



**An Approach
to Grassland
Management in
Rehabilitated
Areas of Satpura
Tiger Reserve,
Madhya Pradesh**

Abstract

Satpura Tiger Reserve (STR), located in Hoshangabad district of Madhya Pradesh, represents Central Indian highlands and is spread over an area of 2140 km². This reserve is well known for its diverse forest types, rich flora and fauna. In order to maintain a healthy prey-predator population, the park management has taken up several steps for improvement of wildlife habitat. This includes restoration of degraded grasslands so as to increase productivity of palatable and preferred grasses. We selected degraded grasslands within STR and conducted systematic survey of herbaceous species. Grassland development areas were located in the villages viz., Bori, Badkachar, Churna, Dhai, Kakdi, Parsapani, Pattan, Nimghan, Rorighat, and Sakot. Annual grasses and Alien Invasive Plants were targeted for replacement by perennial tussock forming grasses and forbs. Seeds of palatable grasses were collected with the help of trained field staff and propagated within nurseries and later planted in selected areas. This paper deals with the status of grassland habitats and results of participatory approaches on these grasslands.

Keywords: Alien Invasive Species; Grassland habitat; Management of Grasslands; Satpura Tiger Reserve.

Introduction

Satpura hill ranges located in the catchments of Narmada and Tapi rivers in Central India form important geographical feature in the subcontinent which separate north India from the Deccan (Krishan, 2013). These ranges are well known for their ancient geological origin, diverse topography, rich biodiversity and cultural heritage. These ranges support a rich array of vegetation types including Dry Deciduous Forests, Savannah Woodlands, Thorn Scrub, and scattered grasslands. Most of the hill slopes, savannah woodlands and other undulating areas harbor grasslands and other herbaceous vegetation depending upon the past and present land use, substrate and various other factors. Considering the hydrological and conservation significance of these areas the Government of Madhya Pradesh has set aside a series of wildlife protected areas in this region such as Bori Sanctuary, Pachmarhi Biosphere Reserve, Satpura National Park and Pachmarhi Sanctuary, collectively designated as Satpura Tiger Reserve (STR; area ~ 2140 km²). The STR is characterized by presence of Tropical Moist Deciduous forests, of which major floristic elements are sal (*Shorea robusta*), teak (*Tectona grandis*), mahwa (*Madhuca latifolia*), jamun (*Syzygium cuminii*), bel (*Aegle marmelos*), and bamboo species (*Dendrocalamus strictus*, *Bambusa bambos*). The dominant species of fauna found in the area include tiger, leopard, sloth bear, wild dog, jackal, sambar, gaur, barking deer, blue bull, chital, chausingha, ratel, flying squirrel, wild pig, langur, giant squirrel, mouse deer, chinkara, porcupine, and occasionally python.

Grasses and grassland habitats form the backbone of tiger conservation in Satpura Tiger Reserve (STR). With increasing abundance of wild ungulates and over grazing by domestic livestock in the village fringes, there has been a decline in grass cover. Dominant grasses in STR, in terms of cover and abundance, include *Heteropogon contortus*, *Andropogon pumilus*, *Chrysopogon fulvus*, *Themeda quadrivalvis*, *Apluda mutica*, *Dichanthium annulatum*, *D. caricosum*, *Cymbopogon martinii*, *Eragrostis unioloides*, *Setaria intermedia*, *Setaria verticillata*, *Setaria pumila*, and *Sporobolus diander*. Although, most of these species are adapted to grow on relatively nutrient poor soil, rocky substratum and frequently grazed areas, at several places the grasslands are severely degraded as evident from high proportion of annual grasses and unpalatable and Alien Invasive Plants (AIPs). Empirical evidences and interaction with the management authorities revealed that many grasslands were degrading rapidly. An intensive study was under taken in order to enumerate the palatable grasses from STR and identify various species. This paper deals with the practical field inputs added for the development and management of grasslands in the relocated sites of the STR.

G.D. Muratkar¹, R. P. Singh²
and A.K. Misra³

¹Head, Department of Environmental Science, Arts Science & Commerce, College, Chikhaldara, Dist. Amravati, Maharashtra

²Field Director, Satpura Tiger Reserve, Hoshangabad, Madhya Pradesh

³Deputy Director, Satpura Tiger Reserve, Hoshangabad, Madhya Pradesh.

