Indian Journal of Animal Sciences **89**(3): 319–323, March 2019/Article
https://doi.org/10.56093/ijans.v89i3.88096

Livestock population dynamics in *Banni* grasslands of Gujarat

B L MANJUNATHA[1], M SURESHKUMAR[2], PRATIBHA TEWARI[3], DEVI DAYAL[4] and O P YADAV[5]

ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan 342 003 India

Received: 14 August 2018; Accepted: 13 September 2018

ABSTRACT

Banni grasslands in Gujarat are home to migratory pastoralists (*Maldharis*) for more than 500 years. *Maldharis* are landless and dependent on livestock for their livelihood. The study was conducted to measure the long-term growth and instability of different livestock species in *Banni* grasslands from 1977 to 2012. Pastoralists (280) were personally interviewed during 2015 to 2017 to prioritize the factors affecting trends in livestock population using Garrett ranking technique. The Compound Annual Growth Rate (CAGR) in population was highest for *Banni* buffaloes (5.89%) followed by Kankrej cattle (1.78%) and it was negative for goat (-0.29%) and sheep (–0.28%) population. Cuddy Della Valle Instability Index was very high for goat (89%) and sheep population (78%) whereas it was low for buffaloes (31%) and cattle (23%). The severity and duration of drought significantly affected the decline in population of goat and sheep. However, the shift in population of buffaloes and cattle was affected by complex of technological and policy factors. Decline in demand of Kankrej bullocks for agriculture use, low milk productivity of cows, and detrimental impact of regular feeding on *Prosopis juliflora* pods (weakening and dislocation of jaws and gradual death of cows) led to significant increase in population of *Banni* buffaloes when compared to Kankrej cattle. The population growth rate of *Banni* buffaloes (457%) was six times higher than the Kankrej cows (70%) from 1977 to 2012. This trend is most likely to continue in the following years as the migratory pastoralism is being gradually replaced by semi-migratory and sedentary pastoralism and establishment of organized dairy industry. Establishment of dairy units/Milk Collection Centres and improved road connectivity of villages in *Banni* have further facilitated in promotion of *Banni* buffalo based pastoralism as the primary source of livelihood. Composition of different livestock species in 2012 (Buffaloes: 72%, Cattle: 16%, Goat: 7% and Sheep: 6%) indicated the dominance of *Banni* buffalo both in terms of number and contribution to livelihood of pastoralists and overall economy of *Banni* grasslands.

Key words: *Banni* buffalo, *Banni* grassland, Kankrej cattle, Livestock, *Maldharis*

Banni grassland in Bhuj taluka in Kachchh district of Gujarat is spread in about 2600 km^2 area and is the largest natural tropical grassland in Indian subcontinent (Banni 2018, Ramble 2018). *Banni* region experiences arid climate with an average annual rainfall of 317 mm received by southwest monsoon between June-September. Recurrent droughts are a common phenomenon in *Banni* and Kachchh region.

Maldhari is a collective term for the livestock-dependent social groups of Gujarat and pastoralism is especially prevalent in the district of Kutch (Tambs-Lyche 1997). *Banni* grassland is home to migratory pastoralists (known as *Maldharis*) for more than 500 years. Hence, *Maldharis* do not have either individual/private land ownership rights or (legally sanctioned) community grazing rights over *Banni* grasslands. High salinity, low permeability, poor organic matter and poor soil moisture regime also make soil in *Banni* grasslands less suitable for agriculture (Geevan *et al.* 2003). The invasion of *Prosopis juliflora* and ingression of salinity are other rising problems of the region, where *Maldharis* are residing in the region without occupancy right (Chaudhary and Singh 2013). Since the 1950s, the *Banni* has experienced major changes that have largely degraded the quantity, composition and productive potential of its plant populations, having serious repercussions on livestock production.

