

Role of Ephemerals in Sustainability of Grazing Lands in Arid Areas



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Abstract

Ephemeral species germinate with onset of rains and complete their lifecycle by setting seeds as the soil moisture declines within one growing season. Though their life cycle is short, they play a multifaceted role in ecological and economic sustenance of arid regions in general and grazing lands in particular. This role of ephemerals emanating from various studies has been synthesized here in respect of Indian arid zone. Nearly half of the reported 682 species in the Indian arid zone are ephemeral and seasonal, the majority being monsoonal. They constitute bulk of alpha diversity on any landscape. These occur on all land uses i.e., croplands and grazing lands. Species composition of ephemerals which varies on different habitats and in varying annual precipitation has been described in this paper.

Changes in species composition, cover and biomass of ephemerals due to grazing have been discussed. Comparing phenology of selected seasonals in different grazing pressures with those in protected areas revealed that increasing grazing stress caused a typical shift in their phenophases. Production potential of ephemerals estimated in a large variety of situations indicated that they contribute differently to the total biomass of the grazing lands representing different range conditions. Since ephemerals being palatable offer grazable material, their role in prolonging duration of range use by the livestock has been proved from case studies. Besides, ephemerals occur as weeds of cropland, their composition and biomass on different habitats have been described to assess their contribution to livestock support. The ecological value of self regenerated ephemerals in rehabilitation of disturbed lands such as mine spoils has been discussed. Many of these ephemerals are also medicinally important with proven economic potential for enhancing the livelihood of desert dwellers.

Keywords: Ephemerals; Sustainability; Grazing; Phenophase; Biomass

Introduction

Arid regions experience a spurt in vegetation emergence during monsoon. While perennials regenerate, the annual species germinate to put up a sprawling green cover bringing profound changes in the desert landscape. These include changes in species compositions, phenology, production and utilization of these ephemerals vis-a-vis perennials. While extensive literature exists on these aspects in respect of perennials, little attention seems to have been paid to the desert ephemerals. Secondly, twelve extreme arid districts in western Rajasthan have 67.2% area under culturable waste which is used as grazing ground [1]. This region provides highest quantum of meat, milk, and wool to the country from an area (36%) of which 2/3 area is largely a degraded wasteland.

Encroachment of these grazing lands is shrinking their area on one hand while quality of the feed is also declining due to overstocking. How constantly shrinking grazing lands in this region, which are also declining in feed quality with less perennial grasses sustain enhancing livestock pressure has been a paradox. Do ephemerals play any role in sustainability of these grazing lands was a question that needed an independent investigation for arriving at unbiased conclusion. An attempt has therefore been made in present paper to collate and synthesize results of studies on various such aspects to prove that ephemerals do play an important role in sustainability of grazing lands in arid areas with special reference to Indian arid zone

The Environment

Region facing annual water deficit of two - third or more of the potential evapotranspiration (PET) is classified as arid [2]. Semi arid regions experience this deficit ranging from one third to two third of PET. Using this criteria 9.56 lakh km² (30.50%) can be classified as semi arid and 3.81 lakh km² (10.16%) area as arid in India. Arid region of India has over 60% area in western Rajasthan and experience extremes of temperature (0 to 4 °C in winter and 45-48 °C in summer), low annual precipitation ranging from 450mm in the east to 10mm in the west, low humidity, high wind velocity and high evapotranspiration. Soils are sandy, poor in nutrient with low water holding capacity and prone to erosion by wind and water. Natural vegetation in such edapho climatic conditions is sparse and stunted, predominantly spiny belonging mainly to grass cover type Dichanthium- Cenchrus-Lasiurus- type and very small area having Sehima- Dichanthium type [3].

Dichanthium - Cenchrus_ Lasiurus Cover Type

This grass cover occurs in the region receiving 100-750mm rainfall with higher mean temperature during summer (42-48 °C) and winter temperature as low as 1 to 2 °C). These grasses occur mainly on alluvial soils with varying amount of loam having high soluble salts and pale gray and brown colours. The geographical extent of 4.36 × 10⁵sq km area is distributed in northern portion of Gujarat, Rajasthan (excluding Aravallis), western Uttar Pradesh, Delhi State and semi arid Punjab and Haryana [4]. This cover type has 11 perennial grasses, 45 other herbaceous species of which 19 are legumes. The predominant woody perennials here include Acacia senegal, Calotropis procera and Cassia auriculata. These areas look typical as savanna lands.

Floristics of Herbage

Table 1: Herbage species and their families in the Indian arid zone (S=season, W=winter, M=monsoon, A=all yr).

Family	Name	S
1. Fumariaceae	1. <i>Fumaria Indica</i>	W
2. Brassicaceae	2. <i>Farsetia hamiltonii</i>	M
	3. <i>Sisymbrium irio</i>	W
3. Capparaceae	4. <i>Cleome gracilis</i>	M
	5. <i>C. gyanandra</i>	M
	6. <i>C. vahliana</i>	A
	7. <i>C. viscosa</i>	M
4. Polygalaceae	8. <i>P. erioptera</i>	M
	9. <i>Polygala irregularis</i>	M
5. Caryophyllaceae	10. <i>Polycarpaea corymbosa</i>	M
	11. <i>Spergula arvensis</i>	W
	12. <i>Stellaria media</i>	W

6. Portulacaceae	13. <i>Portulaca oleracea</i>	M
	14. <i>P. tuberosa</i>	M
	15. <i>P. quadrifida</i>	M
	16. <i>P. meridiana</i>	M
	17. <i>Talinum rotulacifolium</i>	M
7. Malvaceae	18. <i>Hibiscus sp.</i>	M
	19. <i>Malva parviflora</i>	W
	20. <i>Malvastrum coromandelianum</i>	A
8. Tiliaceae	21. <i>Corchorus aestuans</i>	M
	22. <i>C. depressus</i>	A
	23. <i>C. fascicularis</i>	M
	24. <i>C. olitorius</i>	M
	25. <i>C. tridens</i>	M
	26. <i>C. trilocularis</i>	M
	27. <i>Triumfetta pentandra</i>	M
9. Zygophyllaceae	28. <i>Seetzenia lanata</i>	M
	29. <i>Tribulus rajasthanensis</i>	M
	30. <i>T. terrestris</i>	M
	31. <i>T. lanuginosus</i>	A
	32. <i>T. pentendrus</i>	M
	33. <i>Zygophyllum simplex</i>	M
10. Oxalidaceae	34. <i>Oxalis corniculata</i>	W
11. Sapindaceae	35. <i>Cardiospermum halicacabum</i>	M
	36. <i>Alysicorpus glumaceous</i>	M
12. Fabaceae	37. <i>A. heterophyllus</i>	M
	38. <i>A. longifolius</i>	M
	39. <i>A. monilifer</i>	M
	40. <i>A. procumbens</i>	M
	41. <i>A. styracifolius</i>	M
	42. <i>A. vaginalis</i>	M
	43. <i>Atylosia scarabaeoides</i>	M
	44. <i>Clitoria ternatea</i>	M
	45. <i>Crotalaria medicaginea</i>	M
	46. <i>Goniogyna hirta</i>	M
	47. <i>Indigofera astragalina</i>	M
	48. <i>I. cordifolia</i>	M
	49. <i>I. hochstetteri</i>	M
	50. <i>I. linifolia</i>	M
	51. <i>I. linnaei</i>	M
	52. <i>I. sessiliflora</i>	M
	53. <i>Lathyrus aphaca</i>	W
	54. <i>L. sativus</i>	W
	55. <i>Macrotyloma uniflorum</i>	M
	56. <i>Medicago sativa</i>	W
	57. <i>Melilotus alba</i>	W
	58. <i>Melilotus indica</i>	W
	59. <i>Rhynchosia aurea</i>	M
	60. <i>R. minima</i>	M

