both these species are drought evading. Under protection these species cover an area of about 20% while under grazing they hardly cover 2–3% of the total area. There is a wide variety of associates ranging from crop weeds to different species of legumes, grasses and forbes in this type of rangelands. On loose sandy soils *Lasiurus indicus* is the principal grass of the range and is characteristic of low rainfall regions. This grass is tussocky perennial and is drought resisting, nutritious and palatable. The basal cover varies from 5–15%. The associates are relatively few (Gupta & Saxena, 1969b), mostly annuals which are drought evading. *Lasiurus indicus* is extensively grazed by cattle and sheep without any systematic management practices. However, the gerbils are its chief foes. A seeded pasture of this grass was completely ravaged within two months by the gerbils. The main top feed species are *Prosopis cineraria*, *Capparis decidua* and *Zizyphus nummularia*. On account of constant grazing since centuries these rangelands have lost their power of regeneration and the grasses have become rough. During drought, sheep and goats uproot the clumps while browsing, thus accelerating the process of aeolian erosion and making it convenient for the rodents to burrow. The amount of available forage from such regions hardly exceeds 10–12.5 quintals per hact. and it has been estimated that such ranges have a carrying capacity of 3 hact. per adult animal on year long basis. Sometimes these rangelands are associated with a chenopodiaceous shrub, *Haloxylon salicornicum*, which is palatable only while in flower and seeding stage. This is advantageous to ranges as by the time it flowers, the grasses have dried up completely and thus *Haloxylon* provides green feed at a time when other grasses are not available for grazing. Parts of areas occupied by these rangelands are sometimes cultivated and the rest remain fallow and are extensively grazed by the livestock.

Sand dunes cover extensive areas of arid Rajasthan and the grasses which colonise them are mostly *Panicum turgidum*, *Eragrostis ciliaris*, *E. tenella*, *E. tremula*, *Perotis hordeiformis*, *Cenchrus biflorus* and *Aristida* spp., *Panicum turgidum* is the most common perennial tussocky grass which is not much liked by cattle since it soon becomes rough. This grass is often browsed by camels, goats and sheep. *Lasiurus indicus* does not cover appreciably the sand dunes, and the maximum basal cover recorded to have been occupied by this grass is in the inter-dunal area to the extent of about 25%. However, *Panicum antidotale*, a large tussocky perennial is an exotic and is naturalised on some dunes. The basal cover occupied by this grass in a community of *Lasiurus indicus*-*Panicum antidotale* is about 9% where it occupies chiefly the field bundings. The only shrub which colonises the dunes is *Calligonum polygonoides* and is associated with plants like *Crotalaria burhia*, *Tephrosia purpurea*, *Aerua pseudo-tomentosa*, *Indigofera cordifolia*, *I. argentea*, *Arnebia hispidissima*, *Tribulus alatus* and *Tribulus terrestris*. Though *Crotalaria burhia* is browsed in the tender stage it is only in the extreme conditions of drought that this plant is taken and the same may be said for other unpalatable

species like *Tephrosia purpurea*, *Prosopis juliflora* etc. Annuals like *Aristida* and *Cenchrus biflorus* are browsed only during the monsoon, depending upon the shedding of their spiny burs and fruits. These rangelands provide poor quality of forage for the livestock and the average yield of dry forage ranges from 2.5—5 quintals per hect.(Raheja, 1963).

As far as the rodent population is concerned, gerbils form the major group of rodents in the sandy habitat of Rajasthan desert (Table I). The Indian desert gerbil, *Meriones hurrianae* Jerdon, the Indian gerbil, *Tatera indica indica* Hardwicke, the hairy footed gerbil, *Gerbillus gleadowi* Murray, and the soft furred field rat, *Rattus meltada pallidior*, are the dominant rodents in this habitat. However, the northern Palm squirrel, *Funambulus pennanti* Wroughton, Wagner's gerbil, *Gerbillus dasyurus* Thomas, *Rattus gleadowi*, *Mus platythrix sadhu* and the Bush rat *Golunda ellioti* are also found in the sandy plains of the Rajasthan desert. The density of the rodent population in this habitat varies widely depending upon the texture of the soil; loose sandy soils and heavy soils do not support heavy population of rodents while medium heavy soils which are easy to burrow and do not have the danger of sandlip form the ideal habitat for the rodents.