*Email: gmuratkar@gmail.com

Approaches to restoration of grasslands in Satpura Tiger Reserve

The grassland restoration and development works were taken in the village relocation sites. Such sites were dominated by various grasses such as *Dichanthium annulatum* (Plate 11.1), *Heteropogon contortus*, *Eragrostis viscosa*, *Cynodon dactylon*, *Apluda mutica* and few AIPs such as *Xanthium strumarium*, *Parthenium hysterophorus*, *Ageratum conyzoides*, *Commelina paludosa*, *Achyranthes aspera* and *Sida cordifolia*. All the village relocation sites were assessed in terms of species composition, proportion of palatable and unpalatable species, proportion of annual grasses and cover of AIPs. The field staff of STR was oriented towards identification of palatable grasses. All highly palatable perennial grasses were identified and their seeds as well as rhizomes were collected for propagation at rehabilitation sites. Subsequently nurseries were raised for highly palatable species of grasses and other forbs. About 2 ha area was selected and fenced to raise the plantation stock. After 2 years the grass seeds were collected from these nurseries (in December) for further propagation in restoration sites.

In addition to grasses, several native browse species and wild fruit bearing plants were selected for propagation. Simultaneously, removal of Lantana and enrichment of grasses were taken up during monsoon season. Removal of AIPs was taken up 3-4 times in a year which played important role in easy establishment of grasslands. For the restoration of grasslands we selected several weed infested and degraded sites within STR. Such sites included past village grazing lands and abandoned agricultural fields are relocation of the villages, viz., Bori, Dhai, Churna, Kakadi, Sakot, Khakrapura, Pattan, Rorighat, Badkachar, Nimghan, Birjikhapa, Kukra, Nandner, Nankot, Dhargaon, Paraspani (Matkuli), and Parsapani (Bagara Buffer). These grasslands were selected for management inputs because such areas have potential to become prime habitats for grazing ungulates (Plate 11.2).

The wild fruit trees of the natural grasslands which were retained in the grasslands were *Cordia dichotoma*, *Terminalia chebula*, *Terminalia alata*, *Zizyphus mauritiana*, *Zizyphus rugosa*, *Madhuca latifolia*, *Buchanania lanzan*, *Cassia fistula*, *Aegle marmelos*, and *Phyllanthus emblica*. The following species were selected for propagation in the reserve based on their preference by wild ungulates (verified from the experienced field staff): 1) *Dichanthium annulatum*, 2) *Dichanthium caricosum*, 3) *Dichanthium strictum*, 4) *Iselima laxum*, 5) *Iselima prostratum*, 6) *Heteropogon contortus*, 7) *Eleusine indica*, 8) *Chloris barbata*, 9) *Paspalidium flavidum*, and 10) *Cynodon dactylon*.



Plate 11.1: *Dichanthium* seed plot at Pattan

The following leguminous species associated with the grasses were propagated in the grassland development areas: *Atylosia scarabaeoides*, *Rhyncosia minima* var. *minima*, *Rhyncosia minima* var. *laxiflora*, *Vigna trilobata* Syn. *Phaseolus trilobus*. The grasses and wild leguminous plants form the good heterogeneous association of the grasses in the natural grasslands.

Observations

Species composition at village relocation sites: Major communities (identified based on dominant species) at different village relocation sites along with other associated species have been given in **Table 11.1**.

Table 11.1. Grasslands Communities and Associated forage plants at different village relocation sites in STR

