



Ecological, economic and socio-cultural sustainability of different livelihood options and enterprises practised by pastoralists in *Banni* grasslands of Gujarat

B L MANJUNATHA¹✉, M SHAMSUDHEEN², M SURESHKUMAR³ and PRATIBHA TEWARI¹

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

Received: 11 September 2020; Accepted: 17 July 2021

ABSTRACT

The present study was conducted in Banni grasslands to estimate the sustainability of different livelihood options practiced by pastoralist households. The sustainability of livelihood options was measured using a scale consisting of ecological, economic and socio-cultural parameters with 6 indicators each. The primary data were collected from 280 households in 12 villages in Banni grasslands between 2014 and 2019. It was found that there were 11 distinct livelihood options practiced in Banni grasslands: *Banni* buffalo based pastoralism, goat and sheep rearing, *Prosopis juliflora* based charcoal production, honey collection, gum extraction, embroidery, leather work, labour, services, tourism and trade. The sustainability of buffalo rearing was found to be highest on ecological, economic and socio-cultural indicators. Migratory pastoralism has evolved over five centuries adapting to climatic and man-made changes, has deep socio-cultural heritage and employed 70% households at present while generating highest revenues to individual households and the Banni economy. The economic sustainability of charcoal production was higher than the goat and sheep rearing whereas the ecological and socio-cultural sustainability of the latter was higher. Charcoal production employed 80% households (as primary and secondary enterprise) whereas goat and sheep rearing employed merely 3% households indicating the economic significance of the former enterprise. It was evident that economic sustainability was the immediate goal of individual pastoralist households to attain income, food and nutritional security. Goat and sheep rearing could provide an alternative to charcoal production while being more sustainable. Charcoal production was an adaptation strategy for livelihood security. Control of *P. juliflora* will have positive implications on the ecology of Banni grasslands and livelihoods of pastoralists. The recognition of community grazing rights of Maldharis over Banni grasslands would further augment this shift. Similarly, handicrafts (embroidery and leather craft) and trade offer sustainable alternatives to charcoal production in the context of expanding tourism and market access.

Keywords: Banni buffalo, Banni grassland, Charcoal production, Livelihood, Maldharis, *Prosopis juliflora*, Sustainability

The nomadic pastoralist communities in Banni grasslands are generally known as Maldharis, comprising 22 ethnic communities. Migratory pastoralism is their principal livelihood over five centuries and agriculture is not practiced in the entire Banni grasslands. Maldharis are landless and are dependent on gauchars (village commons) for their livestock rearing. *Banni/Kundi* buffaloes, *Kankrej* cattle, *Pathanwadi* and *Duma/Marwari* sheep, *Kachchhi* goat, *Kachchhi* and *Tari* camel and *Sindhi* horse are the domesticated animals. Banni buffalo was recognised in 2010 as the eleventh buffalo breed of the country by ICAR-National Bureau of Animal Genetic Resources (NBAGR), Karnal (NBAGR 2020). Livestock rearing was and is the predominant source of livelihood for pastoralists.

During princely rule (1875–1942), the Maharao of

Present address: ¹ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan. ²ICAR-Directorate of Cashew Research, Darbe (P.O), Puttur, Dakshina Kannada, Karnataka. ³Regional Research Station, Bhuj, Gujarat. ✉Corresponding author e-mail: B.Manjunatha@icar.gov.in

Kachchh declared Banni as a *Rakhal* (reserve grassland) where only milch cattle were allowed to graze, and sheep and goats were strictly prohibited. Permanent human settlements were also not allowed. However, later sheep and goats were also allowed to graze in the area but grazing was regulated by imposing fee at various rates for different categories of livestock ranging from ₹ 0.12 per annum for each sheep and goat to ₹ 2.5 for buffaloes. These grazing regulations were in force until 1957. Later, the grazing regulations slowly disappeared, and open access regime emerged. All kinds of livestock from every part of the state and neighboring states gained free entry into the area. Besides resident livestock, large numbers of livestock used to immigrate for grazing during 3–4 months of monsoon (Bharara 1987; Bharara 1993; Ferroukhi 1994). After independence, Revenue Department of Gujarat state designated Banni as revenue wasteland, which was managed as grassland, mainly to meet the fodder demand of the livestock under the ownership of the Revenue Department. It was declared a “Protected Forest” in May

