

Small Ruminant Sector in India: Present Status, Feeding Systems and Greenhouse Gas Emissions

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Abstract

This paper reviews the economic contribution, breeds, feeding systems and greenhouse gas emissions from small ruminant sector in India. Small ruminants (sheep and goat) are widely distributed across various agro-ecological zones of India, playing an important role in socioeconomic development of resource poor farmers in rural areas. The populations of goats and sheep in India are 135.04 and, respectively, with 146 breeds of goats and 233 breeds of sheep. The total goat and sheep meat production was but most of it is consumed directly by the producer or locally. The goat milk has increased at an annual growth rate of 2.6 % from 3.6 to 4.7 million tonnes during 2002 - 2011. Enteric fermentation of small ruminants (sheep and goat) was responsible for 402, 446 and 436Gg of methane in 2000, 2007 and 2012, respectively. Manure management emitted about 7.71, 8.65, and 8.46 Gg of methane and 5.28, 5.88 and 5.75 Gg of nitrous oxide for the year 2000, 2007 and 2012, respectively. The production sheep/goat is limited by many factors including lack of feed and fodder availability, market facilities, poor policy support, and postproduction systems like collection, handling, marketing, slaughter facilities. Therefore, there is need of scientific management of breeding, pregnancy, nutrition, housing and healthcare with considerable economic investment to fetch more returns from sheep/goat rearing. The profitability and economic returns from the sector can be considerably enhanced through value addition of the animal produce and better market accessibility.

Keywords: *Small Ruminant Sector; Feeding Systems; Greenhouse Gas Emissions*

Introduction

Small ruminant sector is an integral part of Indian rural farming especially in the arid/semi-arid and mountainous areas [1]. On an average, 15% of households in rural areas rear sheep/goat across the country and around 70% of goat/sheep are reared by small and marginal farmers and landless labourers, playing an important role in their nutrition, supplementary income and livelihood security [2]. The goat sector alone contributes 8.4% to the India's livestock gross domestic product (GDP) and generates about 4.2% rural employment to the small, marginal farmers and landless labourers [3].

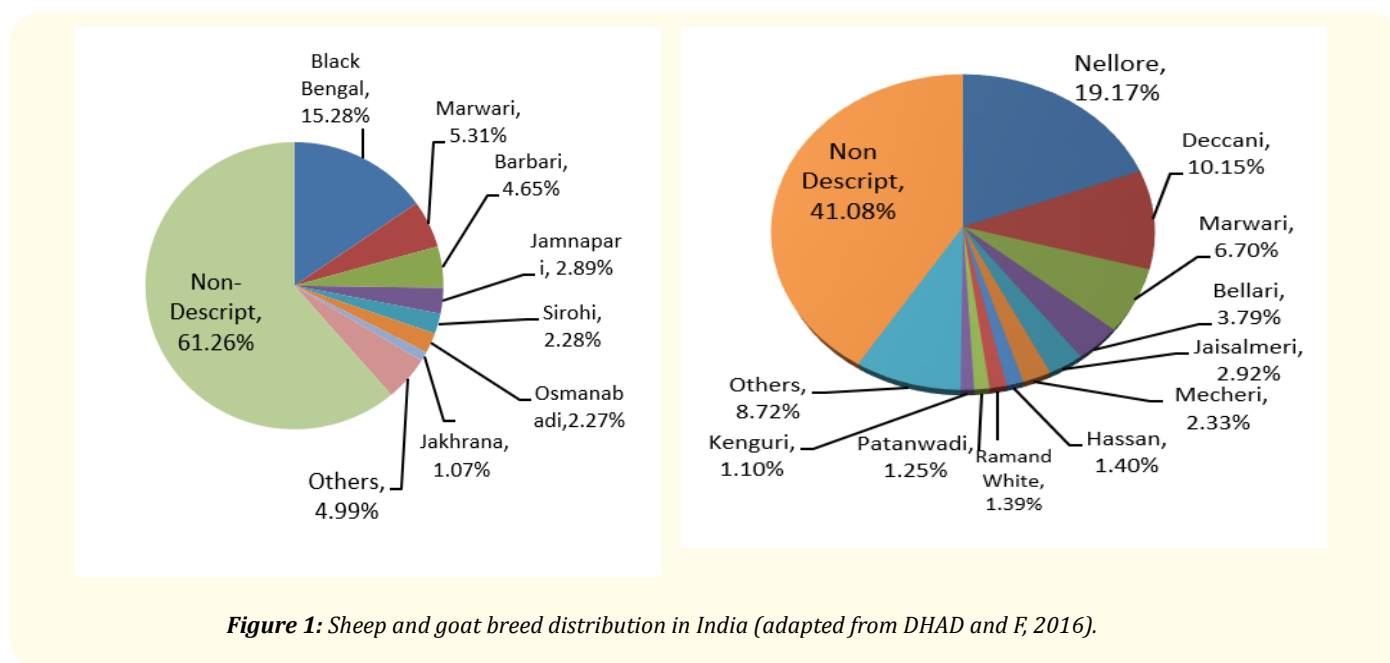
The country possesses about 135.2 million goats, one of the largest in the world and 65.07 million sheep, which account for 12.71% and 26.4% of total livestock population of India, respectively (DHAD and F, 2016). India has a vast diversity in sheep and goat genetic resources with 42 and 23 breeds respectively, recognised by National Bureau of Animal Genetic Resources, Karnal, spread in different agro-climatic zones. However, most of the sheep (38.68%) and goat (61.26%) are of non-descript type with a low production potential. These are reared for meat, milk (goat), dung, hair, wool and hides and in some countries like Turkey, Iran, Greece, Italy, and Spain, sheep milk has a great importance.

