Original Research

Development of Livestock Sector in the Semi-arid Regions of Karnataka: Status and Strategies

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Abstract

The integrated watershed management approach is proved to be a suitable strategy for achieving holistic development in the semi-arid and arid regions through collective action. Among various livelihood options, livestock sector has emerged as one of the fastest-growing agricultural sub-sectors in India. However, there exists considerable scope for further development of livestock sector in watershed areas with the concerted effort of multiple stakeholders to improve livestock production and productivity. In this context, an attempt was made to study the present status and issues in livestock sector, estimate gross value added (GVA) and propose technical interventions for integrated watershed management project implemented in selected villages of Ballari District, Karnataka state using primary and secondary data. The study has identified various issues and constraints viz. presence of low yielding non-descript cattle, low milk yield, less breedable population, lack of green fodder, etc. in the project villages. Further, the study also estimated that contribution of GVA was highest from Kurekoppa village (Rs 647.06 lakh) among the project villages, while it was highest from buffaloes (Rs 776.35 lakh) among the different species reared in the villages. The study also found that per animal GVA was very low in the project villages for different species. Depending on the status and issues in the project villages, the authors have proposed technical interventions after discussion with multiple stakeholders through which there would be an improvement in the production and reproduction performance of the livestock, ultimately leading to increase in GVA from the project villages.The authors also propose that these strategies are relevant for livestock sector development in SAT regions of Karnataka. However, need-based research and extension activities by different organizations in the region may be emphasized for the benefit of farming community.

Key words: Ballari, Gross Value Added (GVA), Karnataka, Livestock, Semi-arid Regions, Technical Interventions, Watershed Management

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Introduction

The integrated watershed management approach is proved to be a suitable strategy for achieving holistic development in the semi-arid and drier regions through collective action. The very purpose of the watershed development programs is to reduce water-related risks in rain-fed agriculture by improving the local soil-water balance through in-situ and ex-situ interventions. Further, proper management of these resources is crucial to build the resilience of these systems to cope with varying climatic risks and to improve livelihoods. Among various livelihood options, livestock sector has emerged as one of the fastest-growing agricultural subsectors in India. It is a rich source of high-quality foods such as milk, meat and eggs and a source of income and employment to millions of rural farmers, particularly women. Within livestock sector, dairying, small ruminant rearing and backyard poultry have been tried and tested livelihood options for many rural poor, especially for the landless, marginal and small farmers. Further, livestock farming is essentially an endeavor of smallholder farmers and the landless who rear animals on crop residues and common pool resources. They involve in livestock rearing with virtually low capital, resource and no training. In this context, there exists a considerable scope for further development of livestock sector in watershed areas with the concerted effort of multiple stakeholders which is very vital to improve livestock production and productivity.

The study also attempted to estimate the total gross value added (GVA) across sample villages and the pilot site as a whole from livestock sector at pilot sites using household survey information collected during baseline survey. The level of production of any sector is important because it largely determines how much a country/state/district/village can afford to consume and it also affects the level of employment. GVA is key indicator of the total economy and at the firm level, GVA can also be used to measure how much money a product or service has contributed towards meeting the fixed cost. These estimates can be used as 'benchmark values' for monitoring the progress of the sector over a period of time.

This study has made an effort to document the status of livestock farming in Ballari distict of Karnataka state through available secondary data and in selected watershed villages through sample survey at household level. This document has greatly emphasized on dairying and small ruminant since these are the major farming systems in the semi-arid regions of Karnataka including project villages of Ballari district. NAIP (2014) and Veeranna and Rathod (2019) have highlighted almost similar conditions in different SAT regions of Karnataka and hence, the authors also propose that the strategies discussed in this paper are also relevant for livestock sector development in different SAT regions of Karnataka.

Materials and Methods

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has been working towards rural livelihood improvement through integrated watershed development program in five villages (viz.

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Lingdahalli; Bannihatti; Nagalapur; Kakubala; Kurekoppa) in Sandur taluk of Ballari district during the past two years. The overall goal in this initiative is to establish an exemplar "Site of learning" by establishing a "Proof of Concept" to demonstrate how agricultural and livestock productivity can be substantially improved in low rainfall zones such as Ballari district which receives 600- 650 mm per year through integrated watershed management approach by adopting science-led development for sustainable management of natural resources. These project villages depict typical SAT regions in Karnataka state and hence, the findings of this study are similar to majority of the SAT regions in Karnataka.

Before testing and scaling-up these interventions, it is necessary to document the current status of the agrarian situation at the project sites. A primary household survey was conducted from representative samples from five villages. Information on socio-economic status, livestock production status, milk productivity and consumption pattern, livestock feed and feeding, breeds and breeding, etc. were collected to develop 'benchmark values' for monitoring the project's progress over a period of time.

Study Area

The study villages in Sandur taluk of Ballari district is depicted in Fig.1 and the geo-coordinates are mentioned in Table 1. Sandur taluk is situated in a semi-arid zone with dry climate. The soil is moderately sandy and red loamy, rich in iron and quartz content with 65 - 75% iron-ore. The soil is feasible for cultivation of agriculture and horticulture crops.

