Review Article

Livestock Development for Sustainable Livelihood of Small Farmers

Abstract

Livestock is significantly contributing to livelihood and food security of more than a billion people in different parts of the world. However, the performance has been poor in many developing countries, due to various reasons. This paper reviews the distribution of different species of large and small ruminants and their status of production in different countries. The Indian experiences of improving cattle and goat husbandry to generate sustainable livelihood, has been very successful in empowering the poor, which has also been presented. Significant factors which have contributed to the success were genetic improvement, promotion of suitable technologies, development of infrastructure to strengthen the value chain and mentoring of small livestock owners to address their technical and business related problems. This review on status of livestock in different countries, demand for various products of livestock origin and impact of various interventions on performance will help to set priority for investment on development of different species.

Keywords: Livestock development, animal husbandry, Small farmers, Dairy value chain

Introduction

Animal Husbandry is an integral part of agriculture, making a significant contribution to the rural economy and socio-economic development in many developing countries. Livestock is also linked closely with the local culture and traditions, which are being followed ever since the domestication of livestock for economic benefits. For instance, the cow is considered to be sacred by most of the Hindu communities in India while the goat is offered as a sacrifice during certain festivals and rituals in both Muslim and Hindu religions. However, pigs are neither maintained nor consumed by the Muslims and only certain communities leading a nomadic life, have been maintaining sheep.

Presently, livestock has been directly contributing to livelihood and food security of more than a billion people in different parts of the world. A majority of them have been living in the developing countries, with small land holding, deprived of assured income from crop production and depending heavily on livestock husbandry for food security. In general, there is good scope to improve the productivity of these livestock by introducing suitable technologies and systems. However, for these communities, it is a slow and extremely difficult process to bring about a change in the practices followed so far, due to traditional mind set and lack of infrastructure to develop the value chain. Simultaneously, as ruminants have been identified as a source of greenhouse gases (GHG) emission, it is necessary to keep a control on the population and management systems, to reduce their interference on the ecosystem and the environment. Therefore, modernization of the livestock development sector should carefully consider the traditional systems and gradually introduce desired changes, involving the stake holders in the developing countries.

On the contrary, livestock husbandry has been prospering in many developed countries, where it was taken up as a commercial venture, with advanced science and technology, to enhance productivity and profitability. Modern livestock husbandry is highly competitive and labour efficient, to an extent, that it can even pose a threat to traditional livestock keepers, for their employment and livelihood. Hence, it is a challenge for policy makers in the developing countries to promote sustainable practices, striking a balance between local livestock owning communities, environmental conservation and competing commercial enterprises. It is also

essential to ensure that small farmers remain efficient and closely connected with the changing marketing scenario. It is the responsibility of the Governments and Development Organizations to promote suitable policies and programmes, targeting the welfare of small livestock holders in their respective countries.

Distribution of World Livestock Population

The estimated world livestock population in 2014 included 1.494 billion cattle, 0.2 billion buffaloes, 1.173 billion sheep and 1.006 billion goats [1]. These ruminants are a source of nutritious food in the form of milk and meat. They also provide skin, fibre, manure and animal power in many countries. Livestock husbandry is very dynamic with higher rate of growth, as compared to crop husbandry. The unique feature of livestock is its easy mobility and ability to withstand the changing weather conditions, while generating year round employment. Although livestock husbandry is a commercial activity with fairly high capital investment, it is also an important source of livelihood for small farmers in the developing countries. However, most of these farmers are scattered in remote villages, deprived of technical services and market connectivity, and experiencing low production and reduced income. In such a situation, livestock often turn into a liability, instead of contributing to the economy. This problem can be addressed by empowering small livestock holders to improve their livestock productivity.

This paper reviews the distribution of different species of ruminants in different countries and the strategy adopted for improving the productivity of animals owned by small farmers.

Among different species of ruminants, cattle is most popular in more than 100 countries, where the population is over one million cattle. In 2014, Brazil ranked first in cattle population with 211.76 million, followed by India, China and the United States, as presented in Table 1. Over the next three years in 2017, there was a marginal increase in the population by 1.6 per cent, with some changes in the ranking of countries [2]. Among 25 top ranking countries in cattle population in the world as presented in Table 1, 19 countries except USA, Australia, Russia, France, Canada and New Zealand, were developing countries, where a majority of the herds were of small size, owned by farmers having lower income. The other countries with more than 10 million cattle population and where poor farmers were dependent on small herds for their livelihood, were South Africa, Turkey, Paraguay, Uganda, Uruguay, Niger, Uzbekistan, Madagascar, Chad and Mali. However, there has been a serious concern about the negative contribution of cattle towards global warming, which has influenced many developed countries to reduce the population. This pressure has certainly had a significant impact on the cattle population during recent years, as reflected in the population in 2017 in Table 1. Figure 1 presents the cattle population density in different regions across the world [3]. Some of the countries having dense population of cattle are India, Bangladesh, Brazil, China and Ethiopia, where the number of cattle per km^2 ranges from 50 to 200 heads. Population density in the developing countries can be directly correlated to the dependence of farmers on cattle for their livelihood. Cows and bullocks are generally maintained for milk, meat, hide, manure and draught power for farming and transportation. In many of these countries, performance of cattle is under stress, due to low productivity, shortage of fodder and feed resources, outbreak of various diseases and poor market development, which need to be addressed on priority.

