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Goat Meat Production and Influencing Factors

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ABSTRACT

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This abstract provides an overview of a thesis study on developments in goat meat production, particularly in Pakistan, a significant exporter of goat meat, in the context of agricultural and economic expansion. The study's objectives are to evaluate recent data, forecast goat meat demand and supply in the future, and look at factors that affect output. The data was collected from primary and secondary sources like FAO STAT, Pakistan economic survey and Pakistan statistical book 2022. The data was analyzed based on growth and compound annual rate. The contribution of Pakistan towards Asian and global stocks was also determined. On the basis of findings, it is concluded that Pakistan has significant contribution and major exporter of goat meat. Study also depicts that factor like food, disease management; demand and supply have remarkable impact on the recent trends. In order to preserve the viability of the goat meat sector, the study emphasizes the significance of disease prevention and government actions. It highlights the importance of effective illness management techniques and offers guidance for future study and business administration. This research provides valuable information for farmers, exporters and policymakers involved in the goat meat industry.

CHAPTER 1

INTRODUCTION AND OBJECTIVES

Goat production plays an important role in Pakistan's economic progress as Agriculture contributes 34% of the country's GDP, supports 75% of the population, and employs 52% of the entire labor force. The cattle sector alone accounts for around 28% of overall agricultural GDP and earns 15.7% of total export revenues. By 2050, the world's population is expected to reach over 9 billion people (FAO 2017), which will significantly increase demand for meat, particularly goat meat. Production of goat meat, often known as "chevon" or "caprine meat," is an essential element of the world's meat trade. It is of greatest significance for providing for the nutritional requirements of a burgeoning population as well as supporting the livelihoods of millions of small-scale farmers and herders globally. Goat meat has gained popularity among people looking for alternatives to conventional forms of meat due to its nutritional value, lean composition, and distinctive flavor. Understanding the complex elements affecting the production of goat meat is crucial for ensuring food security and sustainable agricultural practices as the demand for goat meat continues to rise globally (Solaiman 2007).

Goats, which adapt well to many agro-ecological zones, provide a feasible option for sustainable meat production, especially in areas where scarcity of resources and adverse conditions make other livestock systems less viable. Furthermore, particularly in developing nations, goat farming frequently is essential to the survival of smallholder farmers including Pakistan. These farmers depend on goats for milk, skins, and other byproducts in addition to meat. Therefore, the factors affecting the production of goat meat go beyond purely economic concerns; they also have significant socio-cultural impacts, especially in rural populations (Webb 2014).

Pakistan contributes 2.9% of global meat trade. Pakistan is lacking some of the prospects to contribute more. To meet the meat demand, the slaughtering of very young female goat has been done which results to the shortage of meat in country and eventually increase in the prices (Randhawa *et al*. 2018). The demand of meat has been increased in last few years and expected to increase in upcoming years as consumers. Consumers have increased demand for organic meat and meat products. Moreover, there is an increase in population of the world and food security is a main issue. Goat meat as a rich source of protein and other nutrients is one of the main focus to solve

food security issue. If a growing proportion of the population adopts them, they may have an impact on global meat markets.

In the present study, the data has been collected to analyze by the execution of empirical studies, and the provision of useful insights. The goat and meat production data of Asia and Pakistan was used for comparative analysis. The objectives of study are as following:

1. Analyze goat and meat production trends of last five year of Pakistan, Asia, and World in terms of production rate, growth rate and regional variations.
2. To determine and evaluate the key elements, such as population demographics, demand patterns, and economic considerations, that have an impact on the production of goats and mutton in Pakistan, Asia, and worldwide.
3. Comparing Pakistan's goat and mutton production systems to those in Asia and the rest of the world in terms of resource consumption, growth rates, output yields and Pakistan’s contribution towards Asia and Globe.
4. Contributing knowledge and data to the development of plans and policies aimed at boosting the productivity and sustainability of goat and mutton production, notably in Pakistan.

CHAPTER 2

LITRATURE REVIEW

2.1. Importance of goats

Goat-farming is becoming a genuinely significant form of animal husbandry in a world where climate change adaptation will increasingly determine our future. This is because it helps to sustain production levels and has a relatively low impact on the environment because goats exhale less methane than other livestock (Darcan & Silanikove 2018). There are around one billion goats in the world, and in the previous forty years, their population has more than doubled. Over 90% of goats are found in developing nations, according to the Food and Agriculture Organization; Asia and Africa are the two continents with the biggest goat populations globally. In these regions, the goat farmers do farm for milk and meat. According to FAO statistics, 73.4% of goat meat is produced by the Asian Countries and 22.5% of world meat is produced by Africa in year 2017-2021 (Figure 2.1) (FAO STAT). It has been predicted that the global production of goat would reach to 119 million by 2026. India is the world largest goat producer with approximately 15 million goats in 2021. China, Nigeria and Pakistan are at second, third and fourth position respectively.

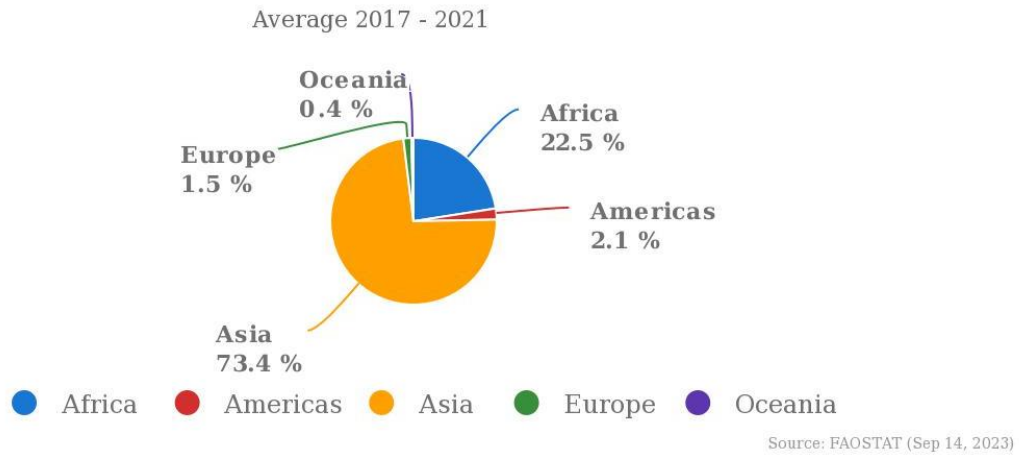

Figure 1: Production share of meat of goat, fresh or chilled by region

Pakistan is 3rd largest country in the production of goat meat in Asia. Livestock contributed 61.89% in agriculture and 14.04% in total GDP and the increase in growth was recorded from 2.38 to 3.26% in 2022.