	61. <i>Sesbania bispinosa</i>	M
	62. <i>Tephrosia leptostachya</i>	M
	63. <i>T. strigosa</i>	M
	64. <i>Trigonella corniculata</i>	W
	65. <i>T. hamosa</i>	W
	66. <i>T. monantha</i>	W
	67. <i>T. occulta</i>	W
	68. <i>Vicia sativa</i>	W
	69. <i>Vigna trilobata</i>	M
	70. <i>Zornia gibbosa</i>	M
13. <i>Caesalpinaceae</i>	71. <i>Cassia occidentalis</i>	M
	72. <i>C. pumila</i>	M
14. <i>Rosaceae</i>	73. <i>Neurada procumbens</i>	M
	74. <i>Potentilla supina</i>	W
15. <i>Lythraceae</i>	75. <i>Ammannia baccifera</i>	M
	76. <i>Ammannia desertorum</i>	M
	77. <i>A. multiflora</i>	M
16. <i>Vahliaceae</i>	78. <i>Bistella digyna</i>	M
17. <i>Onagraceae</i>	79. <i>Ludwigia perennis</i>	M
18. <i>Cucurbitaceae</i>	80. <i>Citrullus fistulosus</i>	M
	81. <i>C. lanatus</i>	M
	82. <i>Ctenolepis cerasiformis</i>	M
	83. <i>Cucumis callosus</i>	M
	84. <i>C. melo var agrestis</i>	M
	85. <i>C. melo var momordica</i>	M
	86. <i>C. prophetarum</i>	M
	87. <i>Dactyliandra welwitschii</i>	M
	88. <i>Luffa acutangula</i>	M
	89. <i>Luffa echinata</i>	M
19. <i>Molluginaceae</i>	90. <i>Mukia maderaspatana</i>	M
	91. <i>Corbichonia decumbans</i>	M
	92. <i>Gisekia pharnacioides</i>	M
	93. <i>Glinus lotoides</i>	M
	94. <i>Mollugo cerviana</i>	M
	95. <i>Mollugo nudicaulis</i>	M
20. <i>Aizoaceae</i>	96. <i>Sesuvium sesuvioides</i>	M
	97. <i>Trianthema potulacastrum</i>	M
	98. <i>T. triquetra</i>	M
	99. <i>Zaleya redimita</i>	W
21. <i>Rubiaceae</i>	100. <i>Borreria articularis</i>	M
	101. <i>Borreria pusila</i>	M
	102. <i>Hedyotis corymbosa</i>	M
	103. <i>Kohautia aspera</i>	M

22. <i>Asteraceae</i>	104. <i>Acanthospermum hispidum</i>	M
	105. <i>Ageratum conyzoides</i>	W
	106. <i>Bidens biternata</i>	M
	107. <i>Blainvillea acmella</i>	M
	108. <i>Blumea lacera</i>	W
	109. <i>Caesula axillaris</i>	M
	110. <i>Carthamus oxycantha</i>	M
	111. <i>Cotula hemispherica</i>	M
	112. <i>Dicoma tomentosa</i>	M
	113. <i>Echinops echinatus</i>	W
	114. <i>Eclipta prostrata</i>	A
	115. <i>Flaveria trinervia</i>	M
	116. <i>Glossocardia setosa</i>	M
	117. <i>Gnaphalium luteo album</i>	W
	118. <i>G. polycaulon</i>	W
	119. <i>G. pulvinatum</i>	W
	120. <i>Grangea maderaspatana</i>	A
	121. <i>Lactuca runcinata</i>	M
	122. <i>Lagascea mollis</i>	M
	123. <i>Launea procumbens</i>	W
	124. <i>L. remotifolia</i>	W
	125. <i>L. resedifolia</i>	A
	126. <i>Oligochaeta ramosa</i>	W
	127. <i>Pentanema indicum</i>	M
	128. <i>Pegolettia senegalensis</i>	M
	129. <i>Pulicaria angustifolia</i>	M
	130. <i>P. Crispa</i>	M
	131. <i>P. rajputanae</i>	M
	132. <i>P. wightiana</i>	M
	133. <i>P. foliolosa</i>	M
	134. <i>Sonchus asper</i>	W
	135. <i>Sonchus oleraceus</i>	W
	136. <i>Sphaeranthus senegalensis</i>	W
	137. <i>Tridax procumbens</i>	M
	138. <i>Xanthium strumarium</i>	M
23. <i>Primulaceae</i>	139. <i>Anagalis arvensis</i>	W
24. <i>Apocyanaceae</i>	140. <i>Catharanthus pusillus</i>	M
25. <i>Boraginaceae</i>	141. <i>Arnebia hispidissima</i>	M
	142. <i>Coldenia procumbens</i>	A
	143. <i>Heliotropium curassavicum</i>	M
	144. <i>H. ellipticum</i>	M
	145. <i>H. paniculatum</i>	M
	146. <i>H. supinum</i>	M
	147. <i>Nonea edgeworthi</i>	W
	148. <i>Trichodesma amplexicaule</i>	M

26. Convolvulaceae	149. <i>Convolvulus rhyniospermus</i>	M
	150. <i>Convolvulus stocksii</i>	M
	151. <i>Ipomoea coptica</i>	M
	152. <i>Ipomoea dichroa</i>	M
	153. <i>I. eriocarpa</i>	M
	154. <i>I. hederifolia</i>	M
	155. <i>I. nil</i>	M
	156. <i>I. quamoclit</i>	M
	157. <i>I. sindica</i>	M
	158. <i>I. turbinata</i>	M
	159. <i>I. verticillata</i>	M
	160. <i>Merremia aegyptia</i>	M
	161. <i>M. rajasthanensis</i>	M
	162. <i>Ipomea pestigris</i>	W
27. Solanaceae	163. <i>Datura innoxia</i>	M
	164. <i>D. metal</i>	M
	165. <i>D. stramonium</i>	M
	166. <i>D. ferox</i>	M
	167. <i>Nicotiana plumbaginifolia</i>	W
	168. <i>Lycopersicon lycopersicum</i>	W
	169. <i>Physalis minima</i>	M
	170. <i>Solanum nigrum</i>	M
28. Scrophulariaceae	171. <i>Anticharis glandulosa</i>	M
	172. <i>A. senegalensis</i>	M
	173. <i>Bacopa monnieri</i>	A
	174. <i>Dopatrium junceum</i>	M
	175. <i>Glossostigma diandrum</i>	W
	176. <i>Lindernia parviflora</i>	M
	177. <i>Schweinfurthia papilionacea</i>	M
	178. <i>Sopubia dephinifolia</i>	M
	179. <i>Striga anqustifolia</i>	M
	180. <i>Verbascum chinense</i>	M
	181. <i>Striga gesnerioides</i>	M
	182. <i>Veronica agrestis</i>	W
	183. <i>Veronica anagallis -aquatica</i>	W
29. Orobanchaceae	184. <i>Orobanche aegyptica</i>	W
	185. <i>O. cernua</i>	W
30. Pedaliaceae	186. <i>Pedalium murex</i>	M
	187. <i>Sesamum indicum</i>	M
	188. <i>S. mulayanum</i>	M
31. Martyniaceae	189. <i>Proboscidea louisiana</i>	M