| Grassland Type | Location | Association |
|---|-----------------------|--|
| Short grassland : <i>Dichanthium-Iselima</i> | Churna | <i>Dicanthium annulatum</i> , <i>Eragrostis viscosa</i> , <i>Cynodon dactylon</i> |
| | Sakot | <i>Dicanthium annulatum</i> , <i>Eragrostis viscosa</i> , <i>Indigofera linifolia</i> (Leguminous plant) |
| Intermediate : <i>Dichanthium -Themeda</i> | Khakrapura | <i>Dicanthium annulatum</i> , <i>Cynodon barberi</i> , <i>Andropogon pumillus</i> , <i>Iselima prostratum</i> , <i>Chloris virgata</i> |
| | Pattan | <i>Dicanthium caricosum</i> , <i>D. annulatum</i> , <i>Apluda mutica</i> , <i>Imperata cylindrica</i> , <i>Iselima laxum</i> , <i>Chloris virgata</i> , wild legumes. |
| | Parasapani (Buffer) | <i>Heteropogon contortus</i> , <i>Iselima laxum</i> . <i>Paspaladium flavidum</i> , <i>Dicanthium annulatum</i> . |
| Taller : <i>Themeda -Heteropogon</i> | Bori | <i>Themeda quadrivalvis</i> , <i>Dicanthium caricosum</i> , <i>Saccharum spontaneum</i> , <i>Heteropogon contortus</i> , <i>Vetiveria zizanioides</i> , <i>Chloris barbata</i> |
| | Rorighat | <i>Apluda mutica</i> , <i>Themeda quadrivalvis</i> , <i>Heteropogon contortus</i> , <i>Chloris virgata</i> , <i>Dicanthium annulatum</i> , <i>Eragrostis tenella</i> . |
| | Nimghan | <i>Apluda mutica</i> , <i>Themeda quadrivalvis</i> , <i>Heteropogon contortus</i> |
| | Kankadi | <i>Themeda quadrivalvis</i> , <i>Dicanthium annulatum</i> , <i>Saccharum spontaneum</i> , <i>Heteropogon contortus</i> , <i>Eleusine indica</i> , <i>Sorghum halepense</i> |
| | Dhai | <i>Themeda quadrivalvis</i> , <i>Dicanthium caricosum</i> , <i>Saccharum spontaneum</i> , <i>Heteropogon contortus</i> , <i>Vetiveria zizanioides</i> , wild legumes |

Species composition in savannah woodland and other habitats:

Grasses growing on dry region rocky substrata: *Arthraxon lanceolatus* var. *lanceolatus*, *Alloteropsis cimicina*, *Andropogon pumilus*, *Aristida adscensionis*, *A. funiculata*, *A. hystris*, *A. redacta* , *Arundinella tuberculata*, *Cenchrus ciliaris*, *C. fulvus*, *C. polyphyllus*, *Eragrostiella bifaria*, *Heteropogon contortus*, *H. ritchiei*, *Lophopogon tridentatus*, *Melanocenchris jacquemontii*, *Microchloa indica*, *Oropetium roxburghianum*, *O. thomaeum*, *O. villosulum*, *Tripogon jacquemontii* and *T. pungens*

Grasses growing on Ghat Slopes: *Arthraxon lanceolatus* var. *meeboldii*, *A. lanceolatus* var. *raizadae*, *A. lanceolatus* var. *villosus*, *Arundinella pumila*, *Dichanthium armatum*, *D. maccannii*, *D. parviflorum*, *Heteropogon triticeus*, *Ischaemum dalzellii*, *I. semisagittatum*, *Spodiopogon rhizophorus* and *Themeda quadrivalvis*

Grasses of steep slopes and hanging rocks: *Arthraxon jubatus*, *Ischaemum nervosum*, *I. sulcatum*, *Pennisetum orientale*, *Pseudodicanthium serrafalcoides*, *Tripogon bromoides* and *Melanocenchris jacquemontii*.

Grasses of low elevation lateritic rocks: *Arundinella nervosa*, *A. setosa*, *Chrysopogon fulvus*, *C. polyphyllus*, *Dimeria bicornis*, *Oryza rufipogon* and *Sacciolepis indica* var. *intermedia*.

Grasses of stream beds rocks: *Arundinella nepalensis*, *Coix lacryma-jobi*, *Dichanthium glabrum* and *D. tuberculatum*.

Grasses on the Plateaus : *Themeda*, *Heteropogon*, *Dicanthium*, *Cynodon*, *Apluda*, *Chloris barbata*, *C. virgata*, *C. gyana*, *C. dolichostachya*, *Brachiara mutica*, *Eleusine indica*, *Eleusine glauca*, *Panicum typhoides* and *E. gigantean*.

Fodder value and main features of 10 important fodder grasses: Characteristic features of key fodder grasses along with their nutrient contents are given in **Table 11.2 & 11.3**.

