# Sustainable Goat Farming for Livelihood Improvement in South Asia

Edited by
**Nure Alam Siddiky**

SAARC Agriculture Centre (SAC)
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Regional Expert Consultation on Sustainable Goat Farming for Livelihood Improvement in South Asia: Opportunities, Constrains and Potential held on 22-24 August 2017 at National Agricultural Research Centre, Islamabad, Pakistan

**Edited by**
Nure Alam Siddiky
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2017



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# Foreword

Goats are known as 'poor man's cow. Goats contribute to the livelihoods of millions of rural poor in South Asia where 29% of the world's goat population is concentrated. Small and marginal farmers as well as landless, particularly women are increasingly relying on goat keeping for their socio-economic upliftment. Goat is well integrated in the farming systems of the small and marginal farmers of South Asia due to low capital requirement, easy handling and ability to adopt in versatile environmental conditions. Goat rearing can offer more opportunities to the developmental agencies for their further intervention in micro credit, extension and marketing support especially to rural women, landless and small farmers.

Goat production has flourished in poorly endowed areas viz. dry zones and the mountainous areas in the developing countries of Asia and Africa, where over 95% of the world goat population is concentrated. The small and marginal farmers including landless agricultural laborers, mostly in non-green revolution areas where irrigation facilities are poorly developed, prominently rear goats. Over the last 15 years, the number of goats has increased by almost 50% at world level, whereas, cattle population has increased by 9% only, but the sheep population has decreased by 4%.

Goat is an ideal animal species for farming in the rainfed regions where crop production is uncertain, and rearing large ruminants is hampering because of acute feed and fodder scarcity. Goat rearing has distinct economic and managerial advantages over other livestock species because of its less initial investment requirement, low input requirement, higher prolificacy, early sexual maturity and easy in marketing. Goats can efficiently survive on available shrubs and trees in unfavorable environment. In pastoral societies of south Asian region, goats are kept as a source of additional income and as an insurance against income shocks of crop failure. In addition the rural poor who cannot afford to maintain a cow or a buffalo find goat as the best alternative source of supplementary income and milk. Owing to their greater socio-economic relevance, the growth in goat population in south Asia has been increasing.

In spite of having potential of good economic returns from goat rearing, income of goat farmers is at low level. There are a number of causes for such a situation. The important cause is that potentially of goat in South Asian countries has never been properly recognized by the policy makers and scientists though South Asia possess almost one-third of the world's goat

population. The productivity of goats under the prevailing traditional production system is low mainly because of feed scarcity and lack of adoption of improved technologies and management practices. However, to harness this potential, the productivity and profitability of existing goat production system needs to be improved substantially.

This is the compilation of the country status reports has been presented by focal point experts from SAARC Member States in a consultation meeting held on 22-24 August 2017 at National Agricultural Research Centre, Islamabad, Pakistan organized by SAARC Agriculture Centre, Dhaka, Bangladesh. The expert consultation also generated a good number of recommendations under different thematic areas through intensive discussion. This book contains the information of goat genetic resources, production performances, production systems, nutrition, housing, disease managements and marketing from each of the SAARC Member States which would help extension workers and researchers for adopting profitable goat production system, which is most suitable for their countries. This would also help to exchange different sustainable goat farming livelihood improvement modes between the interested countries.

I would like to acknowledge the contribution made by the focal point experts of SAARC Member States in preparing a comprehensive and informative country paper and participating in the expert consultation meeting. The contribution of Dr. Md. Nure Alam Siddiky, Senior Program Officer, SAARC Agriculture Centre to the conceptualization, technical guidance, inputs, reviewing and editing of this publication is duly acknowledged. I personally hope that this publication would provide detail and comprehensive information on sustainable goat farming practices existing in SAARC Member States. I would appreciate to receiving feedback, comments and suggestions from users for our future endeavors.

**S. M. Bokhtiar**
Director, SAC

# Contents

# Abbreviations

| | |
|---|---|
| AAU | Assam Agricultural University |
| AFSP | Agriculture Food Security Project |
| AI | Artificial Insemination |
| AICRP | All India Coordinated Research Program |
| AMOVA | Analysis of Molecular Variance |
| AnGR | Animal Genetic Resources |
| BAU | Birsa Agricultural University |
| BBGs | Black Bengal Goats |
| BBS | Bangladesh Bureau of Statistics |
| BDT | Bangladeshi Taka |
| BER | Bangladesh Economic Review |
| BLRI | Bangladesh Livestock Research Institute |
| CARI | Central Avian Research Institute |
| CCHF | Crimean-Congo Hemorrhagic Fever |
| CDR | Central Development Region |
| CGR | Common Grazing Resources |
| CIRG | Central Institute for Research on Goats |
| Cm | Centimeters |
| COI | Cytochrome Oxidase 1 |
| CSWRI | Central Sheep and Wool Research Institute |
| DDP | Daira Din Panah |
| DLS | Directorate of Livestock Services |
| dNTPs | Deoxynucleotide Triphosphates |
| DoL | Department of Livestock |
| EDR | Eastern Development Region |
| EISA | Enzyme Immune Slide Assay |
| ELISA | Enzymed Linked Immuno Sorbant Assay |
| FMD | Foot and Mouth Disease |
| FWDR | Far Western Development Region |
| GBPUA&T | G. B. Pant University of Agriculture and Technology |
| GCC | Gulf Cooperation Council |
| GDP | Gross Domestic Product |
| HVAP | High Value Agriculture Project |
| IFNα | Interferon Alpha |
| ISAG | International Society for Animal Genetics |
| IUCN | International Union for Conservation of Nature |
| IVRI | Indian Veterinary Research Institute |
| KUBK | Kisan ka Lagi Unnat Bui Bijan Karyakram |
| KV&ASU | Kerala Veterinary and Animal Sciences University |
| LDDB | Livestock and Dairy Development Board |

| | |
|---|---|
| MPKV | Mahatma Phule Krishi Vidyapeeth Rahuri |
| MT | Metric Tons |
| mtDNA | Mitochondrial Deoxyribo Nucleic Acid |
| MWDR | Mid Western Development Region |
| NARC | Nepal Agricultural Research Council |
| NARI | Nimbkar Agricultural Research Institute |
| NDRI | National Dairy Research Institute |
| NIAB | Nuclear Institute of Agriculture and Biology |
| NIBGE | National Institute of Biotechnology and Genetic Engineering |
| Nu | Nublang |
| ONBS | Open Nucleus Breeding System |
| OUA&T | Orissa University of Agriculture and Technology |
| PATCO | Pakistan Agro Tech Company |
| PDDC | Pakistan Dairy Development Company |
| PIC | Polymorphic information content |
| PKSF | Palli Karma Sahauk Foundation |
| PPR | Petri Des Petits Ruminants |
| PrP | Prion Protein |
| PrPSc | PrP scrapie |
| RAU | Rajasthan Agricultural University |
| RFLP | Restriction fragment length polymorphism |
| RT-PCR | Reverse Transcriptase Polymerase Chain Reaction |
| RUV&AS | Rajasthan University of Veterinary and Animal Sciences |
| SAARC | South Asian Association for Regional Cooperation |
| SKUAST | Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir |
| SNP | Single Nucleotide Polymorphism |
| SSRs | Single Sequence Repeats |
| STRs | Short Tandem Repeats |
| TAP-1 | Antigen Processing-1 |
| Taq | Thermus Aquaticus |
| TMR | Total Mixed Ration |
| VNT | Virus Neutralization Test |
| WBUV&FS | West Bengal University of Veterinary and Fishery Sciences |
| WDR | Western Development Region |

# Chapter 1

# Sustainable Goat Farming for Livelihood Improvement in Bangladesh: Opportunities, Constrains and Potential

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## 1. Introduction

Goat has been described as a poor man's cow because of its immense contribution to the poor man's economy. It not only supply nutritious and easily digestible milk but also regular source of additional income for poor and landless or marginal farmers. Being small-sized animals, goats can easily be managed by women and children. Feeding, milking and care of goats do not require much equipment and hard work. Capital investment and feeding costs are also quite low. The role of women in goat keeping is very significant in the rural families of Bangladesh and goat is the most important means through which rural women are able to contribute meaningfully to the cash needs for their family members. Moreover, goat rearing is the most useful way of women earning those who stay at home. There is a close relationship between the status of women and the socioeconomic development of any country. To ensure a balanced socio-economic development of the country, improvement the status of women is a precondition. This may be achieved only when there is increased participation of women in development activities (Nahar, 2000 and Alam, 2001) and goat rearing can be a good approach.

The contribution of the livestock sector to overall GDP was 1.66% for 2015-16 where, the share of livestock in total agricultural GDP was 14.21 (DLS, 2016). Goat provides 20 million square feet of skins and skin obtained from the Black Bengal goats are of excellent quality. The export earnings from all leather and leather goods were 4.31% of the total export in 2012 (BER, 2012). The contribution of goat skin plays a significant role in this regards. Thus, goat farming plays an important and potential role for poverty reduction, income generation, contribution to food and nutrition security and employment generation.

## 2. Goat Population and Demography

Bangladesh is a densely populated country having about 145 millions of people in its 147500 sq. km of area. About 49 percent of population of the country is female (BBS, 2011) and most of the goat reared by rural people, especially by women and children. In Bangladesh, goat population is about 25.77 million in the year 2015-16 (BBS, 2017) of which about 90% are Black Bengal goat. The rest 10% are comprises of Jamunapari, Boar and different crossbred goats. Figure1 shows the total goat population and its growth pattern changes in Bangladesh for last 10 years. Approximately 65% of the households are connected with goat farming either as a primary or secondary occupation (Chowdhury et al., 2015). In Bangladesh, the average number of goats per farm is 4 and up to 41% farm incomes come from goats in some parts of Bangladesh (PKSF, 2014). There are about 56000 registered goat farms available in the country where about 281000 people works directly (Figure 2).

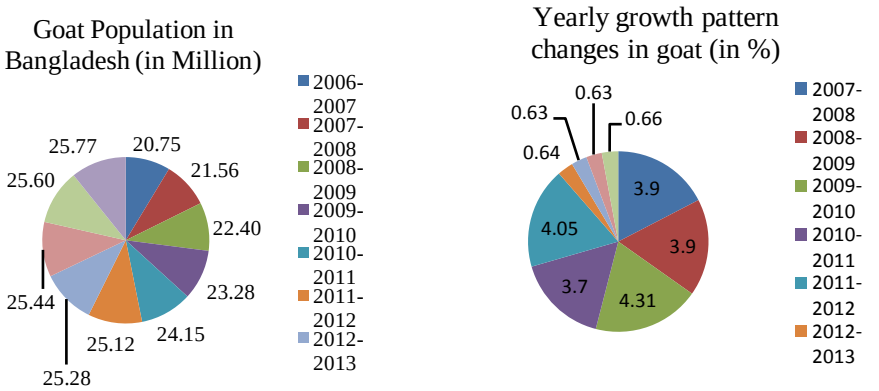



Figure 1. Goat population and its growth pattern changes in Bangladesh for last 10 years (Bangladesh Economic Review, 2015-16)

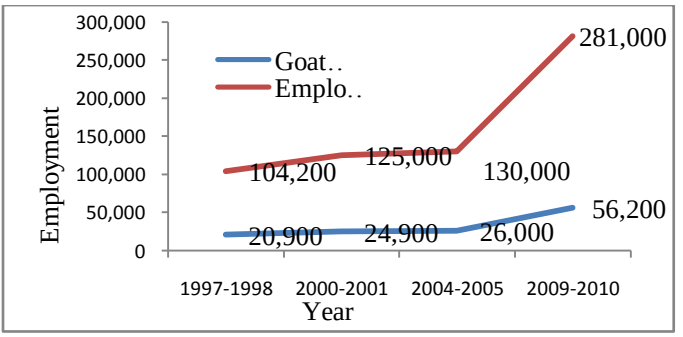



Figure 2. Contribution of goat farm in employment (Source DLS: 2011, adopted from M.A. Hamid and K. M. Hossain-2014)

Although, the growth of goat population drastically reduced after 2011-12 in Bangladesh but till it is in increasing trend. This is may be due to involvement of women in other professions specially in readymade garments sector. Currently, it has been also observed that commercial medium and large scale goat farming increasing to meet the local demand as rural goat keeping are decreasing in trend. Moreover, at present goat farming has become a profitable business due to high demand of goat meat (chevon) in local market with high price.

# 3. Breeds and Breed Description

## 3.1 Indigenous breed

### 3.1.1 Black Bengal

Bangladesh has only one goat breed of its own, known as the Black Bengal. More than 90% of goat population in Bangladesh is comprised of Black Bengal having some variation in coat color and size. Most of the Black Bengal goat bears black hair coat but they may also carry white, brown, black and white, white and brown coat color (Husain, 1993) (Figure 3). It has soft, glossy short hair. The legs are short with a straight back and a beard is found in both sexes. The horns in male are curved in backward but in female it is upward or straight and thinner compare to male. Mature body weight of buck is about 25-30 kg and doe is 20-25 kg.

Figure 3. Black Bengal goat with different coat color

## 3.2 Exotic breed

### 3.2.1 Jamunapari

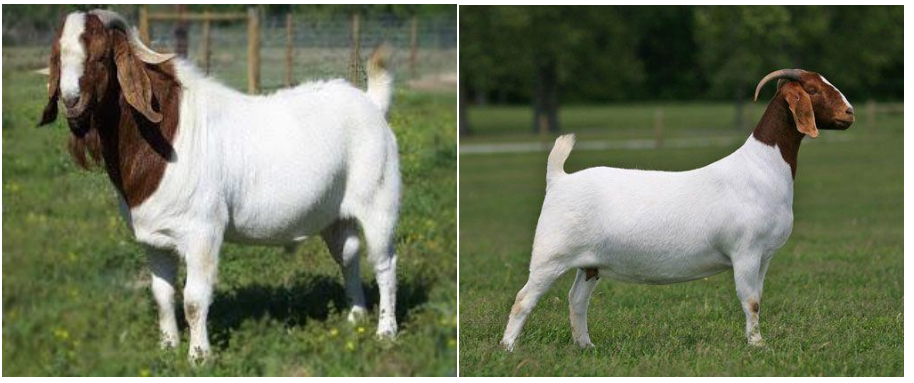
The breed is originated in India but also found in Bangladesh. Although this breed found throughout the country but more concentration is found in the western and northern part, the district those are adjacent to Indian boarder. The number of this breed is not known but it has been estimated that about 8-9% goat are Jumunapari (Figure 4). This breed also popular in Bangladesh for its heavier size and more milk production compare to Black Bengal goat.

The weight of adult buck and does are varies from 50-70 kg and 40-50 kg, respectively.

Figure 4. Jumunapari goat in Bangladesh

### 3.2.2 Boar

Boer goat is considered to be one of the most desirable goat breeds for meat production. It has gained worldwide recognition for excellent body conformation, fast growing rate and good carcass quality. It's popularity increased as a meat type goat breed during the last decade in Australia, New Zealand and later in North America and other parts of the world. Considering the increased demand of meat and milk Boer goat was introduced in Bangladesh in 2012 from Malaysia. Bangladesh Livestock Research Institute (BLRI) studying on different aspects (Breeding, feeding and management) of Boer goat rearing in Bangladesh and suggest that this breed is suitable for Bangladeshi condition (Talukder et al., 2016). Now, its population is increasing rapidly day by day.



Boar goat (Buck) Boar goat (Doe)

Figure 5. Physical conformity of Boar goat

### 3.3 Crossbred goats

Some crossbred goat also observed in Bangladesh. They are mainly Black Bengal x Jumunapari. Currently, some other crosses are also found in the country. Bucks of some other exotic breeds are being imported (mainly illegal trade) from India and used for cross-breeding, especially in south-western region of Bangladesh. Although, national livestock development policy, 2007 is not support any cross breeding with Black-Bengal goat.

## 4. Production System

### 4.1 Farming practices

In Bangladesh, goat generally reared through subsistence, smallholder and small-scale-commercial operations. According to Islam et al. (2009), most of the farmers (80.5%) reared goats in semi-intensive system but few farmers (7.3%) used confinement system of rearing while 12.2% farmers used free range system. About 75.6% farmers kept goat at night in the goat house. In subsistence condition farmers rear 2-5 goats with or without other large ruminants along with other agricultural operation or other non-agricultural professions. In this case animals are reared by women and children. In rural area, about 73.20% goat is reared under low input production system (only natural grass and tree leaves) and the rest (26.80%) are supported by the medium inputs (natural grass+ some concentrate). About 6.20%, 8.10% and 12.5% of goats supported by medium inputs are reared in the subsistence, smallholder and small-scale-commercial operations, respectively (Mia, 2001). In recent times, the medium scale-semi intensive (20-25 does) and large intensive/semi-intensive farms (≥ 100 does) also gaining popularity due to demand and profit from goat farming and private entrepreneurs are coming forward to invest in this sector. Some urban and semi urban area, it is also observed some rooftop small scale goat farm that gaining popularity.

Figure 6. Small scale rooftop goat farm in the capital city of Dhaka

### 4.1.1 Housing

Housing for goat rearing depends on the rearing system. In rural area, as most of the goat reared landless farmers and women and that case they don't provide separate housing for their goat. Goats are housed in a part of their living house or kitchen or houses used for other large ruminant or storing of goods. For medium scale-semi intensive system farmers use a house where there are facilities to shelter and to supply feed (grass + concentrate). This type of houses prepared with bamboo and galvanised tin. In this system farmers cultivate some grasses in their own land or rented land. Large intensive and semi-intensive farm houses are made with concrete structure where different type of facilities necessary for goat rearing are present. They have own lands for grassing and cultivation of grasses. This type of housing present in different government owned farms, research institute, universities and also in some commercial private farms. Figure 7 shows different types of goat house in Bangladesh.

A rural house: goat sheltered with cattle at night

A rural goat house made with bamboo

A rural goat house for shelter at night and adverse condition

A small scale commercial semi-intensive goat house

Figure 7. Different types of goat houses in Bangladesh

### 4.1.2 Feeding

Under traditional feeding systems, the goats are grazed on harvested or fallow lands, roads, river and canal sides etc. In normal practice and/or in adverse weather condition different tree leaves are also used to fed the goats. The important fodder trees are Jackfruit (*Artocarpusheterophyllus*), Mehgoni (*Trichilia emetic*), Bamboo (*Bambusa spp.*), Mango (*Mangiferaindica*), Banana (*Musa spp.*), Babla (*Acacia nilotica* and *Acacia planifrons*), Tetul (*Tamarindusindica*), Neem (*Azadirachtaindica*), Koroi (*Albizialebbek*), Bot (*Fiscusbenghalensis*), Aswatha (*Fiscusreligiosa*) and Boroi (*Ziziphusmauritiana*) etc. In the rural area, tetheringof goats in the harvested or fallow lands, roads and river sides are a common practice. It is a convenient means of rearing goats from the stand point of control, minimum labour input and utilization of feed in situ. A variation of this method is combining tethering with grazing up to 5 goats at a time, led by ropes held by women and children. In low input farms goats depend on only natural grass and tree leaves where the medium input farms also provide some concentrate (rice polish and broken rice etc.). But medium and large scale commercial farm provide the balanced ration to their goats with green grass and a concentrate mixture. Different types of cultivated grasses are used in feeding goats in Bangladesh. Among them, Napier (*Pennisetum purpureum*), German (*Echinochlo apolystachya*), Jumbo (*sorghum bicolour sorghum sudanefe*), Maize (*Zea mays*), Oats (*Avenasativa*), Dhaincha (*Sesbaniarostrate*), Triticale (*Triticosecale*) and newly introduced and Pakchong-1 are more common.

### 4.1.3 Breeding

In Bangladesh most of the farmers used natural mating systems to serve their does. Although, some NGO's started artificial insemination in goat with very limited scale. Hossain et al. (2015) found that majority of goat keepers (70.7%) used village buck to inseminate their does and most of the farmers (73.2%) paid service charge to the buck keepers while, most of the farmers (80.5%) did not keep bucks for breeding. Bangladesh Livestock Research Institute (BLRI) trying to improve the performances of Black Bengal goat through selective breeding and open nucleus breeding system (ONBS) system. Beside distribution of improved buck to the farmers for breeding their does, BLRI also conserve Black Bengal goats. There are five government owned goat development farms have been established in different parts of the country (Dhaka, Sylhet, Rajshahi, Chuadanga and Jhenaidah). These farms are also involved in conservation and extension of Black Bengal breed, buck production and its distribution to poor and distressed women at low price.

Figure 8. Distribution of improved Black Bengal buck to the rural farmer by BLRI

# 5. Performances of Different Goat Breeds in Bangladesh

## 5.1 Black Bengal

Performances of Black Bengal goat varies according to the farming practices and nutritional status of the animals. Although some other factors also influences on it. The performances of Black Bengal goats are presented in the table1.

**Table 1**. The performances of Black Bengal goat

| Sl. No. | Parameters | Performances | References |
|---|---|---|---|
| 1 | Birth weight, kg | 1.0-1.22 | Jalil et al., 2016; Paul et al., 2014 |
| 2 | Age at first heat, months | 8.0-8.87 | Jalil et al., 2016; Chowdhury et al., 2002 |
| 3 | Age at first kidding, months | 13.85 | Jalil et al., 2016 |
| 4 | Litter size, no | 1.92 | Jalil et al., 2016 |
| 5 | Services per conception, no | 1.24-1.68 | Chowdhury et al., 2002 |
| 6 | Gestation length, days | 146 | Chowdhury et al., 2002 |
| 7 | Kidding interval, days | 177 | Chowdhury et al., 2002 |
| 8 | postpartum estrus interval, days | 21±6.9 | Chowdhury et al., 2002 |
| 9 | Kid mortality up weaning, % | 6 -30 | Islam et al., 2009; Ershaduzzaman et al., 2007; Chowdhury et al., 2002 |
| 10 | Milk yield, ml | 354.76 | Mia, 2011 |

## 5.2 Jamunapari

The average performances of Jamunapari goats found in Bangladesh are presented in the table 2.

**Table 2**. The average performances of Jamunapari goats

| Sl. No. | Parameters | Performances | References |
|---|---|---|---|
| 1 | Birth weight, kg | 1.51-1.73 | Talukder et al., 2015; Bhowmik et al., 2014; khan et al., 2013; Hasan et al., 2010 |
| 2 | Weaning weight, kg | 6.59-7.09 | Talukder et al., 2015<br>khan et al., 2013 |
| 3 | Weaning age, days | 127.0 | Talukder et al., 2015 |
| 4 | Growth rate, g/day | 40.0 | Talukder et al., 2015 |
| 5 | Age at first heat, days | 335.00 | Bhowmik et al., 2014 |
| 7 | Litter size, no | - | Talukder et al., 2015 |
| 9 | Post-partum heat period, days | 63 | Talukder et al., 2015 |
| 10 | Gestation length, days | 145 days | Talukder et al., 2015 |
| 11 | Kidding interval, days | 210-240 | Talukder et al., 2015<br>Bhowmik et al., 2014 |
| 12 | Milk yield, ml | 500-1200 | Talukder et al., 2015<br>Bhowmik et al., 2014 |

## 5.3 Boar

Boar is the newly introduced goat breed in Bangladesh. Only one published study is available about this aspect in intensive farming condition. Average birth weight, weaning weight, weaning age, growth rate, litter size, gestation length, post-partum heat period and kidding interval are 3.40±0.23 kg, 18.50±1.42 kg, 90.40±2.82 days, 0.168±0.01 kg/d, 1.52±0.07, 147.33±3.84 days, 145.33±43.88 days and 272.85±12.78 days, respectively (Talukder et al., 2015).

## 6. Diseases and Health Care Services

The goat rearing inherently incurs different diseases which intern reduces profitability of farming by treatment costs, reducing productivity and by mortality. Black Bengal is vulnerable to rain water and water logging conditions. Viral diseases like PPR, goat pox, contagious ecthyma and viral pneumonia, and bacterial diseases such as enterotoxaemia, tetanus, FMD, brucellosis, mastitis and metritis, mycotic diseases like ring worm infection, and ricketsial infections like conjunctivitis are common causes for goat mortality in Bangladesh. Gastro-intestinal nematodiasis, fascioliasis and tape worm causes less mortality but cause severe depression in the growth and reproductive rate of the BBGs. About 6-30% kid mortality reported by different authors in well managed farm to rural scavenging system (Islam et al., 2009; Ershaduzzaman et al., 2007; Chowdhury et al., 2002). In rural areas, Pneumonia, PPR, Contagious ecthyma, Diarrhoea and Tetanus are more common diseases (Kashem, et al., 2011). Although, large and medium scale intensive and semi-intensive commercial goat farm use regular vaccination against PPR, they generally not faced the problem of PPR. But in rural areas, PPR causes heavy economic losses in every year especially in rainy seasons and also decreases the productive performances of goats. The prevalence of PPR disease was higher in Black Bengal goat (54.93%) than in Jamunapari goat (31.78%) (Islam et al., 2012). In the rural areas high mortality rate of kids are regarded as the most important constraint in goat production. Major causes of kids mortality are in PPR (25%), pneumonia (21.15%), diarrhoea (17.31%), and also the invasion of predator (23.08%) (Kashem et al., 2011). But in intensive and semi intensive system of commercial goat farming, major causes of kid mortality are infectious (63%) followed by predators (10%), mechanical (4%) and congenital (1%) and among infectious causes the prevalence of different diseases are diarrhoea, pneumonia, bloat & enterotoxaemia, ecthyma and others like, 30%, 27%, 23%, 17% and 2%, respectively (Ershaduzzaman et al., 2007).

The health care and veterinary services are inadequate that also causes a considerable constraints for sustainable goat production in the country. Department for Livestock Services (DLS) is the main actor to provide health care services to the farmers through Upazilla Livestock Office and hospital. But the manpower is not sufficient to cover almost 0.7 million animals in about 200 villages of each Upazilla. The DLS has mostly engaged with treatment of sick animals, while preventive care has been grossly neglected. Consequently, epidemics like PPR and other diseases often kill goats and impose huge losses for farmers. The quality and quantity of different vaccines produced and delivered by the DLS at present are not adequate. Commercial vaccines are available but these are costly and its efficacy and

quality are not checked by DLS. Lack of ambulatory services also leads to limitation of veterinary services only around the upazilla head quarters. On the other hand, quarantine is not visible neither in the ports nor in the country. These results occurrence of transboundary movement of diseases and spread within the country. Moreover, unorganized animal slaughter and in adequate veterinary inspection in slaughter house and live animal market lead to spread of infection from one area to another area. Thus, it is important to adopt better management and preventive intervention to reduce the adult and kids mortality in Bangladesh to improve goat production as well as living status of goat farmers.

Commonly practiced vaccination schedule for goat production in Bangladesh is given in the following table.

**Table 3**. Vaccination schedule for goat production in Bangladesh

| Sl. No. | Name of the vaccine | Time | Remarks |
|---|---|---|---|
| 1. | PPR | Every 12 months after | Age at least 2.5 months |
| 2. | FMD | Every 06 months after | 1st dose at the age of 03 months |
| 3. | Goat pox | Every 06 months after | Age at least 5 months |
| 4. | Tetanus | Every 12 months after | Age at least 1.0-1.5 months |

## 7. Marketing Channel and Value Chain

A marketing channel describes the movement of a product or commodity from the site of production to the place of consumption. A large number of collectors, traders and butchers are associated with live goat and goat meat business. Live goat and its meat marketing in Bangladesh, is traditional and poorly organized alike to other agricultural products. The figure 9 displays the pattern of existing goat and its meat marketing channels in Bangladesh. The animals pass through different channels or middlemen before it reach to the butcher/ retailer/ consumers. The most prominent channel of goat marketing is the movement of live goats from producers/farmers to the trader (middlemen)/ butchers in the village itself. The goat generally moves from the producers/farmers to traders/butchers in weekly village bazaar. In bazaar live goats to be sold are displayed by the owners and the primary traders purchase those individual basis. They sell their goats either to secondary traders (whole sale traders) or to the butchers at bigger markets. Secondly, traders mainly sell goats in flock to the city dealers or butchers.

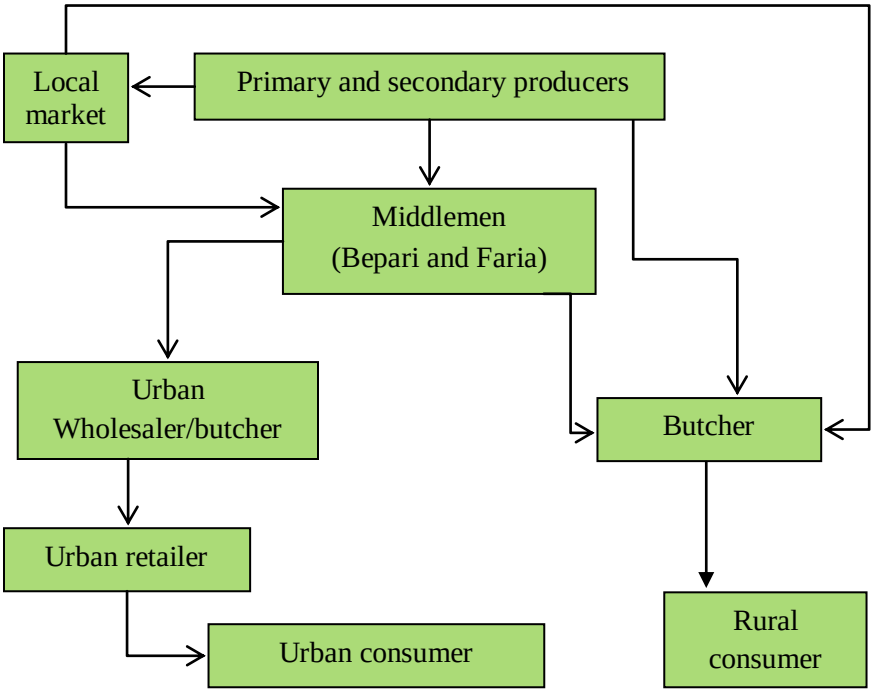



Figure 9. Marketing chain of goat and goat meat in Bangladesh

Goat value chains include all inputs and services that enable live goat production through transporting, processing and marketing of outputs, to creation of added value products such as meat through consumption of the animal source foods and related products (Mohamadou, 2013).

Village goat market

Middlemen

Butcher/whole sealer

Goat value chain analysis made by Chowdhury et al. (2015) in Bangladesh and found the cost of production per kg is BDT 352.00 while the selling price is BDT 382.00 and the profit is only BDT 28.00 for farmers. It was observed that middleman's profit margin was higher for selling to butcher (BDT 228/ US$ 3) compared to traders (BDT 177/ US$ 2.3). Therefore, correct intervention particularly in husbandry practices would be needed in order to minimize cost of production to maximize farmers' profit margin. At present no value added products/processed meat available from goat in the market.

## 8. Goat Research and Development

Bangladesh Livestock Research Institute (BLRI) playing the key roles in conducting different researches related to goat development in Bangladesh. Besides, different universities also doing researches in this aspect. BLRI already developed different technologies those are successfully using in the field levels. The important technologies are-

- Goat rearing for poverty alleviation.
- Black Bengal goat rearing under stall feeding system.
- Black Bengal goat rearing under semi-intensive system.
- Use of different tree fodder as feeds of goat.
- High quality goat selection for starting Black Bengal goat farm.
- Rearing of Black Bengal kids.
- Development of PPR vaccine.
- Integrated treatment approaches for PPR.
- Development of Goat pox vaccine.
- EISA method for the detection of goat pox.
- C-EISA method for the detection of antibody against PPR.

## 9. Benefit Cost Analysis for the Rearing of 100 Black Bengal Goats

Profit from goat farming depends on many things. Following table gives estimation about the expenditure and income from a 100 Black Bengal goat rearing farm.

| Product/Item | Details |
|---|---|
| Farming system | Semi intensive |
| Goat breed | Black Bengal |
| Bucks | 10 |
| Does | 100 |
| Sex ratio (doe: buck) | 10:1 |
| Kid mortality rate | Maximum 10 percent (!!) |
| Saleable kids age | 11-12 months |
| Kidding/ interval | 8 months |
| Percentage of kidding | 80 |
| Average litter size | 1.7 |
| Expenditure 1st year | |
| Area/land/pasture | Your own |
| House/shelter construction cost | US$ 1000 |
| Equipment cost (US$ 1 for every four goats) | US$ 25 |
| Bucks (10 no.) | US$ 80*10= US$ 800 |
| Does (100 no.) | US$ 60*100= US$ 6000 |
| Feed item | Cost |
| Green food cultivation | US$ 150 per season |
| Supplementary feed/doe (6.75 kg/month @ 225 g/day) for two months. One month before kidding and one month after kidding. | (6.75*2*100=1350)* 0.375= US$ 506.25 |
| Supplementary feed/buck (7.5 kg/month @ 250g/day) for two months during breeding season and/or when necessary) | (7.5*2*10=150)* 0.375= US$ 56.25 |
| Supplementary feed/growing kid (3.75 kg for 30 days @125 g/day) | (3.75*100*1.5=563)*0.375= US$ 211.125 |
| Supplementary feed cost/kg | US$ 0.375 |
| Labour | 1 |
| Labour cost/year | US$ 150*12= US$ 1800 |
| Veterinary cost/year | US$ 120 |
| Other | US$ 50 |
| Total | US$ 10,718.625 |
| Income 1st year | |
| Sale of 130 growing kids (1.7% kidding rate) | US$ 60*130= US$ 7800 |

| Product/Item | Details |
|---|---|
| Sale of manure | Use it for farmers own green food/fodder cultivation |
| Total | US$ 7800 |
| Total profit 1st year | |
| Total income – total expenditure = US$ 7800- US$ 10,718.625= -US$ 2918.625 | |

In 1st year we have some permanent cost. However, now we will calculate the total cost and income in 2nd year.

| Expenditure 2nd year | |
|---|---|
| Area/land/pasture | Own |
| House/shelter construction cost | 0 (already have) |
| Equipment cost (US$ 1 for every four goats) | 0 (already have) |
| Bucks (10*) | 0 (already have) |
| Does (100*) | 0 (already have) |
| Feed item | Cost |
| Green food cultivation | US$ 150 per season |
| Supplementary feed/doe (6.75 kg/month) for two months. One month before kidding and one month after kidding. | (6.75*2*100=1350)* 0.375= US$ 506.25 |
| Supplementary feed/buck (7.5 kg/month @ 250 g/day) for two months during breeding season and/or when necessary) | (7.5*2*10=150)* 0.375= US$ 56.25 |
| Supplementary feed/growing kid (3.75 kg for 30 days @ 125 g/day) | (3.75*100*1.5=563)*0.375= US$ 211.125 |
| Supplementary feed cost/kg | US$ 0.375 |
| Labour | 1 |
| Labour cost/month | US$ 150*12= US$ 1800 |
| Veterinary aid cost/year | US$ 120 |
| Other | US$ 50 |
| Total | US$ 2893.635 |
| Income 2nd year | |
| Sale of Buck | 30*US$ 80= US$ 2400 |
| Sale of does | 40*US$ 60= US$ 2400 |
| Sale of 100 growing kids (1.5% kidding rate) | US$ 60*100= US$ 6000 |
| Sale of manure | Use it for your own green food cultivation |
| Total | US$ 10800.00 |
| Total profit 2nd year | |
| Total income – total expenditure = US$ 10800.00 - US$ 2893.635= US$ 7906.365, along with this income also have 110 goats and a ready farm with equipment for next years. | |

The benefit cost analysis suggests that actual farm income started from the 2nd years of goat farming.

## 10. Constraints for Sustainable and Commercial Goat Farming

The goat farmers face a number of constraints in different phases of farming. As most of the goat reared in the rural area and goat mainly depends on natural pasture, the main constraint that faces the framers is lack of available natural pasture and scarcity of land for fodder cultivation. Seasonal fluctuation and availability of feed also affect goat farming. Beside these, some other major constrains listed below that affect sustainable and commercial goat farming in Bangladesh:

- Lack of knowledge of the farmers on improved production management of goat rearing and preparation of feeds properly.
- The low cost complete feed is not available.
- Acute shortage of good quality Black Bengal breeding bucks/breeding services.
- Non-availability of vaccines, especially PPR or lack of farmers awareness about vaccination of their goats is another major constraint.
- Poor access to veterinary services and proper treatment also a severe constraint.
- The trade of live goats, which is unorganized and is in the hands of a large number of middlemen, traders and butchers, does not favor goat farmers.
- Lack of effective transport system to carry live goat from farm gate to market.
- Lack of slaughter house.
- Inappropriate wholesale market or lack of linkage between wholesale market and farmers.
- Diversion/cross of original Black Bengal goat breed with Indian and other breed like Jamunapari is also a threat for conserving our pure Black Bengal goat.
- The non availability of credit to scale up goat rearing as a business is also a constrain for sustainable and commercial good farming.
- Lack of insurance coverage.
- Lack of coordinated effort by government, NGO's, research and educational institutions and entrepreneurs to develop this enterprise.

# 11. Recommendation for Future Research and Extension Service

To improve the productivity of Black Bengal goat and goat product in Bangladesh, investment in research and development should be increased. As well as extension services should be optimize to create facilities to the producers to boost up the production. In this regards, research and extension services in the following areas should be explored.

## 11.1 Research

- Conservation of Black Bengal goat and production of superior buck through selective breeding and ONBS approach.
- Use of genetic tools (breeding, genetics and biotechnology) to improve productivity of Black Bengal goat.
- Find out and utilization of non-conventional feed resources to mitigate the shortage of green grass/natural pasture.
- Researches to increase meat quality and safely and to develop processing method and value added products.
- Development of different effective vaccines and herbal sources for the prevention and treatment of different diseases.
- Development of agro-industrial by-product based complete pellet feed for commercial goat production etc.

## 11.2 Extension service

- Formation of farmers group and build capacity of the small scale farmers through proper training.
- Provide extension services to build capacity of the small scale farmers for improved goat rearing and its management.
- Develop linkage of farmers among the good commercial input suppliers, Govt. livestock department, research institute, universities and NGOs.
- Steps should be taken to make available all necessary inputs at fair prices in the local markets so that farmers can purchase their inputs at the door steps.
- Besides research institute and universities, government goat development farms and NGOs/private sectors can facilitate to protect and improve the Black Bengal goat and disseminate to small scale farmers with subsidized rate for commercial farming.
- Opportunity to available quality buck and introducing commercial AI services similar to cattle breeding when smallholder farmers will rear goat at enterprise level.

- Establish adequate numbers of slaughter house and linking farmers with the slaughter house.
- Develop farmers group marketing system to minimize the cost of transportation.
- Develop direct farmer-market linkage by facilitating group farmers to link with the superstores/meat processing farms.
- Create awareness and provide training to different stakeholders on meat quality and safety.

## 12. Conclusion

There are many challenges facing goat farmers of the country, including scarcity of pasture/feed, seasonal fluctuation and availability of feed resources, scarcity of superior buck, lack of training for better management of their goats, insufficient veterinary services, lack of credit facilities and also marketing facilities. Although, goats play an essential role in connection with food security and rural development as part of an integrated farming system, which is tailored to local needs. Goats not only provide food, it also enables poor landless people, especially women, to enter into the cash economy. Investment in the research and development to improve the productivity of goat should also be an approach. Thus, it is possible to boost up the goat production in the country as well as poverty alleviation, women empowerment and employment generation by mitigating the above mention constraints of goat production.

## 13. Acknowledgement

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# Chapter 2

# Sustainable Goat Farming for Livelihood Improvement in Bhutan: Opportunities, Constrains and Potential

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## 1. Importance of Goat in the National Economy

In Bhutan goats are reared mostly exclusively in southern districts of the country for meat, manure, religious offerings and commercial purposes as a quickest source of income. Goats are traditionally sent in the forest to graze. This type of management is restricted due to the environmental degradation by their grazing habits. However, the existing government policy restricts on rearing of maximum number of four goats per household, which disallow exploring goats' farming potential in reducing poverty. Goat husbandry can play important role in addressing this issue by enhancing rural income generation mainly by producing and marketing of niche domestic chevon. The existing goats' population in Bhutan is 39362 (Figure 1) comprising of 17879 male and 21483 female (Figure 2) (DoL, 2016). The estimated annual chevon production within the country is 191.221MT (Figure 3) (Livestock Statistics, 2016). Bhutan import goat meat about 18MT worth of Nu.6208811.00 in 2016 (Bhutan trade statistics, 2016).

Goats played a significant religious and socio-economic role to rural communities. They are sacrificed on special occasions such as annual Hindi festivals (example Dasai) to appease local deities and also during social occasions example, new year and weddings. Quick economic returns helped smallholder farmers to generate income in a shortest period of time. Quick economic returns from goat within 1-1.5 years helps farmers to generate income in a shortest period of time, reduces time lag and avoids accumulation of interest of loans if availed. It provided social security to farmers as it can be sold as and when there is urgent need for cash. Because of high demand both for live as well as dress goats, some farmers believe that keeping goats is as good as having cash in hand. Farmers used income from goats for schooling of children, overcome food shortage, pay taxes and repair

houses helping them to alleviate poverty and improve the quality of life. It is not scientifically proven; local people believe that chevon has medicinal property to cure sub-tropical diseases including malaria.