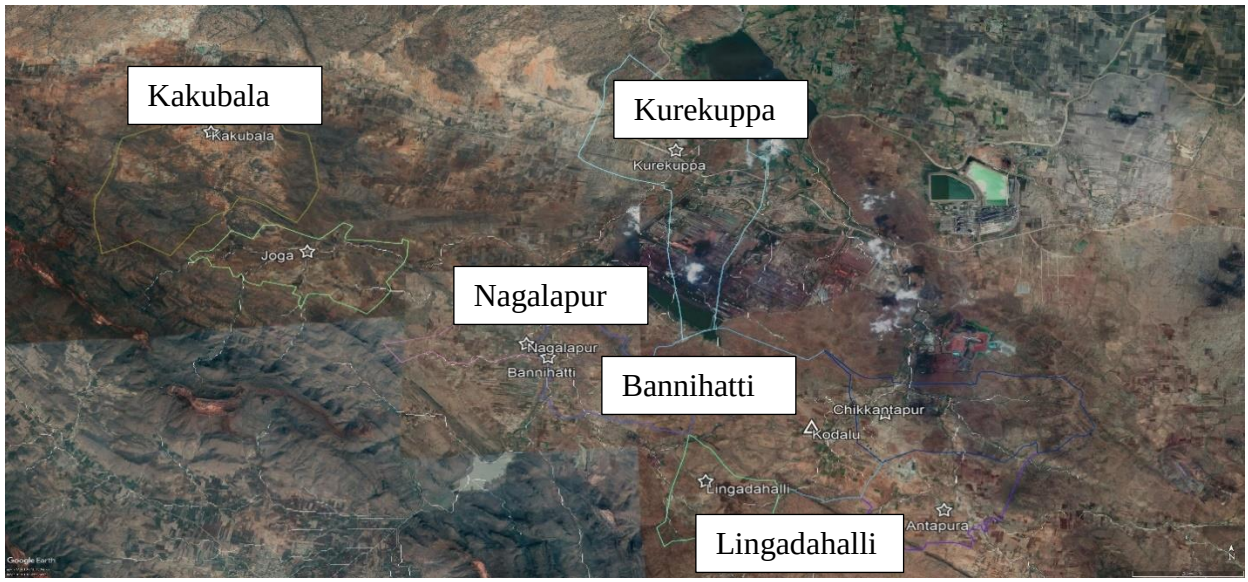

Fig. 1: Pilot sites of watershed interventions

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Sample Design

The sampling framework has been designed for the pilot sites by considering extent of cultivars in pilot sites. Among the total respondents, only few farmers reared livestock and hence, 15 livestock farmers from each village were identified making a total of 75 respondents for this particular study (Table 1).

Table 1: Sample design

Name of village	Total cultivars in village*	Total No. of respondents (Includes all types of farmers)	No. of respondents with livestock
Bannihatti	132	132	39
Kurekuppa	203	149	40
Lingdahalli	269	167	95
Nagalapura	335	211	80
Kakubala	442	310	105
Total	**1381**	**969**	**359**

**Source: GoI (2011) Census Report*

Tools Used for Data Collection

A structured interview schedule was developed based on the objectives of the study and review of literature. These tools were developed in consultation with the experts and literature, keeping in view the objectives of the study. The interview schedule was pre-tested in sample area for practicability and relevancy, suitable modifications were made based on the experience gained before administering in the main sample area. Further, PRA was also conducted in the project villages to gain various observations in the villages.

Data Collection

The background information about the study area was obtained through consultation with the key informants and others involved along with the other secondary sources available. The process helped to build up rapport with respondents and enable them to express and generate information reliably and in a relaxed atmosphere. The data from the livestock farmers were collected either at their farm or house. Information through observation during interview, group discussion and secondary sources like departmental documents, records, reports and other sources were also collected. Further, this study also has identified major constraints or critical gaps in the project villages and has devised suitable strategies for livestock sector development in the project villages.

Statistical Analysis

The data collected from sample respondents were coded, tabulated, analyzed and presented in the form of tables. Various need based statistical tools were used for analysis of the data. The inferences were drawn in light of the results obtained, keeping in view the objectives laid in the study.

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Methodology of GVA Estimation

Gross value added (GVA) is the measure of the value of goods and services produced in an area, industry or sector of an economy. The GVA is estimated by valuating the products and by-products and ancillary activities at the prices received by the producers and deducting there from the value of inputs of raw materials and services consumed in the process of production at purchasers' prices (GoI, 2007). The data includes milk yield of cattle and buffaloes, their disposal including dung, feed consumption, sheep and goat number, age, number slaughtered and weight at time of selling for slaughter in the case of meat production. The methodology for the estimation of GVA is-

m_{rij} = number of animals in milk for which a day's yield is recorded from the j-th household in the i-th village---------- (1)

Yijk = total milk yield of the k-th animal in the j-th household of the i-th village -- (2)

Total Milk production = (1)x(2) ---------- (3)