India is the largest milk producer in the world. In 2015-16, India produced 155.48 million tonnes of milk of which 73.65 million tonnes (50.8 per cent) was contributed by cows and the rest by buffaloes. United States was the second largest milk producer with 93.5 million tonnes but the entire production was from cows [4]. Hence, the United States is the largest producer of cow milk. The list of ten largest milk producing countries in the world is presented in

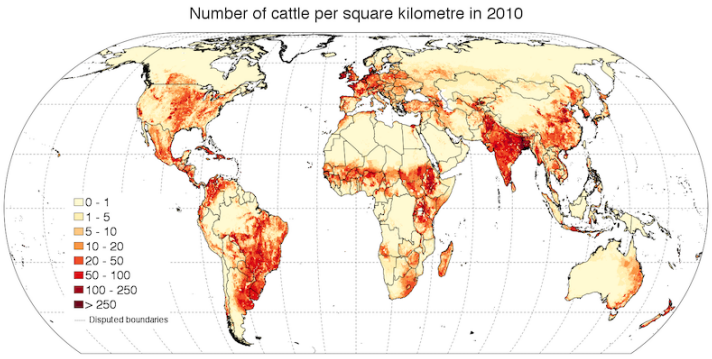
Table 2. The average milk yield of cows in selected countries is presented in Table 3. The world average yield is 2200 kg per lactation, while the highest yield of over 10,000 kg has been recorded in Saudi Arabia and Israel. South Korea and USA have an average yield of over 9000 kg. All the 20 top rankers in average milk yield are developed countries [7]. Among the developing countries, China has an average milk yield of 3300 kg while India has only 1310 kg per lactation. This reflects on the superior genetic base and efficient management systems in the developed countries, where the aim is to produce more milk with lesser number of cattle because of stagnant demand for milk and restriction on cattle population. In the developing countries in Asia and Africa, there is a shortage of milk due to growing demand and lower milk yield. Hence, the challenge is to increase production, through increase in yield, while reducing the cost of production.

Table 1. World Cattle Population in 2014 and 2017

Rank in 2014	Country	Population in 2014 (Million)	Population in 2017 (Million)	Rank in 2017
1	Brazil	211.764	214.900	1
2	India	189.000	185.104	2
3	China	113.500	83.210	4
4	United States	89.300	93.705	3
5	Ethiopia	54.000	60.927	5
6	Argentina	51.095	53.354	6
7	Sudan	41.917	30.734	9
8	Pakistan	38.299	44.400	7
9	Mexico	32.402	31.772	8
10	Australia	29.291	26.176	11
11	Tanzania	24.532	26.400	10
12	Bangladesh	24.000	23.935	12
13	Colombia	23.141	22.461	13
14	Nigeria	20.000	20.773	14
15	Russia	19.930	18.752	16
16	France	19.096	19.233	15
17	Kenya	18.139	18.339	17
18	Indonesia	16.607	16.599	19
19	Venezuela	14.500	16.483	20
20	Myanmar	14.350	17.147	18
21	Turkey	13.917	14.080	22
22	Uganda	13.020	15.593	21
23	Canada	12.215	11.535	24
24	Uruguay	11.500	11.754	23
25	New Zealand	10.182	10.146	25
	World Total	**1,467.549**	**1,491.387**	

Source: [5, 6]

Fig. 1. Density of Cattle Population in the World



Source: [3]

Table 2. Largest milking producing countries in the world in 2014-15

Rank	Countries	Annual Milk Production (Million tonnes)
1	India	146.31
2	USA	93.5
3	China	45.0
4	Pakistan	43.0
5	Brazil	35.7
6	Germany	29.34
7	Russia	29.00
8	France	23.2
9	New Zealand	21.53
10	Turkey	19.00

Source: [4]

Buffalo is another important source of milk, but it is confined mostly to Asia. The world buffalo population in 2017 was 201 million of which 195 million (97 per cent) was in Asia, as presented in Table 4. India has the highest buffalo population of 113.33 million, followed by Pakistan and China. There are two types of buffaloes, namely Swamp type and River type. Swamp types belong to three different species, which prefer to wallow in muddy water. These are found in China, Thailand, the Philippines, Indonesia, Vietnam, Myanmar, Laos, Sri Lanka, Kampuchea, Malaysia and North Eastern states of India. Swamp type buffaloes yield less than 200 kg milk per lactation. They are hardly milked and are generally used for meat and farming operations. River buffalo species was domesticated in India, where buffalo was the main milk producing species till the last few decades. These buffaloes, also known as Asian water buffaloes, are found in India, Pakistan, Bulgaria, Hungary, Turkey, Italy, Egypt, Brazil and Caucasia. These are maintained primarily for milk production and used for meat and draught purposes as well. They prefer to wallow in clean water and rivers. Although the share of buffaloes in world milk production was only 12 per cent, this species was the main source of milk in India and Pakistan. Table 5 presents the ranking of countries based on buffalo milk production. Major buffalo milk producing countries are India, Pakistan, China, Egypt and Nepal [8].

Table 3. Average Milk Yield of Cows in Different Countries in 2010

Rank	Countries	Yield: kg/ Lactation
1	Saudi Arabia	10,133
2	Israel	10,035
3	Republic of Korea	9,816
4	U S A	9,314
5	Denmark	8,389
6	Sweden	8,144
7	Canada	7,963
8	Finland	7,873
9	Japan	7,284
10	Spain	7,278
11	Netherlands	7277
12	United Kingdom	7271
13	Luxembourg	7,002
14	Czech Republic	6,884
15	Germany	6,877
16	Estonia	6,780
17	Switzerland	6,651
18	Hungary	6,596
19	Jordan	6,521
20	Kuwait	6,448
Others	Russia	4,030
	China	3,300
	Brazil	1,906
	Pakistan	1,542
	India	1,310

Source:[7]

Sheep is another species of livestock maintained for wool, meat, hide and manure. Out of 1.176 billion sheep, five countries together own 37 per cent of the world sheep population. China has the largest sheep population of 187 million, followed by India and Australia, as presented in Table 6. Sheep population density was high in Central Asia, Iran, Sudan, Nigeria, New Zealand, UK, Pakistan and South Africa [3]. Traditionally, sheep was the main source of wool, till synthetic fabrics started replacing wool in the late 20th century. Presently, sheep is reared in most of the developing countries more for meat, with wool as a secondary product. Sheep flocks are generally large in size, maintained by specific nomadic communities who move with their flock for several months in search of fodder.