Banni area comprises 48 hamlets/villages organized into 19 Panchayats with a population of 21,338 people in 2011–12 (Directorate of Animal Husbandry 2016). The nomadic pastoralist communities are generally known as *Maldharis* comprising 22 ethnic communities. *Maldhari* panchayats have united at a regional level as the *Banni* Panchayat Parishad, which is the regional body addressing various issues concerned with *Banni* grasslands and *Maldharis*. *Banni Pashu Uchherak Maldhari Sangathan* (Banni Breeders' Association), formed in 2008 is a registered

Present address: [1]Scientist (manju4645@gmail.com), [3]Principal Scientist and Head (pratibhatewari1@gmail.com), Division of Transfer of Technology and Training, [5]Director (director.cazri@icar.gov.in). [2]Scientist (suraforestry@gmail.com), [4]Principal Scientist and Head (ddayal58@gmail.com), Regional Research Station, Bhuj, Gujarat.

society which is also working to address various socio-economic and livelihood issues of *Maldharis* in *Banni* area such as conservation and improvement of grasslands and native livestock breeds, recognition of community grazing and land use rights over *Banni* region, developing organized dairy market in the region and other issues (The Biocultural Community Protocol of Maldharis of Banni 2010). *Maldharis* are landless, and migratory pastoralism is the main source of livelihood. They are dependent on *gauchars* (village commons) for their livestock rearing. *Banni* buffaloes, *Kankrej* cows, *Pathanwadi* and *Duma/Marwari* sheep, *Kachchhi* goat, *Kachchhi* and *Tari* camel and *Sindhi* horse are the domesticated animals. Banni buffalo was recognized as the distinct buffalo breed of the country in 2010 (NBAGR 2018). Livestock constitute as the predominant source of employment and income for Maldharis in *Banni* grasslands even to this date. In this context, it was of immense importance to explore the nature and extent of different livestock species in *Banni* grasslands over a period of time. The specific objectives of this research paper were to measure the long-term growth and instability trends in livestock population in *Banni* grasslands and delineate the factors behind such a growth and instability.

MATERIALS AND METHODS

The study was conducted in *Banni* grasslands in Bhuj taluka of Gujarat's Kachchh district using both primary and secondary data. The secondary data on population of different livestock species in *Banni* grasslands from 1977 to 2012 were collected from different sources (Vijay Kumar *et al.* 2011, Directorate of Animal Husbandry 2016, MoA 2012). The data on livestock population as per 19th Livestock Census 2012 (MoA 2012) was available in published form for district level. Livestock data (census 2012) pertaining to 48 villages under Banni grassland was personally collected by the researchers from the office of the Animal Husbandry Department in Bhuj specifically for this study. This data was not in any published form. The Compound Annual Growth Rate (CAGR) method was used to measure the population growth rate of various livestock species. It gives year-over-year growth rate of a variable under study (population) over a specified period of time. The CAGR is calculated by taking the nth root of the total percentage growth rate, where n is the number of years in the period being considered. It was calculated using the following formula:

$$CAGR\ (t_0, t_n) = \left(\frac{V(t_n)}{V(t_0)} \right)^{\frac{1}{tn-t_0}} - 1$$

where, $V(t_0)$, Start value (value at the beginning of the year); $V(t_n)$, Finish value (value at the end of the year); and $(t_n - t_0)$, Number of years.

The Cuddy-Della Valle Instability Index (Cuddy and Della Valle 1978) was used to measure the instability in population growth of different livestock species in Banni grasslands using the following formula:

$$CD = CV(1-R^2)^{0.5}$$

where CD, Cuddy-Della Valle Instability Index; CV, Coefficient of Variation in population (%); and R^2, Coefficient of Determination adjusted for number of degrees of freedom obtained from trend regression in equation.

The exhaustive list of factors affecting changes in livestock population and composition was prepared based on extensive review of literature and discussion with key pastoralists, experts and stakeholders during a pilot study conducted in January 2015. The primary data was collected from 280 pastoralist households (sample size) from 12 villages in *Banni* grasslands (Dhordo, Hodko, Patgar, Uddo, Varli, Sadai, Burkhal, Mehar Aliwand, Madhavnagar, Udai, Sargu Nava and Bhirandiyara) between January 2015 and June 2017 by personal interview method using a structured interview schedule. An *ex-post facto* and survey research design was adopted for the study. Respondents were asked to rank various factors affecting the change in population of different livestock species using Garrett ranking technique. The outcome of such ranking was converted into score value with the help of the following formula:

$$\text{Per cent position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

where R_{ij}, Rank given for the ith variable by jth respondent; and N_j, Number of variables ranked by jth respondent. In the study $N_j = 5$.

With the help of Garrett's table, the % position estimated is converted into scores. For each factor, the scores of each individual are added and total value of scores and mean values of score is calculated. The factor having highest mean value is considered most important.

