



Small ruminant production in dryland regions of India: Status, challenges and opportunities

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Received: 15 July 2021; Accepted: 21 July 2021

ABSTRACT

Small ruminants are important components of smallholder production systems in dry regions of the country and require technological transformation for bringing the farmers out of the vicious cycle of poverty. There is huge scope of improving the income and livelihood of farmers in these harsh topographies because of expanding market and demand for small ruminant products. Live animal sale is the main source of income from small ruminants contribute up to three-fourths of total income. Milk of sheep is produced in negligible amount and consumed in households while goat milk is well in demand but small portion is sold by farmers and mostly used in households. The price of wool is depressed, whereas carpet wool produced in some regions receives prime price in the market. The main factors affecting small ruminant production in dry areas are feed scarcity, poor genetic make of animals, poor health cover facilities, lack of proximity to market and climate change effects. The technological adoption for enhancing productivity of small ruminants in dry areas has been discussed in this overview. The genetic improvement of small ruminant resources, valuation of breeds, exploring value addition/alternative uses of wool and goat milk, improvement of range management, feed base, use of unconventional feeds, flock health management, reproduction management, improving feed efficiency, value addition, quality issues, creating farmers' organisations, improving market access are some of the issues that need priority in research and development for improving productivity of small ruminants for better livelihood security and income generation of farmers in dryland regions. With the concerted efforts of research, extension and development workers, living conditions of small ruminants farmers can be improved which will alleviate poverty, create employment opportunity in rural areas and reduce migration of younger generation to the cities.

Keywords: Challenges, Dryland, Opportunities, Production, Small ruminants

India is blessed with huge livestock population under diverse production systems and agro-climatic conditions. Livestock plays an important role in the economy of the country in general and sustainable livelihood of poor people of dryland areas in particular, because of uncertain rainfall and recurrent droughts making crop farming very risky. Livestock sector contributes 4.9% to National GVA and 28.4% to agricultural GVA at current prices during 2017-18 (BAHS 2019). Goat farming provides 4% rural employment in the country. A total of 33 million rural households (24% of households) are rearing goats; out of these, 20 million are marginal, small farmers and landless rural families and they are holding >76% of goats (DAHD, Singh *et al.* 2018). Apart from the monetary benefits from milch animals, the role of small ruminants like sheep and

goats is very important, as they serve as a lifeline during drought years by providing income and sustenance. Out of the total households rearing sheep in the country, 89.12% of them were from dryland regions and in case of total households rearing goats, 66.56% were from dryland regions of the country. In dry regions, sheep contribute sizably to income and livelihood of farmers (DAHD 2014). Among livestock, 72.44 million (97.54%) sheep and 111.41 million (74.83%) goats in dryland region together play a very important role in economy of the region, provide livelihood to two-thirds of rural community and contribute a lion's share in country's production from small ruminants i.e. 1319.05 million kg (74.28%) meat, 5.53 million tonnes (90.70%) milk and 38.75 million kg (95.87%) wool in 2018-19 (BAHS 2019). India has 328.76 million hectare of total land, out of which 50.94 million ha (15.49%) land falls under arid, 122.52 million ha (37.26%) land under semi-arid, 75.42 million ha (22.94%) land under dry sub-humid and 7.0 million ha (22.34%) land under cold arid regions (Tewari *et al.* 2014).

Traditionally, small ruminants are reared by the poor

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marginal and small farmers, and landless labourers, particularly in the dryland areas of the country due to its certain advantages like lower financial and labour investment, easy upkeep, availability of market, faster return etc. over other livestock. The multi-faceted utility of sheep and goat in terms of meat, milk, wool, skin and manure, thus can be referred as *five star animals*, contributes significantly to the rural economy, especially in dry areas. Small ruminants are like moving bank/ATM and only means of investment for many marginal, small farmers and landless people belonging to dryland areas. By around 2050, it is predicted that the demand of meat and milk will be 60–70% more than present (Blache *et al.* 2016). Small ruminants from dryland regions can play a very significant role in fulfilling a part of this emerging demand. However, the production capacity is adversely affected by climatic uncertainties prevailing in dryland regions. Small ruminant production in dryland areas is mainly through extensive system, sometimes short and long distance migration within the state or neighbouring states in search of better grazing resources. Though dry areas have many inherent problems due to harsh climatic conditions posing as big obstacles for small ruminant farming, they are home to many well-known breeds of sheep and goats. Over the years, many emerging challenges in terms of shrinking of grazing land, deforestation and gradually fading interest of young generation in sheep and goat rearing are posing big threats to the traditional small ruminant farming practices in the country. In this overview, attempts have been made to assess the significant role of dryland regions in country's small ruminant production, delineate the emerging challenges being faced by this sector and how we can bank upon the inherent opportunities present there to devise suitable strategies in improving small ruminant production.

Dryland regions of India

The dryland agro-ecosystem plays a very important role in Indian agriculture; it occupies 67% of the cultivated area contributing 44% of the food grains, and supports 40%

human and 65% livestock population (Venkateswarlu 2005). Dryland areas include cold and hot arid regions, hilly and undulating uplands, ravines and coastal and non-coastal saline areas. Nine states of India, namely Rajasthan, Madhya Pradesh, Maharashtra, Gujarat, Chhattisgarh, Jharkhand, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu make up >80% of the dryland areas of the country. As per the classification of Thornthwaite and Mather (1955), 228 million ha (69%) of about 328.76 million ha geographical area of India fall under the dryland areas which includes arid, semi-arid and dry sub-humid, spread across a large number of states. The annual rainfall of dryland areas ranges from < 150 mm to 1600 mm; the soils vary from sandy, shallow, low-fertility soils of the deserts to medium to deep black soils (Vijay 2006). Major problems of dryland areas are low rainfall, extreme temperature, prolonged dry spells, moisture and nutrient deficient soil leading to acute shortage of feed and fodder, high mortality and morbidity in sheep and goat flocks. The prominent dryland areas of India are presented in Table 1.