## 2. Goat Population and Demography

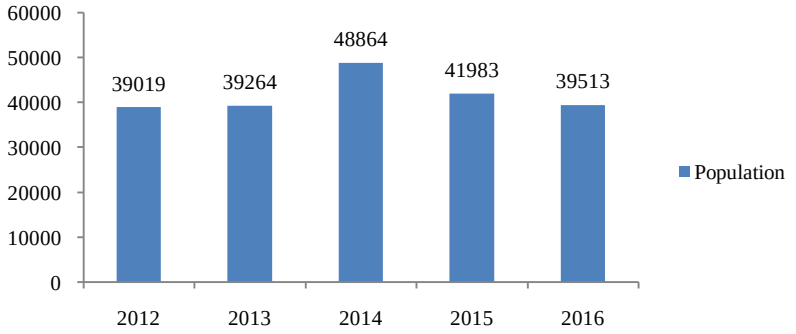


Figure1. Showing goat population from 2012-2016

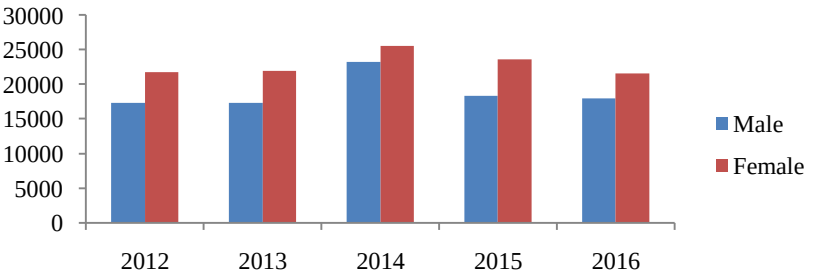


Figure 2. Showing goat population in male and female

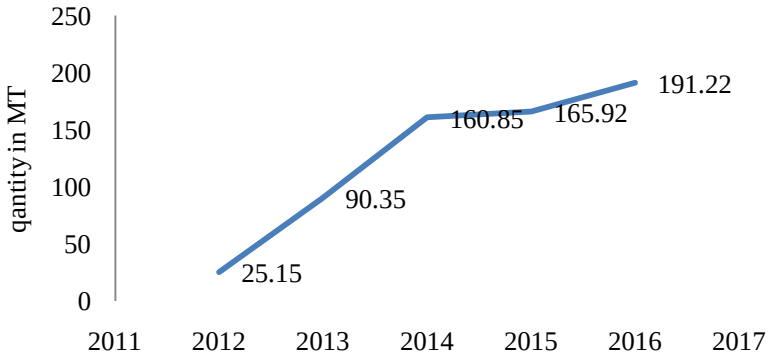


Figure 3. Showing the trend of chevon production from 2011-2016

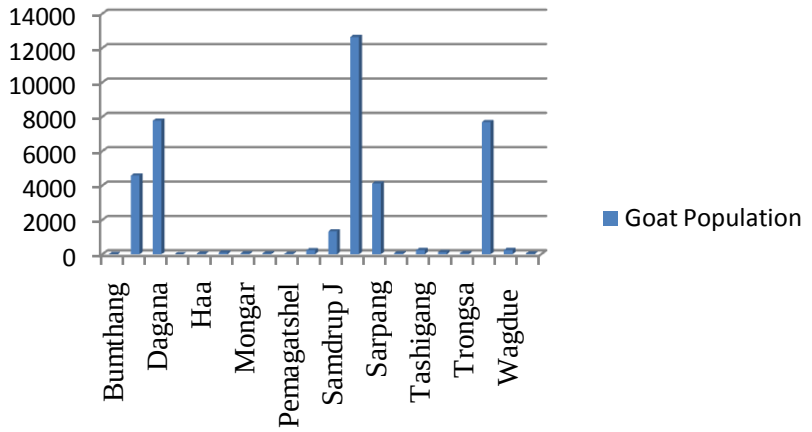


Figure 4. Goat population in districts

# 3. Breed and Breed Description

## 3.1 Black Bengal (Indigenous breed)

Bhutanese goat types are similar to the bezoer type goat with medium body size and straight or concave facial profile. But they are genetically affected by Indian breeds in southern areas or Tibetan goats from north. Irrespective of sexes, the coat colour is mostly black with fewer white and brown with typical black dorsal lines. The horns are mostly twisted and face bearded. They have dropping ears and only fewer animals possess horizontal ears.

Adult male weighs 25-30 kg & female 20-25 kg. Poor in milk production. Goat gains sexual maturity very fast. Females become pregnant twice a year and give birth to 3-4 kids with common twin kidding twice a year. It is well known for excellent chevon and superior skin quality.

Figure. Native breed of Black Bengal

## 3.2 Jamunapari (Exotic breed)

This breed originates from areas between river Ganga and Jamuna in Utter Pradesh (UP), India. There is a great variation in coat colour but they are generally white or light yellowish tan with light brown spots on the neck and face, and occasionally patches of tan or black are found on the body. The typical character of the breed is a highly convex nose line with a tuft of hair known as 'Roman nose' or parrot mouth appearance. The ears are very long, flat and drooping. Both sexes are horned with short and thin tail. A thick growth of hair is present on the buttocks, known as feathers. The breed has well developed udder round in shape with large conical teats.

They are good for milk and meat. Doe usually kids once a year, giving birth to single is 57% while twinning is 43% cases. Live body weight for doe 45-60 kg and buck 80-90 kg. Milk yield 1.4-2 lit/day, length of lactation 160-210 days and kidding rate 1.4 kids /litter.

Figure 6. Jamunapari (Exotic breed)

## 3.3 Sirohi (Exotic breed)

Originates from Indian state of Rajasthan. Sirohi is reared mainly for meat since milk is less than a litre/day. Compact medium-sized animals. Coat colour predominantly brown with light or dark brown patches' a very few individuals are completely white. The body is covered fairly densely with hair which is short and coarse. Ears are flat and leaf like, medium sized and drooping. Both sexes have small horns, curved upward and backward. The breed is well suited to stall feeding. Kidding is 40% single and 60% twin, with two kidding a year and first kidding in 19-20 months. Milk yield: 0.75-1kg/day. Live weight for doe 23-25 kgs and buck 50-52 kgs.

Figure 7. Sirohi goats

## 3.4 Boer (Exotic breed)

The Boar goat of South Africa is a meat type goat with good conformation, high growth rate and fertility. It has short white hair and red marking on the head and neck. Boers are well known goat breeds for milk production. Live weight of doe 80-100 kg, buck 90-140 kg and litter size 1.5.

The mature Buck weighs 110-135 kg and does 90-100 kg. Average daily gains over 200g/day in feedlot. Kidding rate of 200% is common. Reach early puberty, usually about 6 months for the males and 10-12 months for the females. Boer goat also has an extended breeding season making possible 3 kids every 2 years.

Figure 8. Boer goats

## 3.5 Beetal (Exotic breed)

The breed originates from Gurdaspur and Amritsar district of Punjab,India. It is duel purpose breed. The breed is large and good dairy type. Coat colour is variable, predominantly black (about 90%) or brown (10%) having spots of different sizes. The ears are long and flat, curled and drooping. Both sexes have thick, medium-sizes. The ears are long and flat, curled and drooping.

Both sexes have thick, medium-sized horns, carried horizontally with a slight twist directed backward and upward. They have Roman nose. Male possesses marked beard and females are beardless. The tail is small and thin. The udder is large and developed having big conical teats. Live body weight of doe 45-55 kg and buck 70-80 kg. Milk yield 1.4-2.5 lit/day, length of lactation 170-210 days and kidding rate 1.4 kids/litter.

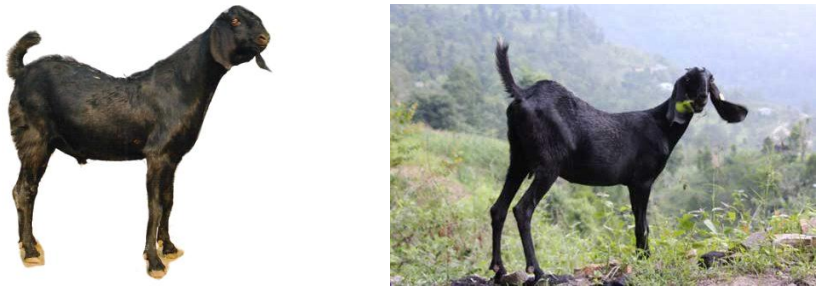

Figure 9. Beetal goats

# 4. Production System

## 4.1 Reproduction and breeding (Native breed)

The breeding stock is selected within local population ad crossbred among the existing breeds. One or two males were kept in the community for breeding and rest of them are castrated at an early age to fatten for sale. Most mating takes place from September to October ad kidding from February to March-April. Twin birth is very common. Triplet and even quadruplet birth is also reported. Kids (young ones) are weaned at about four months of age.

**Table 1**. Reproductive parameters of native goats

| Parameters | Mean | SE(means) |
|---|---|---|
| Age at puberty (months) | 6.8 | ±0.12 |
| Age at first kidding (months) | 12.2 | ±0.14 |
| Kidding Interval (months) | 6.5 | ±0.04 |
| Kids per year (nos) | 2.5 | ±0.08 |
| Life expectancy of doe (yrs) | 12.8 | ±0.23 |
| Reproductive life of doe (yrs) | 9.8 | ±0.13 |
| Total kids during life time (nos) | 19.6 | ±0.51 |

## 4.2 Feeding system

In mid-altitude areas farmers mostly tether their goats while in low altitude areas most farmers stall fed them. Farmers in both areas however also open

graze goats. When stall-feed goats are mostly fed with weeds such as artemesia *vulgaris (Pati),Eupatorium adenophorum (Kala zhar)* in the mid–altitude while in low-altitude they are fed with *Buhari Jhar, Bayar* (throny plants). *Cromolaena ordorata* (Siam weed), lopped fodder trees, aracanut leaves and grasses. Crop by-products such as maize hulls also fed to adult goats. Compound feed as concentrate are seldom fed but whole cereal grains, bran and salt are fed to fatteners. Kids are generally fed with gruel made out of cereals. Due to docile nature of goat, it can be fed and managed by anyone in a household including women and children.

## 4.3 Housing

Most of the farmers sheltered goats in their homestead for manure production as goat and sheep manure are considered best for growing crops. Housing is simple with enclosure made out of bamboo, poles or roughly finished timber. The wall is made of solid bamboo or wood and thatched with rice straw. The floor is often slatted for faeces and urine to pass through as goat reportedly loves to live on dry shed and often avoids dampness and rain.

Traditional shed Improved shed

Figure 10. Different types of traditional sheds

# 5. Goat Development in Bhutan

In April 2007, trail was established in Research Sub Centre, to generate basic data and found that goat breeds in the country is of poor quality (poor growth degenerated etc.) due to repeated inbreeding and use of inferior quality bucks. In year 2010, procured Indian goat breeds to study the performance and adaptability of pure breeds and their crosses. The Department of Livestock has established National Goat Nucleus Farm in the country to serve as a model nucleus farm in the country for breeding and production of quality breeding animals. The unit mandated to provide quality breeding bucks to goat rearing communities for genetic up- gradation of indigenous goat population and enhance chevon meat production to meet consumer demand in the market.

## 5.1 Performance in government farm

The only exotic breeds like Beetal, Sirohi and Jamunapari kept in the farm to study the adaptability and see the performance of the breed and their crosses. More kids given kidded in the day time (23 kids) as compared to the night (4 kids). In the farm the single kidding was recorded highest (21 kids) as compared to twin kidding (3 numbers). So far no records of kidding triplets. Between the sex the male kids progeny (16) were more than the female kids (8).

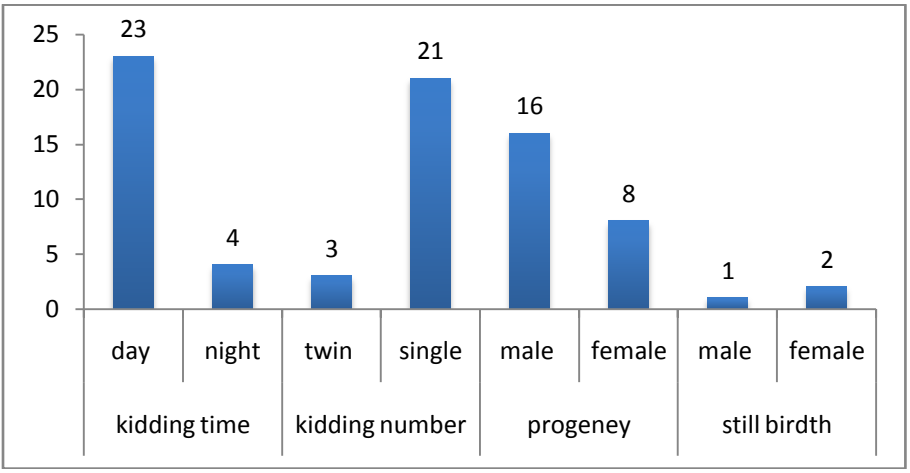


Figure 11. Performance of kids

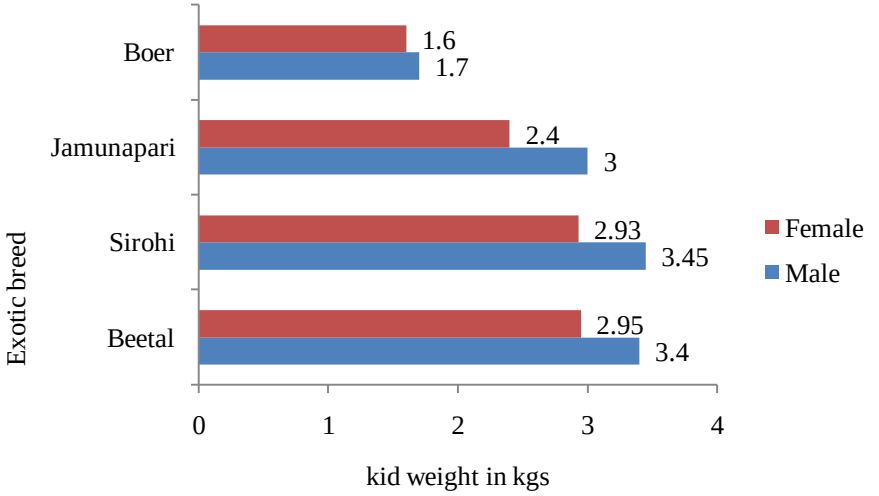


Figure 12. Average birth weight of the kids in different breeds

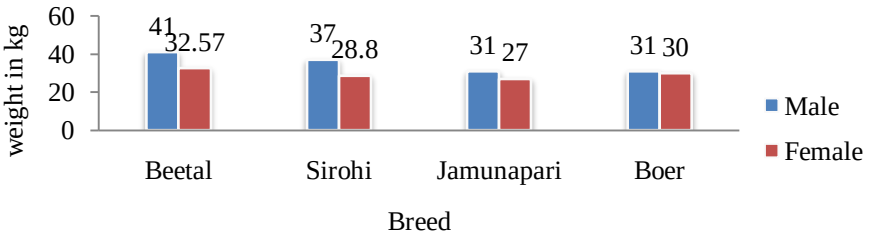


Figure 13. Average adult weight

## 6. Goat Marketing System

Most farmers traded live goats to local customers and dealers from capital city and across the Indian borders. Farmers seem to have no difficulties in selling goats as sale is accomplished at the farmer's doorsteps most of the time. Higher market price fetched by chevon (goat meat) in the locality and towns near the Indian border could be because unlike pork and beef, there are no religious sentiments attached to its consumption. Long tradition of consumption chevon could have helped to develop special test for it and has become delicacy over the period of time. Moreover, due to high demand at the urban centre such as capital city, chevon suppliers to this town are willing to pay the price tagged by farmers. These factors could also have aid to market price for chevon. Goat sales timed to coincide with special period increased demand (such as festivals) is said to fetch better market price.

## 7. Diseases and Health Services

In Bhutan animal health services is not well developed like other countries. National Centre for Animal Health is only Unit looking after the animal health in Bhutan. We do have four RLDC (Regional Livestock Development Centre) which they take care of the animal health which fall under their jurisdiction. We have one each veterinary and para veterinary in district and block.

Farmers reported occasional death of goats. At times death was due to unknown diseases and debility while some other time, it was reported to have died all of sudden probably because farmers failed to detect the sickness on time. But in general farmers feel that it is less susceptible to disease than other livestock. But in recent years the following emerging diseases has been reported in goats.

Peste des petits Ruminants (PPR) is an economically important viral disease, mainly affects the small ruminants. In the past, breeding goats (male and female) were procured from India by the Bhutan government and distributed

to farmers for breed improvement. We also believe that cross-border movement of animals and unofficial imports of goats by farmers along the porous borders of southern Bhutan let to outbreak of PPR. The disease was first reported in 2010 Sarpang District and later the presence was reported from other parts of the country. Due to the endemicity of the disease, the Government of Bhutan launched a national level control program with an aim to vaccinate all susceptible goats.

Crimean-Congo hemorrhagic fever (CCHF) is a highly infectious tick-borne disease caused by a high-risk group of viruses belonging to the family *Bunyaviridae*. Findings indicated all goats that tested positive for CCHFV were reported to have been either bred within households that kept goat herds or procured from other villages within the district. Exact sources of those seropositive goats could not be ascertained. (NCAH Volume 22, Number 5, May 2016).

**Most prevalent infectious goat diseases in Bhutan:**

- Peste des Petits ruminants (PPR)-
- Contagious *Caprine Pleuropneumonia*
- Pneumonia
- Abortion
- Diarrhea

**Prevalent parasitic and production diseases**

- Gastrointestinal nematodes
- Mange mites
- Mastitis
- Tympany and bloat
- Sarcoptic mange

## 8. Constrains for Goat Farming

- Inadequate technical capacity, and technological facilities.
- Lack of adequate and trained staff on goat production.
- The widespread breeding of genetically inferior animals.
- Inadequacy and poor quality of feed and fodder.
- Subsistence production system and small holdings.
- Limited animal health coverage, infectious diseases of economic importance in remote areas.
- Inadequate economic incentives to small producers.

## 9. Recommendations for Further Intervention

- There is a widespread need for training in breeding, feeding and health care for goats.
- There is a good opportunity for networking among the private and public sector in goat dairy /chevon production.
- Need of research on exotic breeds adaptation and production performances in southern foothills.
- Evaluating goat feed and fodder available in the area and scope.
- Marketing and value adding to the goat products such as meat, milk, fibre, skin and manure.

## 10. Conclusion

Small livestock such as pig, poultry and goat can be managed easily in backyard with less investment compared to other livestock. They have higher feed conversion ratio which is advantages to the poor livestock keepers. With low inputs system of management, farmers can derive substantial income since they demand fewer resources. They are less vulnerable to diseases compared to large ruminants and farmers are not at bigger loss during incidental death. It is considered as easily disposable commodity and farmers can sale them easily at the hour of need. Raising large livestock requires greater investment, which exceeds the ability of most farmers, requiring handsome capital turnover with its higher associated economic risks. As the result, goats are an appropriate species for poor farming households. Small ruminant production has significant benefits for poverty reduction programmes in comparison with cattle and buffalo. Rural population and poor livestock keepers have options and opportunity to diversify and enhance their income sources through raising small livestock. Hence they have added advantage for resource poor farmers to meet their urgent monetary need, generate household income and alleviate rural poverty. Affirmative large-scale development is necessary to shift from subsistence to market-oriented production systems, backed by institutional and policy support, and increased resource to increase production and directly benefit and improve the livelihoods of the poor.

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# Chapter 3

# Sustainable Goat Farming for Livelihood Improvement in India: Opportunities, Constrains and Potential

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## 1. Socio-Economic Importance of Goats

Nearly 72.2% population of India is living in 6.38 lakh villages, mostly dependent upon agriculture and livestock for their livelihood. About 29% rural population in the country is below poverty line, 15% of the rural families are landless, and more than 80% land-holders belong to marginal and small farmer's category. Besides poverty, food and nutritional security is big challenge of agriculture policy and livestock farming has been focus point for both poverty alleviation and nutritional security. Crops productivity is largely restricted by uncertain and erratic rainfall, scarcity of water for irrigation and deterioration in soil health. Out of the 138 million Indian rural households, about 33.01 million (24%) are maintaining goats.

Households cultivating less than 2.0 ha of land (marginal and small) are the custodian of more than 76% of the total goats in the country. Dairy goat is considered the cow of poor as its maintenance requires less input and produces sufficient milk for family consumption. Goat rearing has many distinct economic and managerial advantages over other livestock because of its less initial investment, low input requirement, higher prolificacy, extended breeding season, forage preferences to graze a wider spectrum of plants, early sexual maturity, better efficiency of crude fibre digestion from low grade roughages, ease in handling and round the year market and resistance to many diseases. Goat has much lesser potential for range degradation than sheep. Goat has been playing multiple role in livelihood of the rural people by providing income, employment, nutrition, supporting crop production by allowing purchase of critical inputs and risk aversion in case of crop failure.Landless people, particularly women are increasingly relying on goat keeping for their socio-economic upliftment. Physiological adaptability attributes of goat for extreme climatic conditions and in scarce feeding resources made these animals critically important for the livelihood in most of the disadvantageous regions (hot and cold desert mountains). Goat is an ideal animal for livelihood and nutrition (animal protein) in the rain-fed regions where crop production is uncertain, and rearing large ruminants is

costly and competitive due to feed and fodder scarcity. In the mixed species grazing system which is prevalent in rural India, goats browse on plants which are less preferred by other species and thus add flexibility to the management of different species of livestock. Goat could be easily integrated with other livestock species, crops and perennial trees. Population of goat have been increasing by >3% annual growth in spite of about 56% slaughter and 15% mortality is strong indication of potential of species. Unlike a cow or buffalo, a few goats can be maintained easily and easily liquidated in times of distress. Goat farming is very well integrated in the different farming systems of the small and marginal farmers, pastoral societies in India due to low capital requirement and ability to adopt in versatile environmental conditions.Presently commercial goat farming has emerged as important drivers of agriculture growth in India. Goat farming has huge opportunity in rural development as goat has potential for export of products, capital storage, household income, employment and nutrition. It is suitable for women and could be used for rural women empowerment. Therefore, goat has become one of the most inclusive species of livestock.

## 2. Role of Women in Goat Farming

Women played a major role in care and management of goats particularly care in pregnancy (36.7%), parturition (45%), feeding (25%), watering (48.3%), care of neonates (50%), churning of milk (56.7%), making dung cake (68.3%), cleaning shed (41.7%) etc. However, women were not exposed for scientific goat rearing.Women and children were mainly used for tethering/grazing and watering for goats. Since the goats were tethered mainly in the vicinity of home, this brings them closer in the cycles of women and children. About 3-4% women had land ownership and almost the same extent had household ownership. On an average, 2.18% women controlled over family resources as against 48.15% men, and family resources pertaining to backyard were under the control of women. Access over family resources is 6.80% by women and 34.69% joint control and access over family resources were 36.37% and 58.52%. Ownership and decision to sell goats was done mainly by the whole family. Fewer cases of women owning goats independently were observed. Since women play an important role in goat farming under agro-pastoral systems, their ability to benefit from the system depends on the knowledge, their role in decision making and access to economic resources. It is therefore important to enhance the capacity of women and strengthen their resource base to achieve maximum benefit from goat farming.

## 3. Ownership Pattern of Goat

More than 76% of goats are possessed by the marginal and small landholdings. The share of goat ownership has improved with marginal category by 2% between 2001-02 and 2006-07. Small and marginal together constitute about 83% of total land holdings.

**Table 1**. Distribution of goats according to land holding size (million)

| Land Categories | 1996-97 | 2001-02 | 2006-07 |
|---|---|---|---|
| Marginal (<1.0) | 51.5 (53.8) | 60.4(52.6) | 54.8(56.7) |
| Small (1.0 - 1.99) | 18.8(19.7) | 24.6(21.4) | 18.8(19.4) |
| Semi-Medium (2.0 - 3.99) | 13.4(14.0) | 17.0(14.8) | 12.9(13.3) |
| Medium (4.0 - 9.99) | 8.1(8.5) | 9.6(8.4) | 7.5(7.8) |
| Large (10 and above) | 3.9(4.0) | 3.3(2.9) | 2.7(2.8) |
| All groups | 95.7(100.0) | 114.9(100.0) | 96.7(100.0) |

Source: Input survey, Agricultural Census, Govt. of India

## 4. Role of Goat in National Economy

The meat production in the country was 6.6 million tons with a per capita availability of 4.94 kg (2014-15) and proportion of goat is 914 thousand tons, which is 19% of total meat production (3$^{rd}$ after poultry (36%) and buffalo's meat (22%).

**Table 2.** Contribution of goats in national economy

| Items | Production (Thousand) tons) | Value in Crores |
|---|---|---|
| Meat | 905 | 22625.00 |
| Milk | 4782 | 9564.00 |
| Fiber | 0.06 | 15.00 |
| By-products | 601.06 | 3005.28 |
| Manure | 10233.79 | 1535.07 |
| Blood | 103.04 | 206.08 |
| Skin | 149.07 | 1490.70 |
| Increment in stock (Million heads) | 0.7423 | 148.46 |
| Total | | 38590 |
| Output value from livestock at current price | 459051 crores | |
| Share to value of output from livestock | 8.41% | |

Source: Author's estimates based on National Accounts Statistics (CSO) methodology

The goats and its products contribute Rs. 38,590 crores annually to the national economy (Table 2). This accounts for 8.4% to total value of output (at current prices) from livestock sector in 2010-11. Goat meat alone contributes about Rs. 22625 crores (59%) to total value of output from goat sector followed by milk (Rs.9564 crores), by-products (Rs.3005 crores), manure (Rs.1535 crores). The sector also generates gainful employment to about 1.5% of country's total workforce in rural area.

## 5. Goat Population and Dynamics

There is significant growth in population of goat in India during 1982-2007 (Table 3). Maximum increase (16%) was recorded during 1982 to 1987 followed by 13% during 2003 to 2007 period. The Goat population however, has declined by 3.82% over the previous census, attributed to high rate of slaughter, effect of consumer shift and shrinking grazing lands. However, in long term it may have bad consequence as shortage of goat meat may increases the prices of meat. Shortage of meat may put pressure for imports which would be detrimental to the poor goat farmers who would lose the opportunity of increasing their income unless support from government. Annual growth in goat population was recorded 3% during 1982 to 1987. However, it was declined to 0.27% during 1997 to 2003 but further increase and maintained about 2.5% during 2003 to 2007.

**Table 3**. Trends in goat population

| Census year | Goat Population (million) | Periods | % increase/ decrease | CAGR (%) |
|---|---|---|---|---|
| 1982 | 95 | - | - | - |
| 1987 | 110 | 1987-82 | 15.79 | 2.96 |
| 1992 | 115 | 1992-87 | 4.55 | 0.90 |
| 1997 | 123 | 1997-92 | 6.45 | 1.26 |
| 2003 | 124 | 2003-97 | 1.34 | 0.27 |
| 2007 | 140 | 2007-03 | 13.01 | 2.48 |
| 2012 | 135 | 2012-07 | -3.82 | -0.78 |

Source: Basic Animal Husbandry Statistics, 2015

Major reason of steady increase in goat population was increase in demand for chevon in urban areas as compared to other food groups due to increased income. However, average productivity (carcass and milk yield) remained stagnant over these periods.To study rate of decline in goat population in major goat population states during 2007-2012 are summarized in top ten states for the disaggregation and shown in table 4

**Table 4**. Change in major goat population states during 2007-2012

| State | Increase or decrease (%) | CAGR (%) |
|---|---|---|
| West Bengal | -23.65 | -5.25 |
| Maharashtra | -18.82 | -4.08 |
| Tamil Nadu | -12.20 | -2.57 |
| Madhya Pradesh | -11.09 | -2.32 |
| Odisha | -8.61 | -1.79 |
| Andhra Pradesh | -5.76 | -1.18 |
| Jharkhand | -0.15 | -0.03 |
| Rajasthan | 0.76 | 0.15 |
| Uttar Pradesh | 5.36 | 1.05 |
| Bihar | 19.54 | 3.63 |
| All India | -3.82 | -0.78 |

## 6. Goat Production System in India

India has 2.30% of land area of the world, maintaining nearly 18% of the world's human population and about 20% of the livestock. It is not a mere coincidence that goat are reared in India primarily on waste land. The goats and its products contribute Rs. 38,590 crores annually to the national economy (Table 2). This accounts for 8.4% to total value of output (at current prices) from livestock sector in 2010-11.Goats are bred randomly without considering potential of progeny and breed purity. Landholdings in general have negative association with small ruminant farming. The small size flocks predominately maintained by women becoming common in high crop intensity traditionally occupied by large ruminant. Flocks of large size (50-300) are reducing due to gradually shrinking of grazing land. Large flocks of goats are found either in rain fed or Trans Himalayan zone where abundant waste land is available for grazing. Nearly one third rural population of this region is nomad pastoralists, which is highest in the country. Lack of quality buck and their excessive use is major breeding problem of this region. Population of goat during last one to two decades is increasing in most of the eastern Himalayan regions. In northern arid and semi-arid regions of India goat has critical significance on account of coping up draught as compared to crops and large ruminants. Major forage sources in this region are rangelands, grazing land (common grazing resources, CGR) and post-harvest crop residues. Population of goat is highest in arid and semi-arid regions with maximum biodiversity for genetic resources (60%).There is high competition for feed resources between small ruminants and large one's in this region. Heavy stocking rate is major constraint of this region. In southern arid and semi-arid region goats are kept with sheep in medium size flocks. Goats are maintained mostly on grazing or barren land with acute

feed and fodder shortage in summer. Population of goat is increasing over the periods in southern region. The eastern region comprises of middle and an upper gangetic plain is predominated by high goat population intensity in India. Goat breed mainly reared in this region is Black Bengal which has maximum share to total population of descript breed. Flocks are small and reared under extensive and mixed farming systems. Several management systems of goat are being practiced simultaneously in between and within agro-climatic region which can be described broadly under three systems viz. extensive, semi-intensive and intensive.

# 7. Production System

## 7.1 Extensive system

More than 80% goat population is rear under extensive system. Majority of goat keepers have big knowledge gap and economically poor (unable to provide adequate inputs). The system is based on low resource use thus productivity of goat is low and mortality rates are very high. This system includes nomadic, transhumance, free range, pasture, tethering and range grazing management. Dissemination and adoption of management practices/technologies is low. There is marked fluctuation in feed availability and its nutritive value among different regions, years and seasons therefore productivity of goat also highly varied under this system. Flock sizes varied from small (02) to large (500) and unpaid family member is the main input. Bucks are mostly selected from own flock, mostly non-descript and utilized extensively for long period. Housing is highly inadequate (overcrowded) and improper. Disease incidence and mortality is high (20-60%). Marketing of goat is highly unorganized and heavily exploited by middlemen. Studies have shown that the range grazing cannot support optimum growth and production thus additional supplementation with concentrate mixture (100-200 g/d) and/or leguminous fodders (500 g/d) are recommended for critical production stages and periods. The income under extensive management system ranges from Rs. 2000 to 4000/adult female goat/year. The ratio of profit: cost mostly is 1:5 to 2:1. Critical Gaps of Goat Farming under extensive rearing are summarized in table 4.

**Table 5**. Critical Gaps in Goat Farming in India

| Item (s) | Gap (%) | Normal Value | Base Value |
|---|---|---|---|
| Goat Stoking Rate (goat/hectare) | >400% | 10 | >50 |
| Bucks Availability | 150 | 1:40 | 1:100 |
| Pure-bred pedigreed bucks availability | 450 | 1:40 | 1:300 |
| Kids (< 3 month) mortality | 250 | 10 | 35 |

| Item (s) | Gap (%) | Normal Value | Base Value |
|---|---|---|---|
| Adult mortality | 166 | 7.5 | 20 |
| Fodder (lopped, cultivated etc.) availability (g/goat/day) | 233 | 1000 | 300 |
| Concentrate availability (g/goat/d) | 400-500 | 200-300 | 25-50 |
| Body weight at 12 month (kg) in medium size north temperate region | 33 | 20 | 15 |
| Body weight at 12 month (kg) in medium-large size north-western region goats | 39 | 25 | 18 |
| Body weight at 12 month (kg) in medium size southern region goats | 38 | 22 | 16 |
| Body weight at 9 month (kg) in east and north eastern region goats | 57 | 11 | 7 |
| Milk yield (kg/lac/goat) in medium size north temperate region | 50 | 60 | 40 |
| Milk yield (kg/lac/goat) in medium size north and western region goats | 71 | 120 | 70 |
| Milk yield (kg/lactation/goat) in medium size southern region goats | 50 | 90 | 60 |
| Milk yield (kg/lac/goat) in small size eastern and north-eastern region goats | 150 | 25 | 10 |
| Vaccination against infectious diseases | 900 | 100 | 10 |
| Deworming against endo-parasites | 900 | 100 | 10 |
| Services for treatment against ailment | 500 | 60 | 10 |
| Profit/adult female goat per year with (zero-input) and strategic input | 72 | 4300 | 2500 |
| Profit/adult female goat per year with and adequate input and support services | 100 | 5000 | 2500 |

## 7.2 Semi-intensive system

It is a combination of limited free range grazing and feeding in stalls. The animals are grazed for 4-5 hours and supplemented with kitchen wastes, concentrate mixtures, crop residues green, dry fodders and tree leaves etc. The level of nutrition is optimum. Substantial improvement in weight gain, prolificacy, milk yield, wool yield, quantity and quality of meat production can be achieved by supplementing with concentrate mixtures and leguminous fodders/ tree leaves. Results obtained from commercial goat farming indicated that income under semi-intensive management system supported by smart marketing ranges from Rs. 5000 to 8000/adult female goat/year. The ratio of profit: cost varied from 2:5 to 3.5:1 under this system.

### 7.3 Intensive system

The intensive system of small ruminant includes grazing on developed pastures and/or feeding completely in stalls on cultivated fresh or conserved fodders, crop residues and concentrates, adequate housing and health coverage. This system is becoming popular now a day and suitable for those locations where sufficient land is constraint and grazing land is not available. Selection or suitability of breeds is important criteria for this system. The total confinement of goat in stalls however, proved to be detrimental some times. In India the intensive system is mostly practiced by those goat keepers who raise goats (male) for sacrifices (Eid) under which they provide concentrate rich in protein. The profit from this system is almost similar to semi-intensive system. This system is profitable when feed, fodder, labour cheap, health services and housing ensured and access of good market for goat and goat products is available. The feed requirement (dry matter) of goats should be provided 1/3$^{rd}$ by concentrate and 2/3$^{rd}$ by roughages (preferably 60% green and 40% straws). This system is objective oriented and more suitable for fattening of kids at 3-9 months of age to harvest maximum feed conversion efficiency.

## 8. Goat Value Chain and Marketing Channels for Goats

A goat value chain is a network of firms engaged in buying and selling of the goats to supply a milk/meat or services to final consumers. Simply, it's a journey from farm to plate. Under value chain, it is explored that how poor goat farmers may improve their income and suggests changes in existing value chain's structure for better price realization. Moreover, it is a set of activities required to bring goats and their products (milk and meat) from different stages of production to ultimate consumer. Goat markets in India are highly unorganized and one of the most unexplored areas. Documentation on number of goat markets, fair/hats and their frequencies, status of buyers and sellers, integration between the markets, volume of trade, nature of competition, role of middlemen and finance hardly been attempted. In most of the places, goat and sheep are traded in the cattle/goat fairs organized at conventional places through market committee at fixed intervals. A large part of the consumer's costs are due to inefficient slaughter operations and high transportation costs. Understanding the market and preparing itself to respond to emerging market trends would be the prime instrument for enhancing the domestic livelihood opportunities in the small ruminant sector. There is an absolute necessity for market oriented goat production system and integration of small scale producers on the supply chain.

### 8.1 Existing marketing channels for goats

- Farmer cum goat keeper- farmer
- Farmer- itinerant trader- farmers
- Farmer- itinerant trader- butcher
- Farmer- butcher
- Farmer- local trader-wholesale trader

## 9. Status of Goat Diseases in India

Diseases still persist to be a main hurdle in profitable livestock enterprise, which need a meticulous attention over control of such economical clinical maladies. Goat production is facing diverse challenge and multiple constraints necessitating continued research efforts and development of cost effective interventions/ technologies. Emergence and re-emergence of diseases lead to considerable economic losses, therefore, their control is of paramount importance in present era of bio-security and food safety. Goat is considered as most acclimatized in diverse climatic condition, but there are some diseases imposing serious economic losses to goat farmers. Neonatal mortality is vital to the profitability of goat husbandry and is critical for the optimum growth of small ruminants in the country. Several studies have shown that on an average 20% of the kids are lost every year, based on this mortality rate, the estimated total deaths would be around 10-12 million kids each year. *Colibacillosis* and septicemia generally taken as the most common cause of mortality in juvenile kids in India along with other infectious organism like *Cryptosporidium* spp., rotavirus, *Clostridium perfringens* and *Salmonella* species. In growing kids particularly under intensive management, enterotoxemia caused by *Clostridium perfringens* is very common and case fatality is very high. In growing kids, reared under organized intensive rearing coccidiosis is a serious problem. Oocyst positivity in goats ranges 60-90 %; however, mortality ranges 10-20% but affected kids are left as stunted / poor body weight gainer, which renders them less profitable enterprise. Among infectious diseases, Peste des petits ruminants (PPR) is most important and reported from all parts of country, except Andaman & Nicobar island. Most outbreaks occurs after transportation of unvaccinated goat, resulting a severe set-back to central /State sponsored programme on improvement livelihood security through goat distribution to poor farmers. Continuous PPR vaccination had resulted in decline in the occurrence of the disease. Goat pox is a serious disease with high mortality rate of 50-60%, characterized by skin eruption on whole body and pneumonia. In India, goat pox is frequently observed in West Bengal, Bihar, Maharastra, Orissa, Rajasthan, Jharkhand, Chattishgarh and adjoining areas of these states. FMD impose considerable economic losses due to

reduction of milk, meat, and kid mortality. In India, type O, A, and Asia-1 have been found prevalent in goats. Paratuberculosis (Johne's disease) is one of the most important chronic wasting diseases of adult goat, especially in intensively managed goat farm. This can be managed by meticulous nutritional management and vaccination. The prevalence rate of brucellosis, reported in goat varies from 5-15 % and higher rate in organised farming system and need awareness in goat farmers, being potential zoonotic diseases. Among nematodes *Haemonchus contortus* is most important and widely prevalent in goats, causing severe anaemia due to voracious blood sucking nature of parasite. *Trichostrongylus columbriformis* and *cooperia* sp are also bloodsuckers that penetrate deep into the mucosa. Main symptoms include diarrhoea, loss of appetite, and emaciation. Small intestine is also affected with *Strongyloides papillosus, Nematodirus sp, Bunostomum trignocephalum and Gaigeria pachyscelis*. Control of goat diseases, mainly PPR, ET, Goat Pox, FMD, ecto and endo parasitic diseases are important in all system of management, health management assumes prime importance in the crucial time of shifting of animal agriculture from extensive to intensive i.e. commercial system of management in country. Strategic control and eradication of economically important diseases will result in enhancing goat production in the country.

## 10. Goat Genetic Resources of India

India is rich source in goat genetic resources as 28 breeds with great diversity. These genetic resources possess potential for production of meat, milk, fiber, delicate skins and climatic resilience. All these 28Indian goat breeds are great performer in their habitat under adequate feeding and bear great degree of resistance for disease and climatic fluctuations. Some of the breeds show overlapping characteristics which might be due to intermixing among the breeds in a region (s) where two or more breeds exist. Indigenous goat breeds, however, low in production potential because (a) these breeds were subjected to selection in the past for adaptability to the climatic stress and tropical diseases, rather than improving the genetic production potentials for production (b) poor expression of their production potential due to in-adequate feed, fodder, housing, health measures and harsh climatic conditions (c) lack of long term structured field genetic improvement programmes.

The goat breeds on the basis of broad agro-climatic regions are described though systemic studies breeds under optimum feeding and management conditions are lacking.

## 10.1 Northern temperate region

Chegu, Changthangi, Gaddi and Pantja are the important breeds of the region. Chegu and Changthangi are distributed in northern upper Himalaya region (Laddakh and Kashmir) above 3500 msl, are medium in size and produce finest quality of under coat hair called 'Cashmere' or 'Pashmina' beside quality meat. Pashmina is highly heritable economic trait with heritability ranging from 0.12 to 0.91 and fineness of pashmina fibre of Changthangi breed is similar to Soviet Down and Chinese Cashmerer. Therefore, genetic potential of mountain goats were raised by selective breeding at upside (Jammu and Kashmir) for Changthangi and regional station of IVRI at Mukteshwar for Chegu goats. The pashmina yield ranged from 60-80 g at one year of age in Chegu goats which increases to 125-200 g at 4 years of age, whereas in Changthangi it increases from 70-120 g at one year of age to 200-275 g at 4 years of age. Rearing of mountain goats at lower altitude resulted in declined quality and quantity. It was recommended to enhance the pashmina yield through selection without compromising fibre fineness. The production level of Chegu is lower than Changthangi. Pashmina breeds are confined to the cold-arid region of the country at an altitude above 4000 meters in the Himalayas. Prolificacy, milk yield and body growth rate however is low, attributed mainly to very harsh climate, almost no housing and health care and severe scarcity of feed. Gaddi is habitat of medium Himalaya region (Jammu, Himachal and Uttrakhand) medium in size, produce coarse fibre beside chevon and milk. Pantja is recently developed goat breed by GBPUA&T, Pantnagar. These goats are found in lower regions and foothills of Uttrakhand. It is a medium size breed with good prolificacy (40% multiple birth).Average carcass weight and dressing percentage of these breeds is 8-12 kg and 45-52%.

## 10.2 North-western region

This region has maximum caprine biodiversity with 11 breeds i.e. Beetal, Jamunapari, Barbari, Sirohi, Marwari, Jakhrana, Surti, Gohilwadi, Kutchi, Zalawadi, Mehsana. These goats are medium to large in body size, dual purpose with special attribute of higher milk yield (150-350 liter/lactation). Body weight at 12 month (20-40 kg), Prolificacy (liter size 1.3 to 1.7) and kidding rate (1.3 to 1.6) of breeds of this region is also moderate to high. The goats of north-western region have potential to be developed as dairy goat and nay play great role in sustainable nutritional security of poor people. Many breeds (Beetal, Jamunapari, Sirohi, Zakhrana, Barbari etc.) are candidate breed for grading up of non-descript goat of arid and semi-arid regions of India.Large size breeds have potential to attain 19-23 kg body weight at 6 months of age. Goats of this region have potential to attain 40-50

kg weight at one year of age under high input management. Barbari is one of most recognized breed of semi-arid northern region and occupied very important place among commercial goat farmers due to its suitability and performance under intensive/stall feeding. Similarly, Sirohi has become National breed among goat farmers who rear them extensive or partial semi-intensive feeding management. This is due to its ability to perform under scarce grazing and ability to move long in search of biomass and climatic resistance. Average carcass weight of these breeds is about 12-18 kg with an average of 14.0 kg. Dressing percentage of these breeds varies from 48-56%.Heritability of milk yield of these goat breeds estimated at institute farms were 0.2-0.4.

Studies on crossbreeding in goats for improvement in milk production were mainly initiated in 1972 under the AICRP on Goats at few organized farms. Alpine, Saanen, Anglo-Nubian and Toggenburg were used as exotic dairy breeds whereas; Beetal, Malabari and Sirohi were mostly used as indigenous breeds. The advantages in milk improvement through exotic crosses were discounted by abysmally high mortality and low fertility. The depression in performance was primarily ascribed to climatic stress and subsistence management conditions. However, no crossbreeding program in goats was initiated officially for enhancing potential of Indian goat for meat production.

## 10.3 Southern region

Goats in the Southern and Peninsular part of the country, though of dual utility but low in milk yield as compared to goats of north-western region and possess better traits for meat breed. Sangamneri, Osmanabadi, Kanna-aidu, Kodi-adu, Malabari, Konkan Kanyal, Berari, Teressa and Black Attapady are the main goat breeds of the region. These goats possess good ability for prolificacy (40-80%). Goat breeds of southern region attain body weight of 20-28 kg at 12 months of age under semi intensive and 25-34 kg under intensive feeding. The milk yield of southern goat breeds is low in comparison to western breeds. However, Sangamneri and Malabari breeds yield 80-120 litres of milk/lactation. Breeds of southern region have lactation length of 60-100 days. Heritability of milk yield of different goat breeds were moderate i.e. 0.2-0.3.

## 10.4 Eastern region

Black Bengal is main breed of eastern region of India. It is a dwarf size meat goat breed and has great recognition for prolificacy (>80% females produces multiple birth), skin and carcass qualities however, low in milk yield. Body weight at 12 month varies from 10-22 kg thus bear great scope of improvement through selection. Main goat of eastern region (Black Bengal)

is dwarf breed with 10-14 kg body weight at 12 months. Dressing percentage of Black Bengal varies from 42-48%. Ganjam,Salem Blackand Sumi-Neare other localized meat breeds of this region. These goats have great value for climatic resistance, rear on low quality community grazing resources thus low in milk, growth rate and prolificacy. The goat breeds of eastern region have low potential for milk yield (35-60 litres).