Focussed group discussions were held with other stakeholders such as representatives of *Banni* region, researchers/academicians and NGOs/CSOs working in *Banni* grasslands to validate the primary data. The published secondary sources were also used to supplement the primary data.

RESULTS AND DISCUSSION

Growth and instability in population of different livestock species in Banni area: It is estimated that there were approximately 50,000 Kankrej cattle in *Banni* grasslands in late 1960's. It could be seen that population of all livestock species has seen a great decline in the period between 1982 and 1992 (Table 1). This was mainly attributed to severe and consecutive droughts experienced by the region in this period as there were severe and very severe droughts (<50% of average rainfall) during 1982, 1985, 1986, 1987 and 1991 and mild and moderate droughts (50–75% of average rainfall) during 1984 and 1990 (Vijay Kumar *et al.* 2011). The decline in population was severe in case of sheep and goat due to large scale deaths, out migration and distress sale to cope with severe and successive droughts. The decline in cattle population was higher than the buffaloes. Other than this period, the

Table 1. Absolute change in population of livestock species in *Banni* grasslands (1977–2012)

Species	1977	1982	1992	2007	2012
Buffalo	8789	21957	16776	27626	48982
Cattle	6295	9640	6065	11006	10681
Goat	5173	3726	1006	12537	4746
Sheep	4379	12791	1399	5892	4022

population of buffaloes has increased continuously. The population of cattle, sheep and goat declined again between 2007 and 2012. Compound Annual Growth Rate (CAGR) in the entire period from 1977 to 2012 was highest for buffaloes (5.9%) and was three times higher than the Kankrej cows (1.8%). The CAGR for goat (–0.29%) and sheep (–0.28%) was found to be negative indicating that their population has marginally declined during this period (Table 2).

In good rainfall years, it has been estimated that over 20,000 small ruminants, principally sheep, are brought into this region from Rajasthan to graze. During four consecutive years of regional drought, from 1986–89, large numbers of cattle and migrating small ruminants virtually eliminated many of the scattered pockets of vegetation that remained in Banni. However, the prolonged length of the drought finally resulted in massive livestock die-offs and a general out-migration of cattle during that period often to South Gujarat covering distances up to 800 km (Bharara 1987; Bharara 1993). Rathore (1993) in his study on livestock population dynamics between 1951 and 1988 in Rajasthan reported that intensity of droughts was the factor that influenced the differential growth rates of various types of ruminants. As seen in the study, even at the national level, the number of cattle and buffaloes has increased from 77.04 million to 80.52 million between 2007 and 2012 showing a growth of 4.51%. There is a decline in the population of sheep and goat by 9.07% and 3.82% respectively (MoA 2012).

The instability in population growth was highest for goat (89%) and sheep (78%) indicating that their numbers varied drastically depending on absence or presence of drought and its severity. Goat and sheep herders either sold these animals or migrated outside the region during severe droughts. Around 400 camels were reported to be present in Banni grasslands in 2007 but their population has reduced drastically after this period. In 2012, around 950 horses were reported in the region. The Human:Livestock population ratio in *Banni* grasslands in 2012 was 2.73 indicating that there were approximately three livestock heads for every human being.

The livestock population in Banni grasslands as per 2011–12 household survey data (Directorate of Animal Husbandry 2016): Buffaloes (48,982) constituted 72% of livestock population in Banni grasslands followed by cattle (10681) at 16%. The goat (4746) and sheep (4022) together contributed 13% of livestock population. Further, buffaloes constituted 82% among major ruminants (buffaloes and cattle). Shah *et al.* (2010) in their study conducted in three villages in Bhitara panchayat in Banni grassland reported that population of buffaloes, cattle, goat and sheep ranged from 77–82%, 10–21%, 3–7% and 0–1%, respectively.

Breeding of Kankrej bullocks for draught purpose was the traditional occupation of Maldharis until 1970's. They bred and sold these animals to farmers in Gujarat and other parts of the country. Until 1970's, Banni buffaloes were domesticated mainly for meeting household requirements of milk and milk products. However, since late 1970's there has been a gradual shift in livestock population in favour of Banni buffaloes over Kankrej cows. It was evident from table 2 that the growth rate of Banni buffalo (457%) between 1977 and 2012 was more than six times the Kankrej cattle (70%).

