



Goat Development: An Opportunity to Strengthen Rural Economy in Asia and Africa

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

Editor(s):

(1) Dr. Osama Anwer Saeed, University of Anbar, Iraq.

Reviewers:

(1) Kush Shrivastava, IVRI Deemed University, India.

(2) Hussin Jose Hejase, Al Maaref University, Lebanon.

(3) Francisco Diniz, Portugal.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/57510>

Review Article

Received 25 March 2020

Accepted 02 June 2020

Published 11 June 2020

ABSTRACT

Goat has been economically important to people living in arid, semiarid, hilly and remote tribal areas, because of its tolerance to harsh weather conditions, ability to feed on inferior quality crop residues, high prolificacy, short gestation period and high rate of growth. The presence of 94.36 per cent of the world goat population in Asia and Africa reflected on its utility where most of the world's poor have been living. Goat is a source of milk, meat and financial security, for families of lower most income groups. However, the production potentials of goat have not been optimally tapped due to unavailability of services required for breeding, veterinary care, mobilisation of feed resources and market connectivity for milk and meat. Guiding and providing critical technical services to goat keepers through placement of field guides to improve yield and quality of the produce, instead of mere increase in population should be the focus of goat development programmes. Strengthening of infrastructure for supply of good quality inputs, processing of various goat products and marketing can enhance the income of goat keepers by several folds. Goat husbandry being an important tool for empowering women and poor and for ensuring nutritional security, it is an important livelihood support programme in the developing countries.

Keywords: Goat husbandry; goat breeds; goat for women empowerment; goat keepers.

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*This work was done while the corresponding author was former President of BAIF Development Research Foundation.

1. IMPORTANCE OF GOAT

Goat (*Capra hircus*) was the first animal to be domesticated for milk production, from wild bezoar ibex (*Capra aegagrus*) by the farmers in western Asia, to the southern slopes of Zagros and Taurus mountains in Iran, Iraq and Turkey, about 12,000 years ago [1]. Since then, goat has widely moved all over the world because of its versatility to adapt to harsh environmental conditions and poor quality feed resources. Goat has proved itself useful to human beings since ages, due to its productivity and non-competitiveness with human beings for food. It has low body mass and low metabolic requirements, to survive even after facing prolonged feed shortage [2]. Goats have a mobile upper lip which allows them to pick up more feed. They are able to consume tannin-rich herbs and digest them to extract nutrients because they can secrete proline-rich proteins which reduce the detrimental effects of tannin [3]. Hence, goats have been economically important to people living in arid, semiarid, hilly and remote tribal areas. They have high prolificacy, short gestation period, high rate of growth and instant marketability. Goats hardly need any veterinary care [4]. People who are allergic to cow's milk are able to tolerate goat's milk. It has been a source of supplementary income for marginalised rural families in Asia and Africa, where other species of livestock have not been able to perform well [5]. Goat is most suited for ensuring poverty reduction and food security for women, because it can be easily acquired by the poor, easily tended by women or children and provide valuable nutrients even in remote areas [6]. It also has an important role in religious rituals [7].

Poor families in Asia and Africa have been maintaining a small number of does. Depending on the yield and domestic needs, they have been collecting some milk for home consumption. Generally, male kids were sold after 5 to 12 months and female kids were retained as future breeding stock. As they were dependent on grazing on common lands, they earned some income without any investment. Often, these goats served as emergency cash reserves, to meet urgent needs such as medical treatment, education of children, procurement of agricultural inputs, etc. Thus, in spite of the resistance by some environmental lobbies, who falsely blamed goat as a cause of biodiversity loss, without any scientific proof [8] and lack of support from the Government for development, goat population has been growing at a faster rate compared to

other livestock species [9]. However, most of the families dependent on goat husbandry could not enhance their income to improve their quality of life. This was because the potential of goats was underestimated and their contribution to the livelihood of the poor was not understood [10]. There were several constraints in improving the productivity of goats, which could not be managed by the goat keepers. This study was carried out to understand the current status of goat husbandry, identify the challenges faced by small goat keepers in the developing countries and make suitable recommendations to improve the profitability.

2. GOAT DISTRIBUTION IN THE WORLD

The world goat population has been steadily increasing during the last six decades, because the families belonging to weaker socio-economic groups in Asia and Africa have been shifting from cattle to goats, to cope up with the problems of global warming and eroding biodiversity. The world goat population which was 348.727 million in 1961, increased to 1045.916 million in 2018, resulting in 200 per cent increase over 60 years [11]. Out of the total, 94.36 percent goats were located in Asia and Africa (Table 1). The goat population in Oceania had increased by 1246.51 per cent over the last six decades, while the increase in Africa and Asia was 364.81 per cent and 176.65 per cent respectively, reflecting on the popularity of goats in certain regions.

The population growth of goats was highest between 1961 and 2018 as compared to other species of livestock, particularly in Asia, Africa and Oceania (Table 2). The population of goats in the Americas had increased by 14.92 per cent, while it had decreased by 25.16 per cent in Europe, during this period. This indicated that goats were in greater demand in the developing countries of Asia and Africa. The largest goat population in the Americas was in Brazil, Mexico and Argentina.

The ranking of countries, based on goat population in 2018, has been presented in Table 3 [11]. Among these countries, China ranked first, with 138.383 million goats, followed by India with 132.750 million. The goat population in China over the past 58 years has increased by 169.74 per cent. The population in 1961 was 51.303 million, which reached its peak of 152.219 million in 2005 and decreased to 138.383 million in 2018 (Table 1). During the same period, goat population in India steadily

increased to 137.321 million in 2010 and reduced to 132.750 million in 2018, registering an increase in population by 118.11 per cent. However, as per the latest population census, the goat population in India in 2019 was 148.9 million, thereby claiming first rank in the world [12].

In Europe, France has the highest goat population of 12.987 million, followed by Greece (3.998 million) and Spain (2.765 million). The goat population in the world represented 26.47 per cent of the total ruminants, while cattle and sheep represented 37.70 per cent and 30.61 per cent of the total population, respectively. However, the percentage of goat population in Bangladesh, Myanmar and Nigeria was significantly high as compared to other species, which indicated the importance of goats in supporting rural livelihood.