Goat breeds according their major function are classified as:

**Milk:** 1. Beetal, 2.Jamunapari, 3. Jakhrana 4. Surti

**Meat:** 1.Barbari 2. Black Bengal 3. Gaddi 4. Ganjan 5. Gohilwadi, 6.Kannai-Adu 7.Kutchi 8. Malabari 9. Marwari 10. Mehsana 11. Osmanabadi 12. Sirohi 13. Sangamneri 14. Zalawadi 15. Black Attapady 16. Konkan Kanyal 17. Pantja 18. Teressa19.Kodi-Adu20. Ganjam21.Sumi-Ne. 22. Salem Black

**Fiber:** 1.Changthangi 2.Chegu 3.Gadddi

## 10.5 Threatened goats breeds

A breed classified as endangered is dependent upon number of factors i.e. the actual number of animals, the rate of decline in the population size, the closeness of relationship between individuals within the population, the geographical range and the rate of reduction of that range, special threats from introduced species, rapid changes in the environmental conditions, predators and parasites (Hensen, 1992). As per FAO a goat breed will be included in threatened category if there are less than 500 breeding females and four or less distinct male lines as defined. Breeds were listed if there were less than 500 breeding females. Rich caprine diversity of India has been in danger and mainly attributed to indiscriminate cross-breeding on account of sale/castration of superior male, lack of clearly defined breeding policy and it's faulty implementation, poor adoption of improved management practices, degraded eco-system and lack of marketing infrastructure. Due to above said reasons not only population of many well-known goat breeds (Jamunapari, Beetal, Surti, Barbari, Changthangi, Sangamneri) but also their genetic variability, adaptability for climatic fluctuations and productivity etc. has been declining. Goat breeds mentioned are vulnerable to the extent that either the populations are declining numerically or their security is in danger.

The well recognized breeds of goats surprisingly facing a greater threat of endanger ness mainly due to improvement of goat increasingly emphasized the development of few breeds at the expense of others, changes in rearing objective i.e. during last 2-3 decades goat rearing for milk has been given low attention by goat keepers, sale of high potential goats without their replacement i.e. in many breeds such as Jamunapari, Jakhrana, Barbari the

high producing goats (male and female) were purchased by traders for commercial farming in a region which was not suitable for that particular breed resulted in loss of introduced genotype and also created scarcity of improved animals for multiplication in their respective home-tract. Castration of superior male for slaughter left inferior and impure male to breed the females which has been resulting in negative genetic contribution in productivity, thus reduces profit and population size of a goat breed. Dilution of breeds has emerged a bigger threat in India and pushing many important goat breeds in endangerment such as Barbari, Jamunapari, Sangamneri, Beetal, Surti has been diluting by Sirohi and many lesser known goat strains such as Sojat, Totapari etc. So, besides decline in population size purity level of many breeds has also jeopardized.

The International Union for Conservation of Nature (IUCN) has classified the animals in to seven categories on the basis of their viability as (a) Extinct, (b) Endangered (c) Vulnerable (d) Rare (e) Intermediate (f) Insufficiently known and (g) Out of danger. Threatened goat breeds in India are falls under two categories i.e. endangered and vulnerable. A breed is considered as endangered, when the effective population size is too small to prevent genetic loss through inbreeding leading to infertility and lack of survivability resulting in ultimate loss of the population. According to FAO, a breed with a population size of 5000 breeding females or less can be an endangered breed. However, the need for conservation depends upon several factors e.g. (i) rate of decline in the population size (ii) closeness of relationship between individuals within the population (iv) sex ratio (v) geographical range and its rate of reduction (vi) special threats from introduced breed/species (vii) rapid changes in the environmental conditions (viii) predators, parasites, disease etc. A breed is vulnerable, when the population is rapidly declining numerically or its security is under threat.

## 10.6 Approach and mechanism of conservation

If the breeds are disappearing in its natural habitat then action to conserve the breed should be taken immediately. The following information (estimate) is necessary in planning conservation strategy.

- Descriptive information on breeds, production characteristics and distribution/location.
- Breed population dynamics.
- Rate of breed dilution/introgression.
- Health risk status, epidemics and endemic diseases.
- Estimate the other risks and natural calamity.

The mechanism for the conservation is dependent upon rate of genetic loss and the increase in homozygosity. The increase in homozygosity within a small population causes the loss of ability to adapt, inbreeding depression and extinction. The maintenance of diversity in a population depends on founder population and effective population size. The population size, birth and survival rates, sex ratio and levels of variation must be taken into account before deciding the conservation approach and strategy. Two major approaches *Ex-situ* and *In-situ* have been used for conserving the goat population in India.

*In situ:* The maintaining animal in its natural habitat or in their adaptive environment as close as possible is called *in-situ* conservation.

*Ex Situ*: It is the storage of animal genetic resources, which farmers are not currently using in field condition. It includes cryogenic preservation and maintenance of breeds of domesticated animals in farms, zoos and other location away from its home tract. It is the preservation of semen, ova or embryos, DNA segments in frozen blood or other tissues. Both *in-situ* and *ex -situ* methods are equally important for conserving Indian goats.

## 11. Breeding Policy for Goat Improvement and Conservation

- Selective breeding and grading up are major breeding approach and may be implemented through nucleus schemes. Up gradation of huge non-descript goat population by improver breed should be seriously implemented. There should be clearly described breeding policy for each breed in every states/regions/farming system.
- Evaluation of goat genetic resources with respect to production environment, production attributes, genetic architecture and for end use suitability and, establishment of Inventory of important breed.

## 12. Goat Improvement Programmes in India along with cross-breeding experiences

During pre-independence period few missionaries, voluntary and non-governmental organizations undertook the sporadic developmental work in some pockets of the country and introduced Swiss-Alpine, Israel-Saanen and Boer goats; mainly in Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Himachal Pradesh and Jammu & Kashmir. In 1939, a goat improvement programme was taken up at the government livestock farm, Hissar to improve milk production through selection in Beetal goats. Some work on goat development just after independence was also carried out at RBS College, Bichpuri, Agra involving Beetal, Jamunapari, Black Bengal and Sirohi (Singh and Sengar 1990). Later on, few missionary/voluntary and

NGOs undertaken goat development by crossbreeding local goats with Saanen, Alpine, Anglo-Nubian, Toggenburg and Boer.

**12.1 Indo-Swiss Goat Development and Fodder Production Project (ISGP)** was started in 1981 in Rajasthan, with the objective of improving goat production through genetic improvement, fodder production and creating marketing infrastructure. Bucks of Alpine and Toggenburg exotic breeds were used to improve milk yield. The milk yield of cross-bred goats was slightly higher (23%) than the Sirohi but with lower kidding (69%) in crossbred as compared to Sirohi goats (Kropf et al., 1992). The 60 and 180-day lactation milk yield was recorded as 90±29.7 and 245.3±74.2 kg (de Groot et al., 1992). Based on above results genetic improvement through selective breeding was followed. Results revealed that that 35% of the lactations produced more than 300 kg and 9% produced more than 400 kg milk yield with overall average of 269 kg. These findings provided concrete information about the importance and potential of Sirohi goat for its adaptability, performance and as tool for livelihood security of poor people. These goats also got recognition as an improver goat breed for harsh climatic conditions particularly for semi-arid conditions. A milk recording and buck rearing scheme' was introduced in 1989. Buck kids from does with 180-day lactation yields of > 300 kg were identified at 2–3 months age as potential breeding bucks and were purchased by ISGP at the age of one year. This project was operated in 146 villages, with 677 goat keepers and 564 'poorest of the poor' goat keepers owning about 18,000 breedable does. The project was terminated in 1992 with improvement models for genetics and extension programmes.

Under five year plan in the year 1971's ICAR through its network programme to achieve rapid increase of genetic potential of indigenous goat for improved milk, meat and mohair yield by cross-breeding indigenous breeds with high yielding exotic breeds (milk and mohair) and other better-producing indigenous breeds for meat component. Alpine, Saanen, Anglo-Nubian and Toggenburg were identified as exotic dairy breeds whereas; Beetal and Malabari goats as indigenous breeds for enhancing milk potential by crossbreeding. Gaddi and Sangamneri were used as native breed and Russian Angora as exotic breed of goats for mohair. Major objective of crossbreeding of Indian goats with exotic breeds was to rapidly evolve new breeds of milch goat suitable to the local agro-climatic conditions and capable of yielding at least 300 kg in a lactation period of 150 days. The experiment (for milk) was started at NDRI, Karnal in 1971 using Beetal and Alpine and Saanen as improver exotic breed. Similarly another unit was set up at KAU, Trichur in 1972. Malabari goat breed were used as dam and Alpine and Saanen as improver exotic breeds.

## 12.2 Salient achievements

Different genetic combinations of Alpine, Saanen and Beetal with various levels of exotic genes were generated and tested for their comparative performance. The Saanen x Beetal crosses with 75% of exotic inheritance was the best having an average yield of 399.1±34.0 kg. Saanen x Malabari and Alpine x Malabari crosses were found to be superior to pure-bred Malabari in growth, survival, milk yield, fecundity and feed conversion efficiency. The Saanen x Malabari had an average lactation yield of 211.5 kg in 200 days, which was 147% higher than contemporary pure-bred Malabari goats. The Saanen x Malabari crosses were found more suitable to the local agro-climatic conditions of Kerala and recorded enhancement in milk yield by 200%. Crossbreeding with exotic breeds has resulted in enhancement in milk production by 200%. The crossbreeding with Beetal and Malabari project was terminated in 1985 and 1989 respectively, because it also results in high mortality and low fertility. The depression in performance was primarily ascribed to climatic stress and subsistence management conditions. Apart from lower adaptability and higher mortality among the crossbreds, the prices fetched by goat milk were also a disadvantage resulting into disinterest of clients. Experiences have revealed that breed substitution of temperate region found to be invariably unsuccessful and unsustainable in the long term.

## 12.3 Fibre component

AICRP on goats for mohair production was started in 1972 at Mahatma Phule Krishi Vidyapeeth in Rahuri, Maharashtra with the objective to evolve a mohair breed of goat attaining an average body weight of 30 kg at 3 years of age and producing 2 kg of mohair per year with an average fibre diameter of 30 microns and staple length of 10 cm and suitable for local agro-climatic conditions. For crossing, Gaddi and Sangamneri were used as native breeds and Russian Angora as exotic breed of goat. The 7/8 Angora had superior mohair yield and quality compared to other genotypes although its reproductive efficiency was poor. Therefore, Reciprocal cross-breeding of 3/4 Angora and 7/8 Angora was done. Commercialization of mohair production among farmers was very low due to less quantity of mohair yield. The quality and yield of 7/8 Angora was a good. Angora crosses with Gaddi and Sangamneri did not succeed because the mohair production was not obtained until the Angora blood was increased to 87%. Higher grade of Angora showed poor feed conversion efficiency and low reproductive traits. The project was terminated 7$^{th}$ plan (1992–97) due to high mortality and no market value for mohair.

## 12.4 Crossbreeding of local with Indian improver breed

Crossbreeding experiments, especially using exotic strains did not yield very encouraging results either for meat and milk production. It was felt that improvement in indigenous breeds, well adapted to field conditions should be started through selection within the breed. AICRP on goat set up three farms of Black Bengal in 1976 at BAU, Ranchi, Assam local goat in 1977 at AAU, Bernihat and Shingari in 1983 at Jorethang Sikkim with goal to evolve meat goat breeds, suitable to the local agro-climatic conditions and capable of attaining 15 kg body weight at 6 months age under intensive feeding. The Jamunapari and Beetal were used as improver breed and diallel crossing of Jamunapari, Beetal, Barbari and Black Bengal indicated Jamunapari was the best improver breed for milk yield and Beetal for carcass and reproductive traits. Beetal was found to be better improver goat over Jamunapari due to its better adaptability and reproductive performance. However, crosses of Jamunapari and Shingari were better than Beetal in Sikkim. The body weights single born male kids of Beetal and Jamunapari were 13.30 and 15.66 kg, respectively at 6 months of age. The crossbreeding resulted in to improved performance of Shingari goats. Experiments carried out by involving Black Bengal and Jamunapari Crosses revealed that selective breeding with in Black Bengal was more appropriate for live weight gain and improved carcass value. The crossbreds were superior with respect to body weight at early ages, kidding efficiency, multiple births (%), feed efficiency and dressing percentage. However, age at first kidding and mortality was substantially high in crossbred therefore project was closed in 9$^{th}$ plan with the recommendation that Beetal could be used as an improver breed in the Chhotanagpur plateau region. The AICRP on goat at CSWRI, Avikanagar, was started in 1976 to study purebred performance of important indigenous breeds viz. Sirohi, Marwari and Kutchi of north-western region under semi-intensive and intensive feeding system. Six-month body weight of Sirohi, Marwari and Kutchi male kids were 26.4, 24.7 and 25.4 kg, respectively under intensive feeding however, highest feed conversion ratio was achieved in Sirohi followed by Kutchi and Marwari. Performance of all the three breeds was good under semi-arid agro-climatic conditions of Rajasthan. The AICRP on Goats for milk at R.A.U., Bikaner was initiated in 1987 (7$^{th}$ five year plan) for improvement of milk production in Jakhrana goats through selection. However, later on Marwari was opted for meat and milk production to bring upon improvement in the farmer's flock.

## 12.5 Current major programme (All India coordinated research project goat Improvement)

AICRP on goat improvement is a long term, multi-disciplinary, structured programme operating in consortia mode to bringing upon genetic

improvement and conservation of goat genetic resources of the country in their native tracts. The present approach for improvement being adopted is out crossing (selective breeding). The major traits of goat improvement are body weight, weight gain, milk yield, fibre yield, reproduction rate (prolificacy, kidding percentage, fecundity), adaptability, survivability, production life and profit. The programme explores genetic variations in local breeds by supporting technological interventions and financial assistance for systematic animal identification, pedigree and performance recording, preventive health care, selecting superior goats on the basis of performance for multiplication, development and transfer of technologies, capacity building of goat farmers and creating marketing infrastructure. Under 12$^{th}$ plan large weightage has been given through linkage development with state livestock development agencies, NGO's and Farmers for breed based genetic improvement for sustainable livelihood and feed security of poor goat keepers. Improvement and conservation of goat resources/breeds of different regions is focused in farmers flock through establishing breed societies, cooperatives multiplier flocks, strengthening marketing structure and capacity building of goat farmers. Presently, thirteen breeds and five locally adaptive and lesser known genetic groups are covered through eighteen centers across the country. All the centers are solely concentrating in improvement of villagers goat flocks predominated in tribal and disadvantageous regions of the country.

**Table 6.** Breeds under AICRP goat improvement programme along with location

| Sl. No. | Name of the centers | Breed | Purpose | Starting date |
|---|---|---|---|---|
| 1 | C.I.R.G., Makhdoom (U P) | Jamunapari | Milk &Meat | 1993 |
| 2 | C.I.R.G., Makhdoom (U P) | Barbari | Meat & Milk | 1993 |
| 3 | CSWRI, Avikanagar (Raj) | Sirohi | Meat & Milk | 1993 |
| 4 | RUV&AS, Bikaner (Raj) | Marwari | Meat | 1993 |
| 5 | WBUV&FS, Kolkata | Black Bengal | Meat | 1997 |
| 6 | OUA&T, Bhubaneshwar | Ganjam | Meat | 1997 |
| 7 | MPKV, Rahuri (MH) | Sangamneri | Meat | 1997 |
| 8 | G.A.U., Navsari (Gujarat.) | Surti | Milk & Meat | 1997 |
| 9 | KV&ASU, Thrissur (Kerala) | Malabari | Meat & Milk | 1997 |
| 10 | RUV&AS, Vallabhnagar (Raj.) | Sirohi | Meat & Milk | 1997 |

| | | | | |
|---|---|---|---|---|
| 11 | NARI, Phalton (MH) | Osmanabadi | Meat | 2009 |
| 12 | HPKVV, Palampur (HP) | Gaddi | Fiber & Meat | 2009 |
| 13 | BAU Ranchi (JHK) | Black Bengal | Meat | 2009 |
| 14 | AAU,Burnihat | Assam Hill | Meat | 2009 |
| 15 | IVRI Campus, Mukteswar | Himalyan Goat | Meat | 2014 |
| 16 | SKUAST-K Leh, J&K | Changthangi | Pashmina & Meat | 2014 |
| 17 | GBPUA&T, Pantnagar (Uttrakhand) | Pantja | Meat | 2014 |
| 18 | CARI, Port Blair | Andmani | Meat | 2014 |

## 12.6 Impact of AICRP on goat improvement and conservation

- Identification of pure-bred 1500-3000 goats of each breed in farm/farmers flocks.
- About 15000 superior goats of different goat breeds were supplied to farmers and development agencies for improvement and conservation.
- Development of low cost technologies, improved management practices, value added products and by-products for different breeds/region.
- Significant increase has recorded in population size of several threatened goat breeds.
- Establishment of goat based agri- business, livelihood and breed conservation models.
- Significant improvement in body weight (19- 43%), milk yield (12-32%), prolificacy (11-29%), kidding rate (15-40) and survivability (up to 200%).
- Created infrastructure and designed road-map for livestock improvement in general and goat in particular.
- The income of goat keepers at different locations in the country has increased up to 300% annually through scientific goat rearing under AICRP.
- Programme has improved capacity and skill of more than 10000 people across the states.

## 13 Constraints of Goat Production in India

- Inefficient and inappropriate production system (extensive-zero-input).
- Prevalence of non-descript or poor genetic-make-up of animals, and lack of organized breeding programmes. Scarcity of superior bucks is causing indiscriminate breeding, breed dilution and almost nil genetic improvement.
- Scarcities of feed-fodder: Under feeding of goats deteriorate the production and immunity animals and made them vulnerable for diseases. Costs of feed ingredients are also high. During last few decades' flock sizes have been reducing due to shrinkage of common grazing resources and deficiency of biomass in rangelands. During draught or flood the availability of biomass from CPR reduces from 3.5 t/ha to 0.5 t/ha per year.
- Large knowledge gap on improved/strategic management practices and technologies.
- Inadequate space and improper housing of goats. Goats were housed predominately in human dwelling and in open under enclosures made up bush (50-55%). Moreover, houses are not properly ventilated and cleaned, heavily reduces productivity and survival of goats.
- Less availability of veterinary services, breeding buck or artificial insemination and institutional credit.
- High mortality of kids (30-50%) and adult goats (15-30%) on account of inadequate prophylactic measures.
- Inadequate goat based specialized and integrated livelihood and business models suitable for different agro-climatic conditions and diversified farming systems.
- Unorganized marketing, lack of co-operatives/producers' associations/companies. Distress sale of goat due to very urgent natures of domestic needs and thus farmers realized lesser share of income. Thus goat keepers get much less price of their goats and goat products.
- Less efforts to popularize nutritive and medicinal properties of goat milk and meat in mass resulting in less price and profit to goat farmers

## 14 Challenges of Goat Farmers under Prevailing Production System

- Acceleration and enhancement of goat productivity and profit on limited resources through genetic potential improvement, technological interventions and value addition of goat products.
- Breeding male (Buck keeping): Goat keepers are unwilling to keep bucks due to fear of increase in rearing cost and difficulty in handling/ management.
- Potential evaluation of about 70% non-descript goat population.
- Perfection in artificial insemination with frozen semen technology and it's popularization.
- Minimization of uncontrolled slaughter and sale of high potential male to conserve potent breeds and to check sudden demand.
- Establishment of buck Mother Farms. There is urgent need to establish buck mother farms of potential breeds on ONBS model to supply superior bucks to farmers.
- Reduction in feed and fodder cost as expenditure on feed and fodder account for more than 60% of recurring cost. Technologies for improving utilization of perennial grass, low quality forage, feed, agricultural and industrial waste. It will be key factor in replacing extensive management with semi-intensive or intensive management.
- Mechanism, rule and regulations needs to form to minimize depletion of grazing resources and uncontrolled grazing and high stocking rate.
- Capacity building of uneducated traditional 30 million goat keepers. Lack of well trained and exposed trainer. Moreover goat keepers (Men and women) are not ready to pay and willing to leave their animals and houses.
- Development of low cost goat shelter and house models suitable for different agro-climatic regions, farming systems under traditional and commercial farming**.**
- Monitoring and surveillance of important goat disease and effective utilization of veterinary (health services) staff, facility, infrastructure, medicines support to goat farmers for prevention of goat diseases.
- Development of dairy goat (3.0 liter milk/ day) for ensuring nutritional security of poor rural people and for marketable products.
- Institutional credit to goat keepers with simple process.
- Effect of climate change on goat productivity, survivability and profit.
- Linking production, products and by- products to market.

# 15 Strategies for Improving Goat Productivity for Sustainable Livelihood Security

Goat based integrated and specialized farming may play lead role in transferring package of technologies and for improving income as it has scope to resolve the multiple challenges of livelihood, nutrition and employment of farmers.The extent to which goat keepers will be benefited will mainly depends at what rate and magnitude semi-intensive and intensive system replace largely followed extensive management system, access to technology, development of market, institutional credit and efficiency production resource utilization.Technologies to improve productivity of goat do exist, however, the awareness and rate of adoption is consistently low, because of the existing extension set up, infrastructure etc. To improve sustainable income of goat keepers there is a necessity to launch short-term and long term improvement-cum development programme in different regions/state/breed as per the requirement.

## 15.1 Short-term measures and programmes

Promoting semi-intensive or strategic feeding management System: Goat keepers (>95%) rear their goat on zero input and earn average profit of Rs. 12500/year from a unit of five adult females. The profit from five goats becomes double or more than that i.e. Rs. 25000 by shifting goat management from extensive to semi-intensive or intensive management. The same is elaborated along with impact in table 5:

**Table 7**. Case study on profit of Barbari goats under extensive and strategic management system

| Character | Performance of goats in extensive management | Performance of goat with strategic interventions |
|---|---|---|
| Kids mortality | 25% | <8% |
| Adult goat mortality | 15% | <5% |
| Lactation period | 65 days | 110 days |
| Lactation milk yield | 40 Liter | 65 Litre |
| Body wet at one year | 16 kg | 22 kg |
| Kidding interval (KI) | 12 month | 8 month |
| Age at first kidding (AFC) | 18 month | 14 months |
| Multiple birth (%) | 40% | 65% |
| Increase in number of kids/year/goat due to decrease in AFC and KI and increased multiple birth with 5 female | 6 kids | 9 kids |

| Character | Performance of goats in extensive management | Performance of goat with strategic interventions |
|---|---|---|
| Number of surplus kids/year (assuming average adult flock size of 5 and 25% kids mortality in Extensive management and 7% with strategic management) | 07 | 11 |
| Net income/goat/year due to increased productivity (body weight, milk yield, kidding rate, Saving due to reduction in age at first kidding, kidding interval) and survivability.<br>1. Kids for sale increased from 7 to 11<br>2. Weight increased from 16 kg to 22 kg /goat.<br>3. Surplus milk 25 kg @ Rs. 25.<br>4. Survival of adult goat.<br>5. Declined feed, labour cost due to decrease in AFC, KI | Rs.3000 | Rs.5000 |
| Income from surplus milk/adult goat/year | Nil | 625 |
| Manure @Rs. 1/goat/day | 4300 | 5840 |
| Income from sale of male @ Rs. 4500 under EMS Income from sale of male @ Rs. 6000 under SIM on account of higher weight (6 kg) | 35000 | 66000 |
| Survival of adult goat (0.6) | - | 3000 |
| Saving of feed and labour on account of reduction in AFK, Kidding Interval | - | 5000 |
| Book value of 5 adult goats | 25000 | 30000 |
| Cost/goat/year @ Rs. 1550 goat/year (5 adult+7 kid) in EMS (labour, health etc) Additional cost @ Rs. 3000/goat (feed, health, housing) in strategic Management | 18600 | 48000 |
| Net profit with flock of 05 adult female/year | Rs. 16400 | Rs. 32465 |

Profit per goat under extensive management from one adult Barbari goat is 3280 whereas with strategic feeding support it was Rs. 6493. The profit increased with strategic support on account of Increased body weight (>40%), increased milk yield (80%), increased survivability (50%), increased multiple birth (50%), increase in premium value on account of breed purity (20%) etc.

- 100% timely vaccination of goats against infectious diseases has to be performed in mission mode by each state to achieve quantum jump in profit.
- Well-structured grading up programme with back up of sufficient number of high potential breeding bucks of Improver breeds.
- Capacity building of goat farmers.
- Wide popularization of goat based business and livelihood models.
- Development of feeding resources at village level by improving wasteland and community pastures and, it's judicious utilization.
- Strengthening and regularization of goat marketing structures including Goat Marketing Information System (MIS).
- Sell of high potential males for slaughter should be minimized by making aware farmers.
- Credit process and access should be simplified and made effective particularly for promoting scientific goat production and value addition of goat products.

## 15.2 Long -term measures and programme

### 15.2.1 Development of genetic stock by supply of high potential pure-bred bucks

Selection of breeds adaptable to the existing agro-climatic conditions that can thrive well on un-conventional feed and fodder resources should be given priority in goat based rural development cum breeding programme. There is need to encourage the farmers to breed local non-descript goat with improver breed suitable for that particular region.Upgrading of goats through elite purebred bucks should be seriously implemented. Establishment of Kids nursery farm of improver breeds for regular supply of breeding bucks to goat keepers for improvement in genetic potential of goats is also very important. Government may assist Farmers and NGO's in this endeavour. Impact data of improvement programmes operated in field have indicated that progenies born out from superior bucks yielded 40-75% more production. Kids born from such purebred high potential bucks also fetched 25-40% higher price in market as breed premium.

### 15.2.2 Promotion of prophylactic measures (Goat health calendar)

Goat keepers (>75%) were either not aware or nor adopted vaccination against infectious disease such as Peste des petits ruminants (PPR), goat pox, enterotoxaemia and foot and mouth disease (FMD) are the major diseases of goatsand responsible for high economic losses (30-60% goat mortality). Vaccination and deworming of goats have reduced the mortality (< 10%) thus; increase in the survival of goat has increased the net income of Rs 3500-4500/year with a unit of five goats. It require expenditure of only Rs 300/year on five unit of goats.

### 15.2.3 Green fodder resources

Fodder supplies in villages can be enhanced substantially by increasing the productivity of traditional food and forage crops. Inter-cropping with twin objective, using seed for human and leaves for animals, short duration and quick growing leguminous forage crops should be promoted. Farmers made skilled for collection, processing and storage of fodder resources available in the CPRs during the monsoon for meeting the forage demand during the lean period and their nutritive/value addition. The degraded grazing lands and CPRs should be converted in to productive system like silvi-pastoral. Drought tolerant grasses, shrubs and fodder trees need to be promoted on field bunds. Improvement the natural rangelands, reseeding with perennial grasses (grass yield increase from 1.0 to 4.0 ton per hectare per year), intercropping of legumes, plantation of fodder trees and most importantly judicious utilization of natural resources. Agro-forestry should be popularized among farmers for improving per unit land and enhance fodder availability to animals. Feeding of concentrate ration to small ruminant @ 250 g/day during lactating period and growth increased the milk yield and body weight of kids of goats by 20 to 64%. Semi-intensive feeding system (strategic concentrate feeding) need effective adoption especially during last quarter of pregnancy, first quarter of lactation (60-90d) and post-weaning growth (3-9m).

### 15.2.4 Strengthening of credit, support services and extension network

Credit is very important asset for goat keepers to access technological interventions such as improve housing, purchase of concentrate, quality animals, value added products etc. Financial institute should provide micro-level credits to the farmers at soft rate so that they can afford it. It will encourage goat keepers to switch their goat from extensive (zero-input) to semi-intensive management system and up-scaling the introduced innovations.

### 15.2.5 Motivation and popularization of package of improved management practices

Goat keepers should be made aware for improved management practices such as breeding calendar (optimum age and weight of breeding at first time, season/months of breeding to obtain maximum survival, production and profit, health calendar (schedule of vaccinations and deworming), strategic feeding (efficient use of feed and fodder as per age, sex, productivity) to trigger production and smart marketing for higher prize. Feed supplementation of growing kids with 175 g of concentrate for 180 days may increase 30% of their body weight at 9 months of age. The improved feeding may also affect milk yield of breeding does by improving 50% over the current milk yield. Avoid overcrowding of goats especially in growing kids. Floor should be cleaned regularly and kept dry by proper cleaning of waste materials and adequate sun light exposure. Replace old and caked soil once in every year in March-April with new soil mixed with lime @10kg/$m^3$ of soil. Maintain cleaning of goat house/shelter. Goat sheds should have a provision of open as well covered space. The area of open space is normally double of the covered area. The covered area is utilized mainly to provide the shelter to the animals to protect them from inclement weather. The floor space requirement (closed area ($m^2$)) for 0- 3, 3-6, 6-12 months old goat, adult goats and breeding bucks, pregnant/ lactating goats are 0.20-0.25, 0.50-0.75, 0.75-1.00, 1.50 and 1.5-2.0, respectively.A case study conducted in draught prone Bundelkhand region in 2012-13 revealed that by proper adoption of improved management practices a farmers earned an additional income of Rs. 18348/year over on 5 unit of goat. Goat based interventions also provided employment to the tune average of 182 day/year with 5 goats.

**Table 8.** Impact of improved management practices on income of goat keepers

| Parameter | Before | After |
|---|---|---|
| Adult goat flock size | 5 | 5 |
| Multiple births (%) | 20 | 45 |
| Survivability (%) | 74.5 | 90 |
| Kids available up to one year | 4.2 | 6.5 |
| Body weight at 12 month (kg) | 16.6 | 24.0 |
| Income (Rs.)from sale of kids @ Rs. 160/kg live weight | 10458 | 25056 |
| Total milk yield/goat/year | 49 | 83.5 |
| Surplus milk yield(l)(sold/ consumed) | 3 | 37.5 |
| Income from milk @Rs.20/liter | Fed to kids | 3750 |
| Total gross income (Rs.) | 10458 | 28806 |

| | | |
|---|---|---|
| Operational cost (Rs.) per year | 2092/goat | 5761/goat |
| Net gross income (Rs.) per year | 6758 | 23706 |
| Additional income (Rs.) | - | 18348 |
| Additional income/goat (Rs.) | - | 3670 |
| Net income (Rs.) | 1352 | 4741 |

### 15.2.6 Formulation of farmer's groups, SHGs cooperative, societies for transfer of technology

Such groups should be periodically empowered (credit access, knowledge and incentives).

### 15.2.7 Development of technologies and models for low cost goat houses

Due to scarcity of space and high of inputs/items cost for goat houses there is urgent need to conduct research to build multilayer and low cost houses as most of goat keepers are poor.

### 15.2.8 Manure management

Manure produced from goat is rich source of NPK and has long lasting effect on soil fertility and minimizing soil erosion. Technology pertaining to value addition, storage and utilization of manure should be made available to farmers.

### 15.2.9 Value addition of goat products to increase income and nutrition

Sustained livestock production to provide livelihood and ensure food and nutritional security is dependent on efficient utilization of animal products. Meat and milk producers are in the search of alternative market opportunities. Value-added products have great opportunity. Processing of goat products to value added products can contribute to sustained demand for meat and milk and efficient marketing of these products to earn reasonable returns by farmers. Such added value can be obtained in terms of shelf stability, improved technological functions, better sensory quality or even more convenience. Today's consumers are no longer fully satisfied with the traditional products, rather they look for variety, nutrients and convenient ready-to-eat products. These convenient items are economical and cost-effective and provide options for changes of menu, having better shelf-life and acceptability than traditional products. Value addition of goat products may help farmers to increase their products sell and get more return.

### 15.2.10 Mitigation strategies for climate change

Occurrences of natural calamities at regular interval are outcome of erratic climate changes. It has been decreasing productivity, profit and economic stability of all livestock species including goat. Therefore, it is imperative to modify livestock production system to minimize effects of climate change. More attention is required in selection of hardy/resistance breeds (genetic make-up), housing feed and feeding practices.

## 16 Popularization of Goat Based Business (livelihood) Models with Different Breeds

Recently many educated youth have set–up goat farms on semi-intensive or intensive management. They are getting good regular income with little-bit problems in beginning. Goat farmers of eastern region (Bihar, Bengal, Jharkhand) are switching for northern breed like Barbari, Jamunapari and Sirohi. Many feedbacks have indicated that performance of these northern breed declined up to 35% in hot-humid eastern region climate, Therefore farmers are advised to keep good stock on improved diet. The net profit from different breed in their respective home tract is presented in table4 from data provided by commercial goat keepers.

**Table 9.** Production and economic characteristics of major goat breeds of India

| Sl. No. | Production Characteristics | Barbari | Jamunapari | Sirohi | Black Bengal |
|---|---|---|---|---|---|
| 1 | Suitable climate | Semi-arid | Semi-arid | Semi-arid | Hot-humid |
| 2 | Cost of adult female (Rs.) | 5000 | 8000 | 7000 | 3500 |
| 3 | Age at first kidding (months) | 12-16 | 18-22 | 18-20 | 10-12 |
| 4 | Kidding interval (months) | 9 | 10 | 10 | 8 |
| 5 | Multiple birth (number) | 1.6 | 1.3 | 1.3 | 2.2 |
| 6 | Kids produced in 3 years | 6.4 | 4.7 | 4.7 | 10 |
| 7 | Survival of kids up to 12 months (%) | 92.5 | 92.5 | 92.5 | 80 |
| 8 | Survived kids available in 3 years | 6.4 | 4 | 4 | 8 |
| 9 | Body weight at 12 months (kg) | 22 | 27 | 27 | 16 |
| 10 | Weight delivered/goat/ year | 42 | 38 | 38 | 42 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | Milk yield /goat/year | 80 | 135 | 100 | 30 |
| 12 | Surplus milk /year (liter) | 25 | 78 | 60 | 0 |
| 13 | Income surplus milk | 625 | 1950 | 1500 | - |
| 14 | Maintenance cost of adult female & its kid /year | 4250 | 4550 | 4150 | 3840 |
| 15 | Sale price of kids/year (Rs.) | 8400 | 7300 | 7300 | 8440 |
| 16 | Net profit per goat per year | 4775 | 4700 | 4650 | 4600 |

Note: Productivity and economics are obtained of those goats which are maintained under semi-intensive feeding system where they will be provided about 50% feed-fodder requirement through supplementation and 50% from grazing area. If biomass in grazing areais not available then percentage of supplementary feeding should be increased proportionally.

## 16.1 Goat based business model (sacrificed-eid) under intensive feeding system

Table 8 provides economics of sacrifice goats of Black Bengal, Jamunapari, Sirohi and Barbari. Kids of respective breeds will be procured at the age of 3 months. Quantity of feed intake varied as per age categories. Cost of concentrate, green and dry fodder was Rs.15, Rs. 2 and Rs. 4 per kg, respectively. Annual expenditure on prophylactic measures was incurred as Rs.75/ goat and Rs. 2.5/goat/day was considered as labour cost. Male kids will be retained up to 18 months. The average body weight of Black Bengal, Jamunapari, Sirohi and Barbari was 35, 67, 63 and 52 kg, respectively under intensive-stall feeding. Sale price of goat per kg live weight was Rs. 350 for Black Bengal and Rs. 375 for Jamunapari, Sirohi and Barbari breed. Finally, net income per kid was estimated to be as Rs. 5115, Rs. 9719, Rs. 8445 and Rs. 8999 for Black Bengal, Jamunapari, Sirohi and Barbari breed. Considering all breeds, average net income per sacrifice goat kid was estimated as Rs. 8000

**Table 10.** Goat based business model (sacrificed-eid) under intensive feeding system

| Particular | Breed | | | |
|---|---|---|---|---|
| | Barbari | Jamunapari | Sirohi | Black Bengal |
| Cost of kid at 3 months | 2000 | 3000 | 3000 | 1500 |
| Cost of concentrate feed | | | | |
| 3-6 months | 562.5 | 787.5 | 787.5 | 450 |
| 6-9 months | 1125 | 1687.5 | 1462.5 | 900 |
| 9-18 months | 3240 | 6075 | 6075 | 1890 |
| Green fodder | | | | |
| 3-6 months | 90 | 90 | 90 | 75 |
| 6-9 months | 150 | 180 | 180 | 120 |
| 9-18 months | 648 | 648 | 648 | 252 |
| Dry fodder | | | | |
| 3-6 months | 120 | 150 | 150 | 90 |
| 6-9 months | 210 | 270 | 270 | 150 |
| 9-18 months | 918 | 1080 | 1080 | 420 |
| Health (Rs.) | 75 | 75 | 75 | 75 |
| Labour (Rs.) | 1362.5 | 1362.5 | 1362.5 | 1212.5 |
| Weight (kg) | 52 | 67 | 63 | 35 |
| Sale price @ 400/kg/live wt | 19500 | 25125 | 23625 | 12250 |
| Net income (Rs.) | 8999 | 9719.5 | 8444.5 | 5115.5 |

## 16.2 Goat based integrated livelihood models for rain-fed/disadvantageous regions

Livelihood models for different categories (resources) farmers were suggested based on implemented interventions on six thousand seven hundred fifty five farmers. Finally three hundred and forty-two households were studied to develop livelihood models for different categories. Model revealed that a landless /marginal household having 15 adult female goats and 25 poultry birds may yield Rs. 82727 per annum. Similarly, a landless/marginal/small household with 10 adult goats, 2 cows and 50 chicks and 1 ha rain-fed land may earn Rs. 100634 per year. Marginal, small and medium farmers with 5 adult female goats, 2 buffalo, 2 cows and 2 ha of rain-fed land may earn Rs. 119000/year. Whereas, a semi-medium, medium and large farmer may earn Rs. 119000 per year with keeping 10 goats, 2 buffaloes, 2 cows and crop production on 2 ha semi-irrigated land. These

recommended models were highly adopted by farmers of draught prone Bundelkhand region.

**Table 11.** Integrated livelihood models

| Sl. No | Model | Unit | Net income (Rs.) | Suitability for household category | Number of HH covered under trial |
|---|---|---|---|---|---|
| 1 | Goat+ Poultry | 15 adult F+ 25 Chicks | Rs. 82727 (71115+11612) | Landless marginal | 64 |
| 2 | Goat+ Cow+ Poultry+ Crops (Rain-fed) | 10 adult F+ 2 cows + 50 chicks + 1 ha. | Rs. 100634 (47410+22000+ 23224+8000) | Landless marginal small | 142 |
| 3 | Goat+ Buffaloes+ Cows+ Crop (semi-irri) | 5 adult F + 2 buffaloes+ 2 cows + 2 ha. | Rs. 109705 (23705+34000+ 22000+30000 | Marginal small medium large | 80 |
| 4 | Goat Buffaloes Cows Crop (semi-irri) | 10 adult F 2 buffaloes 2 cows 2 ha | Rs. 119000 (47410+32000+ 22000+30000) | Semi-medium medium large | 56 |

## 17 Probable Economic Gain at National Level from Present Goat Population

An ex-ant assessment study at national level with all important aspects of goat production was conducted by using both primary and secondary data. Present study on disaggregated analysis of net gain by individual intervention has been indicated that breeding intervention has been focused to yield economic gains of Rs. 23713 million, which include Rs. 9977 million as cost of intervention. The healthcare intervention, which includes vaccination against important diseases, may generate an additional income of Rs. 24064 million. An additional net gain of Rs.14002 million has been estimated through nutritional intervention after deducting Rs. 29651 million as the cost of nutrition intervention. The net economic gain through marketing of kids at commercial age has been estimated to be Rs.11842 million. This has been worked out after deducting cost of Rs.13534 million for keeping animals for additional 4 months to attain the commercial age (Table 10). The order of magnitude can be gauged that opportunity cost of technological interventions

on health care, nutrition and marketing together are equivalent to about 1.24% of total value of output from livestock sector in 2010-11 and 14.74% of the value of output from goat sector for the year 2012.

**Table 12.** Economic gains from proposed technical interventions in goat production (Rs.)

| Interventions | Gross gain | Cost of intervention | Net gain | Gross gain to cost ratio |
|---|---|---|---|---|
| Breeding | | | | |
| Additional kids born and survived due to improved prolificacy | 10834 | 5318 | 13735 (24.15) | 2.38 |
| Improvement in body weight | 6703 | 4659 | | |
| increment in milk yield | 6175 | | | |
| Prophylactic measures | | | | |
| Reduction in mortality due to health intervention | 24064 | 6758 | 17306 (30.42) | 3.56 |
| Feed and nutrition | | | | |
| Body weight gain due to nutrition intervention | 19795 | 11757 | 14002 (24.62) | 1.47 |
| Milk yield | 23859 | 17894 | | |
| Marketing | | | | |
| Sale of kids | 25376 | 13534 | 11842 (20.82) | 1.87 |
| Overall | 116809 | 59922 | 56887 (100.00) | 1.95 |

## 18 Recommendations for Goat Research and Development

- Capacity building of goat farmers.
- Replacement of extensive goat management by encouraging semi-intensive and intensive goat management.
- Development of genetic stock by supply of high potential pure-bred bucks to farmers.

- Grading up of non-descript goats/poor performance goats with pure bred bucks of high genetic merit suitable for that particular agro-climatic regions.
- Development of forage resources in community land.
- Promotion of prophylactic measures which include proper vaccination and deworming.
- Clean and adequate housing as per breed, age, sex and production stage.
- Value addition of goat products and by products.
- Popularization of Goat based economic viable models suitable for different regions.
- Support for regulatory market of goat and credit support to poor goat farmers.

## 19 Conclusion

Goats have huge potential to play important role in providing sustainable livelihood and nutritional security of poor people. It is life-line of millions of pastoralist and poorest people in climatically disadvantageous regions. Acceleration in goat productivity and profit are major concern. Indigenous goat breeds have immense production potential in given climate provided they get congenial environment. At national level focus is essential for holistic genetic improvement of goats for meat, reproduction and milkalong with support services and marketing infrastructure. Traits of local importance (adaptability to climate, disease resistance and irregular and scarce feeds availability etc.) should be given due weightage in selection programmes. Improvement objectives of a breed(s) should be well defined along with breed based improved package of practices. Up gradation of non-descript goats should be implemented in big way. Sell of high potential males for slaughter should be minimized by making farmers aware.Capacity building of goat keepers will be key factor in increasing farmer's income by adoption of important technologies and management interventions for different farming systems. Critical inputs for goat farming such as bucks, vaccine, medicine, credit etc. should be made available with easy access. Formation of goat breeder's cooperative/ societies/buck mother farm/multiplier flocks should be encouraged for holistic and sustainable goat development. Facilitation access of appropriate goat production technologies, farming system models, linkage of farmers with market and restoration of grazing resources are the key component of poor goat keeper's livelihood improvement.