Population dynamics of sheep and goat and contribution to rural people

In most of the dryland regions, livestock farming is a major player as more than 70% of family income is derived from livestock. In various government programmes, rearing of sheep and goat is promoted as an income generating activity for landless and poor people, because it has an immediate and direct impact on poverty. Farmers of dryland regions prefer rearing of small ruminants because: (1) they are less expensive to purchase and require minimal inputs and maintenance costs; (2) they are less susceptible to stress due to adverse changes in climatic conditions and (3) they have a relatively high reproduction rate and easy to dispose off. The sheep and goat population in India as per recent livestock census (2019) are 74.26 and 148.88 million, respectively. A major portion of sheep and goat population thrive well in dryland areas of India. The change in sheep and goat population in the dryland states in 2012 and 2019

Table 1. Prominent dryland regions of India

Dryland region	Areas/States	Soil type/ rainfall
Cold arid	Western Himalayas in erstwhile Jammu and Kashmir (Leh and Kargil Districts of Ladakh UT) and Himachal Pradesh (Lahaul, Spiti, parts of Chamba and Kinnaur)	Shallow skeletal soils; rainfall <150 mm
Hot arid	Western Rajasthan, Kutch and northern part of Kathiawar peninsula	Desert and saline soils; rainfall <300 mm
Semi-arid	Rajasthan uplands (Aravalli) and Chambal districts of Madhya Pradesh	Alluvium-derived soils and land degradation leading to ravines
	South western Uttar Pradesh	Alluvial and Aravali soil; rainfall <700 mm
	Central highlands, including Gujarat plains and western Madhya Pradesh (Malwa)	Medium and deep black soils; rainfall 500–1000 mm
	Deccan plateau, including Maharashtra and northern Karnataka	Red and black soils; rainfall 600–1000 mm
	Telangana (Interior of erstwhile Andhra Pradesh)	Red and black soils; rainfall 600–1000 mm
	Tamil Nadu uplands and western Karnataka	Red loamy soils
Sub-humid	Eastern Plateau (Chhattisgarh)	Red and yellow soils; rainfall 1000–1600 mm
	Eastern Chhotanagpur plateau (Jharkhand), western Odisha and northern Andhra Pradesh	Red and lateritic soils; rainfall 1200–1600 mm

Source: Vijay (2006).

Table 2. Trend of sheep and goat population in states with dryland areas

State	Sheep population (million)		% change in sheep population		Goat population (million)		% change in goat population	
	2007	2007–12	2012–19	2007–19	2007	2007–12	2012–19	2007–19
Jammu and Kashmir	4.13	–17.87	–4.19	–21.31	2.07	–2.44	–14.26	–16.34
Himachal Pradesh	0.90	–10.70	–1.68	–12.20	1.24	–9.78	–0.99	–10.67
Rajasthan	11.19	–18.86	–12.95	–29.37	21.50	0.76	–3.81	–3.08
Gujarat	2.00	–14.68	4.66	–10.71	4.64	6.87	–1.84	4.91
Haryana	0.60	–39.70	–20.48	–52.05	0.54	–31.43	–9.34	–37.84
Punjab	0.21	–38.25	–33.43	–58.89	0.29	12.84	6.32	19.97
Uttar Pradesh	1.19	13.99	–27.25	–17.08	14.79	5.36	–7.09	–2.11
Madhya Pradesh	0.39	–20.75	5.06	–16.74	9.01	–11.09	38.07	22.75
Maharashtra	2.91	–11.31	3.87	–7.87	10.39	–18.82	25.72	2.06
Chhattisgarh	0.14	20.03	7.14	28.60	2.77	16.52	24.19	44.72
Jharkhand	0.48	20.60	9.99	32.66	6.59	–0.15	38.59	38.38
Andhra Pradesh + Telangana	25.54	3.35	39.00	43.66	9.63	–5.76	15.27	8.63
Karnataka	9.56	0.27	15.31	15.61	6.15	–22.05	28.63	0.27
Tamil Nadu	7.99	–40.10	–5.98	–43.68	9.27	–12.20	21.43	6.62
Odisha	1.82	–13.04	–19.10	–29.65	7.13	–8.61	–1.84	–10.29
Total dryland states	69.05	–9.03	15.32	4.91	106.02	–4.90	10.50	5.09
All India	71.56	–9.07	14.13	3.78	140.54	–3.82	10.14	5.94
% of All India	96.49				75.44			

Source: DAHDF (2010, 2014); DAHD 2019.