Though large ruminant dairy sector is more profitable but small ruminants have some advantages over the counterparts. They have wide adaptability to harsh environments, low production inputs and capital investment, high fertility and fecundity, low feed and management needs, less space and feeding requirements, and high feed conversion efficiency [4]. Because of their smaller size they are suited for mountainous regions, limited land and other resources. Thus, small ruminant sector may be regarded as complementary, rather than competitive with cattle farming. However, the potential contribution of small ruminants is constrained by inefficient production systems, poor breeding strategies, weak marketing structure, and inadequate official support [5]. The goat and sheep populations have declined by 3.82% and 9.1% from 2007 census. This may be because of high slaughter rate, effect of consumer shift resulting pressure on small ruminants, shrinking grazing lands and migrations [3].

This paper discusses small ruminant sector in India, its contribution to economy, production systems, greenhouse gas emissions and challenges faced by this sector.

Genetic resources and regional distribution

Out of 135.04 million of indigenous goats, 26.97% are pure breed, 11.77% are graded breeds and remaining 61.26% are non-descript breeds (DHAD and F, 2016). Among the indigenous breeds, Black Bengal breed shares maximum proportion (15.28%) followed by Marwari, Barbari, Jamnapari, Sirohi, Osmanabadi and Jakhrana. In case of sheep, 38.68% are exotic/crossbred, 55.51%-indigenous and 38.68% are non-descript breeds. The proportions of different sheep/goat breeds are shown in figure 1.



The small ruminants are widely distributed over the different agro-climatic zones of India. They are classified on the basis of agro-ecological regions viz.

- a) North temperate region,
- b) North-western arid and semi-arid region,
- c) Southern peninsular region,
- d) Eastern region.

The sheep are also classified on major products

- a) Apparel wool,
- b) Carpet wool,
- c) Meat and carpet wool,
- d) Meat types.

Northern Temperate Region

Comprises the states of Jammu and Kashmir, Hilly regions of Uttarakhand and Uttar Pradesh. The goat breeds in this region are Chegu, Changthangi, Gaddi and Kashmiri Pashmina. These are reared for meat and fine fiber production. The Pashmina breed is reared for fine quality fiber known as pashmina and yield of hair varies from 21 - 56 g/goat/year. The important sheep breeds in this region are Rampur Bushair, Gaddi, Gurej, Karnah, Bhakarwal, Poonchi, Kashmir Merino and Changthangi. Main uses are carpet and apparel wool (Kashmir Merino) production.

North - West arid and Semi-arid region

Includes states of Rajasthan, Haryana, Punjab, Plains of Uttar Pradesh, Madhya Pradesh and Chhattisgarh. The breeds of goat in this region are Sirohi, Jhakrana, Beetal, Barbari, Jamunapari, Surti, Zalawadi, Marwari and Kutchi, reared for milk and meat production. The important sheep breeds in this region are Chokla, Magra, Nali, Pugal, Marwari, Malpura, Sonadi, Jaisalmeri, Kheri, Patanwadi, Munjal, Muzaffarnagri, Jalauni and Hissardale. This region is the most important in the country for carpet-wool production.