In the years 2021–2022, Pakistan would produce 52.996 million tons of meat (Pakistan Economic Survey 2021-22). Only approximately 2% of the meat is exported, while the majority is consumed locally. Goat meat contributed almost 2% of the total meat production. Last year, meat exports generated a total of USD 333.4 million in revenue. The principal products include camel, goat, poultry, mutton, and beef. The 11th largest provider of poultry meat is Pakistan. Al-Muqeet International is a top best company to export goat meat from Pakistan. Due to the abundance of pasture in the northern regions, Cholistan, and Thar, natural animal rearing capacity, meat-producing breeds, and optimum climatic conditions, the country has a large cattle and goat farming industry. Vietnam, Afghanistan, Indonesia, and China are the top export destinations, along with six GCC nations (Paracha 2022).

There are almost 25 known breeds in Pakistan. In Pakistan the name of the goat breed has been decided on their location or their characteristics. There are many breeds which are produced by the farmers including Beetal, Dera Din Pannah, Hairy, Kamori, Nachi and Teddy. In Pakistan grazing is the most common type of feeding for goats. Concentrate feeding is rare. Goats usually graze in the form of flocks but due to malnutrition many goats got diseased. The history, culture, and economy of Pakistan are strongly influenced by goats. According to archaeology, the first domestication of goats may have taken place in Pakistan's Indus Basin. Pakistan, the third-largest producer of goats in the world, has about 54 million goats, and the number is constantly rising. There have been many shows to exhibit the goat characteristics including weight, beauty, and walking style. The Nachi breed is famous for its walking style. Goats have also been exhibited a week before Eid-ul-Azha to access their weight. One article featured the results of 2018 competition in which the heaviest goat weighed 300kg weight. As meat is a major demand from goats so farmers and breeder goat association are concentrating on the production of larger size goats to fulfill the meat demands (Miller 2019).

Goats are also described as the "poor man's cow" because of their diminutive size and superior capacity for producing milk and meat. There are several varieties that require little maintenance and can produce enormous quantities of milk or meat. The main purpose of goat breeding is meat. However, the farmers use their milk to make cheese and hairs for making rugs, but the market demands meat of the goat. The Eid season is famous for selling goats. Goats are produced in large flocks for the purpose of sacrificing on someone’s death to fulfil a custom. Goats are also famous for finding water sources, so they are also used in other animal flocking. Goats also alarm the farmer to save the flock from any wild animal by bleating. As livestock is a major contributor in agriculture sector of Pakistan, it is also the main earning source of a lot of

families in Pakistan specially in KPK areas. The goat breed Damani is the local goat of these areas (Banu, Dera Ismail Khan, and Peshawar). Families utilize their milk, skin, hair and meat to earn money. Since Pakistan came into being, the goat farming was profession of small farmer which were even homeless. The production systems adopted by these farmers were nomadic, transhumant, and sedentary. Nomadic system is famous in Sindh and Baluchistan areas. According to this system, the flocks move throughout the year in search of food. In transhumant system, flocks move for grazing most time of the year but for little period they stay at a fixed place. The sedentary system allows the flocks to stay at the same place throughout the year near canal banks and some fields. Flocks feed by grazing on nearby field or food is provided by the owner. In the present time, sedentary system is common, people are shifted toward small farms near their houses because rangelands are deteriorating, there are more droughts and floods. Women also participate actively in rearing the livestock. The study suggested that 92% women having livestock do care of livestock and almost 4-6 hours are reserved for livestock. Another study also demonstrated that women have significant role in feeding, grazing, sick animal care, assisting parturition, post parturient care, and selecting buck in India. (Zubair *et al*. 1999, Tyagia *et al*. 2014).

The most demanding breed of goat during the Eid season is Beetal (Figure 2.2) as its body is compact and well-developed and weight in the range of 46 kg and 37 kg for adult males and females respectively. Its life span is 12-15 years. Dera din Panah goat (Figure 2.2) is named after the town of Muzaffarabad, it is primarily kept for meat production purposes. Its life span is 10-11 years. A study investigated that the daily growth rate of Beetal breed from birth to one year is 81.82g. It has been reported that Beetal breed can be used for further genetic modification and farmed under suitable conditions proved to be useful for the meat production (Waheed *et al*. 2018). Farmers feed these breeds on the availability of resources available to the farmer. Some allow them to graze on natural lands, others use concentrate feeding and crop residues with added minerals to feed them. They allow the bucks of desired characteristics to breed so that the better child could produce by natural selection. They are allowed to breed with other goat breeds also to enhance the characteristics of other breeds (Arshad & Sabir 2008)

A)  B) 

Figure 2: A. Beetal breed (https://pranikhamar.in/beetal-goat-in-west-bengal/) B. Dera din panah (alchetron.com)

2.2. Goat meat production

Goat meat demand is increasing every year. In the USA with the increasing population of halal food lovers, the 30 million dollars import is annually increased. The main goat meat exporter is Australia which has export goat meat of almost 191.6 million dollar (46.4% of total goat meat exports) in year 2021. As many people are conscious regarding halal food and it mainly depends on the religion preferences, the halal meat demand is increasing everywhere. Goat meat is also a source of protein, other essential vitamins, and minerals (Table 2.1). Further it also contains bioactive compounds including anserine, carnosine and creatine. Goat meat contains lower saturated fats as compared to red meat. It is proven to be a good protein source for people having high cholesterol problems (Joseph 2023).

