



Sustainability of Badri cattle rearing in the hills of Uttarakhand

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ABSTRACT

The indigenous cattle of Uttarakhand has become the first registered cattle breed of the state with the name of 'Badri Cattle' during 2016. The present study was carried out to assess the sustainability of Badri cattle rearing in the hills of Uttarakhand. Sustainability of Badri cattle rearing was evaluated by measuring 4 indices, i.e. Economic Sustainability Index (ESI), Social Sustainability Index (SSI), Environmental Sustainability Index (EnSI), and Composite Sustainability Index (CSI). Economic sustainability was measured by 6 indicators, viz. production efficiency, net profit, marketing, lactation length, dry period, and calving interval. Social sustainability was measured by 2 indicators, viz. community relation of Badri cattle owners and their access to resource and support services and Environmental sustainability was measured by 4 indicators, viz. animal welfare, dung utilization pattern, waste management and preparedness for disasters. The CSI for each respondent was calculated as mean of the indices. The mean values for ESI, SSI, EnSI and CSI were 0.39 ± 0.09 , 0.34 ± 0.21 , 0.42 ± 0.11 and 0.38 ± 0.09 respectively. The result revealed that the majority of respondents (41.7–97.5%) had medium level of ESI (0.34–0.66), SSI (0.34–0.66), EnSI (0.34–0.66) and CSI (0.34–0.66) suggesting that Badri cattle rearing is sustainable in the hills of Uttarakhand. Further social participation of the respondents and their formal information source utilization score had a positive and highly significant effect on the sustainability of Badri cattle rearing.

Key words: Badri cattle, Sustainability, Uttarakhand

The indigenous cattle of Uttarakhand has become the first registered cattle breed of the state with the name of 'Badri Cattle' during 2016. These cattle are available in the hilly areas of Uttarakhand and are small in size, weighing between 200–250 kg, having small straight legs and varied body colours – black, brown, red, white or grey. Hooves and muzzle are black or brown in colour. Hump is prominent and udder is small in size, tucked up with the body. These are well adapted to the hilly terrain and climatic conditions, comparatively more resistant to diseases (Pundir *et al.* 2014) and can play significant role in development of Uttarakhand as a real organic state (Banga *et al.* 2005). Estimated population of the breed is approximately 16 lakhs. The decreasing population growth in indigenous cattle population is noticed in the state of Uttarakhand i.e. 20.40% decrease from previous census against an increase of 46.40% in crossbred cattle population which warrants an in-depth investigation before policy formulation to analyse and focus on points which can enhance the sustainability of Badri cattle rearing. The present study was, accordingly, undertaken to evaluate the sustainability of Badri cattle rearing in the hills of Uttarakhand.

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MATERIALS AND METHODS

The study was conducted during 2016–17 in the hills of Uttarakhand as Badri cattle has become first certified cattle breed of the state. Among all the districts, two highly cattle populated district from the Garhwal and Kumaun Mandal i.e Pauri Garhwal and Almora were selected purposively for the study. The population of indigenous cattle has its highest proportion present in Pauri Garhwal (17.8% i.e. 2,69,994) followed by Almora (11.5% i.e. 1,97,326) district (19th Livestock Census 2012). From each district, two blocks were selected (Almora district: Lamgara and Bhikyasane block and in Pauri Garhwal district: Jaiharikhal and Duggada block) for the study and from each block, three villages were selected for the study making a total of 12 villages. Selection of blocks and villages was done randomly. For the study, 10 respondents from each village i.e. 60 respondents from each district making a total of 120 respondents having two Badri cattle with a minimum of two years of experience were selected randomly.

Measurement of sustainability: The sustainability of cattle rearing was assessed as per scale developed by Rahman (2011). The multi-dimensional concept of sustainability of Badri cattle rearing is considered to be composed of 3 indices, i.e. Economic Sustainability Index (ESI), Social Sustainability Index (SSI) and Environmental Sustainability Index (EnSI) and both positive and negative directional contribution have been documented which

explains the overall effect of Badri cattle rearing examining social participation, economic gain and environmental contribution. Indicators used in each dimension are according to Swaminathan's concept of sustainable livelihood security, i.e. 'livelihood options which are ecologically secure, economically efficient and socially equitable' (Swaminathan 1991).

