

Present status of the world goat populations and their productivity

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Introduction

Goats were among the first farm animals to be domesticated. As indicated by the archaeological evidence, they have been associated with man in a symbiotic relationship for up to 10,000 years (Ensminger and Parker, 1986). Goats disseminated all over the world because their great adaptability to varying environmental conditions and the different nutritional regimes under which they were evolved and subsequently maintained. They proved useful to man throughout the ages due to their productivity, small size, and non-competiveness with him for food.

In the developing countries, goats make a very valuable contribution, especially to the poor in the rural areas. The importance of this valuable genetic resource is underestimated and its extent of contribution to the livelihood of the poor is inadequately understood. They are often neglected in comparison with cattle and sheep. Part of this attitude towards them can probably be due to a recognition of their capability, rather any prejudice against them, as it is believed that goats are intelligent, independent, agile, tolerant to many diseases and parasites and can look after themselves much better than other livestock species.

Research and development investments to improve the relatively low level of goat's productivity do not match their potential importance, resulting in many goat breeds that are not genetically explored, especially in the developing countries. Nevertheless, goats are going to be more important source of livelihood for many more people in coming years and, thus, they deserve greater attention at both the micro and macro levels. Now, it is the time to consider and pay attention to the value and capacity of goats for producing food. This article discusses and reviews the present status of the world goat populations and their productivity.

Number of goats in the world:

Accurate statistics are required to determine the future outlook of the goat populations and their productivity. They are also needed before any improvement policies can be planned on a realistic basis and implemented with confidence. Table 1 presents numbers of goat and sheep populations in different parts of the world, along with the ratios of goat to sheep and their percentages out of the total number of goats and sheep in the world (FAOSTAT, 2008).

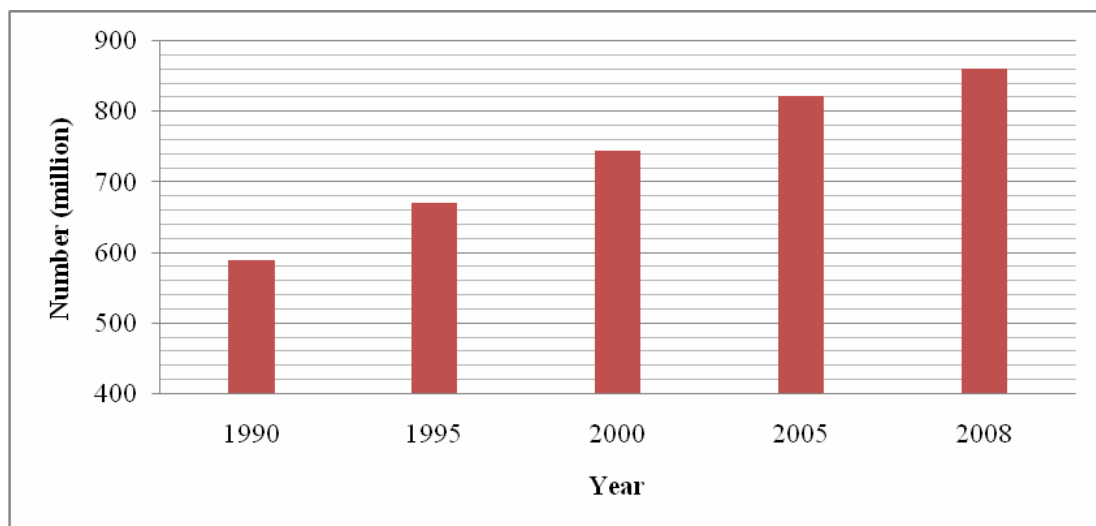
Table 1: Numbers of goats and sheep in different parts of the world, ratio of goat to sheep per each and their percentages out of the world total number (FAOSTAT, 2008)

Continent	Number (million)		Ratio		Percentage of world total (%)	
	Goats	Sheep	Goats	Sheep	Goats	Sheep
Asia	514.4	452.3	1	0.9	59.7	42.0
Africa	291.1	287.6	1	1.0	33.8	26.7
Northern America	3.0	6.9	1	2.3	0.4	0.6
Central America	9.0	8.1	1	0.9	1.0	0.8
Caribbean	3.9	3.1	1	0.8	0.5	0.3
South America	21.4	73.1	1	3.4	2.5	6.8
Europe	18.0	133.9	1	7.4	2.1	12.4
Oceania	0.9	113.1	1	119.2	0.1	10.5
World	861.9	1078.2	1	1.25		

