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Introduction

K. Justin Davis¹, Sunita Choudhary², and Tanmoy Rana³

¹Department of Veterinary Epidemiology & Preventive Medicine, College of Veterinary & Animal Sciences, Mannuthy, Kerala, India

²Department of Clinical Veterinary Medicine, College of Veterinary & Animal Sciences, Rajasthan University of Veterinary & Animal Sciences, Bikaner, Rajasthan, India

³Department of Veterinary Clinical Complex, West Bengal University of Animal & Fishery Sciences, Kolkata, West Bengal, India

1.1 Introduction

Goats are important domesticated animals in various parts of the globe that have served humankind for centuries. Along with sheep, cattle, and pigs, goats are considered as the first domesticated ungulates and originated from their wild ancestor, the bezoar or *Capra aegagrus* (Naderi et al. 2008). They were domesticated as early as 10000 years ago in the area around the Zagros Mountains, western Iran. Ancient farmers used wild goats for milk and meat, dung, bones, and hair. Domestication of goats played an important role in the development of agriculture and civilization (Zeder and Hesser 2000). Currently, goats are spread globally, with more than 300 breeds living on every continent except Antarctica (Kumar et al. 2010). Their extraordinary adaptability to desert, mountainous, and tropical areas along with their hardiness led to their rapid spread. The domestication of goats was favored by their body size, which made them more suitable for management, with their earlier puberty and maturity, greater reproduction rate, social nature, and obedient behavior. These animals are raised for meat, milk, and dairy products, and for fiber and skin products. They are tagged the “poor man’s cow” or the “bank on the hoof” because of their role in rural economies. There are a large number of goat breeds that are grouped into meat breeds, dairy breeds, dual-purpose breeds, fiber breeds, and pet breeds based on the utility and purpose of rearing them.

1.2 Global Distribution

The world goat population is 1128.10 million, which places them third in the total livestock population after cattle and sheep. The world population of goats has an

increasing trend (Figure 1.1), which indicates huge demand for goat products like chevon (goat flesh), fiber, and milk. Asia is the continent with the highest population, representing 51.35% of the world’s total goat population. The majority of the total population (94.5%) is distributed in Asia and Africa (FAOSTAT 2020) and the lowest proportion is in Oceania (0.38%). The population density of goats in particular regions may be due to historical and religious reasons. Chevon is more used in Muslim countries where pork is forbidden. In Asia, the highest population is noticed in India (Figure 1.2) where beef is not among traditional foods.

1.3 Advantages of Goat Rearing

Goats can adapt well in areas where other livestock or crops are not suitable (Figure 1.3). They are opportunistic and selective feeders, which makes them thrive well on depleted pastureland and enables them to convert poor-quality forage (Figure 1.4). They can consume, digest, and extract nutrients from tannin-rich browse. Goats are more able to withstand adverse climate conditions like heat stress compared with cattle and sheep. Their bipedal stance helps them access tree leaves that are considered unavailable to other livestock species. Their better feed efficiency than other ruminant species distinguishes them as a good candidate for farming. Goat rearing does not require specialized shelter structures, which along with reduced labor increases its popularity among farmers (Figure 1.5). To meet the growing demands of the human population, scientists have proposed goats, which are climate-adapted animals and are expected to perform better than other species.

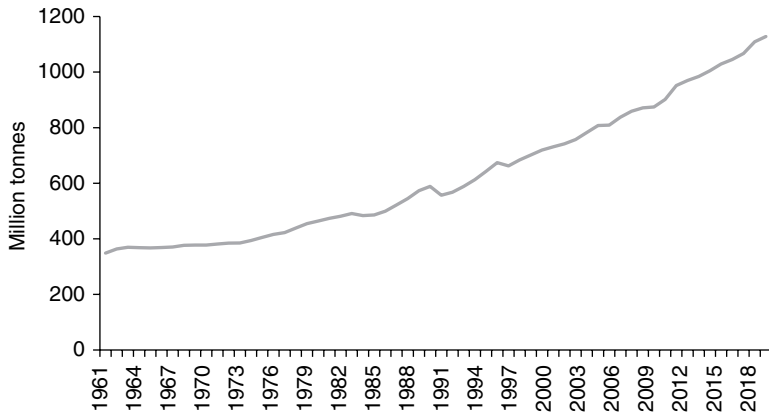


Figure 1.1 Global goat population, 1961–2020.