Economic sustainability index was calculated by using six indicators, viz. production performance (average milk yield/day/animal), net profit (net profit generated/animal/year), marketing referred to accessibility of market in which a score of 3 was given for selling milk directly from home, 2 for selling milk within a distance of 5 km from their house and 1 for selling milk at a distance greater than 5 km from the house, lactation length, dry period and calving interval.

Social sustainability index was measured by 2 indicators, viz. community relation of Badri cattle owners and their access to resources and support services. For measuring community relations, a score of 1 was given for each statement i.e. involvement in any community activity, involvement in any local community organization and consultation with any progressive farmer regarding Badri cattle rearing and maintenance making a maximum score of 3. Access to resources and support services in which a score of 1 was given for each statement i.e. access to road connectivity, veterinary hospital/ AI centre, L.E.O, information about demand for milk and milk products in the area, water source, bank and livestock insurance agency making a maximum score of 7.

Environmental sustainability index was measured by 4 indicators, viz. overall health (proportion of diseased animals in a herd), housing condition (a score of 0 was given for unclean and inadequate housing, 1 for inadequate but clean and dry house, 2 for house maintained in clean and dry conditions and 3 for house which provide maximum space for normal social behaviour and minimize cow stress so had maximum score of 3), calf raising condition (a score of 1 was given for each statement i.e. calf consume colostrum during first 48 h of birth, calf receive roughage by 2 weeks of age, sufficient space provided for calf to lie comfortably, provide clean, dry and well ventilated housing, calves' navels are dipped in iodine and vaccinated against FMD and HS so making maximum score of 6), dung utilization pattern (dung utilized for manure purpose was given score of 2, dung utilized for manure and fuel was given a score of 1 & that utilized only as fuel was given a score of 0), waste management (a score of 1 was given for each statement i.e. manure storage structure located at maximum distance from water source, structure are of sufficient capacity, structure are located down slope from water source, structure always remain covered making a maximum score of 4), preparedness for flood (a score of 1 was given for each statement i.e. preserve dry fodder, sufficient straw is available, raised area is present in village to keep animals and deworming and vaccination are performed before and after calamities/ disasters making a maximum score of 4). Sustainability assessment of Badri

cattle rearing was measured in following steps.

Construction of the index:

The first step is to construct the index (Iij) for each ith indicator representing jth dimension of composite sustainability index. For making indicator scale free following methods were applied:

$$I_{ij} = \frac{X_{ij} - \text{Min}X_{ij}}{\text{Max}X_{ij} - \text{Min}X_{ij}} \quad (1)$$

$$I_{ij} = \frac{\text{Max}X_{ij} - X_{ij}}{\text{Max}X_{ij} - \text{Min}X_{ij}} \quad (2)$$

where i = 1,2,3.....n (Indicators), j = 1,2,3 (Dimension of sustainability), X_{ij}, the value of ith indicator of jth dimension. Equation (1) was applied for indicators having positive implication on sustainability, while equation (2) was applied for indicators having negative implication on sustainability.

Calculation of the indices for various dimensions of composite sustainability index: Having calculated the Iij for all indicators, the second step was to calculate the indices for various dimensions of Composite Sustainability Index. It is calculated as a weighted mean of their respective variables:

$$ESI = \frac{\sum_{i=1}^6 WI_{ij}}{6} \quad SSI = \frac{\sum_{i=1}^2 WI_{ij}}{2} \quad EnSI = \frac{\sum_{i=1}^4 WI_{ij}}{4}$$

where W denotes weight assigned to respective indicators. ESI denotes Economic Sustainability Index. SSI denotes Social Sustainability Index. EnSI denotes Environmental Sustainability Index.

Calculation of the composite sustainability index (CSI): Then, the composite sustainability index for Badri cattle rearing for each respondent was calculated as a mean of the indices obtained from equation:

$$CSI = \frac{ESI + SSI + EnSI}{3}$$

The obtained index was categorized into low, medium and high on the basis of dividing the sustainability from 0 to 1 into equal class intervals.

To compare the dimensions of various index and sustainability indices, the dimensions were generated, organized and subjected to statistical analyses using SPSS statistics software.