Number of calf's and adult animals sold per household ---------- (4)

Total dung produced in a village ---------- (5)

Average price of milk---------- (6)

Average price of animals sold ---------- (7)

Average price of dung---------- (8)

Estimated number of animals slaughtered in households privately in a year is given by (9)

Average price of slaughtered animals---------- (10)

Total costs of rearing = C …….... (11)

GVA = ((3) x (6) + (4) x (7) + (5) x (8) + (9) x (10))- (11)

Results and Discussion

Socio-Personal and Economic Characteristics of Respondents

Table 2 shows that majority of the respondents in the study area belong to 40-50 years age group with the average age of 46 years which might be attributed to the fact that they were hardworking and continued the conventional methods of farming. The young generation might be hesitant of farming and hence, involved in different jobs. Further, majority of respondents were found with primary education followed by illiterates which might be due to their poor economic status, improper guidance and less awareness about importance of higher education.

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Table 2: Socio-personal, economic and psychological characteristics of respondents (N=75)

Variables	Categories	Frequency	Percentage
Age (Years)	< 40 years	9	12
	40-50 years	51	68
	> 50 years	15	20
Education	Illiterate	31	41.33
	Primary School	33	44
	High school	9	12
	College &Above	2	2.67
Occupation	Agriculture	69	92
	A.H	2	2.67
	Business	1	1.33
	Government service	1	2.67
	Labour	1	1.33
Land holding	< 3 acres	11	14.67
	3-6 acres	56	74.67
	> 6 acres	8	10.66
Herd size (Livestock Units-LU)	< 3 LU	15	20
	3-6 LU	36	48
	> 6 LU	24	32
Social participation	Nil	66	88
	Member of one organization	3	4
	Member of more than One Organization	1	1.33
	Office bearer	1	1.33
	Public leader	4	5.34
Purpose of rearing (Multiple options)	Conventional/ Ancestors rearing	65	86.66
	Milk	34	45.33
	Meat	12	16
	Urine	11	14.66
	Dung	42	56
	Egg	6	8
	Others	8	10.66

Majority of the respondents pursued agriculture as their major source of livelihood and animal husbandry as the secondary occupation since these occupations were interdependent and integrated since generations. It was also found that farmers considered farming as the sole option of livelihood since they didn't have any other options of livelihood. The study (Table 2) also indicated that majority of respondents had 3-6 acres of landholding and 3-6 LU of livestock holding. However, the average landholding and livestock holding was 5.13 acres and 3.077 LU respectively in the project villages. This might be due to the fact that majority of respondents belong to nuclear family with agriculture and livestock as the major occupation possessing manageable size of herd size and land holding over a period of time. Due to limited land and

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livestock holding, the farmers could earn moderate income primarily through agriculture and animal husbandry in the study area. Table 2 depicts that majority of the respondents did not have any social participation which could be attributed to low level of education, hesitation to work in group to solve the problems and did not show interest in social participation for their development. It was also found that farmers were involved in livestock farming since it was the traditional occupation followed by their ancestors in the project villages.

Livestock Population and Production System

As per the livestock census (Fig. 2), Ballari district has dominant indigenous cattle population over crossbred cattle and buffalo population. Similar is the condition in the project villages which depicts that by and large, non-descript indigenous cattle of very low productivity accounts for major cattle population followed by buffalo population in the region. Further, analysis of cattle population also reveals that crossbred cattle accounts for a negligible population indicative of low production in the region.