3. GOAT FOR MILK PRODUCTION

Goat is one of the five livestock species which produces milk for human consumption. The world milk production in the year 2018 was 843.035 million tons, of which cattle contributed 81.04 percent, buffaloes 15.10 per cent and goats contributed only 2.22 per cent (Table 4). Nevertheless, goat was an important source of milk in many countries. Between the years 2000 and 2018, the world milk production had increased by 45.47 per cent. The increase in total milk production between 2000 and 2018 was highest at 108.95 per cent in Asia while it was 52.25 percent in Africa. Among milk of different species, buffalo milk production had increased by 91.05 per cent while goat milk production had increased only by 47.13 per cent. Increase in goat milk production in Asia during this period was 66 per cent while it was only 46 per cent in Africa. This increase in goat milk production was mainly due to increase in goat population, while substantial increase in buffalo milk production could be attributed to special programmes such as providing breeding services at the doorsteps of farmers and improving health care and feed management to increase the yield per animal. This indicated the potential for increasing goat milk production through introduction of scientific breeding and good husbandry programmes. With respect to goat milk, although the share in total milk production was only 2.2 per cent, it has been making a significant contribution to the nutrition and diet of poor families [10].

Table 5 presents the quantity of goat milk produced in different regions and the list of countries ranking top 10 in goat milk production. Out of 18.712 million tons of goat milk produced in 2018, Asia shared 56.80 per cent production, followed by Africa (24.49 per cent) and Europe (14.55 per cent). Asia and Africa together produced 81.24 per cent of the total goat milk, reflecting on its importance to people of these continents, where most of the poor in the world lived and where goat has been the main source for milk. Thus, goat was universally called "Poor man's cow" [4]. As the quantity of milk produced was very small, 0.20 kg to 1.00 kg per day, selling of small quantity of milk was not attractive and hence it was kept for home consumption, particularly for children and women. Thus, goat was an important tool to combat malnutrition in the developing countries.

According to Table 5, the world average of goat milk yield was 86.5 kg per year, with a wide variation between the continents. The milk yield in Oceania was least at 29.4 kg/year while Europe had the highest yield of 299.8 kg/year. This was because Europe has been maintaining high yielding goats for producing premium quality cheese, while the focus was on meat production in Oceania. In Asia and Africa, goats were mostly maintained by small farmers for milk and meat. Out of 216.232 million goats in milk production, 91.95 per cent were located in Asia and Africa and Europe and America had 4.20 per cent and 3.85 per cent milking goats respectively. Among the goat milk producing countries, India was on top with 6.099 million tons of milk in 2018, followed by Sudan, Bangladesh and Pakistan, each producing around one million ton per year. France, Spain and Greece from Europe were among the top 10 countries, where goat milk has always been a delicacy and goat cheese has been very popular. Goat farming in Europe has been highly intensive with high yielding dairy goat breeds.

The dairy goat sector has been expanding in the Netherlands during the last two decades, and many dairy farmers shifted from cows to goats, due to quotas for cow milk. Dutch dairy goat producers have used technologies such as artificial insemination (AI), confinement rearing, computerized record-keeping, etc. They sold most of the goat milk for processing into cheese in factories or processed the milk on their farm for home consumption. Years of genetic selections in these countries have enhanced the milk yield. In the Netherlands, the average

Table 1. World goat population from 1960 to 2018

Goat population in Millions								
Years	Asia	Africa	Americas	Europe	Oceania	World	China*	India*
1961	198.406	94.255	33.292	22.474	0.301	348.727	51.303	60.864
1970	212.584	115.411	32.341	17.070	0.288	377.694	60.670	66.526
1980	274.168	141.108	31.464	17.294	0.288	464.323	80.762	86.900
1990	350.169	176.785	36.949	22.168	2.939	589.001	96.350	113.200
2000	458.819	243.790	34.832	18.937	2.396	750.774	148.478	123.533
2010	510.818	348.912	37.041	17.501	3.917	918.189	142.157	137.321
2018	548.883	438.111	38.050	16.819	4.053	1045.916	138.383	132.750
% Share	52.48	41.88	3.64	1.61	0.39	100.00	13.23	12.69
% Rise 1960 -2018	176.65	364.81	114.29	-25.16	1246.51	199.92	169.74	118.11

Source: FAO [11]. * Population of China and India are included in the Population of Asia

Table 2. Change in the population of species of livestock between 1961 and 2018

	Cattle	Buffalo	Sheep	Goat	Pig
World 1961	942.175	88.322	994.269	348.727	406.180
2018	1489.745	206.601	1209.467	1045.916	978.332
Increase %	58.12	133.92	21.64	199.92	140.86
Asia 1961	319.012	86.019	232.289	198.406	118.474
2018	454.810	201.258	514.987	548.883	559.920
Increase %	42.57	133.97	121.66	176.65	372.61
Africa 1961	122.537	1.501	135.126	94.255	5.668
2018	355.694	3.506	383.955	438.111	40.525
Increase %	190.27	133.58	184.15	364.81	614.98
Americas 1961	284.247	0.068	158.971	33.292	110.819
2018	522.867	1.397	82.421	38.050	183.745
Increase %	83.95	1954.41	- 48.16	14.92	65.81
Europe 1961	192.288	0.733	266.732	22.474	168.115
2018	119.358	0.439	130.704	16.819	188.397
Increase %	- 47.93	- 40.11	- 51.00	- 25.16	12.06
Oceania 1961	24.091	0.0007	201.150	0.301	3.105
2018	37.015	0.0003	97.401	4.053	5.746
Increase %	53.65	- 57.14	- 51.60	1246.51	85.06

Source: FAO [11]

Table 3. Ranking of countries based on goat population and comparison with other ruminants in 2018