Southern peninsular region

Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Maharashtra and other central parts of India. Goat breeds of this region are Osmanabadi, Sangamneri, Kanniaadu and Tellicheryor Malabari. These are mostly reared for meat production and some give milk also. This region has the largest sheep population of the country. Important breeds of sheep of this area are Deccani, Bellary, Nellore, Chennai Red, Mandya, Tiruchy Black, Mecheri, Ramnad White, Nilgiri, Coimbatore, Kilakarsal, Kenguri, Hassan and Vembur. Almost half of these produce no wool, rest produce very coarse, hairy and colored fleeces (Deccani, Bellary, Mandya, Coimbatore and Mecheri). Most sheep in this region, except the Nilgiri, are maintained primarily for meat.

Eastern and North- Eastern Region

Bihar, Orissa, West Bengal, Sikkim and Seven Sisters i.e. Arunachal Pradesh, Assam, Nagaland, Manipur, Meghalaya, Mizoram and Tripura. The important breeds are Shahabadi, Chottanagpuri, Garole, Ganjam, Balangir, Bonpala and Tibetan sheep. Most of the breeds are primarily maintained for meat and produce extremely coarse and hairy fleeces.

Meat production

Sheep and goat are main meat producers in India and their meat does not have any social taboo or religious sentiments associated. Majority of Indian population prefer sheep and goat meat than large ruminant meat. This could be one of the reasons for 98% of meat produced from small ruminants is consumed in the country itself with a meagre export. The country stands second largest goat meat producer in the world, sharing 12% production. The total meat production in country was about 7.0 million tonnes during 2015 - 16 of which sheep and goat meat contributed 7% and 13% respectively (DHAD and F, 2016). The major income (70%) in sheep farming comes from sale of live animals for mutton purpose. The top five mutton producing states are Telangana (23.78%), Andhra Pradesh (19.07%), West Bengal (17.165), Rajasthan (7.71%) and Tamil Nadu (7.33%). The major goat meat producing states are West Bengal, Uttar Pradesh and Andhra Pradesh (BAHS, 2013).

The country exported sheep and goat meat worth of 130.17 USD millions during the year 2016 - 2017 and major countries for export are United Arab Emirates, Saudi Arabia, Qatar, Kuwait and Oman. However, at present, only 2% of the meat is processed and remaining meat is sold in fresh or frozen form [6]. Slaughter of sheep has been increased over the period from 33.13% in 2007 - 08 to 47.05% in

2011 - 12, which has reflected in decline of sheep population [7]. The estimated mutton requirement in the country would be 813 million kg by 2020, and 986 million kg in 2030 and 1408 million kg in 2050. The annual per capita availability of meat in India is 4.2 kg against the recommendation of 11 kg/head/annum by ICMR, a wide gap between the availability and demand. However, carcass yield of Indian sheep is relatively low as compared to the world average and present systems of rearing under traditional extensive and/migratory systems will not support growing demands [2]. Thus, there is an urgent need to improve the body growth and reproduction through breeding, nutrition, health and management.

Milk production

The country stands first in goat milk production and shares about 29% of total world goat milk production. The total milk production was 155.5 million tonnes for 2015 - 16, of which 3 - 4% was contributed by goat milk. Goat milk production has increased from 3.6 to 4.7 million tonnes during 2002 - 2011 with an annual growth rate of 2.6 %. The goat milk possesses medicinal and health-promoting properties and serves as a ready source of family nutrition preferably to infants, old age and sick persons [8]. Sheep milk production is confined to the Near East countries such as Turkey and Iran, and to Southern and Central Europe (Greece, Hungary, France, Italy, Spain and the Czech and Slovak Republics). There is no milk producing sheep breed in India. Bioactive peptides of sheep milk have many health properties like antihypertensive, antimicrobial, antioxidant and immunomodulatory. Dairy sheep is more profitable and gives 2.2 times more net income than per flock over non-dairy sheep [9]. The breeds like Patanwadi and Malpura produce 0.8 - 1.1 kg milk daily in early lactation [9].