An approach to grassland management in rehabilitated areas of Satpura Tiger Reserve, Madhya Pradesh

Table 11.2. Characteristic features of key fodder grasses in Satpura Tiger Reserve along with their nutrient contents

| Name of grass | Ecological features and nutrient values |
|------------------------------|---|
| <i>Dichanthium annulatum</i> | Perennial, palatable pasture grass |
| <i>Dichanthium caricosum</i> | Propagation by seeds, rhizome, stolons 2) Perennial, palatable short day plant grass 3) Grow in variable soil-Alkaline, Acidic soil. 4) Shows heterogeneous association with other grasses. 5) Easy to establish 6) Good soil binder. 7) A tolerant grass. |
| <i>Iselima laxum</i> | Indicator of good soil moisture. 2) Perennial, palatable grass. 3) Good soil binder 4) Tolerant grass. |
| <i>Sehima nervosum</i> | A taller grass with homogeneous type of grassland. 2) Soil binder grass. 3) Biomass can maintain by cutting the grass thrice in a year. 4) Grow in murmi, red soil. |
| <i>Chloris virgata</i> | Grass of smaller grassland. 2) Grass with large leaf blade, ligules maintain water content in the aerial part. |
| <i>Heteropogon contortus</i> | Tolerable grass 2) Grow in acidic, red murmi soil. 3) A grass with large number of rhizomes 4) Good soil binder in hilly areas. 5) Good % of seed dispersal. 6) Palatable, perennial grass. |
| <i>Cynodon dactylon</i> | Well ecologically adopted grass. 2) Amphiterrestrial grass, develop in submerged condition and terrestrial habitat. 3) High % of water content in ligules and leaf lamina 4) Perennial, palatable, soft grass of smaller grassland. 5) A long day grass. 6) Ethno-botanically and Ethno-veterinary point of view important t grass. |
| <i>Iselima prostratum</i> | Perennial, palatable grass. 2) Due to prostrate habitat a good soil binder grass. 3) Indicator of good soil moisture. |
| <i>Paspaladium flavidium</i> | Perennial, palatable grass 2) Indicator of high altitude, acidic soil. 3) Grass with large leaf lamina, soft. 4) Good soil binder. |
| <i>Digitaria stricta</i> | Grass of intermediate grassland. 2) Annual, palatable grass 3) Good fodder grass 4) Grow in any type of soil. 5) Shade loving grass. |



Plate 11.2: Chital in grasslands of Satpuda Tiger Reserve

Table 11.3. Chemical composition of palatable grasses

| Name of grass | Annual / Perennial | Starch (%) | Proteins (%) | Fiber (%) | Moisture (%) |
|--------------------------------|--------------------|------------|--------------|-----------|--------------|
| <i>Dichanthium annulatum</i> | Perennial | 40 - 51 | 7.5 | 28-30 | 56 |
| <i>Dichanthium caricosum</i> | Perennial | 46 - 50 | 7.5 | 33.2 | 46 |
| <i>Iselima laxum</i> | Perennial | 31 - 40 | 5.5 | 23-28 | 76 |
| <i>Sehima nervosum</i> | Perennial | 55.8 | 7.5 | 32.8 | 36 |
| <i>Chloris virgata</i> | Annual | 48.2 | 7.1 | 29.6 | 67 |
| <i>Heteropogon contortus</i> | Perennial | 46. 51 | 6.5 | 36.8 | 66 |
| <i>Cynodon dactylon</i> | Perennial | 48.7 | 7.8 | 38.6 | 76 |
| <i>Iselima prostratum</i> | Perennial | 42 - 57 | 9.5 | 18-21 | 66.8 |
| <i>Paspaladium flavidium</i> | Annual | 34-38 | 7.2 | 32-36 | 48 |
| <i>Digitaria stricta</i> | Annual | 39-42 | 7.8 | 37-45 | 56 |
| <i>Apluda mutica</i> | Annual | 29-32 | 8.2 | 39-46 | 32 |
| <i>Chrysopogon polyphyllus</i> | Perennial | 57-59 | 8.4 | 37-41 | 38 |
| <i>Themeda quadrivalvis</i> | Annual | 42-8 | 7.1 | 38-41 | 28 |
| <i>Themeda triandra</i> | Annual | 43.2 | 7.9 | 43-45 | 58-60 |

Grasslands palatability and productivity is determined by the chemical composition and biomass of the grasses. The grasses having biomass more than >7 tons per hectare are listed in Table 11.4.