Sl. no.	Countries	Goat Million	Sheep Million	Cattle Million	Buffaloes Million	Total Ruminants	Goats % of Ruminants
	World	1045.916	1209.467	1489.745	206.601	3951.729	26.47
1	China	138.383	164.079	63.418	27.119	392.999	35.21
2	India	132.750	61.666	184.464	114.152	493.032	26.93
3	Nigeria	79.382	42.972	21.418	-	143.72	55.23
4	Pakistan	74.134	30.498	46.084	38.848	189.564	39.11
5	Bangladesh	60.074	2.274	24.086	1.485	87.919	68.33
6	Myanmar	45.919	1.334	17.418	3.790	68.461	67.07
7	Chad	36.525	33.215	29.063	-	98.803	36.97
8	Ethiopia	33.048	31.688	62.600	-	127.336	26.33
9	Sudan	31.837	40.846	31.223	-	103.906	30.64
10	Mongolia	27.125	30.555	4.381	-	62.061	43.71

Source: FAO [11]

Table 4. Region-wise milk production by different livestock species in 2000 and 2018

Species	Asia	Africa	Americas	Europe	Oceania	World	Increase % 2000- 2018
Cattle 2000	94.695	22.015	142.365	207.652	23.148	489.875	39.47
2018	213.201	34.628	184.304	220.377	30.706	683.217	
Buffalo 2000	64.476	2.030	-	0.144	-	66.651	91.05
2018	124.958	2.120	-	0.259	-	127.338	
Goat 2000	6.398	3.126	0.679	2.515	-	12.718	47.13
2018	10.628	4.582	0.780	2.722	-	18.712	
Sheep 2000	3.656	1.830	0.080	2.877	-	8.442	25.93
2018	4.924	2.448	0.091	3.168	-	10.631	
Camel 2000	0.181	1.641	-	-	-	1.823	72.08
2018	0.262	2.875	-	-	-	3.137	
Total 2000	169.406	30.642	143.124	213.188	23.148	579.509	45.47
2018	353.973	46.653	185.175	226.526	30.706	843.035	
Increase %	108.95	52.25	29.38	6.26	32.65	45.47	

Source: FAO [11]

Table 5. Region-wise goat milk production and ranking of countries based on goat milk production in 2018

Sl. No.	Country	Milk Production Million tons	Goats in Milk Production Million	Av. Milk Yield Kg/Year
1	World	18.712	216.232	86.5
2	Asia	10.628	114.375	92.9
3	Africa	4.582	84.442	54.3
4	Europe	2.722	9.080	299.8
5	Americas	0.780	8.333	93.6
6	Oceania	0.00004	0.0013	29.4
Rank	Country wise Ranking in Goat Milk Production			
1	India	6.099	36.834	165.6
2	Sudan	1.151	17.979	64.0
3	Bangladesh	1.123	30.097	37.3
4	Pakistan	0.915	8.949	107.0
5	France	0.652	0.887	735.1
6	Turkey	0.562	5.327	105.5
7	Mali	0.526	18.919	27.8
8	Spain	0.461	1.203	383.6
9	Greece	0.398	2.974	133.8
10	Iran	0.271	5.454	49.7

Source: FAO [11]

production per doe has been 798 kg/year while in France and Spain, the average production has been 687 kg and 352 kg/year respectively. Some of these breeds have already been introduced in Africa and Asia and the success was linked with good management practices and climatic conditions. Therefore, along with genetic upgradation, promotion of good goat husbandry practices will be necessary to increase the milk yield of goats [13].

Important advantages of goat milk over cow and buffalo milk are better nutritive value and certain therapeutic values in medicine. Goat milk contains 3.8 per cent fat, 3.4 per cent protein, 4.1 per cent lactose, 0.8 per cent ash and 8.9 per cent SNF, and is considered as a good substitute for mother's milk for feeding infants [14]. Goat milk has better digestibility and alkalinity. Consumption of goat milk has been recommended for people allergic to cow and buffalo milk. Hence, production and marketing of goat milk as a high value product, can help farmers to increase their income.

4. GOAT FOR MEAT PRODUCTION

The world meat production which was 84 million tons in 1965, reached 335 million tons in 2018, recording a four-fold increase in nearly 50 years. Out of it, 124.633 million tons were contributed by poultry and ducks, 120.881 million tons by pigs, 67.354 million tons by cattle, 9.788 million tons by sheep, 4.247 million tons by buffaloes

and 5.977 million tons by goats. Although goat meat, popularly known as chevon, was only 1.8 per cent of the total meat, it was in high demand in Asia and Africa, because of its nutritional value, taste and religious taboo. In comparison to beef, it has lower fat, higher calcium, magnesium, potassium, similar iron and lower B12 and folate contents, with lower quantity of saturated fatty acids and cholesterol and hence, healthier than other red meat [5].

It can be seen from Table 6 that 71.56 per cent goat meat was produced in Asia and 23.87 per in Africa in 2018. During that year, 479.172 million goats were slaughtered in the world to produce 5.977 million tons of meat and collect 1.173 million tons of goat skin [11]. Out of this, 95.23 per cent skins were collected from Asia and Africa. Among the top ten goat meat producing countries, China ranked first, with 38.98 percent of the world goat meat production, followed by India (8.45 per cent). It has been reported from many developing countries that a significant part of the goat meat produced was not traded like other meats, but consumed locally by the communities. Even in many developed countries, the market structure has not been developed well for goat meat producers and hence, the meat production is under-reported in many countries [5]. It has been estimated that over 35 million goats have been sacrificed at the *Hajj* and *Bakri Eid* festivals every year in the world. The average carcass weight in the world was 12.5 kg, and among the top meat producing countries,

Pakistan had the highest carcass weight of 17.2 kg, as presented in Table 6. Indian goats had an average carcass weight of 10.0 kg while Bangladeshi goats had the least carcass weight of 7.0 kg, which could be due to the predominance of dwarf Black Bengal breed. The carcass weight was influenced by the size of the breed, level of feeding and health status.