livestock census in comparison to 2007 census has been presented in Table 2. The share of the states with dryland areas to total sheep population increased from 96.49 to 97.54% during 2007 to 2019. As per 2012 census, sheep population in states with dryland areas decreased over 2007 census at par with national level (9.03% vs. 9.07%), whereas in 2019 census it increased more than the national figure (15.32% vs. 14.13%). In 2012, except Jharkhand (20.60%), Chhattisgarh (20.03%), Uttar Pradesh (13.99%), Andhra Pradesh (including Telangana; 3.35%) and Karnataka (0.27%), all other dryland states registered a decline of 10.70 to 40.10% in sheep population compared to 2007. In the last two censuses (2019 vs 2012), the highest decline in sheep population were recorded in Punjab (33.43%), Uttar Pradesh (27.25%), Haryana (20.48%), Odisha (19.1%), Rajasthan (12.95%), Tamil Nadu (5.98%) and Jammu and Kashmir (4.19%). However, it increased in Andhra Pradesh (including Telangana; 39%), Karnataka (15.31%), Jharkhand (9.99%), Chhattisgarh (7.14%), Madhya Pradesh (5.06%), Gujarat (4.66%) and Maharashtra (3.87%). Though, the last three states registered an increase in population in 2019, it had actually declined to the tune of 16.74%, 10.71% and 7.87%, respectively, over their 2007 population. The increase in other states was from 3.78 to 43.66% during the same period. There was an overall increase of 4.91% sheep population in dryland states in 2019 over 2007. The contribution of dryland states towards total goat population is decreased from 75.44 to 74.83% from 2007 to 2019. The decline in 2012 goat population over 2007 in dryland states is higher than the national figure (4.90% vs. 3.82%). Though, the decline in different dryland states ranged from 0.15 to 31.43%, some states like Chhattisgarh (16.52%), Punjab (12.84%), Gujarat (6.87%),

Uttar Pradesh (5.36%) and Rajasthan (0.76%) registered an increase in goat population. In 2019 census, goat population increased little more (10.50 vs 10.14%) than the overall national population as compared to 2012 census. While Jharkhand (38.59%), Madhya Pradesh (38.07%), Karnataka (28.63%), Maharashtra (25.72%), Chhattisgarh (24.19%), Tamil Nadu (21.43%), Andhra Pradesh (including Telangana; 15.27%) and Punjab (6.32%) recorded increase in population, states like Jammu and Kashmir (14.26%), Haryana (9.34%), Uttar Pradesh (7.09%), Rajasthan (3.81%), Gujarat (1.84%), Odisha (1.84%) and Himachal Pradesh (0.99%) showed decline in goat population. Compared to 2007, 2019 overall increase in goat population in dryland states is less than the national level increase (5.09% vs 5.94%). Though goat population is increased in most of the dryland states ranging from 0.27 to 44.72% during 2007 to 2019, some states like Haryana (37.84%), Jammu and Kashmir (16.34%), Himachal Pradesh (10.67%), Odisha (10.29%), Rajasthan (3.08%) and Uttar Pradesh (2.11%) registered decline in population.

Sheep and goat breeds of dryland

India registered 44 sheep and 34 goat breeds as of June 2021 (NBAGR 2021). However, some of the locally known important breeds of these species are yet to be registered. The available population data of 37 out of 44 registered breeds of sheep including their graded types constituted only 55.50% of total sheep population recorded in 2012 census. The rest consisted of 0.72% exotic, 5.10% crossbred and 38.69% non-descript type. Similarly, available population data of 23 out of 34 registered goat breeds including their graded types added up to only 38.74% of total goat population of 2012. A very large population

Table 3. Prominent sheep and goat breeds of dryland region

Dryland regions	Breed	Major utility	Pure + Graded population (Heads)
<i>Sheep</i>			
Cold arid	Changthangi, Rampur Bushair	Mutton	1,16,158
Hot arid	Chokla, Jaisalmeri, Magra, Marwari, Nali*, Pugal	Carpet wool	69,79,624
Semi-arid	Malpura, Kheri@*, Sonadi, Patanwadi, Panchali*, Muzaffarnagari, Jalauni, Munjal@*, Deccani, Bellary, Hasan, Mandya, Kenguri, Mecheri, Coimbatore, Kilakarsal, Madras Red, Ramnad white, Tiruchi Black, Vembur, Katchaikatty Black*, Chevaadu*, Nellore, Kajali*	Mutton, Carpet wool	2,69,63,769
Hot humid	Chhotanagpuri, Ganjam, Balangir, Kendrapada*	Mutton	9,29,710
Total dry region (%)			3,49,89,261 (53.77%)
Total India			6,50,69,189
<i>Goat</i>			
Cold arid	Changthangi, Chegu, Gaddi	Pashmina, Meat	8,51,063
Hot arid	Marwari, Kutchi	Meat, Milk	76,25,895
Semi-arid	Jakhrana, Sirohi, Mehsana, Gohilwadi, Surti, Zalawadi, Kahmi*, Barbari, Jamunapari, Bundelkhandi@*, Rohilkhandi*, Beetal, Osmanabadi, Sangamneri, Berari, Bidri*, Salem black*, Kanni Adu, Kodi Adu*, Nandidurga*	Meat, Milk	2,17,49,027
Hot humid	Ganjam, Konkan Kanyal	Meat	4,47,336
Total dry region (%)			3,06,73,321 (22.69%)
Total India			13,51,73,093

@Not registered; *Population figures not available. *Source:* DAHDF (2015).

(61.26%) of goats were of non-descript type (DAHDF 2015). Presently, there are 36 prominent breeds of sheep and 27 goats native to the dryland areas of the country (Table 3). Some of these breeds have not yet been registered and those for which population figures are available, constituted 53.77 and 22.69% of total sheep and goat population of the country, respectively. These numbers indicated that majority of well-recognized breeds of small ruminants have been evolved in the dryland areas. The unique capabilities of these animals to adapt and produce under harsh environmental conditions of aridity has made it possible to rear them at a low cost on natural vegetation, grazing lands, waste lands and uncultivated lands, and play an important role in livelihood security of people living in dryland areas. Dryland states were also home to a large proportion, 95.31 and 80.41%, respectively, of non-descript sheep and goats of the country (DAHDF 2015).