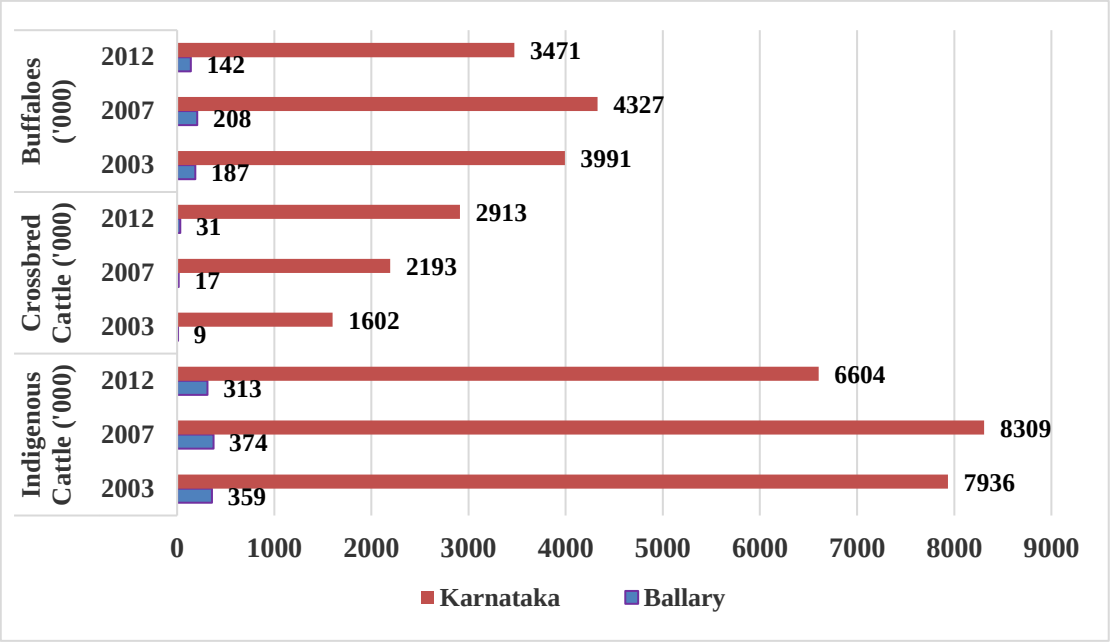

Fig. 2: Livestock Population in Ballari District and Karnataka State (NDDB, 2015)

With regards to small ruminants, the primary data depicted that sheep were more populous as compared to goat population with an average population of 85.1 and 14.2 per village in the project villages. However, it was also observed that majority of the sheep were reared by few communities in the region and were migratory in nature. The respondents in the project villages followed extensive to semi–intensive production system. However, very negligible number of farmers have shifted to intensive system of rearing

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in the recent days. Although Ballari region has commercial poultry farms, the respondents in the project villages were limited to backyard poultry rearing only.

Milk Production and Consumption Pattern

As per the reports of NDDB (2015), Ballari district had bovine milk production of 2.614 kg/day and 2.654 kg/day for 2011-12 and 2012-13 respectively. On similar lines, it was found that majority of the farmers were in the range of 2.5-5.0 litres of daily milk production in the project villages which might be due to the presence of non-descript indigenous cattle of very low productivity and poor emphasis on cross-bred cattle and buffaloes. The primary data also depicted that milk yield varied from 2-3 kg/day, 3-4 kg/day and 5-6 kg/day for indigenous cattle, buffaloes and crossbred cattle respectively in project villages of Ballari district.

Table 3: Milk production and consumption pattern in project villages (N=75)

Variables	Categories	Frequency	Percentage
Total milk yield (Litres per day)	< 2.5 litres	9	12
	2.5-5.0 litres	59	78.67
	> 5.0 litres	7	9.33
Milk utilization pattern	Home use only	43	57.33
	Home use and selling	32	42.67
	Selling only	0	0
Type/Facility of market (n=32)	Cooperatives	10	31.25
	Middle men	18	56.25
	Others	4	12.5

With regards to milk utilization patterns, it was found that the majority of the respondents (43%) utilized the milk for home consumption and the excess milk was sold to the middlemen or local vendors since these villages lacked institutional mechanisms like dairy cooperative for milk marketing. Only one village i.e. Kakabalu had primary dairy cooperative society for milk procurement. However, the farmers also opined that they obtained low price for milk which was not remunerative due to low fat and SNF and also lacked market-related information/knowledge. However, certain key issues like strengthening of dairy cooperative network, increasing the share of marketable surplus milk in the organized sector, enhancing processing facilities and other related aspects need to be addressed with greater focus.

With regards to small ruminant marketing, it was found that farmers sold the goats and sheep on conventional methods rather than weighing of animals. Due to lack of market access in their nearby areas, the respondents depended on middlemen for selling goats and sheep. In emergencies, the farmers preferred forced sale at the age of 3 or 6 months for very low prices also.

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Feed and Feeding Pattern

The major feed resource available for feeding is coming from the crop residues of millets, maize, jowar, groundnut etc. However, due to frequent deficiency of rainfall in the region, crop yields are lower in the region as a whole consequently resulting in a shortage of crop residues. Further, majority of the respondents preferred grazing during day time and rarely practiced stall feeding to their animals at home. The variation in frequency of feeding may be attributed to the availability of feed and fodder resources with the farmers also. The farmers provided green grasses available in the fields during monsoon and leaves of trees. It should be noted that very negligible number of farmers cultivated fodder due to lack of land availability for growing fodder, irrigation facilities, and inputs for fodder cultivation. The report of ICAR-NIANP (NDDB, 2015) also indicated that Ballari district had very negligible area under fodder cultivation in comparison to the net sown area. The farmers also lacked awareness and non-availability of proper technologies such as dry fodder enrichment, silage and hay making, etc. due to poor extension services. Further, it was observed that very negligible number of farmers provided extra concentrate to pregnant animals and lactating animals which might be due to their knowledge about its role in increasing milk production and maintenance of good health. Farmers did not follow any special ration for increasing fat content in milk and this might be due to high cost involved in the feeding. Almost similar poor adoption of livestock technologies or practices was also reported by Rathod *et al.* (2014) in Bidar district of Karnataka where similar situation prevails.

Table 4: Feeding practices in project villages (N=75)

Variables	Categories	Frequency	Percentage
Feeding type	Grazing	45	60
	Grazing+ Crop residues	68	90.66
	Grazing+ Concentrates	4	5.33
	Grazing+ Cultivated green fodder throughout the year	2	2.66

It was observed in the study that rearing of small ruminants emphasized on extensive system in which they were forced to graze on non-palatable and miscellaneous vegetation. Stall feeding, flush feeding and supplementary feeding are also very negligible in the region.