Table 1: Nutrition facts for cooked goat meat per 3.5 oz (100-gram) serving (US Department of Agriculture).

Name	Amount
Calories	143kcal
Protein	27 grams
Fats	3 grams
Iron	3.7 mg
Cholesterol	75 mg

Goat farming provides 275,000 tons mutton, 21,400 tons hair, 25 million skins and about 851,000 tons milk annually. Goat farming is subsidizing 2.5% of total national income of Pakistan and the production is increasing day by day. Still in the present era, huge by products from goat farming are coming from backward families and only some commercial producers are contributing. The 74.1 million goats in Pakistan are kept by approximately 6.8 million farmers. Province Punjab is contributing highest to the goat production which is almost 37% followed by Sindh (23%), Baluchistan (22%) and KPK (18%). There are a lot of advantages of goat farming in Pakistan as goat farming is less laborious, less costly and goats can accommodate in small area and on small amount of food. This business is cost effective because of raising demands in the local and international market. A study has been conducted to analyze the feasibility of good breeding. The purpose of the study was to produce goats in disease fee environment that would survive in Pakistan climate. The study demonstrated that starting from 109 females the progeny would be 333 goats having equal percentage of male and female sex. The male would be sold after the age of 7-8 years and 190 females would also be sold in market. The farm field capacity would be 503 goats. The estimated land required was 9-acre, 8 acres to grow fodder and 1 acre for goat farming. Hyderabad, Nawabshah, Larkana, Dadu, Qila Saifullah, Panjgur, Pishin, Zhob, Barkhan, Quetta, Bannu, Laki Marwat, Kohat, Mardan and Peshawar can be the most suitable locations for good breeding because

they have excess water supply and area to grow fodder. Lahore, Multan, Bahawalpur, Bahawalnagar, Faisalabad, Rawalpindi, Karachi, Hyderabad, Quetta, Ziarat, Peshawar, D.I. Khan.and Sargodha are the main targeted cities to sell goats. This business model costs 9,817,160 PKR as capital amount and 14,183,588 PKR as total project cost (Ministry of Industries & Production 2021).

2.3. Factors affecting goat meat

Goat meat is called red meat in most countries. Good meat quality is usually assessed based on color and firmness. The color of the meat mainly depends on myoglobin and its derivatives including red oxymyoglobin, and brown metmyoglobin. pH also impacts muscle color as high pH causes less retention of water, which causes the loss of water binding protein and denaturation of muscle fibrillar proteins. As a result, muscle turns pale in color. Its smell and appearance are different from other meat, it is less juicy due to low contents of fats. The aroma of the meat depends on the age, breed, gender, fat and method of cooking and is caused by branched chain fatty acids including 4-ethyloctanoic acid (Webb 2014). Goat meat's flavor greatly benefits from hircinoic acid (Wong 1975). The fat in the samples was found to have significant amounts of hircinoic and 4-methyl-nanoic acids. The common flavor seen in cooked mutton and goat meat is thought to be caused by these two acids. According to Devendra and Owen (1983), both preharvest factors including breed, age sex, and nutrients as well as postharvest factors might have impact on the organoleptic quality of goat meat. In a survey done by Kawabata *et al.* (1980), 48% of the respondents liked goat meat, while 95% of the same respondents said they preferred beef. Goat meat was roughly equally as palatable as mutton or lamb. Goat meat's flavor was contrasted with that of lamb, beef, pork, and horse meat by Smith *et al.* (1974). Comparable to beef, pork, and horse meat in terms of juiciness, goat meat scored lower than all the other meats in terms of flavor, overall satisfaction, and tenderness. This study found that goat meat is roughly equivalent to horse meat in terms of taste to lamb, beef, and pork.

The quality and storage conditions of meat highly depend on the subcutaneous fat retained in goat meat. It has been reported that goat having concentrate in their feed have more monosaturated and saturated fats in their meat as compared to goats which just do grazing. The concentrate must contain minerals and proteins. Some examples are cereal grains, oilseed meals, wheat middlings, soybean hulls and corn gluten feed. Now a days using byproducts of biofuel is another trend in goat farming. It has been observed that concentrate aids in

increasing goats dressing percentage, body wall fat thickness and longissimus muscle region. The forage type is also necessary not just for meat but also milk production. The use of straw in forage increases the yield of meat weight. Browse consumption also results in intake of plant secondary metabolites and other important nutrients. It also decreases the chances of parasite larvae intake and secondary metabolites also proves to be somehow toxic against helminths. The method of milking also affects the meat quality. Compared to milk substitute, suckling milk can affect the meat characteristics of young children. Kids who were breastfed had more tender meat than those who were given mile substitutes, likely because of quicker adaptation to and increased use of dry feedstuffs. Gender also affects the meat as it was noted that male goats are more muscular than females. (Goetsch *et al*. 2011).

Now a days, meat is all about its quality, safety, and nutritional value. Pakistan being a blessed country has land to nourish livestock, but lack of infrastructure contributes to market value of meat. Industry should be made to facilitate the export of high-quality meat. As Muslim population is present all over the world, halal food is becoming a trend. France, Brazil, Australia, Canada and USA are the major exporters of halal meat. Pakistan government and private sector are focusing to export quality meat having halal certification and meet the export demands. Pakistan has export halal mutton of almost 58.9 million USD in 2013-24 and export is raising with every year. Almost 14 Pakistani companies are exporting halal meat specifically to Bahrain, Kuwait, Oman, Qatar, and middle east countries. These companies include PK Livestock Company, Quick Food Industries, Anis Associates, Al-Shaheer Corporation and The Organic Meat Company, Lahore Meat Company, Everfresh Meat. Now Fauji Meat Limited and Big Birds have also started exporting meat (Shoaib & Jamil 2017).

Lack of contemporary abattoirs and processing facilities is one of Pakistan's biggest challenges for the meat trade. Most of the meat sold in the local market is still sold in the open market, and slaughterhouses lack adequate sanitation systems and educated workers, which results in unclean conditions and a considerable health risk. Old slaughterhouses also don't have sufficient drainage systems for wastewater and blood. Additionally, waste blood typically congeals in the drainage system, creating an unpleasant odor and many environmental hazards. By only allowing large meat processing plants and tightly controlled slaughtering, this system can be modified (Shoaib & Jamil 2017).