RESULTS AND DISCUSSION

Economic sustainability index (ESI): Economic indicators were used to measure the productivity, profitability and viability of the cattle rearing activities. Production efficiency of Badri cattle ranged between 0.5–3 litres with an average yield of 1.62±0.69 litre/day (Table 1). Among Badri cattle owners, majority of respondents (41.7%) revealed that average milk yield of

Badri cattle is between 1.34–2.17 litre/day followed by 0.5–1.33 litre/day by 37.5% of respondents and 2.18–3.00 litre/day by 20.8% of respondents. These observations were close with the findings of Pundir *et al.* (2013) who reported that milk yield of Uttara cattle is between 0.5–3 kg with an average of 1.12 kg in Uttarakhand. Balaraju (2016) in Karnataka reported that average milk yield of indigenous cattle is 1.89 litre with majority (43.8%) of respondents having cattle with milk production between 0.5–1.66 litre/day. Average daily milk yield for Hallikar was 2.07±0.13 litre and 2.11±0.17 litre for Malnad Gidda as revealed by Singh *et al.* (2008a) and (2008b). The average net profit/annum from Badri cattle earned by the respondents was ₹ 979/animal/year. The results were similar to the findings of Das (2010) reported that net profit from local cattle was ₹ 2447. Rahman (2011) who reported the net profit from local cattle to be ₹ 2078 and Pushpendra *et al.* (2016) reported the average net profit for Gangatiri breed as ₹ 1637.

The average lactation length of Badri cattle as reported by the respondents was 11.78±2.11 months (Table 1). These observations were similar with the findings of Pundir *et al.* (2013) who reported that lactation length of Uttara cattle is between 8–18 months with an average 275 days (9.2 months). Balaraju (2016) reported that majority (51.20%) of respondents expressed that their indigenous cattle had short lactation length (6–8 months) in Karnataka. Lactation length in different breeds of indigenous cattle, viz. Hallikar cattle ranged between 5–8 months, Malnad Gidda cattle and Pulikulam had lactation length of 9–15 months (Singh *et al.* 2012, Singh *et al.* 2008a, Singh *et al.* 2008b). The study shows that dry period of Badri cattle ranged between 0.5–4 months with an average of 1.9±0.73 months (Table 1). Pundir *et al.* (2013) found that the dry period for Uttara cattle ranged between 4 – 6 months with an average

of 147 days (4.9 months). Balaraju (2016) reported that majority (49.2%) of respondents reported dry period of 3.7 to 4.7 months with an average of 3.9 months for indigenous cattle (Amritmahal, Deoni, Hallikar, Khillari, Krishna Valley, Malnad Gidda) of Karnataka. Pushpendra *et al.* (2016) reported that the dry period of Gangatiri cattle was 176 days.

The calving interval of Badri cattle ranged between 11–18 months with an average of 13.72±1.98 months (Table 1). Pundir *et al.* (2014) found that the average calving interval of Uttara cattle was 456 days (15.2 months). Balaraju (2016) reported that inter calving period of indigenous cattle is between 11–13 months with an average of 13.98 months in Karnataka. Various researchers (Singh *et al.* 2008a, Singh *et al.* 2008b and Chandran *et al.* 2014) reported calving interval in different breeds as 12–36 months for Hallikar cattle, 17.0±0.7 months in Malnad Gidda and 12 to 17 months in Bachur cattle. The study revealed that cent percent of the respondents sold their cattle milk directly to the consumers. The findings were in line with Rahman (2011) who reported that 86% of the respondents were selling their milk directly to consumers and Pushpendra *et al.* (2016) reported that 87% of the respondents were selling their milk directly to consumers while Senthilkumar (2004) found that most of the respondents marketed their milk in the market only. Majority of respondents (45.8%) sell their milk within 5 km distance of their house followed by 40.8% of respondents who were not selling their milk, 10.8% respondent sold their milk in the area above 5 km distance. In 2.5% cases, consumer collect milk directly from the house of respondents whereas Pushpendra *et al.* (2016) reported that in 66% of cases the milk was collected directly from home.

The ESI for the respondents ranged between 0.15–0.60

Table 1. Mean scores of indicators of Sustainability of Badri cattle rearing

Indicators of sustainability	Almora	Pauri Garhwal	Pooled
<i>Economic indicators</i>			
Production efficiency (litres)	1.69±0.70	1.55±0.68	1.62±0.69
Net profit (₹)	9400.33±726.63	8666.84±1232	9006.5±979.33
Marketing	1.13±0.98	1.07±0.99	1.10±0.98
Lactation length (Months)	12.49±2.11	11.06±1.86	11.78±2.11
Dry period (Months)	1.75±0.72	2.13±0.70	1.94±0.73
Calving interval (months)	14.24±1.99	13.20±1.85	13.72±1.98
<i>Social indicators</i>			
Community relations	0.52±0.85	0.17±0.49	0.34±0.71*
Access to resources and support services	3.83±0.69	4.6±0.62	4.22±0.76*
<i>Environmental indicators</i>			
Overall health	0.04±0.11	0.04±0.11	0.04±0.11
Housing	1.07±0.93	2.13±1.05	1.60±1.12*
Calf raising conditions	2.73±0.58	2.68±0.72	2.71±0.65
Use of dung	2±0	1.97±0.18	1.98±0.13
Waste management	0	0	0
Preparedness for disaster (Landslide, Flood, Cloudburst)	2.32±0.47	2.23±0.43	2.27±0.45