In India, chevon is a popular meat priced at Rs.450/kg as compared to poultry and buffalo meat at Rs. 180/kg. Due to high price, only around 10 per cent of Indians consume chevon, while other meat eating population consume fish, poultry, eggs and other types of meat [15]. As the demand for goat meat has been increasing in India, the Government has been planning to double the production by 2030. FAO estimated a four times increase in production of goat meat between 2009 and 2030 in India, but such an increase in chevon production was not possible, unless the goat keepers adopted improved management practices. In spite of growing domestic demand, India has been exporting a small quantity of chevon, to the Middle East, accounting for 2 per cent of the global meat export. In 2014, India exported 23,612 tons of chevon, worth Rs. 8.281 billion [15].

5. GOAT FIBRE

Pashmina is a premium fibre produced from certain breeds of goats which are confined to cold hilly regions of China, Mongolia, Iran, Afghanistan, Nepal, India, Australia, New Zealand and Britain [16]. Out of the total world pashmina wool production of 15,000 tons, China has the highest share of 70 per cent, followed by Mongolia (20 per cent) and India contributes only 1.0 per cent to the world's pashmina production. In India, pashmina is obtained from Ladakh region, Lahul and Spiti valley of Himachal Pradesh, Uttar Kashi, Chamoli and Pithargarh districts of Uttaranchal. The pashmina produced by Changthangi goats in Changthang sub-division of Ladakh is known as Changthangi pashmina whereas that produced in HP and Uttaranchal is known as Chegu pashmina. Changthangi pashmina is considered to be the best quality pashmina in the world. This region has been producing about 40 tons of pashmina from 1.6 lakh pashmina goats. The length of the fibre is higher in males but females yield more fibre [17]. To increase the production of Pashmina, the Government of India launched a scheme in 2014 by supporting over 800 nomadic families engaged in rearing 0.2 million Pashmina goats, through increase in Changthangi goat

population and fibre yield, which resulted in an average increase in the yield of *Pashmina* wool by 9.30 per cent in two years [18]. Production of goat fibre has good potential to improve production, fetch premium price and generate additional employment in the garment sector through development of a strong value chain, involving all the stake holders.

Mohair is the fibre from Angora goats, produced in South Africa and Texas in USA. South Africa produces 50 per cent of the world's Mohair. There are about 0.859 million Angora goats in Eastern Cape of South Africa, producing 3.6 million kg Mohair, which is semi-processed and exported to USA, Europe and the Far East [19].

6. IMPORTANT GOAT BREEDS IN THE WORLD

There are over 570 breeds of goats which have originated from different parts of the world, with 25.8 per cent from Europe, 25.6 per cent from Asia and the Pacific and 15.6 per cent from Africa [20]. Goats can be grouped into four categories, based on the utility, namely breeds for milk, meat, dual-purpose (meat and milk) and fibre (Mohair and Pashmina). Europe has been working on genetic improvement of dairy breeds since long and has developed some of the best dairy goat breeds. There are many goat dairy farms, with 100 to 375 milking goats, for selling fresh milk or processing cheese on the farm itself. The average milk yield per goat has been the highest at 796 kg/year in France, 295 kg in Spain and 172 kg in Greece [21]. Alpine and Saanen are outstanding dairy breeds which originated in Switzerland and were introduced in many countries. The average milk yield of selected herds was around 750 kg in 280 days. The details of important European dairy breeds are presented in Table 7. Ionica, Maltesa and Lucania were the dairy breeds of Italy which yielded 250 to 350 kg milk in 175 to 240 days. Toggenburg was another Swiss breed which yielded 170- 200 kg per lactation. Other European dairy breeds such as Nubian, British and La Mancha, yielded up to 250 kg in 190 -210 days. The performance of selected Mediterranean breeds such as Alpine, La Mancha, Saanen and Charmois  e were above 2.55 kg/day. Boer goat had the highest milk fat of 5.88 per cent, while the fat content of Malaguena and La Mancha breeds were 5.49 per cent and 4.95 per cent respectively [22].

Boer is a meat breed which originated in South Africa, and which has been used extensively for

breeding local goats in many countries. Kiko is a popular meat breed of New Zealand. Ma T'ou is a dual purpose breed from China. Etawah (Jamnapari) is an important dairy breed in Indonesia. In Pakistan Bujri, Damani, Dera din Panah, Jattan, Jarakhell, Kamori, Koh-I Ghizer, Kurri and Patteriare are the important dairy breeds and Chapper, Kachari, Kacchan, Kajli, Kuranasari and Labri are dual purpose breeds. Bach Thou is a dairy goat breed in Vietnam [20]. Kilis and Malta are the dairy goat breeds reared in Turkey [23]. Pure breed Saanen does had more days in milk and higher milk yield than other breeds in goat dairy farms in New Zealand. However, despite its popularity around the world due to high milk yield, there were many less known local breeds in the desert regions, having milk with higher fat and protein than Saanen does. In Western Asia and North Africa (WANA) region, there were over 32 breeds of goats adapted to the semi-arid and arid climate as well as to the oasis or humid coastal regions with most of them in neglect. Damascus or Shami breed was the most important breed which originated in Syria and was introduced in many other regions. As there was a clear genotype by environment interaction effect, the performance of breeds in other regions was very often lower than the performance in their original regions. In Nepal, there were four main breeds of goats, namely Chyangra (in mountain), Sinhal (in high hills and low mountains), Khari (in mid hills) and Tarai (in lower plains), mostly maintained for meat purpose, with 52.2 per cent population concentrated in the hills. In the past, three Indian breeds namely Jamnapari, Barbari and Beetal and Boer from South Africa were introduced for crossing with Khari and Tarai breeds. Crossing of Sinhal goat with Boer improved the growth and reproductive performance of the progeny in well-established farms but further evaluation was needed before its recommendation to small farmers [24]. A very careful adaptability study is necessary before introducing goat breeds to and from other eco-systems.