An extensive study has been deduced that the preslaughter transportation stress affect meat quality as it changes the hormonal concentration in blood and muscle metabolism. It has been observed that the stressed goats had more glucose and cortisol than control but less muscle glycogen than control goats. According to these findings, goats' stress reactions and muscle metabolism can change noticeably during short-term pre-slaughter travel (Kannan *et al*. 2003). Another study conducted by Kannan *et al*. (2000), it is concluded that the transportation stress does not immediately shrink the weight of the animal but after 3 hours of transportation, stress response started in goats which includes high urea, glucose, and cortisol concentration in the blood. Additionally, time significantly affected plasma creatine kinase activity, the ratio of neutrophils to lymphocytes, and the differences in leukocyte counts (neutrophils, lymphocytes, monocytes, and eosinophils). The muscle characteristics have also been studied after transportation stimuli. It has been found that stimulated meat had shorter muscle fibers but if this meat is treated with electrical stimuli, the pH falls greater expressed juice, longer sarcomere length, and lower shear force value. Electrical stimulation enhanced the features of meat quality, suggesting that it can enhance the meat quality of transported animals (Kadim *et al*. 2010). Another study also determined that 14-day ageing and high voltage electrical stimulation were successful in increasing the softness of the flesh from cabrito carcasses (King *et al*. 2004).

To meet the increasing demand of meat, high reproductive rate is considered as substantial option. In this regard, goats' excellent reproductive qualities are extremely helpful in difficult tropical climates where only the most resilient and well-adapted females may raise their young in accordance with their ability to consume a low- or medium-quality pasture. A lower mortality rate is also necessary for the breeding population to produce more offspring (number). This characteristic is linked to the effects of diseases, inadequate nutrition, and poor management. Additionally, the weight of the offspring generated affects the productivity of the flock in terms of meat. Therefore, weight increase along with growth and development is another crucial factor. Meat production depends on biotic, abiotic, and socio-economic factors including genotype, environmental conditions, and husbandry. Disease management must be done to ensure the safety of livestock as well as consumers. In this regard, rotational grazing is a solution which controls nematodes in goats' gut as it does not allow nematodes to complete their life cycle. Breed selection is also an option; goats develop acquired immunity against many diseases. Also, there are some breeds which can provide more meat than others. Enhanced breeding methods, energy and protein supplementation boost reproductive performance and infants' growth and survival. If nutrition is not available to goats, farmers can choose the times and frequency

of mating to strike a balance between the flock's high demands and the unpredictable inadequate resource availability (Barger *et al.* 1994).

According to their body size, goats are typically split into three groups: dwarf breeds, small breeds, and large breeds. At around 15 months of age, the body weights of goats with small frames range from 15 to 30 kg. but at the same age, large-framed breeds can reach body weights of up to 55 kg. In comparison, dwarf goats rarely weigh more than 25 kg when they are between 15 and 24 months old. Meat quality is dependent on fat content of the meat. Subcutaneous fats are used to estimate the yield of meat. Less subcutaneous fat renders goat carcasses more susceptible to moisture loss and cold shortening upon chilling (Webb 2014). A study has been conducted in Sindh to analyze the productivity of goat breeds. Almost 10 goat breeds were studied, and it was concluded that tapri, thari and kamori breed could be used for meat production as pre-weaning growth rate of kids was high on these breeds (Bilal *et al*. 2018).

Figure 3: Processed goat meat (https://www.johnandbiola.co.uk/real-goat-meat-medium-chunks)

2.4. Breeding techniques

Breeding and genetics also play an important role in meat production as breeding is one method to raise competent organisms. Composite breeds have been developed as a result of crossbreeding tactics in an effort to combine the best traits of two or more different breeds. The wide range of economically significant production qualities within and between goats breeds creates a wealth of opportunities for improving the output and yield of meat goats through breeding and selection techniques (Goetsch *et al*. 2011).

A study has been conducted to analyze the breeding methods of goats in Pakistan. It has been concluded that most of the farmers are illiterate and do not understand the scientific basis of breeding and its outcome. More than 50% of respondents have herd of less than 20 animals and do not have agriculture land to nurture goats. Grazing is a common method adapted by breeders to feed goats. However, some breeders have agriculture land. This makes the goat farming low input in Pakistan as grazing along with some fodder is given to goats for their survival. It has also been observed age of goat breeders ranged from young to old. The old myths and methods are still now in trend among breeders as young breeders got their education from older ones. It indicates the active role of old breeders in present farming directly and indirectly. Usually, breeders sell male goats when they are kids or raised them till Eid if demand of male is high in market (Ramzan *et al*. 2020).

Superior males and females should be sorted in the age of 6 years depending on their body weight, litter size and immunity. These animals can help in the improvement of flock. If some indigenous and exotic breed is introduced in the flock, the performance of that breed must be analyzed under strict supervision. The introduction of certified superior breed is also a better option to improve livestock and yield. (Goat Meat Production in Asia 1988). The latest breeding techniques involve artificial insemination and embryo transfer. There are two techniques used to execute artificial insemination, cervical insemination in which semen is deposited in cervix of female and laparoscopic insemination in which sperms directed to uterus using medical equipment. The embryo transfer required super ovulated female to donate eggs being fertilized by artificial insemination and placed in multiple recipient female goats. The advantage of both methods is genetic improvement of livestock with-out the cost of raising a superior male. The sexually transmitted disease ratio automatically reduced in this process (Goat Reproduction Reproductive Techniques 2019).

2.5. Supply Chain of meat

The supply chain of goat meat includes farmers, collectors, slaughterhouses, dealers and distributors, retailers and processing units and market. The goats are collected at the slaughterhouses and slaughtered, and offal processing is done. The chilling of goat meat was done followed by deboning. The meat is then packed and dispatched via road, sea, or air. It has been investigated that animal production and management is the most important step of supply chain. Proper research, genetic improvements, goat management guidelines, and government services must be improvised to improve meat quality and taste as well as quality of animal production and breeding. Cold chain supply is also facing many hurdles including poor communication of suppliers. Logistic tasks across far distances, on time supply, poor quality roads, sanitation and weather

conditions are present challenges faced by industry and growth. Trust and quality are the main aspects considered by the consumers. (Star *et al*. 2021).