Meat, wool and milk production in dryland areas

Meat production: During 2018–19, sheep and goats produced a total of 0.68 and 1.10 million tonnes of mutton and chevon, contributing 8.36 and 13.53%, respectively, to the total meat production of India (BAHS 2019). The share of sheep and goats from states with dryland areas were 95.89% and 60.93%, respectively, to the total meat produced from sheep and goats in India (Table 4). These higher levels of contribution of dryland states to the meat production from sheep and goats were achieved from slaughter of 94.10 and 52.51%, respectively, of the total

animals of these two species all over India. The number of sheep (50.86 million) and goats (97.19 million) slaughtered in India during 2018–19 account for 68.49 and 65.28%, respectively, of the 2019 population of these two species. In case of dryland states, 66.08% sheep and 45.81% goats of 2019 population of these states were put to slaughter. The average carcass yields from sheep and goats in dryland states were higher (13.58 and 13.11 kg, respectively) than the national averages (13.33 and 11.30 kg, respectively) (BAHS 2019). Further, the carcass yield of sheep in India is below the Asia (16.2 kg) and World (16.5 kg) averages; the same for goats is at par with Asia (13.2) and higher than the world (12.4) averages (FAOSTAT 2019).

Wool production: Majority of the animals from established breeds and non-descript sheep found in the dryland areas produce carpet type wool. The wool production showed much fluctuation over last few decades. It was 40.42 million kg in 2018–19. The dryland states contributed 95.87% of total wool produced in India (Table 4). These states contributed 92.18, 96.63 and 96.65% of wool produced from ram/wether, ewes and lambs, respectively, in the country. Among the dryland states, Rajasthan (35.93%) contributed highest to the India's wool production, followed by Jammu and Kashmir (18.88%), Telangana (10.55%), Karnataka (7.57%) and Gujarat (5.62%). Emphasis on wool production is declining fast due to low productivity of Indian sheep, low price of raw wool, high shearing cost not even recoverable from the sale of wool produced by the sheep itself, thus making it a burden

for the poor sheep farmers.

Milk production: Both sheep and goats are mostly reared for meat production in India. Goats contributed 3.25% to the milk production of the country in 2018–19. Few sheep breeds in India produce good amount of milk, but the data on milk production of sheep is not available, as they are not reared primarily for this purpose. During 2018–19, goats produced 6.10 million tonnes of milk; out of this 90.70% was produced from the goats of dryland states (Table 4). Rajasthan (34.75%) had the highest share in goat milk production, followed by Uttar Pradesh (22.36%), Madhya Pradesh (13.06%), Gujarat (5.23%) and Maharashtra (4%). Like wool, goat milk do not fetch proper price in the market due to fat percentage based milk pricing policy in use by the dairy companies; sometimes, it is less than the price of one litre of bottled drinking water. Some of the goat breeds are good milk producers and farmers mostly use goat milk for domestic consumption or sale it by mixing it with cow/buffalo milk.

Households engaged in sheep and goat farming

In the states with dryland areas, 40.57 lakhs households and households enterprises (HHE), which were 2.05% of total households (more than the national figure of 1.73%) located in rural and urban areas, owned sheep (Table 5). There were 89.12% of total sheep rearing HHE of the country located in the dryland states. Besides, 21.98 million households and households enterprises, 11.10% of total households located in rural and urban areas in dryland states, were engaged in goat rearing. They constituted 66.56% of total goat rearing households of the country. Jammu and Kashmir (14.27%) had the highest proportion of HHE engaged in sheep rearing, followed by Rajasthan (6.51%), Himachal Pradesh (4.95%), Tamil Nadu (4.65%), Karnataka

(3.81%) and Andhra Pradesh (including Telangana) (3.51%). Rajasthan (32.24%) had the maximum proportion of HHE involved in goat rearing, followed by Jharkhand (29.06%), Tamil Nadu (12.77%), Jammu and Kashmir (12.42%), and Uttar Pradesh (12.25%).

Challenges and opportunities of small ruminant production in dryland areas

Now-a-days, sheep and goat farmers are facing multiple emerging challenges throughout the country and more so in the dryland areas. There is an urgent need to adopt appropriate initiatives to combat these issues. Under the current situations, both sheep and goats are being mainly reared for meat purposes, keeping aside the other important produces like wool and milk, respectively, due to non-availability of proper market for these products. The emerging challenges and inherent opportunities of sheep and goat production in dryland areas of the country are summarized below.