Wool and leather production

The wool contributes only 15 - 20% to the income of sheep farmers. Wool production in India is almost stagnant at 45 million kg since last two decades. Wool production was 46.05 million kg during 2012 - 13 and increased to 48.1 million kg in 2014 - 15 but declined to 43.6 million kg in 2015 - 16, a negative growth of -9.47%. Average annual wool production from Indian sheep is 0.7 kg against the world average of 2.4 kg. The Indian wool is coarse in nature and has short staple and best suited for carpet manufacturing. Magra and Chokla are best quality wool producing breeds in India. About 85% is carpet grade wool, 5% apparel grade and remaining 10% coarser grade wool. Nearly 71% of wool produced is contributed by ram/weather and ewe and lamb contribute 25% and 4% respectively.

States	Wool production Qty ('000 kg)
Rajasthan	15026.83
Jammu and Kashmir	8709.70
Karnataka	7754.53
Andhra Pradesh	5036.83
Gujarat	2578.06
Rajasthan	1502

Table 1: Top wool producing states in India (2014-15).

The wool exports for 2014 - 15 stood at US\$ 1,869.8 million with US and EU being the key importers of Indian wool and wool-blended products. The import of raw wool and wool blended products and export of wool and wool blended products has shown a decline of 4.8% and 3.2% (in rupees terms) during 2015-16 as compared to 2013-2014 [10]. The higher global demand for Indian wool and products has led to higher import of wool to meet the demands of local industry. The requirement of fine wool may not be met but demands of carpet wool with appropriate policies and technologies can be done [9]. The country produced about 37 million pieces of sheep skin in 2011-12, Tamil Nadu alone accounts for 70% of the country's tanning capacity and 40% of its leather exports [2].

Feeding systems for small ruminants

The small ruminant production systems are widely varied as socio-economic and agricultural situations in India and depend on the region, utility and economic conditions of the farmer [11]. The choice of production system will largely depend on the level of production (subsistence or commercial) and production resources to support this. Sheep and goat are generally managed together in the traditional systems, but choices can be different for commercial purposes. Three types of feeding systems are generally practiced in our country such as extensive (tethering/ free range), intensive (stall feeding), and semi intensive/semi scavenging system. Singh, *et al.* [12], and Bhatia and Arora [13] reviewed the production systems for goats and sheep, respectively in the country. The production systems are broadly divided into six zones on the basis of agro-climatic conditions; North temperate region, North-western arid and semi-arid region, Southern peninsular region and Eastern region. In most of these systems, goats are reared commonly under extensive system of production on community grazing lands, postharvest and barren agriculture land, on periphery of forestlands, village's common land, roadsides, canal

banks, and pond beds. The nomadic and transhumance type of extensive production system is also practiced. The semi-intensive type of management (fenced grazing, tethering and fattening) is also being followed in some areas and small quantity of concentrate is provided to advance pregnant does, breeding bucks and during lactation period. In sheep, most of the flocks are stationary and some are migratory except in Haryana and Punjab. In the Eastern region, migration to neighboring districts occurs only during scarcity periods.

Greenhouse gas emissions

The livestock sector is a significant source of anthropogenic greenhouse gases (GHG) contributing about 18% of global anthropogenic emissions [14]. The emissions from livestock management include methane (CH₄) from enteric fermentation, and CH₄ and nitrous oxide (N₂O) from manure management. The enteric fermentation and manure management are largest sources of CH₄ and N₂O emissions to agriculture [15]. Globally, livestock account for about 37% anthropogenic CH₄ and 65% of anthropogenic N₂O emissions [14]. The national GHG inventories provide essential information on quantification of GHG emissions, tracks emission trends and development of mitigation policies [16]. The Intergovernmental Panel on Climate Change [17], proposed three methods to estimate GHG emissions from each species of domestic animals, Tier 1, 2 and 3 approaches.

The national inventory for livestock is based upon the default emission factors of IPCC [17] and country specific emission factors [18]. The country specific emission factors (Tier 2) [17] are used for estimation of enteric CH₄ in cattle, buffalo and goats. These factors are based on the studies conducted at National Dairy Research Institute, Karnal using sulphur hexafluoride tracer technique (Johnson et al., 1994). The default emission values (Tier I) of IPCC [17] are used for other livestock categories like sheep, horse, donkey etc. There are no systematic studies on GHG estimation from livestock waste in India, probably due lesser importance and a wide variability in managerial practices in different regions of the country. Manure CH₄ and N₂O emissions are estimated in accordance with IPCC Tier 1 method [17], accounted for manure management practice. The CH₄ emission is estimated by multiplying emission factor with total dung produced (estimated from digestibility of the feeds). Direct N₂O emissions are calculated by multiplying total nitrogen excreted in each type of manure management with IPCC default emission factor for that type of manure management system (Tier I, [17]).