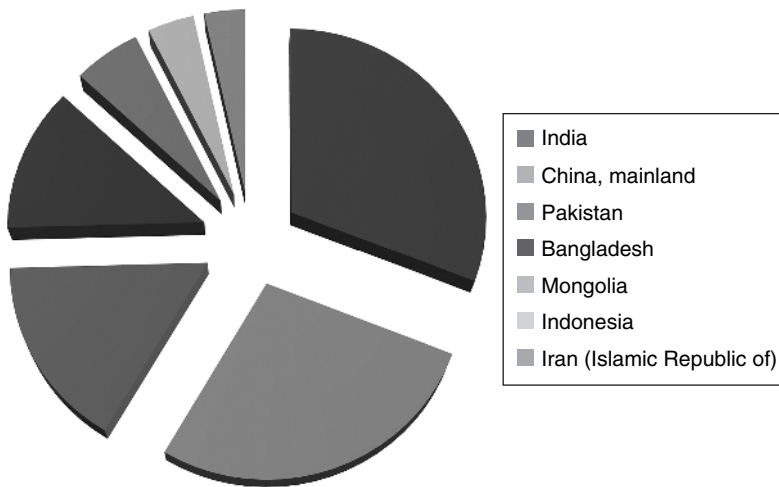


Figure 1.2 Country-wise distribution of largest goat producers in 2020.



Figure 1.3 A flock of goats.

1.4 Goat Milk and Products

Goat rearing is a major source of income for poor farmers and women in rural areas, especially in developing countries. Goats are considered as the “poor man’s cow” and are kept for milk, meat, fiber, or fertilizer. They can

thrive well on difficult terrains with a small amount of feed, which, along with their small size, makes them suitable for farming with reduced maintenance costs. Dairy goats are fewer in number than dairy cows, but they contribute 1.3% of world total milk production, while milk produced by cattle is 83.1% (Mazinani and

Figure 1.4 Goats grazing in a field.



Figure 1.5 An owner with his goat.

Rude 2020). Dairy goats can produce 2.8–3.8l of milk daily during their peak lactation time.

Goat's milk production is showing an increasing trend due to increased demand for goat's milk and related products. There is a well-organized market for goat's milk in Europe, especially in France, where the goat sector is dedicated to milk production and cheese making. Goat's milk can be a replacement for those who suffer from an allergy or intolerance to cow's milk or other animal milk protein. It is a source of fat, lactose, protein, minerals, and vitamins. Goat's milk is easily digested and more similar to human milk than cow's milk. Fat globules in goat's milk are smaller and have different casein types that are easier to digest. Goat's milk can be used for the preparation of different products like dried milk, cheese, fermented milk, desserts, sweets, whey products, and so on. Cosmetic products are

also produced from goat's milk, including soaps, creams, body lotions, shampoos, hair conditioners, and aftershave lotions, which are marketed in many countries such as the United States and Switzerland (Ribeiro and Ribeiro 2010).

1.5 Chevon

Goats are reared mainly for chevon, goat meat, which serves as a source of fat, amino acids, and several micronutrients such as vitamins and minerals including zinc and iron (Webb 2014). China and India are large chevon producers at 2.3 and 0.55 million tonnes, respectively. Goat meat is rich in essential amino acids, low in cholesterol, high in protein, and a good source of iron. The world consumption of beef is higher than that of chevon, especially in western countries, but goat meat can serve as a great source of protein to humans, especially in developing countries, hence the goat populations are higher in those countries. Per capita meat consumption approximately doubled from 20 to 43 kg globally from 1961 to 2014, with marked variations in direction and rate among countries (Ritchie et al. 2017). Countries that underwent a strong economic transition had the highest variations. China saw a 15-fold increase since 1961 and the rate in Brazil nearly quadrupled, whereas the rate stayed same in India with per capita consumption less than 4 kg per person. Chevon can act as a staple food in countries where there are restrictions on other red meats such as beef and pork. These include Muslim countries where pork is forbidden and in India where beef is not considered a traditional food. China ranks first in production of chevon, followed by India and Pakistan. Most of the goat meat produced is consumed

locally in the communities of developing countries, as the market structure has not = developed to trade within the country and internationally.