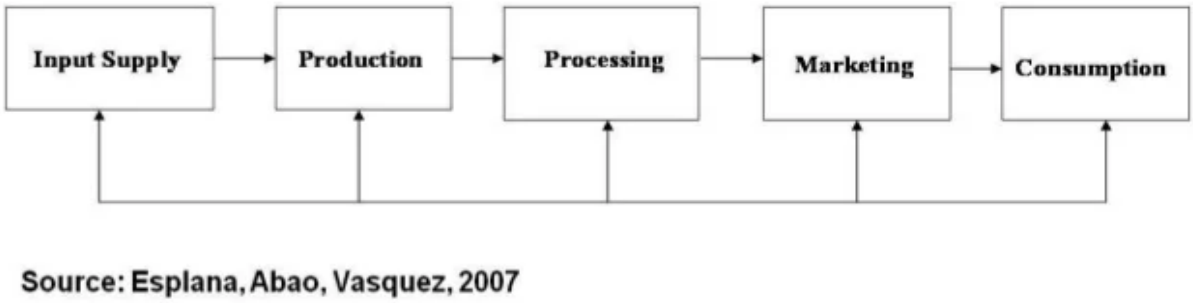

Figure 4: Goat industry supply chain framework

2.6. Genetics

Mitochondrial DNA analyses revealed that four strains of wild capra species could be the source of today's breeds. Study also suggested that the mehrgarh may be the ancient center of goat domestication (Sultana *et al.* 2003). According to the studies there are several genes which affect production in goats including BMP15, BMPR1B and GDF9. The most important gene is BMP15 which plays an important role in ovulation and developmental stages including humans. The polymorphism in this gene enhances the ovulation efficiency and litter size, on the other hand homozygosity has been reported unproductive. It has been reported that six polymorphic sites in BMP15 gene have been observed in teddy breed which enhances its fertility. Another study also revealed that two polymorphic sites at exon 2 also contribute to ingenuity (Jalbani *et al.* 2017, Di Pasquale *et al*. 2004, Davis 2005).

A study has been conducted to analyze the genetic diversity among different goat's breeds. The breeds selected from Sindh included Bari, Bugi toori, Kamori, Pateri, Tapri, White Tapri and Black Tapri. The genes responsible for body size were identified. The SOCS2 gene was found in Bari, Black tapri, Pateri and Tapri. The genes related to reproducibility were BMPR1B, GNRHR, INSL6, JAK2 and EGR4. The study also suggested that 94.5% of SNPs displayed polymorphisms observed in all breeds except bugi toori and bari. It was concluded that the diversity is due to the admixture with other breeds (Kumar *et al*. 2018).

During breeding morphological characteristics are mainly focused. A study has been done to analyze the genes related to morphological characteristics including body weight and growth. It is reported that EPH Receptor A5 was a potential gene for body length. The connection between pancreatic islet cells is mediated by EPHA5 and EFNA5 to control insulin production that is driven by glucose. In this study it is also demonstrated that two SNPs (45231-scaffold617-879437 on chromosome 16 and snp24590-scaffold25-1223464 on chromosome 8) were associated with morphological traits and these SNPs were present in the coding region of the genes (Moaeen-ud-Din *et al*. 2022). The Punjab breeds were also investigated using 50K SNP technique. Genetic diversity was found among these breeds. It was concluded that inbreeding coefficient was higher in Barbari (Figure 2.5) and Daira Deen Panah (Figure 2.2) goats as compared to other breeds (Muner *et al*. 2021).

Genetic modifications have been done to improve the quality and quantity of goat meat. In a extensive study done by Song *et al*. (2022), the mutation in myostatin gene has been done using TALENS. It results in hyperplasia and hypertrophy, as a result the muscle double. Goat fetal fibroblasts were used to do mutation and mutated cells were used as nuclear donor cells in somatic cell nuclear transfer technique. Similar research has been done using CRISPR system in which myostatin gene knock out goats were produced. It was observed that weight of knocked out goat was significantly higher than wild type, also it showed different carbohydrate, lipids, and protein metabolism. The inheritance of mutation has also been observed by PCR analysis (He *et al.* 2018).

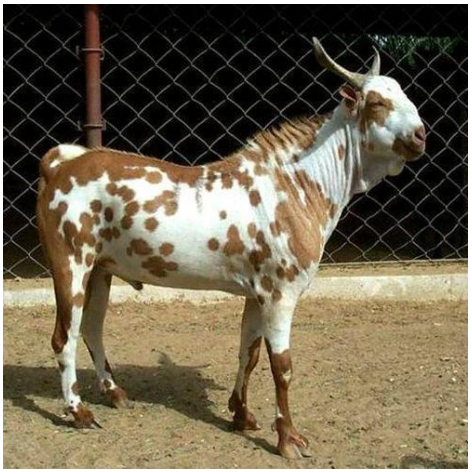

Figure 5: Barbari breed (https://www.ukatheya.com/barbari-goat/)

2.7. Problems and solutions

There is a risk for goat breeds as there is no breeding policy and direction from the government. All goat breeds must be genetically characterized. Several goat breeds might not be economically viable. Therefore, it is necessary to establish the genetic relationships between various breeds. Additionally, it is necessary to identify certain phenotypic traits of each breed of cattle, such as disease resistance and tick resistance before developing a conservation policy. The breeds including Beetal, Kamori and Dera Din Panah are competent regarding milk and meat production so they can be used in sustainable selective breeding program.

