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Sustainable management of tropical grassland in the rain-shadow area of South India

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Abstract

Grasslands are one of the major production systems in the world providing livelihood to a large number of people through animal agriculture. Tropical grasslands in general wherever they are, are mostly overgrazed. Livestock have invariably been blamed for the loss of vegetation cover and the land going barren. However, human interventions and ownership right play a more profound effect on sustainability of a system as has been practiced by the farmers in the grassland falling in the rain-shadow area in South India. The grassland studied receives an average of 675 mm annual rainfall. Historically, these grasslands have thrived under paddock system since ages in spite of frequent drought due to failure of monsoon. The soil of the region is red loam of various degree and has a sub soil rich in Kanker-gravel, rich in calcium and phosphorus. The grassland dominated by *Cenchrus ciliaris,* is divided into paddocks of size 2-4.5 ha and is fenced with live hedge of *Balsamodendron berryi*, a highly drought resistant thorny shrub. The paddocks are interspersed with 42- 50 *Acacia* trees ha^{-1} which provide shade to the animals at mid-day besides supplying pods (CP 14.86%) for feeding and other multipurpose uses. The rainfall is just sufficient to raise a crop of grass and hence animal agriculture is the major source of livelihood to the people. The pasture in the grassland is efficiently managed wherein animals are withheld to permit re-growth of grasses after rain, they are rotated between the paddocks, legumes like *Phaseolus trilobus* and *Dolichos biflorus* are grown during rainy season every 2-3 years and the soil is broken once in 4-5 years by cultivating a crop, preferably sorghum. Crossbred cattle and sheep are the choice of animal in the grassland, which provides income and employment to the people with an overall stocking rate of 0.96 adult cattle unit (ACU) per ha.

Key words: Tropical grassland, sustainable management, ownership right, paddocks, live hedge

Introduction

"*Grass is the king. It rules the world. It is very foundation of all commerce. Without it the earth would be a barren waste, and cotton, gold and commerce –all dead*" (Robinson, quoted by Achariyar, 1921).

The saying amply describes the importance of grassland even today especially for the arid and semi-arid regions because rangeland systems offer less scope for technical interventions that can directly benefit the poor, but natural resource conservation and management and relevant policies to sustain livelihood need to be addressed (ILRI, 2000). Rangelands occupy 51 percent of earth's land surface (almost 90 percent of agricultural land in Africa), contain about 36 percent of its total carbon in living and dead biomass, support 50 percent of the world's livestock and are livelihood of millions of people (25 million in Africa alone) who would otherwise have to make a living outside the rangelands at a greater net cost to the environment (Mearns, 1996). Wherever the grasslands have been abused, the losses have been colossal in terms of degradation of land, soil and nutrient erosion, loss of bio-diversity, impact on the livelihood of people together with widespread starvation and migration of human and livestock. About 20 percent of the world's grazing lands or 680 million ha have been significantly degraded since 1945 (Olderman et al., 1991).

The present study describes the practices which farmers in the tropical grassland located in the peninsular India have been following since ages managing their grassland and their livestock in a sustainable manner under conditions where occurrence of drought is a regular phenomenon. Under favourable years too, the rainfall is just sufficient to raise a crop of grass. The study is of particular interest because under similar rainfall, a vast expanse of land elsewhere in the country is overgrazed, degraded with very low carrying capacity making them virtually an exercising ground for the livestock. This provides us some important lessons, which may be replicated elsewhere to provide more livelihood opportunities for the rural poor.

Materials and methods

Study area

The grassland of Kangayam tract located in peninsular India is spread over five districts namely, Erode, Karur, Namakkal, Dindigul and Coimbatore of Tamil Nadu state. The grassland is known for the famous Kangayam breed of cattle which is native of this region. Presently, the first two districts were taken for the detailed study. In Erode district, of the total 20 administrative blocks, eight were having the grassland under paddock system whereas, in Karur district four blocks were having paddocks out of a total of eight blocks. Extensive field survey were carried out to study the grassland management practices, the management and feeding of livestock, the output obtained, the vegetation and soil studies. The data on demographic characteristics, land utilization, land holding pattern, sources of irrigation, livestock and cropping pattern were obtained from the statistical department of the district. The data for the blocks where grassland exist were grouped for drawing inferences. The different categories of livestock were concerted to standard adult cattle unit as per Patel and Kumbhara (1983).