Challenges

Shortage of feed and fodder resources: The dryland regions of the country are known for harsh climatic conditions. There are low to very low rainfall resulting in frequent droughts and problems of soil degradation, soil deficient in multiple nutrients and low organic carbon. Impact of climate change has further aggravated the already unfavorable conditions for carrying out agricultural operations including production of feed and fodder resources for the livestock. Conversion of agricultural land for other activities, together with rapid deforestation and other associated activities, has significantly impacted the natural vegetation as well as production and availability of feed and fodder for livestock production. These factors have

Table 4. Meat, milk and wool production from sheep and goats in states with dryland areas (BAHS 2019)

State	Sheep		Goat	
	Mutton ('000 tonnes)	Wool (000 kg)	Chevon ('000 tonnes)	Milk ('000 tonnes)
Jammu and Kashmir	21.37	7629.28	12.33	79.03
Himachal Pradesh	0.92	1503.14	2.32	51.90
Rajasthan	51.47	14521.84	78.66	2119.25
Gujarat	0.43	2270.51	0.78	319.04
Haryana	12.52	718.50	6.50	50.26
Punjab	3.79	524.85	8.84	67.71
Uttar Pradesh	18.78	1315.97	86.70	1363.83
Madhya Pradesh	1.12	410.17	27.91	796.65
Maharashtra	12.73	1456.93	124.78	247.95
Chhattisgarh	2.19	81.95	15.52	54.97
Jharkhand	1.03	198.59	21.68	149.43
Andhra Pradesh	161.55	797.12	46.20	3.55
Karnataka	47.42	3057.92	32.40	113.20
Tamil Nadu	60.64	2.28	62.33	103.13
Telangana	236.59	4263.51	64.99	6.65
Odisha	17.55	—	77.01	5.24
Total dryland	650.10	38752.56	668.95	5531.79
(% of all India)	(95.89%)	(95.87%)	(60.93%)	(90.70%)
All India total	677.99	40420.00	1097.91	6098.73

Table 5. Number of households and household enterprises (rural and urban areas) rearing sheep and goats in states with dryland areas

State	Number of households	% of households rearing sheep	% of households rearing goats
Jammu and Kashmir	19,00,452	14.27	12.42
Himachal Pradesh	15,72,067	4.95	10.53
Rajasthan	1,46,88,713	6.51	32.24
Gujarat	1,36,63,130	0.59	7.56
Haryana	52,74,507	0.42	1.28
Punjab	46,10,921	0.20	1.60
Uttar Pradesh	3,69,29,882	0.30	12.25
Madhya Pradesh	1,69,33,095	0.11	10.58
Maharashtra	2,83,58,315	0.35	7.05
Chhattisgarh	52,69,657	0.38	11.57
Jharkhand	61,72,894	1.71	29.06
Andhra Pradesh+ Telangana	2,01,31,233	3.51	3.68
Karnataka	1,39,94,427	3.81	5.11
Tamil Nadu	1,73,65,066	4.65	12.77
Odisha	1,10,95,910	2.16	11.46
Dryland Total	19,79,60,269	2.05	11.10
All India Total	26,29,11,314	1.73	12.56

Source: DAHDF (2014).

synergistically contributed to the shortage and resultant increase in cost of feed resources for livestock including small ruminants. Faster population growth, rapid urbanization, expanding real estate business etc. are gradually forcibly swallowing the traditional grazing areas, forests, hills etc. leaving the small ruminant rearing communities hopeless in continuing with their traditional family profession. It is becoming difficult to meet the fodder requirements for the animals due to loss/shrinkage of grazing lands day-by-day. Further, the farmers of arid and semi-arid regions who traditionally migrate with their sheep to other states during the dry season in search of better grazing resources are forced to abandon it due to obstructions/loss of the specific migratory route.

It is estimated that pastures in India have reduced from about 70 million ha in 1947 to just about 38 million ha in 1997 (NITI Aayog 2011). India lost 5.65 million hectares (31%) of grassland area in a decade from 2005 to 2015 as per data presented by the Union Government in the United Nations Convention to Combat Desertification (UNCCD 2019) during the 14th Conference of Parties (COP) at New Delhi. The total grassland area reduced from 18 million ha to 12.3 million ha between 2005 and 2015. The country has also lost 19% of its common lands (from 90.5 million ha to 73.02 million ha) during the same period (Pandey 2019). The major proportion of the loss of pasture lands is from the village commons. Small ruminant production on commons is important both in terms of the meat, wool and milk produced, and a number of people depend on them for their livelihood. These commons supply fodder, fuel as well as other minor forest products and supports production from stationary to traditional nomadic system (Singh *et al.* 2005).

Lack of awareness about choice of good and suitable germplasm: Until today, farmers/farming communities do not bother much about the productivity of their animals, and undertake small ruminant farming in smaller flocks in non-profitable way. There is lack of awareness among farmers about choice of keeping animals of good genetic merit suitable for the local climatic conditions and available production system, though animals of well-recognized high performing local breeds are available. The situation is becoming more complicated due to absence of any appropriate state breeding policy leading to unrestricted inter-state migration of breeds to non-native areas at a very faster rate which is resulting in unplanned crossbreeding/mixing with local breeds. The small size breeds with some unique characteristics like higher prolificacy, better meat quality etc. are in constant danger of dilution/elimination due to general preference for large size breeds.

Major part of population is non-descript: A large proportion of non-descript sheep and goat populations (95.31 and 80.41%, respectively) of the country are found in dryland areas. These animals are smaller in size, having low production potential and responsible for overall low production from small ruminants in the country. This non-descript population presents a huge challenge in improving productivity of sheep and goats in the country.

Lack of adoption of scientific rearing practices: Majority of the small ruminant farmers are not aware about the benefits of adopting scientific farming practices like systematic breeding, feeding, and management including timely health care practices. They rear sheep and goats as part of their traditional family farming without any focus on increasing returns from the same. The traditional ways of sheep and goat rearing by the poor, marginal farmers and landless labourers are facing many difficulties, forcing the younger generation of these families to adopt other less laborious professions. Farmers are forced to keep smaller flocks of 2–5 animals to avoid the emerging problems in their upkeep.