7. GOAT BREEDS OF INDIA

India has 34 registered goat breeds. Based on their utility, these breeds have been grouped into 3 categories, namely, Dual purpose, Meat, and Pashmina. Meat and skin were available from all goat breeds. There are no dairy breeds with high milk yield like in Europe. The details of important Indian goat breeds are presented in Table 8 [25, 26]. These breeds have been well adapted to local eco-systems and local people have a liking for them. However, due to lack of scientific

breed improvement programmes in the field, there has been severe genetic erosion. In India, out of 135 million goats, only 26.97 million goats were categorized under specific breeds, 11.77 per cent were graded breeds, while the remaining 61.26 per cent goats were nondescript with poor productivity [26]. Among Indian goat breeds, Surti had the highest milk yield of 2.50 kg/day as presented in Table 8. Gaddi, Assam Hill, Surti and Black Bengal breeds are small in size. Black Bengal has been very popular for meat and high quality skin [27], while Jamnapari has been extensively used for upgrading nondescript goats to improve the milk yield of the progeny [28].

As over 61 per cent goats in India were nondescript, the meat and milk production has been significantly low and the available options to improve their progeny are either to upgrade by breeding with recognized local breeds or to cross with exotic breeds. In the early 1970s, cross breeding of Indian goats with exotic goat breeds was initiated for improving milk and fibre under the All India Coordinated Research Project on Goats launched by the Government of India. For improving milk yield, Beetal, Malbari and Black Bengal breeds were crossed with Alpine and Saanen. The crossbred progeny of Beetal and Malbari had higher milk yield over their mothers, but the increase was not substantial. The average milk yield of Beetal was 157 kg in 186 days, while Alpine and Saanen under Indian Conditions yielded 308 kg and 286 kg respectively, as compared to their yield of 1850 kg and 1900 kg in USA respectively [29]. In late 1970s, the Rural Agricultural Institute at Narayangaon in Maharashtra, imported Saanen bucks and crossed with local goats. The crossbred doe yielded more milk compared to the mother but acceptance for meat was poor because of its slim body (personal communication). In arid and semiarid regions, where goats are maintained under extensive grazing system, crossbreeding of native goats with exotic breeds has not been suitable under Indian field conditions [30]. In general, success of cross breeding of native goats in Asia with European breeds has been very limited, while there has been a huge concern about the loss of genetic erosion and emergence of new diseases [20].

8. GOAT BREEDS IN AFRICA

The indigenous goats of Southern Africa were large sized breeds like Nguni, Tswana and Matebele, and smaller East African breeds such

as Landim, Mashona and Malawian, which have slow growth rate and low milk yield. To improve productivity of these goats, cross-breeding with exotic breeds was initiated in the 1980s, but it was not successful. In such harsh regions, sustainable utilization of indigenous goats, with efficient conservation, breed improvement, management, and marketing was the best option [31]. In West Africa, goat keepers have been maintaining native dwarf breeds. High temperature was the main constraint for growth and performance of even local breeds and for introduction of exotic breeds.

In the 1990s, several international organisations, non-governmental organizations (NGOs) and national institutions promoted goat development to reduce poverty and enhance food and nutrition security. The programme aimed at promoting genetic improvement of local goats by crossing with exotic dairy goats for increasing milk and meat yield, while raising the income of smallholder goat farmers. The exotic dairy breeds introduced were Anglo-Nubian, British Alpine, German Alpine, Saanen and Toggenburg. During the same period, the German Development Cooperation, introduced the German Alpine. The community-based approach to coordinate various services and marketing, resulted in increasing employment opportunities, income and nutrition among goat keepers [32]. Timely availability of support services was critical for the sustainability of the

improved performance [33]. In the eastern highlands of Kenya, the FARM-Africa, under a community based goat improvement programme, imported Toggenburg dairy goats for crossbreeding with the local goats, with good success [34]. In Sub-Saharan Africa, dairy breeds such as Saanen, Toggenburg, Alpine and Anglo-Nubian were introduced in selected regions which performed well [35].

It was observed that there were wide variations in growth and milk yield performance among the breeds of different continents and efforts were made to cross the low yielding breeds with high yielding breeds from other continents. However, the success has been very limited under specific ecological conditions, with a high risk of eroding very precious native breeds, which have ability to tolerate harsh weather, water scarcity, diseases and poor quality feeds. Hence, efforts should be made to improve the precious local breeds through selection of superior germplasm from the field and application of modern biotechnological tools.

9. GOAT MANAGEMENT SYSTEMS

Depending on the traditional custom prevailing in the region, fodder and grazing land availability, goat keepers in different countries have adopted different systems of management. In Asia and Africa, where goats were maintained by marginal and poor families, three major systems of goat

Table 6. Region wise goat meat production and top goat meat producing countries in 2018

Sl. No.	Country	Goat Meat Production Million tons	Goats Slaughtered Million	Skin Production Million tons	Average Carcass Yield Kg/animal
1	World	5.977	479.172	1.173	12.5
2	Asia	4.277	324.118	0.864	13.2
3	Africa	1.427	134.170	0.253	10.6
4	Americas	0.135	9.920	0.027	13.6
5	Europe	0.108	8.868	0.020	12.2
6	Oceania	0.030	2.097	0.008	14.2
Rank	Country wise Ranking in Goat Meat Production				
1	China	2.330	153.778	0.464	15.2
2	India	0.505	50.407	0.092	10.0
3	Pakistan	0.344	20.028	0.081	17.2
4	Nigeria	0.250	26.310	0.040	9.5
5	Bangladesh	0.223	31.856	0.063	7.0
6	Chad	0.120	10.025	0.022	12.0
7	Sudan	0.119	13.343	0.023	8.9
8	Mali	0.105	7.468	0.101	14.0
9	Iran	0.093	12.189	0.017	7.6
10	Ethiopia	0.085	10.000	0.085	8.5

Source: FAO [11]

Table 7. Lactation length, milk yield and fat content of selected European goat breeds