*Significant at 5% level

with the majority of the respondents (70.0%) having ESI in the range of 0.34–0.66 i.e. medium level of economic sustainability. The average ESI also fell in medium level (0.39±0.09) (Table 2). Economic sustainability of Badri cattle is needed to be improved and can be done by improving the production performance of the cattle, increasing the net profit earned/ cattle and improving marketing facility for cattle milk and other products. The production performance can be increased by providing better nutritious feed and fodder to the cattle which will increase milk yield and will also reduce reproductive problems; various selective breeding interventions which will lead to establishment of high producing germplasm. Net profit earned through cattle can be increased by improving the production as well as market for milk and milk products. For improving marketing facility, the Uttarakhand Cooperative Dairy Federation i.e. Aanchal can enhance their network towards villages and should collect milk either directly from the house or farmers' groups. Various value added products like ghee, curd, *lassi*, whey (*mattha*) and panchgavya can be prepared and marketed.

Social sustainability index (SSI): Respondent's relationship and participation in their social system, access to resources such as water, veterinary aid, etc. and support services such as extension and financial services were taken as underlying factors to measure social sustainability of Badri cattle rearing. It was observed that the SSI for the respondents ranged between 0–0.80 with maximum number of respondents (77.50%) having no community relations, followed by low (13.3%) level of community relations. No community relations were also reported by Rahman (2011) for non members of SHGs. Low social participation of livestock owners was reported by Rathod *et al.* (2012), Verma *et al.* (2014) and Pushpendra *et al.* (2016) in their respective study area. Whereas Singh (2006) and Prakash (2009) reported medium level of community relations of the respondents. Most of the respondents were marginal farmers or labours and were busy rearing their animal and doing agriculture and household work so were not having appropriate time to maintain better community relations. Majority of the respondents (41.7%) had high level of access to services with mean score of 4.22±0.76 (Table 1). Whereas Prakash (2009), Rahman (2011) and Pushpendra *et al.* (2016) reported medium level of access to resources and support services. All the respondents rearing Badri cattle were having road connectivity, access to veterinary hospital/AI service and

water resources.

The average SSI for the respondents was 0.34±0.21 (Table 2) with majority of respondents (48.3%) having medium followed by low (46.7%) SSI of rearing Badri cattle which indicates that Badri cattle rearing is socially sustainable. The findings were in line with the findings of Rahman (2011) and Pushpendra (2013). The social sustainability of Badri cattle can be increased by enhancing the community relationship of the respondents. For this they can enroll themselves as the member of some local community organization, get involved in any community activity and can remain in touch with some progressive farmers which will help them in many ways to improve their rearing practices and to maximize their profit. Majority of Badri cattle rearer were female so they should be motivated to join SHGs, Aganbadi or other groups created exclusively for females. Apart from this, their accessibility to various resources and services like bank, livestock insurance, information about the demand of milk and milk products in the nearby areas, veterinary officers, livestock extension officers and krishi vigyan kendra etc. can be further enhanced.

Environmental sustainability index (EnSI): The overall health of the herd was measured as proportion of cattle with disease condition to total cattle herd. Majority of the respondents (97.5%) were having low proportion of diseased cattle in their herd followed by medium (2.5%). The result supported that Badri cattle have high disease and parasitic resistance and is very well adapted to local climatic conditions of the hills. The diseases/problems found were fever, indigestion, bloat, wound/ injury fracture, repeat breeding, abortion etc. Chauhan (2017) reported that Indian cattle breeds have developed resistance against diseases, natural calamities as well as the variable environmental conditions. Balaraju (2016) also reported that quarantine and isolation practice were not followed by farmer in Karnataka as indigenous cattle are resistant to most of the diseases. Pushpendra (2016) reported majority of respondents with medium proportion of diseased cattle in their herd.