1955, using the nomenclature of the Indian Forest Act, 1927. Since then, the actual transfer of the land from the Revenue department to the Forest department has not been completed. Hence, Maldharis do not have either individual/private land ownership rights or (legally sanctioned) community grazing rights over Banni. Historically, agriculture is not practised in the entire Banni area. 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). Only grazing land was available and no agriculture was practiced. The invasion of *Prosopis juliflora* and ingress of salinity are other rising problems of the region, where Maldharis are residing in the region without occupancy right (Chaudhary and Singh 2013).

Plantation of *P. juliflora* is an important landmark in the history of Banni grasslands because of its huge unintended ecological and socio-economic impact. *P. juliflora* was planted during 1960's by Gujarat State Forest Department on 31,550 ha (315 km²) to fight salinity ingress and barrenness/desertification (Vijay Kumar *et al.* 2011; RAMBLE, 2020; Banni 2020). This species was chosen because of its ability to establish and survive in the saline soils and low moisture regimes. The invasion of *P. juliflora* was severe because of its competitive advantage over native species and dispersal of its seeds by the livestock. The rapid invasion of *juliflora* has resulted in drastic reduction of grazing areas, both in terms of extent and species composition. It has also reduced the population of native woody species such as *A. nilotica*, *A. senegal*, *S. persica*, *S. oleoides* and *P. cineraria*. The prevailing conditions in Banni, including successive droughts, increasing salinity and excessive grazing pressure provided highly suitable environment for the growth and spread of *P. juliflora*. Once the species found optimum soil and climatic condition for the growth and development, it rapidly increased in other parts of grasslands in a very little time (Tewari *et al.* 2000). The ecological succession changed the structure of vegetation complex and entire area was dominated by *P. juliflora* in terms of distribution, abundance, basal cover and canopy cover (Tewari *et al.* 2011). By 2010's *juliflora* has spread to 1,500 km² in Banni (SAC, 2002; RAMBLE, 2020).

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. The growth rate of Banni buffalo (457%) between 1977 and 2012 was more than six times the Kankrej cattle (70%) (Manjunatha 2019a). 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 when compared to cows (Manjunatha 2019a).

Significant changes have occurred in Banni after independence such as declaration of Banni as Protected Forest, invasiveness of *P. juliflora*, shift in livestock composition (from cattle to buffalo), lack of community grazing rights of Maldharis over Banni, improved road connectivity and gradual establishment of organized dairy industry (Manjunatha 2019a; Manjunatha 2019b). Traditional migratory pastoralism has been gradually replaced by semi-migratory pastoralism and sedentary livestock based dairy enterprise. These changes have affected the livelihood structure and income of pastoralists in a significant way.

The present study was aimed at finding the livelihood options practiced by the pastoralist households at present and their sustainability from economic, ecological and socio-cultural indicators. The specific objectives of this research article are to study the nature and extent of livelihood options practiced by pastoralists in Banni grasslands; and to estimate the sustainability of different livelihood options practiced by pastoralists in Banni grasslands.

MATERIALS AND METHODS

Research design: An *ex-post facto* and survey research design were adopted for the study.

Locale of the study, sample and sampling procedure: Banni grasslands located in Bhuj taluka in Kachchh district of Gujarat was purposively selected as the study area. There are 48 villages in the administrative jurisdiction of Banni grasslands. Twelve villages (Dhordo, Hodko, Patgar, Uddo, Varli, Sadai, Burkhal, Mehar Aliwand, Madhavnagar, Udai, Sargu Nava and Bhirandiyara) were selected for the study using stratified sampling technique to represent different parts of Banni.