Goat is another popular species of small ruminant, maintained for meat, milk and hide. There are a few breeds thriving in temperate regions and producing special quality fibre called Pashmina, which is used for making expensive garments. Goat milk is considered superior to cow or buffalo milk, particularly for feeding infants and children. China has the highest goat population of 148.4 million, followed by India and Pakistan, as presented in Table 7 [11]. Other countries having more than 10 million goat population are Nigeria, Sudan, Bangladesh, Iran, Somalia, Indonesia, Tanzania Ethiopia, Kenya, Niger and Burkina Faso. Goat population is generally concentrated in semi-arid regions, which are not suitable for cattle husbandry.

The data on livestock population and production suggests the scope for improving livestock productivity in the developing countries.

Table 4. Ranking of the countries in the world based on buffalo population

Rank	Countries	Population in 2017 Million	% of World Total
1	India	113.330	56.38
2	Pakistan	37.700	18.76
3	China	23.469	11.68
4	Nepal	5.178	2.58
5	Myanmar	3.747	1.86
6	Egypt	3.376	1.68
7	Philippines	2.882	1.43
8	Vietnam	2.492	1.24
9	Bangladesh	1.478	0.74
10	Indonesia	1.395	0.69
11	Brazil	1.381	0.69
12	Lao PDR	1.189	0.59
13	Thailand	0.996	0.50
14	Cambodia	0.655	0.33
15	Italy	0.401	0.20
16	Colombia	0.300	0.15
17	Sri Lanka	0.284	0.14
18	Iraq	0.209	0.10
19	Azerbaijan	0.197	0.09
20	Malaysia	0.119	0.06
	Asia & Pacific	194.914	96.97
	World	**201.000**	**100.00**

Source:[9]

Table 5. Ranking of countries producing buffalo milk

Rank	Country	Milk Production in 2013-14 (Million Tonnes)
1	India	70.000
2	Pakistan	24.370
3	China	3.050
4	Egypt	2.614
5	Nepal	1.188
6	Myanmar	0.309
7	Italy	0.195
8	Sri Lanka	0.065
9	Iran	0.065
10	Turkey	0.052
Total World		**101.908**

Source: [8]

Table 6. Ranking of Countries based on Sheep Population

Rank	Countries	Sheep Population (Million)	% of World Total
1	China	187.00	15.9
2	India	75.000	6.4
3	Australia	74.722	6.3
4	Sudan	52.500	4.4
5	Iran	48.750	4.1
	World Total		**100.0**

Source: [10]

Table 7. Ranking of Countries based on Goat Population in 2012

Rank	Countries	Goat Population (Million)	% of World Total
1.	China	148.412	12.65
2.	India	123.358	10.52
3.	Pakistan	52.763	4.50
4.	Nigeria	47.552	4.05
5.	Sudan	42.030	3.58
6.	Bangladesh	39.600	3.38
7.	Iran	25.679	2.19
8.	Somalia	13.000	1.11
9.	Indonesia	12.722	1.08
10.	Tanzania	12.556	1.07
11.	Ethiopia	12.000	1.02
12.	Kenya	11.946	1.02
13.	Niger	10.390	0.89
14.	Burkina Faso	10.036	0.86
	World Total	**1173.000**	**100.00**

Source: [11]

Strategy for Livestock Development in India

The livestock population density and distribution of in different countries will help in identifying the countries where priority should be given to certain species. Further information on livestock productivity along with the future demand for various commodities, will be useful to decide on the investment priorities. In India, the demand for livestock products is also growing steadily. Table 8 presents demand and supply status of various products of livestock origin [12]. It can be observed that by 2030, India will have surplus production of milk and buffalo meat, while there will be shortage of mutton and pork. Thus, the development priority may focus on improvement in milk yield and reduction in the cost of production. There is also scope for improving the productivity of goats while generating year round employment for small farmers. There is also scope for investing in processing the produce for value addition and to explore the export market.

While taking up livestock development, it should be ensured that small farmers maintaining ruminants are supported to improve their profitability. This will benefit rural women in particular, who can remain engaged in livestock enterprise from home itself, while taking care of their household activities. As livestock has been imposing pressure on biodiversity because of increasing shortage of feed and emission of GHGs, sustainable management should be the goal, which can be achieved by improving productivity through genetic up-gradation, culling of unproductive animals, timely health care and balanced feeding. This can be achieved through introduction of new technologies and development of value chain for establishing backward and forward linkages. As Indian livestock holders typically represent small livestock holders in developing countries, any successful development model in India, can be widely replicated in many other developing countries.

Table 8. Demand and supply of livestock products in India in 2000 and 2030

Product	Year	Consumption (Million Tonnes)			Production (M* Tonnes)
		Urban	Rural	Total	
Milk	2000	18.565	47.883	66.448	81.627
	2030	59.327	86.450	145.777	178.408
Beef	2000	0.733	1.895	2.628	2.861
	2030	1.609	2.537	3.966	4.266
Mutton	2000	0.190	0.497	0.687	0.696
	2030	0.513	0.762	1.275	1.025

Source: [12]. M*: Million

Ownership of Livestock in India: In India, about 67% land holders belong to the category of marginal farmers, who own less than 1.0 ha land. Additional 18 per cent are small farmers, owning between 1 to 2 ha land. For these 117 million families, livestock is a source of livelihood. This is because in the absence of fertile lands and assured sources of irrigation, income from agriculture is not adequate to sustain their livelihood. Among small and marginal landholders, those having irrigation or fertile lands, prefer to maintain large ruminants such as cattle and buffaloes, while others who have no confidence in maintaining large animals, prefer to own goat and sheep. According to the recent livestock survey, 65.34 million families owned cattle, 39.18 million families owned buffaloes, 33.01 million families owned goats and 4.55 million families owned sheep. The population of different livestock species in 2012 is presented in Table 9 [13].

Table 9: Livestock Population in India

Sr. No.	Species	Livestock Census 2003 (Million)	2012 (Million)	% Increase in 10 years (Million)	No. of families Engaged (Million)
1.	Cattle	185.2	190.90	3.08	65.34
2.	Buffalo	97.9	108.70	11.03	39.18
3.	Sheep	61.5	65.07	5.80	4.55
4.	Goat	124.4	135.17	8.66	33.01
5.	Other Animals	16.05	13.19	-21.68	3.50
Total Livestock		**485.0**	**512.06**	**5.58**	

Source: Govt. of India, 2014.