The housing condition maintained by majority (70.0%) of respondents for their cattle herd was found unsatisfactory. Singh *et al.* (2004) found that in Uttarakhand, condition of cattle shed was not satisfactory and were not well ventilated with improper light and dampness. Pundir *et al.* (2014) found that drainage of shed for hill cattle was not proper. Kumar and Gaur (2016) reported that houses were not

Table 2. Mean values of sustainability index of Badri cattle rearing

Sustainability index	Almora	Pauri Garhwal	Pooled	Range
Economic sustainability index (ESI)	0.41±0.086	0.37±0.098	0.39±0.09	0.15–0.60
Social sustainability index (SSI)	0.28±0.21	0.40±0.18	0.34±0.21*	0–0.80
Environmental sustainability index (EnSI)	0.419±0.12	0.425±0.10	0.42±0.11	0.19–0.65
Composite sustainability index (CSI)	0.37±0.093	0.39±0.076	0.38±0.09	0.19–0.64

*Significant at 5% level

cleaned and without proper drainage in majority of the cases. Rahman (2011), Verma *et al.* (2013) and Pushpendra *et al.* (2016) also found the housing conditions maintained by majority of respondents were unsatisfactory.

Results revealed that in majority of respondents (89.2%) calf raising condition was unsatisfactory. The respondents although were providing colostrum during first 48 h, sufficiently clean, dry and well-ventilated housing but were not following naval dipping in iodine and vaccination against FMD and HS which lead to a lower mean score (2.71 ± 0.65) (Table 1) of calf raising practices. Kumar and Mishra (2011) studied calf management in Uttarakhand and reported that majority (85%) of the cattle keepers did not cut and disinfect the naval cord. The results obtained were in line with Rahman (2011) whereas Pushpendra *et al.* (2016) found satisfactory calf raising condition for majority of respondents.

Dung utilization pattern of the respondents was highly environment friendly with high mean score (1.98 ± 0.13) (Table 1) as majority of the respondents (98.3%) were using dung only for manure purpose followed by 1.7% respondents using it both as manure and cow dung cake. Cow dung cake when used as fuel causes serious health problems as it causes emission of carbon monoxide. It also causes air pollution and harms the environment so cow dung cake not used by respondents as fuel is a good initiative for the environment and contributes to its environmental sustainability. Premchand (2008) and Rahman (2011) reported that the dung utilization pattern amongst respondents was similar as it was mostly used for manure. Pushpendra *et al.* (2016) reported that majority of the respondents used dung for fuel as well as manure. The study showed that there were no manual structures prepared for waste disposal and the waste was collected in heaps near shed and agricultural fields and used as manure and plastering the house. So the waste disposal conditions were unsatisfactory. Rahman (2011) also reported unsatisfactory waste management practices whereas Pushpendra *et al.* (2016) found satisfactory waste management practiced by majority of respondents.

Uttarakhand is very much prone to landslide, cloud burst, forest fire etc so preparedness for disasters is a major concern for welfare of livestock as well but preparedness for disasters by majority of respondents (72.5%) was unsatisfactory. The respondents preserved dry fodder for scarcity period but timely deworming and vaccination of animal, shed preparedness at some safe place to safeguard animals at the time of disasters was not followed. The result obtained was in line with Rahman (2011) but Pushpendra *et al.* (2016) reported disaster management by majority of respondents as satisfactory.

The EnSI for the respondents considering these indicators ranged between 0.19–0.65 with an average of 0.42 ± 0.11 (Table 2). The results indicate that majority (80.0%) of respondents had medium level of EnSI (0.34–0.66) followed by 20.0% of respondents having low EnSI (0.00–0.33). So it was concluded that rearing Badri cattle

is environmentally sustainable. The result obtained were in line with Rahman (2011) and Pushpendra *et al.* (2013). The sustainability index had the highest score on EnSI for the Badri cattle. The major contributors for this were the disease resistant property of the cattle and dung utilization pattern of Badri cattle. Further, environmental sustainability can be increased by improving the animal welfare practices like housing conditions and calf raising conditions. The shed built should be clean, dry with well-maintained ventilation and drainage facility and large enough to allow normal social behaviour and minimize cow stress. The calf should also be provided well ventilated, clean and dry housing, their naval cord should be dipped in iodine after birth and should be vaccinated after 3 months against FMD and HS.