Data collection tools and analysis: A structured interview schedule was developed specifically for the study. The primary data were collected between July 2014 and June 2019 by personally interviewing 280 households selected randomly from these 12 villages. The respondent households were classified into various categories based on the combination of primary and secondary occupations contributing to family annual income. Annual incomes were calculated for the agricultural year 2016–17 based on the prices prevailing in Banni grasslands in April 2017 (Manjunatha 2019b).

Sustainability of different livelihood opportunities and enterprises was measured adopting the GTZ Sustainet parameters of sustainability (GTZ, Sustainet, 2006). The scale was modified to suit the objectives and variables of the present study. The scale consisted of three components/

parameters: ecological, economic and social and cultural sustainability. Each component/ parameter consisted of six indicators (Tables 2, 3, and 4). Pastoralists' responses to the indicators under each of the three components of sustainability were sought as to whether they agreed or disagreed with the statement with scores of 1 and 0 respectively. The mean values of ecological, economic and socio-cultural sustainability were calculated to assess the relative sustainability of different components of a livelihood option/ enterprise. The overall mean sustainability was calculated to measure the relative sustainability of different livelihood options and enterprises. The overall mean sustainability scores were converted into percentile scores for comparison of sustainability of different livelihood options and enterprises.

The primary data collected from pastoralist households was corroborated through extensive field visits in Banni grasslands, field visits to pastoralists' livestock yards at their home and during migration. Charcoal production units were visited. Embroidery and leather work products were observed at the selected respondents' houses and at exhibition stalls during Rann Utsav. Focussed group discussions were held with key pastoralists in each village and other stakeholders such as representatives of Banni region (Banni Breeders Association), researchers and NGOs (Gujarat Institute of Desert Ecology (GUIDE), SAHJEEVAN, Research And Monitoring in the Banni Landscape (RAMBLE), Ashoka Trust for Research in Ecology and the Environment (ATREE)) working on Banni grasslands to validate the primary data collected from pastoralists.

RESULTS AND DISCUSSION

Nature and extent of livelihood options practised by pastoralist households in Banni grasslands

The respondent households were grouped into various categories based on the combination of different primary and secondary occupations contributing to annual family income (Table 1).

The results in Table 1 indicated that there were eleven distinct livelihood options and enterprises practiced by the pastoralists in Banni grasslands. Among these, Banni buffalo based pastoralism, *Prosopis juliflora* based charcoal production, sheep and goat rearing, leather work, services, tourism and trade were the primary occupations (contributing highest share (%) among all livelihood options practiced by the household) whereas embroidery, honey collection, gum collection and labour were the secondary occupations (Manjunatha 2019b). Few households in each village owned 2 to 3 cows. The number of households who exclusively owned cows in large numbers was found to be rare (< 2%). Pastoralists shared that number of Kankrej cows in each household was higher than Banni buffaloes till 1960's. Since then, there was a gradual shift towards buffalo based pastoralism. The number of families who owned sheep and goat was very low and the herd size was also very low in majority of these families. The number of pastoralists who owned camels was very low (< 1%) although the average herd size was very high (Manjunatha 2019a).

Critical analysis of the livelihood structure in Banni grasslands indicated that the region is still a traditional society predominantly based on primary sector both in terms of number of households employed and income generated. Livestock rearing was a primary occupation for 73% households and charcoal production supported 20% households. The share of secondary and tertiary sector in employment and income was very low (approximately 3% each). Secondary sector included embroidery and leather work which were again traditional occupations. The employment in tertiary sector was restricted to services and tourism. Even those who were in services were in unorganized sector (drivers) or were unskilled and semi-skilled labourers in factories.