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# Chapter 4

# Sustainable Goat Farming for Livelihood Improvement in Nepal: Opportunities, Constrains and Potential

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## 1. Introduction

Nepal is rich in animal genetic resources (AnGR) both in terms of diversity and numbers. So far these resources have been exploited to a limited scale. There are 7.303 million cattle (including Yak and Chauri), 5.168 million buffaloes, 0.800 million sheep, 10.986 million goats, 1.291 million pigs, 68.630 million poultry and 0.392 million ducks in the country (DLS, 2016). Livestock can utilize the vast natural resources like natural pastures (12 percent); forest (40 percent) and agriculture land (28 percent) and convert these to high value nutritive food like milk, meat, eggs, draught power and fertilizer to support agriculture production system (Country Report, 2014). Thus, AnGR can play an important role in meeting the future demands of food and agriculture thereby improving the livelihood through nutritional security.

Livestock is an important, integral and dominant component of mixed farming system in high altitude regions of Nepal. Livestock contributes almost one third (33%) of country's Agriculture Gross Domestic Product (AGDP). Livestock has been considered as insurance against crop failure under subsistence farming system and also as a means for poverty reduction in the country which can equally contribute for food and nutrition security. They are the major source of animal protein (milk, meat and egg) for human consumption, supply high value raw materials (wool and fiber) for cottage industries as well as for export products, provide manure for maintaining soil fertility to support agricultural production and source of animal energy for agricultural operation (draught), act as means of transportation and carrying

loads particularly in road inaccessible areas. With all these economic contributions, livestock are also equally important in terms of social and cultural significance.

Goat farming is one of the ancient practices in Nepal widespread throughout the Central Himalaya and surrounding foot hills. However, majority of goat farming is subsistence type and it has been estimated that at present there is a deficit of 500-600 thousands heads of goat per year for meat purpose with an estimation of around US$ 37.5 millions spent every year excluding informal trade with India making this figure more vigorous (Rajwar, 2012). It has emerged as one of the vital enterprises for improving livelihood through addressing youth unemployment, enabling equitable profit distribution, ensuring gender equity and social justice, utilization of unused lands and productive use of remittances to goat industry to achieve self-sufficiency and import substitution. Goat meat are second (20.36%) most preferred livestock commodity after buffalo (54.34%) in terms of contribution on national meat production (DLS, 2016).

Four distinct types of goats have been identified and characterized so far in the country. The Terai goats are found in Terai region, Khari goats across the hills, Sinhal in the high hills and Chyangra in the high mountain and Trans Himalayan region of the country. Within Khari breeds, different subtypes have been identified, the goats from western parts being heavier in body size compared to the goats from central or eastern part of the country. Despite of having significant number of goats, the country is still not self sufficient in fulfilling goat meat demand within the country. Also for production of Pashmina garments, which have significant contribution in foreign exchange to the country through export, the raw materials are being imported from abroad. In this context it has been realized that sustainable improvement in goat (for meat, milk and fiber) production and productivity through commercialization is necessary for import substitution and export promotion (particularly meat and fiber) in the country.

Goat rearing is a dynamic activity that requires substantial attention to feeding, housing and breeding management. Thus gender roles and involvement are mostly done in a mutual understanding instead of men only or women only. Due to lack of enough feed resources, often-medium level resource holding farmers are more inclined to goat rearing rather than resource poor but it is not limited to resource rich only. Thus financial and technical access in terms of women, poor and marginalized is not visible at household level that is taking the shape of joint involvement for prominent activities (HVAP, 2011).

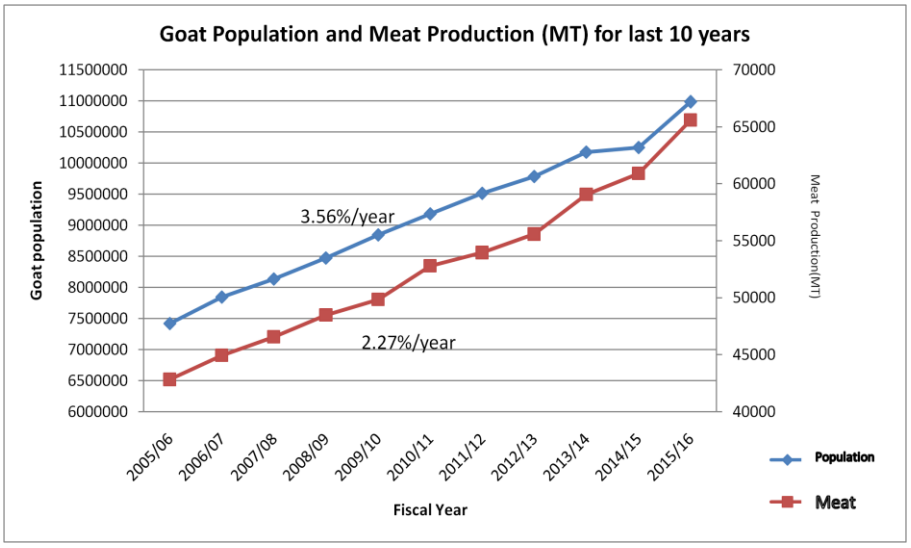
This country report on sustainable goat farming for livelihood improvement in Nepal: opportunities, challenges and potentials is prepared with an

objectives to review and document the existing goat breeds and goat farming practices; to identify the constraints for the sustainable and profitable goat farming; and to recommend research and development on sustainable goat farming for the future interventions in Nepal to aid overall management on goat farming aspects in SAARC region.

## 2. Goat Population and Demography

Western mountain and Himalayan region districts posses the least number of goats compared to other districts. The current estimated goat population in the country is around 10.986 million heads (DLS, 2016). Region wise, Central Development Region has the highest goat population (28.15%) followed by EDR (24.6%) and least in FWDER (9.8%) as presented in table 2. Ecological region wise, the hilly region has highest goat population (52.2%) followed by Terai (36.26%) and high mountain (11.5%) (DLS, 2016).

The major goat population is concentrated in mid-hills and terai regions of the country. Similarly Eastern part is dominant in goat production as compared to Western, Mid western and far western regions of Nepal (Figure 1). More than 50% of the goat is found across mid hills and mountains of Nepal. Khari/Hill goat and their crosses with Jamunapari, Barbari, Ajmeri/Sirohi and Boer are dominant goat breeds in mid-hill region.




Source: DLS, 2016

Figure 1. Graph showing population trend and meat contribution with their annual increment for last 10 years (2004/05 to 2014/15)

**Table 1**. Different goat breeds and their estimated population (in millions) distribution in Nepal

| Sl. No. | Goat Breeds | Percentage | Population (in millions) |
|---|---|---|---|
| 1 | Terai | 27 | 2.967 |
| 2 | Khari | 56 | 6.152 |
| 3 | Sinhal | 16 | 1.758 |
| 4 | Chyangra | 1 | 0.109 |
| | Total | 100 | 10.986 |

Source: Country Report, 2014; DLS, 2016

**Table 2.** Goat population distribution in the country (2015/16)

| Regions | EDR | CDR | WDR | MWDR | FWDR | Total | % age |
|---|---|---|---|---|---|---|---|
| Mountain | 334070 | 370497 | 43536 | 265686 | 251608 | 1265397 | 11.54 |
| Hills | 1184586 | 1524116 | 1412825 | 1080255 | 535049 | 5736831 | 52.20 |
| Terai | 1188014 | 1198517 | 679097 | 626625 | 291633 | 3983886 | 36.26 |
| Total | 2706670 | 3053130 | 2135458 | 1972566 | 1078290 | 10986114 | |

Source: DLS, 2016

Government of Nepal has focused on goat research and development programmes for the improvement in production as well as upliftment in livelihood of rural farmers and import substitution through commercial goat farming. For this, number of research, development and resource farms has been established across the country (Figure 2). Three farms were established in far and mid western development region of Nepal namely Goat Development Farm at Budhitola, Kailali; Regional Agriculture Research Station at Khajura, Banke; and Sheep and Goat Research Programme at Jumla. In western development region Goat Research Station at Chaap, Bandipur has been serving as major resource center for pure breeds like Khari, Boer and Sannen as well as crossbred of Boer, Jampunapari, Barbari and Sannen goats. Agriculture and Forestry University (AFU) at Rampur, Chitwan has owned a goat farm for research purpose and Goat Development Farm at Chitlang, Makwanpur for development purpose are two farms in Central Nepal. In eastern Nepal, Agriculture Research Station (ARS) at Pakhribas is working for research in eastern Nepal.

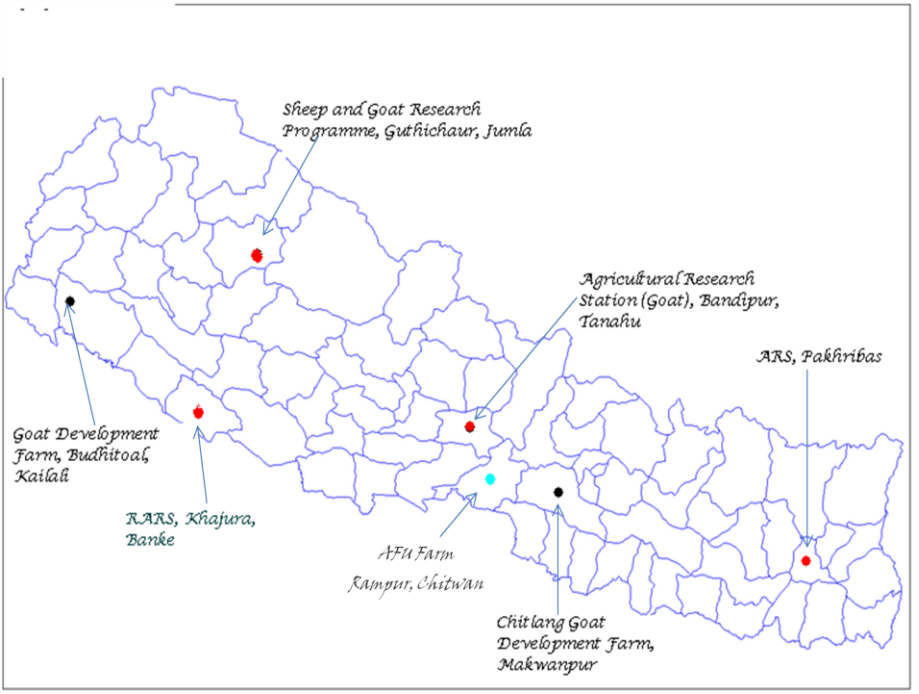



Figure 2. Government owned goat research and development farms in Nepal

# 3. Breed and Breed Description

## 3.1 Indigenous breeds

There are four indigenous breeds of goat available in the country distributed across various ecological zones that has been identified and characterized so far. They are Terai, Khari, Sinhal and Chyangra (Pradhan and Gurung, 1985; Shrestha, 1995; Kharel, 1997; Neopane, 1997, Gorkhali et al., 2014). Across southern plains and inner terai (100 to 500 masl) from east to west Nepal, Terai goats are dominant. Khari or hill goats are the major goat species found across the mid-hills region of Nepal at an altitude of 500 to 1500 msl. Besides this, presence of some subtypes/strains is also found for Khari goats in the country. Kunwar (2000) studied that Khari goat is found across the hills of the country and reported that three distinct strains (small, medium and large) existed among Khari population. Small types based on body size are found in the eastern region while large type was found in the western region. In high hills or mountains Sinhal goats are major goat species from 1500 to 2400 msl. Chyangra goats are dominant across northern trans-Himalayan regions from an altitude of 2500 to 5000 msl.

**Table 3**. Positive attributes, distribution and population status of Nepalese goats

| Breeds | Positive attributes | Distribution | Status | Characterization |
|---|---|---|---|---|
| Terai | Hardy, good size, suitable for terai | Across the terai | Population declining | Phenotypic+ Chromosomal+ mtDNA |
| Khari/ Hill | Principal breed, suitable for hills, hardy, prolific, meat animal | Across the mid hills | Normal | Phenotypic+ Chromosomal+ mtDNA |
| Sinhal | Hardy, suitable for high hills, pack animal, large size | Across the high hills | Population declining | Phenotypic+ mtDNA |
| Chyangra | Hardy, suitable for transhumance system, multipurpose (meat, pack and pashmina) | Across the Himalayas | Population declining | Phenotypic+ mtDNA |

Source: Pokharel et al., 2012; Gorkhali et al., 2014

### 3.1.1 Terai (*Capra hircus*)

Terai goats are located across terai region and inner valleys (tropical and sub-tropical climate) of the country and are meat type animals. They have been characterized at phenotypic, chromosomal and mitochondrial level (Annual Report ABD, 2003; Gorkhali et al., 2014). They are heavily crossed with Indian breeds (Boer, Jamunapari, Barbari, Ajemeri/Sirohi and Beetal) and it is difficult to find pure line of Terai goats which makes them at risk from the conservation point of view. This breed constitutes 27% of the total goat population of the country (Kharel and Neopane, 1998).

Body colour varies from pure white to pure black with mixed patches of different colours. Its compact body weights around 30 kg with body length of 60 cm and chest girth of 65 cm. Wither height is 58 cm. Body weight varies from 30-35 kg for male and 25-30 kg for female.

### 3.1.2 Khari (*Capra hircus)*

Khari goats are the principal goat breed of the country and are found across the hills and inner valleys in the country. They are prolific and good for meat

purpose. They are hardy and well adapted to local environments. They represent 56% of the total goat population in the country (Kharel and Neopane, 1998). They are productive breed having twinning and shorter kidding intervals. They have been characterized at phenotypic, chromosomal and mitochondrial DNA level (Rasali et al., 1997 and Gorkhali et al., 2014). They are normal from conservation point of view.

Body colour varies from white to black. There are six sub-types within Khari (Hill) goats based on colour namely *Seti, Kali, Khairi, Ghorli, Singari* and *Dhobini* (Oli, 1986). Seti are pure white in colour while Kali are pure black in colour. Khairi are brown in colour while Ghorli are brown mixed with white or other colour. Singari is black in colour with white stripes on face. Dhobini are ash colour and are bigger in size than the other five types. Its body weight around 30 kg with body length, chest girth and withers height of 63 cm 65 cm and 56 cm respectively. Cross breeding of Khari goats with Boer bucks and also artificial insemination with frozen semen has been practicing in the hilly regions across the country through the initiation of leading private sectors engagement (Bagmati Goat Seeds Pvt. Ltd., Dhadhing; Bagaichha farm house, Nawalparasi; Jagatput Agro, Chitwan etc.), Ministry and internationally funded projects (Agriculture Food Security Project (AFSP)- World Bank , Kisan ka Lagi Unnat Bui Bijan Karyakram (KUBK)-IFAD etc.). The performance of different blood level of Boer crossbred is presented in table 4.

**Table 4**. Khari goats from different clusters of Eastern, Western and Mid-Western Regions of Nepal

| Parameters | Cluster A (46) | Cluster B (70) | Cluster C (73) |
|---|---|---|---|
| Body length (cm) | $69.3\pm0.3^{a}$ | $66.5\pm0.2^{b}$ | $64.9\pm0.2^{c}$ |
| Wither height (cm) | $66.9\pm0.2^{a}$ | $64.7\pm0.1^{b}$ | $59.2\pm0.2^{c}$ |
| Heart girth (cm) | $69.9\pm0.3^{a}$ | $66.5\pm0.2^{b}$ | $65.9\pm0.2^{c}$ |
| Flank girth (cm) | $81.7\pm0.2^{a}$ | $80.1\pm0.2^{b}$ | $71.4\pm0.1^{c}$ |
| Flank height (cm) | $68.9\pm0.2^{a}$ | $67.3\pm0.1^{b}$ | $61.1\pm0.2^{c}$ |
| Ear length (cm) | $15.6\pm0.2^{a}$ | $13.3\pm0.2^{b}$ | $13.3\pm0.1^{b}$ |
| Horn length (cm) | $16.7\pm0.6^{a}$ | $10.7\pm0.5^{b}$ | $11.3\pm0.3^{b}$ |
| Adult weight (kg) | $38.6\pm0.8^{a}$ | $31.8\pm0.4^{b}$ | $27.7\pm0.5^{c}$ |

Note: Number in parenthesis indicates the number of observations. Cluster A: Goats from mid-west region (Salyan and Surkhet); Cluster B: Goats from West (Lumle and Bandipur); and Cluster C: Goats from east (Sindhuli and Pakhribas) of Nepal.

Terai Goat

Khari/Hill Goat

Sinhal Goat

Chyangra Goat

Figure 3. Indigenous goat breeds of Nepal

**Table 5**. Comparative morphometric measurements of indigenous breeds of goat (Values are means in cms ± standard errors)

| Parameters | Terai | Khari | Sinhal | Chyangra |
|---|---|---|---|---|
| Body length | 60.6±0.87 | 63.1±0.39 | 68.7±0.44 | 62.3±0.36 |
| Heart girth | 65.2±0.44 | 65.5±0.37 | 77.8±0.44 | 71.3±0.37 |
| Height at wither | 57.9±0.32 | 55.9±0.28 | 59.2±1.06 | 62.4±0.23 |
| Height at hip bone | 60.8±0.73 | 51.5±1.76 | M: 51.7±1.27<br>F: 53.3±0.72 | M:60.8±0.78<br>F: 58.7±0.85 |
| Head length | 18.3±0.25 | 15.5±0.56 | 16±0.4 | 15.1±0.6 |
| Tail length | 13.4±0.2 | 12.6±0.3 | 12.0±0.4 | 15.1±0.6 |
| Horn length | 8.37±0.2 | 11.5±1.3 | 15.3±0.84 | 18.2±0.7 |

| Parameters | Terai | Khari | Sinhal | Chyangra |
|---|---|---|---|---|
| Ear length | 18.7±0.30 | 16.2±0.4 | 14.5±0.5 | 10.5±0.4 |
| Neck length | 25.7±0.45 | 20.5±0.56 | 20.7±0.76 | 20.2±0.7 |
| Loin girth | 74.1±0.65 | 72.8±0.53 | 73.5±1.19 | 70.3±0.43 |
| Barrel girth | 84.7±5.8 | 86.7±3.3 | 53.2±4.7 | 75.3±1.4 |
| Fore legs above knee | 19±0.52 | 17.8±0.47 | 18.7±0.49 | 16.1±0.51 |
| Fore legs below knee | 16.2±0.3 | 16±0.57 | 16.3±0.33 | 15.2±0.65 |
| Rear legs above knee | 23.2±0.61 | 22±0.58 | 23.2±0.65 | 18.3±0.54 |
| Rear legs below knee | 22.6±0.49 | 19.8±0.4 | 21.2±0.3 | 17.8±0.45 |
| Adult body weight (kg) | F 23.3±0.1<br>M 30-35 | F 24.1±0.34<br>M 28-40 | F 34.8±0.12<br>M 28-42 | F 29.1±0.69<br>M 35-40 |

Source: Annual report ABD (1997); Kharel and Neopane (1998); Upreti and Pradhan (1998); Tiwari et al. (2002); ARS, Bandipur (2007)

### 3.1.3 Sinhal (*Capra hircus*)

Sinhal goats are located in high hills of the country and are good for meat and transportation as pack animals under transhumance system with low input. They are large sized hardy and well adapted animals to local harsh conditions. They have been characterized at phenotypic and mitochondrial level. They are the heaviest native goat breed and represent 16% of the total goat population (Kharel and Neopane, 1998). The farmers are conserving them in situ but they need to be more focused with better management practices on breeding, feeding, housing and health. They are at risk from conservation point of view.

Its body colour is variable from black, white, grey, mixed black and white colour. Adult body weight is 35 kg. Body length is 69 cm recorded and heart girth is 78 cm on an average. Wither height is 59 cm. Body weight averages 35 kg for buck and 29 kg for doe.

### 3.1.4 Chyangra (*Capra hircus*)

Chyangra goats are the mountain goat originating from Tibet reared in trans-Himalayan region along with Bhyanglung type of sheep in high-mountain and trans himalayan region above 2500 meter sea level (msl). They have

been reared in situ condition by farmers themselves. They are suitable for meat, pack and are popular for high value as well as fine quality called *Chyangra* fiber known as *Pashmina* (FAO, 2010). Their population is declining and hence need attention. They have been characterized at phenotypic and mitochondrial level. Chyangra fiber has high market potentials, as it has unique blend and qualities, hence popular within and outside the country. Chyangra population is estimated to be around 1% of the total goat population i.e. 0.11 millions heads in Nepal (DLS, 2016).

Body colour varies from pure white to pure black with mixed patch of different colours. Its compact body weights around 30 kg with body length of 62 cm, chest girth of 71 cm and wither height is 62 cm. Body weight varies from 29 -32 kg for female and 35-40 kg for males.

## 3.2 Exotic Breeds

### 3.2.1 Jamunapari

Jamunapari is a breed of goat originating from Indian subcontinent. It is dual purpose breed kept for both milk and meat. There is a large variation in color but the typical Jamunapari is white with patches of tan on the neck and head. Their heads tend to have a highly convex nose, which gives them a parrot-like appearance. They have long flat drooping ears which are around 25 cm long. Both sexes have horns. The udder has round, conical teats and is well developed. They also have unusually long legs. The Jamunapari male can weight up to 45-50 kg, while females can reach around 35-40 kg. The average lactation yield per day has been found to be slightly less than two kilograms.

### 3.2.2 Barbari

The Barbari is a meat type breed that is found in Mathura District of Uttar Pradesh, as well as Gujrat, Jhelum and Sargodha districts in Punjab Province of India. They are small size having coat color white creamy to golden with brown spots. Their meat conformation is considered good. Triple kidding and early maturity are common features of these goats.

### 3.2.3 Sirohi/Ajmeri

The Sirohi or Ajmeri is a meat type breed that is found in Sirohi district of Rajasthan. The breed also extends to Palanpur in Gujarat. Mature male weight around 50 kg but females weight only 25-30 kg. These are compact, medium-sized animals. Coat colour is predominantly brown, with light or dark brown patches; a very few individuals are completely white. Ears are flat and leaf-like, medium-sized and drooping ear length of 18.8cm. Both

sexes have small horns, curved upward and backward. Tail is medium in length and curved upward. Udder is small and round, with small teats placed laterally.

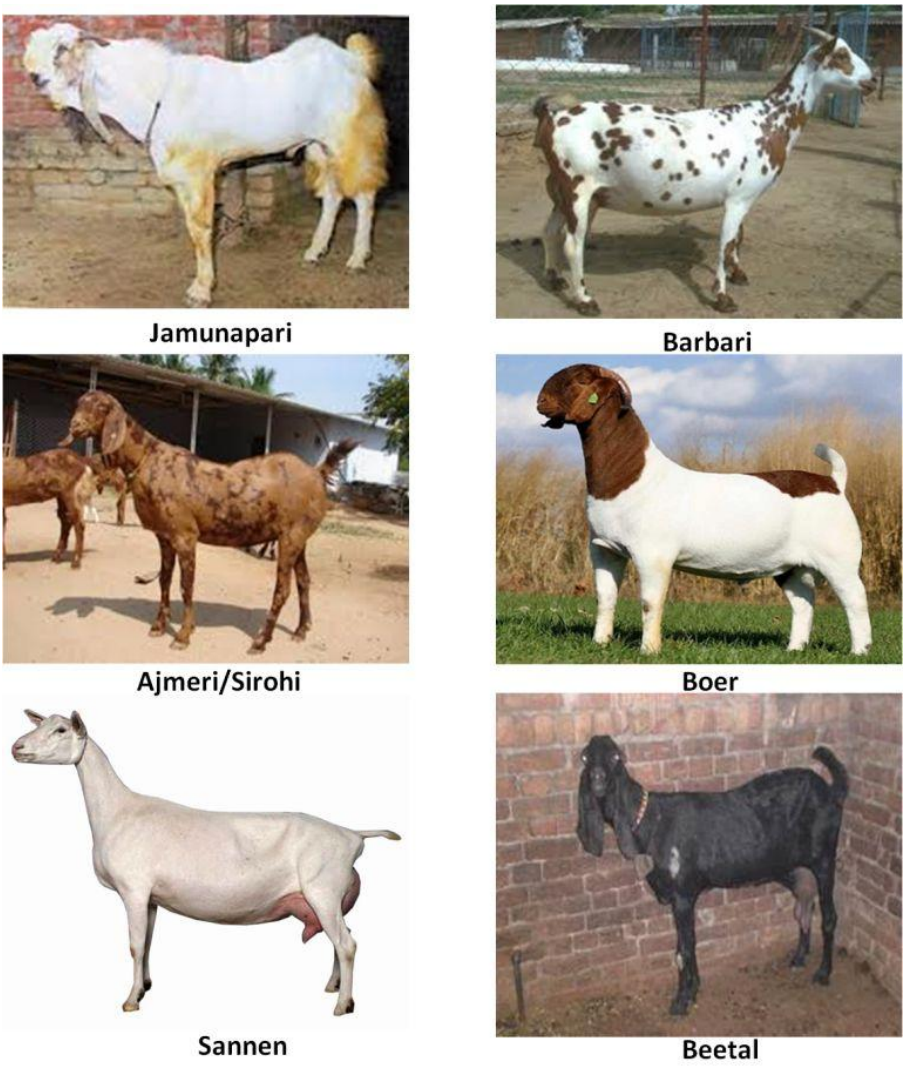



Figure 4. Different exotic goat breeds available in Nepal

### 3.2.4 Boer

The Boer is an improved breed with some infusion of European, Angora and Indian goat breeding developed in South Africa in early 1900s. The Boer goat is primarily a meat goat with several adaptations to the region in which

it was developed. It is a horned breed with lop ears and showing a variety of color patterns. The most common color of this breed is white body with red head and large, muscular frame. The Boer goat is being popular for its browsing ability and limited impact on the grass cover. Producing weaning rates in excess of 160% the Boer goat doe is a low maintenance animal that has sufficient milk to rear a kid that is early maturing. The mature buck weights between 110-135 kg and does between 90 and 100 kg. Performance records for this breed indicate exceptional individuals are capable of average daily gains over 200 g/day in feedlot. More standard performance would be 150-170 g/day. The ovulation rate for Boer goats ranges from 1 to 4 eggs/doe with an average of 1.7. A kidding rate of 200% is common for this breed. Puberty is reached early, usually about 6 months for the males and 10-12 months for the females. The Boer goat also has an extended breeding season making possible 3 kids every 2 years.

Boer goat was introduced in Nepal from Private sector to improve growth performance of local goats. Recently, projects funded by World Bank (WB) and International Fund for Agriculture Development (IFAD) implemented by Ministry of Agriculture Development namely Agriculture Food Security Project (AFSP) and Kisan Ka Lagi Unnat Bui Bijan Karyakram (KUBK) respectively are working for producing crossbreds with the local Khari/Hill goat in research, government and breeders' farmers of mid and far western region. Goat Research Station, Bandipur; RARS, Khajura and GDF, Budhitola are the government owned farms with nucleus herd of Boer goat in Nepal. However, a comprehensive study on survivability, growth & reproductive performances as well as efficiency (economics) need to be investigated

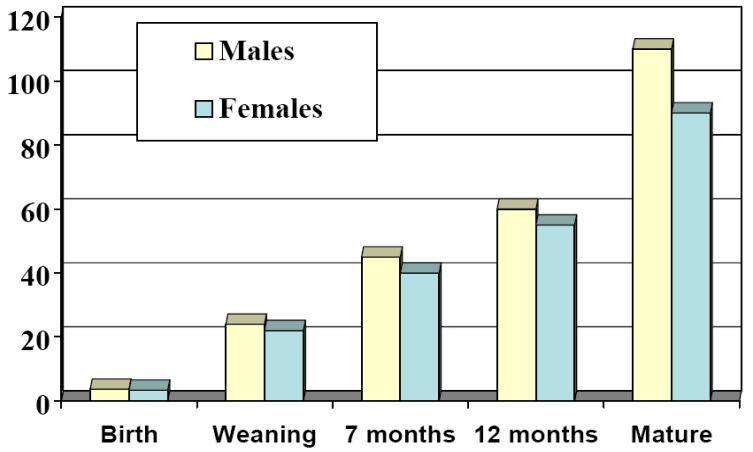



Figure 5. Body weights (kg) of male and female Boer goats at various ages

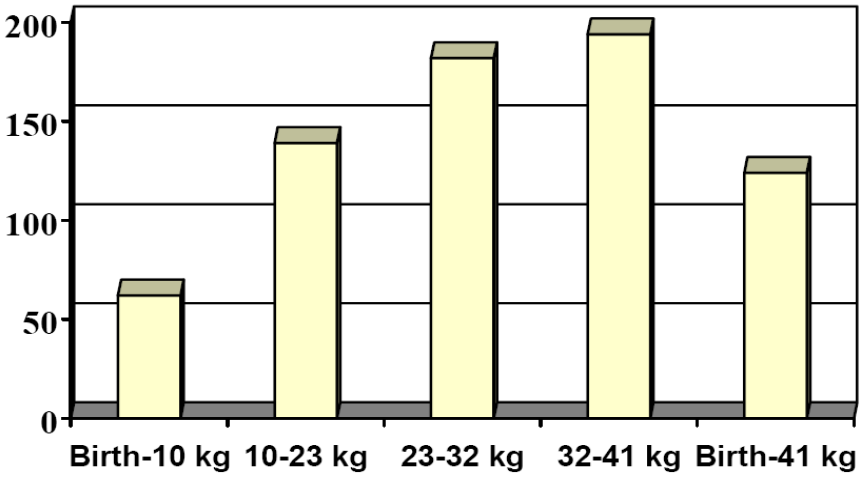



Figure 6. Growth rate (g/day) of Boer goats at different weights

### 3.2.5 Sannen

Saanen are dairy goat originated in Switzerland, in the Saanen Valley. Saanen does are heavy milk producers (on an average of 4 liters/day) and usually yield 3-4 percent milk fat. It is medium to large in size (weighing approximately 65-70 kg) with rugged bone and plenty of vigor. Saanen are white or light cream in color, with white preferred. The hairs are short and fine, although a fringe over the spine and thighs is often present. Ears are erect and alertly carried, preferably pointing forward. The face is straight or dished. The breed is sensitive to excessive sunlight and performs best in cooler conditions.

### 3.2.6 Beetal

The Beetal is a breed used for meat and milk production. Found in both Punjab of India and Pakistan, the Beetal is usually black. The males have long twisting horns. The breed is similar to the Jamunapari but smaller. The adult male weighs around 60 kg and females are 35-40 kg. The coat is short and lustrous. The face line is convex, with typical Roman nose but not as prominent as in Jamunapari. Ears are long and flat, curled and drooping with ear length of 24.8 cm. The udder is large and well developed, with large conical teats.

## 4. Production System

The animal production system in Nepal has influenced by most diversified climate and vegetation ranging from sub tropical to alpine type, from semi

arid tropics to semi arid temperate and from dry to very wet monsoon areas. The wide variation in ecology, climate and environment within a short distance as a result of differences in mountain topography at different elevation influences the animal production system resulting to tremendous biodiversity in both plants and animal genetic resources. Broadly, the major animal production practices are namely:

## 4.1 Transhumant migratory system

The migratory Transhumant system of movement of animals to the alpine meadows and temperate pasture in summer and to the lower altitude pastoral, forest and cropped areas around villages is the common animal production system in Trans-Himalayan region of Nepal. The herds of Yak, Nak, Chauries, Chyangra goat and Bhyanglung sheep are taken to the alpine meadows and temperate pasture for four months from June to September by keeping them in different pastoral areas depending on the feed availability and climatic condition. With the onset of cold weather as the winter approaches, the herds are brought down close to the village forest, pastoral land, crops residues in harvested cropped land. During the snow falls, these animals are fed with hays and crop by products like straws and chopped fodder root crops mixed with water and salt.

Figure 7. Different production system adapted across different ecological zones in Nepal

In the middle hills and low-mountain, the productive animals (like lactating) are kept in the shed with intensive care and the other dry animals are taken to alpine pasture during summer months. During other months the animals are kept nearby villages. The traditional practices of taking sheep and goats to lower areas of subtropical regions in winter has been stopped due to the problems raised by various community to protect their community managed forest. In the region, tree fodders are fed to the animals and there are several types of fodder trees available including evergreen and deciduous trees. During dry winter season (December to March) it is the tree fodders that are mainly fed to the goats as a green fodder.

### 4.2 Stationary with semi-migratory or with semi-intensive

This type of animal keeping system is more common in the mid hill region. The goats are kept in shed during night in winter months and are taken out for grazing during day time. In summer, the dry goats are taken in high pasture areas as migratory type. The high valued animal like lactating, pregnant and sick animal are kept in sheds or around villages for intensive care and management. In winter the animal are kept on moving in cultivated land for fertilizing the land from terraces to terraces. The animals live on straws and shrubs around village forest grazing. In the high mountain areas, the animals are kept in shed during winter months and are fed with hays or straws.

### 4.3 Stationary stalls feeding or closed system intensive farming

In most of the urban and sub urban areas, the goats are kept in stall feeding system and fed with straws and other crop by products along with concentrates with limited amount of green fodders in cut and carry system. In road accessible market areas the farmers have practiced to grow cultivated fodder, multipurpose fodder trees and feeding balanced ration to their goats. The commercial farmers followed this type of production system in Nepal. Usually, the cross-bred goats are kept in such system. The probable reasons for this might be the accessibility to inputs and facilities. The lower belt of the country is accessible to roads and market.

## 5. Feeding Practices

The goats, being a ruminant, are able to live and be productive on fibrous vegetation of relatively poor quality. Farmers mostly rear goats in a traditional system where stall feeding or grazing in the nearby forest is the common methods. They are natural browser and are able to eat quite woody stems of trees and bushes. Goats naturally prefer to eat at a height 20-120 cm above the ground and discard the feed stuffs dropped on the ground. Feeding

practices are different to the different management system in different agro ecological zone of the country. Agro ecological zone of the country has been divided into three such as the Terai, Hills and Mountain. Management systems adopted in these zones are (1) Extensive management comprising (a) Trans-humane system and (b) sedentary system (2) Intensive system (a) Tethering and (3) Semi intensive system.

## 5.1 Feeding standards of goat

The amount of nutrients required by animals is called Feeding standards. Major feeding standards are used worldwide;

- National Research Council Standard (NRC-USA).
- Agriculture Research Council Standard (ARC-UK).
- Indian Feeding Standard (ICAR-India).

Nepal adopts NRC based ICAR standard. However, Nepal Needs it own Feeding Standard either to be developed by National Pasture and Feed Center (NPFC) or NARC.

**Table 6**. Nutrient requirement for all physiological state

| Sl. No. | Physiological stage | Body weight (kg) | DM % of body weight (kg) | Energy (Mcal) | Crud Protein (CP)(g)/d | Minerals (g) Ca | P |
|---|---|---|---|---|---|---|---|
| 1 | Kids (75 g/d) | 10 | 3.5 | 1.09 | 45.0 | 1.9 | 1.5 |
| 2 | Hogget (75 g/d) | 15 | 3.3 | 1.30 | 55.0 | 2.2 | 1.7 |
| 3 | Pregnant/Lactating (100 g/d) | 30 | 3.3 | 2.71 | 71 | 4.0 | 2.8 |
| 4 | Pregnant/Lactating (50 g/d) | 40 | 3.0 | 3.05 | 129 | 4.0 | 2.8 |

Source: Keral, 1982

# 6. Breeding Practices

For the genetic improvement of native goats, many exotic breeds namely Jamunapari, Barbari, Beetal, Sirohi, Sannen, Boer, Alpine, Toggenburg, Damascus, Mamber, Kiko and recently Boer goats from Australia as live animals or in the form of frozen semen have been introduced by various institutions in different times for crossbreeding. Later on, for the hill condition, Khari goat has been found to be more productive (meat output/doe/annum) due to its prolificacy and selective breeding for genetic improvement has been recommended. Though many goat breeds have been

introduced, extensive studies for their suitability in our condition have not been fully explored. Farmers' preferences for exotic breeds/crossbred are mainly influenced by the larger body size and butchers preference has been due to higher dressing percentage. It is imperative that still research has to be focused in identifying suitability of different goat breed/crossbred for different ecological regions and production management for facilitating commercial production in the country (Shrestha and Pokharel, 2013).

## 7. Housing Practices

Housing and management of goats play an important role in goats farming. Use of local materials helps to reduce in the cost of production. It varies with the agro ecological zone of the country. Nepal has divided into ecological zones such as the Tarai, Hills and Mountain. In high mountains and Himalays goat are raised under different housing system

(1) Extensive system of housing:
   (a) Trans-human system: Under this system, goats flocks are constantly moved from one place to another in predefined routs (e.g. from Jumla to Jajarkot and even Salyan,) to search the feed and to escape the cold during winter. This system is discouraged by community forest user groups and therefore a traditional goat management system is endangered.
   (b) Sedentary system: Rearing of goats at the homestead on the communal grazing/ forest areas and /or arable land. Crop fields are known as sedentary management.

(2) Intensive System: Goats are kept in confinement with limited access to grazing. They are grazed under tethering system where goats are tied by a long rope and frequently shifted.

(3) Semi intensive system: Goats are kept under the grazing system and are also supplemented with concentrates and minerals, crop byproducts.

**Table 7.** Floor requirement for different age groups of goat

| Sl. No. | Age Group | Covered space (sq.m/goats) | Open space (sq.m/goats) |
|---|---|---|---|
| 1 | Up to 3 months | 0.2 -0.3 | 0.4 -0.6 |
| 2 | 3-9 months | 0.6-0.75 | 1.2 – 1.5 |
| 3 | 9-12 months | 0.75- 1.0 | 1.5 -2.0 |
| 4 | Yearlings | 1.5 – 2.0 | 2.0 |
| 5 | Adult goats | 1.5 – 2.0 | 3.0 – 4.0 |
| 6 | Lactating/ Pregnant goats | 1.5 | - |

# 8. Health Practices

Health management is an important and indispensable part if goat farming throughout the world and it has become even more critical if the production system is intensive. Herd management programs are necessary to improve herd productivity through general health management, parasite control, vaccination, environmental management and accurate record keeping. Although, the diseases in both systems are common, yet some disease becomes more problematic with some systems because of rearing conditions and practices. Some infectious diseases are common in all management systems, but the prevalence and magnitude of other diseases are especially the parasitic diseases would vary according to ecological, climatic and management conditions.

At farm level, health practices includes proper health care of pregnant , neonates young and adult animals and incorporates the practices and approaches to reduce neonatal mortality, preventive strategies against infective, parasitic and metabolic diseases of young animals and overall health management of the flock. It also includes the general flock management which is associated with the survival and better health of animals like prevention of hypothermia/hypoglycemia and adequate supply of colostrums to newborn for passive transfer of maternal antibodies to newborn kids to increase their resistance to prevalent diseases (Joshi et al., 2012). Massive vaccination programs against PPR and foot rot has been organized by government twice a year which has been effective to control these diseases in some scale.

# 9. Performances

## 9.1 Production

**Table 8**. Growth performances of different indigenous breeds at various ages

| Breeds | Sex | Weight at | | | | | |
|---|---|---|---|---|---|---|---|
| | | Birth | 3 M | Weaning | 6 M | 9 M | 12 M |
| Sinhal | Pooled | 2.1 | | 10.97 | 13.59 | 15.77 | 18.34 |
| Khari | Male | 1.53 | 7.25 | 9.01 | 11.34 | 14.11 | 15.15 |
| | Female | 1.48 | 6.37 | 7.92 | 9.49 | 11.49 | 12.44 |
| Terai | Male | 1.58 | 7.10 | 7.80 | 10.0 | 12.5 | 14.20 |
| | Female | 1.44 | 6.30 | 7.18 | 9.10 | 10.30 | 11.9 |
| Chyangra | | 1.6 | | 9.5 | 11.0 | 13.8 | 20.0 |

**Table 9.** Morphological characteristics (Mean and Standard Error) of different native breeds of goats of Nepal

| Breeds | Morphological Characteristics (mean ± se) | | | | |
|---|---|---|---|---|---|
| | Adult body size (kg) | Body length (cm) | Wither height (cm) | Chest girth (cm) | Horn length (cm) |
| Chyangra | Male: 35-40<br>Female: 27-30 | 62.4±0.4 | 62.4±0.2 | 71.4±0.4 | 22.4±0.1 |
| Sinhal | Male: 42.0<br>Female: 34.8 | 68.8±0.4 | 67.0±0.4 | 77.76±0.5 | 18.7±0.3 |
| Khari | Male: 28-40<br>Female: 17-26 | 63.2±0.4 | 55.9±0.3 | 65.5±0.4 | 10.7±0.2 |
| Khari | Pooled: 31.9 | 66.6 | 63.1 | 67.1 | 12.4 |
| Terai [a] | Male: 30-35<br>Female: 18-32 | 58.1±0.4 | 57.9±0.3 | 65.2±0.4 | 8.1±0.2 |
| Terai [b] | Pooled: 27.3 | 60 .6 | 60.3 | 68.3 | 18.7 |
| Terai [c] | Pooled: 32.14 | 64.2 | 62.4 | 71.8 | 16.6 |

**Table 10.** Morphometric performances of crossbreed goats

| Breed | Morphological Characteristics (mean ±SE) | | | | |
|---|---|---|---|---|---|
| | Sex | Adult body weight (kg) | Body length (cm) | Wither height (cm) | Chest girth (cm) |
| Jamunapari X Khari | M | 52±4.80 | 73.0±6.0 | 74.3±2.9 | 82.7±2.7 |
| | F | 34.4±10.2 | 66.3±3.4 | 69.0±1.8 | 77.8±2.7 |
| Barbari X Khari | M | 43.5±4.9 | 63.0±4.2 | 66.3±6.4 | 80.0±4.2 |
| | F | 27.4±6.6 | 57.0±4.2 | 57.1±3.4 | 67.0±3.5 |
| Kiko X Khari | M | 46.6±5.0 | 69.0 | 71.0 | 79.0 |
| | F | 33.6±5.8 | 63.0±2.8 | 59.0±2.6 | 72.8±3.5 |

**Table 11**. Growth Performances of crossbred goats

| Breed | Sex | Weight (kg) at | | | | |
|---|---|---|---|---|---|---|
| | | Birth | 4 month | 6 month | 9 month | 12 month |
| Jamunapari x Khari | M | 2.36±0.5 | 9.9±3.8 | 11.4±3.5 | 13.7±3.6 | 15.7±4.6 |
| | F | 2.39±0.5 | 9.7±3.0 | 11.5±2.8 | 13.1±3.4 | 14.5±3.1 |
| Barbari x Khari | M | 1.67±0.3 | 6.7±2.6 | 9.1±4.4 | 12.9±4.6 | 16.4±5.1 |
| | F | 1.58±0.4 | 7.6±1.7 | 9.2±2.0 | 11.1±1.9 | 12.8±2.2 |
| Kiko x Khari | M | 1.68±0.4 | 7.7±1.7 | 9.0±1.9 | 13.2±2.0 | 19.6±1.9 |
| | F | 1.52±0.3 | 7.2±0.9 | 8.6±1.5 | 13.9±2.1 | 18.7±3.7 |
| Saanen x Khari | Both | 2.22±0.69 | 13.0±3.6 | - | - | - |
| Damascus x Local | Both | - | - | - | - | 23.1±1.8 |
| Mamber x Local | Both | - | - | - | - | 20.8±2.1 |

## 9.2 Reproduction

**Table 12**. Reproductive Performances of indigenous goat breed of Nepal

| Sl. No. | Reproductive traits | Goat Breeds | | | |
|---|---|---|---|---|---|
| | | Khari | Terai | Sinhal | Chyangra |
| 1 | Age at first kidding (d) | 478 | 459 | 731 | 730 |
| 2 | Kidding interval (d) | 268 | 225 | 365 | 365 |
| 3 | No of kids born /doe/annum | 1.97 | 1.93 | - | 1 |
| 4 | Twinning percentage | 57.0 | 46.00 | 27.3 | 3-4 |
| 5 | No of kids weaned per doe per annum | 1.71 | - | 1.11 | - |
| 6 | Live weight gain per doe per annum | 21.76 | - | 17.42 | - |

**Table 13**. Comparative performance of indigenous and crossbred goats

| Breed | Body Weight kg (Mean±SE) | | | | |
|---|---|---|---|---|---|
| | At birth | 4 Month | 6 Month | 9 Month | 12 Month |
| Khari | 1.75±0.38 | 7.57±2.33 | 11.02±4.31 | 15.23±6.17 | 19.24±5.67 |
| Sinhal | 1.87±0.10 | 11.22±3.49 | 14.03±3.12 | 17.34±4.67 | 22.05±5.68 |
| Barberi | 1.43±0.42 | 7.35±1.01 | 10.48±1.88 | 14.40±3.89 | 19.38±4.89 |
| 50% Jamunapari | 2.32±0.65 | 9.11±2.74 | 14.69±4.60 | 18.38±4.44 | 21.27±5.06 |
| 50% Barberi | 1.73±0.28 | 6.87±2.32 | 10.31±1.26 | 14.35±3.63 | 18.43±4.21 |
| 50% Kiko | 1.83±0.72 | 7.86±1.10 | 12.27±3.68 | 17.81±4.38 | 20.0±3.97 |
| 50% Boer | 2.20±0.61 | 13.80±3.29 | 17.85±4.36 | 25.25±5.88 | 34.10±8.62 |

Source: GRS, 2012

**Table 14**. Reproductive performances of crossbred goats

| Sl. No. | Reproductive traits | Khari x Jamunapari | Khari x Barbari | Khari x Kiko | Saanen x Khari |
|---|---|---|---|---|---|
| 1 | Age at first kidding (d) | 577 | 564 | 576 | 423±45 |
| 2 | Kidding interval (d) | 319 | 286 | 496 | 257 |
| 3 | Twinning percentage | 45.50 | 58.33 | 33.00 | 91 |
| 4 | No of kids/doe/annum | 1.79 | 2.09 | | 2.6 |
| 5 | No of kids weaned per doe per annum | 1.28 | 1.60 | 1.14 | |
| 6 | Live weight gain per doe per annum (kg) | 19.14 | 16.15 | 18.37 | |

## 9.3 Milk

**Table 15**. Milk production (liters) of Sannen does at GRS, Bandipur for consecutive three months

| Parameter\Months | Month 1 (liters) | Month 2 (liters) | Month 3 (liters) |
|---|---|---|---|
| Total milk prod /month | 296.5 | 387.5 | 207 |
| Avg/day/doe | 1.11 | 1.39 | 1.52 |
| Max Avg/day/doe | 2.29 | 2.0 | 2.63 |
| Min Avg/day/doe | 0.58 | 1.0 | 0.75 |

# 10. Diseases and Healthcare Services

Diseases are important cause for survival, growth and productivity of goats. Many diseases of goats are as yet unconfirmed by laboratory and identified only clinically. The causative agents for some clinical manifestation like diarrhea, abortion, pneumonia are not identified properly and reported on clinical outcome basis. The disease diagnostic capacity and system is poorly developed. Under subsistence production system in the remote regions, diseases are neither reported nor investigated unless there is epidemic, hence all goat diseases are neither reported nor diagnosed.