Change in vegetation pattern, especially invasion of *Prosopis juliflora* is unanimously attributed by pastoralists as one of the main reasons for this occupational shift. Feeding on *P. juliflora* pods (containing hard seeds) over a period of time leads to weakening and dislocation of jaws in cows gradually leading to their death. Pastoralists expressed that Banni buffaloes do not prefer to feed on *P. juliflora* pods whereas cows prefer them. Even when buffaloes feed on *P. juliflora* pods, they are less susceptible to its ill effects compared to cows.

Forest department introduced *P. juliflora* in 1960–61 on 31,500 ha to stop the advancement of Rann. However, *P. juliflora* soon spread throughout Kachchh via the ingestion of its fruit (pod) by cattle, and the distribution of its scarified seed in faeces (Shukla *et al.* 1984). *P. juliflora* occupied 33% of *Banni* in 2009 and would cover 57% area by 2020 (SAC 2002). Rapid expansion of *P. juliflora* resulted in loss of natural habitats, degradation of natural resources and significant loss of native biodiversity (Shah *et al.* 2010; Deepa 2009).

Mechanization of agriculture in Kachchh and other parts of Gujarat has led to reduction in use of bullocks for draught purpose. Consequently, the demand for Kankrej bullocks has also reduced drastically. Establishment of milk

Table 2. Growth rate and instability in population of livestock species in *Banni* grasslands (1977–2012)

Species	% Growth					CAGR	CDV Instability Index
	1977–1982	1982–1992	1992–2007	2007–2012	1977–2012		
Buffalo	149.82	–23.60	64.68	77.30	457.31	5.89	31.29
Cattle	53.14	–37.09	81.47	–2.95	69.67	1.78	22.87
Goat	–27.97	–73.00	1146.22	–62.14	–8.25	–0.29	89.48
Sheep	192.10	–89.06	321.16	–31.74	–8.15	–0.28	77.67

collection centres/dairy units in the region has played a vital role in growth and development of Banni buffalo based dairy enterprise. The productivity of Banni buffaloes (more milk with high fat content) is higher and hence they are more preferred over cows. Hence, number of Banni buffaloes has increased drastically since 1980's when compared to Kankrej cows (Table 3). Improved road connectivity of villages in *Banni* area to Bhuj city and other towns and supply of Narmada canal water for drinking purpose have further acted as facilitating factors. These push and pull factors have led to a shift in occupational structure of pastoralists in *Banni* region. These factors have together contributed in development of organized dairy industry in Banni area. The frequency and duration of migration has also reduced resulting in gradual sedentarization of pastoralists. Sedentarization of pastoralists is now widespread, both because of active government policies and because of lack of support for migratory pastoralism (Sharma *et al.* 2003). Presently, rearing of Banni buffaloes for production and sale of milk and milk products is more predominant economic activity in the region.

Table 3. Factors that affected shift in population from Kankrej cattle to Banni buffaloes (n=280)

Factor	Mean Score	Rank
Decline in demand of Kankrej bullocks for agriculture purpose	89.11	I
Invasion of *Prosopis juliflora* in Banni grasslands	81.23	II
Milk productivity of Banni buffaloes is higher than Kankrej cattle	71.54	III
Establishment of dairy units/Milk collection centres in Banni area	63.89	IV
Policy interventions in favour of developing organized dairy industry (Better road connectivity, establishment of grass depots, etc.)	62.76	V

It is evident from tables 1 and 2 that population of goat and sheep between 1977 and 2012 has decreased marginally. There was a consensus among the pastoralists and other stakeholders that the main factor behind differential growth of goat and sheep was severity of drought and its duration. Gradual sedentarization of pastoralists has also contributed to decline in number of migratory pastoralists owning small ruminants. Studies by Rathore (1993) and Casimir (1996) also support these findings. Sheep and goat rearing was a primary occupation for only 3% households at present in *Banni* grasslands.

The Kankrej cattle are basically dual purpose (milch and draft) breed. However, the use of bullocks of this breed in agriculture has reduced drastically due to mechanization. Hence, domestication of Kankrej breed only for milk production is less economical when compared to Banni buffalo as evident in Table 4. The characteristics of Banni buffalo as milch animal such as age at first calving, calving interval, lactation yield, lactation length and fat content in milk are superior to Kankrej cattle (NBAGR 2018).