Household and hired labour was an integral and indispensable part of all livelihood options practiced in Banni grasslands. However, labour, in the present study

Table 1. Occupational structure of pastoralist households in Banni grasslands (N = 280)

Category	Primary occupation	Secondary occupation 1	Secondary occupation 2	Number of households	% households
I	Buffalo rearing				
IA	> 40 animals	Charcoal production	Tourism/ embroidery	8	2.9
IB	21–40 animals	Charcoal production	Embroidery/ tourism	20	7.1
IC	11–20 animals	Charcoal production	Embroidery/ leather work	56	20.0
ID	6–10 animals	Charcoal production	Embroidery/ leather work	70	25.0
IE	< 6 animals	Charcoal production	Embroidery/ leather work	42	15.0
II	Charcoal production	Labour work (including migration)	Goat rearing/ embroidery	56	20.0
III	Sheep and goat rearing	Charcoal production	Labour work (including migration)	8	2.9
IV	Handicrafts (leather work)	Charcoal production	Embroidery	8	2.9
V	Services	Charcoal production	Embroidery	6	2.1
VI	Other (trade, etc.)	Labour work	Charcoal production	6	2.1
Total				280	100.0

Source: Manjunatha (2019b).

meant labour engaged in Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) and agricultural and non-agricultural labour during migration outside the Banni grasslands.

Sustainability of different livelihood opportunities and enterprises in Banni grasslands

The sustainability of these 11 livelihood opportunities in Banni grasslands was studied and the results are presented in Tables 2 to 5.

(a) *Ecological sustainability*: Pastoralism is the traditional and predominant occupation in the Banni grasslands practiced over 500 years. The region has experienced a shift in composition of livestock over a period of time and Banni buffalo based pastoralism is the predominant occupation at present (Manjunatha 2019a, Manjunatha 2019b). Few households also owned Kankrej cows and a very small percentage (<2%) of households owned camels. Pastoralists have developed their own Indigenous Traditional Knowledge (ITKs) for maximizing productivity of each enterprise without affecting its sustainability. These enterprises have evolved over five centuries adapting to climate and manmade changes is an indicator in itself of their ecological sustainability.

Agriculture is not practiced in the entire Banni grasslands and pastoralism is the main source of livelihood. Livestock rearing (buffalo, cow, goat, sheep and camel) as pastoralism and semi-pastoralism as practiced in Banni grassland would add manure to the soil and improve its fertility. Hence, the soil and ecosystem is least disturbed. Tubewells are not dug for agricultural purposes and hence exploitation of groundwater was nil. Native grass and shrub species and pastoralism are interconnected parts of a system and add to the sustainability of each other.

Plantation of *P. juliflora* in 1960's in Banni grasslands had huge unintended ecological and socio-economic consequences. The rapid invasion of *P. juliflora* (from 315 km² in 1960's to 1,500 km² in 2010's) has resulted in drastic reduction of grazing areas and loss of biodiversity. Ban on harvest of *P. juliflora* was placed in 1980's and was lifted in 2004. Ban on tree's harvest was re-imposed in 2008 considering the unregulated felling. From 2009 onwards, its cutting is regulated by Gujarat State Forest Development Corporation (GSFDC) Limited through contracting/licensing. Charcoal production was found to be less sustainable from ecological perspective since it is completely based on cutting of *Prosopis juliflora*. Pastoralists agreed that control/management of *P. juliflora* was required for restoration of native grass and shrub species.

Honey and gum collection were secondary occupations practiced by the Vadha Koli community. These occupations were dependant on flora in the region. However, these occupations did not contribute to soil fertility and conservation of water. Hence, the sustainability of these enterprises was low. Four indicators of the ecological sustainability were not relevant to embroidery, services and

leather work leading to low sustainability scores.

Buffalo and cow rearing and goat and sheep rearing were found to be the most sustainable enterprises from ecological point of view.

The time dimension in ecological sustainability was highest compared to ecological and socio-cultural sustainability. Ecological sustainability reflects the sustainability of different enterprises over a long period of time. The time dimension is in centuries. The enterprises belonging to primary sector being practised over centuries using natural resources were found to be the most sustainable over recently introduced secondary and tertiary enterprises.