The population of livestock in 10 years between 2003 and 2012, increased by 5.6 per cent, but increase in cattle population was only 3 per cent. Increase in buffalo population was 11 per cent and in goat, it was 8.7 per cent. Over the last 50 years, there has been a significant development in the dairy husbandry sector to empower poor farmers to improve their livelihood through dairy husbandry.

Performance of Cattle and Buffaloes in India: Inspite of achieving the highest milk production in the world, the productivity of cattle has been extremely poor. As observed in Table 3, average milk yield of cattle in India was 1310 kg per lactation, as against the world average of 2200 kg. Such low milk yield can be attributed to a large population of genetically eroded nondescript cattle representing 60 per cent of the population, and which are yielding 450 to 500 kg milk per year. The situation in 1973-74 was worst when nondescript cattle represented 80 per cent of the population and when the annual milk production was 23.2 million tonnes. Over the last few centuries, India had a rich cattle wealth, which was used by farmers for manure, bullock power and milk. Production of bullocks was the priority in most

parts of the country, whereas milk production was prominent in selected regions, depending on the productivity of local cattle. This was how several breeds of cattle were developed in different parts of the country, to suit the needs of local communities.

Important Breeds of Cattle in India

Among the cattle, 39 breeds were recognized in three categories, namely, Milk breeds, draft breeds and dual purpose breeds – useful for both milk production and as bullocks for draught purpose. In Table 10, various Indian cattle breeds under different categories are presented. Among these only four breeds namely Gir, Red Sindhi, Sahiwal and Tharparkar, with an average milk yield of 1500 kg/lactation are milch breeds, while seven breeds are dual purpose, for milk and tillage, with 800 to1200 kg milk yield. Other 28 breeds with annual milk yield below 800 kg, are draught breeds for bullocks. This reflects on the importance of cattle in supporting agriculture rather than milk production, although milk and milk products are an integral part of every meal in India. Most of the farmers used milk for household consumption and the surplus milk was used for producing butter and milk concentrate for producing a wide range of sweets.

Table 10. Indian Cattle Breeds

	Breed Characters	Breed Names
1	**Milch Breeds:** Milk production > 1500 kg/lact.	Gir, Sahiwal, Red Sindhi, Tharparkar
2	**Dual-purpose Breeds:**	
2.1	**Medium milk yield:** 1000-1500 kg/lact.	Hariana, Kankrej, Rathi, Minari, Ongole, Dangi,
2.2	**Low milk yield:** <1000 kg/lact.	Mewati, Deoni
3	**Draught-Purpose Breeds:** Milk production <500 kg/lact.	Nagor, Bachaur, Malvi, Hallikar, Amritmahal, Khillar, Bargur, Panwar, Siri, Gaolao, Krishna Valley, Kankatha, Kherigarh, Khangayam and others

Source: [14]

Genetic Erosion of Cattle Breeds: Except for a small number of large cattle owners, rest of the farmers depended on private bull owners for breeding their cows, which involved both time and cost. Very often, the cows were served by stray bulls, when let out for grazing on community lands. These factors contributed to the increasing number of nondescript cattle over the years. By 1950, a few years after Indian Independence, more than 80 per cent cattle were nondescript, resulting in heavy genetic erosion. With the introduction of farm machinery, it was uneconomical for marginal and small farmers to maintain bullocks. Hence, low yielding cows became uneconomical.

In the 1960s, realizing the erosion of precious cattle genetic resources, the Government of India launched breeding services through Artificial Insemination (AI) and conservation of native breeds in their home tracts. As a result of these efforts, some of the nondescript cows produced upgraded progeny of these native breeds. However, farmers had no interest in these breeds as most of them attained puberty after a long period of 24 – 30 months and their milk yield was also low. In 2012, the population of pure indigenous breeds including all the 38 breeds, was only 9.35 per cent of the total population and 10.51 per cent cattle were upgraded

progeny of these breeds born to nondescript cattle. The population of important indigenous breeds and their upgraded progeny in India in 2012 is presented in Table 11 [13]. It can be observed that upgradation of nondescript cattle by using only good dairy breeds such as Gir and Sahiwal was accepted by the farmers to a limited extent, while Hariana and Kankrej were popular among the dual purpose breeds. Among the draught breeds, there was some demand only for Khillar and Ongole breeds in their home tracts.

Breeds of Buffaloes in India

Buffalo has been the major source of milk since decades in India. India has a very rich genetic diversity of buffaloes, with over 20 important breeds of buffaloes (Asian River type), including 10 well-defined breeds. These are Murrah, Nili-Ravi, Jaffarabadi, Surti, Bhadawari, Banni, Mehsana, Marathawadi, Nagpuri, Pandharpuri and Toda. Murrah is the most popular breed, followed by Jaffarabadi and Nili – Ravi breeds. Surti is a small breed. Pandharpuri can tolerate high temperature. Banni, Mehsana and Godavari breeds have originated from Murrah breed, which are popular in their home tracts [15]. These breeds give a wide option for farmers to make their own choice to upgrade their native animals, although most of the farmers want to upgrade their buffaloes with Murrah. Many other breeds such as Kundi, Manda, Marathwada, Kalahandi, Jerangi, Sambalpuri, South Kanara, etc. are almost on the verge of extinction. Characteristics of major Indian buffalo breeds are presented in Table 12. Inspite of such rich breeds, there was heavy genetic erosion due to lack of breeding services, resulting in indiscriminate breeding by stray bulls. Thus, the contribution of buffaloes to milk production has also been poor, except in the home tracts of elite breeds, till artificial insemination using frozen semen, was introduced in the late 1970s.