The world total numbers of goats and sheep were 861.9 and 1078.2 million, respectively, i.e. there is about one goat to approximately 1.25 sheep in the world (FAOSTAT, 2008). There are tremendous variations among the different parts of the world regarding the number of goats, its ratio to sheep and their percentages. The largest number of goats is observed in Asia, followed by Africa, representing about 59.7% and 33.8%, summing up to 93.5% out of the total number of the world, respectively. The lowest number of goats is found in Oceania, accounting for 0.1% out of the world total number. The ratio of goat to sheep ranged between one goat to 0.8 sheep in the Caribbean to one goat to 119.2 sheep in Oceania. The ratios of goat to sheep in Africa, Central America and Asia are approximately equal, indicating the considerable importance of goat populations in these parts of the world, especially to the poor and landless peasants.

The total number of goats in the world increased by 146% of the total number (590.1 million) encountered in 1990. Number of goats in the world has been increasing since 1990 by about 1% to 4% each year (Figure 1). During the same period, cattle number increased by 5%, while that of sheep decreased by 10%, reflecting the emergence of goats as a major livestock species.

Figure 1: Number of goats in the world during the period from 1990 to 2008 (FAOSTAT, 2008)



The total numbers of goats in the top ten countries are presented in Table 2. The ten countries have approximately 65.7% of the world total number. Seven countries of this list are in Asia, and the rest is in Africa. The largest number of goats in the world is in China, followed by India, Pakistan and Bangladesh, all of them are in Asia. Number of goats in these four countries constitutes about 45% of the world total. Great variation in terms of the ratio of goat to sheep exists among them, ranging between 1 goat to 0.02 sheep in Bangladesh to 1 goat to 2.13 sheep in Iran.

Goat Production:

Goats are mainly kept: to produce milk, meat or fiber (Mohair and Cashmere). This article focuses on meat and milk production, as there is little information on fiber production.

Milk

Dairy goat is considered the cow of the poor. The goat eats little, occupies a small area and produces enough milk for the average unitary family, whereas maintaining a cow at home cannot be afforded by the homeowner, hence, the growing popularity of goat as the poor person's cow. Dairy goats produce about 15.2 million metric tons (MT) of milk, accounting for about 2% of the world total amount of milk produced by livestock species (FAOSTAT, 2008). The developing countries produce approximately 83% of the total amount. In Europe, goat breeding is strongly oriented towards milk production, with

Table 2: Numbers of goats in the top ten countries, the ratio of goats to sheep and their percentages from the total number in the world (FAOSTAT, 2008)

Continent	Number (million)		Ratio		Percentage of world total (%)	
	Goats	Sheep	Goats	Sheep	Goats	Sheep
China	149.4	136.4	1	0.91	17.3	12.7
India	125.7	65.0	1	0.51	14.6	6.0
Pakistan	56.7	27.1	1	0.48	6.6	2.5
Bangladesh	56.4	1.6	1	0.02	6.5	0.2
Nigeria	53.8	33.9	1	0.63	6.2	3.1
Sudan	43.1	51.1	1	1.19	5.0	4.7
Iran	25.3	53.8	1	2.13	2.9	5.0
Ethiopia	21.8	25.0	1	1.15	2.5	2.3
Mongolia	20.0	18.4	1	0.92	2.3	1.7
Indonesia	15.8	8.4	1	0.53	1.8	0.8
World	861.9	1078.2	1	1.25		

only 3% of the world goat population producing about 15% of the world's goat milk, which is mostly used for cheese production (Lejaouen and Toussaint, 1993). Table 3 shows the amount of goat milk produced by the top ten countries in the world, along with the total number of dairy does and the average of milk produced per doe (FAOSTAT, 2008).