## 10.1 Prevalent infectious goat diseases in Nepal

- Peste des Petits ruminants (PPR)
- Contagious ecthyma
- Johne's disease
- Sheep and goat pox
- Contagious *Caprine Pleuropneumonia*
- Pneumonia
- Abortion caused by *Toxoplasmosis, Chlamadiosis* and *Brucellosis*
- Diarrhea

## 10.2 Prevalent parasitic and production diseases

- Gastrointestinal nematodes
- Flukes
- External parasites
- Mange mites
- Mastitis-especially in dairy goats
- Clostridial infection (Enterotoxaemia)
- Tympany and bloat
- Urolithiasis
- Abomasal worm (*Haemonchus contortus*)
- Sarcoptic mange

## 10.3 Important diseases in the commercial production system

- Infectious diseases like PPR
- Clostridial diseases like Enterotoxaemia when the goats are reared under feedlot management
- Coccidial infection in young kids (below 6 months old)
- *E. coli*, Rota virus and Cryptosporidium
- Respiratory infection-*Mycoplasma*

## 11. Marketing Channels and Value Chain

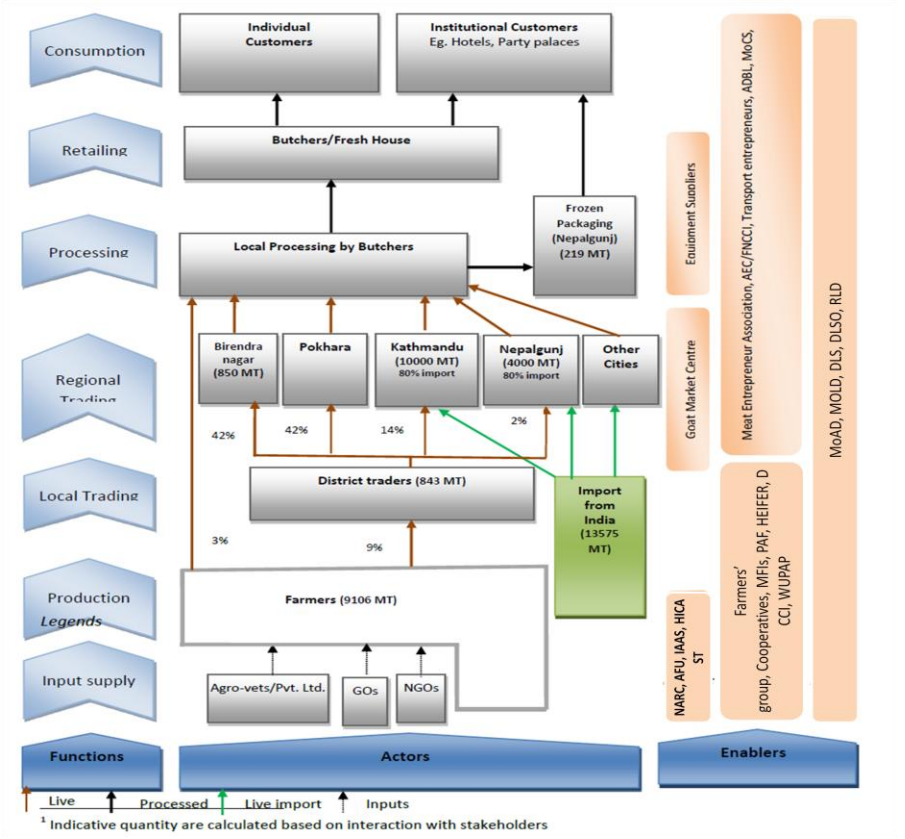
Goats are distributed all over the world because of their great adaptability to varying environmental conditions and the different nutritional regimes under which they were evolved and subsequently maintained. They proved useful to human throughout the ages due to their productivity, small size, and non-competiveness with human for food. It is believed that goats were among the first farm animals has been domesticated. As indicated by the archaeological evidence, they have been associated with human in a symbiotic relationship for about 10,000 years (Ensminger and Parker, 1986). Goats are the most prolific domesticated ruminants; farmers are increasingly relying on goats as means of survival and a way of boosting their income (Peacock, 2005). Goats can withstand heat stress and can endure prolonged water deprivation. They have additionally great adaptability to adverse climatic and geophysical conditions, where cattle and sheep cannot survive. Moreover goats can efficiently utilize poor quality forage; their peculiar feeding habits make it easier to choose diets to meet their requirements. It is also learned that farmers and pastoralists are increasingly relying on goats as means of survival and a way of boosting their income (Peacock, 2005).

The increasing frequency of droughts, with long-term environmental degradation is causing pastoralists to change from cattle or sheep to camels or goats whereas overgrazing makes rangelands increasingly suitable for browsing species such as goats. Goats are considered intelligent, independent, agile, and tolerant to many diseases and parasites, with their characteristics of look after themselves much better than other livestock species. Goat enterprises suits the landless, marginal and small farmers equally since it provides substantial income and helps to create employment to the farm family, including women and children with comparatively low input demanding. Moreover, goat is regarded as the handy source of money in need and is considered as the living bank for marginal and small farmers to supply the immediate need of cash. Indeed several reasons make goats particularly attractive for poverty reduction and improvement of family food security and livelihood of the poor in developing countries.

There are, however, several challenges associated with increasing meat production including consumer and producers' education, lack of slaughter and processing plants and lack of organized breeding programs, markets and developed marketing channels. The importance of this valuable genetic resource is under estimated and its extent of contribution to the livelihood of the poor is inadequately understood. Goat meat has an immense potential in terms of demand and price.

## Typical goat value chain map

An example adapted from HVAP, 2011, the value chain map of goat meat in the Mid-Western region of Nepal is presented in figure 9. The map presents the various functions, actors and enablers on different levels of value chain.




Adapted from: HVAP, 2011

Figure 8. Typical value chain of goat marketing

## 11.1 Actors and functions

It has been identified that major functions involved in goat value chain are input supply, production potentials and local level butchering at the farmer/village level collection, domestic trading and supply to the distance market at the traders' level and often preliminary processing, and/or value addition by butchering and or refrigerating at regional or at the national level with limited practice. The actors in relation to the goat meat value chain are described below:

### 11.1.1 Input suppliers

Common inputs include salt, minerals, concentrates, veterinary medicines, some common forage/fodder tree seeds and saplings that are mainly supplied by the private agro vets. Government and non-governmental agencies working at district level such as the DLSO and local NGOs provide technical knowledge and inputs as per provision to the farmers, whereas flow of inputs and knowledge/technology are limited. For traders, handling related materials such as threads, rope, holding places with limited feeds and forages are major inputs.

### 11.1.2 Goat raising farmers

Mainly three types of farmers are engaged in goat keeping: (a) Small farmers with scattered and low level of production, (b) semi-commercial farmers characterized by 5-10 does keeping and targeting the market for selling, and (c) commercial farmers keeping at least 50 does and 2-3 bucks with the target on larger market scale for meat production as well as serving for the resource centers. In general, the goats from the small farmers rarely enter the market, and it is very limited, especially in the local market or in the villages that is handled by the local butchers. Semi-commercial and commercial farmers sell most of their goats to the various market intermediaries through local collection centres.

### 11.1.3 Local butchers

Local butchers are unorganized and perform the butchering business as and when it is available, or often business in the local market/town by establishing butchering shops. Local butchers directly buy goats from the farmers and often hold in their own collection/holding centre in order to supply as per the local demand of the meat. In some cases they also deal with the live goat selling to the large buyers/traders and serves as an intermediaries.

### 11.1.4 District traders

In Nepal, mainly three types of district traders have been identified by various (HVAP, 2011; DLS, 2013) studies: (a) those who buy, hold/collect in the collection centre and send to the distance markets (Pokhara, Kathmandu) as quickly as possible with their agents in the destination to deal with the further selling activities, (b) those who collects goats from the villages and involves himself/herself in the further selling process by taking the goats to the big cities and market such as Kathmandu, and (c) those who collects the goats from the villages, holds in the collection centre/holding rooms and supply to the near- by market in the road-corridors; sell to the local butchers,

and often sends some goats to the distance market such as Kathmandu. In the case of (b) and (c) traders often involve with credit purchase with the farmers and pay them back once the goats are sold in the distance market. Horizontal linkages exist between farmers and traders in line with collecting and selling process.

### 11.1.5 Sub-national traders

The traders in this category handle and sell the collected goats at the sub-national/regional centres. Process include live goat selling to the butchers/fresh houses.

### 11.1.6 National traders

The traders who have been active in trade of goat in Kathmandu, Pokhara are called national traders. They collect goats from different goat rearing potential district traders and sell live goats in the national market mainly to the butchers/fresh houses.

### 11.1.7 Retailers

Retailers are butchers/ fresh house keepers who process the live goats and sells meat directly to the consumers, sekuwa corners, restaurants, hotels in the big cities and market. This could be taken as the end market from the national market perspectives. Some fresh houses in Nepalgunj and Itahari are involved in processing of the meat. Processing usually consist of cleaning, removing head and legs and wrapping in plastic for storage. The meat is stored in deep freeze for longer time and is delivered to customer mainly to Kathmandu using the insulated vans.

### 11.1.8 Enablers and facilitators

Major functions at the enabler level include activities as public research and related technology development, agreement on professional standards/rules/ norms, provide promotional services through extension activities, advocacy and other related service providers.

### 11.1.9 Enablers in production and local level butchering

Nepal Agricultural Research Council (NARC) in collaboration with different line agencies of Department of Livestock Services (NARDF, RLDs, DLSOs, LSCs etc) and dedicated agricultural educational institutions (AFU, IAAS, HICAST, CTEVT etc) are mainly working to develop and disseminate different production and management related goat-rearing technologies. Similarly co-operatives and goat keeping farmers' groups are often involving

to facilitate goat-rearing activities. In the production process, microfinance institutions and cooperatives assist farmers by providing loans whereas such practices are slowly emerging. I/NGOs as Heifer International, externally funded government projects like, PACT, AFSP, KUBK, HIMALI are involved in providing technical and financial assistance to the cooperatives as well as directly to the farmers to support/encourage local level production.

# 12. Constraints for Profitable Farming

## 12.1 Technology & product development

- Poor supply, low investment
- Improper technology (feed, health, breed, shed)
- Lack of scientific model shed
- Poor breeding activities for improvement
- lack of cross breeding facilities and plan with local breeds
- Limited products diversification
- Limited training to the farmers on improved rearing
- Low motivation to commercial production

## 12.2 Input supply

- Lack of provision for winter feeding (especially in High altitude)
- No enough fodder/forage seeds
- Not enough supply of medicine/vaccines
- Lack of goat resource centre to supply elite doe and buck to the farmers (based on Khari,
  Boer, Sirohi or Jamunapari blood level standardized crosses)
- Farm owner does not have adequate knowledge of diseases and treatment methods
- Due to the limited resources, DLSO is often unable to provide technical support in remote area
- CFUGs have band to goat grazing in Community Forest areas

## 12.3 Access to finance

- Low or no investment from private banks (traders & farmers); even no access in case of women and marginalized community. Low knowledge on the process to access fund; if provided interest rate is high
- Poor facility of loan disbursement from government
- High interest rate
- Low priority of banking sector to collator lands and property in the rural areas
- Lack of group fund mobilization

### 12.4 Regulatory (policy)

- Transportation means undefined
- Lack of plan for emergency and rescue dealing during disease outbreak
- No subsidy or support on means of meat/live animal transportation
- Lack of animal wealth protection policy and or insurance
- Lack of minimum pricing policy while selling live goats
- Poor monitoring mechanism on meat slaughtering and trading
- Poor implementation of meat Act (certification, inspection)

## 13. Recommendation for Future Research and Extension Service

For hills - commercial goat production under intensive system

- Female- all local Khari goat
- 2-5% best Khari does to nucleus flock (research or development farm)-open nucleus breeding scheme
- 15-18% of does- pure breeding with Khari buck (selected)
- 80% does- crossing with Boer buck
- All F1- under feedlot and marketed
- Males from pure Khari breeding- distributed to subsistence farmers for breeding
- Females from pure mating- replacement stock

For hills - commercial goat production under semi-intensive system

- All as above except- Jamunapari as Sire breed instead of Boer for producing F1 for feedlot
- Research and Development farm to maintain high genetic worth pure breeds, rigorous selection and improvement and supply breeding bucks to commercial farms

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# Chapter 5

# Sustainable Goat Farming for Livelihood Improvement in Pakistan: Opportunities, Constrains, and Potential

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## 1. Introduction

Goats are an essential part of livestock farming systems and are raised for meat, milk, fibre and skins. The relative importance of each of these products varies from region to region and is largely determined by ecological and economic factors. Current prices for goats' meat are encouraging because goats become mature quickly and have a short growth period as compared to cattle and buffalo. Farmers can bring products to market very quickly and improve their cash flow. Therefore, herd and flock sizes of the goat are increasing rapidly due to its quicker return and profitable business.

Rearing of goats has greater advantages over other livestock. These advantages include shorter gestation length, multiple births, adaptability to different environments, feeding on a variety of plant species, low water requirements, small size and early maturity. They can be raised even on marginal lands and meager resources. Goat not only supplements the farmer's income but also compliment the crop production business. It provides means of subsistence to the poor and helps in overcoming under-employment in rural areas and enhances food security thus improving the socio-economic conditions of rural community.

Goat meat, milk and its value added dairy products are valuable goods. Goat farming is an integral part of agricultural production system and in some areas they are the main source of animal protein for people particularly in rural areas. Goat is a poor man's cow due to its ability to provide meat, milk, skins and fiber for the farmer. There are many reasons why goat farming is more suitable than cattle for smallholders. The goat is cheaper to buy and replace, and easier to rear than the cattle. Goat farming is a very popular, unique and incredible business model in Pakistan. It requires comparatively less labor and management and it integrates well with both crops and other livestock production.

## 2. Goat Population and Demography

Pakistan is home of about 72 million of goat population and there is a vast diversity of goat population in the country. The goat population has the highest growth rate in Pakistan mainly due to demand for sacrificial purposes and more preference of goat meat in some parts of the country (Punjab, AJK and Sindh). The province wise goat population is given in table 1. The highest goat population is found in Punjab followed by Sindh and Balochistan. There are 6.8 million farmers that are involved in goat farming in Pakistan. The number and distribution of goats by size of flocks are presented in table 2.

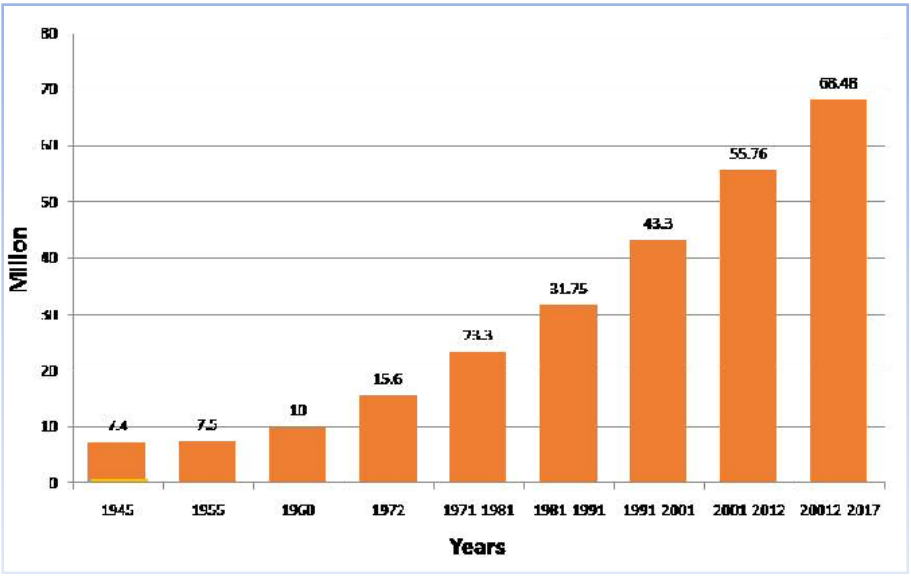



Figure 1. Goat population trend in Pakistan

**Table 1**. Province-wise population of goat in Pakistan (Million numbers)

| Year | Khyber Pakhtunkhwa | Punjab | Sindh | Balochistan | Total |
|---|---|---|---|---|---|
| 2010-11 | 11.07 | 22.76 | 14.14 | 13.53 | 61.5 |
| 2011-12 | 11.36 | 23.35 | 14.51 | 13.88 | 63.1 |
| 2012-13 | 11.68 | 24.01 | 14.93 | 14.28 | 64.9 |
| 2013-14 | 11.99 | 24.64 | 15.32 | 14.65 | 66.6 |
| 2014-15 | 12.31 | 25.31 | 15.73 | 15.05 | 68.4 |
| 2015-16 | 12.65 | 26.01 | 16.17 | 15.47 | 70.3 |
| 2016-17 | 13.00 | 26.71 | 16.61 | 15.88 | 72.2 |

Source: Economic Survey of Pakistan, 2016-17

**Table 2**. Distribution of goat population by size of flock in Pakistan

| Size of Flock | Number of Goats (Millions) | Percentage | Cumulative % |
|---|---|---|---|
| 1 to 5 Goats | 11.92 | 22.2 | 22.2 |
| 6 to 15 Goats | 15.65 | 29.1 | 51.3 |
| 16 to 30 Goats | 8.61 | 16.0 | 67.3 |
| 31 to 50 Goats | 4.89 | 9.1 | 76.4 |
| 51 to 75 Goats | 2.86 | 5.3 | 81.7 |
| 76 to 100 Goats | 1.68 | 3.1 | 84.8 |
| 101 to 150 Goats | 2.03 | 3.8 | 88.6 |
| 151 to 200 Goats | 1.16 | 2.2 | 90.8 |
| 201 to 350 Goats | 1.64 | 3.0 | 93.8 |
| 350 Goats and above | 3.34 | 6.2 | 100 |
| Total | 53.78 | 100 | |

Source: Livestock Census, 2006

Flock size varies in different production system but 6-15 animals are more common. About 76% goats are distributed in flock size less than 50 animals while 9.2% are in flock size of more than 200 animals. Goat in the world mainly exists and survives on rangelands, however, in Pakistan 62% population is either stall fed or grazing on marginal land.

Goats are kept primarily for meat production. Some goat breeds such as Beetal, Daira Din Panah (DDP), Nachi and Kamori are known as milch breeds. These are breeds whose meat is also most liked in their respective areas, especially Beetal and Kamori. Therefore, these breeds are known as dual purpose. Teddy is a small size breed, which has gained wide distribution and popularity over the last 30 years because of its prolificacy and faster growth rate. Population of dairy goat breeds is given in table 3

**Table 3**. Dairy goat breeds and their population in Pakistan

| Breeds | KPK | Punjab | Sindh | Balochistan | Total |
|---|---|---|---|---|---|
| Beetal | 0.65 | 3.10 | 0.24 | 0.21 | 4.20 |
| DDP | 0.05 | 0.08 | 0.02 | 0.01 | 0.16 |
| Nachi | 0.02 | 0.03 | 0.03 | 0.04 | 0.12 |
| Kamori | 0.05 | 0.04 | 3.90 | 1.30 | 5.29 |
| Pateri | 0.01 | 0.02 | 1.34 | 0.02 | 1.39 |
| Damani | 0.90 | 0.05 | 0.03 | 0.33 | 1.31 |
| Total | 1.68 | 3.32 | 5.56 | 1.91 | 12.47 |

# 3. Breeds and Breeds Description

## 3.1 Ingenious breeds

Pakistan including Azad Kashmir (AJK) and Gilgit Baltistan has 36 breeds of goat which are listed below in table 4.

**Table 4**. Goat breeds in Pakistan

| Province | Number of breeds | Name of breeds |
|---|---|---|
| Punjab | 5 | Beetal, Dera din Panah, Nachi, Teddy, Potohari |
| Sindh | 14 | Barbari, Bari, Bugi Toor, Bujri, Chappar, Jattan, Kacchan, Kamori, Kurri, Lohri, Pateri, Sindh Desi, Tapri, Tharki |
| KPK | 3 | Damani, Gaddi, Kaghani |
| Balochistan | 3 | Kajli, Kharasani, Lehri |
| Gilgit Baltistan & AJK | 11 | Baltistani, Beiari, Buchi, Jararkheil, Jattal, Koha-i-Ghizer, Kooti, Labri, Piamiri, Shurri |

Source: Isani and Baluch, 1996

The phenotypic description, habitat and morphological characteristics of these breeds are given below:

### 3.1.1 Beetal

Beetal goats are found in almost all the irrigated areas of the Punjab including districts Jhelum, Gujrat, Mandi Bahauddin, Sialkot, Gujranwala, Lahore, Sheikhupura, Faisalabad, Sargodha, Jhang, Multan, Sahiwal and Okara. Body color is golden brown or red spotted with white or black patches. The body is compact and well developed. The head is massive and broad, nose roman and ears long, broad and pendulous. Spiralled horns are long in males and shorter in females. They have long stout legs. The udder is well developed. Adult males and females weigh 46 and 37 kg, respectively. Milk yield is 290 litres per lactation of 130 days. Beetal males are reared especially as sacrificial animals for slalughter on Eid-ul-Azha.

### 3.1.2 Daira Din Panah

Districts Muzaffargarh and Multan in Punjab are the home tract of this breed. They are named after Dera Din Panah, a town in Muzaffargarh district. These goats are black and hairy with a large well developed body, large head with Roman nose and long broad ears. Horns are thick and long with two to three spiraled curves. Udder is well developed and milk yield is 245 litres in 135

day lactation. Adult males and females weigh 45 and 40 kg, respectively. These goats are reared for milk, meat and hair production.

### 3.1.3 Nachi

These goats are found in Bahawalpur, Multan, Muzaffargarh and Layyah districts in Punjab province. They have a dancing gait, hence the name Nachi. Nachi goats are usually black but sometimes they are black and white spotted. They have a compact body, medium head with Roman nose, small and thin horns and medium ears. Milk yield is 110 litres in 100 day lactation. Adult males and females weigh 33 and 28 kg, respectively. Nachi goats are reared for meat and milk.

### 3.1.4 Teddy

This breed is said to have been imported from Bangladesh. Its present home tract comprises the Districts of Sargodha, Gujrat, Jhelum and Rawalpindi in Punjab and the adjoining areas of Azad Kashmir. Teddy goats are creamy white, brown, black or patched with these colors. They have a compact body, small and droopy ears and slightly prominent nose. Both horned and polled specimens are found. Horns may have spirals. Hind quarters are muscular. Milk yield is 65 litres in 130 day lactation. Adult males and females weigh 30 and 23 kg, respectively. Teddy goats are reared for meat. Early maturity and high prolificacy are important features of this breed.

### 3.1.5 Potohari

This breed is found in Potohar area of Punjab & adjoining parts of Kotli & Mirpur districts of Azad Jammu and Kashmir. This is a small size breed having major utility as meat type and dressing percentage is 45-55%. Its body colour is black, grey or white. Birth weight of male 2.0 kg and female 1.8 kg and adult weight of male is 28 kg and female 22 kg. Milk production is 110 litre in 150 days lactation length. The average hair production is 0.45 to 0.75 kg per year. This breed has head & ears of medium size, hairy growth on chin, udder not well-developed. Ninety percent does produce single birth and only 10% twin births.

### 3.1.6 Barbari

This breed is found in parts of Hyderabad, Dadu, Larkana, Khairpur, Nawabshah and Jacobabad districts of Sindh. A strain of this breed is also found in Jhang, Sargodha, Faisalabad and Lahore districts of Punjab. Body color is usually white, brown or spotted. It has a compact body, small head with a long narrow snout, small straight and erect deer like ears which is a distinctive feature of this breed. Horns are small and pointed. Polled animals

are also seen. Milk yield is 100 litre in 110 day lactation. Adult males and females weigh 23 and 20 kg, respectively. Barbari goats are predominantly a meat breed, however, they look like a deer, they are also reared as a fancy breed.

### 3.1.7 Bari

This breed is found in Hyderabad, Dadu, Larkana, Khairpur, Nawabshah and Jacobabad districts of Sindh and some parts of Punjab. It is generally white in color but grayish and spotted specimens are also found. It is a small sized breed resembling deer in shape and size. The ears are small and erect resembling those of a deer. Body coat is covered with short hairs. Milk yield is 0.8 to 1.0 litre/day. Adult males and females weigh 29 and 24 kg, respectively. They are reared for milk and meat.

### 3.1.8 Bugi Toori

This breed is found in parts of districts Hyderabad, Badin and Mirpurkhas. They are white colored hairy animals. They have a medium head with spirally twisted horns rising in an upright position and drooping medium ears. While walking, their neck and face are held upward. Adult males and females weigh 30 and 25 kg, respectively. These goats are reared for meat and hair.

### 3.1.9 Bujri

Bujri goats are found in the districts of Thatta and Badin in Sindh province. They are usually white colored animals. The body is covered with long hairs. The face is medium sized and bridge of nose is slightly bulged and convex. Small, slender shaped horns are present in both males and females. Adult males and females weigh 45 and 35.5 kg, respectively. These goats are reared for meat and hair.

### 3.1.10 Chappar

This breed originates from the south western mountain ranges of Sindh and the adjoining hilly parts of Balochistan, hence the name Chappar meaning mountainous. The area comprises Karachi, Thatta, Dadu and Larkana Districts in Sindh and Lasbela district in Balochistan. Chappar goats are all black or white or spotted with black and white and they are hairy. The head is small with an evident forelock. Ears are small to medium. Both males and females are horned and the horns have blunt ends. Males and females are both horned. Milk yield is 90 litres in 120 day lactation. Adult males and females weigh 26 and 22 kg, respectively. Chappar goats are raised for meat and hair production.

### 3.1.11 Jattan

This breed is named after the camel-raising tribes of Jats in Sindh. Jattan goats are found in the irrigated areas of Mirpurkhas district bordering Thar desert. Their color is fawn, red or black. This is a large sized breed with long legs. The medium drooping ears are white and splashed with fawn, red or black. Males have a black ring around the base of the neck. Males and females are both horned. Milk yield is 225 litres in 130 day lactation. Adult males and females weigh 50 and 42 kg, respectively. Jattan goats are raised mainly for milk.

### 3.1.12 Kacchan

This breed is found in Hyderabad and parts of Badin districts. They have generally black or brown bodies with white marking around cheeks and ears and around the base of ears. This is a large sized breed. Ears are folded at base and open at the middle and appear like those of a cow. Legs are long and are covered with hair above the hocks. Milk yield is 1.5 to 3.0 litre/day. Adult males and females weigh 78 and 50 kg, respectively. They are raised for milk and meat.

### 3.1.13 Kamori

Although Kamori goats are popular all over Sindh, they are considered a breed of the irrigated tract. True to type specimens are found near Hala and Saeedabad extending to parts of Nawabshah district. Kamori are dark brown with light brown or black patches of varying sizes. They are large and compact animals. The head is also large, nose Roman and ears long, wide and drooping. Males and females are both horned. Milk yield is 210 litres in 115 day lactation. Adult males and females weigh 50 and 44 kg, respectively. Kamori goats are primarily raised for milk.

### 3.1.14 Kurri

This breed is found in Kandhkot, Jacobabad, south of Sukkur and Nawabshah and eastern side of Kashmir. They are generally black or brown. This is a medium sized breed. Ears are small and conical and turned. Average length of ears is 5 to 6 cms. Because of short conical ears it is called Kurri. Milk yield is 1.0 litre/day. Adult males and females weigh 50 and 35 kg, respectively. They are raised for milk and meat.

### 3.1.15 Lohri

This breed is found in Kacha area of river Indus on both sides of the river in some parts of district Dadu, Larkana, Khairpur and Sukkur. They are

generally off white, rusty with black legs up to knees and below hocks also found in black or brownish color. Black specimens are also found in some flocks. This is a large sized breed. Ears are 50 cm long and ribbon like. The back side of the body is covered with long hair. Milk yield is 0.75 litre/day. Adult males and females weigh 58 and 45 kg, respectively.

### 3.1.16 Pateri

The Pateri breed is found in the districts of Hyderabad, Nawabshah, Khairpur and Sanghar in Sindh. Body color is white and face, neck, ears and legs are reddish brown. The Pateri is one of the heaviest breeds of goat found in Sindh. The ears are long and drooping. Milk yield is 170 litres in a 120 day lactation. Adult males and females weigh 52 and 42 kg, respectively. These goats are reared for meat and milk. Fattened males are in great demand for sacrificial slaughter on the occasion of Eid-ul-Azha.

### 3.1.17 Sindh Desi

They are found in Dadu, Nawabshah, Sukkur and parts of Larkana districts in Sindh. The body of desi goats is usually all black but white, grey or spotted animals are also seen. The head and parts of neck are black. They have a compact body and medium head. Milk yield is 140 litres in 95 day lactation. Adult males and females weigh 48 and 39 kg, respectively. These goats are reared for meat and milk.

### 3.1.18 Tapri

These goats are found in the eastern part of Hyderabad district contiguous with Mirpurkhas in Sanghar district and parts of Khairpur in Sindh. Tapri goats are camel colored or reddish brown although occasionally a white body color is also seen. The head and ears are small and neck is short. Adult males and females weigh 22 and 18 kg, respectively. Tapri breed is early maturing and prolific. They are raised mainly for meat production.

### 3.1.19 Tharki

These goats are named after Thar, the desert area of Sindh, which is the home tract of this breed. The body of tharki breed is usually black but red animals are also found. They are medium sized hairy goats with medium head and ears. Milk yield is 110 litres in 120 day lactation. These goats are reared for meat, milk and hair production.

### 3.1.20 Damani

These goats are found in Bannu, Dera Ismail Khan and parts of Peshawar district in Khyber pukhtun khwa. Damani goats have a black body hair coat

and tan or camel colored head and lower half of legs. The head and ears are medium sized, horns curved and pointed. Milk yield is 110 litres per 100 day lactation. Adult males and females weigh 31 and 26 kg, respectively. Damani goats are reared for meat and milk.

### 3.1.21 Gaddi

Gaddi breed is found in the Kaghan valley. Gaddi goats are generally black but white and grey animal are also found. They are fairly large sized hairy animal with a massive head and long ears and horns. Milk yield is 125 litres in 150 days. Adult males and females weigh 50 and 42 kg, respectively. These goats are raised for meat, milk and hair.

### 3.1.22 Kaghani

The home tract of this breed is the Kaghan valley of Khyber pukhtun khwa and its range includes Abbottabad, Mansehra and Swat districts and the Kohistan area. Muzaffarabad district of Azad Kashmir also forms part of its home tract. Kaghani goats are usually black but white, grey or brown ones are also seen. The body is well developed and compact. They have a large head and medium ears. The thick horns extend upwards and backwards. The adult males and females weigh 42 and 35 kg, respectively. Kaghani goats are reared for meat and hair.

### 3.1.23 Lehri

This breed is named after the town of Lehri in the Kachhi area of Sibi district in Balochistan. Most are black but white or grey animals are also seen. The body is compact and covered with long hair. Their head is of medium size. Ears are very long and pendulous. Males and females are both horned. Adult males and females weigh 35 and 30 kg, respectively. Lehri goats are reared for meat and hair.

### 3.1.24 Khurasani

This breed is found in Chaghi, Loralai, Quetta and Zhob Districts in Balochistan. Khurasani goats are black but white or grey animal are also seen. Heads and ears are of medium size. Large and spirally curled horns are found in males. Milk yield is 180 litres in 150 day lactation. Adult males and females weight 30 and 25 kg, respectively. These goats are raised for meat and milk.

### 3.1.25 Kajli

Kajli goats are from Dera Ghazi Khan District in Punjab and Loralai district in Balochistan. They are usually black but sometimes white, brown or grey.

Their muscular body is covered with long hair. The head is small. Ears erect and pointed and horns thin. Milk yield is 120 litres in 120 day lactation. Adult males and females weigh 30 and 25 kg, respectively. Kajli goats are raised for meat, milk and hair.

### 3.1.26 Baltistani

This breed is found in Baltistan district of the northern areas. Body color is black with white patches of varying sizes. The small head is black with short horns in both males and females. They resemble Teddy goats but are taller in stature. Adult males and females weigh 29 and 25 kg, respectively. Milk yield is almost 100 litres per lactation. These goats are raised for mutton, milk, hair and manure.

### 3.1.27 Beiari

Beiari goats are from Kotli district and adjoining parts of Mirpur district of Azad Kashmir. These short-haired goats are all white or grey, or have white or grey patches. The body is compact. Ears are long and drooping. The horn grows upwards and backwards. Adult males and females weigh 25 and 20 kg, respectively. The udder is fairly well developed and milk yield is 135 litres in 150 days. This breed is raised for meat and milk.

### 3.1.28 Buchi

These goats are found in parts of Kotli, Muzaffarabad and Poonch districts in Azad Kashmir. Buchi are black or grey. They have a massive head with a slightly Roman nose and very small ears, hence the name Buchi. Both males and females have horns. The udder is medium sized. Milk production is 90 litres in 150-day lactation. Adult males and females weigh 30 and 22 kg respectively.

### 3.1.29 Jararkheil

These goats are from the Chilas valley in Diamir district in the northern areas and parts adjacent to Hazara district and Azad Kashmir. They are usually black with white patches. They have a well developed body with long hair, large drooping ears with white patches and large horns. Adult males and females weigh 52 and 45 kg respectively. Milk yield is 135 litres per 100 day lactation. Jarakheils are reared for mutton, hair, milk and manure.

### 3.1.30 Jattal

These goats are found in parts of district Kotli and Mirpur Azad Kashmir. They are usually black. They are medium sized with slim body covered with 8 to 10 cm long hairs. Neck is thin and long. Head is massive and straight.

Adult males and females weigh 23 and 19kg respectively. Milk yield is 80 litres per 150 day lactation.

### 3.1.31 Koha-i-Ghizer

Koha-i-Ghizer goats are found in an area located along Kohai Ghizer, extending from Gilgit to Yasin and Imit in northern areas. They are generally black with white patches on the belly and brown rings around the eyes. The head is small and the ears drooping. Males are horned and most females polled. Milk yield is 70 litres in 100 days. Adult males and females weigh 35 and 30 kg respectively. Goats of this breed are raised for milk, meat, hair and manure.

### 3.1.32 Kooti

Kooti goats are found in Almut, Kail and Shonther in Azad Kashmir. Kootis have black and white patches on their body. The body, head and ears are small. Their small horns are spiraled. The legs are short and stout. Milk yield is 100 litres in 150 day lactation. Adult males and females weigh 20 and 15 kg respectively.

### 3.1.33 Labri

This breed is found in parts of Jhelum, Leepa and Neelam valleys of Muzaffarabad district and adjoining areas of Poonch district in Azad Kashmir. Labri goats are mostly black but some have patches of light grey or brown. They are fairly large sized goats. The head is large with long ears. Both males and females have long thick horns. Milk yield is 170 litres in150 day lactation. Adult males and females weigh 48 and 40 kg respectively. Labri goats are raised for meat, milk and hair.

### 3.1.34 Piamiri

Piamiri goats are found extensively in the upper Hunza valley near Khunjarab territory in the northern areas. Piamiri goats are usually all black but brown or grey-white patches are occasionally seen. They are medium sized animals. Legs are short and hairy. Milk yield is 80 litres in100 day lactation. Adult males and females weigh 36 and 30 kg respectively.

### 3.1.35 Shurri

Shurri goats are found in the Jhelum, Leepa and Neelam valleys of Muzaffarabad district and Bagh and Haveli areas of Poonch district in Azad Kashmir. They are solid white, grey or black or patched with these colors. Their body is compact. The head and ears are medium. Males and females are both horned. Their legs are long and stout. Milk yield is 135 litres in150

day lactation. Adult males and females weigh 38 and 32 kg respectively. Shurri goats are raised for meat and milk.

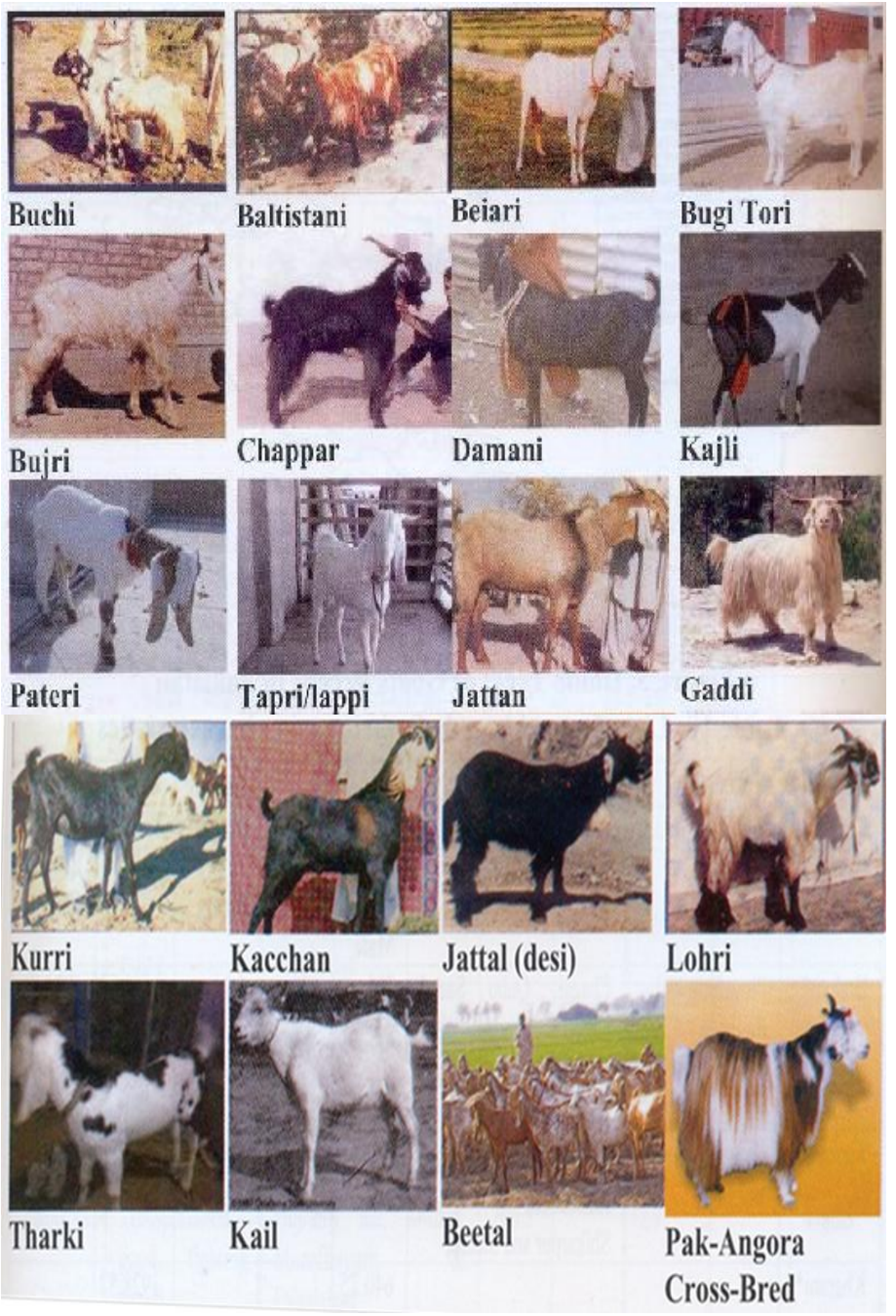



Figure 2. Pictures of different goat breeds in Pakistan

## 3.2 Exotic Breeds

### 3.2.1 Angora goat

The Angora goat originated in the district of Angora in Asia Minor. The Angora dates back prior to early biblical history. Mention is made of the use of mohair at the time of Moses, which would fix the record of the Angora sometime between 1571 and 1451B.C. according to the Angora goat Mohair industry publication from USDA (Miscellaneous Bulletin 50, 1929). Mohair became a valuable product in commerce early in the nineteenth century. In order to increase the supply of mohair available for export to the European countries, the Turks crossed the Angora goat with common stock to increase the poundage of salable hair.