Breeds	Lactation Length Days	Total milk kg	Milk yield kg/day	Milk fat %
Alpine	248	601	2.66	3.33
Anglo-Nubian	270–305	592	0.90	3.71
Boer	-	-	1.72	5.88
Canaria (Canary)	251	183	0.79	3.96
Damascus	270	378	1.88	4.46
La Mancha	270–305	720–800	2.63	4.95
Malagueña	240–270	500–700	1.47	5.49
Maltese	250	283	2.23	3.77
Murciana-Granadina	231	368	1.70	4.59
Nordic	250–300	600–700	1.92	4.28
Saanen	250	615	2.55	3.28
Chamois��e	265–290	645	2.55	3.40
Toggenburg	245	424	1.82	3.37
Carpathian	270	240	0.90	4.50
Balkan	235	280	0.85	3.51
Payoya	220	240–280	1.10	4.20

*Sources: Ferro et al. [22]***Table 8. Habitat and economic traits of different goat breeds of India**

Breed	Broad habitat	Population In 2012	Body Wt. (Kg)		Milk
Dual-purpose breeds (milk and meat)		Million	Male	Fem.	Kg/day
Barbari	Agra, Mathura, Etah and Aligarh districts in U.P.	3.15	37.9	22.6	0.71
Beetal	Gurdaspur, Amritsar and Ferozpur districts in Punjab	0.30	59.1	35.0	0.95
Gohilwadi	Bhavnagar, Amreli and Junagadh districts in Gujarat	0.32	37.1	36.0	1.71
Jakhrana	Jakhrana village in Alwar district of Rajasthan	1.95	57.8	44.5	0.99
Jamunapari	Chakarnagar Block in Etawah district of U.P.	1.05	44.7	38.0	1.06
Kutchi	Kutch district in Gujarat	0.66	43.5	39.3	1.84
Malabari	Kozhikode, Kannur and Malappuram districts in Kerala	0.71	39.0	31.1	0.31
Marwari	Western Rajasthan	7.57	33.2	25.9	0.53
Mehsana	Mehsana and Banaskantha districts in Gujarat	0.59	37.1	32.4	1.32
Sirohi	Sirohi and Ajmer districts in Rajasthan	2.91	50.4	22.6	0.41

Breed	Broad habitat	Population In 2012	Body Wt. (Kg)		Milk
Surti	Surat and Vadodara districts in Gujarat	0.67	29.5	32.1	2.50
Zalawadi	Surendranagar and Rajkot districts in Gujarat	0.82	38.8	33.0	2.02
Sangamneri	Ahmednagar district in Maharashtra	0.21	38.4	29.0	0.82
Berari	Vidarbha region of Maharashtra	0.19	36.0	33.0	1.00
Meat breeds					
Black Bengal	West Bengal, Jharkhand, Odisha, Bihar and Assam	20.92	32.4	20.4	0.48
Gaddi	Chamba, Kangra, Kulu, Bilaspur, Kinnanaur and Lahul-Spiti districts in Himachal Pradesh	0.47	27.5	24.7	0.3
Ganjam	Ganjam district in Odisha	0.15	44.1	31.9	0.32
Kannai Adu	Ramanathpuram and Tirunelveli districts in Tamil Nadu	2.09	35.8	28.6	-
Osmanabadi	Osmanabad district in Maharashtra	1.55	33.7	32.4	0.50
Konkan Kanyal	Konkan region of Maharashtra	-	35.0	30.0	-
Assam Hill	Assam	-	25.0	22.0	0.20
Attappady Black	Palakkad district in Kerala	0.007	35.0	31.0	-
Pashmina breeds					
Changthangi	Ladakh district in Jammu and Kashmir	0.21	20.4	19.8	-
Chegu	Uttarkashi, Chamoli and Pithoragarh districts in Uttarakhand	0.01	39.4	25.7	-

Source: Acharya [25]; Mandal et al. [26]

husbandry were in practice. These were extensive system, semi-intensive system and intensive system. Under the intensive system, farmers maintained goats in a shed or fenced yard with 100% stall feeding. This system was generally adopted by small goat keepers having 1–2 animals or large farmers owning commercial farms. Under intensive production, goats were fed in confinement with limited access to land. It involved high labour and cash inputs. Under this system, animals were monitored properly. Under semi-intensive system, generally, the village goat keepers maintained small to medium size flocks, let them out regularly for grazing and also provided supplementary feed. This was a combination of intensive and extensive systems. The nature and extent of combination of the two systems in the semi-intensive system depended on the availability of grazing area, type of crops grown and the availability of feed and water [15]. Dairy goats in Europe were under intensive management, while making good use of the pasture lands, which not only reduced the feeding cost but also controlled the weed problem in the pasture. In Europe and North America, modern goat farmers were adopting pasture grazing, to reduce costs, maintain natural behaviors and improve the environment. Depending on the climate and distance to markets, it was economical to graze dairy goats for a part or all round the year.

The other system was extensive grazing which was generally followed in sheep and to some extent in goats, where goat keepers took their goats out of the village in search of fodder [9]. Extensive production system was adopted on marginal lands, usually in very low rainfall areas, having low carrying capacity. This system was practiced by nomadic people, or during winter months when crop residues were available. There have been many variations in the systems, taking advantage of the local conditions. In the sub-humid and humid zones, tethering was common either in the pasture or in agricultural fields, after harvesting the crops. This facilitated controlled grazing, without damaging crops in the surroundings. Goats browsed more effectively than other livestock, and when grazed with cattle, reduced the parasite burden [13].

In India, over 33 million families are engaged in rearing goats with an average flock size of 4 heads, with 40% annual replacement. For poor families, goat has been a source of milk, meat, manure and emergency cash reserve [36]. Over 93% of goat keepers belonged to marginal, small

and landless categories and 87.2% lived in poverty. For landless and marginal farmers, village common pasture lands, roadsides, forest areas, field bunds, river banks and fallow areas were the main sources for grazing. In addition, they collected branches of avenue tree species such as *Azadirachta indica* (Neem), *Ficus* or *Acacia nilotica* for feeding at home [21]. In hilly and desert regions, with better access to Common Property Resources, local goat keepers generally increased the flock size to enhance their income [5]. It was generally the women and the elderly in the family, who were responsible for taking the goats out for grazing. Women also took up the responsibility of collecting supplementary fodder, providing drinking water, cleaning of the shed, milking, etc. Generally, goats were left free for grazing during the day and tied in the shed at night. These were extended sheds adjoining their houses, with other livestock. Farmers having larger flocks were housing separately in thatched houses. Men helped in treating sick animals and in selling goats [36].