Middleman menace and non-existence of market chain: Farmers exercise hard labour in rearing sheep and goats, but they have hardly any say in fixing the prices of their animals. In the absence of any nearby market or transparent market chain, majority of the farmers sell their animals to the middle men to fulfil their urgent needs. Thus, farmers regularly suffer economic losses as they get prices much lower than the prevailing market rates of the area. There is lack of an established market chain to give more returns to the farmers. Non-availability of any nearby processing facilities for sheep and goat products also restricts the farmers' income.

Lack of easily available financial support: Sheep and goats are mostly reared by marginal and small farmers, and landless labourers. They are resource-poor and depend on natural conditions for feeding their sheep and goats. They have very less to nil savings and are not capable of incurring any additional expenditure on purchase of feed and fodder resources, medicines, vaccines etc. Many a times, they

remain dependent on the money lenders for fulfilling their basic necessities. There is no or insufficient provision for appropriate financial support to them from Govt. agencies for sheep and goat farming.

Occurrence of diseases and mortality losses: The incidence of diseases and parasitic infection is one of the major constraints in the development of sheep and goat sector. Diseases in sheep and goats cause mortality, in addition, morbidity losses resulting in low productivity of the animals. Existing veterinary services for prevention and control of diseases in sheep and goats in the rural areas are inadequate. Livestock services available to small holder sheep and goat keepers are biased towards delivering curative veterinary services. Preventive veterinary care receives less attention, and vaccination coverage of animals is below the level of effective protection (Ahuja *et al.* 2000). Preventive health care is more important for small ruminants as the diseased animals are more vulnerable to risk of mortality.

Opportunities/Strengths

Sustainable development in dry lands can only be achieved through optimum utilization of the natural resources for livestock particularly sheep and goats. There is tremendous scope of increasing productivity of existing sheep and goats by improving the feed and fodder resources. Participation of farmers proved to be an effective and efficient mechanism for faster technology diffusion. Animal health camps in villages helps in creating awareness among farmers regarding the adoption of better livestock practices like supplementation of mineral mixture in the concentrate ration, chopping of crop-residues, cultivation of improved forage cultivars, etc. The major constraints the smallholder farmers are facing in the dry land areas are inadequate availability and poor quality of feed and fodder; poor genetic potential of animals; high incidence of diseases; and inadequate knowledge on appropriate management of livestock. Adoption of the basic strategies of improved breeding, feeding, general and health care management of the flocks can significantly improve the productivity of sheep and goats. Several technological interventions such as provision of timely availability of veterinary services, exposure visits, training and demonstration on balanced feeding and scientific management may be implemented with active consultation and involvement of the stakeholders in their respective farming conditions to improve the productivity of animals. The integration of livestock farming with fodder production in the farmers' field under dryland areas will provide better livelihood by maximizing the use of limited resources available with them. The following interventions can be adopted for livestock development.

Large sheep and goat population and diversity: Dryland areas are native to a large number of well-known sheep and goat germplasm. Some of them possess unique traits like prolificacy, production of high value fibre Pashmina, disease resistance, high degree of adaptability to harsh

climatic conditions, besides producing good amount of meat and milk. Superior high performing germplasm, particularly rams and bucks of these well-recognized breeds can be used as improver in genetically upgrading the low performing non-descript sheep and goats in and around their respective breeding tract. Converting the non-descript sheep and goat population into the nearest well-known breed of the breeding tract through grading up will result in higher productivity and overall production of meat, milk, wool etc. For well-established recognized breeds of sheep and goats, continuous selection based on specific economic traits (growth, wool, pashmina etc.) followed by selective breeding using high genetic merit rams/bucks of the particular breed will eventually lead to further improvement in the production traits.

Access to advanced technologies for fodder production: Advanced and innovative technologies and practices such as fodder crop planning, planning for aberrant weather, fodder crop substitution, efficient fodder cropping system, fertilizer use, rain water management, water-shed approach for fodder resource improvement and utilization, alternate land use system, efficient implements etc. can be used for effective dryland agriculture as well as for production of feed and fodder resources for sheep and goats.

Sheep and goat as source of livelihood for a large number of households: A large proportion of households of the country earning their livelihood from sheep (89.12%) and goat (66.56%) rearing are from dryland areas. It provides a big opportunity to improve the nutritional and food security of these large numbers of households through improvement in small ruminant production in these areas.

Increasing non-vegetarian population: The human population of the country is increasing at a very faster rate creating high demand for animal produces to feed them. With the improvement in financial status of the population leading to increasing purchase power of individuals making rapid transformation in food preferences, many are turning towards non-vegetarian diet. The growing demand can be fulfilled by undertaking scientific sheep and goat rearing practices for intensive production of meat, milk, wool and other produces and products.

Low-input, less labour-intensive and low-cost farming: Sheep and goat farming are generally a low-input and less-labour intensive activity. Sheep and goats thrive well in harsh climatic conditions, in areas with less availability of feed and fodder resources. They are mostly reared through extensive management system by letting the animals loose in forest areas, common grazing land, hills etc. for grazing throughout the day with occasional labour involvements. The necessary infrastructures for housing are generally made from the available materials in the house.

Wider acceptance of goat and sheep meat: Meat of sheep and goats are not linked to any religious/social restrictions as in case of beef and pork, and is widely accepted all over the country. Sheep and goats are the best available option for meat to the consumers, possibly after chicken.