Results and discussion

Area and Population

The grassland in Erode and Karur districts located in 12 administrative blocks out of a total of 28 blocks is spread over an area of 4727 sq km. The total human population of the grassland area is 1.2 million with a density of 256 persons per sq km. Livestock rearing is their major occupation in the grassland. The area corresponds to the mixed rainfed arid/ semi-arid (MRA) production system given by Thornton et al., (2003).

Rainfall Pattern

The average annual precipitation is 675 mm in the grassland (Figure. 1). Every month of the year receives some rainfall but the distribution is not uniform. The hot summer months (Feb-May) brings 20 percent of the total precipitation followed by South-West monsoon (Jun-Sept) 30 percent and North-East monsoon (Oct-Jan) 50 percent (Figure. 2). The South-East monsoon which heralds the rainy season in the Indian sub-continent brings plenty of rain on the Western Ghats which lies east of the grassland. The rain clouds while climbing up the hills empties itself thereby bringing only cool breeze and little rain to the grassland. The retreating N-E monsoon brings bulk of the rainfall to the grassland. Hence, inspite of the low total precipitation, its distribution makes it a thriving ecosystem. There is frequent occurrence of drought in the region. Anonymous (1908) has classified the preceding ninety-three years as 6 good, 25 fair, 51 unfavourable and 11 really bad.

Soil

The soil of the grassland is red-loam of various degree and has a sub soil rich in ‘Kanker gravel’ which is a calcium-phosphorus compound. It adds to the fertility of the soil by breaking up the continuity and thus providing aeration and greater absorption of moisture apart from enhancing the dissolved calcium and phosphorus content for plants. The soil is periodically broken up by cultivating a crop once in 4-5 years.

Land utilization

The land utilization pattern in the district (Table 1) indicates that the forest is almost absent (0.6%). The total grazing area has been estimated to be 2632 sq km, which is 56% of the total land area. Similarly, the grazing area under paddock system of management (with live fence) has been estimated to be 1247 sq km, which is 26% of the total land area and 47% of the grazing area. It is interesting to note that the revenue records show only 1.8% of the area under pasture and grazing land and they do not account the area devoted by the farmers to grazing under this classification. Historically, this area does not have communal grazing land as Littlewood (1936) reported that the Dharapuram taluk, which lies in the heart of the grassland has no cultivable waste, no communal grazing land and no forest grazing. Yet it was one of the best managed cattle rearing area with an excellent system of mixed farming. Hunter (1881) has reported that most of the cultivators had occupancy rights since last 200 years. When the East India company assumed the administration in 1800, and the system of direct settlement with the cultivators was introduced. Wastelands, overgrown with cactus were leased rent-free for 10 years for bringing them into use. This had encouraged the farmers to invest the profits from agriculture in well building and improvement of land. In 1881, 57,000 wells in Coimbatore district were worth 1 million £ invested (Hunter, 1881). The resettlement of land in the region was completed in 1882 by the British rulers (Anonymous, 1908).

Ownership of land has a far reaching impact on the management of natural resources. The Garrett Hardin’s well known ‘Tragedy of Commons’ thesis (Hardin, 1968) has been in operation in most part of the country causing degradation of the grazing lands. Gill (1995) has also advocated that the local people should be conferred the inalienable unsufructuary rights of natural resources to maintain, sustain and rehabilitate them using their indigenous knowledge and skill. The distribution of land and the policy and legal processes by which poor people especially women gain access to and maintain security over land are vital (DFID, 2002). Dick and Gregoria (2004) have also stressed that rights should be of sufficient duration to allow one to reap the rewards of investment and should be backed by an effective socially sanctioned enforcement institution. The grassland still do not have communal grazing land and this has been the single factor having far reaching impact on sustainability of the system in terms of grassland management, regulation of livestock grazing and sustainable livelihood from the system. Had the area under grazing been communal land, the area would now resemble a desert with widespread starvation and migration of people because of over grazing and decline in carrying capacity. The grassland presents an excellent example of how the ownership right has a direct bearing on the sustainability of a system.