Angora stock was distributed to different countries, and a pair of Angoras was imported to Europe by Charles in 1554. In 1765 an importation was made by the Spanish government and twenty years later a considerable number were imported into France. None of these importations were successful in establishing mohair production. On the other hand, Angoras were taken to South Africa in 1838, and from this importation and later importations mohair production was established in that country. The Union of South Africa is one of the three leading mohair-producing sections in the world and is exceeded in production only by the United States and Turkey.

The most valuable characteristic of the Angora as compared to other goats is the value of the mohair that is clipped. The mohair is very similar to wool in chemical composition but differs from wool in that it is has a much smoother surface and very thin, smooth scale. Consequently, mohair lacks the felting properties of wool. Mohair is very similar to coarse wool in the size of fiber. It is a strong fiber that is elastic, has considerable luster, and takes dye very well. Mohair has been considered very valuable as an upholstering material for the making of plushes and other covering materials where strength, beauty, and durability are desired.

The Angora is very picturesque animal in which both sexes are horned. The bucks usually have a pronounced spiral to the horn, which comes back and away from the head; the horns of mature bucks sometimes reach two or more feet in length. In contrast, the horn of the female is comparatively short, much smaller, and has only a very slight tendency to spiral. The horn of the female seldom exceeds nine or ten inches. The ears are heavy and drooping. The Angora goat is a small animal as compared to sheep, common goats, or milk goats. There is considerable variation in the size of goats, but mature bucks will usually fall in a weight range of from 80 to 100kg but do not reach their maximum weight until after five years of age. Does will fall in a weight range of from 32 to 50 kg when mature. The Angora goat is not as prolific as other goats and twins are not the usual birth. Goats in large range bands will usually kid from 60 to 70 percent, but in well-managed small herds of purebred goats the rate of reproduction may be slightly over 100 percent. A herd of Pak angora is kept at Rakh Kherewala District Layya.

### 3.2.2 Sannen Goat

The Saanen dairy goat originated in Switzerland, in the Saanen Valley. Saanen does are heavy milk producers and usually yield 3-4 percent milk fat. It is medium to large in size (weighing approximately 65kg) with rugged bone and plenty of vigor. Saanens are white or light cream in color, with white preferred. Small spots of color on the hair are allowable, but not desirable. Ears are erect and alertly carried, preferably pointing forward. The face is straight or dished. A tendency toward a roman nose is discriminated against. The breed is sensitive to excessive sunlight and performs best in cooler conditions. The provision of shade is essential and tan skin is preferable. Pakistan received 1000 doses of saanen semen which is being used at NARC Islamabad.

## 4. Production Systems

In Pakistan, seven million people are involved in goat production. Majority of these people are landless or have 2 to 3 acre land mostly for the grain

production. In Khyber Pakhtun khwa mostly, the goat flocks are kept on the grassland particularly during the summer season in search of feed resources. Whereas, due to the change in the feed availability, there is a shift in the pattern of production systems. The shepherd community is adopting the sedentary system more because of the high demand and value of goat mutton and milk.

Goats are raised under different production systems. There are four main systems of production for goats namely nomadic, transhumant, household and sedentary in various regions of the country since unknown times. The distribution of goats under different production systems is depicted in table 5 and figure 3. According to FAO (2003) small ruminant production is mainly under sedentary and transhumant production systems. However, it seems that due to degradation of rangelands, drought and flood for the last 10-14 years, production system of the goats might have further changed. Due to limited grazing land, shepherds are keeping more goats under sedentary and household systems.

**Table 5**. Distribution of goats by production system

| Production System | 1993 (%) | 2003 (%) |
|---|---|---|
| Nomadic | 44 | 6 |
| Transhumant | 38 | 32 |
| Sedentary | 6 | 40 |
| Household | 12 | 22 |

Ishaque (1993), FAO (2003)

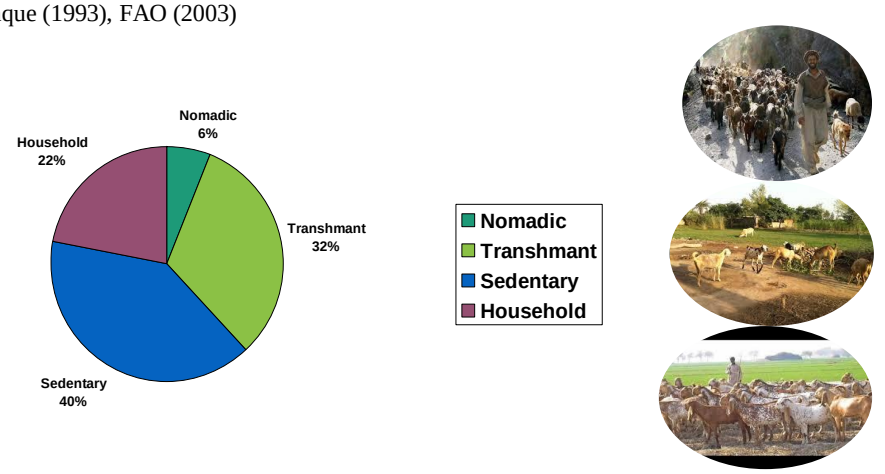



Figure 3. Goat distribution by production systems in the country

It is possible that the extensive and very extensive production system would apply more to meat rather than dairy goats certainly in terms of distance

walked per day in search of feeds and water. The main purpose of goat farming is mutton production because of demand in the country. Goat milk is mainly used by the shepherds and the others usually do not prefer it because of taste and odour. Dairy goat farming is not practiced on a large scale in Pakistan.

The sedentary and household is more common in Punjab and Sindh province while about 59% of goats are under the transhumant system and 30% under the nomadic system in Balochistan. As reported by Habib (2013) that 68% sheep and goat population are raised under the extensive production system (Transhumant and nomadic) in Pakistan.

## 4.1 Farming practices

Pakistan has a continental type of climate characterized by extreme variations of temperature, both seasonally and daily. Latitude and longitude of Pakistan are 29.4000° N, 69.1833° E. Very high altitudes modify the climate in the cold, snow-covered northern mountains; temperatures on the Balochistan Plateau are somewhat higher. Along the coastal strip, evenings are cool; the diurnal variation in temperature may be as much as 11 °C (52 °F) to 17 °C (63 °F). The average annual rainfall in Pakistan is between 60 to 1000 mm mostly during summer and in winter the rainfall is between 30 to 100 mm.

Goat farming is practices are mostly traditional. It is mostly for mutton production but goat milk is also important in some parts of the country (Khan, 2004). In arid and semi-arid areas where buffalo and cattle milk is not available, people depend upon the goat milk. In upper Balochistan, goat milk is preferred as compared to buffalo and cow milk.

## 4.2 Housing

Housing is generally limited to open kraals (enclosures) which may have a mud / brick wall but use of thorny bushes is common to prevent the flocks from getting out and the predators from getting in at night. In most cases, the grazers sleep close to their flocks especially when roofed sheds are available. In Pakistan, we usually recommend 15 sq. ft. covered area and 30 sq. ft. for the open area. At the government livestock farms, bricks and cemented housing is used for goat housing.

## 4.3 Feeding

### 4.3.1 Feeding practices in extensive production system

Animals raised under this system satisfy their nutritional needs entirely from grazing the existing vegetation and is most prevalent in arid, semi-arid and

mountainous regions of Pakistan. The animals are not offered any supplement. It is estimated that 68% goats are raised under this system in Pakistan. The rangelands in Pakistan are classified into: moist temperate, dry temperate, sub-tropical humid, sub-tropical dry, tropical and sub-tropical thorn scrub. The climatic conditions vary enormously across these rangelands and the vegetation developed in response to the climatic conditions thus largely differs.

### 4.3.2 Feeding practices in mixed extensive system

In this system, a combination of grazing and stall-feeding of animals with some supplements is practiced. Animals are grazed during day time and on return are offered supplements in the form of crop residues, hay, tree leaves or concentrate mixture. Lopped leaves mostly from Zizyphus, Acacia and Grewia tree species are fed as fresh or dried. Home-made concentrate comprising equal parts of oilseed cakes and cereal bran are fed in quantity of 200 g/day to milking goats.

Organized intensive feedlot fattening of mutton is in its infancy stage and the demand for mutton is met from the animals as a by-product of dairy sector. Young males and culled animals are transported to the cities for slaughtering and processing. However, fattening of animals for sale on Eid festival is a common income generating activity in rural small holder system. These animals are grazed and provided 500 g/day home-made concentrate mixture containing equal parts of grains, pulses and oilseed cake together with legume straw for four months before sale. Fattening animals are also drenched 300 ml/day vegetable oils as extra energy source two weeks before sale.

### 4.3.3 Feeding practices in mixed crop-livestock system

In this system, small herd sizes of livestock species are reared in complementation to agricultural cropping and depend on feed from arable land, primarily consisting of fodders, crop residues and other crop by-products produced at the farm. This type of mixed farming system forms the backbone of the small holder system in Pakistan and nearly one-third of the small ruminant livestock population is raised under mixed crop-livestock system in both irrigated and arid regions. Feeding practices in mixed crop-livestock system is mostly conventional. Animals are mostly stall fed with restricted grazing on marginal lands if any. Normally fodder ad libitum serve as basal diet which is replaced by cereal straws/stovers in lean periods. Milking goats are offered home-made concentrate on average 400 g/day/head in addition to green fodder. The concentrate supplement is prepared by mixing oilseed cake, wheat bran, dried waste bread in equal proportions. The

mixture is soaked in water few hours before feeding and mixed with wheat straw at the time of milking. Some farmers also add grains up to 20% in the concentrate mixture. The farmers in dry area are relatively resource poor and the daily allowance of concentrate feed is half of that offered in irrigated areas.

Grazing on road side
Banks of canals
Crops residues
Loping of Trees
Concentrate is given to lactating goats

Figure 4. Feeding management

### 4.4 Breeding

Generally speaking breeding of goats is not organized. Farmers usually raise their own buck for natural breeding. Such bucks are not selected for true to type breed rather depends on the availability of a particular male. There are two breeding season (Autumn, and Spring) in a year. Male progeny are usually disposed off at the age of 4-6 months or kept for sale at Eid-ul Azha. All females are kept for replacement. Goats normally breed thrice in a two-year period and give birth to single or twins and sometime triplets at a time. Initiation of purposeful goat breed development program is a key to reduce poverty and increase the livelihood of goat farmers.

## 5. Performances (Reproduction, Milk, Meat)

Several studies have been conducted on the performances of some of these breeds. Some representative data of Teddy and Beetal breed is given table 6.

**Table 6**. Least squares means of reproductive traits in different breeds

| | Teddy goats | | Beetal goats | |
|---|---|---|---|---|
| Traits` | Number` | Mean ± SE | Number | Mean ± SE |
| Age at first service (days) | 7421 | 245.65±0.73 | 840 | 750±8.50 |
| Weight at first service (kg) | 7421 | 14.07±0.01 | 840 | 34.1±0.16 |
| Age at first kidding (days) | 7402 | 18.06±0.01 | 924 | 902±7.80 |
| Weight at first kidding (kg) | 7402 | 18.11±1.56 | 924 | 43.8±0.20 |
| Services per conception | 20929 | 1.24±0.004 | 3777 | 1.11±0.00 |
| Service period (days) | 8305 | 153.58±0.73 | | 160±9.70 |
| Kidding interval (days) | 9314 | 327.53±1.12 | 1910 | 367±2.81 |
| Dry period (days) | | | | 125.46±6.84 |

## 5.1 Animals slaughtering

The capacity of slaughter houses is much lower than the requirements in Pakistan. Due to shortage of slaughtering facilities, the number of animals is slaughtered outside. In Pakistan there are 295 recognized slaughter houses, 27 in Khyber Pakhtun khaw (KP), 174 in Punjab, 60 in Sindh and 34 in Balochistan. All the big cities of Pakistan have slaughter houses under the control of public sector but these facilities are insufficient. Recently 35 slaughter houses have been established under the private sector; these are ISO certified and support the export of meat; 19 modern slaughter houses are in Punjab, 13 in Sindh and 3 in KP; all under control of private sector (GOP, 2016), but not a single slaughter house in Balochistan. It is expected that in the future more slaughter houses under the private sector will be established to meet export requirements.

## 5.2 Meat production in Pakistan

In Pakistan, meat is produced by cattle, buffalo, sheep and goats. Bulk of the meat comes from cattle and buffalo and is called beef. Meat from sheep and goats is called mutton. It was estimated that a total of 1,998 thousand tons of red meat was produced in 2006; 72.0% was beef and 28.0% was mutton. The trend of red meat production in Pakistan from 2006 to 2015 is presented in

table 6 indicating that total beef production increased by 35% and mutton by 21%.

**Table 7**. Trends in red meat production in Pakistan, 2006-2015 (000 tons and %)

| Type of Animals | 2006 | % | 2010-11 | % | 2014-15 | % |
|---|---|---|---|---|---|---|
| Cattle | 702 | 35.13 | 845 | 36.39 | 974 | 37.23 |
| Buffalo | 742 | 37.14 | 861 | 37.08 | 971 | 37.120 |
| Sheep | 207 | 10.37 | 220 | 9.47 | 235 | 8.98% |
| Goat | 347 | 17.37 | 396 | 17.05 | 436 | 16.67 |
| Total | 1998 | | 2322 | | 2616 | |

Source: Livestock Census of Pakistan, 2006 & Pakistan Economic Survey 2014-15

It is evident from table 7 that share of cattle meat has increased over time while it remained almost static in the case of buffalo meat but reduced in the case of sheep and goat meat.

## 5.3 Mutton production

For mutton production, goats are more important than sheep, which is mainly due to a consumer preference for goat meat. The contribution of sheep in total mutton production declined from 10.37% in 2006 to 8.98% in 2014-15. The trend in goat meat production over the same period is depicted in table 6 which is also showing a decreasing trend in meat production.

## 5.4 Goat milk production

Goats produce about 2.0 % (891 thousand tons of milk which is about 2%) of the total milk produced in the country.

**Table 8**. Total goat milk production

| Year | Production (000 tonnes) | Human Consumption (000 tonnes) |
|---|---|---|
| 2009 | 739 | 739 |
| 2010 | 759 | 759 |
| 2011 | 779 | 779 |
| 2012 | 801 | 801 |
| 2013 | 822 | 822 |
| 2014 | 845 | 845 |
| 2015 | 867 | 867 |
| 2016 | 891 | 891 |

Source: Agricultural Statistics of Pakistan, 2012 and Economic Survey of Pakistan, 2016-17

The increase in milk production is not due to increase in milk yield per head but it is due to increase in number of milking goats. Total milk production from different livestock species in Pakistan are given in table 9

**Table 9**. Milk production from different livestock species in Pakistan (000 tons)

| Species | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Goat | 759 | 779 | 801 | 822 | 845 | 867 | 891 |
| Sheep | 36 | 37 | 37 | 38 | 38 | 39 | 39 |
| Cow | 16,133 | 16,741 | 17,372 | 18,027 | 18,706 | 19,412 | 20,143 |
| Buffalo | 28,694 | 29,565 | 30,350 | 31,252 | 32,180 | 33,137 | 34,122 |
| Camel | 818 | 829 | 840 | 851 | 862 | 873 | 885 |
| Milk (Gross Production) | 46,440 | 47,951 | 49,400 | 50,990 | 52,632 | 54,328 | 56,080 |

Economic survey of Pakistan, 2016-17

Major milk supply is coming from buffalo which is about 60%, the second major contribution is from cow which provides about 35% and the goat contributes about 2% in the total milk supply. In the recent year, milk supply from cow is increasing which is mainly due to the increase of foreign crossbred animals in the country.

## 5.5 Milk production potential of different dairy goats

The average milk yield from selected dairy goat breeds of Pakistan are given in table 10. Beetal goat is the highest producers (2 liter/day) of daily milk yield followed by Kamori (1.8 liter /day), Kacchan (1.7 liter /day), DDP (1.6 liter /day) and Damani (1.3 liter /day).

**Table 10**. Average milk yield of selected dairy goat breeds of Pakistan

| Breed | Lactation Milk yield (L) | Lactation length (days) | Average daily milk yield (L) |
|---|---|---|---|
| Beetal | 272 | 140 | 2.0 |
| DDP | 205 | 130 | 1.6 |
| Damani | 115 | 100 | 1.2 |
| Kamori | 204 | 115 | 1.8 |
| Kacchan | 190 | 110 | 1.7 |
| Nachi | 214 | 160 | 1.3 |

Source: Isani & Baloch (1996), Rehman & Shah (2003) and Iqbal et al. (2003)

The genetic potential does exist for milk production in these breeds of goats in Pakistan. It needs to be exploited through selective breeding and better management.

## 6. Diseases and Health Care Service

The vaccines are available for a number of pathogenic contagious diseases like Peste des petites ruminant (PPR), Contagious Caprine Pleuropneumonia (CCP) and Enterotoxaemia (ET). The large commercial farms usually practice vaccination and deworming to their goat flocks. However, the small and landless farmers get their animals treated after the appearance of disease in their flocks, and in most cases vaccines are not available when needed. Usually the government supports the landless farmer free of cost vaccination in their flock through a veterinary service extension network which is offering services to the farmers.

Recently, FAO has also launched a program in Pakistan for the eradication of PPR. Under the program, free of cost vaccine is being provided to goat farmers in the country. Due to the tropical environment, the parasites are also a major problem in goat flocks maintained on extensive and semi-extensive system. Farmers usually do the de-worming by themselves mostly twice a year. In some part of the country particularly in Northern area, people use the leaves of the peaches and outer cover of pomegranate for the control of internal parasites in goats.

**Table 11**. Veterinary service institutes in various provinces/regions of Pakistan

| Province | Civil Veterinary Hospital | Civil Veterinary Dispensary | Civil Veterinary Centre | Mobile Veterinary Dispensary | Artificial Insemination Centre | Artificial Insemination sub centre | Disease diagnostic Labs | Vaccine production units/ Research |
|---|---|---|---|---|---|---|---|---|
| Punjab | 438 | 1606 | 724 | 116 | 23 | 96 | 31 | 1 |
| KP | 98 | 363 | 218 | - | 415 | - | 7 | 1 |
| Sindh | 119 | 60 | 608 | - | - | - | 7 | 2 |
| Balochistan | 116 | 783 | - | | | | 15 | 1 |
| GB | 12 | 165 | - | - | - | - | 7 | - |
| FATA | 25 | 212 | 207 | - | - | - | 1 | - |
| ICT | 4 | 7 | - | - | - | - | 1 | 1 |
| AJK | 59 | 66 | 129 | - | - | - | 6 | - |
| Total | 871 | 3262 | 1886 | 116 | 438 | 96 | 68 | 6 |

FATA Federally Administered Tribal Areas, ICT Islamabad Capital Territory, AJK Azad Jammu and Kashmir, GB Gilgit Baltistan

There are 871 veterinary hospitals, 3262 dispensaries and 1189 veterinary centers which are providing veterinary services to livestock farmers including goat farmers in the country. Vaccination schedule for goats against various diseases are given in table 12.

**Table 12**. Vaccination schedule for sheep and goats against various diseases

| Sl. No | Disease | Vaccination time | Duration of immunity |
|---|---|---|---|
| 1 | Enterotoxaemia | December-January and June-July | Six months |
| 2 | Pleuro-pneumonia | October-November | One year |
| 3 | Sheep pox | March | One year |
| 4 | Goat pox | March | One year |
| 5 | Anthrax | February | One year |
| 6 | Peste des petits ruminants (PPR) | Four months after kidding or lambing/ Once in a life time | 3 years |

## 7. Marketing Channels and Meat Value Chain

There are thousands of selling and buying markets throughout the country for live animals. These are held daily (in big cities), weekly, fortnightly and monthly. Mostly these markets are designated open places outside villages or alongside the roads, generally without any facilities. There are no proper access roads, electricity, loading and unloading facilities, veterinary care and no records of transactions. Vendors arrange for basic needs such as fodder and water. Almost all of these markets are organized by the local governments but generally contracted out to private operators through annual auction. Everyone selling animals has to pay a commission as a percentage of the sales value of animals or on a per head basis to the operator/contractor. Almost all the markets are meant for all types of species of livestock. Annually, special markets are organized in and around large cities and towns for the sale of specially reared animals for sacrifice on the religious festivity, Eid-ul-Azha.

The prevailing marketing system is more or less the same for both large and small ruminants. Farmers in the villages sell their animals to the itinerant traders, the butchers or to other farmers. In large cities and towns commission agents, called Arhtis, also operate in most parts of the country. In Lahore, there is another group of wholesalers called rewaitees (Traditional buyers). These rewaitees buy large number of sheep and goats from the beoparis, through the Arhtis, have them slaughtered and then sell them to the retailers through secret bidding. Several butchers collectively may also buy

animals from the Arhtis, slaughter them and sell the dressed meat directly to consumers. There are no commission agents in Balochistan. The Beoparis buy large numbers of animals directly through producer markets in Quetta and then transport the animals to the main consumption centres such as Karachi, Lahore and Peshawar. A typical marketing channel for goats in Pakistan is illustrated in figure 5:

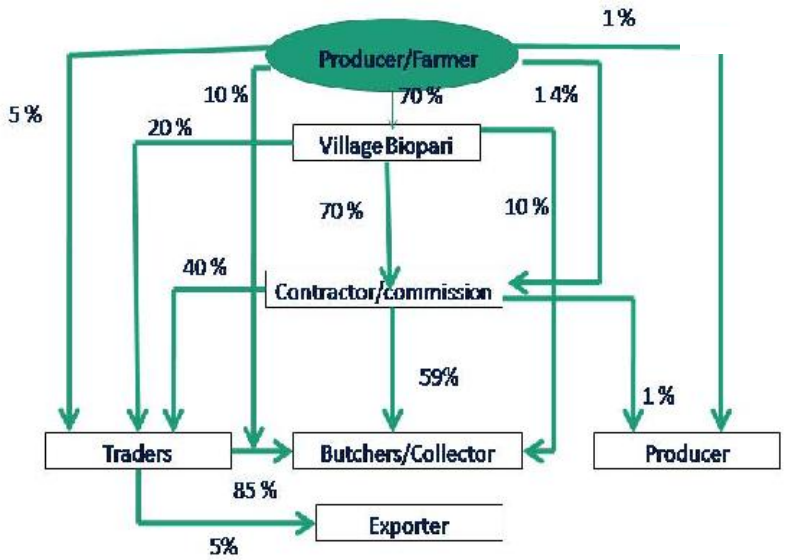



Figure 5. Marketing channels of small ruminants (Source: Sharif, 2003**)**

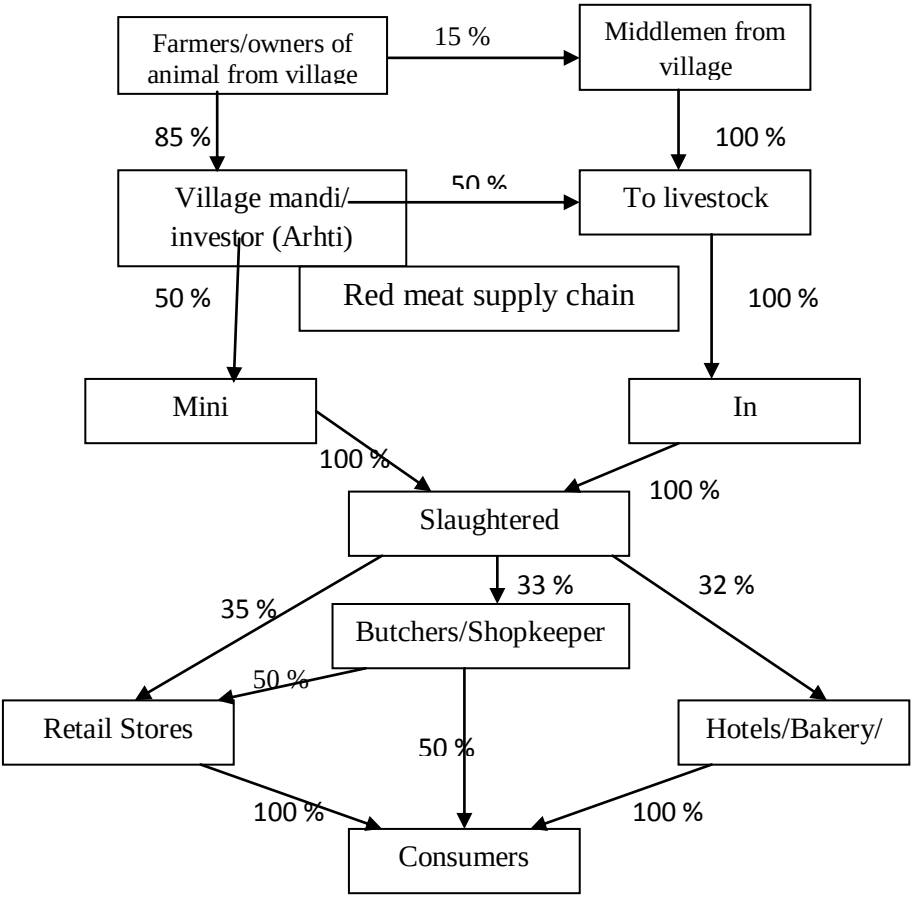
The marketing of live goats is usually by a traditional bargaining method (bidding under cover). The buyer and seller hold hands beneath a piece of cloth and certain positioning and pressing of the fingers indicates the price offered or demanded. During the whole negotiation not a single word is spoken so other persons standing nearby do not know at what price an animal is sold. This secret price discovery method of traders and producers prevents other market participants becoming aware of the market price being paid as well as conflicts. In reality this process restricts market competition. Producers are not getting optimum price for their animals due to the following reasons:

- Under cover (secret) bidding system
- Poor market information
- Poor marketing infrastructure (transport and market places)
- Controlled pricing policy
- Irregular marketing

In conclusion, many factors like breed, age, sex, weight, general appearance and production performance determine the price of animals. There is no objective grading or classification system of livestock in Pakistan and as a result lot of variation exists in the prices of livestock of the same category within the same market and between different markets. Some recurring factors such as drought prevalence and disease outbreaks also affect the price of live animals.

## 7.1 Value chain for meat

The animals purchased by the butchers or wholesale traders are brought to the slaughter house for slaughtering and then the meat is transported to either retail stores or butcher shops and ultimately sold to the consumers. The meat value chain in Pakistan is illustrated through figure 6.




Most of these Beoparis are the agents of the contractors or commission agents and get a fixed percentage of the sales value.

## 7.2 Value chain for mutton

Mutton is the main product from small ruminants for which they are raised. Most of the small ruminants are raised under rural subsistence production systems by the landless and poor farmers and under nomadic and transhumant production systems. Most of these animals are raised on natural grazing land. Some farmers feed the animals with concentrates for a few weeks before selling in order to get a higher price. They sell the animals on per head basis rather than on weight basis. The price of the animal varies from area to area. Normally in Punjab province sheep/goat with average weight of 20-30 kg is sold in the local market at Rs. 9000-12000/animal. With good management and feeding, an extra weight of 10-15 kg/per animal can be achieved.

Most of these animals are sold to village Beoparis who then sell these animals to contractors/commission agents with profit margins of 10-12 percent. The commission agents transport these animals to wholesalers with 10-15 percent commissions to the big cities for slaughtering. Butchers usually get a profit of about 7-10% through the sale of meat, offal and skin. The butchers in big cities have more profit margin than the town/ village butchers. In the mutton value chain the middle man earns the maximum profit while the consumers pay a relatively high price and producers get a low price.

## 7.3 Export of halal meat

Export of halal certified meat and preparations from Pakistan increased from US$ 132.8 million in 2010-11 to US$ 243.5 million in 2014-15, thus showing an increase of 83%. Pakistan exported halal mutton amounting to US$ 58.9 million and beef US$ 133.5 million in 2013-14 to various countries. Export figures of halal meat and meat preparations for the last five years are presented in table 13.

**Table 13**. Export of halal meat and preparations (US$000)

| Year | Value | % Change |
|---|---|---|
| 2010-11 | 132,804 | +36.8 |
| 2011-12 | 173,818 | +30.9 |
| 2012-13 | 210,881 | +21.3 |
| 2013-14 | 229,924 | +9.0 |
| 2014-15 | 243,529 | +5.9 |
| 2015-16 | 269,092 | +10.5 |
| 2016-17 | 221,137 | -17.82 |

Source: Trade Development Authority of Pakistan

Pakistan ranks 22nd in the world to export of halal meat. More than half of Pakistan's halal meat exports consist of beef. Major international markets for Pakistan halal certified mutton and beef are Saudi Arabia, UAE, Bahrain, Kuwait, Oman and Qatar. Country wise export of halal beef from Pakistan is given in table 14.

**Table 14.** Country-wise export of halal (Certified) mutton from Pakistan (US$ 000)

| Country | 2016-17 | 2015-16 | 2013-14 | 2012-13 |
|---|---|---|---|---|
| Saudi Arabia | 11940 | 21243 | 30,814 | 32,264 |
| Bahrain | - | - | 10,166 | 12,883 |
| UAE | 7750 | 8502 | 7,674 | 10,161 |
| Oman | 1433 | 2268 | 3,174 | 3,799 |
| Kuwait | 996 | 1045 | 2,483 | 2,774 |
| Qatar | - | - | 1,733 | 1,878 |
| Afghanistan | 13 | - | 1,135 | 14 |
| Vietnam | 271 | - | 353 | 109 |

Source: Trade Development Authority of Pakistan, 2016-17

Pakistan's strength is a 100% halal production base as a Muslim country, with over 170 million consumers within Pakistan and direct access to a grand total of 470 million halal consumers in Afghanistan, Central Asia and the Middle East (Memon, 2016). Pakistani halal meat is gaining ground in international halal market therefore the government should expedite measures to start halal certification to boost worldwide trade.

## 8. Successful Traditional and Modern Technologies for Profitable Farming

Several studies had been conducted at various research institutes in the country. Among such studies one study was conducted at NARC in which forty two male Beetal goats (6 months old). The male Beetal goats were randomly divided into three groups as follows:

- Thirteen Beetal males were kept in the group, they were supplemented with concentrate (600 g/animal/daily) along-with normal grazing.
- Fourteen Beetal males were kept in the group, they were given NRC 100% (1021 g/animal/daily) along-with normal grazing
- Fifteen Beetal males were kept in this group and they were given concentrate add libitum along-with normal grazing.

The fodder used for the trials was Millet, Jantar and Oats. The proximate analysis of fodder samples revealed the following composition:

**Table 15.** Proximate composition of fodder

| Fodder | DM | CP | CF | Ash | EE | NFE | TDN |
|---|---|---|---|---|---|---|---|
| Millet | 25.85 | 10.33 | 30.79 | 9.49 | 2.50 | 46.89 | 60.52 |
| Jantar | 30.04 | 15.43 | 29.75 | 6.63 | 3.07 | 45.12 | 65.54 |
| Oats | 33.99 | 6.06 | 32.25 | 6.05 | 2.27 | 53.37 | 60.22 |

Experimental Feed: The concentrate prepared by Feed Technology Unit, ASI, NARC was used for the research trials with the following proximate composition:

**Table 16**. Proximate composition of feed

| | DM | CP | CF | Ash | EE | NFE | TDN |
|---|---|---|---|---|---|---|---|
| PARC Feed | 84.62 | 16.09 | 13.15 | 9.57 | 5.61 | 45.58 | 75.59 |

An adaptability period of 10 days was provided to each group of animals in order to adjust to different feeding regimes. Weighed quantities of concentrate diet were offered to each group along-with grazing or roughage feeding with seasonally available fodders. The refusal of feed and fodder was weighed to estimate the daily intake.

The performance of Beetal goat under different treatments are given in table 16. Under traditional farming system of Pakistan, small ruminant's weight gain ranges from 50-70 grams (Khan et al., 1999) and weight gain under balanced feeding and management system has an improvement as reported by Khan et al., 2006 and it is very much in line with the results of the present study.

**Table 17**. Performance of male Beetal Goats kept under different feeding regimes

| Particulars | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| No. of animals on trial (n) | 13 | 14 | 15 |
| Mean initial body wt. (kg) | $24.6^{a}$±1.04 | $28.6^{ab}$±2.01 | $28.8^{b}$±2.16 |
| Mean final body wt. (kg) | $52.6^{a}$±5.48 | $59.3^{ab}$±6.26 | $62.4^{b}$±8.94 |
| Total weight gain (kg) | 28.0 | 30.7 | 33.6 |
| Daily wt. gain (g/animal) | 132 | 145 | 156 |
| Daily feed intake (g/animal) | 600 | 1021 | 953 |
| Cost of daily feed intake (Rs./animal) | 15.40 | 26.20 | 24.50 |
| FCR | 5.6 | 7.0 | 6.51 |
| Cost benefit ratio (Rs. /kg gain) | 117 | 181 | 157 |

Means with different superscripts differ significantly $P<0.05$

Infect, according to the review of Wilson (1992), feeding is one of the most important factors to influence meat production and carcass quality of small ruminants and the present study also shows such trends with improved feeding regimes.

## Carcass Evaluation

In order to evaluate the carcass characteristics of the experimental Beetal male goats, the random samples from each of the above-said three groups was slaughtered and their carcass was examined. The results of the assessed carcass traits are given in table 18. There was 47.2% dressing percentage in group 1, whereas highest dressing was in group 2, in which it was 51.3%. It means that dressing percentage was increased with the improvement in the status of nutrition.

**Table 18**. Carcass evaluation of male Beetal goats

| Particulars | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| No. of animals slaughtered | 3 | 2 | 3 |
| Average live weight before slaughter (kg) | 60.3±11.93 | 59.5±9.19 | 63.3±8.33 |
| Average live weight after slaughter (kg) | 58.2±11.73 | 57.5±9.19 | 61.0±8.53 |
| Carcass weight (kg) | 27.5±7.78 | 29.5±4.95 | 30.2±5.30 |
| Dressing (%) | 47.2 | 51.3 | 49.5 |
| Blood (kg) | 2.2±0.29 | 2.0 | 2.3±0.29 |
| Skin (kg) | 5.2±1.28 | 4.8±0.35 | 5.1±0.97 |
| Stomach with ingesta (kg) | 6.5±0.50 | 6.2±1.91 | 6.8±2.16 |
| Stomach empty (kg) | 2.3±0.31 | 1.8±0.11 | 1.8±0.52 |
| Intestine with ingesta (kg) | 5.9±1.63 | 4.8±0.86 | 5.4±1.19 |
| Intestine empty (kg) | 3.4±0.50 | 2.2±0.03 | 3.0±1.04 |
| Head (kg) | 3.4±0.40 | 3.4±0.14 | 3.2±0.43 |
| Liver (kg) | 1.5±0.24 | 1.1±0.07 | 1.3±0.25 |
| Heart (kg) | 0.23±0.102 | 0.22±0.028 | 0.25±0.050 |
| Left Kidney with fat (kg) | 0.213 | 0.470 | 0.540 |
| Right Kidney with fat (kg) | 0.220 | 0.280 | 0.620 |
| Left Kidney without fat (kg) | 0.086 | 0.060 | 0.073 |
| Right Kidney without fat (kg) | 0.093 | 0.060 | 0.080 |
| Lungs (kg) | 0.67±0.061 | 0.62±0.254 | 0.61±0.163 |
| Fat (kg) | 4.5±1.40 | 4.0±0.92 | 5.2±1.96 |

# 9. Constrains for Subsistence and Commercial Goat Farming

## 9.1 Subsistence level constrains

Lack of awareness in farmer communities regarding modern farming practices, lower productivity per capita, limited outreach of governmental resources and development initiatives, lack of integration between livestock value chain and supply chain and weak farm-to-market linkages are the major issues facing the sector on the supply side. The domestic regulatory framework is weak in the areas of import/export policies, food safety and quality, sanitary and health standards, investment, pricing and environmental regulations. Following are the pertinent constraints related to subsistence goat farming:

- Inadequate feeding of animals due to decreasing in communal grazing lands.
- Lack of genetically superior breeding bucks.
- Presence of contagious diseases.
- Lake of awareness of farmers with modern management practices.
- Lake of extension services.

**Possible Solutions**

- Efficient use of feed resources (grazing, browsing, fodder improvement, new fodder varieties).
- Provision to supply of elite male bucks for subsistence farmers.
- Availability and quality of vaccine.
- Training of farmers/keepers in advanced goat production.
- Improving rangelands.

## 9.2 Commercial goat farming

There are three stages in the meat value chain: production, marketing and processing. The constraints of each stage are as follows:

### 9.2.1 Production constraints

Breeding is haphazard and the farm management is traditional and as a result, the productivity of the animals is low. The goats are maintained mainly under sedentary and nomadic/transhumant production systems, produce mutton. All these production systems can be characterized as low- input low- output systems.

### 9.2.2 Marketing constraints

Most of the animals are purchased by the traders at the farm gate. Some of the farmers also take their animals to the local market if it is not too far. The biggest constraint in the marketing of meat animals is the common sales system on a per head basis, instead of on a live weight basis.

The live animal market is itself also a serious constraint because they do not even have the basic facilities like animal shed, water, feeds/fodder and veterinary services. The situation in the slaughterhouses is also very basic and below standard. Facilities such as pre and post slaughter examination, chilling, use of by-products and proper transportation of carcasses are nonexistent.

Retail outlets do not have basic facilities such as cooling, except in large cities where the availability of electricity facilitates safe holding of meat.

Another constraint is the fixation of meat prices at retail end by the local administration in disregard to the cost of production.

### 9.2.3 Processing constraints

In Pakistan there is hardly any processing of meat for sale to the consumers, except cutting the meat according to the choice of the customer and mincing in the butcher shops.

### 9.2.4 General constraints in meat value chains

- Improper and unhygienic means of transportation to carry meat to the market. During unhygienic transportation meat may be infected and its quality will also be affected.
- Unavailability of meat chilling facilities throughout the chain. No proper system exists for chilling meat throughout the value chain. This hampers the export market as well.
- Lack of interest by the various authorities to improve the meat industry and increase the production of export quality meat. There is a lack of government investment in the industry. The total allocation for livestock in most of the five-year development plans had not exceeded 1% and is less than 8% of the agriculture sector allocation.
- Insufficient green fodder and feed availability for fattening of beef animals. Firstly, the estimated feed and fodder resources only meets 70% of the total feed requirements and secondly the quality of feed for fattening is questionable. The overall feed supply has declined from 20 to 25 percent below the level needed to maintain the existing

livestock population due to over grazing, feed depletion and the prolonged drought.

- Absence of a meat grading system. In Pakistan only four percent of the total meat production is exported to high value countries in the Gulf and South East Asia. There are only 23 slaughter houses that meet requirements for international standards.
- Low producer prices for many livestock products are major constraint to the adoption of intensive animals fattening techniques. In particular low returns mitigate against livestock raising for meat. Even though the retail prices of red meat in the country have increased very recently, there are very little premiums gained for producing a quality product with the consumer being price sensitive.
- The traditional meat marketing system has remained a constraint for the development of meat industry. This system provides almost no incentive and motivation to produce quality meat. There is no incentive to upgrade the facilities unless a mature export market is targeted.
- The district authorities fix the retail price of mutton and beef. No consideration in price is given to quality, age, breed or the different cuts of the meat for example, in the Karachi cattle colony, it is common practice to sell and slaughter tender aged young buffalo calves, in order to save milk, the calves would consume before coming to grazing age.
- There are a number of fees and payments incurred during the marketing chain which eats into the farmer's profitability. It is estimated that up to 10 percent equivalent value of animals is paid out in various payments, legal or illegal in the marketing chain.
- Professional beoparis and animal traders largely dominate the animal markets especially in the remote areas. Farmers as individuals cannot break the tradition and monopoly of the traditional marketing systems.
- Smallholder farmers lack knowledge of proper animal production methods. Smallholder farmers rear their animals as dairy animals for their immediate family needs for milk and sell surplus milk in the local market. Meat is seen as a byproduct. Smallholders only sell their animals when they need financial support and animals are diseased or dried off after completion of their lactation. Young calves are sold to reduce feeding expenses keeping livestock as a matter of prestige rather than an economic activity.
- Lack of financial resources and insurance policies to improve meat products activities by livestock holders. No banks in Pakistan including Zari Taraqiati Bank Ltd (ZTBL) have a scheme for

offering soft loans to small livestock holders for rearing of meat animals. These loans/support exists in most other sectors.

- There is no insurance policy in favour of goat production; raising meat animals using traditional systems is not a profitable enterprise. The overall productivity is low.
- Unavailability of basic facilities like water and infrastructure. In some areas of Karachi, Sindh and similarly in Balochistan province, there is an acute water shortage. Small livestock holders/land holders have no sufficient infrastructure to keep small ruminants animals.
- Sales of animals on per head basis is a crucial aspect of the marketing system confronting mutton development.

## 10. Recommendation for Future Research and Extension Service

Halal meat is one of the fastest growing markets in the world, contributing around 16% to the total world trade. Halal meat market is growing rapidly throughout the world and its demand is increasing rapidly. Pakistan ranked 18$^{th}$ in the production of halal meat market and its volume is only 2.9% of the global halal meat production which is very low. This justifies extra efforts on the part of the government to give a much needed boost to this sector.

Pakistan can play pivotal role in this growing market, it has more than 160 million quality livestock including 71 million cattle & buffalos, and 93 million goats & sheep (Pakistan Economic Survey, 2014-15). There is no muslim country included in the list of first ten halal meat exporters, although Pakistan, Sudan and other Muslim countries have big potential of exporting halal meat globally.

The federal government of Pakistan could help raise halal food exports by formulating sound policies in collaboration with the private sector. To overcome the constraints the following recommendations are suggested to improve the livelihood of goat farmers.

### 10.1 Development of potential mutton and dairy breeds of goats

In Pakistan there are 36 goat breeds with main utility of meat production. Simply selecting good bucks for producing next generation can help boosting the sector itself and consequently raising the income of poor farmers. Beetal, Kamori, Pateri, Teddy, Barbari goat breeds have good mutton potential.

There is a general consensus amongst all stakeholders that a national level policy should be implemented to develop breeds especially for meat production. Development of the potential mutton/dairy breeds and production

of their breeding animal's at large scale at production farms should be carried out for selling to common farmers on subsidized rates.

Further research is recommended to determine the profitability of businesses involved in fattening of male animals for meat production as opposed to dairy farming only.

## 10.2 Introduction of feedlot

The government's initiated projects that were completed under the ministry of livestock and dairy development prior to devolution have resulted into completion of more than 13,000 feedlot fattening operations resulting into the production of 163,000 beef animals and 200,000 mutton producing animals. To ensure increased level of investment in the meat animal production, it is imperative to build the investment based on the structure of the poultry industry. Currently fattening is not a profitable enterprise due to high cost of production, lack of buying guarantee to the producers and weak farm-to-market linkages. Following the example of the poultry industry, the government should encourage a separation of activities and stakeholders in breeding and rearing (fattening) of calves/kids for sale to slaughterhouses and meat processors through its investment agencies, thereby lowering the overall cost of production.