(b) *Economic sustainability*: Up to 70% of the households in Banni grasslands were dependent on Banni buffalo based pastoralism. Buffalo rearing contributed to highest mean net annual incomes (₹6,18,393) compared to all other enterprises. It also contributed to nutritional and food security of the households. Charcoal production was a primary occupation to 20% households and secondary occupation to 80% households. However, the mean net annual incomes (₹44,822.37) were low compared to buffalo rearing. The families engaged in charcoal production were generally poor and did not own any livestock or owned very few meeting domestic requirement of milk and milk products. Hence, families dependent on charcoal production had limited access to milk and milk products in their diets. Service sector employed 3% households and their mean net annual incomes (₹47,500/-) were equivalent to those engaged in charcoal production.

The mean net annual incomes of the households dependent on goat and sheep rearing (₹167,250) was higher than those engaged in charcoal production but only 3% households were engaged in it. The economic sustainability of other livelihood options was low because of: (a) less number of households was dependent on these enterprises; and (b) relatively very lower incomes. It is to be noted that many of these enterprises were seasonal. For instance, Vadha Koli community was engaged in honey and gum collection during summer months (March to May) as an extra income generating activity rather than a full-fledged enterprise. The mean annual net incomes contributed by honey collection (₹1856.25) and gum collection (₹900) to these households were too low. Hence, the extent of households dependent on the enterprise, nature of employment (primary or secondary), its duration (full-fledged or part-time) and contribution to net annual income of households affect the economic sustainability of an enterprise. The time dimension in economic sustainability is least compared to ecological and socio-cultural sustainability. Economic sustainability reflected the relative financial sustainability of different enterprises during/ around the period of study. The time dimension is few decades. For instance, charcoal production as an enterprise was started during 1990's, and it has emerged as the second most important livelihood option in terms of employment and incomes. For detailed analysis of household income of

Table 2. Ecological sustainability of livelihood options and enterprises in Banni grasslands (N = 280)

Indicator	Buffalo and cow rearing	Goat and sheep rearing	Charcoal production	Embroidery	Leather work	Honey collection	Gum collection	Services	Tourism	Labour	Trade
Conserve soil fertility	100.00	89.38	76.25	0	0	0	0	0	7.5	0	0
Conserve the quality and availability of water	85.00	88.75	78.75	0	0	0	0	0	0	0	0
Conserve/ increase biodiversity	80.00	85.63	91.25	0	0	0	0	0	0	0	0
No spread of hazardous substances	66.25	66.88	6.25	90.63	70	83.13	76.88	66.88	69.38	76.25	4.38
Grassland ecosystem will not be affected	76.25	75.00	2.50	97.5	87.50	50	21.25	60.63	7.50	0	51.88
Improve the micro-climate	91.88	86.88	1.88	0	0	11.88	0	0	0	0	0
Mean value	83.23	82.08	42.81	31.35	26.25	24.17	16.35	21.25	14.06	12.71	9.38

Table 3. Economic sustainability of livelihood options and enterprises in Banni grasslands (N = 280)

Indicator	Buffalo and cow rearing	Goat and sheep rearing	Charcoal production	Embroidery	Leather work	Honey collection	Gum collection	Services	Tourism	Labour	Trade
Improve net incomes	82.50	11.88	71.88	8.75	8.75	5	5	6.25	56.88	7.50	10.63
Lead to food and income security	60.63	17.50	65.63	3.75	6.25	0.63	1.25	6.25	9.38	7.50	3.75
Enable to accumulate working capital	53.75	14.38	51.25	2.50	3.75	0	0	3.13	3.13	1.25	3.13
Nutritional situation and food availability secured	82.50	41.88	45.63	3.75	7.50	1.25	0.63	6.25	9.38	7.50	3.13
Can compete with other sectors	61.25	8.13	21.88	3.75	2.50	0	0	3.13	6.88	0.63	2.50
Can aggregate an economic gain at regional/ national level	72.50	11.88	47.50	8.13	5.00	1.25	1.25	6.25	8.75	5.00	5.63
Mean value	68.85	17.60	50.63	5.10	5.63	1.35	1.35	5.21	15.73	4.90	4.79

Table 4. Social and cultural sustainability of livelihood options and enterprises in Banni grasslands (N=280)