Table 3: The amount of goat milk produced in the top ten countries, number of dairy goats and the average amount of milk produced by a dairy doe

Country	Goat Milk production (million MT)	Number of dairy goats (million)	Milk produced per dairy doe (kg)
India	4.0	30.2	132.5
Bangladesh	2.2	27.1	80.0
Sudan	1.5	N.A.	-
Pakistan	0.7	4.9	141.9
Spain	0.6	1.4	422.3
France	0.6	0.8	703.8
Greece	0.5	4.1	123.9
Iran	0.4	13.7	29.9
Somalia	0.4	6.6	59.7
China	0.3	1.4	194.8

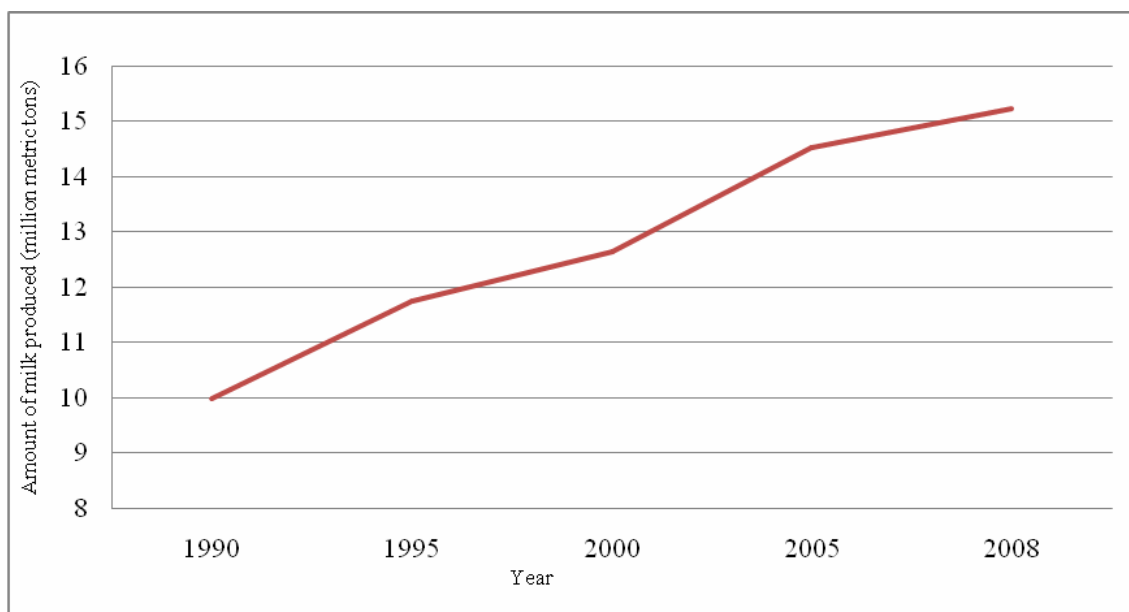
The largest amount of goat milk is produced in India, followed by Bangladesh and Sudan. There are three European countries in the list producing a considerable amount of goat milk: Spain, France and Greece. These three countries produce similar amounts of goat milk. In France, interest in dairy goats has led to the establishment of organized programs for selection, processing and commercialization of goat milk, which is produced mainly from Saanen and Alpine breeds. France leads the list in terms of the annual milk production per dairy doe, while Iran reports the lowest milk production per dairy doe. China has the largest total number of goats in the world, but they are mainly kept for meat production. Milk production per dairy doe ranks third, behind France and Spain. China officially reports 1.4 million dairy goats producing 0.3 million MT of milk (FAOSTAT, 2008). According to Luo (2009), China

had about 5.8 million dairy goats in 2008. Both sources of statistics on goats may be questioned because they are not based on actual censuses, and the number of dairy goats is even more difficult to count due to the lack of breed definition.

Since 1990, interest in dairy goats has been steadily increasing, as manifested by the increase in milk production from about 10 million MT in 1990 to about 15.2 million MT in 2008 (Figure 2). The dairy goat industry has great potential for further growth. It has grown partly because of a trend towards self sufficiency by rural people, especially in developing countries, where goat milk can help to improve the nutrition of millions of people. In developing countries, much of the milk produced by goats is for family consumption, but goat milk can also be further processed into a variety of marketable products.

Marketing of goat milk and its products is still in its infancy. So far, there have been no marketing efforts attempted on a broad scale. As reported by Dubeuf and Boyazoğlu (2009) and Luo (2009), less than 5% of the total milk produced by goats is marketed.