Family farming/women folk managed (back yard)

farming: The women folks of the house can manage sheep and goats easily, alongside their other household chores, requiring no specific attention or labour. It can also be managed by any of the family members themselves whoever is available at home. In many sub-urban, even urban areas, many families keep 1–2 sheep/goats under stall fed condition to meet up their household need of milk and at times, meat.

Strategies for improving income and livelihood of farmers from small ruminants

- Restoration of rangelands with improved grasses, trees and shrubs
- Policies and regulation for use
- Enhancing feed base (forage)
- Use of unconventional feed resources
- Characterization of animals in farmers' flocks
- Genetic improvement of Animal Genetic Resources (AnGR)
- Valuation of breeds
- Adoption of flock health management calendar
- Affordable disease diagnostics
- Regular and timely vaccination, drenching and dipping of animals
- Enhancing efficiency of feeding systems
- Fodder conservation
- Stall feeding of young stock for meat
- Supplementary feeding
- Improvement of market access
- Sale of animals on live weight and body condition basis
- Removal of intermediaries in supply chain

The communities involved in small ruminant rearing are generally from poor financial background and mainly suffer

from resource crunch. Increasing awareness for adoption of scientific sheep and goat management and healthcare practices will alone improve the production performance of the farmers' animals in terms of higher growth, wool and milk yield as well as reduced mortality in the flock. The following specific strategies (Fig. 1) may be implemented for overall improvement in production leading to higher income and better livelihood security of the farmers from small ruminant farming in dryland areas.

Breed improvement programme: There are 44 sheep and 34 goat breeds registered in the country which are well adapted to the specific agro-climatic region. The animals with better growth rate, feed efficiency, bigger size, better adaptability to changing climatic conditions, resistance to diseases and market demand may be propagated for mutton production. Selective breeding may be restricted to the native sheep and goat, and low producing sheep and goat within the tract may be upgraded with the defined, pre-dominant breed of high genetic merit. Progenies of elite ram/bucks add to higher premium price in the market. The animals of the native breed with extraordinary growth may be introduced in specific pockets where environmental conditions and feed resources are optimum for enhancing rapid growth in meat production in the country.

Feeding and nutrition of animals: Major portion (90%) of the income from sheep and goat rearing comes from the sale of lambs and kids for meat purpose. The prime objective of the sheep and goat keeper is to achieve higher slaughter weights of lambs and kids at an early age. In the majority of sheep and goat dominating states, it has been observed that lambs and kids are sold for meat purpose at an early age of 3–4 months when they hardly attain a slaughter weight of 12–14 kg. The study conducted at ICAR-CSWRI, Avikanagar indicated that lambs and kids maintained on

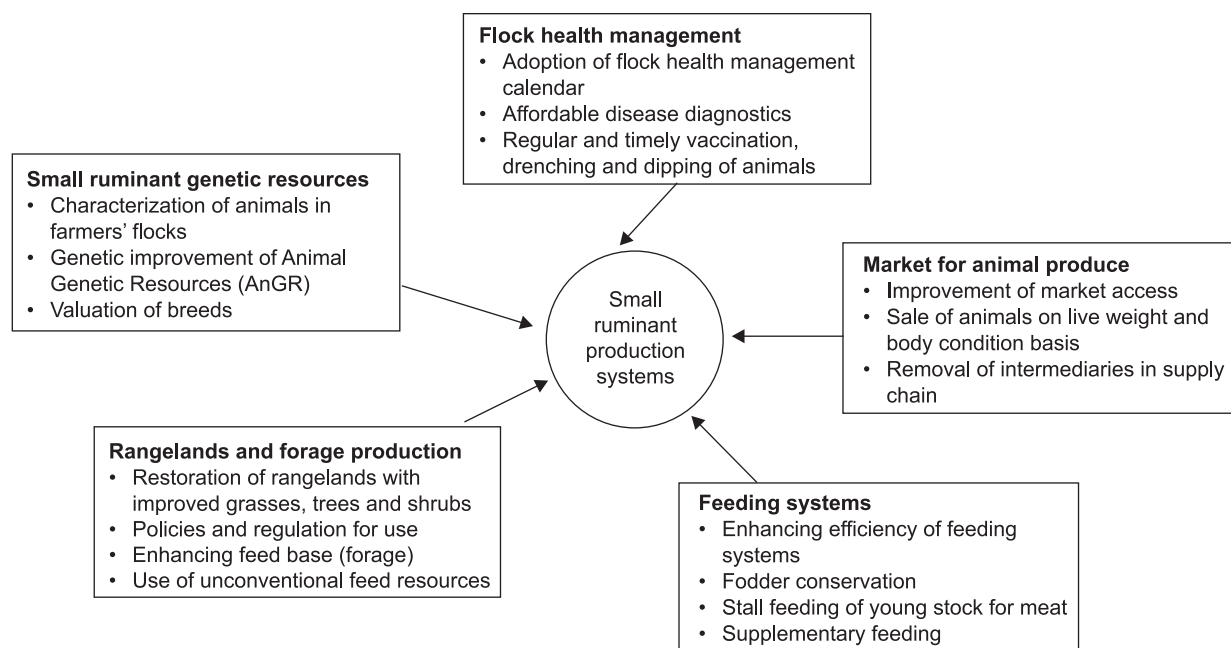


Fig. 1. Strategies for improvement of small ruminant production systems in dryland areas

suckling with *ad lib.* creep ration and tree leaves achieved 14–15 kg body weight at three months of age with ADG of 130–140 g and FCR of 2.0–2.5. There is ample scope of increasing pre-weaning weights by nutritional inputs at economical cost. Lambs and kids reared on grazing on community lands attained 17–18 kg body weight at six months. They can reach > 30 kg body weight at six months with ADG of 170–180 g and feed efficiency of 5.0–5.5.