32. Acanthaceae	190. <i>Blepharis repens</i>	W
	191. <i>B. sindica</i>	M
	192. <i>Dicliptera verticillata</i>	M
	193. <i>Hemidaphnis polyspermus</i>	W
	194. <i>Hygrophylla auriculata</i>	M
	195. <i>Indoneesiella echioides</i>	M
	196. <i>Justicia heterocarpa</i>	M
	197. <i>J. procumbens</i>	M
	198. <i>J. quinquangularis</i>	M
	199. <i>J. simplex</i>	M
	200. <i>J. vahlii</i>	M
	201. <i>Peristrophe paniculata</i>	M
	202. <i>Ruellia tuberosa</i>	M
	203. <i>Lavandula bipinnata</i>	M
33. Lamiaceae	204. <i>Leucas aspera</i>	M
	205. <i>Leucas cephalotes</i>	M
	206. <i>L. nutans</i>	M
	207. <i>L. stricta</i>	M
	208. <i>L. urticaefolia</i>	M
	209. <i>Plantago exiqua</i>	W
	210. <i>Achyranthes aspera</i>	M
34. Plantaginaceae	211. <i>Alternanthera pungens</i>	A
	212. <i>A. sessilis</i>	M
	213. <i>Amaranthus blitum</i>	M
	214. <i>A. graecizans subsp. thellungiamus</i>	M
	215. <i>A. hybridus subsp. cruentus</i>	M
	216. <i>A. spinosus</i>	M
	217. <i>A. tricolor</i>	M
	218. <i>Celosia argentea</i>	
	219. <i>Digera muricata</i>	M
	220. <i>Gomphrena celosioides</i>	M
	221. <i>Nothosaerva brachiata</i>	A
	222. <i>Chenopodium album</i>	M
	223. <i>C. murale</i>	W
	224. <i>Emex spinosa</i>	W
35. Amaranthaceae	225. <i>Polygonum plebium</i>	W
	226. <i>Rumex dentatus</i>	W
	227. <i>Peperomia pellucida</i>	M

38. Piperaceae	228. <i>Acalypha ciliata</i>	M			277. <i>Aristida adscensionis</i>	M
39. Euphorbiaceae	229. <i>Acalypha ciliata</i>	M			278. <i>A. funiculata</i>	M
	230. <i>A. indica</i>	M			279. <i>A. hystricula</i>	M
	231. <i>Chrozophora prostrata</i>	A			280. <i>A. mutabilis</i>	M
	232. <i>C. rottleri</i>	W			281. <i>A. royleana</i>	M
	233. <i>Euphorbia chamaesyce</i>	A			282. <i>A. setacea</i>	A
	234. <i>E. clarkeana</i>	M			283. <i>Brachiaria ramosa</i>	M
	235. <i>E. dracunculoides</i>	M			284. <i>B. reptans</i>	M
	236. <i>E. elegans</i>	M			285. <i>Cenchrus biflorus</i>	M
	237. <i>E. geniculata</i>	M			286. <i>C. prieurii</i>	M
	238. <i>E. granulata</i>	M			287. <i>C. rajasthanensis</i>	M
	239. <i>E. heyneana</i>	M			288. <i>Chloris prieurii</i>	M
	240. <i>E. hirta</i>	A			289. <i>C. roxburghiana</i>	M
	241. <i>E. indica</i>	M			290. <i>C. virgata</i>	M
	242. <i>E. jodhpurensis</i>	M			291. <i>Crypsis schoenoides</i>	W
	243. <i>E. thymifolia</i>	M			292. <i>Dactyloctenium aegyptium</i>	M
	244. <i>Micrococca mercurialis</i>	M			293. <i>Digitaria bicornis</i>	M
	245. <i>Phyllanthus amarus</i>	M			294. <i>D. biformis</i>	M
	246. <i>P. fraternus</i>	M			295. <i>D. ciliaris</i>	M
	247. <i>P. maderaspatensis</i>	M			296. <i>Dignathia hirtella</i>	M
40. Liliaceae	248. <i>Dipcadi erythraeum</i>	M			297. <i>Echinochloa colonum</i>	M
	249. <i>Amischophacelus axillaris</i>	M			298. <i>E. crusgalli</i>	M
41. Commelinaceae	250. <i>Commelina benghalensis</i>	M			299. <i>Eleusine coracana</i>	M
	251. <i>C. diffusa</i>	M			300. <i>Elyonurus royleanus</i>	M
	252. <i>C. forskalaiei</i>	M			301. <i>Enneapogon cenchroides</i>	M
	253. <i>Cyanotis cristata</i>	M			302. <i>Eragostis cilianensis</i>	M
	254. <i>Juncus bufonius</i>	W			303. <i>E. ciliaris</i>	M
43. Cyperaceae	256. <i>C. compressus</i>	M			304. <i>E. minor</i>	M
	257. <i>C. cuspidatus</i>	M			305. <i>E. pilosa</i>	M
	258. <i>C. difformis</i>	M			306. <i>E. tenella</i>	M
	259. <i>C. flavidus</i>	M			307. <i>E. tremula</i>	M
	260. <i>C. iria</i>	M			308. <i>E. unioides</i>	M
	261. <i>C. michelianus</i>	M			309. <i>E. viscosa</i>	M
	262. <i>C. pumilus</i>	M			310. <i>Eriochloa nubica</i>	W
	263. <i>C. triceps</i>	M			311. <i>Hackelochloa granularis</i>	M
	264. <i>Eleocharis atropurpurea</i>	M			312. <i>Iseilema prostratum</i>	M
	265. <i>E. geniculata</i>	M			313. <i>Latipes senegalensis</i>	M
	267. <i>F. bisumbellata</i>	M			314. <i>Melanocenchris abyssinica</i>	M
	268. <i>F. quinquangularis</i>	M			315. <i>M. jacquemontii</i>	M
	269. <i>F. tenera</i>	M				
	270. <i>Mariscus squarrosus</i>	M				
	271. <i>Scirpus grossus</i>	M				
	272. <i>S. littoralis</i>	M				
	273. <i>S. roylei</i>	M				
	274. <i>S. supinus</i>	M				
	275. <i>S. tuberosus</i>	M				
	276. <i>Andropogon pumilus</i>	M				
44. Poaceae						

	316. <i>Panicum trypheron</i>	M
	317. <i>P. psilopodium</i>	M
	318. <i>Paspalum scrobiculatum</i>	M
	319. <i>Perotis hordeiformis</i>	M
	320. <i>P. indica</i>	M
	321. <i>Polypogon monspeliensis</i>	W
	322. <i>Schoenefeldia gracilis</i>	M
	323. <i>Setaria intermedia</i>	M
	324. <i>S. verticillata</i>	M
	325. <i>Sporobolus coromandelianus</i>	M
	326. <i>S. diander</i>	M
	327. <i>S. tremulus</i>	M
	328. <i>Tetrapogon tenellus</i>	M
	329. <i>Tragus roxburghii</i>	M
	330. <i>Urochloa panicoides</i>	M

Arid part of Rajasthan has 682 species. Of these 330 are ephemerals belonging to 44 families [5] (Table 1). Hydrophytes have been excluded from this analysis. Some 54 species are winter ephemerals; 17 occur in both monsoon and winter. In true sense, some 260 species (38.12% of flora) constitute monsoon herbage.