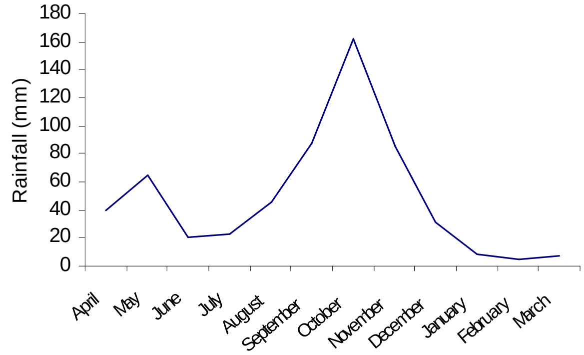

Fig 1. Rainfall pattern in the grassland

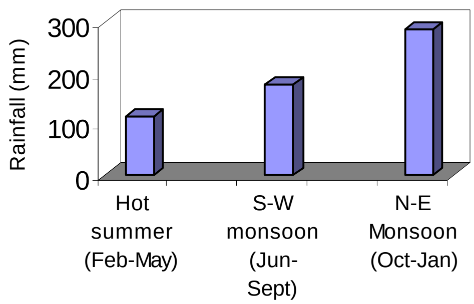

Fig. 2 Seasonal distribution of rainfall in the grassland

Land holding pattern in the grassland

As described in the preceding section, a vast majority of the land is devoted to grazing of livestock although the land use classification does not expressively mention it as grazing land. Looking to the land holding pattern (Table 2) in the grassland, it becomes clear that 57.7% of the total land holding is above 3.0 ha, which could not be brought under cultivation for want of irrigation and they are best utilized as grazing areas only.

Crop and Irrigation

Of the 0.15 million ha net sown area (32.1% of the total, Table 1) in the grassland tract, only 44.1% of it is irrigated. The share of dug well is 67% of the total irrigated area followed by 31.5% by surface water and 1.6% by tube well (Table 3). Each well on an average irrigates 0.48 ha. Digging well in the region is a costly affair because of hard bedrock and the depth of ground water level. The farmers have over generations invested their surplus income in digging wells and deepening them. Most of the wells have either an electric or diesel pump sets to lift the water for irrigation. Big farmers have also installed bore wells/ tube wells besides dug well.

Sorghum (Cholam) is the major cereal crop besides Pearl millet (bajra, cumbu). Sorghum is mainly grown as fodder crop which is harvested and stored for feeding the livestock during periods of scarcity. However, when the rain is good, grain may also be taken besides those grown under wells. Pearl millet is sown usually in July-August as an un-irrigated crop whose straw is also used for livestock feeding. Maize and other minor cereals are also grown.

Vegetation

The phytological studies conducted in the grassland revealed 59 species which included 43 herbaceous (7 perennial, 9 annual grasses, 7 legumes and 20 forbs) and 16 woody species. The grass *Cenchrus ciliaris* was dominant in the region and present at almost all the sites. On the basis of Importance Value Index (IVI) four communities namely, *Cenchrus* community, *Cenchrus-Chrysopogan* community, *Cenchrus-Phaseolus* community and *Dichanthium-Andropogan* community were identified in the grassland.

Livestock holding

The total livestock in the grassland comprising cattle, buffalo, sheep and goat is 1.08 million in the ratio of 1: 0.9 : 2.6 : 1.2. The region is well known for its prized cattle, the Kangayam breed, a medium sized, draught breed, brisk in appearance is used for heavy work. The bullocks are in great demand in whole of south India. It is said that the three things –*Cenchrus* (Kolukattai grass), paddocks with live hedge of *B. Berryi* and Kangayam cattle go together. However, in the recent past there has been rapid decline in the number of Kangayam cattle due to mechanization of agricultural operations. There were 35 buffaloes sq. km^{-1} in the grassland and 135 buffaloes per 1000 human beings (Table 4) as against 28.6 and 91.1 respectively for India as a whole (Kumar, 2004).