The total enteric CH₄ emission from livestock was 10.14, 10.50, 10.55 and 11 Tg during 2000, 2007, 2012 and 2016, respectively. Overall, enteric CH₄ is responsible for a major proportion of total GHG emissions (91.8%), followed by manure CH₄ (7.04%) and manure N₂O (1.15%) emissions [19].

During this period, enteric fermentation of small ruminants (sheep and goat) was responsible for 402, 456,444 and 437Gg of CH₄ in 2000, 2007, 2012 and 2016, respectively. The per cent contribution of goat and sheep to enteric CH₄ emission for the same time period was 2.18 and 1.78, 2.34 and 1.9, 2.34 and 1.8, 2.31 and 1.8 respectively. Manure management of small ruminants emitted about 7.71, 8.65, 8.46 and 8.09 Gg of CH₄ and 5.28, 5.88, 5.75 and 5.50 Gg of N₂O for the year 2000, 2007, 2012 and 2016, respectively. The GHG emissions from manure depend upon manure composition, which in turn depends on the composition and digestibility of the animal diet. The type of manure management system can affect the amount of emissions and the type of gases that are emitted. The detailed contribution of different categories of small ruminants towards GHG emissions is presented in table 2. Andhra Pradesh, Rajasthan, Karnataka and Uttar Pradesh are high methane emitter states for small ruminants, with a contribution of 18.4%, 19.4%, 7.8% and 7.1% respectively. Detailed estimates of State-wise methane emissions from enteric fermentation and manure management for the year 2000-2016 are given in table 3. The percent contribution from the states of Andhra Pradesh, Uttar Pradesh, Orissa and Jharkhand decreased while contribution from the states of Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu and West Bengal declined for the period from 2000 to 2016 attributed to the changes in populations [20,21].

Category	2000	2007	2012	2016
Goat (male)				
0 - 1 year	15	17	17	17
> 1 year	36	38	38	37
Goat (female)				
0-1 year	21	22	22	23
> 1 year (in milk)	75	94	94	94
> 1 year (dry)	73	54	54	55
not calved	0	20	20	21
Crossbred male sheep				
0 - 1 year	1	1	0	1
> year	3	2	2	3
Crossbred female sheep				
0 - 1 year	1	1	1	1
> 1 year	9	6	6	7
Indigenous Sheep (male)				
0 - 1 year	8	11	11	10
1 year and above	30	30	30	25
Indigenous Sheep (female)				
0 - 1 year	14	21	21	20
1 year and above	14	128	128	122
Total methane emission (Gg)	401	445	444	436

Table 2: Enteric methane emission from different categories of sheep and goat (2000 - 12).

States	2000	2007	2012	2016
Andhra Pradesh	56706.37	87479.20	89119.62	90431.97
Arunachal Pradesh	315.64	399.35	435.44	465.69
Assam	4033.04	6779.13	9954.25	12494.34
Bihar	35153.08	22748.22	27949.39	32110.33
Chhattisgarh	5454.13	6778.50	7865.97	8735.96
Goa	16.29	14.87	17.82	20.41
Gujarat	18023.70	17722.93	17794.38	17851.54
Haryana	4486.36	4034.55	1963.57	615.09
Himachal Pradesh	6411.66	6156.57	5468.91	4918.79
Jammu and Kashmir	16370.48	18552.54	17013.87	15782.93
Jharkhand	6695.11	15523.48	16598.79	17459.04
Karnataka	29904.23	37681.02	35441.60	33650.06
Kerala	2034.45	2443.09	1764.13	1222.37
Madhya Pradesh	13719.64	16367.22	14180.93	12965.06
Maharashtra	24681.02	20543.80	18855.68	17505.19
Manipur	57.21	87.31	114.05	135.43
Meghalaya	481.28	537.25	667.78	772.20
Mizoram	23.52	15.27	31.99	45.73
Nagaland	226.85	251.15	143.99	58.26
Orissa	11916.65	12327.45	12877.96	13480.80
Punjab	1849.69	1522.27	1283.09	1115.56
Rajasthan	86457.75	92595.91	83967.08	77064.01
Sikkim	160.16	136.55	157.77	175.56
Tamil Nadu	25514.13	25706.89	25418.83	25188.38
Tripura	771.21	856.44	811.47	782.72
Uttarakhand	3458.76	3842.33	4174.85	4440.87
Uttar Pradesh	27664.71	30426.74	32627.04	34387.29
West Bengal	26906.67	23006.43	17720.31	13679.04
Andaman and Nicobar	89.16	85.87	87.73	89.22
Chandigarh	1.51	2.04	2.54	2.95
Dadra and Nagar Haveli	35.13	38.95	6.04	0.49
Daman and Diu	5.89	3.72	3.26	2.89
Delhi	69.17	61.63	70.50	87.65
Lakshadweep	50.21	85.86	64.74	53.08
Pondicherry	65.93	108.41	81.99	66.29
All India	409810.77	454922.93	444737.36	437857.20