TABLE I

Association between grassland types and dominant rodent species in the Indian Arid Zone.

Ecosystem	Grassland type	Dominant rodent species
I. Rocky		
(a) Hilly outcrops	<i>Sehima nervosum</i> type <i>Aristida</i> type	<i>Rattus cutchicus</i> <i>Mus cervicolor phillipsi</i>
(b) Gravelly	<i>Eleusine compressa</i> type	<i>Rattus meltada pallidior</i> <i>Rattus gleadowi</i> , <i>Mus platythrix sadhu</i>
II. Sandy		
(a) Well drained sandy to sandy loam soils	<i>Cenchrus</i> and <i>Lasiurus</i> type	<i>Gerbillus gleadowi</i> , <i>G. dasyurus indius</i>
(b) Loose sandy soils		<i>Tatera indica indica</i> , <i>Meriones hurrianae</i>
(c) Sandy loam with good moisture holding capacity	<i>Dichanthium</i> type	<i>Tatera indica indica</i> , <i>Rattus meltada pallidior</i> and <i>Golunda ellioti</i> (Mostly on irrigated areas)
(d) Sand dunes	<i>Panicum turgidum</i>	<i>Gerbillus gleadowi</i>
III. Saline		
Depressional saline soils	<i>Sporobolus</i> , <i>Dichanthium</i> type	<i>Meriones hurrianae</i> , <i>Tatera indica indica</i>

Saline Ecosystem

Low-lying saline areas are scattered in the arid regions and serve as drainage basins for underground waters due to hydrostatic pressure of recharge from the surrounding hills. Sanwarla-ka-rann, Pachpadra basin, Khutani and Nilkanth depressional areas in the central Luni Basin are some of the examples of such areas which are unfit for cultivation and serve as primarily the grazing ground for the livestock which migrate

from other areas during the monsoon period. Lowlying areas, locally called *Khadins*, are non-saline and are cultivated for rainfed crops and after the harvest the fields are left open for grazing. A valuable grass on such habitats is *Dichanthium annulatum* which is associated with other species like *Cynodon dactylon*, *Cenchrus setigerus*, etc. The shrub and tree vegetation consists of *Prosopis cineraria* and *Acacia nilotica* ssp. *indica* providing top-feed during the lean periods. Such areas have hardly any infestation of rodents since they are subjected to flooding during monsoon season. Areas where salinity has developed support grasses like *Sporobolus* spp. (*marginatus* and *helvolus*) associated sometimes with a coarse perennial like *Desmostachya bipinnata* and *Cyperus rotundus*. Distinct grass colonies showing a clear succession from bare patches with salt incrustation to areas with *Dichanthium annulatum* and *Cenchrus setigerus* can be seen depending upon the total salts and pH of the soil. Soils having good drainage develop *Cenchrus setigerus* while medium heavy soils with good moisture holding capacity develop towards *Dichanthium annulatum* type of ranges. Lowlying areas with heavy soil contribute to about 17.5–20 quintals of dry forage per hect. while areas with heavy saline soils contribute only 2.5–5 quintals per hectare.

The rodent population on medium heavy soils is relatively low as compared to light soils having *Cenchrus setigerus* as the main grass species. The main species of rodents recorded on such type of range at Jadan were a pure population of *Tatera indica* but at Pachhpadra and Sambhar, only *M. hurrianae* were observed in the saline tracts. Saline soils, it appears, do not adversely affect their population growth as the gerbils are adapted to tolerate extreme salinity conditions. Gerbils from saline environment are, however, paler in colour.

DAMAGE TO RANGE RESOURCES BY RODENTS

Rodents damage the ranges in various ways:

1. *Debarking*: Ranges in the Rajasthan desert are actually an admixture of predominant grasses and shrubs, the latter provide a highly nutritive top feed during lean periods. Rodents debark saplings and young trees of *Prosopis cineraria*, and bushes of *Zizyphus nummularia*. The most affected species are, however, *Prosopis juliflora*, *Acacia tortilis* and *Albizia lebbek* which, though they do not provide highly palatable top-feed, yet conserve the soil moisture which in turn allows a high degree of regeneration and maintenance of grass. The debarking activity is severe during summer season and the stems of bushes and trees as old as seven years are completely cut, resulting in the death of well established tree and shrub flora. The notorious species of rodents which indulge in debarking activity are the Indian desert gerbil, *Meriones hurrianae*, Indian gerbil *Tatera indica indica* and Hairy footed gerbil, *Gerbillus gleadowi*. In the north-eastern sector of the Rajasthan desert, the porcupine, *Hystrix indica indica*, also damages a wide range of shrubs and trees.