Table 2: Vegetation types of Indian Arid zone.

Parameters	Mixed xeromorphic Thorn Forests			Mixed xeromorphic wood lands	Mixed xeromorphic Riverine thorn forests
Habitats	Hills of rhyolite, granite, sandstone			Pediments order alluvial plains underlain with kankar at 25-100cm depth	Younger alluvium around desert rivers
Soils	Skeletal, loamy sand			Sandy loam-clay loam	Deep, sandy soils without hard pan
Community Physiognomy	Thorny and spiny			A mix of thorny and evergreen species	Thorny and evergreen species
	Annual precipitation				
	150-350mm	350-500mm	500-700mm		
Woody perennials	<i>Acacia senegal</i> <i>Salvadora oleoides</i> , <i>Commiphora wightii</i> , <i>Ziziphus nummularia</i> , <i>Grewia tenax</i>	<i>Anogeissus pendula</i> , <i>Acacia senegal</i> , <i>Wrightia tinctoria</i> , <i>Moringa concanensis</i> , <i>Bauhnia racemosa</i> , <i>Cordia gharaf</i> , <i>A. leucophloea</i> , <i>Azadirachta indica</i>	<i>A. pendula</i> , <i>Acacia catechu</i> , <i>Boswellia serrata</i> , <i>Dichrostachys cinerea</i> , <i>Grewia tenax</i> , <i>Dipteracanthus potulus</i>	<i>Prosopis cineraria</i> , <i>Salvadora oleoides</i> , <i>Acacia nilotica</i> , <i>Capparis decidua</i> , <i>Ziziphus nummularia</i> , <i>Calotropis procera</i> , <i>Balanites aegyptiaca</i>	<i>Acacia nilotica</i> , <i>A. nilotica sub sps. cupressiformis</i> , <i>Salvadora oleoides</i> , <i>Tecomella undulata</i> , <i>Tamarindus indica</i> , <i>Tamarix Sps.</i> , <i>Acacia jacquemontii</i> , <i>Cassia auriculata</i>
Herbaceous annuals and perennials	<i>Aristida hirtigluma</i> , <i>A. funiculata</i> , <i>Enneapogon brachystachys</i>	<i>Tephrosia petrosa</i> , <i>Brachiaria ramosa</i> , <i>Tridex procumbens</i> , <i>Achyranthes aspera</i>		<i>Zornia diphylla</i> , <i>Achyranthes aspera</i> , <i>Alysicarpus spp.</i> , <i>Commelina benghalensis</i> , <i>Eragrostis spp.</i> , <i>Fagonia cretica</i>	<i>Tetrapogon tenellus</i> , <i>Zornia disphylla</i> , <i>C. boflorus</i> , <i>Tragus roxburghii</i> , <i>C. prieurii</i> , <i>Dactyloctenium aegyptium</i> .
Parameters	Lithophytic Scrub	Psammophytic Scrub		Halophytic Scrub	
Habitats	Eroded rocky surfaces gravelly plain, pediment plain.	Sands dunes, hummocks, Sandy plains with hummmocks		Low lying saline flats or ranns	
Soils	Shallow soil deposition in pockets	Deep loamy sandy soils, mainly aeolian deposits often calcareous		Deep saline dry soil	

These belong to 188 genera and 44 families. Amongst families, Poaceae has maximum i.e. 55 monsoon species followed by 35 each in Fabaceae and Asteraceae,

Herbage Communities

Vegetation is a reflex of climate, land form and its surface deposit. Broadly classified on the basis of physiognomy, six characteristic types are recognized in the Indian arid zone [6]. These are

- Mixed xeromorphic thorn forest on hill and rock outcrops.
- Mixed xeromorphic wood lands on piedmonts and alluvial plains.
- Mixed xeromorphic riverine thorn forest on younger alluvial plain around desertic river and water bodies.
- Lithophytes scrub on eroded rocky gravelly plains.
- Psammophytic scrub on sand dunes, hummocks and sandy plains.
- Halophytic scrub on low lying saline flats or ranns (Table 2).

Community physiognomy	Stunted, multistemmed shrubs, grazed.	Stunted, multistemmed shrubs, grazed.		Trees absent
		Low rainfall (upto 250mm)	High rainfall (upto 250-350 mm)	
Woody perennials	<i>Acacia senegal</i> , <i>Prosopis cineraria</i> , <i>Capparis decidua</i> , <i>Ziziphus mummularia</i> , <i>Calotropis procera</i> , <i>Prosopis juliflora</i>	<i>P. cineraria</i> , <i>Acacia senegal</i> , <i>Calligonum polygonoides</i> , <i>Clerodendrum phlomoides</i> , <i>Haloxylon salicornicum</i> , <i>Aerva pseudotomentosa</i> , <i>Calotropis procera</i> , <i>Leptadenia pyrotechnica</i>	<i>Prosopis cineraria</i> , <i>Tecomella undulata</i> , <i>Balanites aegyptiaca</i> , <i>Acacia jacquemontii</i> , <i>Calotropis procera</i> , <i>Lycium barbarum</i> , <i>Balanites aegyptiaca</i> , <i>Maytenus emarginatus</i>	<i>P. juliflora</i> is invador <i>Suaeda fruticosa</i> , <i>Salsola baryosama</i> , <i>Haloxylon recurvum</i> , <i>Peganum harmala</i> , <i>Trianthema portulacastrum</i>
Herbaceous annuals and perennials	<i>Aristida mutabilis</i> , <i>Eragrostis spp.</i> <i>Cleome papillosa</i> , <i>Boerhaavia elegans</i>	<i>Dipterygium glaucum</i> , <i>Indigofera cordifolia</i> , <i>Tephrosia tenuis</i> , <i>Cenchrus prieurii</i> , <i>Tribulus alatus</i> , <i>Brachiaria ramosa</i>	<i>Corchorus tridense</i> , <i>Tribulus terrestris</i> , <i>Heliotropium strigosum</i> , <i>Rhynchosia minima</i> , <i>Brachiaria reptens</i> , <i>Gisekia pharnaceoides</i> .	<i>Chloris virgata</i> , <i>Portulaca oleracea</i> , <i>Trianthema portulacastrum</i> , <i>Echinochloa colonum</i>

Each vegetation type has specific trees, shrubs, forbs, grasses and seasonals [7]. Though ephemeral/seasonals are specific to each vegetation type, their common occurrence within two or more vegetation types indicates that their niche requirements are met there. It is important to note that most of the ephemerals often form pure colonies under trees and shrubs. In fact, these are the pioneer species in succession of vegetation on these habitats when their dominance is 80-100% in the beginning of colonization and ecesis and it declines to often 20-30% in the sub-climax to climax formation.