Climatic stress is a problem faced by goats. High temperature reduces the fertility in both male and female. It also drained the electrolytes from the body of goats hence water and salts requirement increase in hot season. Summer season is also favorable for ticks and internal parasites. Tick diseases also interfere with fertility. Trypanosoma disease causes inflammation of testis and epididymis. Helminthes also cause anemia in livestock. Poor diet is another issue for livestock. Malnutrition results in delayed onset of puberty, low litter, reduced reproductive rate and low-quality milk. But goats have natural adaptations to face these challenges. Goats pant and sweat to retain salt and maintain blood plasma. Goats have high digestive efficiency, low metabolic requirements, nitrogen, and water reservoirs. Goats also have a good grazing strategy to cope with malnutrition as they prefer leaves and thin stem which are more nutrients than other parts of plants. The best thing is their high reproductive capacity even under harsh conditions (Alexandre & Mandonnet 2005)

The technique known as feedlot fattening which is common in affluent nations in which the production of mutton and goat meat is done by scientific and commercial principles. One of the main obstacles of producing more meat of higher quality and quantity is the absence of feedlot fattening. The majority of our country's mutton output comes from traditional farming methods with minimal nutrient inputs; therefore, carcass weight is typically lower than the potential of our sheep and goat breeds (El-Hag & El-Shargi 1996).

The main issue faced by the breeders regarding livestock is nutrition. However, the places where resources are enough, health of the livestock counts as a biggest problem. With little supplementation, small stocks are mostly kept on rangelands, farmed fallow lands, uncultivated wastelands, and occasionally crop waste is used as feed for livestock. Tree leaves are also taken as a supplement in several villages. The mortality rate of small ruminants was recorded as 25-80%. It has been reported that nutrition and climate are the main villain of this much mortality rate. Infants are more prone to temperature extremities. Small ruminants' veterinary services were likewise said to be nonexistent. The following illnesses were frequently mentioned: Foot and mouth disease, Peste des petits ruminants, pox, ticks, enterotoxemia, abortions and Gid. There aren't

multiple possible techniques available to diagnose a disease. Importantly, despite extensive government initiatives offering free veterinarian care and medications to farmers, treatments are frequently administered at the wrong times due to intermittent medication supplies, which severely limits their efficacy or drastically lowers the efficiency of these extensive initiatives (Odo 2003).

The lack of meat supply chain is another issue faced by farmers and businessmen. The integrity and hygiene of meat should be maintained by appropriate meat inspection and governmental legislation for price fixing of meat and meat products. Frozen supply chain to increase shelf life of the meat must be managed. As a crucial component of the meat industry, animal welfare also includes proper systems for animal care, the availability of enough feed supplies, reproduction effectiveness, breeding techniques, and disease prevention. Bleeding procedures must also be carefully regulated. To minimize losses, effective vaccination programmes and disease prevention measures should be put in place. Considering the problems and with the objective of rendering Pakistan a global player in the production and processing of meat, the Punjab government devised the Lahore Meat Processing complex (LMPC) under the management of the Punjab Agriculture and Meat Company (PAMCO). This facility includes mechanical slaughtering lines for beef and mutton, sanitary processing facilities, a blood rendering plant, a wastewater treatment plant, a cooling system, as well as value addition through the creation of meat and meat-based products. In order to provide locals with safe, nourishing and hygienic meat and in order to meet global demand, PAMCO is also an ISO, HACCP and Halal certified organization for LMPC (Shoaib & Jamil 2017).

It has been studied that the education of goat farmers is very important. High productivity can be attained by a farmer with a high level of education and experience since educated farmers consider it simple to accept new technology that will boost output. As a result, there is a strong positive correlation between market participation and productivity, which in turn influences commercialization. To maximize productivity and market involvement, government programs that would educate and equip goat farmers must be implemented. Since it improves market performance and provides information on market participants, market information is a crucial component of agriculture development. Additionally, embracing production and marketing technologies is critical for increasing the productivity of rural goat farmers (Hundal *et al*. 2016).

To develop the necessary conditions for the transition from subsistence to market-oriented farming, a road must be made to assist household goat farmers. In this aspect, government support for goat farmers would be significant. The study also suggests creating official market structures where goat farmers can sell their goats

and goat products to encourage market participation and, as a result, improve rural farmers' access to food and ameliorate their poverty. Goats can be proved as socioeconomic and environmental remarkable if goats farming and environment are managed properly. It is noted that commercial goat production, marketing and value-added products are some ways to capitalize the economic importance of goats. Therefore, in order to maintain a steady supply of goats and the sustainability of these new markets it is necessary to investigate the marketing prospects available both locally and internationally (Dubeuf 2021).

Figure 6: Processing of goat meat (https://cantekgroup.com/Slaughterhouse-and-Meat-Processing-Facilities)

CHAPTER 3

METHODS OF THE STUDY

3.1. Data collection

For this study, the data of goat production, meat production, meat export were collected from Pakistan Statistical book 2022 and Pakistan economic survey from the year 2017 to 2021. The data of stocks of goat and production of mutton of Pakistan, Asia and World was retrieved from FAO STAT.

3.2. Methodology

The stock value of goats and mutton production of Pakistan was compared with Asia and world with its contribution to Asia and World production. The percentage contribution of Pakistan to Asia and World was calculated and analyzed.

Moreover, the growth analyses were done for Asia, Pakistan and World goat stocks and mutton production. The growth estimation is done by linear growth rate and compound growth rate method (Randhawa *et al*. 2018). The annual growth rate and compound growth rate of goat population growth, meat production, meat and live animal exports and imports were calculated using the formulae. (Equation 3.1 & 3.2).

a. Annual growth rate

$$g = \frac{X_T - X_o}{X_o} \ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

g is the annual growth rate in percentage.

X_T is the current value of the variable.

X_O is the previous value of the variable.

b. Compound growth rate

$$\text{Compound growth rate} = \left(\frac{EV}{BV}\right)^{1/n} - 1 \ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

EV is the ending value (the final value in the series)

BV is the beginning value (the initial value in the serious)

n is the number of years between the beginning and ending values.

In the present study, the beginning value is the value for the year 2017 and the ending value is the value for the year 2021. The number of years is 4 because the comparison is made for the values over a period of 4 years.