Breeds and Breeding

As per the livestock census (2012), Ballari district has a higher population of non-descript cattle followed by negligible population of Amritmahal, Khilari, Krishna Valley, Hallikar and Deoni breeds. The census also revealed that Ballari district had Jersey and Holsten Friesian crossbred cattle accounting for a negligible population indicative of low production in the region. Further, the district had higher buffalo population of Murrah and Surti, while the population of Mehsana and Pandharapuri was negligible. As per the census data at the village level, project villages consisted majorly of non-descript cattle and buffaloes while the

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cross bred cattle were very negligible in the region. Fig. 3 depicts the breedable population in Ballari district and Karnataka state which ultimately indicates very negligible status for project villages too.

The primary data also found that farmers in the region preferred natural service (94.67%) over artificial insemination (AI) due to the non-availability of trained AI technicians in the villages for undertaking AI. The farmers also lacked the knowledge about symptoms of heat and the right time for insemination. AI was performed by either veterinary officer or VLI of animal husbandry department or else by technician of Bharatiya Agro-Industrial Foundation (BAIF) when the farmers did not get satisfactory results from natural service. In a similar study, poor adoption of AI was also reported by Rathod *et al.* (2014) in Bidar district of Karnataka where similar situation prevails. Hence, there is a need for revisiting the livestock breeding programme in the district in particular and project villages in specific by educating the farmers about advances in breeding.

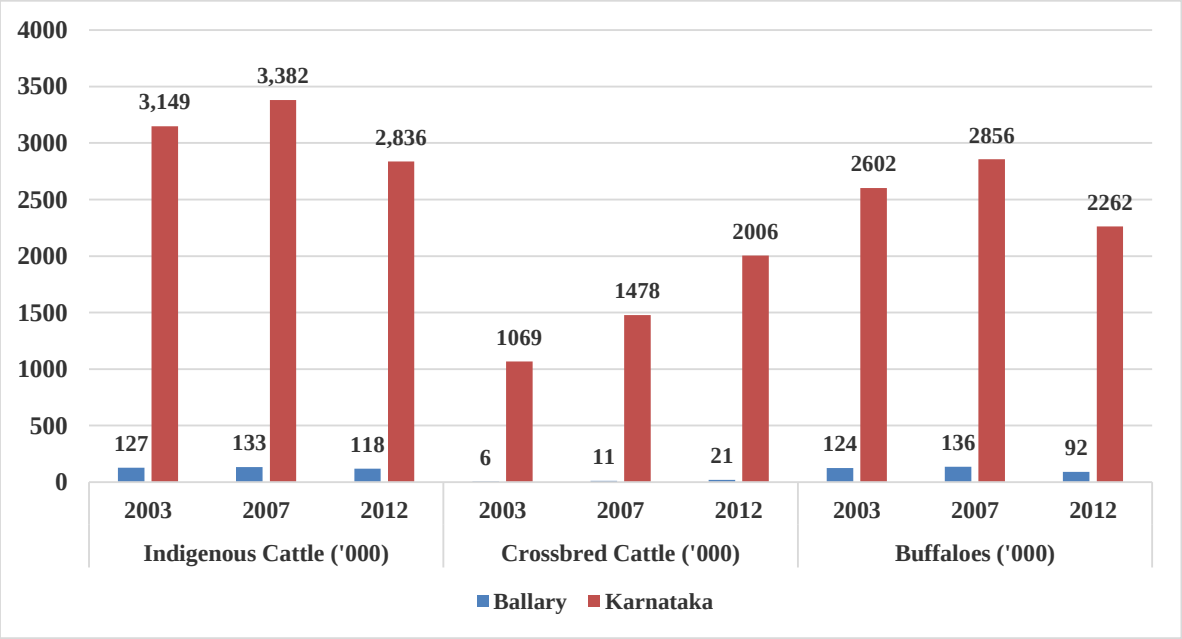

Fig. 3: Breedable livestock population in Ballari district and Karnataka state (NDDB, 2015)

With regards to small ruminants, it was observed that project villages prominently had non-descript goats and sheep in the villages. Further, the sheep of Deccani, Ballari and Kenguri were also found to a limited extent in the project villages. Majority of the sheep farmers were migratory in nature as compared to goat farmers. The farmers lacked scientific information about breeding which was evident from the fact that they didn't emphasize on rearing of males in their herds. Male to female ratio was not scientifically maintained for goat and sheep breeding in the project villages. Almost similar findings were reported by Tekale *et al.* (2013) and Veeranna and Rathod (2019) in Maharashtra and Karnataka respectively.