Table 11.4. Grass species with high biomass (>7 t ha⁻¹)

| S.no | Name of grass | Annual / Perennial | Grass biomass (t ha ⁻¹) |
|------|------------------------------|--------------------|--------------------------------------|
| 1 | <i>Dichanthium annulatum</i> | Perennial | 6-7 |
| 2 | <i>Dichanthium caricosum</i> | Perennial | 7-9 |
| 3 | <i>Iselima laxum</i> | Perennial | 5-7 |
| 4 | <i>Sehima nervosum</i> | Perennial | 8-10 |
| 5 | <i>Heteropogon contortus</i> | Perennial | 7-9 |
| 6 | <i>Cynodon dactylon</i> | Perennial | 6-7 |
| 7 | <i>Themeda quadrivalvis</i> | Annual | 9-10 |
| 8 | <i>Bothriochloa pertusa</i> | Perennial | 7-11 |

Recommendations

Since tropical grasslands are mostly seral in nature and liable to be taken over either by woody species or unpalatable invasive plants, persistent efforts are required to maintain a rich mixture of perennial grazing resistant species in the restoration sites (Plate 11.3 - 11.5). Based on the experience gained in Satpura TR, the following recommendations are made for restoration of grassland habitats in Central Indian PAs:

- All gregarious and fast growing annual weeds should be uprooted, dried and burnt before May. Second and third round of weed removal should be done during July and September – October before they flower and fruit.
- All areas where soil has been exposed due to removal of weeds, rhizomes and seeds of perennial grasses and legumes should be sown before the onset of monsoon (second half of May to first week of June).
- A separate nursery should be established in vicinity of grassland development site, preferably closer to Range Office or fringes of the park where seedlings and rhizomes of fruit bearing, tussock forming grasses, and other browse plants such as native bamboos should be collected and reared ahead of planting season.
- For collection of seeds of legumes and preferred fodder grasses, September – October is the best period of flowering and fruiting.



An approach to grassland management in rehabilitated areas of Satpura Tiger Reserve, Madhya Pradesh

- v. For the first 3-4 years all grassland development areas will need tending and biannual cutting of perennial grasses so as to enhance tiller production and establishment of grass seedlings. Fencing of smaller strips till the establishment of grassland patches and shifting of such fences (strips) is recommended till the larger areas are covered under stable grassland patches.



Plate 11.3: Grass biomass management



Plate 11.4: Grassland at Chruna, Satpuda Tiger Reserve



Plate 11.5: Field training to forest staff for grassland management

Acknowledgement

We are thankful to PCCF Wildlife M. P. and APCCF M. P. State to give an opportunity to work in this area for grassland development and management. I am also thankful to Mr. R. P. Singh, CCF and FD STR to permit me to carry out this work in the grasslands of relocated sites.

References

- D'Antonio, C. M. (1993). Mechanisms controlling invasion by the alien succulent *Carpobrotus edulis*. *Ecology* 74: 83–95.
- D'Antonio, C. M., T. L. Dudley, and M. C. Mack. (1999). Disturbance and biological invasions: direct effects and feedbacks. pp 413–452 in L. Walker (eds). *Ecosystems of Disturbed Ground*. Elsevier, Amsterdam.
- Gupta, S.K. (1971). Studies on phytosociology, productivity and energetics of Grassland at Gyanpur, Ph. D. thesis, Agra University, India.
- Mall, S. L. (1972). Ecological study of *Sehima nervosum* Stapf. MS Thesis, Vikram University, Ujjain.
- Raunkiaer, C. (1934). *The life-forms of plants and statistical plant geography*, Oxford University Press.
- Roy, G. P. (1984). *Flora of India Series 4, Grasses of Madhya Pradesh*, Botanical Survey of India.
- Singh N. P., Khanna K.K., Mudgal V. and Dixit R. D. (2001). *Flora of Madhya Pradesh Vol. III*, Botanical Survey of India Arthur, M. A., and Y. Wang. 1999. Soil nutrients and microbial biomass following weed-control treatments in a Christmas tree plantation. *Soil Science Society of America Journal*, 63:629–637.
- Singh, J.S. (1967). Seasonal variation in composition, plant biomass and net community production in the grasslands of Varanasi, Ph. D. thesis, Banaras Hindu University, Varanasi, India.