Life Cycle Of Ephemerals

Besides showing spatial specificity, some ephemerals are unique in their temporal presence; being 'accidental vegetation' [8]. Accidental vegetation appears only during high rainfall; say once in the years when rainwater collects in depression where these species come up. Monsoon herbage act as 'rain-gauges' i.e. these will germinate only after a particular amount of rain is received in one event. In contrast, there are species which germinate at the very first event of rainfall irrespective of amount. These include large number of species of *Indigofera*, *Aristida* and *Cenchrus*. If

there is no successive rain with in a span of 15-20 days these will start flowering and set seeds as early as 20 days to 40-50 days. This has been confirmed by sequential sampling of permanent plots where seasonal variation in monsoonal vegetation has been charted and measured on rocky habitats [9], alluvial plains [10] and semi rocky habitats [11]. Their findings are: Within 21 days of rain, annuals were maximum 33.58% in August and declined to 13.6% by end of September on rocky habitats of Kailana, near Jodhpur. Likewise, maximum dominance of annual grasses was 14% within 18 days of rain and it declined to almost 1/3 i.e., 4.6% by the end of September on alluvial plains in Jodhpur. It has been found that at each germination event, 20-25% seeds of entire seed bank germinate and remaining are dormant. This is an ecological adaptation in annuals to germinate only a fraction of total seed bank so as to preserve the rest for next rain event. This ensures that if seedlings die or disappear without completing life cycle and formation of seeds, the remaining seed bank portion held with in soil is able to regenerate and continue the progeny. If however, there are continuously well distributed spells of rain, they continue to grow vegetatively till they face water stress. Growth up to 50-60 cm height has been observed in these species in case of prolonged wet spell. This indicates the plasticity in annual habit of these plants.

Composition of Herbage in Protected and Degraded Conditions

Table 3: Botanical composition of herbage in protected (P) and unprotected (Unp) grazinglands in three rain fall situations in Indian arid zone.

Species	Site (Annual precipitation in mm)					
	Chandan (150mm)		Beechwal (250mm)		Palsana (350mm)	
	P	Unp	P	Unp	P	Unp
Grasses						
1. <i>Aristida funiculata</i>	+	+	+	+	+	+
2. <i>Brachiaria ramosa</i>	-	+	-	-	-	-
3. <i>Cenchrus biflorus</i>	+	-	+	+	-	+
4. <i>Cenchrus prieuri</i>	+	+				

5. <i>Tragus biflorus</i> (=roxburghii)	+	-				
6. <i>Eragrostis</i> spp.	+	-	+	+	+	+
7. <i>Latipes senegalensis</i>				+		
8. <i>Dactyloctenium aegyptium</i>					-	+
9. <i>Perotis indica</i>					+	+
10. <i>Fimbristylis</i> spp.					+	-
Forbs						
11. <i>Polygala erioptera</i>			+	+		
12. <i>Olden landia aspera</i>			+	+		
13. <i>Mollugo nudicaulis</i>			+	+		
14. <i>Cleome viscosa</i>	-	-	+	+		
15. <i>Arnebia hispidissima</i>	-	-	+	+	+	+
16. <i>Anticharis linearis</i>	-	-	+	-		
17. <i>Blepharis linearifolia</i>	-	-	-	-		
18. <i>Corchorus tridens</i>	+	-	+	-		
19. <i>Eurphorbia prostrata</i>	+	-	+	-		
20. <i>Gisekia pharnaceoides</i>	+	-	+	+		
21. <i>Heliotropium strigosum</i>	+	-	+	+		
22. <i>Indigofera lin ifolia</i>	+	-	+	+	+	-
23. <i>Indigofera cordifolia</i>	+	-	+	+	+	-
24. <i>I. sessiliflora</i>	+	-				
25. <i>Tribulus terrestris</i>	+	-			+	-
26. <i>T. alatus</i>	-	+				
27. <i>Tephrosia tenuis</i>	+	+				
28. <i>Euphorbia granulate</i>	+	-			+	-
29. <i>Farsetia hamiltonii</i>	+	-	+	+		
30. <i>Indigofera linnaei</i>	-	+	+	+	-	+
31. <i>Portulaca</i> sp.	-	-	+	+		
32. <i>Solanum surratense</i>	-	-	+	+		
33. <i>Sporobolus diander</i>					+	-
34. <i>Sesamum indicum</i>					+	-
35. <i>Borreria hispida</i>					+	+
36. <i>Ageratum conyzoides</i>					+	-
37. <i>Achyranthes aspera</i>					+	-
38. <i>Alysicarpus monilifer</i>					+	-
39. <i>Alysicarpus nudicaulis</i>					+	+
40. <i>Atylosia scarabaeoides</i>					-	+
41. <i>Commelina benghalensis</i>					+	+
42. <i>Euphorbia hirta</i>					-	+
43. <i>Heliotropium marifolium</i>					-	+
44. <i>Peristrophe bicalyculata</i>					+	-
45. <i>Polycarpea corymbosa</i>					+	+
46. <i>Rhyncosia minima</i>					+	-
47. <i>Indigofera hochstetteri</i>					+	-
48. <i>Justicia simplex</i>					+	-
49. <i>Kyllinge monocephala</i>					-	+
50. <i>Launea nudicaulis</i>					+	-
51. <i>Tridax procumbens</i>					+	-

The composition of seasonals undergoes a drastic change upon grazing. A comparison of protected and grazed paddocks of grazingland at the end of 3 years and receiving 150mm, 250mm and 400mm rain at Chandan, Beechwal and Palsana respectively revealed that grazed sites had preponderance of unpalatable annual forbs and such grasses which have awns that deter animals (Table 3) from grazing [12]. Analysis of dominance revealed that in low rainfall zones, seasonals have RIV of nearly 10 in protected conditions and this increased three times upon degradation. In 250mm rainfall zone, the RIV of seasonals nearly 12 in protection became double i.e. 24.33 in degraded conditions. In 400mm rainfall, the seasonals dominated by having RIV of 54 under protection and 75 under degradation. Thus dominance of monsoon seasonals increased with increasing annual rainfall and increased grazing stress.

Production Potential

There are a large number of studies on estimation of dry matter yield of rainy season ephemerals at regional, landscape and local

level. Shankar and Kumar [13] estimated *Aristida* – *Oropetium* cover on 2526sq. km area in Jaisalmer with their yield as low as 5 kg/ha. However, contribution of seasonals varied from 2-27% in total dry matter that was 180 kg to 922 kg/ha on different habitats in Jaisalmer. Potential of fair condition class grazingland was estimated as air dry 14 kg/ha for *Aristida*- *Eragrostis* type, 700 kg/ha in *Digitaria adscendens* type, 3430 kg/ha in *Echinochloa colonum* type and 4570 kg/ha in *Dactyloctenium aegyptium* in Jalore district [14]. At landscape level, production of palatable monsoonals in 3 landscapes in Churu district was 174, 250 and 567kg/ha on forest floor, a planted grazingland and moderately degraded natural grazing land (Table 4). In Sikar, a protected site has 491kg/ha (92.9%) palatable and 40kg (7.1%) unpalatable herbage. The adjoining unprotected site had 230kg/ha palatable (71%) and 95kg/ha unpalatable herbage biomass [12]. Not only the total herbage yield but also yield of palatable species decline upon indiscriminate grazing. This also indicated a potential of regeneration of seasonal palatable herbage to the tune of nearly half a ton per hectare by mere protection.

Table 4: Production potential of grazingland herbage (kg.ha) in Churu District.

Plant type	Forest floor at Taranagar	Protected grazing land at Changoi	Unprotected grazingland at Bighrain
Perennial herbage	568.151	281.489	140.097
Annual palatable herbage	173.623	249.817	567.257
Annual unpalatable herbage	23.101	129.100	60.357

Table 5: Herbage Yield of different grass cover types on different habitats in Guhiya catchment [15].