CHAPTER 4

RESULTS AND EVALUATION OF RESULTS

4.1. Contribution of Pakistan to Asia and World in stock value of goats

Table 2: Stock value of goats of Pakistan, Asia and World in M An

Years	Stock Value M An Pakistan	Stock Value M An Asia	Contribution of Pakistan in Asia	Stock Value M An World	Contribution of Pakistan in World
2017	72179000	557392229	12.96%	1048653991	6.88%
2018	74134000	553690350	13.38%	1063235376	6.97%
2019	76143000	564138856	13.49%	1102578765	6.90%
2020	78207000	569917318	13.73%	1115286975	7.01%
2021	80326000	571890994	14.04%	1111283638	7.23%

Pakistan's contribution to the value of the Asian stock market over the past five years has ranged between 12.96% and 14.04%, while its contribution to the value of the world stock market has been between 6.88% and 7.23%. These percentages give a comparative indication of Pakistan's importance in the Asian and international stock markets of five years.

4.2. Contribution of Pakistan to Asia and World in mutton production

Pakistan contributes approximately 7-8% of Asia Production and 4-5% of World's Production of mutton. Asia and Africa contribute the most in goat meat production of the world which is 72% and 23% respectively. Within Asia China is the largest producer of goat meat. The meat production of goat meat increased drastically in China in 2019 due to decrease in pork production.

Table 3: Estimation production of mutton in Pakistan, Asia and world in Tonnes

Year	Pakistan (Tonnes)	Asia (Tonnes)	Contribution of Pakistan in Asia	World (Tonnes)	Contribution of Pakistan in Asia
2017	701000	9372132.28	7.48%	15376156.8	4.56%
2018	717000	9356106.99	7.66%	15526263.22	4.61%
2019	732000	9463488.41	7.73%	15776161.75	4.64%
2020	748000	9770298.31	7.65%	16105014.86	4.65%
2021	765000	10053474.77	7.61%	16357614.13	4.68%

So, in the years of 2019-2021 China was the major meat producer and meat production was increased approximately 4% from 2019 to 2021 (OECD-FAO 2020). This is the reason that Pakistan contribution towards the production of Asian meat production decreased in these years. However, the contribution of Pakistan in World's meat production increase with every year.

4.3. Growth analyses of goat population, mutton production, stock value and meat export

There is consistence and positive growth rate in the goat population in last 5 years showing moderate growth. As goats have a religious importance in Pakistan due to the sacrifice on prestigious festival of Eid ul Azha, the demand of live animal increased and it led the farmer towards the more production of goats. Moreover, goats are well adapted to climate change, for instance it can survive in arid and semi-arid conditions. This adaptability of goats made them a viable option for farmers (Shankarnarayan *et al*. 1985). The market demand and increasing prices of goats in Pakistan is another reason for the expansion of goat population.

Table 4: Estimated goat population (Thousand heads) in Pakistan

Year	Thousand heads	Annual growth rate
2017	72179	-
2018	74134	0.027
2019	76143	0.027
2020	78207	0.027
2021	80300	0.027
	Compound growth rate	0.027

The statistics show an evident positive trend in Pakistani meat exports over a five-year period, with a compound growth rate of roughly 11.83%. This suggests that the meat export sector is expanding rapidly and steadily. The biggest rate of increase happened in 2020. According to the data, Pakistan's meat export industry has been developing, which can have a beneficial impact on the country's economy, employment generation, and agriculture sector. As meat demand has been increased globally so Pakistan being a producer of organic and halal meat became a exporter of meat (Randhawa *et al*. 2018). It expands its meat industry with many governments initiative and policies to promote meat exports.

Table 5: Meat export (thousand USD) by Pakistan

Year	Meat, fresh, chilled or frozen USD in thousands	Annual growth Rate
2017	211,988	-
2018	227,284	0.072
2019	242,668	0.0677
2020	304,174	0.2534
2021	331,640	0.0902
	Compound growth rate	0.1183

Over this time, Pakistan's goat stock production has been steadily increasing at a steady rate. In comparison to Pakistan, Asia's growth rates were positive but modest, indicating a slower and more erratic economic trend. On the other hand, growth rates in Asia and the World were more erratic, increased in the year of 2019-2020 and decreased in 2021. Despite being positive, growth lagged Pakistan's growth rates. This implies that other Asian nations may have experienced significant difficulties or changes in their goat raising industries during this time.

Table 6: Annual production growth rates of Stock value of goat of Pakistan, Asia and World

Year	**Pakistan**	**Asia**	**World**
2017	-	-	-
2018	0.027	-0.0066	0.0139
2019	0.027	0.0185	0.0370
2020	0.027	0.0102	0.0115
2021	0.027	0.0034	-0.0035
Compound growth rate	0.027	0.0064	0.0146

Asian goat farmers confront several challenges, such as a lack of high-yielding, environment-adapted animals, a lack of quality feeds during a lengthy dry season, a number of infections, and trouble selling their produce (Liang & Paengkoum 2019). The main reason behind it is a lumpy skin disease of cattle prevailed in most of the Asian countries and ultimately affect the stock value of the world. Compared to Asia and the world, Pakistan has had more success maintaining a consistent and moderately fast growth rate for its goat stock output. As no LSV outbreak was reported in Pakistan till 2020 (Azeem *et al*. 2022).

Table 7: Annual production growth rates of mutton production of Pakistan, Asia and World

Year	Pakistan	Asia	World
2017	-	-	-
2018	0.0228	-0.0017	0.0097
2019	0.0209	0.0114	0.0160
2020	0.0218	0.0324	0.0208
2021	0.0227	0.0289	0.0156
Compound growth rate	0.0220	0.0176	0.0155

There is consistency in Pakistan mutton production in last five years. For Asia and the World, the growth rate was less in 2018 and increased from 2019 till 2020 and again showed decline in the year of 2021. The COVID-19 pandemic disrupts supply chain and labor availability in many regions which leads to decline of production in the year 2021. The trades restrictions were also imposed. Lumpy skin disease of cattle also struck in the year of 2020 in the China and India which influence the meat production in Asia as they are major mutton producers of Asia. This disease also affected other countries including Nepal, Sri Lanka, Bhutan, Vietnam, Myanmar, Thailand, Malaysia, Laos and Cambodia in 2020-2021 which is the main reason of decline in meat production of Asia and World (Azeem *et al.* 2022).