Sheep constitutes half of the total livestock in the grassland. Unlike goats, sheep fit very well under the paddock system in the grassland for two reasons. Firstly, they do not damage the live fence by peeling off the bark and secondly, they graze close to the ground. The Mecheri breed of sheep reared in the region is a hairy breed meant for meat production only. Sheep is preferred over zebu cattle. Squires and Sidahmed (1997) have also reported that there are competing land uses between livestock production and cropping and also between forms of livestock production as cattle give way to sheep and goat. The presence of sheep in significant numbers can be appreciated from the fact that there are 115 of them per sq. km and 422 per 1000 human beings (Table 4) as against 17.7 and 57 respectively for India (unpublished data). Although goats are also present in quite substantial numbers, they do not form a part of the paddock system of grassland management for reasons given earlier. The goats are generally grazed along the roadsides and fed on crop residues and kitchen left over.

There is a strong association of livestock and human being in the grassland. For every 1000 human beings there were 879 livestock, which included 148 cattle, 136 buffalo,

Table 1. Land utilization in the Kangayam tract (area in ha)

	Districts		
	Erode	Karur	Total
Forest	2581 (0.82)	312 (0.20)	2893 (0.6)
Barren & Uncultivable	1073 (0.34)	1073 (0.68)	2146 (0.5)
Non-Ag. Use	33871 (10.8)	16910 (10.7)	50781 (10.7)
Cultivable waste	88 (0.03)	46158 (29.2)	46246 (9.8)
Pasture & Grazing land	84 (0.03)	8271 (5.2)	8355 (1.8)
Misc. tree crops	319 (0.10)	360 (0.2)	679 (0.1)
Current fallow	81295 (25.8)	10999 (6.9)	92294 (19.5)
Other fallow	82886 (26.4)	31268 (19.8)	114154 (24.1)
Net area sown	108819 (34.6)	42908 (27.1)	151727 (32.1)
Total Geog area	**314527** (100)	**158259** (100)	**472786** (100)
Total cropped area	111475 (35.4)	45947 (29.0) (29.0)	157422 (33.3)
Area sown more than once	2791 (0.89)	45 (0.02)	2836 (0.6)
Grazing area*	165426	97769	263195
Grazing area as % of total	(52.6)	(61.8)	(55.7)
Paddock area**	84043	40612	124655
Paddock area as % of total	(26.7)	(25.7)	(26.4)
Paddock area as % of grazing area	(50.8)	(41.5)	(47.4)

Figures in ( ) indicate value in percent

*Grazing area =Barren & Uncultivable+Cultivable waste+Pasture & Grazing land+Current fallow+Other fallow

**Paddock area =Barren & Uncultivable+Pasture & Grazing land+Other fallow

Table 2. Land holding pattern in the grassland (ha)

	Districts		
	Erode	Karur	Total
<0.2 ha	0	2625 (2.2)	2625 (0.7)
0.2-0.5	8228 (3.0)	2246 (1.9)	10474 (2.7)
0.5-1.0	21220 (7.8)	9346 (7.8)	30566 (7.8)
1.0-2.0	48994 (17.9)	17518 (14.5)	66512 (16.9)
2.0-3.0	41520 (15.2)	15178 (12.6)	56698 (14.4)
3.0-4.0	32568 (11.9)	12006 (10.0)	44574 (11.3)
4.0-5.0	24947 (9.1)	10747 (8.9)	35695 (9.1)
5.0-7.5	41494 (15.2)	16450 (13.6)	57943 (14.7)
7.5-10.0	21582 (7.9)	10869 (9.0)	32451 (8.2)
10.0-20.0	27060 (9.9)	20693 (17.2)	47753 (12.1)
>20.0	6038 (2.2)	2866 (2.4)	8904 (2.3)
Total	**273000** (100)	**120543** (100)	393543 (100)

Figures in ( ) indicate value in percent

Table 3. Area irrigated by various sources (ha)

		Districts		
		Erode	Karur	Total
Surface water		18234 (35.4)	2862 (18.5)	21096 (31.5)
Ground water				
	Tube well	217 (0.4)	842 (5.5)	1059 (1.6)
	Dug well	33042 (64.2)	11737 (76.0)	44779 (66.9)
	Ground water total	33259 (64.6)	12579 (81.5)	45838 (68.5)
Total irrigated area (ha)		51493	15441	66934