2. *Tunnelling*: The desert gerbil lives in extensive burrow systems (Prakash, 1962). Their tunnels pass through root zones of vegetation and they cut them due to which the plants die. Even if the roots are not completely severed, they are exposed to warm air circulating in the tunnels which desiccate the plants. Grasses suffer to a great extent by this activity of rodents.

3. *Eating and cutting*: Most of the rodent species inhabiting the Indian desert are primarily herbivores in their feeding propensity. They feed normally on seeds but during monsoons they thrive more on shoots, leaves and flowers of grasses which are readily available. The seed consumption is, however, maximum during winter when they are abundantly available, soon after the seeding period of most plant species in the desert. During summer, when shoots and leaves are not available as they desiccate, they turn to rhizomes of the grasses (Prakash, 1962). A 40 acre plantation of *Lasiurus indicus* was completely devastated by *Meriones hurrianae*, *Tatera indica* and *Gerbillus gleadowi*.

The rodents prefer to feed on the grass inflorescence and since they cannot ordinarily reach them, they cut the entire plant and feed on inflorescence tops. The cut plant soon get desiccated and is blown away by the strong desert winds. A study on the food preferences of *Meriones hurrianae* during monsoon (Prakash, 1969) has shown that the animal prefers *Cenchrus ciliaris*. The palatability index was of the following order, the subjective rating ranging from 4 to 1 in four vegetation communities.

<i>Cenchrus ciliaris</i>	4.0
<i>Aristida adscensionis</i>	3.7
<i>Eragrostis ciliaris</i>	3.0
<i>Digitaria adscendens</i>	2.7
<i>Brachiaria ramosa</i>	2.6
<i>Tragus biflorus</i>	2.6
<i>Cyperus arenarius</i>	2.3

Other plants which fringed the rodent menu belonged to the families, Caryophyllaceae, Molluginaceae, Cucurbitaceae, Nyctaginaceae and Convolvulaceae. The density of gerbils in the area of study was estimated to be 477 per hectare and it was estimated that their annual food requirements, assuming that their numbers will be maintained at a static level all the year round, will be 1044 kg of grass per hect., when the annual productivity of edible perennials was between 800-1400 kg per hectare. This estimate, however, does not include the damages done through their cutting and tunnelling activities which would be roughly 8 times the actual consumed rate.

In an earlier study (Prakash, 1964) a comparison of palatability preferences of rodents and sheep revealed that the most nutritive grasses which are preferred by sheep are also preferred by rodents. Under these circumstances it is essential that control operation must be taken while planning for improvement of rangelands.

CONTROL OF RODENTS

Zinc phosphide (1.5%), groundnut oil (5-10%) mixed with wheat (*Triticum*) or *bajra* (*Pennisetum typhoides*) flour as the base, kills upto 95% of rodent population, if the poison baits are laid after a three days prebaiting with ordinary flour. This method, however, requires use of a huge quantity of food grains, which should be conserved for human consumption.

Zizyphus nummularia (vern. *Bordi*) grows in large proportions in the Indian desert and its berries are highly palatable to most rodent species inhabiting the desert (Prakash *et al.*, 1967). The air-dried berries are soaked in a solution of compound 1080 (sodium monofluoro acetate) having a dose of 3 mg/kg. After soaking for 24 hours each berry

is impregnated with a lethal dose for rodents of the 80-100 gms body weight group. One lethal berry and four ordinary berries are pushed inside the burrow. The kill percent touches 100% level. This method is the cheapest so far standardised in India and does not involve any use of foodgrains.

While reseeding the rangelands, surface sowing has been recorded to be the best method where the grass seeds are sown about 2 cm in the soil. This has the advantage of utilising the sporadic showers received after sowing the grass seeds but on the contrary has the disadvantage of blowing away of seeds by wind and often carrying away of seeds by rodents and white ants. In order to check this it has been proved that while reseeding the rangelands the grass seeds should be mixed with moist sand and with a little zinc phosphide and or copper sulphate which acts as repellent for ants so that seeds once sown are not carried away by rodents, white ants or strong winds prevalent in the desert.

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