Role of State Animal Husbandry Services

Inspite of a large number of cattle and buffalo breeds, there was acute shortage of milk in the country and small farmers owning low yielding animals were not taking good care of them. Realising the need for improving the productivity of dairy animals, the Government of India had already introduced a programme of crossbreeding of nondescript cattle in the 1960s. Pilot projects on crossbreeding were already carried out in India between 1910 and 1932, at National Research Institutions and Military Dairy Farms. Based on the successful performance of crossbred cows, several bilateral aided projects were initiated and the Scientific Panel of the Agriculture Ministry in 1965, recommended the upgradation of nondescript cattle with selected indigenous breeds as well as to cross breed with exotic breeds. Crossbreeding of nondescript cattle for increasing milk production was adopted as an official policy of the Government of India in 1969 [17].

Providing animal husbandry and veterinary services to farmers was the responsibility of the State Government, which were delivered free of cost since independence. The services included breeding cattle and buffaloes through AI, preventive vaccination, treatment of sick animals and extension services to promote new technologies. However, in the absence of greater mobility in interior rural areas, most of the services were confined to the periphery of the veterinary clinics established at the block level. With the shortage of qualified veterinary graduates, most of these technical services were gradually assigned to semi-skilled livestock supervisors. In the absence of critical services, most of the farmers could improve the production. There was no scope for sale of surplus produce due to lack of marketing infrastructure. Thus, livestock development, particularly dairy husbandry, could benefit only a small population in selected pockets, while a large section of small farmers were left out. As the Government was providing free services, farmers were reluctant to pay for the services even if private services were available in the vicinity.

To promote crossbreeding for improving the progeny of low productive nondescript cattle in the 1950s, the State Animal Husbandry Departments established semen collection centres in potential districts and liquid semen was sent in thermos flasks to block-level veterinary dispensaries and farmers wanting to inseminate their cows, had to bring them to the centre. However, this programme had several drawbacks such as inferior quality bulls, low sperm motility in the semen at the time of insemination, untimely insemination whenever farmers brought their cows, high incidences of infertility problems, poor follow up and lack of technical guidance. As the conception rate of AI using liquid semen was less than 10 per cent, farmers were not attracted to take advantage of this programme. Thus, livestock husbandry remained stagnant for over 2-3 decades since independence.

Table 11. Population of Important Indigenous Breeds of Cattle in India

	Names of Indigenous Breeds	Pure Million	Graded Million	Total Million	% of Total
1	Hariana	1.639	4.641	6.280	4.15
2	Gir	1.380	3.733	5.113	3.38
3	Sahiwal	1.092	3.790	4.882	3.23
4	Kankrej	1.945	1.083	3.028	2.00
5	Kasali	2.432	0.0004	2.432	1.61
6	Khillar	1.102	0.912	2.014	1.33
7	Hallikar	1.211	0.597	1.808	1.20
8	Malvi	1.158	0.552	1.710	1.13
9	Bachaur	0.741	0.805	1.546	1.02
10	Rathi	0.866	0.372	1.238	0.82
11	Malnad Gidda	0.899	0.150	1.050	0.69
12	Tharparkar	0.197	0535	0.732	0.48
13	Kenkatha	0.393	0.277	0.670	0.44
14	Ongole	0.116	0.519	0.635	0.42
15	Red Sindhi	0.060	0.498	0.557	0.37
16	Motu	0.469	0.067	0.537	0.36
17	Nagori	0.373	0.135	0.509	0.34
18	Red Kandhari	0.235	0.223	0.458	0.30
19	Nimari	0.342	0.112	0.454	0.30
20	Khariar	0.290	0.094	0.384	0.25
21	Deoni	0.151	0.200	0.352	0.23
22	Gaolao	0.122	0.201	0.323	0.21
23	Amritmahal	0.105	0.124	0.229	0.15
24	Kherigarh	0.075	0.124	0.199	0.13
25	Dangi	0.119	0.074	0.193	0.13
26	Kangayam	0.081	0.113	0.193	0.13
27	Mewati	0.015	0.018	0.033	0.02
28	Krishna Valley	0.003	0.011	0.144	0.01
	Indigenous Breeds	17.849	20.070	3.792	25.06
	Nondescript Cattle	-	-	113.253	74.92

Source: [13]

Table 12. Main Features of Indian buffalo breeds

Breed	Habitat	Age at 1st Calving (Months)	Lactation Yield (Litres)	Characteristics
Murrah	Haryana, Punjab, U.P.	45	2000 Fat 7.83%	Black, massive, stocky; heavy bone, horns short, tightly curled; Placid
Jaffarabadi	Saurashtra, Kutch (Guj.)	47	2200 Fat 7.7%	Black, massive, long barrelled conformation; Horns long heavy, broad, bent towards face to cover eyes
Bhadawari	Agra (UP) Gwalior (MP)	49	1150 Fat 9.0%	Copper colour with a white ring at neck, scanty hair, black at base and brown at top, tail switch is white or black and white; Horns are short and grow backward.
Surti	Anand, Surat (Gujarat)	50	1300 Fat 8.1%	Black or reddish skin, having 2 chevrons on chest, white markings on forehead, legs and tail; Sickle shaped medium size horns; Long tail with white tuft
Nili Ravi	Firozpur (Punjab)	42	1800 Fat 7.1%	Similar to Murrah, with white marks on extremities and walled eyes, horns less curled, shorter, well shaped udder
Mehsana	Mehsana (Gujarat)	42 - 44	2000 Fat 6.6%	Resembles Murrah and Surti, jet black, sickle shaped horns; Well developed udder with prominent milk veins
Pandharpuri	Solapur, Satara, Sangli and Kolhapur (Maharashtra)	45	1384 Fat 7.0%	Light to deep black, often with white markings on forehead and legs; Long, sword shaped horns; Hardy, thrives well between 9°C and 42°C.
Nagpuri	Nagpur, Wardha (Maharashtra)	36 - 40	900 Fat 7.0%	Black with white patches on face, legs and switch; Flat, long horns, curved back towards shoulder; Short nasal flap

Source: [15, 16]

The milk production in India in 1950-51 was 17 million tonnes, which increased to 23.2 million tonnes in 1972-73, with an annual increment of over 1 per cent. As per capita availability of 112 gm milk per day, acute shortage of milk, forced the Government of India to use imported milk powder for supplying reconstituted milk to restricted permit holders in four metropolitan cities. To address the challenge of milk shortage, Operation Flood programme was launched by the National Dairy Development Board in 1970 and special schemes were implemented by the Government of India to improve the progeny of low yielding non-descript cattle through crossbreeding and to conserve the native breeds. The Government had given major thrust on use of proven sires and improving the intensity and efficiency of the artificial insemination programme, during the Fourth Five Year Plan between 1969 -1974. However, the programme did not make significant impact, as the problems faced by small farmers were not addressed.