Health management programme: Sheep and goat diseases are major constraints affecting production efficiency and apparent financial losses. Mortality in lambs and kids during the pre-weaning stage is a major problem; effective strategies and health interventions are required to reduce mortality. Sheep and goat diseases adversely affect mutton production in the country; most importantly, PPR and Bluetongue cause substantial mortality and morbidity losses. Farmers incur around 18–20% production losses due to diseases and mortality. A prophylaxis calendar has been developed by ICAR-CSWRI, Avikanagar based on the epidemiology of sheep and goat diseases, which contains timely vaccination, drenching, dipping and tactical health care. Animals should be regularly vaccinated against enterotoxaemia (ET), sheep pox/goat pox, Peste des petits ruminants (PPR) and Foot and mouth disease (FMD). Annual health management calendar that includes timely vaccination, drenching and dipping when effectively implemented in a flock resulted in reduced morbidity and mortality losses. Deworming should be practised for controlling internal parasites during pre-monsoon. Dipping in spring season is required to manage ectoparasites. Besides this, foot bath with copper sulphate is essential during monsoon season. The annual cost comes to around ₹ 70–75 per sheep and goat and reduced mortality losses to < 5% and save 10% animals.

Exploring value addition/alternative uses of wool and goat milk: Today the wool of sheep and goat milk do not fetch additional income to the farmers due to very low market price of both. Wool is further neglected due to easy availability of cheap synthetic fibres and has become a burden to the sheep farmers. Goat milk suffers due to its low fat percentage under a faulty fat based milk pricing system presently being used by the dairy companies. Suitable value addition or alternative uses of both wool and goat milk can be explored to increase their market price. Wool can be popularized to use as an insulator, air purifier, humidity regulator, wool pellets/fertilizer, bedding/furnishing material, sound proofing material, fire retardant etc. Also, possibilities can be explored to develop suitable methods for extracting important amino acids from wool. Similarly, goat milk can be used to prepare various products like paneer, cheese, ice cream, chocolates, infant formula etc. Goat milk can also be used to make medicated soap, face wash, lotion, leap balm etc.

Training, skill development and capacity building of farmers: The focus should be on enhancing skills and capacity building through improving and upgrading small-scale sheep and goat production and processing techniques.

The skill development of stakeholders at each stage right from the farm to fork is need of the hour. Sheep/goat farmers should be trained in scientific rearing for the production of healthier livestock by adopting improved technologies. Similarly, the personnel involved in the processing sector should be trained for hygienic, safe meat, milk and products manufacturing.

The increasing demand for meat and milk and their value-added products can be fulfilled by improving per animal productivity, scientific feeding and management practices and their adoption at sheep/goat farm. Because of shrinkage in grazing lands, the traditional system of sheep/goat management under extensive system should be substituted by semi-intensive/intensive system. There is a need to establish direct tie-up of farmers with processors and consumers in line with contract farming practices so that the farmers can get remunerative prices for their produces. Smart marketing would further increase the profit margin. Further, consumers would also get a safe, hygienic and quality product as per their choice.

Marketing of animals: In India, the marketing system of small ruminants is highly unorganised and a number of intermediaries are involved in between producers and consumers. This reduces the profit margin to the sheep/goat keepers as the large chunk of it is consumed by the middleman. Ideally, sheep/goat marketing should offer remunerative price to owners. Similarly, consumers should get the produce at a reasonable price and also in good quality and sufficient in quantity. Majority of sheep/goats are sold in the market on the basis of physical appearance by visual observation. Rarely, animals are sold on the basis of actual weight and body conformation in the markets. This leads to poor realization of the animal price to farmers. Large channels of intermediaries (Commission agent, butcher, traders) are involved in marketing of goats/sheep. Farmers get only 60–70% of price of animal in the market under normal situation. In drought and other calamities, due to scarcity of fodder and water, farmers have no option but to sell their animals at throwaway prices.

Credit support and insurance: Majority of sheep and goat keepers are from the downtrodden section of society. Credit support from the financial institutions is required to them for establishing sheep/goat farming or introducing new breeding stock and also meeting contingency expenses.

Coordinated efforts from different players: Various players like Central and State Government agencies, Non-Government Organizations (NGO) etc. are working in isolated manner without any collaboration or knowledge sharing, though all have the similar objective of improving livelihood of small ruminant farmers. It is creating unnecessary confusion/conflict, repetition, loss of money, resources and time giving delayed and under par results. Target-oriented coordinated efforts from all of them by adopting a unidirectional approach, sharing of information and regular review of the progress will provide faster and effective results for a larger population of beneficiaries.

Conclusion

Small ruminant production is the most important means of livelihood to a large section of the country's rural population particularly belonging to the dryland regions. In spite of facing several inherent and emerging challenges, these areas are home to many of the prominent sheep and goat germplasm, contributing a lion's share to the country's production from small ruminants. Under the climate change scenario, these breeds may prove to be the most resilient ones. There is an urgent need to implement various effective strategies in a concerted manner to combat the issues faced by the small ruminant farmers of dryland regions to improve their livelihood and further economic upliftment.

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