Figures in ( ) indicate share of each source

Table 4. Livestock population and other attributes in the grassland

	Districts		
	Erode	Karur	Total
Population			
Cattle	142989	48112	191101
Buffalo	121375	50982	172357
Sheep	276910	224876	501786
Goats	161861	58910	220771
Total	**703135**	**382880**	**1086015**
Livestock No. ha^{-1}			
Cattle	0.45	0.30	0.38
Buffalo	0.39	0.32	0.35
Sheep	0.88	1.42	1.15
Goats	0.51	0.37	0.44
Total	**2.2**	**2.4**	**2.3**
Adult Cattle Unit (ACU) ha^{-1}			
Cattle	0.44	0.29	0.36
Buffalo	0.37	0.30	0.33
Sheep	0.15	0.24	0.19
Goats	0.09	0.06	0.07
Total	**1.04**	**0.88**	**0.96**
Livestock no. $(1000\ human)^{-1}$			
Cattle	197	99	148
Buffalo	168	105	136
Sheep	382	462	422
Goats	223	121	172
Total	**971**	**786**	**879**

422 sheep and 172 goats. A large number of people depend on livestock to derive their livelihood. The average household size in the grassland is 5, which makes 97366 families. Taking family as a unit, every family owns 1.96 cattle, 1.77 buffalo, 5 sheep and 2.26 goat. Squires and Sidahmed (1997) have reported that a direct correlation exists between wealth and livestock ownership. Farming has never been associated directly with wealth but livestock do.

The livestock pressure expressed as number per ha in the grassland is 2.32 (Table 4) as against 1.48 in India (Pathak and Kumar, 2004), but when converted to adult cattle unit (ACU) it comes out to be 0.96 per ha, a moderate one. On the basis of the total grazing area available, there are 1.77 ACU per ha of grazing area (Table 4) as against 3.42 in India (Pathak and Kumar, 2004). The Tamil Nadu province where the grassland falls has 3.7 ACU per ha grazing area. Thus the pressure on grazing land in the grassland is manageable.

Management of grassland

Under the paddock system of management, the grassland is conveniently divided into paddocks of 2 - 4.5 ha although very large paddocks also exists. The paddocks are separated by straight rows of live fence of *B. berryi*. The live fence of *B. berryi* has width of 0.6 – 0.75 m and height 1.5 m. There are 16 stalks every meter of length of the fence arranged in two rows of 8 each. The hedge is pruned every two years and gap filling is done by planting the stem during June-July. In Edaiyakottai village, *Moringa* trees and *Agave americana* are also grown along live hedge, which provide additional revenue to the farmers. The dominant species in the grassland is *Cenchrus* which has a tussock density of 18-25 per sq. m. Reseeding with seeds of *Cenchrus* is done by broadcasting to boost the forage yield in subsequent years. The paddocks are interspersed with 42-50 *Acacia* trees ha^{-1} which provide shade to the animals at mid-day besides supplying pods (crude protein 14.86%) for feeding and other multipurpose use. A paddock usually has 1 or 2 cattle/ buffalo and 25-30 sheep. The animals are kept in the paddock day in and out for months together and they are rotated between the paddocks as per the fodder availability. The rainfall in the grassland is not sufficient for cultivating cereal crops but they encourage healthy growth of grasses. The grassland usually witness two flushes of grass growth. The minor one occurs after the rain in May and the major one in Sept-Oct. The animals are withheld from the pasture for one month after rain in May and Sept to let the pasture come up well. From mid June to mid September and from mid October to January, the animals remain on pasture alone and are not provided with any supplementary feed. With the spread of dairy co-operatives, the livelihood of the farmers has become closely associated with the dairy animals and hence has started taking care of their animals well. In many areas, progressive farmers plough the field alternate years and sow them with seeds of *P. trilobus* @12.5 kg per ha in October. A very good crop of legume and grass comes up in which the cows/buffaloes are tethered who graze close to the ground. The animals are advanced a few meters every day to get the intake. This practice continues from mid December till mid January, where after the mixed crop is harvested when still green and stored for lean season feeding.