Challenges of Poor Livestock Owners

If the programme had to benefit the poor, it was necessary to sort out the problems of small livestock holders who were generally poor. Following, were the major problems of small farmers:

- Poor quality animals needing genetic upgradation and severe culling;
- Poor breeding services, with respect to quality of the germplasm and timely breeding, resulting in poor conception and birth of inferior progeny;
- Nutritional deficiency due to shortage of feed and fodder;
- Poor health conditions and high rate of mortality due to lack of preventive vaccinations and timely veterinary care;
- Lack of coordinated efforts to eradicate common diseases;
- High cost of veterinary services leading to neglect of sick animals;
- Lack of technical guidance and credit facilities to improve husbandry practices;
- Lack of market outlets for farmers living in remote villages, resulting in exploitation;
- Outdated technologies due to poor linkage between research institutions and farmers.

Although the Government had realised the need for addressing these problems, there were several policy and practical hurdles. As the Government was using liquid semen for AI, the total number of bulls required was large and hence, the genetic quality had to be compromised. Frozen semen technology was very new and expensive, because of extensive network of cold chain, required for frozen semen storage to reach farmers in the field. In the absence of adequate number of veterinary professionals, unskilled paravets were carrying out the AI services, resulting in poor conception and infertility problems. The extension services to motivate small farmers to adopt dairy husbandry for income generation, were also poor. As the productivity of cattle was poor, farmers were reluctant to pay for any service and expected the Animal Husbandry Department to provide free services. Above all, as most of the small farmers were illiterate, they needed awareness and regular mentoring to adopt good livestock breeding and husbandry practices, which was missing in the programme implemented by the Animal Husbandry Department.

Involvement of Civil Society Organisation in Cattle Development

Realising the plight of small farmers who were owning low productive nondescript cows, which had the potential to provide gainful self-employment and sustainable livelihood, a civil society organization in India, BAIF Development Research Foundation in 1967, decided to promote cattle development for producing high yielding progeny, using low productive cattle owned by small farmers. Never before in India, had any non-government agency been engaged in cattle breeding, which was supposed to be undertaken by the Government, free of cost. Under this programme, BAIF introduced frozen semen for providing breeding service at the barn of small farmers, free of cost. Farmers were trained to detect heat in their cows and invite the paravet for insemination. Timely insemination using frozen semen, not only ensured higher conception rate of 48 - 50 per cent, but also helped to facilitate direct interaction between the paravet and livestock owners, who needed technical guidance and mentoring from time to time. Initially, BAIF raised financial support from various donor agencies to cover the cost of operation. With the birth of new progeny, which had the potential to yield more, farmers were prepared to spend on feeding and health care of their crossbred cattle. The paravet carried out preventive vaccination, training on fodder production and feeding practices and organised milk collection and marketing. As the farmers started earning from sale of milk and surplus animals, the programme turned out to be self-sufficient, reducing the dependence on the Government [14].

The strategy was to breed low productive, nondescript cows with popular exotic breeds such as Jersey and Holstein Friesian, using imported frozen semen. Subsequently, BAIF established its own frozen semen laboratory, to freeze semen of exotic and their crosses and indigenous breeds of cattle and buffaloes. The crossbred progeny could conceive at the age of 24 – 28 months and come into milk production at the age of 3 years, yielding 2500 to 3000 kg milk per lactation. F1 crossbred cows were bred with either exotic or crossbred bulls of same breed to maintain the desired exotic blood level, as desired by farmers. Those who were confident of taking good care, wanted to maintain higher exotic blood level of 75 – 87.5 per cent while small farmers were keeping the blood level restricted at 50 to 75 per cent. Maintaining 3 such cows could provide sustainable livelihood for small farmers, lifting them above poverty.

Without this programme, it was not possible for small farmers to own high yielding cows as elite cows of Indian breeds were in very small number, as shown in Table 11 and it was beyond their capacity to buy such expensive cows. On the contrary, these farmers were able to produce superior quality cows at their door steps and sell at higher prices. While the nondescript cows could be purchased at Rs.1000 – 3000, the crossbred cows were priced in the range of Rs. 25000 and 50000, depending on the milk yield (USD 1= Rs.68). Thus, the programme empowered the poor to participate in dairy development, as a reliable source of livelihood. With the production of high yielding cattle, farmers also started disposing off unproductive animals, thereby reducing their herd size. Most of the farmers used crop residues as the basic feed thereby reducing the cost of feeding green fodder and concentrate. The dung was used as organic manure to boost their crop production. While providing breeding services for cattle, BAIF realized the need for providing services to buffaloes as well. Hence, along with cattle breeding, buffalo development was also initiated by producing frozen semen of elite buffalo breeds. This helped in improving the progeny of buffaloes, benefitting millions of small farmers to take up production of buffalo milk. Thus, dairy husbandry demonstrated an efficient nutrition management, to enhance farm income as well as health status of the rural families, through increased consumption of milk and organic food.

Support Services and Value Chain Development

With the initial success of producing improved progeny, the need for introducing other services was also felt. Efforts were made to establish linkage with various research and development institutes to facilitate backward and forward integration. This in a way, helped small farmers to establish their value chain as shown in Figure 2. For the success of the value chain, a lead organisation should take the responsibility to coordinate the activities. The most appropriate agency is the processing unit. It is also necessary to empower farmers to play a bigger role in due course and take up processing and marketing. As a part of the backward integration, BAIF introduced the following activities, for the benefit of livestock owners living in remote villages.