Composite sustainability index (CSI): Composite sustainability of Badri cattle means degree upto which Badri cattle can't be replaced by other sources of income available and affordable to respondents. Composite sustainability index for the rearing of Badri cattle by respondents ranged between 0.19–0.64 with mean CSI of 0.38 ± 0.09 (Table 2), which indicates that it has medium level of sustainability. Results revealed that majority of respondents (75.8%) had medium level of the CSI, i.e. between 0.34–0.66. The result was in line with Pushpendra *et al.* (2016).

Factors affecting composite sustainability: The sustainability of Badri cattle rearing was positively and highly significantly correlated (0.185–0.549) with the annual income earned by the family, social participation, animal husbandry income, income earned through Badri cattle, milk consumed by family, milk marketed surplus, average milk yield, formal information source utilization score, total information source utilization score and expenditure incurred on concentrate feeding (Table 3). This explains that family having higher income and more earning through Badri cattle were having sustainable rearing of the cattle. Expenditure on concentrate feeding increases the milk production of the cattle so is directly related to the CSI. The social participation and information source utilization of the Badri cattle owner showed that more the owners were involved in social groups and collected

Table 3. Correlation value of factors associated with composite sustainability index of Badri cattle rearing

Factors associated with composite sustainability index	Correlation coefficient
Annual income	0.375**
Social participation	0.282**
Animal husbandry income	0.185*
Income earned through Badri cattle	0.350**
Milk consumed by family	0.336**
Milk marketed surplus	0.322**
Average milk yield	0.301**
Formal information source utilization score	0.549**
Total information source utilization score	0.313**
Expenditure incurred on concentrate feeding	0.288**

*Significant at 5% level, **Significant at 1% level

Table 4. Regression value of factor influencing composite sustainability index of badri cattle rearing

Factors affecting composite sustainability index	Regression coefficient
Annual income	0.117
Social participation	0.232**
AH income	0.049
Income earned through Badri cattle	0.109
Milk marketed surplus	0.149
Milk consumed by family	0.122
Average milk yield	0.112
Formal information source utilization score	0.564**
Total information source utilization score	0.102
Cost of concentrate	0.122

** Significant at 1% level.

information from outside source were better able to manage their cattle in sustainable manner. The correlation values showed that to improve the sustainability of Badri cattle rearing, annual income of the household, income earned through Badri cattle, milk yield, milk marketed surplus, social participation and information source utilization has to be improved so interventions should be made in this direction.

The regression value of factors influencing CSI shows that the two factors which had positive and highly significant effect on CSI were social participation (0.232) and formal information source utilization score (0.564) (Table 4). This explains that the respondents should be motivated to become members of some groups or organizations. The respondents should be given opportunities to collect information from them which can further increase their knowledge about management and production and in turn will increase sustainability.

The sustainability parameters of Badri cattle revealed that Badri cattle rearing has medium level of social, economic, environmental and composite sustainability index which shows that rearing of Badri cattle is good for future generation and is sustainable with the society, environment and economy of respondents. But still, a lot of scope exists to enhance the sustainability index of the cattle. Most of the respondents rearing Badri cattle were marginal farmers. They can't afford animal with high maintenance cost, so it is better to improve the performance of Badri cattle which is reared under low input – low output production system under semi-intensive farming. In spite of low/ no input supply with minimum management interventions, Badri cattle is able to produce and survive. Therefore with suitable scientific interventions like selective breeding, semen preservation of elite Badri bulls, studies on fodder and maintenance requirement of Badri cattle; productivity per animal can be increased. The other area to focus upon is to improve the knowledge level of farmers through enhancing linkages with formal information sources as well as providing them better access to resources and improving their social participation which can improve the

overall rearing and management practices thereby improving the sustainability of Badri cattle in the hills of Uttarakhand.