S.No.	Grass Cover type	Habitat	Average Drymatter yield (kg/ha)	Range (kg/ha)
1	<i>Oropetium thomaeum</i> (Linn.f.) Trin., <i>Eragrostis ciliaris</i> (Linn.) R. Br.	Hill Older alluvial plain Buried pediment	449	270-645
			242	160-384
			283	224-342
2	<i>Dactyloctenium indicum</i> Boiss., <i>Eleusine compressa</i> (Forsk.) Aschers. Et Schweinf.	older alluvial plain	553	132-1098
		Lower hills & piedmonts	1066	1066
		Younger alluvial plain	464	464
3	<i>Sporobolus marginatus</i> Hochst., <i>Chloris virgata</i> Sw.	Saline older alluvial plain	1045	828-1528
		Older alluvial plain	168	168
4	<i>Cenchrus ciliaris</i> Linn., <i>Cenchrus setigerus</i> Vahl.	Older alluvial plain	288	288
		Obstruction dune	700	700
5	<i>Dichanthium annulatum</i> (Forsk.) Stapf. <i>Desmostachya bipinnata</i> (Linn.) Stapf. <i>Cynodon dactylon</i> (Linn.) Pers.	Older alluvial plain	404	160-785
		Saline older alluvial plain	1488	1488
6	<i>Aristida</i> Spp.	Piedmont	470	380-645
		Older alluvial plain	332	332
7	<i>Chrysopogon fulvus</i> (Spreng.) Chiov	Hills & Piedmont	1231	1048-1414

Its dependency on rain amount was proved by [15]. Estimates of grazable biomass in Guhiya catchment covering Pali and southern Jodhpur district (Table 5) revealed that predominantly seasonal grazinglands have approximate 449-470kg/ha dry matter yield, which is comparable to such grazing lands supporting perennials species. A scope of improvement in yield and carrying capacity was also predicted [16]. At village level, estimates in Bikaner district revealed that herbage yield in overgrazed native grazinglands was nearly half (330.98 kg/ha) of the nearby protected area (610.65kg/ha) which was fenced for two years (Table 6). It is interesting to

note that even under protection the bulk of dry matter, i.e. nearly 44% was by a single monsoon legume i.e. *Indigofera cordifolia* (Table 6) though there were other contributors like *Cenchrus biflorus*, *Tribulus alatus*, *Farestia hamiltonii* and *Mollugo cerviana*, their exact contribution was not reported by [17]. But this estimate amply proves that monsoon seasonals not only make up 34% of floristic composition, they also make up over 50% of biomass of grazing lands which is palatable too, in both protection and degraded conditions.

Table 6: Cover, dominance and herbage yield in a protected (P) and unprotected (Unp) village grazinglands in six villages in Bikaner [17].

Species	Cover (%)		Dominance (RIV)		Herbage yield (kg/ha) (% contribution of yield in brackets)	
	P	Unp	P	Unp	P	Unp
Grasses						
<i>Lasiurus indicus</i>	2.33	0.23	16.71	4.02	257.32 (42.15)	81.33 (24.49)
<i>Dactyloctenium indicum</i>	0.2	0.2	7.94	8.65		
<i>Cenchrus biflorus</i>	0.5	0.067	4.86	2.31		
<i>Eleusine compressa</i>	0.03	0.817	24.69	27.5		
Legumes						
<i>Indigofera cordifolia</i>	0.3	0.3	7.48	8.59	268.00 (43.88)	21.33 (6.42)
Others						
<i>Convolvulus microphyllus</i>	0.417	1.01	13.78	21.4	85.33 (13.97)	229.32 (69.09)
<i>Cyperus bulbosus</i>	0.08	0.08	4.74	5.05		
<i>Tribulus alatus</i>	0.13	0.187	6.73	8.11		
<i>Farsetia hamiltonii</i>	0.21	0.217	6.88	7.67		
<i>Heliotropium strigosum</i>	0.13	0.133	4.51	5.0		
<i>Mollugo cerviana</i>	0.006	0.007	1.66	1.70		
Total					610.65	331.98

Similar conclusion was reached by [18] in seven-year monitoring of rangelands of Lawan in Jaisalmer stating that “--- major contribution in all grazing plots was from *Indigofera cordifolia* (1.26-1.98%) and less than one percent from perennial grasses”. In extremely degraded conditions however, all palatable are removed and unpalatable biomass also remain ½ and 1/3 of that in protected situations. The important implication of this finding is that nearly 70% of grazingland in Indian arid zone are degraded while 14% are in fair, 13% in good and 2-3% have excellent condition class [7]. It is these 70% areas which have poor perennial plant cover but a preponderance of monsoon seasonals and these ephemerals constitute available grazable material @ 500Kg/ha to sustain livestock.

Ephemeral's Response to Grazing

Impact of different levels of grazing on cover of selected annual forbs and annual grasses in permanent quadrats and transects

in arid and semi arid regions was investigated in one monsoon season at two sites in India: low rainfall arid site (240mm/year) at Chandan experimental site of CAZRI in Jaisalmer district in western India and a high rainfall semi arid site (400mm/year) at Pali experimental site of CAZRI in Pali district [19]. Treatments were: No grazing (control), 50% or half of carrying capacity (3 sheeps/ha), 100% of carrying capacity (6 sheeps /ha) and 50% more than carrying capacity(8 sheeps/ha). Mild grazing of 3 sheep/ha and sometimes even 6 sheep/ha at arid Chandan site enhanced the cover of three annual grasses, *Aristida mutabilis*, *C. biflorus*, *Latipes senegalensis* from July to October. Such an increase was more than that in control or 8 sheep/ha treatment, confirming the fact that mild grazing promotes the growth. In contrast, annual forbs (*Indigofera cordifolia*, *I. linifolia*, *I. hochstetteri* and *Gisekia pharnaceoides*) cover declined with increasing grazing pressure. Response to increasing grazing pressure was different at semi-arid Pali site: though *Aristida mutabilis* increased with increasing

grazing pressure, the other forbs species also increased up to September and declined later, with increasing grazing pressure.

This was also confirmed by positive significant correlation between cover and grazing intensity i.e., increases in cover with increasing grazing pressure in *Aristida mutabilis*. Importantly, correlation coefficient between grazing pressure and cover of *Indigofera hochstetteri*, *I. cordifolia*, *I. linifolia* at arid site and *C. pumila* at semi arid site was strongly negative. Thus same species behaves differently in two different rainfall situations. It emerged from above that annual species after being nibbled or partly grazed by sheep re-sprout and assume growth in semi arid situation, behaving much as multi cut fodder crop. These findings were in conformity with results of an earlier grazing experiment of three years at Kailana, Jodhpur where per cent plant cover increased from 4.8 to 7.42% and forage yield, 28.3 to 29.8kg/ha after grazing [20].