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Livestock Management Practices

Semi-intensive method of rearing was more common in the project villages followed by the extensive system. Interestingly, cross-bred cattle and buffaloes have a provision of partially scientific animal shed with k*achcha* floor or semi-*pucca* floor which is mostly constructed using the locally available resources. However, the farmers with 2-3 animals tied their animals under the tree or other unutilized space. The cleaning of animals and shed was not a regular practice which led to poor hygiene and occurrence of various diseases. Majority of the farmers in the project villages were not aware about the scientific housing practices which indicate lack of extension services in the region. Interestingly, in one of the villages i.e. Kurekoppa, more than 20 farmers followed rearing of buffaloes on intensive system by procuring the fodder from other sources and also practiced feeding of grains at home. With regards to sheep rearing, it was found that majority of the sheep were migratory in nature and hence, lacked any scientific housing practices. Further, goat farming farmers constructed low-cost sheds for the goats. As a whole, the farmers in the project villages lacked scientific knowledge about management practices.

Table 5: Livestock rearing practices and type of housing in project villages (N=75)

Variables	Categories	Frequency	Percentage
Type of rearing	Extensive	18	24
	Semi-intensive	55	73.33
	Intensive	2	2.67
Type of Housing	Not aware	51	68
	Partially scientific	22	29.33
	Scientific	2	2.67

In project villages of Ballari, without adequate supply of quality water, feed and fodder, the primary effect is on the productive and reproductive performance of animals. It caused heat stress in animals resulting in dehydration in animals, which generally resulted in reduction in milk yield and even death of animals. Further, it was also found that large animals were being replaced with small ruminants to have economy in feeding.

Extension Services

Department of Animal Husbandry and Veterinary Services is presently playing a vital role in providing health care services based on the demand, as and when the farmers call them for the services. However, there is absolutely no mechanism for providing extension and training services to farmers, although short term training is organized by the department whenever they have some budget. There are inadequate arrangements to assess the spread of extension messages, or to feedback findings from the field. A coordinated effort between the Animal Husbandry Department, dairy cooperatives, farmer interest groups

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and NGOs can provide effective extension services in the region. In a similar study, Rathod *et al.* (2015) also reported similar findings in Karnataka.

Table 6: Livestock information sources in project villages (N=75)

Variable	Categories	Frequency	Percentage
Information sources	Input dealers	45	60
	Middle men	7	9.34
	Other farmers	3	4
	Veterinary officers	4	5.33
	Cooperatives	9	12
	Extension Literatures	3	4
	Others	4	5.33

Table 6 depicts that input dealers were the major source of information followed by cooperative and middlemen in the project villages. The input dealers focused more on the health care aspects followed by feeding of mineral mixtures or vitamins to the livestock expecting a sale of these products from their outlet. However, all this might be due to poor education level and poor social participation of respondents leading to negligible contact with other organizations or extension functionaries in the study area. However, the credibility of information is a major concern for the farmers in the project villages since the input dealers did not have specific subject knowledge of veterinary or animal husbandry.

Health Care Services

Karnataka state has a well-established network of veterinary clinics and hospitals in the field. As per the reports of NDDB (2015), Ballari district had 108 veterinary institutions as compared to 3680 institutions in Karnataka. These institutions are engaged in providing breeding and health care services, vaccination, disease investigation etc. As a major stakeholder, the state government is making efforts in controlling various diseases of livestock on a priority basis apart from creating awareness about prevention and control of livestock diseases. However, veterinary officers are engaged in multiple tasks which is causing problems to the farmers and their animals. It is also found that due lack of scientific knowledge and poor socio-economic conditions of the farmers in the project villages, the livestock remain unattended. In a similar study, Rathod *et al.* (2013) also reported similar findings in Karnataka.

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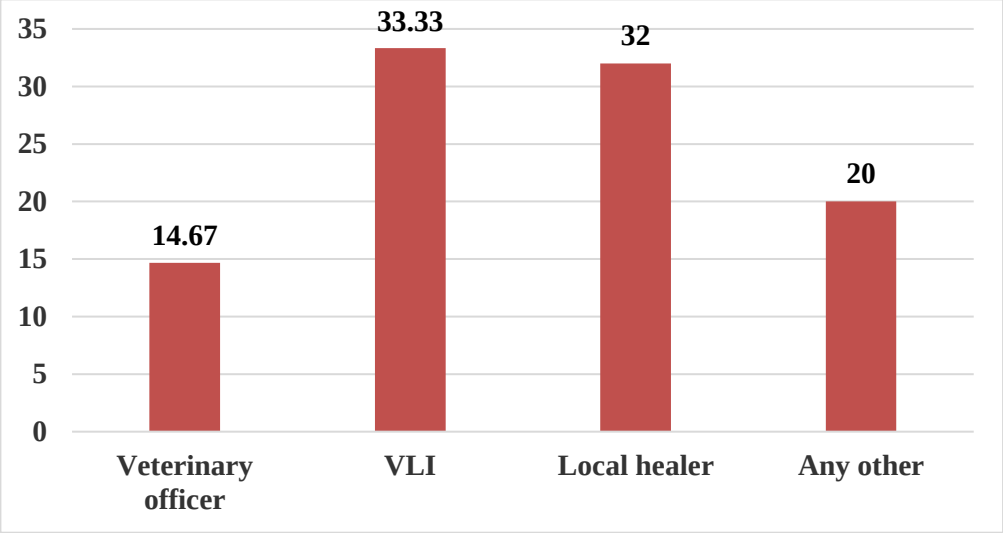