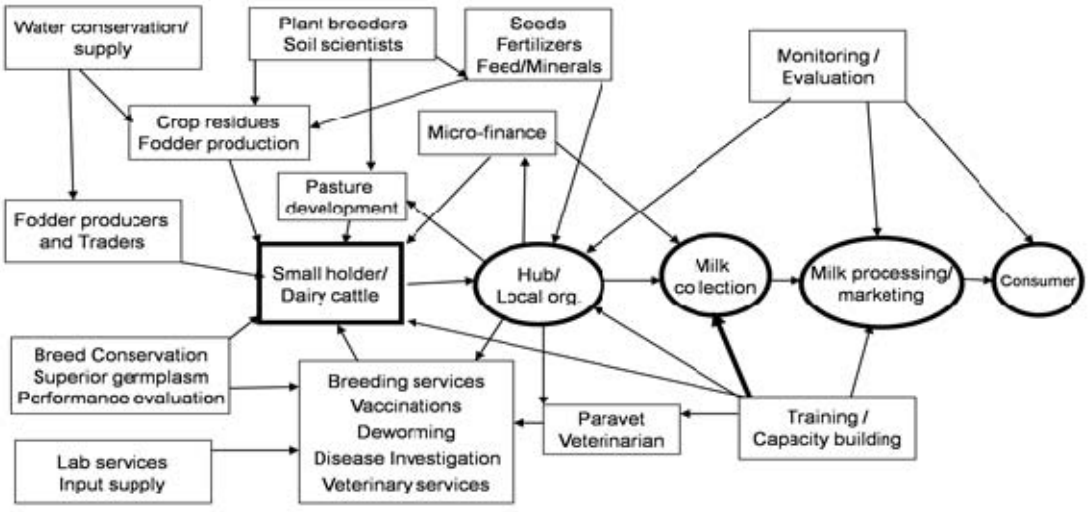
Genetic Improvement: To improve the productivity of new progeny, BAIF initiated the progeny testing programme of bulls used for semen freezing. Apart from high milk yield and fat content in milk, other quality parameters such as body type, udder shape, tolerance to heat stress, etc. were also considered while selecting the bulls. Application of Super ovulation and embryo transfer technology for production of bull mothers and bull calves was adopted. Farmers maintaining elite herds of cattle and buffalo were involved in bull calf production through planned breeding. Conservation of native breeds in their home tracts was an important consideration. This was aimed at through breeding nondescript animals as well as pure bred cows and buffaloes with elite bulls of the same breed in selected areas.

Health Care: Cooperative Dairy Federations and private entrepreneurs were encouraged to take up the responsibility of providing effective health care for the animals owned by the

farmers. Private veterinarians were encouraged to practice in close association with paravets engaged in providing breeding services. This enabled paravets to take up minor treatments and refer major cases to the veterinary doctor, apart from carrying out vaccinations and deworming.

Feed Management: Community pasture lands were developed by involving local communities, which not only eased fodder supply but also brought about greater awareness about the need for conserving fodder resources. New fodder crops such as fast growing *Leucaena* and *Stylo* were introduced on barren lands. On farm studies and demonstrations were laid out to promote cultivation of food crops and varieties which yield higher quantity of crop residues, for use as forage. Awareness was created to make efficient use of crop residues by introducing various techniques. Decentralised complete feed production units were developed to overcome nutritional imbalance in the field. Farmers were advised to reduce their herd size.

Fig. 2. Dairy Value Chain



Source: [14]

Processing and Marketing of Produce: Farmers were trained to take up small scale dairy enterprises to add value to the produce and generate additional income. Marketing of surplus livestock was equally difficult and grossly neglected. In the absence of an organised market, farmers were cheated by traders. The market for meat, wool and skin was highly scattered. Hence, direct linkage with processors and consumers was initiated.

Capacity Building: To promote efficient breeding services, skill oriented training courses were organised for local youth to serve as paravets. Dairy farmers were organized to form their producers' groups and Cooperative Dairy Federation for establishing backward and forward linkages. Village level trainings were organized to promote good dairy husbandry practices. Farmers were linked with local development banks to avail credit facilities.

Impact of Dairy Development Programme

This programme of BAIF was well accepted by 5 million families in 100,000 villages spread across several states, with 52.8% participants belonging to the category of landless, marginal and small farmers. The average milk yield of crossbred cows born to nondescripts was 2413

litres/lactation. The Jersey crosses yielded 1765 in 189 days, H.F. crosses produced 2867 litres in 252 days, while the local cows and buffaloes yielded 208 and 610 litres of milk in 135 and 150 days respectively. The cost of milk production of nondescript cows was 100% higher than crossbred cows due to low yield [18]. BAIF clearly demonstrated the scope for ensuring sustainable livelihood of poor farmers through dairy husbandry [19].

Looking to the success of the cattle development programme promoted by BAIF, the National Dairy Development Board in India and several Cooperative Dairy Federations and the Government of India widely replicated this technology across the country. Several State Governments provided financial support to operate this programme, withdrawing their breeding programme. After a few years, farmers started paying the service charges and financial support from the Government was discontinued, relieving them of this responsibility. Dairy farmers were linked with Cooperative Dairy Federations by establishing milk collection routes in remote villages. These efforts certainly gave a good boost to milk production.

By mid 1980s, crossbreeding programme of cattle was popular across the country, which was reflected in increasing milk production, as presented in Table 13. The annual growth rate in milk production which was around 1-1.5 per cent in 1960s increased to 4 - 6 per cent in the 1990s, which further increased to 8 - 9 per cent. In 2015-16, milk production in India increased to 155.5 million tonnes and to 176.35 million tonnes in 2017-18. This significant increase in milk production could be attributed to genetic improvement and composition of types of cows in the total population. In 1973-74, out of the total cattle population, 80% were nondescript and 20% cows were of 37 native breeds and the composition in 2012 changed to 59 per cent nondescript, 20 per cent indigenous breeds and 21 per cent crossbreds [13].