In the same experimental paddocks at Chandan in Jaisalmer district of western India, phenological changes at monthly intervals were also recorded under different grazing pressures. Concurrently, palatability of species as and when the sheep bites was also noted for one hour each during morning (8-10AM), noon (12-2PM) and evening (4-8PM). Results revealed that vegetative phase was shortened and flowering, fruiting and seed set occurred earlier in perennial like *Lasiurus indicus* as the grazing pressure increased [21]. Thus compressing the vegetative phase emerged as a mechanism of evading grazing pressure in this perennial grass. Reverse was noted in all the ephemeral species. Vegetative phase was prolonged with increasing intensity of grazing and thus seed setting was delayed in ephemeral species *Aristida funiculata*, *Indigofera cordifolia*, *Indigofera linifolia* and *Corchorus tridense*. This shift in phenophase could be related to their relative palatability. Since annual species germinate and grow with their fresh foliage during the monsoon rains, annuals (due to fresh foliage) were eaten in preference over the perennials. This preferred removal of annuals due to their palatability, if continued unabated, would finally remove them completely due to overgrazing. In fact, such a shift in phenophases, induced by increase in grazing intensity, can effectively be used as indicator of beginning of deterioration of rangeland health. And this becomes the start point of desertification in grazing lands in deserts. Moderate grazing is therefore, desirable for maintaining range health for sustainable grazing. On the other hand, it is also important to realize this potential of monsoon ephemerals as grazing material as by way of corollary these can be sown and then cut, not grazed, and fed to animals.

In order to further understand the role of herbaceous annual and seasonal vegetation, another grazing study was undertaken for two consecutive years in *Lasiurus indicus* dominated protected grazingland at experimental area at Chandan in Jaisalmer district by Kumar et al. [22]. There were five grazing treatments: T-1: Control

(No grazing); T-2: Optimum carrying capacity with supplemental feed (6 sheep grazing); T-3: Optimum carrying capacity without supplemental feed (6 sheep grazing); T-4: Double the carrying capacity with supplemental feed (12 sheep grazing) and T-5: Double the carrying capacity without supplemental feed (12 sheep grazing). Results revealed that irrespective of supplemental feed, 70-80% of *L. indicus* cover declined in paddock with double the carrying capacity (T-4 and T-5). This study again proved findings in previous para i.e., preferential consumption of seasonal and low perennials such as *Ochthochloa compressa* and annual *Cenchrus biflorus* in monsoon and post-monsoon. Grazing animals did not eat perennial species as if these have been left by them for future consumption when these ephemerals dry, die and no more available say, after December. This postponement in consumption of perennials effectively prolonged the duration of range-use. On the other hand, as the grazing pressure increased, biomass declined by 80% in two years i.e., from 461.5 (T-2), 306.6 (T-3), 450.5 (T-4) and 341.1 (T-5) kg/ha-1 to 70.3 (T-2), 29.6 (T-3), 28.7 (T-4) and 15.4 (T-5) kg/ha-1. In rain driven ecosystem of arid lands, even a small variation in the quantum, spread and timing of rainfall causes major effect on vegetation composition [23]. These have cascading effects making the whole system vulnerable to drought and adversely affecting sustainable productivity of the rangeland ecosystem [24]. This study thus, concluded that rainy season ephemerals by way of their preferential consumption give temporary or seasonal rest to perennials like *L. indicus* enabling it to grow and recover. Vetter et al. [25] while discussing such differences in composition, structure, diversity and forage production potential of vegetation under different grazing intensities reasoned that these ephemerals can draw water from whole soil profile throughout the growing seasons where as climax grasses withdraw water from deeper layers of 2-5m during droughts [23].

Thus, resource utilization is partitioned to be optimally used among ephemerals and perennials resulting in better growth of both these components. Consequently, grazable material becomes available from the same grazing land for a longer duration and that imparts resilience to the grazing land system. Fynn [26] also reported that short, nutritious grasses in functional wet seasons habitats facilitate optimum intake of nutrients and energy for lactating females, for optimal calf growth and building body stores. Heterogeneity in vegetation composition due to ephemerals was also emphasized for achieving optimum grazing use by [28]. Evidently, Kumar et al. [22] in their study also related the spatial patterns created by patches of seasonal vegetation in the landscape and temporal patterns of biomass (= productivity) availability of seasonals in post monsoon and perennials in winter and summer with long term sustainability. Fynn [26] also concluded that grazing based on spatial and temporal variability in forage quality and quantity would be more sustainable. Nutritionally also, seasonal vegetation having higher crude protein than perennial grasses

[28] meets the nutritional needs of the livestock. Utilizing above mentioned spatial and temporal patterns was also recommended as best range utilization strategy by [27]. But Kumar et al. [23] found that free range animals in monsoonal rangelands themselves do selective grazing based on seasonal availability of biomass i.e., they graze annuals first (August to November) and then perennials (December to April) and both litter and perennials in summer. A mix of cattle, goat and sheep would further optimize to increase range utilization.

Ephemerals/seasonals, therefore, not only provide heterogeneity and complexity to the grazing landscape, they also complement the nutritional needs as well as prolong the period of range use thereby delaying the onset of degradation. This spatial heterogeneity imparted by seasonal vegetation in an overall matrix of perennial tall grasses and woody perennials need to be managed optimally by grazing management of both seasonals and perennials. It was therefore, concluded “.... that

- a) arid rangelands have intrinsic heterogeneity in species composition,
- b) this mix of seasonal and perennials (= heterogeneity) is ably supported by the landscape by way of partitioning of resources,
- c) lifecycle patterns of seasonal fits well to meet the nutritional needs of livestock and

Ephemerals as Crop Area Weeds

Table 7: Dry matter yield of different crops and their weeds in Guhiya catchment. (Source: Shankar and Kumar, 1984).

Habitat	Soil texture	Crop	Dry matter kg/ha		Weed/crop ratio in yield	Botanical composition %			
			Crop	Weeds		Crops	Weeds grasses	Legumes	Others
Older alluvial plain	Sandy loam	Green gram	158.5	740.5	4.67	17.63	51.1	10.46	20.85
	Clayey	Pearl Millet	293.0	1289.0	4.39	18.52	1.71	-	79.77
	Clay Loam	Pearl Millet sorghum	414.0	1195.0	2.88	25.73	36.1	8.08	30.08
	Clayey	Mehendi	6.0	271.2	45.20	2.53	5.06		92.41
Pediment Older alluvial plain	Clay loam	Pearl millet & Gingelly	503.0	1564.0	3.10	24.33	21.5	10.11	44.08
	Sandy loam	Moth been	859.0	1131.0	1.32	85.90	1.05	-	12.05
	Clay Loam	Sorghum	1513.0	589.0	0.39	71.98	0.19	15.15	12.28
	Sandy loam	Sorghum	1898.0	691.0	0.364	56.51	11.69	11.98	20.21
	Sandy loam	Mothbeen, Green gram & Gingelly	1508.0	489.0	0.32	75.49	6.03	0.98	17.49
	Sandy loam	Greengram & Cluster bean	259.0	970.0	3.74	21.07	35.47	0.65	42.79
	Sandy loam	Pearl millet	1196.0	655.7	0.54	64.60	22.54	-	12.86

Ephemerals appear to be out of place in crop lands and hence called weeds. Desert farmers know the utility of these seasonals as valuable forage. Quite often, especially the monsoon ephemerals are collected, air dried and stored in livestock yard for future used. Heaps of such air dried palatable ephemerals are stacked species wise as an effective strategy of escaping drought by way

d) grazing of such seasonal vegetation thus helps sustain perennial tussocky rangelands for longer range-use ...”.