The trend of pushing crops not suitable for an area without the back up of irrigation may result in "Green Famine " as witnessed in many parts if Africa. For example, crop such as maize, not suitable for the unreliable and erratic rainfall were introduced in Africa and year after year "poor" weather have been blamed for its failure to produce grain (Rinaudo, 2002). The Planning Commission of India (2001) also holds the opinion that livestock in the rainfed areas of the country contribute more than 70 percent of the family income and hence recommends that sustainable animal production should be promoted in such areas rather than extending the crops by improving the production of traditional pastures through improved technologies.

During lean season, the animals while still being inside the paddock are provided with supplementary feeding of stored sorghum, pearl millet stalks besides tapioca leaves. The animals in milk are given 1.5 to 2.0 kg rice bran mixed with wheat bran soaked in water overnight. Sheep are provided with 150-200 g of rice bran per head. Besides the *Acacia* pods collected are also fed to animals. In periods of severe draught, palmyra leaves are lopped and fed to animals.

The paddocks which are far off and where daily milk collection is not possible, sheep is the choice of animal reared or alternatively, the farmers buy growing heifers/ dry cows and rear them until calving and then sell off to peri-urban dairies. ILRI (2000) has also said that raising livestock in the drier areas and finishing them in more intensive system closer to the final markets may offer the best option to increase productivity and the best opportunity to improve pastoralist income. The sheep have flourished in the grassland because they are less demanding, hardy and take very little time of the farmer. Once inside the paddock they remain there for months together. However every evening they are herded into a small enclosure inside the paddock (5x 4.5 sq m for 30 sheep) and a dog keeps the guard. Between mid November- mid January, the enclosure is covered with a polythene sheet to protect the sheep from dew in the night.

A typical farmer in the grassland owning 14 ha of land has about 1.6 ha irrigated by well in which sorghum is grown during rainy season which is harvested and stored for animal feeding. The remaining 12.4 ha is divided into 4 paddocks of 2.8 to 3.2 ha each in which 30 Mecheri sheep, 2 crossbred cattle with 3 followers are raised. The farmer sells 50 lambs, 1 newly calved heifer and 1500-1800 litres of milk per year, which is sufficient to sustain the farm and the family.

Lessons in sustainability

The study of the grassland management under paddocks has provided some very interesting lessons in sustainability of the ecosystem. The collective action of the farmers in not letting loose their animals have evolved an organized livestock rearing system. It is mainly because the ownership rights are vested in individual households. The climatic factors limits the agricultural activity but the wisdom of the farmers need to be appreciated in sustaining the system over hundred of years. There are practically no communal grazing lands and most of the grazing area are protected with live fence. Livestock rearing is the major source of livelihood to the farmers and they have evolved practices, which are efficient and labour saving. The farmers need to spend little time in animal management as they remain day in and out inside the paddock for months together adding manure to the field- replenishing the soil and building the organic matter. Knowing the inherent limitation of their soil, the farmers plough their field once in 4-5 years and take a crop and again letting them remain fallow for the fertility to restore. It is thus, a system of lay farming. Irrigation, wherever available is used judiciously raising a crop with a purpose to supplement the animals during lean period. The farmers have identified and used the live fence, which saves them from investing huge sum in securing the paddocks. In earlier times, the Kangayam cattle with Maecheri sheep ruled the grassland but the Kangayam cattle has now lost the favour of the farmers as the demand for draught energy has greatly diminished due to mechanization. Now, Mecheri sheep along with crossbred cattle/ buffalo are dominating the grassland providing income and employment. The practice of cultivating legume with grass, which is adopted by progressive farmers only, need to be widely encouraged. Introducing other legumes like stylo in the grassland will not only improve the biomass production but also provide nutritious fodder to the livestock. Looking to the overall management of the grassland and the livestock, it could be highlighted as a region providing the organic produce from animals. This calls for sensitizing the farmers on this aspect who may readily agree, as their produce will command higher price in the market. The study offers valuable lessons not only for Uganda which is facing drought and degradation of natural resources (IFPRI, 2004) but also to many parts of India and other countries.

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