REFERENCES

- 19th Livestock Census. 2012. District wise report. Available at www.dahd.nic.in. Retrieved on 28-10-2016.
- Balaraju B L. 2016. 'Role of indigenous cattle in the livelihood security of resource-poor farmers: an exploratory study in Karnataka'. Ph.D. Thesis, IVRI, Izatnagar, Bareilly.
- Banga R K, Kumar P, Singhal L K, Sharma A and Chauhan R S. 2005. Red hill cattle is characterized as 'Badri cow' based on physical characters and body measurements. *Indian Cow: Scientific and Economic Journal* 2(3): 10–14.
- Chandran P C, Dey A, Barari S K and Kamal R. 2014. Characteristics and performance of Bachaur cattle in the Gangetic plains of North Bihar. *Indian Journal of Animal Sciences* 84(8): 872–75.
- Chauhan R S. 2017. Disease resistance potentials of indigenous cows (*Bos indicus*) and utility of their by products. Samvaad Bharti Post. Retrived July 20, 2017 from <http://samvaadbhartipost.com>.
- Das M. 2010. 'Certain economic traits and input-output relationship with milk production of crossbred and indigenous cattle in Kamrup district of Assam'. M.V.Sc. Thesis (Unpublished), AAU, Khanapara, Guwahati, Asom.
- Kumar D and Gaur A K. 2016. Studies on hill cattle of Pithoragarh district in Uttarakhand. *International Journal of Research and Scientific Innovation* 3(2): 44–52.
- Kumar S and Mishra B K. 2011. Existing calf rearing and milking management practices followed by dairy farmers in Uttarakhand. *Journal of Hill Agriculture* 2(1): 78–84.
- Prakash A. 2009. 'Impact of self help groups on growth of dairy farming in Haryana'. Ph. D. thesis, NDRI (Deemed University), Karnal, Haryana.
- Premchand. 2008. 'Sustainability assessment of livestock production system in Rajasthan'. Ph.D. thesis, NDRI (Deemed University), Karnal, Haryana.
- Pundir R K, Singh P K, Neelkanth N, Sharma D, Singh C V and Prakash B. 2013. Uttara—A new cattle germplasm from Uttarakhand hills. *Indian Journal of Animal Sciences* 83(1): 51–58.
- Pundir R K, Singh P K, Sharma D, Kumar S, Tiwari R, Singh C V and Prakash B. 2014. Characterization and evaluation of hill cattle of Garhwal region of Uttarakhand, India. *Indian Journal of Animal Research* 48(4): 322–28.
- Pushpendra, Sankhala G, Singh A and Prasad K. 2016. Sustainability of Gangatiri cattle rearing. *Indian Journal of Animal Sciences* 86(8): 936–39.
- Rahman S. 2011. 'Sustainability of dairy based self help groups (SHGs) in Assam: an exploratory study in Kamrup district'. Ph.D. thesis (Unpublished), NDRI, Karnal, India.
- Rathod P, Nikam T R, Landge S and Hatey A. 2012. Farmers perception towards livestock extension service: A case study. *Indian Research Journal of Extension Education* 2: 1–5.
- Senthilkumar R. 2004. 'Entrepreneurial behaviour of dairy farmers of Tamil Nadu'. Ph.D. thesis (Unpublished), NDRI, Karnal, Haryana.
- Singh S. 2008. 'Economic analysis of milk production in Varanasi district of Uttar Pradesh'. M.Sc. Thesis (Unpublished), NDRI, Karnal, Haryana.
- Singh P K, Pundir R K, Ahlawat S P S, Naveen Kumar S,

- Govindaiah M G and Asija K. 2008a. Phenotypic characterization and performance evaluation of Hallikar cattle in its native tract. *Indian Journal of Animal Sciences* **78**(2): 1122–26.
- Singh P K, Pundir R K, Manjunath V K, Rudresh B H and Govindaiah M G. 2008b. Features and status of miniature indigenous germplasm of cattle-Malnad Gidda. *Indian Journal of Animal Sciences* **78**(10): 211–14.
- Singh P K, Pundir R K, Kumarasamy P and Vivekanandan P. 2012. Management and physical features of migratory Pulikulam cattle of Tamil Nadu. *Indian Journal of Animal Sciences* **82**(12): 1587–90.
- Singh P R, Singh M, Verma M L and Jaiswal R S. 2004. Animal husbandry practices in Tarikhet block of Kumaon hill of Uttaranchal. *Indian Journal of Animal Sciences* **74**(9): 997–99.
- Singh U. 2006. 'Multi dimensional impact of women dairy cooperatives societies on beneficiaries in Haryana'. Ph.D. thesis, NDRI (Deemed University), Karnal, Haryana.
- Swaminathan M S. 1991. From Stockholm to Rio de Janeiro: The Road to Sustainable Agriculture. Monograph No. 4, M. S. Swaminathan Research Foundation, Chennai, India.
- Verma A K. 2013. Utilization pattern including conservation measures: A case of Kherigarh breed of Cattle. M.V.Sc. Thesis, IVRI, Izatnagar, Bareilly.