Fig. 4: Common health care service providers in project villages (in %)

Fig. 4 indicates that, when the disease was encountered in herd, Veterinary Livestock Inspector (VLI) or local healers were contacted on priority basis while, the veterinarians were contacted rarely for treatment of their animals. Among different animals, cross-bred cattle and buffaloes received the priority by farmers for health care aspects as compared to the indigenous or non-descript cattle in the project villages. Further, very few farmers vaccinated and dewormed their animals during vaccination programme organized by State Animal Husbandry Department in the project villages due to lack of knowledge about diseases and preventive measures like vaccination and deworming.

Poultry Rearing

Poultry rearing can be adopted by any categories of farmers in the form of backyard rearing; small, medium or large-scale farming depending on resources available with the farmer. Among all the poultry species, chicken is the most popular and still enjoys its 85-90 % share of poultry production. However, negligible number of respondents were involved in backyard poultry in the project villages. The farmers reared *desi*/native chickens and were mostly reared for egg and meat purposes.

Other constraints

Apart from the above-mentioned practices and issues the following observations were also made in the project villages.

- Poor knowledge about scientific livestock farming practices
- Poor institutional mechanism for women and youth in the form of SHGs, FPOs etc.
- Lack of knowledge about livestock insurance and its benefits
- Poor access to government institutions like veterinary hospital/dispensary/SVUs etc.

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GVA in Project Villages

The total GVA value per pilot villages was estimated in order to understand the extent of potential contribution by each pilot village. The village-wise estimations are summarized and presented in Table 7. Per village contribution of GVA was the highest from Kurekoppa village followed by Kakubala village and the lowest contribution is from Nagalapur village. The GVA was highest in Kurekoppa village since it is an irrigated village and has very good population of buffaloes. This village also had more than 20 buffalo farms being reared on intensive systems with 15-30 herdsize each. These farmers sell their buffalo milk to the residents of Jindal industrial area fetching a better price as compared to other villages. There is clear disparity among these villages in terms of potentiality to contribute to total GVA in the pilot site.

Table 7: Village-wise GVA (in Lakh Rupees) in project villages

Village	Cattle	Buffaloes	Sheep	Goat	Total
Nagalapur	13.89	5.77	2.09	8.89	30.64
Bannihatti	23.66	4.8	81.05	35.78	145.29
Lingadahalli	68.11	31.55	0	10.55	110.21
Kurekuppa	113.57	397.28	102.98	33.24	647.06
Kakubala	128.96	248.83	112.25	31.51	521.55
Total	353.76	776.35	298.36	119.97	1548.44

Table 7 also depicts that contribution from buffalo is highest among the sectors followed by cattle and sheep. The goat sub-sector contribution is less compared to the other three sectors. This indicates that buffaloes rearing has been the better alternative source of livelihood in semi-arid zone with dry climate. Further, per capita contribution by animal to GVA is given in Table 8. From the table, it is evident that the per capita contribution from buffalo is highest and sheep is lowest in the project villages.

Table 8: GVA in project villages (Rs in lakh/animal)

Village	Cattle	Buffaloes	Sheep	Goat	Total
Nagalapur	0.16	0.48	0.03	0.04	0.08
Bannihatti	0.18	0.4	0.03	0.04	0.04
Lingadahalli	0.17	0.53	0	0.05	0.16
Kurekuppa	0.24	0.71	0.03	0.04	0.12
Kakubala	0.16	0.36	0.04	0.05	0.1
Mean	0.19	0.58	0.03	0.05	0.1

It should be noted that per animal GVA can be improved by adoption of scientific practices by the farmers. Hence, implementing effective technical interventions is very essential to improve the GVA in the project villages.

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Technical Interventions for Livestock Development and Improving GVA

Based on the existing practices and issues in the project villages, following technical interventions are proposed in the project villages (Table 9 & 10).

Table 9: Critical gaps and technical interventions for dairy development

Critical Gaps	Identified Technical Interventions
Low productivity	Promoting balanced feeding by preparing cost effective ration/ feed at home
	Increasing green fodder availability
	Artificial insemination or sorted sexed semen services would upgrade the local herd and help in obtaining the breed of choice
	Upgradation of local cattle and buffaloes using improved cattle and buffalo breeds.
	Provide/create access to adequate drinking water
Green fodder shortage	Promoting high yielding perennial fodder verities (Both legumes and non-legumes/cereals) cultivation for balanced feeding
	Introducing fodder trees like Sesbanea, subabul etc. on the bunds or unutilized/degraded lands
	Silage preparation for lean season
Fodder wastage	Promoting enrichment of dry fodder and crop residues
	Introducing chaff cutters
	Promoting construction of manger to avoid fodder losses
Health care and diseases	Preventive vaccination and deworming etc. may be introduced in the form of camps
	Clinical services for sick/diseased animals on-demand basis
Lengthy inter-calving period and delayed age at puberty	Creating awareness and improving breeding facilities
	Improving animal breeds through Artificial Insemination/ sorted sexed semen
	Providing proper feeding and balanced ration
	Organizing regular health and infertility camps
Poor marketing and low remunerative price	Establishing an appropriate institutional mechanism such as Farmer's Clubs, SHGs, FPO and strengthening the existing institutions
	Capacity building for developing and enhancing the entrepreneurial skills of farmers.
	Identify and develop niche value-added products specific to the region and establish market linkages.
Lack of scientific knowledge	Capacity building of farmers through training/ awareness campaigns /demonstration/field visits etc.
	ICT tools for scientific information dissemination
Others	Improving animal housing and management practices
	Preparing an inventory of anti-quality/anti-nutritional factors found in different crops/plants growing naturally in drought-prone areas.
	Create awareness about insurance and other government programmes