Figure 2: Total amount of goat milk produced during the period from 1990 to 2008 (FAOSTAT, 2008)



There are many challenges facing the dairy goat industry, including collecting complete and reliable data on all aspects of production through developing nationwide strategies, identifying superior and proven bucks that accelerate the genetic improvement in the commercial herds and solving the seasonality problem to ensure consistent flow of goat milk. Seasonal breeding and the resulting annual fluctuations in goat milk supply have made development of new markets difficult and have dampened the importance of milk yield as a breeding goal (Haenlein, 1984). The development of a professional marketing system is part of the challenge to benefit from the fact that many people consuming dairy products prefer products from goats.

Meat Production

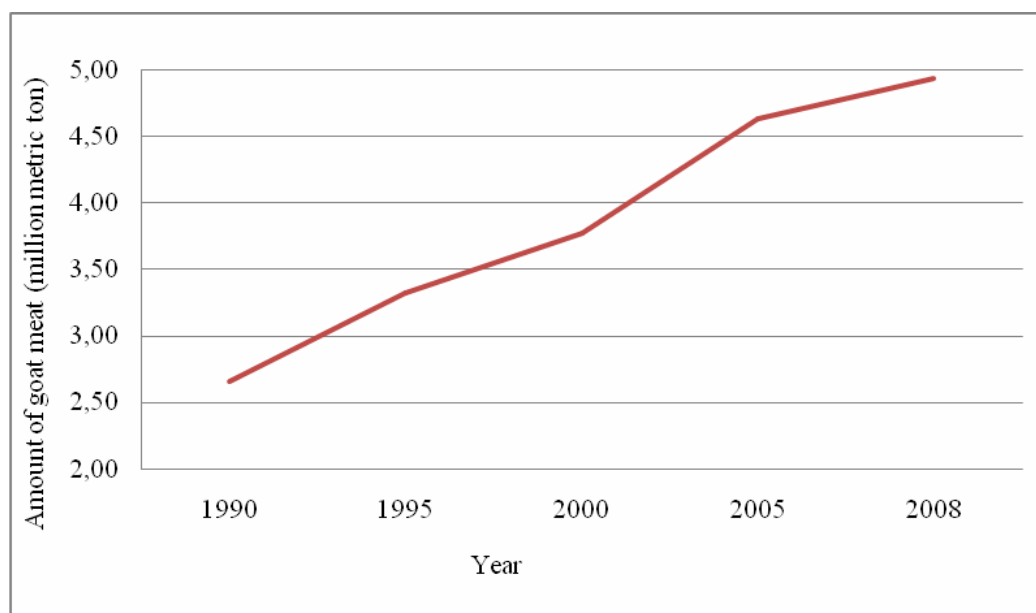
Goat meat is widely consumed in the developing countries. According to FAOSTAT (2008), total meat inventory is about 280 million MT. Goat meat represents only 2% of this total. The total amount of goat meat produced in 2008 was 4.9 million MT. The developing countries produced approximately 97% of this amount, reflecting the great importance of goat meat to feed millions of people in these countries. The top ten countries producing goat meat are presented in Table 4. China leads the world in producing

goat meat, accounting for 38% of the world total goat meat produced. The top ten countries producing goat meat are all from Asia and Africa, indicating the importance of goat meat to the people living in these areas. Goat meat production has been increasing from 2.65 million MT in 1990 to 4.93 million MT in 2008 (Figure 3). The major part of this amount is not traded as other major meats. It is usually produced and consumed locally among the poor in the developing countries. A profitable goat meat business can be ensured by proper knowledge of goat husbandry, budgeting and marketing techniques. There are several challenges associated with increasing meat production including consumer education, producer education, lack of slaughter and processing plants and lack of organized breeding programs and markets and marketing channels.

Table 4: The amount of goat meat produced in the top ten countries, number of animals slaughtered and the average amount of meat produced per animal

Country	Total meat (million MT)	Number of animals slaughtered (million)	Average meat produced per animal (kg)
China	1.8	133.3	13.7
India	0.5	47.8	10.0
Nigeria	0.3	21.3	12.7
Pakistan	0.3	15.4	17.0
Bangladesh	0.2	30.0	7.0
Sudan	0.2	14.5	13.0
Iran	0.1	7.6	14.0
Indonesia	0.1	6.6	10.0
Ethiopia	0.1	7.6	8.5
Niger	0.1	4.4	12.0

Figure 3: Increasing world total goat meat production since 1990



The potential of goats for sustainable supply of milk and meat for human consumption is unquestioned, and their contribution to improved nutrition of rural people is likely to increase. At the same time, goat cheese consumption is likely to increase also in developed countries. This is attributed to the image of goat cheese being a product of natural farm conditions compared with milk and milk products from

high yielding dairy cattle in large industrial farms. Regarding goat meat, rising living standards in some parts of the world and the migration of people preferring goat meat to the developed countries, have increased the demand for goat meat in these areas (Alandia Robles *et al.* 2006). Government programs to support goat farming should focus on research and education in the areas of breed improvement, farm management, control of infectious diseases, milk collection, processing and marketing.