The demand of Pakistani mutton is increasing year by year in the Gulf States. Keeping in view the generation of more demand for export, efforts should be made to increase mutton production by introducing the feedlot fattening of small ruminants in Pakistan.

## 10.3 Meat producers cooperatives

In Pakistan, eighty percent of the farmers are small holder farmers owning less than five animals. This comes to a total of more than 50% of the livestock in Pakistan (mainly cows, buffaloes, sheep and goat raised to acquire milk for self-consumption). These small holders are mostly landless farmers who are geographically dispersed in various parts of the country. This makes outreach of the government's facilitation institutions much difficult and uneconomical. Therefore, meat producer cooperatives at village level are recommended. For this purpose, the use of resources of local Panchayat and Daira facilities of local village heads can be used.

Meat producer cooperatives can be established in the rural areas of Pakistan involving small farmers and Gender. This business activity will improve the economic status of the rural areas of Pakistan.

## 10.4 Strengthening of livestock advisory and extension services

Lack of awareness on part of farmer community can be divided into six major areas that include i) Knowledge of potential and profitable meat animal farming as a commercial business ii) efficient farm practices that can improve meat productivity per animal iii) awareness on feed availability and nutritional values for feedlot fattening of meat animals on the basis of the TMR technique iv) awareness on hygiene, animal welfare and veterinary care matters v) knowledge on development of meat-specific breeds and their development through natural mating and crossbreeding and vi) compliance to the international standards in the meat processing and marketing industry.

Disease prevention and control needs to be given primary importance to promote availability of quality animals and meat in the country and to overcome obstacles in their export. The same can be achieved through stringent regulations that would result in the establishment of Disease-free-zones within various parts of the country.

The animal health needs to be linked directly to public health to raise the significance of proper veterinary care and animal welfare. If the concept can be streamlined into the general veterinary policy in the country, the same can be used as an effective marketing tool in trade with the partner countries.

Government at national and provincial level should activate its available infrastructure. There are a number of animal healthcare hospitals in the country whose effectiveness is far below required levels. Hiring policy for these hospitals and veterinary care centre has to be ensured with preference to the local inhabitants so that their interest in posting at their home stations should be used as a motivational tool to retain them for provision of quality service to the stakeholders.

Vaccination against contagious diseases like Haemorrhangic Septicemia (HS), Black Quarter, Anthrax, Foot and mouth Disease, Rinderpest, Enterotoxaemia (ET), Peste des petits ruminants (PPR), Contagious Caprine Pleuropneumonia (CCPP) should be adopted at mass scale along-with internal parasitic control.

## 10.5 Slaughter houses in the private sector

The basic infrastructure of the meat processing industry in Pakistan is mainly the slaughter houses. According to an estimate, more than 300 slaughter houses have been established by the public sector but they employ primitive slaughtering techniques and unhygienic handling of meat and its transportation. There is also a problem of having a small number of slaughterhouses in the country. It is recommended that establishment of

modern slaughterhouses in the country should be encouraged to be managed by private sector. It is better to plan and regulate smaller slaughterhouses on the basis of towns in large cities, rather than having one large unit in the suburbs. This would ensure a convenient supply chain for the meat processors in terms of cost efficiency and overcoming the perishable factor in meat.

Slaughter house have traditionally been built and operated by local governments in the country. There is a tremendous scope in the establishment of slaughter houses through public private partnerships. The small farmer cooperatives can play significant role the supply chain and will be very helpful in the smooth running of the plants.

## 10.6 Slaughter house byproduct plants

Utilization of slaughter house byproducts and wastes in a manner favourable to environment through establishment of slaughter house byproduct plants. The details of the byproducts plants is given in the table 19 below:

**Table 19**. Number of plants producing livestock byproducts

| Plant Type | Punjab | Sindh | KP | Balochistan | Total |
|---|---|---|---|---|---|
| Animal casings | 55 | 34 | 5 | 2 | 96 |
| Bone processing units | 11 | 8 | 0 | 0 | 19 |
| Gelatine Processing units | 4 | 0 | 0 | 0 | 4 |
| Ready to cook food | 1 | 1 | 0 | 0 | 2 |

Source: Government of Pakistan, 2016

## 10.7 Marketing of products

Meat marketing services are dominated by meat beoparis who along-with the animal traders meet the needs of the industry from the stage of procurement up to delivery at butcher shops. A niche market exists especially in the big cities of the country as well as for export of the prime lamb, prime beef and prime cuts of meat in general. The current meat production practices can be fine-tuned to cater the demand of those niche markets through prime lamb / veal production and prime cut marketing system.

## 10.8 Strengthening of public private partnership

The government must encourage farmers /entrepreneurs in the country through its various business support organizations, such as Livestock and Dairy Development Board (LDDB), Pakistan Dairy Development Company

(PDDC) and Small and Medium Enterprise Development Authority (SMEDA) to undertake livestock farming for meat production as a primary source of income besides crop and milk production. A shift in the mind-set has to be created in the farmer community so that they consider their animals as a potential and valuable investment with financial return rather than as a social capital and insurance in times of financial crunch. Medium and long term policy initiatives and preparedness of all stakeholders to upgrade the present situation. The best example of private public partnership is Pakistan Agro Tech Company (PATCO) at PARC

### 10.9 Production of quality veterinary pharmaceuticals

Due to fake pharmaceutical companies in Pakistan, the use of medicine from these companies resulted in no health cover and also it also increases the cost of production and sometimes resistant is developed due to the use of these fake medicines. So, it is suggested that quality veterinary pharmaceutical products should be developed. So these should be cost effective for the livestock production.

### 10.10 Deregulation of meat price

The intention behind price fixing is to mainly keep meat affordable to the local consumers. The same can be achieved in a more effective and sustainable manner through the introduction of open competition in both the informal and formal sectors. The price of meat will reach equilibrium once the demand for quality is driven by consumers and this would also have a subsequent impact on improving the production efficiencies of livestock farmers, producers and processors to effectively compete in the domestic market.

### 10.11 Development of animal disease free zone

For the export of meat, Govt. should establish animal disease free zones in the country. The potential areas for the disease free zones are southern Punjab, lower Balochistan and interior Sindh.

## 11. Conclusions

People of Pakistan consume meat, milk, eggs, fish and lentils to meet their protein requirements. Per-capita consumption of meat may get tripled in Pakistan between 1993 and 2020, but is still far below developed country levels. Population growth, urbanization and growth in per-capita income will boost meat demand in Pakistan in the coming years.

**Table 20.** Per capita meat consumption (kg/annum)

| Countries | 1983 | 1993 | 2020 |
|---|---|---|---|
| Developed world | 74 | 76 | 83 |
| Developing World | 14 | 21 | 30 |
| Pakistan | 11 | 16 | 47 |

Source: TCP/PAK/0168

Beef prices have increased more or less in line with inflation over the last five years. Mutton prices are almost twice the price of beef on a per kilogram basis while poultry is cheaper than beef. Indeed, overproduction of poultry in the last two years has been a factor capping the price increase in red meat.

According to Bhatti and Arocha (2014), during the last decade, consumption of mutton declined 13%. Poultry has replaced 8% and beef replaced 5%. One of the reasons of reduction in the mutton market share is a higher price which may be attributed to increased exports to GCC (Gulf Cooperation Council) countries. In Pakistan, red meat butcher shops have poultry to their offering and if this trend continues more bovine and mutton could be available for export.

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# Chapter 6

# Sustainable Goat Farming for Livelihood Improvement in Sri Lanka: Opportunities, Constrains and Potential

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## 1. Introduction

Sri Lanka is a tropical island in the Indian Ocean. Sri Lanka has a heterogeneous agro-ecological environment and many workers have made efforts to classify this situation. A particular agro-ecological region represents fairly even agro-climate, soils and terrain conditions and would support a particular farming system with a certain range of crops and farming practices, including forage cultivation and livestock farming.

On rainfall distribution, Sri Lanka has traditionally been classified into three climatic zones. These are the wet zone, dry zone and intermediate zone. The wet zone covers the south-western region including the central hill country and receives relatively high mean annual rainfall over 2,500 mm without pronounced dry periods. The dry zone covers predominantly the northern and eastern part of the country, being separated from the wet zone by the intermediate zone. The dry zone receives a mean annual rainfall of less than 1,750 mm with a distinct dry season from May to September. The intermediate zone receives a mean annual rainfall between 1,750 to 2,500 mm with a short and less prominent dry season.

In differentiating these three major climatic zones; land use, forestry, rainfall and soils are widely used and as a result, they were divided into 24 agro-ecological regions. Environmental change, availability of more spatial and temporal data and advancement of GIS technology has led to the sub-division of the 24 agro-ecological regions of Sri Lanka into 46 sub-regions.

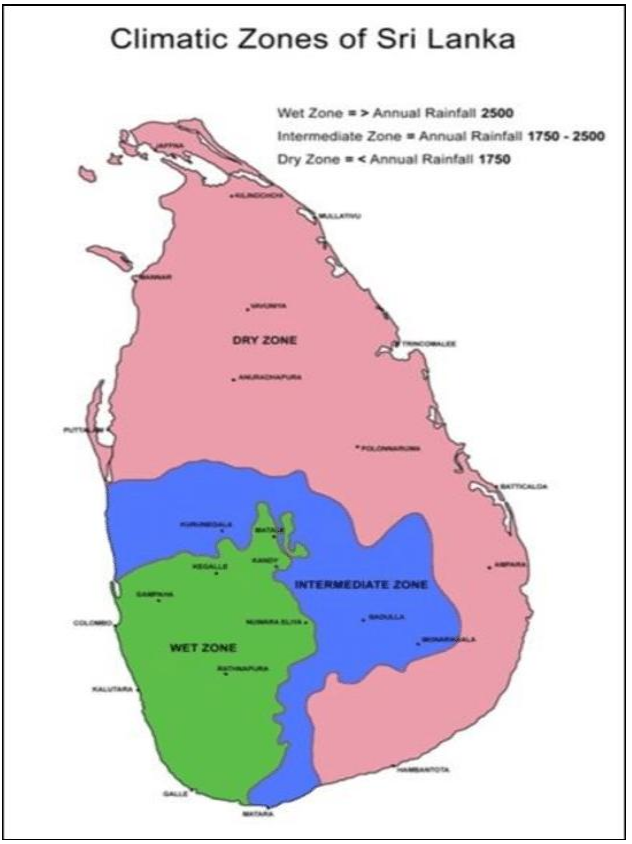



Figure 1. Climatic zones of Sri Lanka

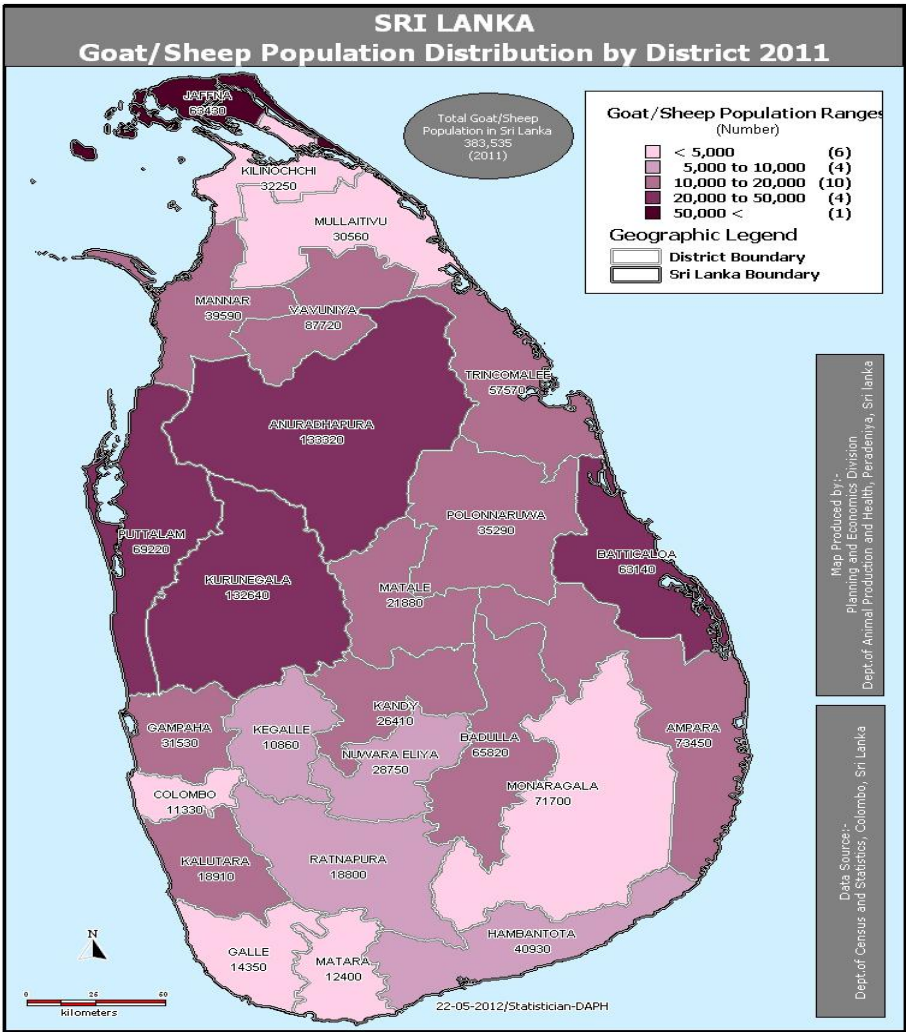
In Sri Lanka, livestock rearing is mainly a rural livelihood activity which utilize idling labour, underutilized agricultural by products, marginal lands in turn support agriculture and improves the nutritional status of rural population. There is a strong symbiotic relationship between the crop and livestock and exploiting the synergies of the two sub-sectors of crop and livestock helps to enhance the productivity of the agriculture economy of Sri Lanka. However, at present, industry and service sectors are rapidly growing comparative to agriculture and hence the contribution of agriculture sector to national GDP is reducing accounts to 7.9% in 2015 (Annual Report, Central Bank of Sri Lanka, 2015), and the contribution of livestock sector is recorded as 0.6% to the national GDP. Though, the livestock sector contribution to national GDP is low the sector continues to grow recording 8% in 2015. The consumption of livestock products has increased dramatically over the last two decades with the increase of per capita income and urbanization. Livestock production, while helping to improve the nutritional status of the

population, offers many possibilities for value addition by converting them into numerous high value products.

Livestock is an important component in small holder agricultural pursuits in all agro ecological zones in Sri Lanka. In rural mixed farm enterprises, most small holder farmers are engaged in crop production as the primary agricultural activity but also rear few goats with minimal cost. The goat industry has a vast potential to develop the economy of Sri Lanka yet it is still growing at a slow rate. The total annual domestic production of mutton was 1.38 MT in year 2016 (Department of Census and Statistics, 2016) and the balance requirement is imported. A total of 485.15 MT of mutton had been imported to the country during 2016 and it showed an upward trend (http://www.daph.gov.lk). Yet the value contributed to rural households is quite significant because goat farming is still one of the most affordable and sustainable ways of enhancing rural household income and it contributes to the economic development of the country.

## 2. Goat Population and Demography

Goat farming is concentrated mainly in dry and intermediate zones of the country where about 75% of goat population is distributed. Goat population in 2015 recorded as 381,375 and number of goat farms in the country recorded as 73,159 (http://www.daph.gov.lk). Northern Province (Jaffna district) is one of the main region in the country, where goat rearing successfully. According to the Department of Census and Statistic (2012), subsequently Jaffana, Puttalam, Kurunagala, Anuradhapura and Batticaloa were the districts bearing higher goat population in Sri Lanka. The map below shows the goat/sheep population distribution by district in the year 2011.




(Source: Department of Animal Health and Production)

Figure 2. Goat/sheep population distribution at district wise in 2011

The production systems are extremely vary between and within the different agro climatic zones in Sri Lanka and therefore, description of the dominant production system for each zone are given only. The production systems can be classified by the breeds utilized and the husbandry practices which in turn are closely related to the agro ecology and climate. The common topographic and climatic features, type of animals and husbandry practices in the major systems are given below in table 01.

**Table 1.** Agro climatic zones, type of animals and husbandry practices in the major systems

| Features | Hill country zone | Mid country zone | Low country zone | Dry zone | Coconut triangle zone | Jaffna peninsula zone |
|---|---|---|---|---|---|---|
| Elevation (M) | >1200 | 450-1200 | 0 - 450 | 0 - 450 | 0 - 450 | 0 - 450 |
| Ambient temperature (C ) | 10 -24 | 21 - 22 | 24 - 35 | 21 - 38 | 24 - 29 | 27.5 |
| Rain fall (mm) | >2000 | 1875 - 5000 | 1875 - 2500 | 1000 - 1750 | 1200 - 4000 | 1000 – 1500 |
| Relative humidity (%) | 58-75 | 55-75 | 75-90 | 70-85 | 60 - 80 | 71-74 |
| Predominant type of farmers | Plantation workers | Agricultural farmers | Agricultural farmers | Agricultural farmers | Coconut land owners/farmers | Agricultural farmers |
| Typical fodder base | Road sides & Ravines | Road sides & home plots | Post-harvest crop fields | Post-harvest crop fields, tanks beds & scrub jungles | Pasture under coconut & Post harvest crop fields | Homesteads & Post harvest crop fields |
| Intensive system | Saanen | Beetal and Saanen | Jamnapari, Beetal,Saanen | Jamnapari, SL Boer, Beetal, | Jamnapari, Beetal,Saanen | Jamnapari, Saanen,Beetal |
| Extensive system | | Beetal | Sri Lanken Boer | Kottukachchiya, Jamnapari x KK | Jamnapari, Beetal | Jamnapari, Beetal |

(Source: National Breeding Policy Guidelines for Livestock in Sri Lanka 1994)

The main reasons for the concentration of goats in the dry zone and dry intermediate zones may be summarized as follows:

(a) Availability of open grazing/ browsing lands that are not used for alternative agriculture.
(b) Availability of suitable fodder that do not compete with arable land for more economic crops.
(c) Availability of grazing land under plantation crops like coconut in the intermediate zone (coconut triangle).

# 3. Breeds and Breed Description

## 3.1 History of goat industry in Sri Lanka

It is possible that sheep and goat were originally introduced to Sri Lanka from India during the first world war when a large numbers of goat were imported via Tuticom, India to fulfill the meat requirement of foreign soldiers (Aberathna, 2007).

In 1937, Jamnapari and Anglo-Nubian breeds of goats were imported to Sri Lanka and these animals were kept at Polonnaruwa and Murukan farms. They were bred pure and the offspring were issued to other goat units in the Department of Agriculture. This marked the first step in breeding improved breeds of goats in Sri Lanka (Aberathna, 2007). In 1960, the government goat farm was established at Kottukachchiya and in 1967, one thousand Jamnapari goats were imported to this farm. Some of these stock were used for pure breeding purpose while others were used for a cross breeding programme. This breed development programme led to the development of "Kottukachchiya" breed of goats (Aberathna, 2007). Subsequently, pure bred saanen goats were imported from European countries, Australia and Newzealand. Stocks were managed at Abewella and Bopaththalawa farms. These animals were bred pure and their progeny were sold to the private sector (Aberathna, 2007).

In 1983, Boar breed of goat was introduced to Kottukachchiya farm from the Germany under SRL/GTZ goat development project. A cross breeding programme were carried out with selected female stock of the farm, with these Boer studs. This cross bred animals called "Sri Lankan Boer". The Sri Lankan Boer was predominantly a meat breed intended to the dry zone areas of Sri Lanka. Kottukachchiya has become the key center for goat breeding and extension (Aberathna, 2007).

However, the goat breeding and extension programme collapsed and most of goat breeder association become non-functional. The Kottukachchiya farm was handed over to the national livestock development board (NLDB). The original goat-breeding programme was abandoned.

## 3.2 Breeds of goats in Sri Lanka

### 3.2.1 Indigenous breeds

Majority of goats in Sri Lanka belongs to indigenous or local breed. They are nondescript type of animals small in size and performances are poor compared to exotic breeds. But the indigenous goats are hardy animals and well adapted to the local conditions. Although the population of indigenous

goats are decreasing due to indiscriminate cross breeding with exotic breeds, some non-descript local breeds are found in isolated pockets of Sri Lanka.

Figure 3. Indigenous goats

Coat color of local goats may be black, white, brown or mixture of these colors. They are non-seasonal breeders, short, have flat nose and medium ears and mostly horned. They produces less amount of milk. The meat production potential of these goats also very low. The average carcass weight is 10-11 kg (Rajaguru, 1988)

### 3.2.2 Kottukachchiya

The Kottukachchiya breed is originated from non-descript animals imported for slaughter from South India in 1968. These animals had crossed with selected local animals and developed a breed called Kottukachchiya, which is the name of the farm where the breeding was carried out.

Figure 1.2: Kottukachchiya goats

Coat color of the Kottukachchiya breed is shiny black. They have medium and slender body, long legs and drooping medium sized ears. Both females and males are horned. They thrive well in dry zone and highly adapted to harsh environment. Resistance to diseases commonly found in Sri Lanka is another imported character of this breed. It is considered as a meat purpose goat.

### 3.2.3 Sri Lankan Boer

Figure 4. Sri Lankan Boer goats

Sri Lankan Boer is a new breed developed by crossing imported German Boer with Kottukachchiya and Jamnapari. The Sri Lankan Boer has 50% German Boer blood. Thus, Sri Lankan Boer is similar to German Boer in appearance with comparatively small body size. Body colour is white with black head and neck. Legs are somewhat short and it is considered as a meat purpose goat.

### 3.2.4 Jamnapari

This breed originated in Uttara Pradesh and Madya Pradesh of India. Jamnapari are large goats with a characteristic roman nose and long, pendulous ears. It has no standard color, but the most common color combination is white and tan. They carry long and thick hair on their quarters and have a glossy coat. It is a dual purpose animal which thrives best under farm conditions with plenty of shrubs for browsing. It is considered as a dual purpose goat.

Figure 5. Jamnapari goats

### 3.2.5 Sannen

The Saanen is a swiss breed which originated in the Saane Valley. It is now the most popular dairy goat breed in many countries, including Australia. Saanen does are heavy milk producers and usually yield between 3% and 4% fat. The Saanen is a typical dairy-type animal, it has a dished or straight facial line and a wedge-shaped body. Saanens are of medium height when compared with the other Alpine breeds in Australia. Does weigh at least 64 kg. The average height measured at the withers, is about 81 cm for does and 94 cm for bucks.

Figure 6. Saanen goat

The coat is all white or all cream and the hair is generally short and fairly fine although some may have longer hair along the spine, hindquarters, or both. Horns may or may not be present at birth. The ears are generally pointed and erect and the head is usually lightly structured.

The breed is sensitive to excessive sunlight and performs best in cooler conditions. The provision of shade is essential, and tan skin is preferable. Saanens are usually very docile animals and like to keep to a routine so are well-suited to machine milking.

(https://en.wikipedia.org/wiki/Livestock_in_Sri_Lanka)

### 3.2.6 Beetal

The Beetal Goat is a breed of goat from Pakistan that is dual purpose goat. The Beetal goat is also known as the Amritsari Goat. Beetal is the large animal with an average male body weight of 45-50 kg. It is found in brown or black with various round white spot in the body. Though the majority of Beetal goats are black in color among them the brown Beetal percentage is less as compare to the black beetal. It's a true resemblance of the Jamunapari goat with convex face and Roman nose. They too have drooping ears which is long and flat both male and female have thick horn of medium size.

Presently, the government and private sector own the goat breeding resources. An inventory of breeding stock in the private sector is not available. Two goat breeding centers are maintained by the department of animal production and health at Thelahera (Kobeigane AGA division) in Kurunegala district and Imbulandanda (Matale AGA division) in Matale district.

Progeny of Jamunapari goats imported from India are available in these two farms. These goats are bred with imported Jamunapari goat semen as well as using selected Jamunapari stud goats. The main objective of running these two breeding farms is to maintain goat nucleus herd and produce breeding goats that are needed to be issued to the field. (http://www.daph.gov.lk)

# 4. Production System

## 4.1 Farming system

Goats rearing farmers pay minimum attention for Breeding, feeding and management systems generally. Most often the animals are walked for long distances in fetch of forage, mainly due to sparse vegetation. This also means a greater requirement of nutrients to meet the energy loss that occurs due to walking long distances in search of feed. Three basic systems of management are commonly found in country namely

(a) The free grazing system or "extensive system" where the animals are left to wander and find their feed, perhaps with or without a person to attend to them.
(b) Controlled grazing or "semi-intensive system" where the animals are confined to a fenced area and have access to whatever feed that is grown or provided to them.
(c) Zero grazing or "intensive management system" are where the animals are housed and the feed carried to them at all times. Whatever the management system that is adopted by the farmer, it should be appropriate to the situation and circumstances.

### 4.1.1 Extensive system /Free grazing system

This system allows the goats the freedom to graze/ browse requiring less effort, labor and input costs to the farmer. However, if improved levels of production are to be achieved, this is the least desirable method. The animals have to spend additional energy in their effort to find their feed requirements. They will perform well only if there is a high density of feed available, and operate a systematically controlled system. Goats wandering freely are also vulnerable to predators. Further, the operation of a controlled or selective breeding program becomes virtually impractical, if both males and females wander freely, as the females will be accessible to any of the males. Uncontrolled goats can be damaging to the environment, as they will eat even the barks of plants and trees thus destroying them.

### 4.1.2 Semi-intensive management

Many of the above problems can be eliminated if the goats are confined to a pen or paddock with a secure fence. This is practical, only if there is a good source of cultivated fodder/ pasture or cut and carried forage. When the animals are kept in a fenced area for a specific period of time, the land has to be rested, to interrupt the parasitic cycle (nematodes) and to allow for re-growth of the pasture. Such lands are rested for 0.5 to 1 year, or other seasonal crops may be grown during this period. If sawn crops are grown, goats or sheep can be allowed to graze in fresh areas (strips) each day. This is termed "strip grazing". It will ensure that the animals will consume most of the fodder before they move to another area. Goats often refuse to feed on material that has been trampled by others and should therefore be avoided. Movable electric fences are often used to control strip grazing. The grazing area/ paddock can be converted into smaller paddocks with permanent fencing so that each paddock may be used for a few days until the forage has been consumed. Under the above controlled grazing system, even though one may achieve improvements in productivity, the economic viability of the

system has to be evaluated, as the fencing costs may be high. Tethering is also practiced by some of the farmers who have access to pasture, as a method of controlled grazing. This method is practiced by smallholders who have a few animals to manage, on an individual basis.

### 4.1.3 Intensive management

In this system the animals are kept in sheds or yards and the feed is cut and carried to them. They have no access to growing fodder. This system provides the best control over the animals in regard to their breeding, feeding, healthcare, management and security. High producing milking goats are often managed in this manner. This system is generally adopted under land limiting situations as well.

Production parameters of the indigenous goats are usually poor in relation to crossbreds like Sri Lanka Boer or purebreds like Jamnapari, Beetal and Saanen or their crosses. Since the indigenous animals and the nondescript goats form the bulk of the national herd, cross breeding and upgrading of the local females to selected males of superior breeds will bring about a quick improvement in the genetic quality and productivity of the progeny.

The breeding policy of the country has to be formulated after having considered the type of farming systems practiced in the different agro-ecological zones and the type of animal found suitable to upgrade the local stock in each system or region. If the objective is meat production, Boer or Sri Lanka Boer would be the (male) animal of choice to upgrade the indigenous goats in the dry zone. Past experience indicate that the crossbred progeny of such a program has performed well in the dry zone. On the other hand, when the primary objective is milk production, superior male of an appropriate breed type has to be selected for the upgrading program. In doing so environmental conditions in the specific region should be taken into consideration; e.g. breeds like Jamnapari or Beetal can be the breeds of choice to upgrade the indigenous stock in the dry zone and dry intermediate zones. Jamnapari may be used for a dual-purpose (meat and milk) objective. It is recognized that temperate breeds like Saanen has a high milk production potential. Selected male animals of these breeds may be used to upgrade the local low producing stock in the plantation sector in the hill and mid country where climatic conditions are more favorable to the temperate breeds and their progeny (DHA Subasinghe - Sri Lanka Veterinary Journal -2016).

## 4.2 Housing

There are two types of housing system in Sri Lanka. Ground level housing and elevated housing /slatted floor sixty percent of the farmers had

permanent goat housing system and rest (40%) of the farmers had temporary goat housing systems. Fifty two percent of floor of the houses are made with slats, 46% of them used clay floors and 2% of the farmers used cement floors. Fifty two percent farmers of the goat houses had an elevated floor. Eighty two percent of the farmers used coconut cadjans, 12% of the farmers used GI sheets and 6% of them used other materials such as polythene as roofing materials.

## 4.2 Feeding

Goats rearing under the free range system, scrub jungle provide major feed supply and allowed for grazing in the road side, agricultural lands after harvesting crops and abandon lands. And also feed various locally available fodders like Gliricidia spp, (*Gliricidia sepium*) Erithrina spp (*Erithrina indica*), Ipil-ipil (*Leucaenea leucocephala*) and other lopping from the garden like jack tree leaves (*Artocapus heterophyllus*) and Ficus (*Ficus benjamina*). Goats rearing under the intensive system practices stall feeding. They are cultivating fodder grass such as CO-3 (Hybrid Napier), fodder legumes like *Gliricidia spp*, (*Gliricidia sepium*) *Erithrina spp*, Ipil-ipil (*Leucaenea leucocephala*) and Ficus (*Ficus benjamina*). In addition to roughages, concentrate feeds such as rice bran, coconut poonac, dall hasck and commercially available concentrate mixtures are supplied.

## 4.3 Breeding

There are two goat breeding centers maintained by the department of animal production and health at Thelahera (Kobeigane AGA division) in Kurunegala district and Imbulandanda (Matale AGA division) in Matale district. Progeny of Jamunapari goats imported from India are available in these two farms. These goats are bred with imported Jamunapari goat semen as well as using selected Jamunapari stud goats. The main objective of running these two breeding farms is to maintain goat nucleous herd and produce breeding goats that are needed to be issued to the field. Artificial insemination (AI) is being performing mainly in six provinces. These provinces are north, north central, central, southern, eastern and Sabaragamuwa (http://www.daph.gov.lk).

Embryo transfer (ET) could be used to implement an accelerated breeding program.

## 5. Performances

**Table 2.** Production performance of goats in Sri Lanka

| Parameter | Goats | |
|---|---|---|
| | Crossbreeds | Local breeds |
| Reproduction performance | | |
| Age at 1st heat (months) | 9 - 12 | 6 - 7 |
| Age at 1st parturition (months) | 14 - 18 | 11 - 12 |
| Kidding interval (months) | 8 - 9 | 7 - 8 |
| Number of kiddings | 6 - 7 | 7 - 8 |
| Twinning frequency (%) | 45 -53 | 55 -65 |
| Milk yield | | |
| Milk yield per day (liters) | 1.5 - 2.5 | 0.5 - 1 |
| Length of lactation (days) | 120 - 150 | 90 - 120 |
| Lactation yield (liters) | 180 -375 | 45 - 120 |
| Milk fat (%) | 3.5 | 3.5 |
| Growth and body development | | |
| Birth weight (kg) | 1.4 – 1.6 | 1.2 – 1.4 |
| Weight at 1 year (kg) | 25 - 35 | 16 - 20 |
| Daily gain in weight (g) | 100 - 150 | 50 - 100 |
| Mature body weight (kg) | 30 - 40 | 20 - 25 |

(Source: Scharge et al., 1997)

## 6. Diseases and Healthcare Service

The Department of Animal Production and Health (DAPH) is the state organization which is responsible for providing technical leadership to the livestock industry and its stakeholders in Sri Lanka. The DAPH presently operates through its five (05) technical divisions such as Animal Health, Animal Breeding, Veterinary Research, Human Resource Development, Livestock Planning and Economics and two (02) support services divisions (Administration and Finance). In addition to provision of technical expert service, the DAPH implements a range of statutes as well, pertaining to the livestock sector. DAPH‘s field level functions were devolved to nine (09) provincial departments headed by provincial directors. There are 287 divisional veterinary offices scattered throughout the country, divisional veterinary offices managed by veterinarians are the main functional units of the DAPH. Health care service at field level provided by divisional veterinary offices. Kid mortality, pneumonia, parasitism, goat paralysis (cerebro-spinal nematodeasis), enterotoxaemia, foot and mouth disease, contagious pustular dermatitis (CPD) is some of the common ailments observed in goat farms. The common diseases are as follows:

## 6.1 Caprine Arthritis Encephalitis Syndrome (CAE)

CAE is a viral disease. In young kids symptoms include a weakness in the rear legs, with no fever, or loss of appetite, however, the unused legs lose muscle strength and structure and the infected kids eventually die. In older goats, the same disease is seen as swollen joints, particularly the knees. The disease develops slowly, and after 2 or more years, the animal has difficulty using its legs properly. Infected goats have no fever, remain alert, and eat well. However, they do not recover from the arthritis. An inexpensive blood test can be used to diagnose CAE. The disease is spread from older infected goats to kids, perhaps by contact or through the milk from an infected doe to her kid. There are no corrective procedures or treatments. Isolating kids at birth and raising them on pasteurized goat milk is done to prevent the spread. It's a good idea to make sure a goat is CAE free before purchasing. However, the blood test only checks for antibodies, and it's possible that an animal is infected and not (yet) producing antibodies.

## 6.2 Mastitis

Mastitis is an inflammation of the mammary gland (udder or milk-giving gland) of animals, usually caused by bacteria. The symptoms of mastitis are heat, pain, and swelling of the udder. Usually you will notice some discoloration of the tissue and abnormal milk. The infected udder will change in color from slightly more pink to a bright red, or to a black and cold udder. The infected udder will feel hot to the touch with fever. The milk from an infected udder will vary in color, texture, and thickness. The California Mastitis Test (CMT) is a good test for subclinical mastitis, but is not 100% accurate. Laboratory culture or growth of the bacteria causing the mastitis is the best way to determine the exact diagnosis. The causes of mastitis are most commonly rough treatment and unclean milking practices. Wash the goat's udder before milking, and dip (or spray) the teats after milking with a teat dip. Wash your hands before milking each goat to prevent the spread. The treatment consists of an intra mammary infusion of antibiotics, sometimes accompanied by additional antibiotics. Consulting a vet is important for this disease since there are many different bacteria that cause mastitis and different antibiotics are best for each. If untreated the infection spreads and the goat may die or lose the udder.

## 6.3 Ketosis

Ketosis (also known as pregnancy toxemia) may occur in pregnant does late in their pregnancy. The doe may be depressed, weak, uninterested in food, and have poor muscle control and balance. If untreated, death follows within a few days. Early in the disease, many does will show a positive test for

ketone bodies in the urine. Ketosis may occur when the doe is carrying two or more kids, or when the doe is very fat. This disease is caused by the sudden extra demand for energy by the fast-growing kids in the pregnant goat and the inability of the goat to eat enough of her normal diet to provide this energy (due to the kids taking up room in the body). The doe will rapidly metabolize fat from her body stores producing ketones and the symptoms of the disease. Treatment with propylene glycol at two to three ounces twice a day will help. If the doe lies down and cannot stand, treatment is usually not successful unless she delivers at that time. As a preventive measure, do not let the doe get fat early in pregnancy and in the last month of pregnancy provide 1-2 pounds of grain in addition to hay.

## 6.4 Enterotoxaemia

Enterotoxaemia, also known as "over-eating disease", is caused by the bacterium *Clostridium perfringins*. This bacterium is a normal inhabitant of the intestinal tract of goats. However, there are certain conditions including stress, which trigger excessive bacterial growth in which lethal amounts of toxin are produced, resulting in death of the animal. Enterotoxaemia can have no symptoms or symptoms such as diarrhea that are commonly confused with other diseases, so prevention is a must. Vaccinate kids once a month from the time they are 1 month old until they are 5-6 months old. Be sure to use a C&D vaccine, commonly sold as a CD/T vaccine. Treatment for the disease can be unrewarding, if your goat has already been diagnosed. Recoveries are rare, but affected goats can be treated with Clostridium antitoxin, penicillin and flunixen. Prevention is the best treatment.

## 6.5 Contagious pastiuler dermatitis

Contagious Pastiuler dermatitis is spread by a para poxvirus that is highly contagious. It is more commonly found in sheep than goats, however goats are still susceptible. It affects primarily the lips and noses of young animals. If they are nursing off dams which have not previously had the disease or been vaccinated, the dams will also display identical sores on the teats and udder where it may cause mastitis. The sores start as small red spots which form blisters that burst to form ulcers. These are followed by characteristic grayish-brown cauliflower like scabs. There will be spontaneous healing and the scabs will fall off in about three weeks. The skin at the corona of the hooves can also be affected. To prevent the disease, there is a CPD vaccine that is available, but because it is a live virus vaccine. If your goat has been diagnosed with CPD, immediately isolate him or her from the rest of the herd. You can apply antibiotic cream to the infected area to prevent secondary diseases.

## 6.6 Caseous lymphadenitis

CLA is caused by a bacterium called *Corynebacterium pseudotuberculosis*, which is often found in some of the same sites favoured by the tuberculosis bacteria, and often causes a wasting syndrome in infected animals. Once one animal on a premise is infected, open draining wounds associated with infected lymph nodes result in environmental contamination. Other sheep or goats are then infected through routine procedures that result in broken skin, such as shearing, tail docking, horn removal and castration. Abscesses usually take one to three months to form from the point of entry in the skin or lymph node, and then slowly spread by blood or lymph to organs or other lymph nodes. CLA abscesses are characteristically thick walled. When fresh they are filled with soft pasty white to green exudate. CLA is considered impossible to completely cure, are very slow to progress and often wax and wane as abscesses rupture and drain.

## 6.7 Pneumonia

Inflammation of lung is known as pneumonia. This disease occurs due to various reasons like bacteria, virus, parasites etc. It is a fatal disease. This disease spread through food, water and breath of disease affected goat. Body temperature of affected goat increases for up to 41° to 45° F. They take breath frequently. Suffer by coughing and snivel ooze from the nose. Tongue get swelled and they always keep it out. Affected goats can be treated with Using antibiotic of sulphonemide group like sulphadimidin, penicillin, tetracycline, ampicillin, tylucin etc. are very effective for this disease.

## 6.8 Cerebrospinal Nematotiosis

This disease is transmitted from cattle to goats through mosquitoes, causing disorders in the nervous system. The disease is caused by the migration of the larvae of Setaria species in the central nervous system. *Setaria digitata* was found Sri Lanka. Symptoms are abnormal movements e.g. ataxia, circling, tremor and abnormal posture. Diseased animals are remained bright and alert with a normal appetite and normal body temperature. Diseased goats can be treated with Hetrazan tables or Ivermicatine. This disease can be controlled by rearing cattle and goat separately, control of mosquitoes and regular deworming of cattle .

## 6.9 Tetanus

Tetanus, or lockjaw, is caused by *Clostridium tetani*, when the bacteria gains entry to the body through a contaminated break in the skin. Animals with tetanus become rigid, exhibit muscle spasms, and eventually die. Treatment

is usually unsuccessful, but the disease can be prevented with vaccination and good hygiene. Tetanus can be transmitted to humans, so care should be taken when handling an outbreak.

## 6.10 Foot rot

Foot rot is caused mainly by the synergistic action of the bacteria *Fusobacterium necrophorum* and *Dichelobacter nodosus*. The bacteria enter the hoof and digest the hard, horny tissue of the sole that protects the fleshy tissue of the hoof. Clinical signs of foot rot include redness and inflammation between the toes and a bad odor. In advanced cases, the hoof horn becomes under run and actually can separate from the hoof wall. Foot rot can cause lameness, reduced weight gain as animals are less willing to move to feed, and decreased reproductive capabilities. To prevent foot rot, avoid the introduction of the disease to a foot rot-free herd. Other management tasks that help maintain good foot health include regular hoof trimming and sound nutrition. Foot soaking baths using zinc sulfate can be constructed to treat foot rot in conjunction with systemic treatment.

## 6.11 Acidosis

Acidosis is caused due to grain overload, develops as a result of animals consuming large quantities of carbohydrates. Excessive consumption of carbohydrates, specifically grain, results in a lowered rumen pH. The lowering of ruminal pH, or making the stomach more acidic, occurs because the microbial population of the rumen is not able to metabolize high levels of lactic acid produced during starch breakdown. In general, goats with the condition demonstrate symptoms of discomfort, anorexia, teeth grinding, muscle twitching, ruminal stasis, and diarrhea that may be off in color with a watery consistency. In sub-acute acidosis, animals may simply decrease intake of high grain or starch diets, while in severe acute cases of grain overload, animals can become extremely sick and the mortality rate is high. To avoid inducing lactic acidosis in sheep and goats, high grain diets should be introduced slowly over a period of 10 to 14 days to allow rumen microbial adjustment to the diet. Dietary buffers, such as limestone or calcium carbonate, can also be fed to neutralize acid present in the rumen and keep appetite and feed intake high.

## 6.12 Internal and external parasites

Parasites pose a significant threat to the health of goats. Parasites can damage the gastrointestinal tract, and result in reduced reproductive performance, reduced growth rates; less productive animals in terms of meat and milk; and even death. General clinical signs that an animal is suffering from a parasitic

infestation include diarrhea, weight loss or reduced weight gain, lethargic, loss of appetite, and reduced reproductive performance.

The most common internal parasite is the roundworm that lives in the abomasum and small intestine of sheep and goats. There are several types of roundworms that infect sheep and goats, including *Telodorsagia* (*Ostertagia) circumcincta, Haemonchus contortus,* and *Trichostrongylus colubriformis.* The most dangerous parasite affecting goats is the gastrointestinal roundworm *Haemonchus contortus*, also known as the barber pole worm. This voracious bloodsucking parasite has a tremendous capacity to reproduce through egg-laying. Clinical signs include anemia (pale mucous membranes), edema, protein loss, and death. Animals suffering from *Haemonchus contortus* become weak and lethargic, often straggling at the back of the herd when driven a distance. Edema, or the accumulation of fluid under the skin, is usually seen as a swelling of the lower jaw, a condition known as bottle jaw. Anthelmintics are drugs that either kill egg-laying adults or kill larvae before they grow into adults and become capable of laying eggs. An anthelmintic is normally administered as an oral drench, a thick liquid suspension deposited at the back of the animal's tongue.

External parasites common to sheep or goats include lice and mites. Infestation of external parasites lead irritates the skin, causing the sheep and goats to itch, which results in hair loss and lesions or scabs. Administering injectable ivermectin or topical insecticides can help affected animals.(http://www.msdvetmanual.com/management-and-nutrition/health-management-interaction-goats/common-diseases-of-goats)

## 6.13 Coccidiosis

*Coccidia* are protozoan parasites that damage the lining of the small intestine. Since the small intestine is an important site of nutrient absorption, coccidia can cause weight loss, stunted growth, and diarrhea containing blood and mucous. Other clinical signs include dehydration, fever, anemia, and breaking of wool or hair. Fly strike and secondary infections can also result from coccidiosis. Coccidia are usually found in animals in confinement or intensive grazing systems, as a result of poor sanitation, overcrowding, and stress. Animals between one and six months of age in feedlots or intensive grazing systems are at highest risk for coccidiosis. Outbreaks of coccidiosis can be controlled by implementing good sanitation techniques, providing clean water, rotating pastures, and avoiding overstocked pens. Outbreaks of coccidiosis can be treated with sulfa drugs.