1.6 Fiber and Other Products

Fiber from goats includes both cashmere and mohair produced by cashmere goats (selectively bred) and angora goats. Cashmere goats produce a double fleece known as guard hair and down hair. Down hair or cashmere gives protection from cold and guard hair covers the animal's body. China and Mongolia are two of the leading producers of cashmere. Cashmere fibers from the beautiful, soft, durable, bright, and elastic downy undercoat of the goat are desirable to the textile industry (Shakyawar et al. 2013). Each animal can contribute from 500 g to 1 kg/head cashmere annually, which can be used for making clothes and fabrics. Mohair is quite different from cashmere, as there is only one type of fleece which does not require dehairing as in cashmere production. One goat can produce around 5–8 kg of mohair a year. It is lustrous, long, and coarse, and is suitable for knitwear, apparel, curtaining, upholstery material, shawls, socks, and accessories.

Tanned leather from goat skin is used for products that require soft hide like gloves, bags, and boots. It has been used for leather book binding and untanned goat skins were traditionally used as containers for water, kefir, wine, and so on (Skapetas and Bampidis 2016). The Black Bengal breed is considered as a high-quality goat skin producer.

Goat manure contains macronutrients as well as micro elements that can be used as an organic soil fertilizer (Sunaryo et al. 2021). Goat manure is considered an excellent source of nitrogen, phosphorus, and potassium, which are essential for plants.

Goats, especially dwarf and pygmy breeds, are commonly used as pets because of their particularly pleasing and fun-loving behavior.

1.7 Goat Production System

Based on fodder and grazing land availability, farmers in different countries have adopted different systems of management for goats (Hegde 2020). In Asia and Africa, where there is the major share of the goat population, they practice the extensive system, semi-intensive system, and intensive system of goat farming. The extensive production system is characterized by a large area with a reduced or low density of animals. This land is not suitable for agriculture and has low rainfall or sometimes extreme temperatures. The economic return will be reduced in this system as there will be

a lower kid crop and the goats will be raised in an adverse climate. There can be a mobile grazing system or a sedentary grazing system. The first system is characterized by movement of the shepherd along with their flock from one place to another in search of feed, whereas the other system involves a farm for keeping animals in during the night. The intensive production system involves confinement of animals with limited access to land. These animals are fed concentrated feeds and have minimal grazing. This requires a high capital income and more labor. The animal density and kid crop are higher in this system than in the extensive system of production. High-producing and fertile animals will be used in the intensive system and it gains more income. The semi-intensive system of goat farming is a combination of the other two systems with limited free-range grazing on fenced pastureland and feeding in stalls. The cost of feed will be higher than in the extensive system.

In Europe intensive management with good use of pastureland is practiced to reduce feed costs, control the weed problem, and maintain natural behavior (Hegde 2020). The extensive system of goat farming is not very common in Europe and North America.

1.8 Constraints in Goat Farming

Even though goat husbandry has so many advantages, it also has some problems, like low body weight gain, disease outbreaks, and mortality, which in turn reduce the production potential of the animal and hence the economics of the farmer. Major constraints in goat farming are in breeding, feeding, healthcare, and marketing, among which marketing is the major constraint, followed by healthcare, feeding, and breeding in India (Patbandha et al. 2018). A structured marketing channel is required to help farmers trade their product with maximum profit. Feed and availability of grazing land are other important limitations in goat farming. Scientific knowledge of farming and inadequate veterinary aids could also act as limitations in goat rearing, especially in developing countries. Planned extension work is mandatory to create awareness among farmers regarding scientific farming. Outbreaks of diseases and mortality can have a severe impact on the economy of the goat farmer. Early detection of disease and prompt control of disease outbreaks are essential to profitable goat farming.