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The adoption of these technical interventions is very critical for improving the production and reproduction performance of the livestock ultimately leading to improved income of the farmers and increase in GVA of the villages. A study conducted by Garg *et al.* (2013); Deen *et al.* (2019); Hossain *et al.* (2019), Vinothraj *et al.* (2019); and Veeranna and Rathod (2019) revealed that feeding the livestock on scientific approach utilizing the green fodder and concentrate feed along with dry fodder improved the milk yield and health status of the livestock under field conditions. Hence, large scale use of this intervention can help to improve the productivity of milking animals with available feed and fodder resources in an environmentally sustainable manner. Further, findings of Rathod *et al.* (2013); Rathod *et al.* (2017) and Saxena *et al.* (2017) reported that scientific health care and breeding management practices assist the farmers in improving their livelihood through higher production and productivity. Over the years, market-driven approach has been a priority in livestock sector for identifying the right market at the right price for the right commodity. The market opportunities with remunerative prices would improve the economic status of farmers. The studies conducted by Gopala *et al.* (2010), SFAC (2014), Shweta (2016) and Saxena *et al.* (2017) reiterate the fact that market opportunities in the form of cooperatives, Farmer Producer Organizations (FPO), Livestock Interest Groups (LIGs) etc. fetch remunerative price at their doorsteps ultimately increasing the GVA of the livestock. Further, NAIP (2014) and Veeranna and Rathod (2019) have revealed that improving the knowledge of the farmers about scientific practices would benefit the farmers in the long run. All the above-mentioned studies conclude that technical interventions would improve the production and reproduction performance of the livestock ultimately leading to improved income of the farmers and an increase in GVA of the villages.

Table 10: Critical gaps and technical interventions for small ruminant development

Critical Gaps	Identified Technical Interventions
Inbreeding	Changing breeding ram/buck at regular intervals
Poor kidding & Kid and lamb mortality twinning rate	Supplementary feeding during breeding and kidding season
	Introduction of vaccination and de-worming
	Supplementary feeding of pregnant does (transition period)
Unscrupulous marketing system	Introduction of weighing machine in marketing
	Establishing an appropriate institutional mechanism such as Farmer's Clubs, SHGs
Lack scientific knowledge	Introduction of capacity building programmes like training/awareness/demonstration/field visits etc.
	Use of ICT tools for scientific information dissemination
Others	Promoting the construction of scientific goat housing/ pen
	Create awareness about insurance and its benefits
	Promote the establishment of common grazing/pasture land and introduce fodder trees suitable for goats.

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With regards to sheep and goat rearing, the GVA can be improved by addressing the following technical interventions. The studies conducted by Gopala *et al.* (2010), SFAC (2014), NAIP (2014), Rathod *et al.* (2018) and Veeranna and Rathod (2019) have revealed that effective implementation of technical interventions would improve the production and reproduction performance of small ruminants ultimately leading to improve the income of the farmers and increase GVA of the project villages.

Poultry Development

Backyard poultry production has a greater demand due to its deliciousness, smaller/medium body and egg size and liking preference by consumers. Also, about 15 chickens produce 1-1.2 kg of manure/ day. The profitability of poultry farming in the project villages can be increased by procuring potential chicks, providing quality feed and water, day today sanitation and hygiene, health care, stress management etc.

Conclusion and Policy Implications

The study has identified various issues and constraints viz. presence of low yielding non-descript cattle, low milk yield, less breedable population, lack of green fodder etc. in the project villages. These issues and constraints are also common in majority of the SAT regions in Karnataka. Further, the study also estimated that the contribution of GVA was highest from Kurekoppa village (647.06 Lakh Rupees) among the project villages, while it was highest from buffaloes (776.35 Lakh Rupees) among the different species reared in the villages. The study also found that per animal GVA was very low in the project villages for different species. Depending on the status and issues in the project villages, the authors have proposed technical interventions after discussion with multiple stakeholders through which there would be an increase in the production and reproduction performance of the livestock ultimately leading to increase in GVA from the project villages. The proposed strategies are also applicable for majority of the SAT regions in Karnataka. Hence, a need-based research and extension activities by different organizations in the state may be emphasized for the benefit of farming community in SAT regions.

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