Such a functional role of ephemerals as revealed in the aforementioned studies in respect of grazing animals has also been found in an entirely different context by Bhardwaj et al. [29] who reported the importance of ephemerals in enhancing the population of critically endangered bird, the Great Indian Bustard *Ardeotis nigriceps* with a remaining population of ~200 birds (IUCN 2011). Biased habitat preference by Great Indian Bustard for new closures which were ploughed instead of old ones prompted a detailed vegetation analysis by [30] amongst different landscape units. The newly ploughed sited had regeneration of lot of ephemerals in the ensuing rains compared to the parched sites in the old ones. This led to devise a very simple management strategy of ploughing the open areas in mosaic pattern for breaking the crust laden hard surface without disturbing the *Lasiurus sindicus* and other perennial grasses, shrubs and trees of old closures annually just before onset of rains. Selective ploughing brought out the stored seed bank of annuals on to the surface enabling them to use moisture of the very first rain and germinate to grow further in subsequent rains. In fact, such slight amount of disturbance is known to increase diversity in all dry land ecosystems and is a desirable management intervention for the conservation of critically endangered Great Indian Bustard.

of providing feed to livestock during ensuing drought when crops fail. It becomes therefore, imperative to assess the quantity of such ephemeral forage in crop fields. A study to assess their biomass revealed that weed biomass often far exceeded their companion crop [30] i.e., their biomass was 2 to 4 times more than crop (Table 7). These are mostly palatable weeds giving 655 to 1564kg/

ha of dry matter depending upon preponderance of weeds. Thus seasonal ephemerals as weed contribute immensely to livestock feed but estimates are not available to assess their contribution at landscape level.

Role of Ephemerals in Rehabilitation of Mine Spoils

Though perennials are preferred for rehabilitation of degraded lands like mine spoils, but once the seeds bank is added to soil, annuals by virtue of their rapid turn over, play a key role in accelerating process of rehabilitation. Kumar et al. [31] reported as many as 14 self regenerated annuals, equivalent to that of perennials in freshly rehabilitated plots of gypsum mine spoil in Barmer, an extreme arid district in western Rajasthan. These provided organic matter to soil facilitating growth of shrubs and trees. These can be therefore, easily employed to grow and prepare niche for future generations of plants. In another rehabilitation programme for backfilled areas after lignite mining in Barmer (1999-2004), surface layering of local soil and murram was carried out and then planted with eight different tree species, seven shrub species and one perennial grass [32]. Monitoring the self-regenerated natural vegetation in these treatment blocks revealed that irrespective of treatments, all blocks had immense regeneration of ephemerals that constituted 46-48% of total self regenerated species that varied from 39 to 75 species in five rehabilitated blocks. Appearance and growth of nearly half of regenerated vegetation being ephemeral proved their crucial role in accelerating the process of rehabilitation by way of organic matter build up and its rapid turn over that later on supports growth of other companion planted species. Evidently, understanding the role of ephemerals as organic matter builder, succession facilitator and ecological moderator deserve deeper studies so as to optimize cost of such programmes and achieve faster system recovery in reclamation of degraded and drastically disturbed lands, especially in arid regions.

Ephemerals as Medicinal Plants

A survey of ethno medicinal plants in 128 villages in four arid districts in western India namely Jaisalmer, Barmer, Bikaner and Jodhpur from year 2001 to 2005 revealed 131 taxa of medicinal importance (Kumar and Parveen, 2004) [33]. Of these, herbs were maximum i.e. 52 (39.69%) followed by 29 shrubs (22.13%), 25 trees (19.84%), 11 climbers (8.39%), 9 grasses (6.87%), 3 sedges (2.29%) and 1 fungus (0.67%). Of the total species, 70 were perennials (53.43%) and 61, ephemeral or annuals including crops (46.57%). These values broadly match the Raunkiaerian's life forms in this desert in which nearly 49% are therophytes or annuals and 51% are other life forms which are perennials *Mertia* and *Bhandari* [34]. The 29 ephemeral medicinal species reported from wild grazing lands in this study are: *Abutilon indicum*, *Achyranthus aspera*, *Amaranthus viridis*, *Argemone mexicana*, *Blepharis indica*, *Cenchrus biflorus*, *Cleome viscosa*, *Corchorus depressus*, *Corchorus*

tridens, *Cucumis callosus*, *Dicoma tomentosa*, *Digera muricata*, *Eclipta alba*, *Eragrostis minor*, *Euphorbia granulata*, *Fagonia indica*, *Heliotropium marifolium*, *Indigofera cordifolia*, *Mollugo cerviana*, *Mukia maderaspatana*, *Neurada procumbens*, *Pedaliium murex*, *Phyllanthus fraternus*, *Polygonum plebeium*, *Portulaca oleracea*, *Pulicaria crispa*, *Sisymbrium irio*, *Solanum surattense* and *Tribulus terrestris*. Almost all of these species come up naturally during monsoonal rains and hence are collected from wild and marketed. Many of these are immensely useful and are species of trade both nationally and internationally i.e., *Tribulus terrestris*, *Pedaliium murex*, *Solanum surratense*, *Fagonia indica*, *Blepharis linearifolia*, *Phyllanthus fraternus*, and *Eclipta alba*. Thus these nature's herbals enhance the cash flow in the hand of farmers. But in view of their increasing demand, a need is felt to domesticate and bring them into cultivation so as to save their native gene pools in the wild from being lost. This will also diversify the cropping system and add to the sustainable livelihood of desert dwellers.

Epilogue

Ephemeral/seasonal species are important herbage component of natural grazing lands, pasture and croplands. They are the only plants available even after the perennials are removed. Persistence to withstand pressures and re-appear once the favorable situations occur, make them highly resilient component of desert vegetation. Their life cycle strategy is also more suited to adverse temporal sequential stresses caused by climatic aberrations. Plasticity in phenological stages exhibited by ephemerals during variable grazing treatments not only provides adaptive edge to survive in harsh desertic conditions but also imparts sustenance to the whole grazing land ecosystem. By way of providing heterogeneity in species composition, ephemerals prolong the duration of grazing land use and also complement the nutritional needs of livestock. This aspect has helped to design conservation strategy of critically endangered Great Indian Bustard in its native landscape by way of provisioning of foraging material by just enabling buried ephemerals seeds to come up on surface through ploughing and then germinating during rains.

They contribute up to 500-600kg/ha dry matter without any management in natural conditions. Grown properly under managed conditions, their yield can be enhanced many folds. This can be achieved by providing moisture just before flowering so that vegetative phase is prolonged, thus capitalizing its ecological properties to further increase its yield to double or treble. Experiments are however needed to confirm whether these could be used as multicut fodder crop in sole or as intercrop. In view of rich ephemeral flora in the Indian desert, we are advantageously placed to select a few chosen species for testing their potential as future livestock feed either raw or as feed cake. Not merely a source of livestock feed, these grazing lands are also cradle of as many as 61 herbal ephemerals which are being used by people as traditional

medicine; many of them having immense trade potential that can add to the kitty of local farmers. In the ecological management of mine spoiled lands, ephemerals as an adjunct to perennial species have proved their potential as a cheaper and faster rehabilitation material.

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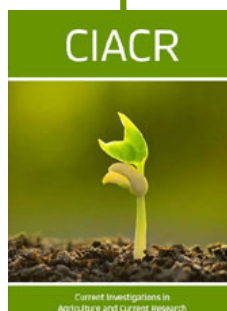


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