Table 4. Economics of milk productivity of Banni buffalo and Kankrej cow per lactation

Breed	Average lactation yield (litres)[@]	Average fat content (%)	Price of milk (₹/fat unit)*	Gross returns/ Animal (₹)	Gross Expenditure/ Animal (₹)	Net return/ Animal (₹)
Banni buffalo	2500	6	3.5	52,500	30,500	22,000
Kankrej cow	1700	3.5	3.5	20,825	10,400	10,425

[@]Lactation yield under farmer conditions is taken. *Price prevalent in *Banni* area in April 2016.

The significance of *Banni* buffaloes in livelihood of pastoralists in particular and the economy of Banni region in general become much more profound when it is noted that *Banni* buffaloes constituted 82% among major ruminants. *Banni* buffalo based pastoralism and *P. juliflora* based charcoal preparation were the major primary occupations for 70 and 20% households respectively at present. Further, charcoal preparation was the predominant secondary occupation for 60% households. Banni buffalo based pastoralism was found to be the most sustainable livelihood option in *Banni* grasslands from ecological, economic and socio-cultural parameters. Goat and sheep rearing was found to be more sustainable in the long run than charcoal production. It is to be noted that goat and sheep rearing is the primary occupation for only 3% households at present whereas charcoal preparation employs 20% households (Manjunatha 2015). Management of *P. juliflora* and rejuvenation of native grasses and shrubs is critical both for the sustainability of livelihoods and grassland ecosystem.

The pre-existing pasturage rights of Maldharis over *Banni* grasslands have to be recognized. Granting Community Rights to *Maldharis* over *Banni* would help them to develop village level plan for conservation, development and management of grassland to enhance their livestock based livelihood. The management of *Banni* grassland as a Protected Forest needs to be amended transferring it into a joint management framework involving pastoral communities and Forest Department (Geevan, Dixit and Silori 2003; The Biocultural Community Protocol of *Maldharis* of *Banni* 2010; Joshi *et al.* 2015). *Maldharis*' demand for community grazing rights over *Banni* grasslands is approved in-principle by the government but requires speedy implementation.

The study found that population growth rate between 1977 and 2012 was 457% for Banni buffaloes, 70% for Kankrej cattle and negative for sheep and goat (–8%). The population of goat and sheep was more sensitive to severity and duration of drought. Since late 1970's, there was a gradual shift in population in favour of Banni buffaloes over Kankrej cattle. Decrease in demand of Kankrej bullocks

because of mechanisation in agriculture, their susceptibility to *P. juliflora* invasion, low milk productivity in comparison to Banni buffaloes have contributed to significant increase in buffalo population. Establishment of dairy units/Milk collection centres has further acted as incentive for Banni buffalo based pastoralism. Composition of different livestock species in 2012 (Buffaloes: 72%, Cattle: 16%, Goat: 7% and Sheep: 6%) indicated the dominance of Banni buffalo both in terms of number and contribution to livelihood of pastoralists. Scientific management of *P. juliflora* is required to improve the livelihoods and ecological sustainability of grassland.

REFERENCES

Banni. 2018. Biodiversity. Retrieved from http://banni.in/biodiversity/grasslands/, Accessed on 18 April 2018.

Bharara L P. 1987. Preliminary report on Socio-economic survey of Banni area, Kutch District (Gujarat). Central Arid Zone Research Institute, Jodhpur, 44 p.

Bharara L P. 1993. Socio-economic aspects of Banni pastoralists and factors effecting changes in their perceptions toward the future. *Pastoralism and Pastoral Migration in Gujarat,* Cincotta. (Eds) R.P. and Pangare G. Institute of Rural Management, Anand, India.

Chaudhary A P and Singh K P. 2013. Social status of Maldharis in Banni area of Kachchh. *AGRES – An International e-Journal* **2**(2): 190–95.

Cuddy J D A and Della Valle P A. 1978. Measuring the instability of time series data**.** *Oxford Bulletin of Economics and Statistics* **40**: 79–85.

Deepa G J. and Lakhmapurkar J J. 2009. Soil salinity versus *Prosopis juliflora* growth –A case of Banni grasslands. Proceedings of the National Symposium on *Prosopis*: Ecological, Economic Significance and Management Challenges, February 20–21, Gujarat Institute of Desert Ecology, Bhuj-Kachchh.

Directorate of Animal Husbandry. 2016. Livestock data pertaining to 48 villages in Banni grasslands collected by researchers from Animal Husbandry Office, Bhuj (Agriculture, Farmers Welfare and Cooperation Department, Government of Gujarat) specifically for this study.