About 90 per cent of the does were bred by nondescript stray bucks or the 'temple' bucks (also known as '*Mata ka Bakra*' in Uttar Pradesh and Bihar and *Amariya* in Rajasthan), wherever these bucks were available [37, 28]. Only in small number of villages, where goat husbandry was taken up as a profitable activity, some farmers kept good quality bucks, which were also used by the other farmers, by paying a service fee. In general, about 40–45 per cent does delivered single kid, 35–40 per cent twins and 10 per cent triplets. Black Bengal breed had higher incidences of twins and triplets. Many farmers have been castrating their male kids at the age of 3 months. Castration was carried out generally by selected local persons, by using stones, successfully. The breed preference varied from region to region, but most of the goat keepers preferred locally known breeds.

Health problems of goats affected the mortality and growth rate. Peste des Petits Ruminants (PPR), Foot and Mouth Disease (FMD), Enterotoxaemia (ET), Haemorrhagic Septicaemia (HS), Goat Pox and Brucellosis were the major diseases in India. Diarrhoea, pneumonia, cough and cold, endo-ectoparasites, mouth and skin lesions were the common ailments while the first two ailments were the major causes of kid mortality. Goats suffered maximum health problems during rainy season [36]. PPR has been a cause of high rate of mortality, varying

from 10 per cent to 50 per cent. Vaccination against PPR has been carried out during recent years to bring down mortality significantly. A majority of the farmers were contacting the local paravet for veterinary help and only about 10 per cent farmers approached the Government veterinarians. Most of the goat keepers were aware of the need for supplementary feeding, deworming and vaccination of pregnant does but only about 10 per cent practiced these practices. About 12-15 per cent goat keepers, provided supplementary feed and fodder when adequate fodder was not available for grazing, but very few farmers practiced stall feeding, except in large commercial farms [9].

In general, the rearing cost of a kid till the age of 11 months was Rs. 1310, which included Rs. 180 on vaccines and medicines, Rs. 80 on feed, Rs. 50 on transportation while the notional labour cost was assumed as Rs. 1000 [15]. 38% of the farmers sold their goats at an age up to 6 months, 30% farmers sold after the age of 13 months and the rest between 7 to 12 months' age. The decision to sell goats was mostly need based and not for earning profit. About 65 per cent farmers sold their goats in or before the sowing season in order to purchase agricultural inputs. Many goats were slaughtered during social occasions like marriages or festivals, when about 31% of the farmers sold their goats. 13% of the farmers sold their goats to meet financial requirements in case of a medical emergency. Only 5 per cent farmers sold their goats at an age they felt, was appropriate for sale. About 80 per cent farmers sold their goats to the local aggregators who roam in the villages on almost a daily basis looking out for goat purchase. Goat keepers received 56 -60 per cent of the final value paid by the consumers, when they were organised to sell on weight basis [36].

In West Africa, goats are maintained by 60-87% of the families, either as the main activity or as a secondary activity. The goat keepers preferred native dwarf breeds, tolerant to high temperature. In spite of several development projects implemented by many government and non-government organisations, the progress has been slow due to constraints related to feeding, health, management and lack of institutional support [38]. In Southern Africa, about 70% of the goats were owned by small farmers with an average flock size of 20 indigenous goats under extensive grazing system with minimal inputs, lack of health care and undefined marketing channels. Due to their adaptability to harsh weather conditions and their ability to browse in

poor and dry areas, farmers preferred local breeds over exotic breeds. In Sub-Saharan Africa, goats have been a source of livelihood for pastoralists, raised for meat but a small number of does having good milk yield, were milked. In some parts of highlands and humid lowlands, where indigenous goats were primarily raised for meat, exotic dairy goat breeds were introduced during pre-colonial times for improving the milk yield. Thus, a good number of crossbred dairy goats are found in some pockets [35]. In high lands of Kenya, where Toggenburg dairy goats were introduced under a community based goat improvement programme, farmers formed their umbrella organizations to organise animal health and breeding services, production inputs, marketing goats and goat products. In seven years, the population of improved goats had increased by three folds and income from sale of milk and live goats had also increased, apart from improved food security [39]. Thus, a well-planned integrated goat development programme to organise backward and forward linkages, can improve goat productivity, enabling goat keepers to improve their food security.

10. CHALLENGES IN IMPROVING GOAT HUSBANDRY

While the demand for goat meat has been increasing, a majority of the small goat flock owners are not able to improve the productivity of their goats. With a steady increase in goat population and increasing threats of global warming, the feed availability on community lands has been reducing significantly. Only a small portion of goat keepers provide supplementary feed, even for pregnant does and weaning kids and a large majority of them are ignorant or incapable of providing the required nutrition. Neglect of pregnant does was the cause of birth of poor kids, high kid mortality and poor growth of new progeny [36]. This was one the main reasons for lower income of goat keepers in India, who earned a net income ranging from Rs.4000 to Rs.10750, contributing 9 per cent to 40 per cent of the annual income, while the families earning less than Rs. 60,000 per annum, fell in the category of poor [20]. In Rwanda, most of the goat keepers had to struggle for their livelihood [40].

Many developing countries did not have adequate support from the Government to provide critical services to goat keepers. In India, several goat development schemes were launched during the last two decades. Most of

these schemes provided partial financial support to procure 10 to 100 female goats with a few bucks to develop their goat flocks. These schemes were not attractive to goat keepers as they could neither mobilise additional finance nor space for housing and grazing. In the absence of support services such as veterinary care and marketing, these schemes were not attractive [41]. Realising these problems, several Civil Society Organisations (NGOs) took up various initiatives during the last two decades and the results were very encouraging for wider replication. Important NGOs who initiated goat development in India, were BAIF, PRADAN, World Vision, HEIFER International, ANTHRA, IBTADA and Bosco Gram Vikas Kendra and others [42].