Table 3: Methane (enteric + manure; Gg) emissions from sheep and goat in different states.

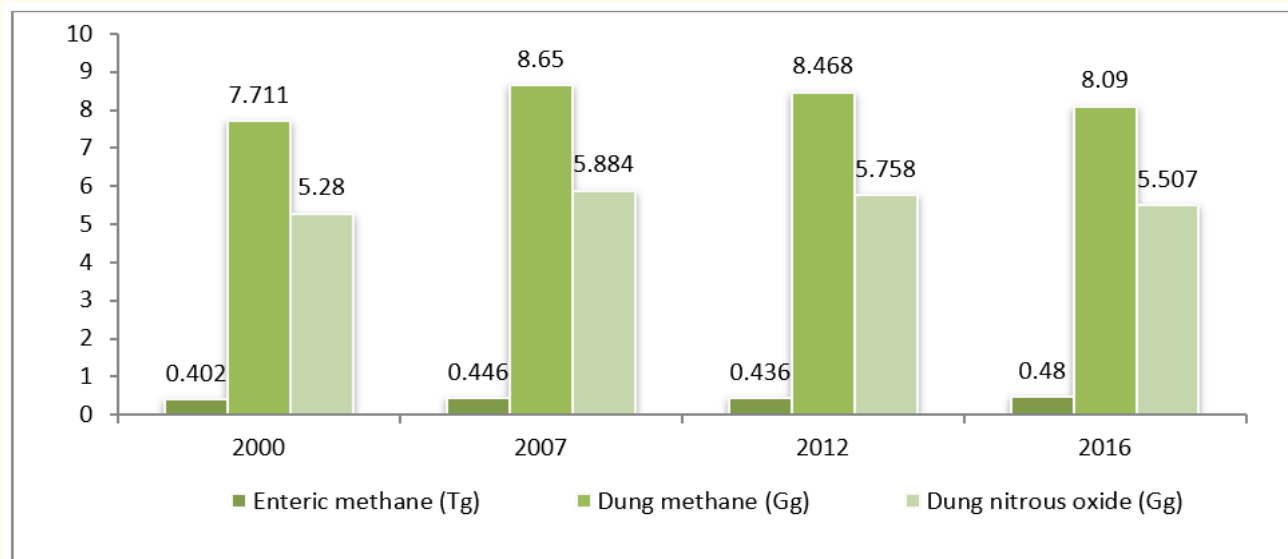


Figure 2: Enteric methane and dung methane and nitrous oxide emissions from sheep/goat sector.

Challenges and developmental issues

There are many constraints faced by this sector which hampers efficiency and productivity of the sector

- Lack of feed and fodder availability
- Shrinking of available grazing land
- Ineffective financial support
- Poor infrastructure
- Lack of organised market for small ruminant products
- Non-availability of high-yielding breeding stock.
- Lack of national breeding policy
- Unorganised and unhygienic slaughterhouses
- Poor initiatives on conservation of indigenous goat breeds
- Climate change
- Limited attention to application of the modern techniques for improving the reproductive efficiency, e.g. AI, synchronization of estrous, semen freezing etc.
- Inadequate control of diseases and parasites due to non-availability of prophylactic vaccines against important contagious diseases
- Lack of knowledge on successful rearing of kids. Kid mortality is very high when weaning is practiced at a very young age.
- Declining interest among new generations on raising small ruminants.

Conclusion

The contribution of small ruminant sector to income and employment and livelihood security of resource poor rural people livelihood of small and marginal farmers is immense but underestimated. The demand of livestock products will continue to increase but the productivity of animals is very low due to poor feeding and management and low genetic potential of animals. The research and development on efficiency and sustainability of different production systems, production quality, market, improved germplasm and animal health is needed.

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