Indicator	Buffalo and cow rearing	Goat and sheep rearing	Charcoal production	Embroidery	Leather work	Honey collection	Gum collection	Services	Tourism	Labour	Trade
Rural poor involved in the livelihood	43.75	20.00	71.88	85.63	8.75	5.00	5.63	31.88	13.75	7.50	5.63
Indigenous knowledge recognized within the approach	88.13	22.50	1.25	95.00	7.50	5.00	5.63	0	16.25	0	2.50
Division of labour and distribution of income	61.88	21.25	66.88	13.13	7.50	5.00	2.50	1.25	11.88	4.38	2.50
Improve the health situation	95.00	20.63	0	0	0	5.00	0	3.75	8.13	0	6.88
Equitable access to assets	60.63	16.88	25.63	7.50	3.75	1.88	2.50	8.13	6.88	1.25	6.25
Livelihood/ enterprise/ technology safer to human, livestock and wildlife	100.00	91.88	22.50	93.75	90.63	11.88	16.25	50.00	68.13	5.63	53.13
Mean value	74.90	32.19	31.35	49.17	19.69	5.63	5.42	15.83	20.83	3.13	12.81

Table 5. Overall sustainability of livelihood options and enterprises in Banni grasslands (N = 280)

Indicator	Buffalo and cow rearing	Goat and sheep rearing	Charcoal production	Embroidery	Leather work	Honey collection	Gum collection	Services	Tourism	Labour	Trade
Ecological	83.23	82.08	42.81	31.35	26.25	24.17	16.35	21.25	14.06	12.71	9.38
Economic	68.85	17.60	50.63	5.10	5.63	1.35	1.35	5.21	15.73	4.90	4.79
Social and cultural	74.90	32.19	31.35	49.17	19.69	5.63	5.42	15.83	20.83	3.13	12.81
Mean value	75.66	43.96	41.60	28.54	17.19	10.38	7.71	14.10	16.88	6.91	8.99

Table 6. Sustainability of different livelihood options and enterprises in Banni grasslands as percentile scores

Indicator	Buffalo and cow rearing	Goat and sheep rearing	Charcoal production	Embroidery	Leather work	Tourism	Services	Honey collection	Gum collection	Labour	Trade
100	58.1	54.98	22.72	22.3	18.63	13.72	11.89	10.19	9.13		

pastoralists refer Manjunatha (2019b).

Social and cultural sustainability: Pastoralism in Banni grasslands is more than five centuries old and has great social and cultural significance besides being the main livelihood option. Pastoralists have developed their own Indigenous Traditional Knowledge (ITKs) over a period of time to achieve economic efficiency without affecting sustainability of the pastoralist system. The people of Banni have rich conventional knowledge on practices ranging from animal breeding, human and animal healthcare, traditional water harvesting system, sustainable use of grasslands, handicrafts and bhungas (wind and earthquake resistant traditional huts) (The Biocultural Community Protocol of Maldharis of Banni 2010, Joshi *et al.* 2015, Manjunatha 2015, Banni 2020, Sahjeevan 2020). The socio-cultural sustainability of the goat and sheep rearing was higher than the charcoal production because it was also an age old profession involving ITKs and contributed significantly to the food and nutritional security of the poor households. Goat and sheep rearing was the second predominant occupation employing poor households who are presently associated with charcoal production.

Generally poor households (owning very few or no livestock at all) were engaged in charcoal production as primary occupation. Embroidery work was a traditional occupation practiced by all households (especially Muslim and Meghwal communities who together constituted >90% population) in Banni grasslands and women in each family spent three to four hours a day in this activity. However, it was an economic activity only in certain villages benefitted by access to market and tourism. Leather work was also a traditional occupation practiced only by Meghwal community (comprising <10% population). The leather work was economically more sustainable over embroidery whereas the latter was socio-culturally more sustainable.