Breeding goals and genetic improvement:

A global overlook of the goat industry indicates that few well organized selection programs have been developed, although goats have the biggest increase in number among the livestock species during the last 20 years (Dubeuf and Boyazoğlu, 2009). Increased numbers do not necessarily indicate a positive development of productivity, but simply reflect the fact that many people in rural areas of the developing countries try to survive by keeping small animals such as goats. Selection programs have been established mainly in developed countries, while most goats in developing countries are randomly bred and mainly used to satisfy the immediate needs of the families. A few breeding programs had been established in developing countries, but most of them failed. Most of these projects have focused on goat improvement rather than on educating the people who kept the animals. A limited number of selected and well characterized breeds for producing milk, meat or fiber has been developed, while the majority is not genetically exploited as a result of the lack of selection schemes and breeding organizations (Gall, 1996). In addition, the production systems are mostly extensive, which make record keeping very difficult, resulting in underutilization and inadequate exploitation of many potentially valuable breeds. The research and breeding work has been carried out mainly by research organizations, with little participation of the farmers. Several crossbreeding programs have also been established in different countries to obtain suitable and improved genotypes. In Turkey, for example, the Saanen breed was crossed to the Turkish breed "Kili" and the resulting cross became the most popular improved dairy goat (Yener, 1989).

Most organizations engaged in the genetic improvement of goats are located in developed countries and dedicated to milk production. France leads in the development of successful breeding plans for dairy goat production. Two breeds, the French Alpine and the Saanen, predominate. Breeding values are estimated for milk, total protein, total fat, percent protein and percent fat, and then combined into an index called ICC (Index Combine Caprine). This index does not include the amount of milk produced. Recently, typing the animal weighted towards the shape and attachment of the udder and the placement of teats has been introduced using a type score. The Spanish selection program for improving goat milk production and its constituents has started in 1993 for some local breeds as Murcrana Granadina, Malagueña and Majorera. The program was based on milk yield as a selection criterion and now changed to protein yield and content (Analla *et al.* 1995). In the USA, genetic evaluation of dairy goats started in 1983 for bucks and in 1984 for does of Alpine, Experimental, La Manchas, Anglu Nubian, Saanen and Toggenberg breeds and their crosses (Wiggans and Hubbard, 2001). Genetic evaluation is performed for milk, fat and protein yield and some type traits, and combined into an index as a sire evaluation program (Wierschem and Dickinson, 1989). A test day model is used for breeding value estimation and genetic improvement of yield traits for dairy goats (Sullivan and Wiggans, 2000). In Italy, selection programs are limited to research centers and universities. In South Africa, the Boer goat is selected for meat production. The systematic application of selection schemes has started in China mainly for the Boer goat (Dubeuf and Boyazoğlu, 2009).

Clear and correct identification of the breeding objectives is the core of any breeding program to be established (Groen, 2000). Progress towards the proposed breeding goals cannot be achieved without accurate evaluation of the genetic merit of each individual animal. The breeding objectives for any genetic improvement of goat productivity are focusing mainly on meat, milk or fiber, while at the same time maintaining high levels of adaptation to the local environmental conditions and the availability of feed resources. Greater rates of genetic improvement are most likely with improving the economies of goat productivity. Such rates cannot be accelerated unless the number of progeny per buck is large. This is achieved by using artificial insemination coupled with short generation interval. Theoretically, there is no limit to the number of selection criteria that may be included in a selection index

defining the overall breeding goal, but from a practical point of view it is better to keep the program simple. The breeding program should also be flexible and allow the incorporation of new selection criteria. The following points should be remembered:

- The more criteria that are considered for selection, the slower the rate of progress per trait.
- Each additional trait included in the index should contribute to more accurate breeding value estimation and higher rate of progress in overall merit.
- Including additional traits must be cost-effective.
- In a national program, the participants should not be obliged to select on exactly the same criteria, but major criteria should be commonly considered.