1.9 Economics of Disease in Goats

Even though goats are resistant to many diseases, they are affected by many animal diseases (Figure 1.6). Some of these are zoonotic, like brucellosis, which can be a real



Figure 1.6 Udder inflammation of denoting a disease.



Figure 1.7 Foot rot disease of goats.

threat to humans. The occurrence of diseases will break the back of a goat farmer be due to direct or indirect losses (Sejian et al. 2021). These losses can be due to mortality, loss of wool, reproductive failure, increased inter-kidding period, higher number of abortions, body-weight loss, treatment costs, and opportunity costs. The economic losses are more pronounced in infectious diseases like bacterial, viral, parasitic, and protozoan diseases (Figure 1.7). Morbidity and mortality are high in viral diseases – peste des petits ruminants (PPR), foot and mouth disease (FMD),

sheep and goat pox – as well as bacterial diseases – enterotoxemia, contagious caprine pleuropneumonia (CCP), and anthrax – followed by parasitic diseases like fascioliasis/distomatosis (Singh and Prasad 2008). Limon et al. (2020) reported that overall economic losses due to goat pox at a farm level ranged from US\$9.6 to US\$6340 depending on the species affected and the production system in northeast Nigeria. The total losses due to PPR have been found to range from US\$11.2 in sheep to US\$11.55 in goats in Maharashtra, India. The annual financial loss due to diseases in goats was calculated as US\$8.17 million in selected areas of Bangladesh. Singh et al. (2014) reported high annual economic losses due to PPR in goats and sheep. Kihu et al. (2015) estimated losses due to PPR in Kenya as US\$19.1 million. Vashist et al. (2021) also reported annual economic losses due to PPR.

1.10 Goat Diseases and Public Health

Goats can act as an important source of infection, which can be transmitted directly or indirectly to humans. Most transmission occurs as an occupational hazard affecting breeders, farmers, veterinarians, and slaughterhouse workers. Transmission of these diseases can be prevented by strict biosecurity, scientific management, and mandatory vaccination programs in animals.

1.11 Prevention of Disease

Proper nutrition and management of goats are needed for the prevention of any disease. Nutrition can exert an immense influence on flock reproduction, milk production, and kid growth. Certain diseases like enterotoxemia, poliоencephalomalacia, urinary calculi, pregnancy toxemia, and white muscle disease are considered to be associated with nutrition and management. So it is imperative to know about the nutrition and management of goats.

Parasitic diseases might result in significant weight loss in goats as well as moderately high mortality. These diseases are distributed worldwide and are responsible for poor health and low yields. Endoparasites of goat reside in the gastrointestinal tract and include nematodes, cestodes, trematodes, and *Protozoa*. Ectoparasites, like ticks, lice, mites, fleas, and flies, can cause losses through reduced productivity, loss of blood by sucking, and so on.

Bacterial diseases in goats have increased due to intensive and unscientific farming. Diseases like brucellosis, tuberculosis, and anthrax are zoonotic diseases that can be transmitted to humans by handling or close contact with infected animals. Goat farming is practiced commonly in

rural areas, where poor scientific knowledge is another factor in the transmission of zoonotic disease. Anthrax, enterotoxemia, gas gangrene, tetanus, listeriosis, caseous lymphadenitis, tuberculosis, Johne's disease, pasteurellosis/mannheimiosis, dermatophilosis, brucellosis, CCP, foot rot, colibacillosis, and salmonellosis are the major bacterial diseases of goats. Goat skin harbors varieties of fungal organisms including dermatophytes and saprophytes like *Aspergillus*, *Penicillium*, *Emmericella*, *Alternaria*, and *Cochliobolus* (El-Said et al. 2009). The opportunistic fungus can cause disease in immune-compromised animals. Mycotic abortion, fungal mastitis, and mycotic pneumonia are not rare in goats and are difficult to diagnose in the early stages. Goats are susceptible to many mycotoxins and these can cause serious production losses in the animal. Dermatophytes and yeast (*Malassezia* and *Candida*) are responsible for skin diseases like ringworm and seborrheic dermatitis (Seyed et al. 2018).