The time dimension in social and cultural sustainability is equivalent (as in case of ITKs) or relatively lower (with respect to equitable access to assets, empowerment of the poor, etc.) than ecological sustainability but higher than the economic sustainability. The social and cultural sustainability encompasses the long term outcome of economic sustainability.

Overall sustainability: Buffalo and cow rearing was found to be more sustainable enterprise from ecological, economic and social and cultural perspective than all other enterprises. Goat and sheep rearing employed only 3% households at present but it was more sustainable (overall) than charcoal production, which was the second most economically significant enterprise after buffalo rearing. Embroidery and leather work were traditional occupations and offered scope in the present time because of increased access to city markets and tourism. Tourism offered employment opportunities to all social groups and economic categories of the region.

The mean values of overall sustainability were converted into percentile scores (Table 6) for better understanding of relative sustainability of different livelihood options.

Buffalo rearing was the most sustainable livelihood option employing largest number of households, generating highest average net incomes and having lot of historical and socio-cultural significance. Buffalo rearing signified affluence, connected to the rich culture and tradition, food and nutritional security and prosperity. Labour was the least sustainable livelihood option. It was a last and distress option for the poorest households who did not own livestock and who could not engage in charcoal production.

The individual households at a given point in time are generally guided by economic sustainability at the cost of ecological and socio-cultural sustainability. Degradation of natural grasslands because of climate change, ever expanding *P. juliflora*, increasing human and livestock population pressure on one hand and government policies resulting in better infrastructure and market access have led to shift in enterprises, which are only economically remunerative in the short term. The study indicated that overall sustainability of goat and sheep rearing was higher than charcoal production. However, it employed only 3% households at present. Charcoal production, on the other hand, employed large number of households because economic sustainability was a more immediate goal for poor households.

Governments, research and development organizations, public representative bodies, civil society organizations and all relevant stakeholders have to engage with the pastoralists and their organizations and develop strategies to promote livelihood opportunities, which are sustainable from ecological, economic and socio-cultural perspective. Engaging and educating pastoralists and enabling policy interventions by governments to incentivize sustainable enterprises are needed. Charcoal production was a livelihood adaptation strategy of the poor households rather than the preferred choice. Control and management of *P. juliflora* will have positive implications on the ecology of Banni grasslands and livelihoods of pastoralists. Goat and sheep rearing could provide an alternative to charcoal production while being more sustainable. The recognition of community grazing rights of Maldharis over Banni grasslands would further augment this positive shift (Devi Dayal *et al.* 2018). Similarly, handicrafts (embroidery and leather craft) and trade offer sustainable alternatives to charcoal production in the context of expanding tourism and market access.

Migratory pastoralism has not only evolved over five centuries adapting to climatic and man made changes but also employed 70% households with highest revenues to households and the Banni economy at present. The analysis of sustainability of different enterprises indicated that Banni buffalo based pastoralism is the most sustainable livelihood option from ecological, economic and socio-cultural indicators. The individual households at a given point in time are generally guided by economic sustainability over ecological and socio-cultural sustainability. Degradation of natural grasslands because of climate change, ever expanding *P. juliflora*, increasing human and livestock

population pressure on one hand and government policies resulting in better infrastructure and market access have led to shift in enterprises which are only economically remunerative in the short term. The study indicated that overall sustainability of goat and sheep rearing was higher than charcoal production, though it employed only 3% households at present. Charcoal production, on the other hand, employed 80% households (as primary and secondary enterprise) with high economic sustainability but low ecological and socio-cultural sustainability. Economic sustainability was a more immediate goal for poor households.

Governments, R&D organizations, public representative bodies, civil society organizations and all relevant stakeholders have to engage with the pastoralists and their organizations and develop strategies to promote livelihood opportunities, which are sustainable from ecological, economic and socio-cultural perspective. Engaging and educating pastoralists and enabling policy interventions by governments to incentivize sustainable enterprises are needed. Charcoal production enterprise was an adaptation strategy rather than the preferred choice. Control of *P. juliflora* will have positive implications on the ecology of Banni grasslands and livelihoods of pastoralists. Goat and sheep rearing could provide an alternative to charcoal production while being more sustainable. The recognition of community grazing rights of Maldharis over Banni grasslands would further augment this shift. Similarly, handicrafts (embroidery and leather craft) and trade offer sustainable alternatives to charcoal production in the context of expanding tourism and market access.