Ferroukhi L. 1994. 'An ecological groundwater harvesting under threat. A case study of the Banni pastoralist's knowledge in the grasslands of the Kachchh district, Gujarat state, India.' MSc Thesis, Swedish University of Agriculture.

Geevan C P, Dixit A M and Silori C S. 2003. Ecological-Economic Analysis of Grassland Systems: Resource Dynamics and Management Challenges–Kachchh District (Gujarat). EERC Working Paper Series: CPR-5, Gujarat Institute of Desert Ecology, Bhuj, p 1–145.

Joshi P N, Bhatti R, Das S. 2015. Traditional conservation of buffalo breed by pastoralists through maintaining of grassland ecosystem, Banni-Kachchh, Gujarat-India. *Proceedings of the XXIII International Grassland Congress* 2015, 20–24 November 2015, New Delhi.

Manjunatha B L, Shamasudheen M, Dayal D, Tewari P and Bhatt R K. 2015. Analysis of livelihood structure of pastoralists in Banni grassland in Kachchh district of Gujarat in India. *Proceedings of the XXIII International Grassland Congress* 2015, 20–24 November 2015, New Delhi.

Michael J Casimir. 1996. *Commission on Nomadic peoples: Some recent publications on pastoralism in the arid lands of western India* (*Rajasthan and Gujarat*): *A review,* pp 155–162, International Union of Anthropological and Ethological Sciences (IUAES).

MoA. 2012. 19th Livestock Census. All India Report. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, New Delhi, pp 1–130.

National Bureau of Animal Genetic Resources. 2018. Banni Buffalo Accession Number: INDIA_BUFFALO_0400_BANNI_01011. Registered breeds of buffalo. Retreived from http://www.nbagr.res.in/regbuf.html, Accessed on 29 May 2018.

Ramble. 2018. Baani. Website of Research and Monitoring in the Banni Landscape (RAMBLE): http://www.bannigrassland.org/AboutBanni.htm. Accessed on 18/04/2018.

Rathore M S. 1993. *Marketing of goats in Rajasthan. Studies on goat production and fodder resource management in Rajasthan. Jaipur/Ajmer, Rajasthan,* pp74, Institute of Development Studies (IDS) and Indo-Swiss Goat Development and Fodder Production Project, Ajmer. ISBN 81-713-056-5.

SAC. 2002. *Prosopis juliflora* mapping in Saurashtra and Kachchh, Gujarat using remotely sensed data and GIS technique. Space Application Centre, ISRO, Ahmedabad, Gujarat, pp 1–30.

Saxena S K. 1993. Present status of the Banni Grassland. *Pastoralism and Pastoral Migration in Gujarat*. (Eds) Cincotta R P and Pangare G. Institute of Rural Management, Anand, India.

Shah J P, Patel A M and Joshi P N. 2010. Participatory natural resource mapping: A case study of Bhitara panchayat in Banni grassland, Kachchh (Gujarat). *Asian Journal of Environmental Sciences* **5**(2): 192–98.

Sharma V P, Köhler-Rollefson I and Morton J. 2003. *Pastoralism in India: A Scoping Study,* pp.1–63. Centre for Management in Agriculture, Indian Institute of Management (IIM), Ahmedabad (India) and the League for Pastoral Peoples, Ober-Ramstadt, Germany.

Shukla P C, Talpada P P and Pande M B. 1984. Agro-Industrial byproducts as livestock feed. *P. juliflora* pods a new cattle feed source. Technical Bulletin. ICAR-Animal Nutrition Department, Gujarat Agricultural University, Anand, India.

Tambs-Lyche H. 1997. *Power, Profit, and Poetry: Traditional Society in Kathiawar, Western India*. Manohar Publishers, New Delhi.

The Biocultural Community Protocol of Maldharis of Banni. 2010. Banni Pashu Uchherak Maldhari Sangathan, Bhuj, Gujarat, pp 1–38.

Vijay Kumar V, Nikunj Gajera and Pratiksha Patel. 2011. Grasslands of Kachchh, pp 113–132. *State of Environment in Kachchh.* (Eds) Kathju K, Vijay Kumar V, Thivakaran G A, Patel P and Veluswamy D. Gujarat Ecological Education and Research (GEER) Foundation, Gandhinagar and Gujarat Institute of Desert Ecology (GUIDE), Bhuj.