### 6.14 Foot and Mouth Disease (FMD)

FMD is a severe, highly contagious viral disease of livestock with significant economic impact. The disease affects cattle and swine as well as sheep, goats, and other cloven-hoofed ruminants. The organism which causes FMD is an aphthovirus of the family Picornaviridae. There are several strains. These are A, O, C, SAT1, SAT2, , Asia1. FMD is found in all excretions and secretions from an infected animal. The virus may be present in milk and semen for up to 4 days before the animal shows clinical signs of disease. Animals that have recovered from infection may serve as carriers of the virus. Infected animals notably breathe out a large amount of aerosolized virus, which can infect other animals via the respiratory or oral routes. FMD is characterized by fever and blister-like sores on the tongue and lips, in the mouth, on the teats and between the hooves. The disease causes severe production losses and while the majority of affected animals recover, the disease often leaves them weakened and debilitated. Prevention can be done by vaccination and maintain sound biosecurity practices.

### 6.15 Brucellosis

This disease results from infection by various species of Brucella. Six species occur in humans and animals. *B. melitensis* is the most important species in sheep and goats. Brucellosis is spread among animals by contact with the placenta, fetus, fetal fluids, and vaginal discharges from infected animals. Animals are infectious after either an abortion or full term birth. The organism is found in blood, urine, milk, and semen; it can be shed in milk and semen (which can be prolonged or lifelong). Brucella can be spread on equipment, clothing, etc. In conditions of high humidity, low temperatures and no sunlight, these organisms can live for several months in water, aborted fetuses, manure, wool, hay, equipment and clothes.

It can cause abortion, retained placenta, and swelling of the testicles. Abortions usually occur in late pregnancy in sheep, and during the fourth month of pregnancy in goats. In goats, mastitis and lameness may be seen. Brucellosis is contagious to humans. Diagnosis can be done by blood tests and culture of tissues listed above. There is no practical treatment that is successful. (https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases. pdf)

## 7. Marketing Channels and Value Chain

There is no organized marketing network for goat meat and milk. Due to limited supply, goat products fetch a high premium price, which is unaffordable to average consumer. The products are sold in the local retail

shops as well as in supermarkets. Goat milk is becoming popular due to its merit in contributing to health benefits and therefore rearing dairy goats under intensive management is becoming popular since recent past.

## 8. Constrains for Subsistence and Commercial Goat Farming

The following factors affecting the development of the sector:

- Inconsistent policies for the industry.
- Low productivity of animals.
- Low farm gate price for milk and meat.
- High cost of milk production.
- Poor extension services and inadequate education on animal health among goat farmers.
- Absence of new investments in the livestock sector due primarily to a lack of state support and financial services.
- Poor marketing options available and inadequate milk-processing facilities.
- Failure to update the technologies, including the development of a proper collection and distribution network in the sector.

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## 9. Conclusions

The goat sector is regarded as the priority sector in livestock development for public investment. The policy goal in developing the goat sector is to achieve sustained and equitable economic and social benefits to farmers while increasing the supply of domestic livestock produce at competitive prices for consumers. To achieve the goal, the strategic approach for promoting goat production for food security is planned as follows:

- Promote a liquid milk market.
- Upgrade the native herd as a fundamental necessity for goat development, while encouraging the active involvement of the private sector.
- Transform the current subsistence-level goat production into a viable commercially oriented activity.
- Focus import policy and fiscal policy on goat products to provide a conducive environment for the domestic goat industry, with market forces governing the pricing of domestic milk and meat.
- Strengthen development of a viable, medium-to-large scale, commercially oriented private sector engaged in goat production, which is crucial for the long-term sustenance of the domestic goat industry.

- Empower goat farmers and facilitate their participation and that of the processors in the value chain of goat products.
- Promote livestock production among vulnerable groups and increase the protein intake by livelihood diversification in rural areas.
- Strengthening artificial insemination and breed-improvement programmes.
- institutional improvements for delivery of veterinary care services and animal health management.
- Stronger extension services and human capital development.
- Value addition at the village level.

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# Chapter 7

# Goat Genome Studies in Pakistan

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## 1. Abstract

Small ruminants have a high potential for milk, meat, wool and leather production. In Pakistan, the goat population is over 62 million and is considered as the third largest goat production country in the world. About 34 goat breeds are documented distributed in all geographical regions of the country. Prion gene analysis depicted our majority of the Pakistani goat breeds have low frequency of genetic susceptibility for prion development. Parasitic challenged trial and interferon gene analysis predicted our indigenous breeds as resistant to parasitic infestation compared to exotic goat breed. The short tandem repeats based molecular markers showed a specific position of indigenous goat breeds. Phylogenetic analysis based on orf region predicted that all goat breeds along with sheep share the same clade and have deer species as the most recent common ancestor. Goat genome sequencing is also initiated for future purposes. Documentation of genetic information is important for designing and implementing the breeding strategies in conservation and better utilization of rich goat genetic resources of Pakistan.

## 2. Introduction

Pakistan is an agriculture country and livestock sector contributes about 11.9 percent in the GDP. Livestock is considered a main source of income for rural areas and agribusiness holders. The major livestock farm species in Pakistan are goat, sheep, buffaloes, cattle and camel and goat is on the top of list.

### 2.1 Goat domestication in the world and Pakistan

The largest goat milk producing countries are China, India, Pakistan and Bangladesh. Goat population in China is the highest with 182.9 million heads which constitutes 18.19% percent of the total world's goat population. Trend of goat population domestication is increasing in the world particularly during period of 2000-2013, which is about 33.8% and highest in Asia. Similarly goat milk production was also increased during this period by 39.2%. Asia shares the largest about 70.7% of total goat meat production in

the world and China is leading in production with 35.89% (FAOSTAT, 2013).

In Pakistan, the goat population shares highest number among livestock species with about 62 million followed by cattle (38.3 million), buffalo (33.7 million) and sheep (28.8 million). Pakistan is a third largest goats producing country in the world. Goat's milk is the fourth major source after buffalo, cow and camel in Pakistan (Economy Survey of Pakistan, 2014). In addition to milk, it is a highly potential source of meat, hair and leather production. Goat meat is a preferred commodity and dictated by traditional background and socio-economic status of the community.

## 3. Goat Breeds in Pakistan

About 34 goat breeds are documented distributed in all geographical regions of the country. The Punjab, Sindh and Baluchistan represent 19 breeds including Barbari, Chappar, Kamori, Beetal, Nachi, Dera Din Panah, Teddy, Bari, Bugi Toori, Bujri, Jattan, Kacchan, Kurri, Lohri, Lehri, Pateri, Tapri, Khurassani and Pahari. The Khyber Pukhtunkha, Gilgit Baltistan and Kashmir shows domestication of 15 breeds including Kaghani, Damani, Gaddi, Lehri, Baltistani, Beiari, Buchi, Jarakheil, Jattal, Kail, Koh-I-Ghizer, Kooti, Labri, Pamiri Potohari and Shurri (Afzal and Naqvi, 2004). Among these, important breeds are Beetal, Teddy and Dera Din Panah Punjab, Kamori and Barbari in Sindh, Jatal and Kaghani in Khyber pukhtunkha, and Lehri, Pahari and Khurassani in Balochistan province. In addition to these indigenous breeds, Angora an exotic breed is also domesticated at many livestock farms in Pakistan. Among these Beetal, Barbari, Dera Din Panah, Khurasani, Pahari Gaddi are famous for milk and meat purposes. Beetal is also known as Poor Man's cow. Teddy has characteristics of fecundity for twinning and triplets and this property increases its significance for meat purposes. Markhor (Capra falconeri) is a wild goat and recognized as a National Animal of Pakistan.

## 4. Genomic Studies of Goat Breeds in Pakistan

The knowledge of genetic structure and relationship among different goat breeds is essential for future breeding policies to utilize the available genetic resources of Pakistan.

### 4.1 Prion protein in Pakistani goat breeds

#### 4.1.1 Prion

Prion is a small membrane-anchored extracellular protein molecule of yet unknown function. This prion protein (PrP) molecule folds into its normal

cellular (PrPc) and misfolded is associated with pathological from (Pastore and Zagari 2007). Misfolding and aggregation of PrP causes a larger family of pathological conditions with characteristic symptoms of astrogliosis, neuraronal apoptosis brain vacuolation associated with accumulation of extracellular proteins of having or not the properties of amyloid fibril deposited in the central nervous system. Prion peptides adopt amyloid conformations but in case of large fragments they depict a degree of complexity in the structures (Wan et al., 2015). Misfolding alters the ration of non-pathogenic functional form α-helical and β-structured oligomericand amyloidogenic froms which causes prion diseases. The monomeric precursors dimerize and initiate misfolding (Moulick and Udgaonkar, 2017). Pathological form of PrP causes a complex group of diseases with mainly affecting the central nervous system of many species including human, cattle, buffalo, sheep and goat. The most common form of prion disease in sheep and goat is PrP scrapie (PrPSc). This abnormal isoform PrPSC have identical primary sequence with normal PrPC molecule but different secondary and tertiary structure. The PrPC shows 43% α-helical and 3 β-sheet whereas PrPc possesses 30% α-helical 43% β-sheet contents. This refolding makes the PrPSc extremely resistant to proteolysis (Pan et al., 1993).The coding sequence of the prion gene is considered to be the most important to scrapie susceptibility.

### 4.1.2 Prion gene screening

The scapie susceptibility in Pakistani goat breeds investigated through restriction fragment length polymorphism and sequencing analysis. The open reading frame (orf) region of PrP gene was sequenced for genetic variant detection in 11 Pakistani indigenous goat breeds. Sequencing performed of 80 goat samples representing 11 goat breeds from all provinces of Pakistan(Hassan et al., 2016). Findings suggested six single nucleotide polymorphism (SNPs) with non-synonymous changes in the amino acid sequence including c.126A>G, c.304G>T, c.379A>G, c.414C>T, c.428A>G and c.718C> T. The c.428A>G SNP was more common compared to other variants in all breeds. Phylogenetic analysis based on orf region predicted that all goat breeds along with sheep share the same clade and have deer species as the most recent common ancestor.

In another study, 72 healthy goats representing five breeds were genotyped through Sanger's sequencing method to determine the scrapie associated regions of the PrP gene as described in the published article (Babar et al., 2008). Genomic DNA was extracted from leukocytes following the standard organic method with minor modification (Sambrook and Russell 2001). Primers were designed for amplification of the 876bp long sequence covering the exon 3 coding region . The forward primer used is as 5-

CTTTAAGTGATTTTTACGTGG-3ˊ and the reverse primer 5ˊ TGGCAAAGATTAAGAAGATAATG-3ˊ The reaction mixture 25 µL was used for amplification is genomic DNA 50ηg, buffer 50 mM KCl, MgCl2 1.5 mM, dNTPs 20mM, Taq. polymerase 1.5 units. Cyclic conditions with initial denaturation of 94°C for 4 minutes, followed by denaturation of 35 cyclesat 94°C for 45 seconds, 54°C for 45 seconds annealing, 72°C for 1 min extension and a final extension of 10 minutes at 72°C. PCR products were purified and sequencing using the following primer pair 5'-AGCAGTGGTAGGGGGCCTTGGT-3 and 5'TTTGGCTTACTGGGCTTGTTCC-3' as already reported. Six genotypes were identified with three reported and two novels. The sequencing data showed three already reported polymorphic amino acid substitution at p.H143R, p.R154H and p.S240P p.H143R positions. Interestingly few individuals of our indigenous breeds were polymorphic with the genotype SIP/RFP based on the amino acid substitutions. Among these, the p.H143R and p.R154H are scarpie associated genotypes and their frequency found lower (34.7%) compared to the wild type genotypes. Two non-synonymous novel amino acid substitutions at p.S39R and p.I185F positions were also detected in Pakistani goat breeds. In addition to these, four nucleotide variations were also identified at c.42A>G, c.138C>T, c.231C>A and c.237G>C position without any change in the amino acid sequence.

The four indigenous goat breeds Naachi, Teddy, Dera Din Panah and Pak-Angora were investigated for PrP genotype analysis (Babar et al. 2009). Genotyping of 186 animals performed for the polymorphic site at c.136 and c.154 through restriction fragment length polymorphism (RFLP) technique. The RFLP analysis of four goat breeds showed monomorphic with genotype of AARR and only one animal belonging to Teddy breeds presented the AARH genotype. After RFLP, sequencing was performed and twenty animals, the two synonymous variations identified at codon 42 and 138 position and one non-synonymous at 240 codon position resulting in amino acid change from serine to proline. Animals of all breeds showed both wild and mutant type polymorphism presented two genotypes PPSSSS and PPSSPS harboring PSS and PSP genotypes at codon 42, 138 and 240 positions. Genetic screening for susceptibility to Scrapie is an important aspect particularly for the trade purposes and this data recommends the more emphasis at large scale to address the future concerns of scrapie.

# 5. Genetics of Goat Immunity

## 5.1 Major histocompatibility complex and interferon alpha

The major histocompatibility complex (HMC) is presented as class I and II group. These are cell surface glycoprotein molecules which play a crucial

role in the immune response against pathogens. These molecules bind with the peptide fragments derived from the foreign particles or pathogens and display on the cell surface for appropriate T cells recognition. A series of reactions consequently occur to kill the pathogen infected cells, activation of macrophages kill the living bacteria in the intracellular vesicles and B cells are produce antibodies to remove or neutralize the pathogens(Neefjes et al., 2011). The MHC is aproduct of multigenes possessing highly polymorphic sites which are the main causes of complexity. The diversified nature of MHC molecules makes it difficult for the pathogens to neutralize the host's immune response system. Very important protein associated with antigen processing-1 (TAP-1) is member of MHC class I and is potential signaling molecule for interferon alpha (IFNα). Molecular mechanism understanding of IFNα and response prediction are important for treatment response which allow the continuation for inefficacy and side-effects (Heise et al. 2016). Interferon alpha (IFN-α) plays pivotal role in cell-mediated innate immune response is produce by viral infected cells is central to the antiviral response of a host. In our study, IFN-α gene was analyzed in thirty unrelated Beetal goat breed through sequencing. Genomic DNA was extracted and sequencing analysis of partial fragment (361 nucleotides) of IFN- α gene revealed three transitional substitutions A83G, A127G and A144G in all investigated animal. The data showed two of them were missense substitution (Lys28Arg, Thr43Ala) and one substitution was synonymous. The phylogenetic tree showed species-wise clustering, the Beetal goat closer to other goat and partial IFN-α gene sequence showed 98.33% homology with referenced goat IFN-α sequence XM_005683621 orthologous gene bank sequence. This pioneer significant information in Pakistani indigenous goats could be applied in the selection of superior animals. Further biological studies in other breeds may provide evolutionary way to acquire elite animals.

## 5.2 Resistant to parasitic infestation

In the developing countries, the livestock productivity is mainly reduced due to parasitic infections. Parasites hamper the production and growth in goats. Among these, *Haemonchus* species are the major gastro-intestinal parasites affecting the small ruminants globally. *Haemonchus* contortus is very common and most pathogenic of ruminants due to its blood sucking nature. These attached with the abomasum and feed on the suck blood resulting in the anemia, low packed cell volume, dehydration and many lead to death in prolonged and heavy infestation loads. *H. contortous* consequently plays an important role in the efficiency, productivity and profitability of the animal (Terrill et al., 2012). Selection of goat breeds having better resistant to gastrointestinal parasites is an important strategy to overcome this problem.

This published study was focused on the genetic resistant of four goat breeds including Beetal, Nachi, Teddy and Pak-Angora against *H. contortus*. Animals (n=13) of each breed were selected irrespective of gender (Babar et al., 2015). These animals were kept under uniform controlled environment and restricted the open grazing to minimize the infestation from nematodes. All the animals were fed at 3% body weight on total mixed ration (TMR). This TMR was a mixture of corn silage, wheat straw and mineral mixture. All the animals were infested with 500 L3 larvae of *H. contortus*. Resistance and susceptibility of each animal was assessed on the baseis of fecal egg count, FAMACHA and packed cell volume on 0,28,35 and 42 days for challenged trial. Dewormer was used after 42 days of infestation. *H. contortus* positive goat samples were used as seeding. Eggs were cultured in the lab to the L3 stage and doses were adjusted with 5000 and administered to the animal. Blood and fecal samples were collected for fecal egg count, packed cell volume, eye color for anemia. The fecal samples were obtained directly from the rectum and examined using McMaster technique. Cumulative values of all the parameters were analyzed, Beetal and Teddy were significantly resistant ($P>0.05$) to the *H. contortus* compared to Angora goat breed.

In another study, *H. contortus* species were genotyped based on internal transcribed spacer 2(ITS2), cytochrome oxidase 1(COI) and nicotine amide dehydrogenase subunit 4 (ND4). Sequencing of these genes in Haemonchus revealed three species *H. contortus*, *H. placei* and *H. longistipes* presented with 12 genotypes circulating in the ruminants of Pakistan including goats. High genetic diversity observed in the *Haemonchus* species. Phylogenetic based on ND4 and COI genes were compared with isolates from 11 other countries. The *H. placei* isolate are genetically differentiated from others countries but not significant deviation ($P<0.05$) among Pakistani *Haemonchus* population (Hussain et al., 2014).

These findings provide an overview of genetic resistant goat breeds and genetic diversity of gastro-intestinal nematode. Further evaluation of goat breeds for resistance to *H. contortus* and genetic screening of molecular marker could help to minimize the anthemintic usage.

## 5.3 Mitochondrial and STR markers

Maternal inheritance is mainly determined through mitochondrial genome markers. The Capra hircus mitochondrial genome is 16,640 bp in length, responsible for 12S and 16S rRNAs, 22 tRNAs and 13 protein coding regions. The mtDNA genome organization difference ranges from 0-15.6% between sheep and goat (Pietro et al., 2003). We have sequenced the selected coding region of mtDNA of five Pakistani goat breeds. The comparative

analysis showed sixty distinct haplotypes of Beetal, Teddy, Nachi and Pahari goats belonging to two main maternal lineages A and B1 with 76.9% and 23.1% frequency respectively.

The single sequence repeats (SSRs) or microsatellite markers are highly informative for reconstruction of evolutionary and population differential analysis. These are widely used in genetic studies (Vieira et al., 2016). Short tandem repeats (STRs) are also known as microsatellites possess several properties which make them useful for population genetic analysis(Calafell et al., 1998). An STR is a small DNA sequence with 2-13 nucleotide units repeated hundreds of time in non-coding DNA region. The number of repeats varies between individuals at a specific location in the genome and identification of repeats can be used for genetic profiling of an individual. STRs based typing is rapid, reliable, cheap and sensitive enough to identify a minor genotype. These STRs are preferred due to high polymorphism, low mutation rate, abundance in the genome, easy to amplify through PCR. Now these markers are accepted worldwide for genetic characterization (Gits-Muselli et al., 2015).

Genetic relationship, diversity and differentiation of Damani and Nachi goat breeds were studied. Genomic DNA from 25 animals of each breeds was extracted using standard organic method with minor modifications (Sambrook and Russell 2001). Microsatellite markers set of 9 recommended by the International Society for Animal Genetics (ISAG) was optimized and analyzed using relative flow method on 12% non-denaturing polyacrylamide gel. The genetic variability was calculated as number of alleles (Na), expected number of alleles (Ne), observed heterozygosity (Ho), expected heterozygosity (He), the Shannon's index (I), inbreeding with population (FIS), inbreeding among population (FIT), gene flow (Nm) and polymorphic information content (PIC) were calculated through POPGENE and POWER STAT software. A total number of 53 alleles identified with mean of 3.2 and 4.6, genetic diversity 0.73 and 0.51 in Damani and Nachi respectively. The FST (0.20), Nm (0.95) showed their divergent and expanded geographical position. The FIT (0.15) and PIC (0.70) represents high level of polymorphism for these STRs markers (Hussain et al., 2013) .

Recently, we conducted a genetic diversity of five economically important goat breeds of Pakistan, Beetal, Kaghani, Teddy, Nachi and Pahari. Fifteen microsatellite loci recommended by ISAG/FAO guidelines were investigated for measures of genetic variability, differentiation and population structure. The genetic variability in terms of allelic diversity and heterozygosity were moderate. The estimated inbreeding coefficient was low in all the investigated goat breeds and not significant. Overall, the populations were less diverse than Eurasian goat breeds, but did not exhibit signs of loss of

diversity. Analysis of molecular variance (AMOVA) showed breed differences accounted for 5.42% of total genetic variation indicating low to moderate genetic differentiation among the investigated goat breeds. The genetic structure analysis revealed Teddy, Pahari, and Nachi as distinct breeds, while Beetal and Kaghani form a single genetic group distinct from the other three goats.

## 6. Conclusion

Our indigenous goat breeds show a genetic diversity as expected on the basis of their geographical location. Teddy and Beetal breeds found more resistant to parasite compared to exotic Angora breed. The measures of genetic variations depict a good scope for effective improvement, conservation and designing national breeding policies for goat breeds in future.

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# Chapter 8

# Peste des Petits Ruminants (PPR) in Pakistan- Past to Present

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Peste des Petits Ruminants (PPR) is an important viral disease of livestock. It is prevalent in large belts across Africa, Middle East and Asia. It plays a major role in rural economics and in the survival during drought and famines. PPR is a priority trans-boundary animal disease (TAD) having potential of rapid spread over vast areas. It is a major constraint to small ruminant production in the regions where it is endemic. It is capable of destroying susceptible host population by provoking epidemics and pandemics inflicting serious economic losses. PPR is threat to food security because 60% small ruminant's population are susceptible to PPRV infection in endemic regions.

## PPR: The Disease

The causative agent of PPR is Peste des Petits Ruminants Virus (PPRV) which is a single-stranded negative-sense RNA virus. It belongs to genus morbilli virus in the family *Paramyxoviridae*. There are four different lineages of PPRV. Major host of PPRV are sheep and goat but it can infect wild ruminants and camels. Its morbidity is 80 to 100% while mortality is 5 to 50%.

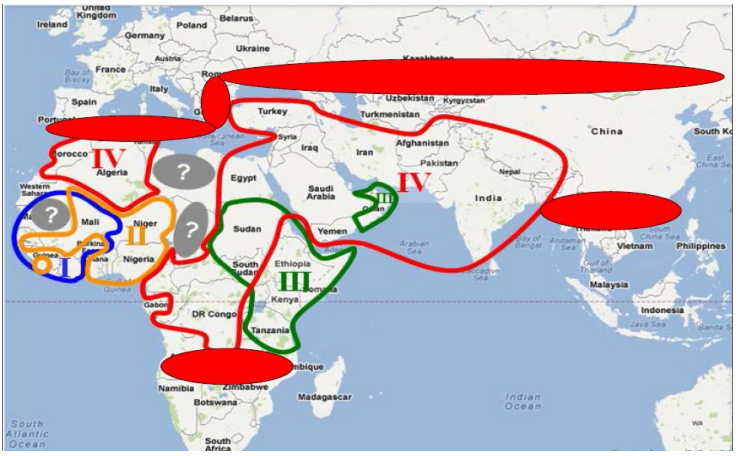


Figure 1. Lineage wise distribution of PPR

## Risk factors for persistence and transmission of PPRV:

Factors having major role is persistence and transmission of PPRV are enlisted below:

- Animal density
- Animal movement
- Prevalent production systems
- Livestock markets
- Seasons and droughts/climate

## Clinical Picture:

Animals affected by PPRV depict the following signs and symptoms:

- Depressed goats with pyrexia
- Conjunctivitis and ocular discharges
- Nasal discharges
- Early necrotic lesions in mouth
- Erosive mouth lesions
- Necrosis on the dorsum of tongue
- Swollen lips
- Scabs on the muco-cutaneous junction
- Respiratory distress
- Diarrhoea
- Mortality

## Necropsy Findings:

Following lesions are observed upon post mortem of animals died of PPR:

- Pneumonic lungs
- Haemorrhages on liver
- Reactive lymphnodes
- Haemorrhages on abomasal wall
- Haemorrhages on kidney

## Differential Diagnosis:

The signs and symptoms of PPR generally confused with following diseases:

- Rinderpest
- Pneumonic pasteurellosis
- Contagious caprine pleuropneumonia
- Contagious ecthyma - ‘orf’
- Bluetongue
- Foot-and-mouth disease

## Historical Perspective (PPR in Pakistan):

PPR was first recognized during early 1990s in Pakistan. Initial reports were based on clinical & epidemiological observations by Pervaiz et al., 1993 and Athar et al., 1995. First lab confirmation of PPR was done in 1994 (Amjad et al., 1996). In spite of all initial studies serious efforts to study the epidemiology of the disease systematically initiated in 2000. Participatory Disease Search (PDS) revealed presence of PPR in different parts of country (Zahur et al., 2008).

In Pakistan PPR has also been reported in Mouflon sheep **(***Ovis Orinetalis***,** OIE, 2000) and Sindh Ibex **(***Capra aegagrusblythi***,** Abubakar et al., 2011).

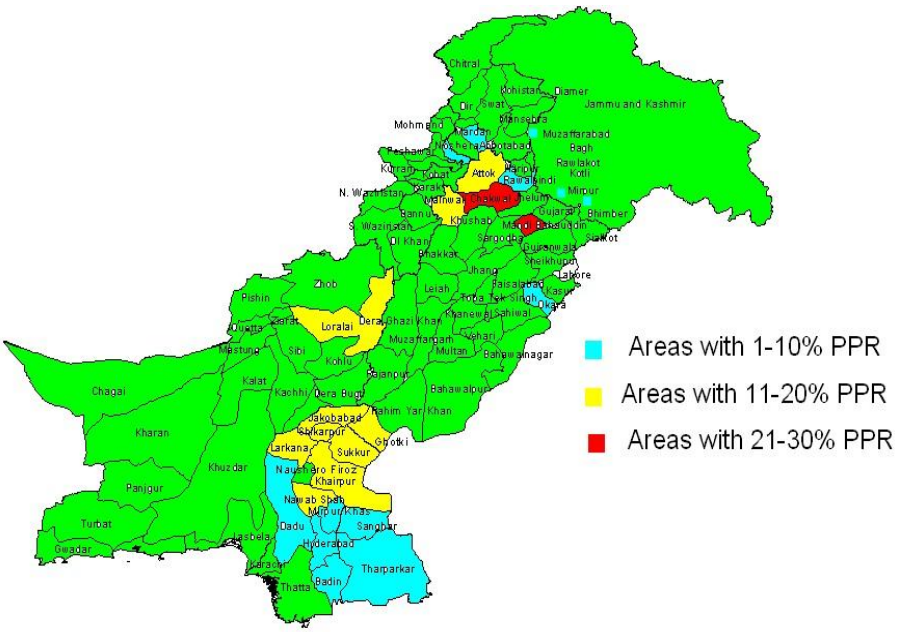


Figure 2. Prevalence of PPR in Pakistan

## Laboratory Tests Available in Pakistan:

A standardized panel of diagnostic assays has been developed and being used:

**Antigen and gene detection**: Antigen Capture ELISA, lateral flow device (field test), conventional RT-PCR, Real-time RT-PCR, RT- LAMP

**Virus isolation:** Isolation on vero cells, characterization by sequencing

**Serological tests**: Competitive ELISA, virus neutralization test (VNT)

## Laboratories carrying out activities on PPR

| Lab | City | Antigen detection (Ic-ELISA) | Antibody detection (c-ELISA) | Virus Isolation | RT-PCR | rRT-PCR | Sequencing |
|---|---|---|---|---|---|---|---|
| NVL | Islamabad | √ | √ | * | √ | √ | * |
| AHP-NARC | Islamabad | √ | √ | √ | √ | √ | * |
| Vet Res. Inst. | Peshawar | √ | * | * | * | - | - |
| Provincial Diagnostic Lab | Lahore | √ | - | - | - | - | - |
| CVDL | Hyderabad | √ | - | - | - | - | - |
| CVDL | Mithi | √ | - | - | - | - | - |
| DI Lab | Quetta | √ | - | - | - | - | - |
| DI Lab | Gilgit | √ | - | - | - | - | - |
| DI Lab | Mirpur, AJK | √ | - | - | - | - | - |
| NIBGE/ NIAB | Faisalabad | * | * | * | * | * | * |
| UDL-UVAS | Lahore | * | * | * | * | * | * |

√ Activity is being carried out, * Has capacity but not being undertaken for PPR on regular basis, - No facility

## PPR Control Initiatives in Pakistan:

- Initially, tissue culture rinderpest vaccine (TCRV) was used.
- 0.2 million doses of PPR vaccine for emergency use under a FAO project.
- 1 million doses of PPR vaccine imported under SLSP, 2005.
- Local production started in 2006-07 at VRI, Lahore and CASVAB, Quetta.
- Awareness campaign to sensitize major stakeholders 2006-09 (PARC and FAO).
- PARC project started a targeted surveillance of PPRV activity and preventive vaccination in 6 selected high risk districts in each of the province and regions of the country along with awareness campaign.
- FAO project started surveillance of PPRV activity in the entire country.
- Emergency vaccination was conducted at the face of an outbreak.

- Preventive vaccination was conducted in selected high risk districts of the country.
- Establishment of models for the control of PPR in Pakistan 2012-16 (ALP- PARC).
- Progressive control of PPR in Pakistan 2013-17 (FAO).

## Development of models for the control of PPR in Pakistan (ALP-PARC):

| Sl. No | Province | Tehsil | No. of animals vaccinated | Vaccinated in subsequent 2 years |
|---|---|---|---|---|
| 1 | Sindh | Umerkot | 2,70,000 | 160 ,000 |
| 2 | KPK | Chitral | 2,70,000 | 140,000 |
| 3 | Balochistan | Lasbella | 2,00,000 | - |
| 4 | Gilgit Baltistan | Chillas | 3,00,000 | 2,00,000 |
| 5 | AJK | Barnala | 2,80,000 | 1,50,000 |
| 6 | Punjab | LiaqatPur | 3,20,000 | In process |

## Capacity building of stakeholders:

| Province | Veterinary Staff | | | Farmers (No) | |
|---|---|---|---|---|---|
| | Workshops | Vets trained | Kits provided | Seminars | Farmers trained |
| Punjab | 7 | 231 | 204 | 6 | 305 |
| Sindh | 10 | 350 | 281 | 8 | 513 |
| Khyber Pakhtunkhwa | 1 | 34 | 34 | 10 | 313 |
| Baluchistan | 4 | 97 | 89 | 2 | 50 |
| FATA | 2 | 22 | 23 | | |
| Gilgit Baltistan | 1 | 10 | 1 | 1 | 140 |
| Azad Jammu & Kashmir | 9 | 95 | 74 | 6 | 521 |
| Islamabad | - | - | - | - | - |
| Total | 34 | 839 | 706 | 27 | 1842 |

## Conclusion

- It is a serious disease which affects food security and rural livelihoods and development.
- PPR eradication program is necessary.

- PPR eradication is desirable, achievable, technically feasible and economically viable.
- To achieve this goal we also need financial and technical resources, political and administrative commitment and regional cooperation and harmonization in surveillance and laboratory SOP.

## Funding Sources


- FAO-EU Trust Fund Project (2002-04)
- Agricultural Linkages Programme (ALP-PARC) (2005-09)
- FAO Regional Project (GTFS/INT/907/ITA) (2005 -09)
- Agricultural Linkages Programme (ALP-PARC )(2012-16)
- FAO "Progressive control of PPR in Pakistan" (2013-17)

# Chapter 9

# Artificial Insemination in Beetal and Jattal Goats: Preliminary Results

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## 1. Abstract

Likewise in developed countries, artificial insemination (AI) can be used to improve the genetic potential of goats in Pakistan. This study was aimed to optimize the AI technique by using frozen-thawed spermatozoa in Beetal and Jattal goats. During the breeding months of 2015-17, Beetal (n=23) and Jattal (n=54) goats were involved in the study. An apronized buck was used as a teaser for the detection of standing heat in goats twice daily at dawn and dusk and cervical AIs were performed with frozen-thawed spermatozoa at approximately 12 hrs post-standing heat. Pregnancy was confirmed through transabdominal ultrasonography at 50-55 days post AI. Chi-square test of independence was used to compare the estrus response and pregnancy rate between Beetal and Jattal goats. The results revealed that the estrus response did not differ ($P > 0.5$) in Beetal (14/23; 60%) and Jattal (29/54; 53%) goats. The pregnancy rate also did not differ ($P > 0.5$) in Beetal (7/14; 50%) and Jattal goats (10/29; 34%); however it tended to be higher in Beetal goats. The average litter size in Beetal goats was 1.33 with total number of kids born were twelve and male to female ratio was 2:1. Whereas, in Jattal goats, the average litter size was 1.25 with total number kids born were six and male to female ratio was 1:2. It is concluded that AI with frozen-thawed spermatozoa can be used in local goats.

## 2. Introduction

Livestock is the most important sub-sector of agriculture in almost all SAARC countries. Livestock not only meets the domestic needs of high quality human foods but livestock products also contribute significantly towards export earnings of the respective countries. Furthermore, a large population of the region is wholly or partially dependent on livestock for their livelihood. Goats contribute to the livelihoods of millions of rural poor in South Asia where 29% of the world's goat population is concentrated. The goat population in Afghanistan, Bangladesh, Bhutan, India, Nepal and

Pakistan is 7.2, 25.11, 0.06, 140, 9.2 and 64.9 million, respectively (FAO STAT, 2014). Pakistan is the second largest goat producing country in the SAARC region after India (FAO STAT, 2014) with 36 goat breeds.

Artificial insemination (AI) has been effectively used in goats for genetic improvement, controlled breeding, introduction of new breeds and conservation of indigenous breeds. Likewise in developed countries, AI can be used to improve the genetic potential of low producing goat breeds in Pakistan and other SAARC countries. In a previous well organized study, pregnancy rates of about 45% were achieved in goats inseminated with frozen-thawed spermatozoa (Batista et al., 2009). More recently, a small scaled study on AI with frozen-thawed spermatozoa in Indian goats reports a pregnancy rate of 44-64% (Kharche et al., 2013). From Pakistan, the only published data on AI in goats is of chilled semen (Mehmood et al., 2011; Andrabi et al., 2015). Therefore, the present study was conducted to optimize the AI technique by using frozen-thawed spermatozoa in Beetal and Jattal goats.

## 3. Materials and Methods

### 3.1 Animals

During the breeding months of 2015-17, Beetal (n=23; mixed strains, Photograph 1a, b) and Jattal (n=54, Photograph 1c) goats were involved in the study at National Agricultural Research Centre, Islamabad, Pakistan ($33.42^{O}$ N). All the goats were fed green fodder with a grazing period of 3-4 hour per day and offered water ad libitum.

### 3.2 Heat detection, AI and pregnancy diagnosis

An apronized buck was used as a teaser for the detection of standing heat in goats twice daily at dawn and dusk and cervical AIs were performed with frozen-thawed spermatozoa at approximately 12 hrs post-standing heat. The Beetal goats were inseminated with Boer AI doses and Jattal with Sannen AI doses. Pregnancy was confirmed through transabdominal ultrasonography at 50-55 days post AI.

### 3.3 Statistical analysis

Chi-square test of independence was used to compare the estrus response and pregnancy rate between Beetal and Jattal goats. A probability level of $P \leq 0.05$ was considered significant. All the data were analyzed by using Minitab (Release 17.3.1; MINITAB, Inc., State college, PA, USA) statistical package.

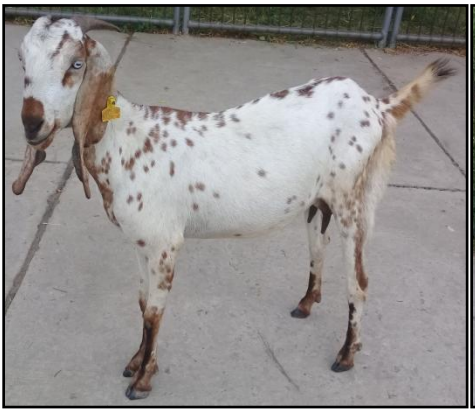

Figure 1a. Beetal (Makhi Cheeni Strain) goat

Figure 1b. Beetal (Nukri Strain) goat

Photograph 1c. Jattal goat

## 4. Results and Discussion

Data on estrus response and pregnancy rate in Beetal and Jattal goats are presented in table 1. The estrus response did not differ ($P > 0.5$) between Beetal (14/23; 60%) and Jattal (29/54; 53%) goats. However the estrus response was quite lower in both breeds as compared to earlier findings in Beetal does during peak breeding season (Andrabi et al., 2015) and in Nubian goats (Romano, 2004). The pregnancy rate also did not differ ($P > 0.5$) in Beetal (7/14; 50%) and Jattal goats (10/29; 34%); however it tended to be higher in Beetal goats. The overall pregnancy rate obtained in present study (42%) with frozen-thawed spermatozoa is quite reasonable as compared to 64% with chilled semen (López-Sebastian et al., 2007) and 40-

60% with frozen-thawed spermatozoa (Holtz et al., 2008; Batista et al., 2009; Romano, 2004). The data on number of kids born, litter size and sex ratio is presented in Table 2 and Photograph 2. The average litter size in Beetal goats was 1.33 with total number of kids born were twelve and male to female ratio was 2:1. Whereas, in Jattal goats, the average litter size was 1.25 with total number kids born were six and male to female ratio was 1:2, indicating the "breed differences".

**Table 1**. Estrus response and pregnancy rate in Beetal and Jattal goats

| Breed | Variables | |
|---|---|---|
| | Estrus response (%) | Pregnancy rate (%) |
| Beetal (n=23) | 60 (14/23) | 50 (7/14) |
| Jattal (n=54) | 53 (29/54) | 34 (10/29) |
| Overall | 56.5 | 42.0 |

The pregnancy per AI was calculated as: (goats pregnant/ goats inseminated) × 100.

**Table 2**. Litter size and sex ratio (male: female) in Beetal and Jattal goats

| Breed | No of Kids born | Litter size | Sex ratio (male:female) |
|---|---|---|---|
| Beetal | 12 | 1.33 | 2:1 |
| Jattal | 06 | 1.25 | 1:2 |

Figure 2. Kids born through AI with frozen-thawed spermatozoa at NARC, Islamabad

## 5. Conclusion

The results indicated that AI with frozen-thawed spermatozoa can be used in local goats.

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# REPORT OF THE REGIONAL EXPERT CONSULTATION MEETING ON "SUSTAINABLE GOAT FARMING FOR LIVELIHOOD IMPROVEMENT IN SOUTH ASIA: OPPORTUNITIES, CONSTRAINS AND POTENTIAL"

(Held on 22-24 August 2017 at (NARC), Islamabad, Pakistan)

SAARC Agriculture Centre (SAC), Dhaka, Bangladesh in collaboration with Pakistan Agricultural Research Council (PARC), Islamabad, Pakistan jointly organized an expert consultation meeting on "Sustainable Goat Farming for Livelihood Improvement in South Asia: Opportunities, Constrains and Potential" which was held in National Agricultural Research Centre (NARC), Islamabad, Pakistan during 22-24 August 2017. The meeting was attended by seven focal point experts as well as good number of local experts. There are thirteen technical papers has been presented, i.e. seven country study reports as well as six local research papers on goat genomics, reproduction and diseases. Apart from this, one presentation was made by the representative of International Livestock Research Institute (ILRI). The meeting was productive and fruitful in terms of participation, knowledge sharing and interaction and it was really interactive and outcome based. The meeting was inaugurated by H.E. Mr. Sikandar Hayat Khan Bosan, Federal Minister, Ministry of National Food Security and Research, Pakistan and concluded by Mr. Muhammad Abid Javed, Secretary, Ministry of National Food Security and Research. Following elaborate and extensive discussion, the meeting proposed a good set of recommendations on different thematic areas for further intervention. The proposed recommendations are as follows:

**Thematic Area1 (**Researchable Issues):

- Genomic analysis to be undertaken for indigenous goat breeds
- Development of genetic stock (gene bank) by supply of high potential bucks/embryo/semen
- Production of superior buck through selective breeding and open nucleus breeding scheme approach
- Utilization of non-conventional feed resources to mitigate the shortage of feeds and fodder
- To ensure quality and safe mutton production and value addition of goat products to increase income and nutrition for poor farmer
- Development of different effective vaccines and herbal sources for the prevention and treatment of different diseases
- Development of agro-industrial by-product based least cost complete pellet feed for commercial goat production

- Exotic breeds adaptation and production performance under different ecological zones
- Identification of breed specific traits of different indigenous goat breeds adapted in different agro climatic conditions

**Thematic Area 2** (Extension and Development Issues):

- Establishment of nucleus farms for genetically superior goats for its conservation and development
- Promotion of balanced feed and feeding practices in rural goat farming
- Management and rehabilitation of range land based production system
- Formulation of farmer's groups, self help groups (SHGs), cooperatives and societies for improved utilization of available resources and marketing of goats and their products
- To improve capacity of the small scale farmers for scientific goat rearing
- Wider popularization of goat based business and livelihood models for rural farmers
- Provision/ facilitation for input services to small farmers
- Motivation and assurance of regular vaccination and de-worming practices
- Provision for supply of superior quality buck to the progressive goat farmers
- Development and provision of artificial insemination for smallholder farmers
- Develop and facilitate linkages among farmer-market and processors-consumers
- Create awareness and provide training to different stakeholders on quality and safe milk, wool and mutton production
- Development and implementation of effective disease surveillance and reporting system
- Capacity building of farmers for minimum record keeping of their goats for effective selection process
- Establishing virtual system/ use of ICT to improve goat production.

**Thematic Area 3** (Policy Issues):

- Develop and promote linkages among the designated regional R & D organizations for sharing of expertise and experiences
- Simplification of credit process and packages for small rural farmers
- Strengthening of public and private sector partnership

- Exchange of goat germplasm among the Member States for mutual benefits
- Extending of support services and extension network to reach the small holder farmers
- Incentives to be provided for the production and exchange of superior quality buck
- Regular organization of goat expo and competition for creating awareness and encouragement of the goat farmers
- Institutionalization of breeder association/ societies for conservation and development indigenous goat breeds
- Organization of regional exchange visit, exposure visit and short internship for professional and scientific community
- SAARC leading reference laboratory may be developed/ identified for the genomic analysis of indigenous goat breeds

**Federal Minister for NFS&R Sikandar Hayat Khan Bosan, Chairman PARC Dr. Yusuf Zafar T.I., SPO (Lifestock) SAC Dr. Muhammad Nure Alam Siddiky, DG NARC Dr. M Azeem Khan and other Addressing on the Occasion of SAARC Regional Expert Consultation on Sustainable Goat Farming for Livelihood Improvement in South Asia: Opportunities Constrains and Potential at NARC (22nd August 2017)**

Honorable Minister and Other Guests delivering their speech at Inaugural Function

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