REFERENCES

- Banni. 2020. Biodiversity. Website: <http://banni.in/biodiversity/grasslands/>. Accessed on 10/09/2020.
- Bharara L P. 1987. Preliminary report on Socio-economic survey of Banni area, Kutch District (Gujarat). Central Arid Zone Research Institute, Jodhpur, p44.
- 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*. (Eds). Cincotta R P and Pangare G. Institute of Rural Management, Anand, India.
- Biocultural Community Protocol of Maldharis of Banni. 2010. Banni Pashu Uchherak Maldhari Sangathan, Bhuj, Gujarat, pp. 1–38.
- 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.
- Devi Dayal, Rahul Dev, Sureshkumar M and Manjunatha B L. 2018. Managing Banni grassland: Issues and opportunities. *Indian Farming* 68(09): 112–14.
- 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. M.Sc. dissertation, Department of Soil Sciences, 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, pp. 1–145.
- Joshi P N, Ramesh Bhatti and Sabyasachi Das. 2015. Traditional conservation of Buffalo Breed by pastoralists through maintaining of grassland ecosystem, Banni-Kachchh, Gujarat-India. *Proceedings of the XXIII International Grassland Congress* 20–24, November 2015, New Delhi.
- Manjunatha B L, Shamasudheen M, Devi Dayal, Pratibha Tewari and Parihar R P. 2015a. Traditional Water Harvesting System of Maldharies in Banni Grassland. *CAZRI NEWS* 4(4): 3–4.
- Manjunatha B L, Shamsudheen M, Sureshkumar M, Pratibha Tewari and Yadav O P. 2019b. Occupational structure and determinants of household income of pastoralists in Banni grasslands of Gujarat. *Indian Journal of Animal Sciences* 89(4): 453–58.
- Manjunatha B L, Sureshkumar M, Pratibha Tewari, Devi Dayal and Yadav O P. 2019a. Livestock population dynamics in Banni grasslands of Gujarat. *Indian Journal of Animal Sciences* 89(3): 319–23.
- NBAGR. 2020. Banni Buffalo Accession Number: INDIA_BUFFALO_0400_BANNI_01011. Registered breeds of buffalo. National Bureau of Animal Genetic Resources. Website: <http://www.nbagr.res.in/regbuf.html>. Accessed on 09/09/2020.
- RAMBLE. 2020. About BANNI. Website of Research and Monitoring in the Banni Landscape (RAMBLE): <http://www.bannigrassland.org>. Accessed on 18/08/2020.
- 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.
- Sahjeevan. 2020. Center for pastoralism. Website: http://sahjeevan.org/pages/center_for_pastoralism.html Accessed on 01/09/2020.
- Sustainet. 2006. *Sustainable agriculture: A pathway out of poverty for India's rural poor*. Deutsche Gesellschaft, Technische Zusammenarbeit, Eschborn.
- Tewari J C, Harris P J C, Harsh L N, Cadoret K and Pasiecznik N M. 2000. *Managing Prosopis juliflora (Vilayati Babool) - A Technical Manual*. CAZRI, Jodhpur and HDRA, Coventry, UK, 96 p.
- Tewari J C, Ratha Krishnan P, Harsha S L and Bohra H C. 2011. *Prosopis juliflora: Past, Present and Future*, pp. 1–115. (Eds) Tewari J C, Ratha Krishnan P, Harsha S L and Bohra H C. Desert Environmental Conservation Association (DECO), Jodhpur and Central Arid Zone Research Institute (CAZRI), Jodhpur.
- 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, Pratiksha Patel and Devi Veluswamy. Gujarat Ecological Education and Research (GEER) Foundation, Gandhinagar and Gujarat Institute of Desert Ecology (GUIDE), Bhuj.