Table 13. Milk Production in India from 1950-51 to 2017-18

Years	Total Milk Million tonnes	% Increase in 10 Years
1950-51	17.00	
1960-61	20.00	17.7
1973-74	23.20	16.0
1980-81	31.60	36.2
1990-91	53.90	70.6
2000-01	79.65	47.8
2005-06	95.62	
2010-11	121.85	53.0
2015-16	155.48	
2017-18	176.35	44.7

Source: Hegde, 2019

In 2011-12, buffaloes, crossbred cows and indigenous cows contributed 49 per cent, 26 per cent and 21 per cent milk respectively to the total milk production in India, as presented in Table 14. The national daily average milk yield of crossbred cows was 7.33 kg, while the yields of indigenous breed cows, nondescript cows, buffaloes of recognised breeds and nondescript buffaloes were 3.41 kg, 2.16 kg, 5.76 kg and 3.80 kg respectively [20]. While crossbred cows made significant contribution to the income of small farmers, there was further scope to improve the yield through use of proven sire for future breeding, proper feeding and timely health care. This can be achieved through investment in advance research and infrastructure, awareness among farmers and timely delivery of various services.

Table 14. Contribution of different types of livestock to Milk Production in 2012

Sr. No.	Species	% of Total Milk Production	Yield Kg/day
1	Buffalo indigenous	35	5.76
2	Buffalo non-descript	14	3.80
3	Cow indigenous	11	3.41
4	Cow non-descript	9	2.16
5	Cow cross-bred	26	7.33
6	Cow exotic	1	11.21
7	Goat	3	0.45

Source: [20]

Goat Development

Goat is an integral part of the farming system and finds multiple use in meat, skin, milk and manure. The goat population in India has grown by about 2.4 per cent over the last census to exceed 128 million, inspite of about 15 per cent mortality and 38 per cent annual slaughter. It is essentially, a low input - low output livelihood support for most of the poor sections of the society comprising of the landless, women and small and medium farmers. Generally, these families rear 4-5 goats and the flock size tends to be larger in areas adjoining the forests. In terms of domestic and export market, the contribution of goats is high and its share is increasing gradually over the last few decades. Apart from export of hide and meat, the domestic market of meat is growing due to increasing human population and restriction on cow slaughter. However, goat development has been given low priority and is often neglected in most of the States. Main reasons for stagnation in goat husbandry were:

- Small flock size owned by poor farmers, maintained on free grazing on community lands, resulting in poor growth;
- Indiscriminate breeding by inferior quality stray bucks, leading to genetic erosion;
- High mortality and morbidity due to absence of preventive vaccinations and veterinary care, and poor disease diagnostic services;
- Lack of marketing network, forcing goat keepers to sell their animals at low price;
- Lack of credit support and absence of insurance services to cover the risk.

In the 1970s, the Government of India had promoted several goat development schemes wherein the poor families received financial support to procure 5 to 10 female goats with a few breeding bucks, which invaded the community lands and village forests. These programmes were heavily criticized and ultimately discontinued. With the negative tag of destroying the environment, no donors were willing to support goat development projects in the recent past.

Sustainable Goat Husbandry: Against this background, with a view to help the existing goat keepers, a pilot project was launched by BAIF in 2005 in association with the State Animal Husbandry Department in West Bengal state in the eastern part of India. The goal was to promote goat husbandry for sustainable livelihood, while improving the breed. The joint project was aimed at demonstrating sound goat husbandry practices for enhancement of income of goat keepers, while upgrading their managerial skills through the following activities:

1. Formation of Women Goat Keepers' Groups, with 8-12 women, representing their families, together owning about 50 female goats;

2. Providing one elite buck for each group for breeding the goats owned by the members. One of the members was responsible for maintaining the buck and collecting a nominal service fee to cover the cost of feeding and maintenance of the buck;

3. Appointment of a female Field Guide, preferably from the local community, who was trained in basic goat husbandry practices, to provide services such as vaccination, deworming, castration, guidance on feeding and fodder production and selling of surplus goats. Each field guide could support 5-6 groups. She was paid by the members for the services provided. Being a female guide, the women goat keepers felt very comfortable to interact with each other for seeking solutions to their problems.

4. Demonstrations on forage production, feeding of concentrates and mineral mixture were set up in every village and a weighing balance was provided to understand the impact of various interventions.

5. The goat keepers were trained to weigh their goats from birth for monitoring their growth. They were sensitized to sell goats based on body weight. A general guideline was developed to fix the selling price at 60 per cent of the prevailing price of mutton, which empowered them to bargain for a higher price.

This programme covered 2500 participants having a population of 10,000 goats in two districts of West Bengal, namely, Burdwan and Bankura, spread over 100 villages. Field Guides served as effective link persons between the goat keepers and the external agencies. The programme could bring about a change within a short span of 8-10 months. The kids born, were of superior quality and healthy, and were vaccinated at the age of 3 months. There was significant reduction in the death of kids from 40 per cent to less than 5 per cent, mainly due to timely vaccination, higher growth rate due to better feeding, deworming, early castration of male kids and greater awareness about marketing. The goat keepers reported that their income increased by 500 per cent, without increasing the herd size.

Two guiding principles which received support from the development organisations were, firstly, not to distribute female goats which would increase the pressure on fodder and feed and secondly, the goat keepers should aim at restricting the flock size, till they adopted stall feeding. Hence, rigorous culling, particularly of sick and nondescript goats could help in maintaining healthy goats of recognized breeds. This model was adopted under various programmes in India in recent years. The advantages of the goat development programme were short gestation period and opportunity to help the poor and women-headed families who were the most vulnerable sections of the society [14].

Like cattle, buffaloes and goats can also be promoted by organizing the livestock owners at the village level and empowering them to develop their value chain. There are many such success stories in the developing countries which can be suitably modified to suit the local situation, for wider replication.

Conclusions

Livestock development programme in India, focussing on providing sustainable livelihood to rural poor, has been very successful having potential for wider replication. The key to success are introduction of suitable technologies, creation of infrastructure to develop the value chain and mentoring of small livestock owners to ensure that all the problems, both technical and business related, are addressed from time to time. As livestock husbandry is an opportunity

for poor and illiterate rural families, it is necessary to ensure that these family enterprises are able to generate adequate income for sustainable livelihood.

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