Goats are susceptible to many viral infections that can cause a severe economic burden to farmers. PPR, bluetongue, goat pox, and orf are the common viral diseases in goats.

Transboundary diseases are highly contagious and transmissible epidemic diseases of animals that can disrupt or inhibit trade in animals or animal products within a country or internationally. The majority of these are emerging viral diseases like PPR, FMD, goat pox, and Rift Valley fever. Transboundary, emerging, and exotic diseases are major zoonotic diseases of goats.

Toxicity in the goat is mainly caused by the consumption of toxic plants and the clinical signs vary with the toxic content.

Selection pressure and domestication lead to the occurrence of undesirable traits commonly recognized as due to inherited diseases or disorders. These disorders or diseases occur sporadically and rarely cause a serious economic impact.

Common nutritional or metabolic diseases of goats arise due to insufficient intake of nutrients and their repercussions on the metabolism. Pregnancy toxemia, polioencephalomalacia, urolithiasis, subacute ruminal acidosis, lactational ketosis, hepatic lipidosis, hypocalcemia, low

milk-fat syndrome, and vitamin E or selenium deficiency are major diseases.

Different methods are available for accurate diagnosis of diseases in goats, which is an integral part of disease identification and management.

The temporal and spatial distribution of infectious disease can vary in different countries. Awareness of the diseases and the availability of veterinary services are the main factors in prevention of infectious diseases. Reduced vaccination coverage is also attributed to economic loss due to disease. Knowledge about a disease and its transmission helps the farmer to effectively control the disease. Even though goats are resistant to many infections, intensive farming, reduced pasture facilities, and climatic changes make them more vulnerable.

Vaccination can increase immunity against most bacterial and viral infections among goats. The effectiveness of a vaccination program depends on several factors, including general health, nutrition, stresses, and so on. A vaccine should be administered to a systemically healthy animal. Deworming prior to vaccination is recommended. Vaccines against bacteria (clostridial diseases types C, D, and T; foot rot; *Brucella* for caseous lymphadenitis; *Campylobacter fetus* and *Campylobacter jejuni* bacterin; bacterial pneumonia from *Mannheimia haemolytica* and *Pasteurella multocida*; chlamydia; and anthrax) and viruses (sore mouth, bluetongue, PPR, goat pox, FMD, and rabies) are commonly used in goats as a control measure.

Effective biosecurity measures should be employed to control the transmission of disease from outside and the spread of disease inside a flock. These are a set of protocols intended to control the spread of disease. The transmission of disease can be multifactorial. It depends on the epidemiological triad: host factors (health status, immune status), environmental factors (temperature, pasture condition, etc.), and the disease agent (virulence, pathogenicity). The fundamental goal of biosecurity is either to break the transmission of disease or to minimize its effect. Biosecurity controls disease transmission not only among animals, but also from animals to human and vice versa.

Multiple-Choice Questions

- Which among the following are ancestors of goats?
 - Bezoars
 - Aurochs
 - Hyracotherium
 - Wild boar
- Currently, goats are spread globally, with more than 300 breeds living on every continent except which one?
 - Antarctica
 - Asia
 - Africa
 - Americas

- 3 Which among these species are highest in number worldwide?
 - A Sheep
 - B Goat
 - C Cow
 - D Pig
- 4 What is goat meat known as?
 - A Mutton
 - B Chevron
 - C Venison
 - D Beef
- 5 Where is the highest population of goat seen?
 - A China
 - B India
 - C Pakistan
 - D Bhutan
- 6 What is known as the poor man's cow?
 - A Goat
 - B Cow
 - C Buffalo
 - D Sheep
- 7 Which country contributes the highest production of goat milk?
 - A India
 - B China
 - C Afghanistan
 - D Estonia
- 8 Which country is the largest producer of chevon?
 - A India
 - B China
 - C Nepal
 - D Pakistan
- 9 What breed of goat produces mohair?
 - A Angora
 - B Cashmere
 - C Gadi
 - D Malabari
- 10 How much cashmere can each goat contribute annually?
 - A 100–250 g
 - B 500 g–1 kg
 - C 1–2 kg
 - D 2.5–5 kg

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