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

- The demand of goat meat is rising with every year with increasing of goat meat production in Pakistan and fluctuating production in Asia and throughout the world. This growth is an indication of increasing demand due to shift in diet pattern or growing world population. China has started focusing to produce goat meat after the decrease in production of pig meat. Production of mutton fluctuated due in 2020 and 2021, the lumpy skin disease, a severe problem impacting goat herds all over the world, was the cause of these changes. Production levels were significantly impacted by the illness's high incidence, which led to persistent output declines and market disruptions.
- The demand for meat is expected to rise by 11% by 2029. Goat meat consumption is similar in both emerging and developed countries, and it is expected to rise modestly during the forecast period as prices remain high. Despite limitations caused by urbanization, desertification, and feed availability in some countries, sheep and goats are a popular species that are well adapted to the local circumstances and the intensive production techniques. Climate change, obesity, technological improvements, and changing consumer demands are all essential elements to consider, especially as they influence legislative initiatives and movements towards environmentally friendly purchasing patterns (OECD-FAO 2020).
- Pakistan was not strike with the disease in the year of 2020-2021 but there are chances that in future such disease can affect livestock population. The vaccinations of cattle must be monitored by the government. Government, private companies, and farmers should emphasize the necessity of efficient disease management plans and biosecurity precautions in the goat meat industry to address such issues.
- Farmers should be educated in this regard so that they can provide animals with nutritious food which helps in the carcass growth and immunity against diseases. Moreover, they should know the importance of vaccination and proper breeding techniques. Research work is lacking in Pakistan for the betterment of cattle, government should allocate funds for continued research into goat breeds that are disease-resistant and better breeding techniques. Create and advance genetic strains that are more resistant to prevalent illnesses. Collaboration with neighboring countries also aids to address disease outbreak as same region experiences same kind of disease. Well established slaughterhouses and supply chains must be available to flourish the meat industry. Government and companies should improve all aspects of the value chain for goat meat, including production, processing, and marketing. To access export markets, encourage the construction of processing facilities that adhere to international and halal standards. Also ensure that there are appropriate

regulatory structures in place to uphold animal welfare and food safety standards. Consumers and export partners may become more trustworthy as a result.

SUMMARY

The study on trends in goat meat production is highly relevant in the context of agricultural and economic growth, especially in countries like Pakistan being a one of the largest exporters of goat meat where goat husbandry is a significant source of rural income. Moreover, it's a source to solve the issue of food security as its demand is increasing in the world.

The study was aimed to assess the recent data to predict the future demand and supply of meat. The factors that affect the goat meat production in selected years were also examined which provides the information about the future plans and policies to deal with these kinds of issues to sustain the meat industry. In the study the data of recent five-year of goat meat stocks value and mutton production was analyzed. The data of the meat exports of Pakistan and goat population was also analyzed by statistical methods. The data of Pakistan was compared with Asian and world's data and Pakistan contribution to Asia was also studied. The contribution of Pakistan to the world stock market ranged from 6.88% to 7.23% being a 3rd largest contributor to Asia stock value and 4th largest contributor to world stock value.

The study highlights the economic importance and potential for continued growth of the production of goat meat while also stressing the industry's vulnerability to disease outbreaks. It underlines the importance of research and investments in disease prevention and control to ensure the sustainability and resilience of the goat meat producing sector in the years to come.

The study claims that Pakistan's goat industry has been exporting meat and experiencing a moderate increase in goat population, making a significant contribution to both the Asian and international markets. Issues like lumpy skin disease and COVID-19 pandemic disruptions have had an impact on the global and Asian landscape of beef production. However, Pakistan's constant advancement demonstrates the tenacity of the goat business.

These findings provide essential insights into the dynamics of goat production and its role in the larger context of agriculture and trade. They emphasize the importance of disease management, the adaptability of market demand, and government initiatives in shaping the future course of Pakistan's goat industry. Farmers can decide how to effectively manage their livestock and produce meat based on knowledge about market trends and the demand for goat meat. By comprehending Pakistan's position in the international meat market, exporters can identify opportunities and challenges for advancing international trade. The study also underlines the requirement for efficient disease management strategies by illuminating how conditions like lumpy skin

disease affect output patterns. The findings also pave the path for additional research on numerous factors that can hit the meat industry in future and their management ideas so that in future the industry will not be affected.

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STUDENT DECLARATION

Signed below, **Sheharyar Riaz,___** student of the Szent Istvan Campus of the Hungarian University of Agriculture and Life Science, at the BSc Course of **Agriculture Engineering** declare that the present Thesis is my own work and I have used the cited and quoted literature in accordance with the relevant legal and ethical rules. I understand that the one- page-summary of my thesis will be uploaded on the website of the Campus/Institute/Course and my Thesis will be available at the Host Department/Institute and in the repository of the University in accordance with the relevant legal and ethical rules. Confidential data are presented in the thesis: yes no*

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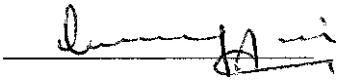


Student

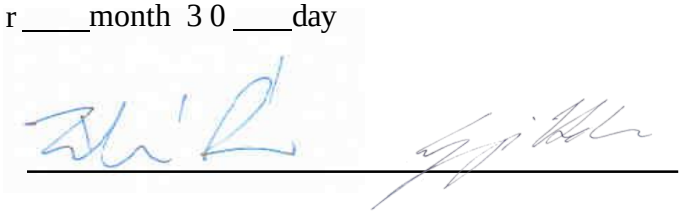
SUPERVISORS' DECLARATION

As supervisors of the author of this thesis, we hereby declare that review of the thesis was done thoroughly; student was informed and guided on the method of citing literature sources in the dissertation. Attention was drawn on the importance of using literature data in accordance with the relevant legal and ethical rules.

Confidential data are presented in the thesis: yes **no** *

Approval of thesis for oral defense on Final Examination: **approved** not approved

* Date: 2023_____Year October____month 30 ____day



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