BAIF Development Research Foundation, a civil society organisation engaged in promoting dairy husbandry in India, tried to identify the problems of goat keepers [28]. A majority of the goat keepers considered goat husbandry as a casual household activity and not as an enterprise important enough to make necessary investments to improve the production. As goat rearing was dominant in ecologically fragile and drought prone areas, increase in goat population further threatened the biodiversity. Hence, a programme was designed to increase goat productivity, with control on goat population and an Eco-Friendly, sustainable goat husbandry project was launched in 2006 in West Bengal. Two basic principles were to refrain from procuring female goats from other regions for distribution and to increase production through genetic improvement, using popular local breeds, with control on goat population through rigorous culling of inferior goats. Formation of Goat keeping Women Groups, each group with 10 to 12 women members, maintaining an elite buck by each group for breeding their does, engagement of a trained local youth, preferably a woman, to serve as a Field Guide, for providing various services to goat keepers were some of the initiatives which were taken up. The Animal Husbandry Department provided guidance to field guides about minor health care. The impact of the aforementioned programme was significant as vaccination against PPR, deworming and feeding concentrate and mineral mixture resulted in low mortality and higher body weight gain. Progeny born to selected buck had good breed characters, higher twinning rate and higher body weight. Improved health status and higher weight gain reduced the age at puberty. Goat mortality reduced from 35 per cent to 3-5

per cent. In 2-3 years, all the nondescript and sick goats were replaced by superior progeny of recognized breeds, without increasing the flock size substantially. Goat keepers insisted on selling goats on actual weight basis, with a thumb rule of 50 – 60 per cent of prevailing market price of chevon, instead of selling indiscriminately. This helped in increasing the income of goat keepers by 300 – 400 per cent from the third year. The average flock size increased by 30 - 40 percent in 5 years, but the enlightened goat keepers adopted various innovative methods for providing supplementary feeds, instead of depending on community lands for grazing [28]. Based on the success, similar programmes were launched in Rajasthan and Jharkhand states with the support of ILRI and IFAD during 2010-13. Presence of a paravet in the village for regular guidance, helped goat keepers to learn good husbandry practices while gaining confidence to manage goat husbandry as an enterprise.

In another goat development programme in Bihar state of India, the Aga Khan Rural Support Programme, engaged women para-veterinarians to provide preventive health care and introduce good husbandry practices, which helped the goat keepers to improve the productivity and income [43]. Engagement of local paravets to motivate and guide goat keepers was very effective. The Goat Trust promoted the engagement of female paravets, known as *Pashu Sakhis* as an important component of the goat development programme, which is becoming very popular in India. Presently, this Trust has been supporting over 50 organisations in 14 states to promote appropriate technology, formation of livestock rearers' association, value addition of livestock and livestock based products [44]. The Goat development programme supported by Bill and Melinda Gates Foundation and IFAD in India, has set a vision for 2030 to promote comprehensive growth of the goat sector with a goal to develop the backyard and commercial farms, with focus on organised marketing and processing of goat products to ensure quality, while ensuring environmental sustainability. The aim is to change the image of goat as a "poor man's cow" to a 'Green Business Option for the Bottom of the Pyramid' [45].

11. SUGGESTED COMPONENTS FOR SUSTAINABLE GOAT DEVELOPMENT PROGRAMME

For wider replication of successful goat development programmes, the following

components and policy support should be considered.

1. Engagement of Field Guides, Paravets or *Pashu Sakhis* (Women paravets) for handholding of small goat keepers and facilitate breeding, health care and other services.
2. Genetic improvement of important local breeds by selecting superior germplasm from the field, applying modern biotechnological tools and providing incentives for conservation.
3. Disease Surveillance through Disease mapping, Diagnostic services, Public awareness and Cold Chains for vaccinations.
4. Improvement of feed resources through community pasture development, forage production on wastelands and use of crop residues to develop complete goat feed, while encouraging adoption of stall feeding.
5. Promotion of market development to showcase chevon as a unique product; establishment of meat processing facilities and hygienic packing by involving the private sector; establishment of block level market yards; promotion of startups and Farmer Producer Companies to support aggregation and direct marketing of goat milk and meat, while empowering Goat Keepers to manage their own value chain.
6. Promotion of goat development programme for women empowerment and nutritional security in the developing countries and encouraging goat milk feeding for malnourished children and women.
7. Strengthening research facilities on goat breed improvement, reducing kid mortality, nutrition, feed management, effective delivery of breeding and health care services in remote villages.
8. Facilitation of soft loans for goat keepers to take up goat husbandry, meat and milk processing as rural micro-enterprises and to prevent distress sale.
9. Awareness among goat keepers on conservation of community pastures, breed improvement, preventive vaccination, supplementary feeding of kids during pre-weaning period and population control, with an aim to improve production without indiscriminately increasing the goat population.

12. CONCLUSION

Goat being a source of nutritional security and livelihood for the poor living in harsh agro climatic conditions in many countries of Asia and Africa, productivity improvement of goats owned by small goat keepers can directly empower these communities. Priority should be given to address the problems related to breed improvement, health care, feed resources development and establishment of processing and marketing facilities, while keeping a control on goat population. Empowerment of goat keepers through formation of their groups, engagement of local paravets to handhold goat keepers and establish effective linkage with the research institutions, veterinary services, financial institutions and market, can enhance goat productivity while improving the socio-economic status of goat keepers, who are struggling to earn their livelihood.

13. RECOMMENDATIONS

Several successful interventions in Asia and Africa suggest that interaction with goat keepers at the micro level, can empower them to transform goat husbandry as a sustainable enterprise within a short span of 4-5 years. For ensuring success, it is recommended to incorporate the above suggested components in the goat development programmes for small goat keepers in Asia and Africa.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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