For breeding programs concentrating on milk, the objective should be “Enhancement of the quality and quantity of milk produced from healthy animals that are easy to milk in order to achieve high profitability”. The following main criteria can be considered:

Volume of milk: It is the most obvious characteristic for any dairy animal. It is usually included as a criterion in any breeding program. However, it may not be incorporated in a selection index, as milk volume is made up of solids, mainly fat, protein and sugar, in addition to water. In any case, milk volume must be measured.

Fat: The fat content is important for the quality of processed products. However, continued selection for increased fat content of the milk is not desirable. Thus, it is preferred to increase the total fat produced per due, while keeping the same level of concentration. In France, both criteria are included in a selection index.

Protein: Good cheese making depends on the concentration of protein in the milk. So, protein is a major component in any selection scheme for dairy animals.

Total solids: This trait can be used as composite selection criterion for fat and protein.

Cell count: This trait is an indicator for the bacteriological status of the milk and it seems to be a tool for management rather than breeding. However, recent research has shown that this trait is also moderately heritable (Rupp *et al.* 2004) and can thus be improved by breeding.

Management criteria: These criteria have great impact on the profitability of the dairy goat herds. Ease of milking and udder shape compatible with rapid machine milking are criteria which need to be improved. Udder shape is moderately heritable (Luo *et al.*, 1997) and can be improved by genetic selection. Another trait of interest is faecal egg count used as indicator for disease resistance (Woolaston and Baker, 1996).

Other criteria: Recent advances in molecular genetics techniques increased our understanding of animal's genome and the identification of genes associated with functional activities. For example, French researchers identified a major gene for alpha s1 casein that has an effect on protein production (Grosclaude, 1987). This allele is particularly useful for manufacturing cheese. As this gene and others yet to be discovered are simply inherited, they can be incorporated in selection programs.

In a breeding program focusing on improving meat production, the key traits to be considered are adaptability, reproduction, growth rate and carcass characteristics.

Adaptability: This trait is the most important of all the production traits. Although the goat has proven to be the most adaptable of all domesticated livestock and survives in a wide range of environments worldwide, it does not always realize its production potential when taken out of one environment and placed in another. Adaptability is a trait with low heritability and therefore difficult to improve by selection. It includes a range of adaptive traits which enable goats to survive and be productive, including disease resistance, heat resistance, water tolerance, ability to cope with poor feed quality (Baker and Gray, 2004).

Reproduction: For animals kept primarily for meat production, reproductive rate is the most important factor contributing to the efficiency of production (Shelton and Willingham, 1992). Reproductive traits

of interest in a meat goat enterprise would be conception rate, kidding rate and the ability to breed out of season. Prolificacy is also an important reproductive criterion. It should be noted that goats of the temperate zones tend to be seasonal breeders, while those from the tropics are non-seasonal breeders and kid year-round. This desirable trait of non-seasonality should be incorporated in a meat goat enterprise. Multiple births should be given high priority in the breeding programs, if the income is derived primarily from selling the kids.

Growth Rate: Growth can be effectively divided into two periods: pre-weaning average daily gain (ADG) and post-weaning ADG. Pre-weaning ADG reflects the genetic potential of the kid and the mothering ability of the doe. Post-weaning ADG becomes an important production factor if kids are sold as yearlings or older.

Carcass Characteristics: Carcass characteristics of interest are dressing percentage, ratio of lean to fat and muscle distribution. Carcass characteristics can not be measured on the farm. Good record keeping with traceability of data from a dedicated processing plant should help the meat goat breeder to measurably increase the productivity of the meat goat enterprise.

Productivity Indexes: Several productive and reproductive traits can be combined into an index to give a measure of total productivity.

Advantages of goat keeping

In many parts of the world where the geophysical properties of the terrain are not suitable for other livestock species, goats seem to be the best choice. The role of goats in supplying food to humans has been well stated by many researchers (Devendra, 1985). Based on the accumulated information on goat characteristics, it can be stated that goats have a specific place in the animal agricultural economy of many countries. These characteristics can be summarized in the following points:

1. 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.
2. They can efficiently utilize poor quality forage and cover long distances looking for food. Their peculiar feeding habits make it easier to choose diets to meet their requirements.
3. Goats are the most prolific domesticated ruminant. Faster reproduction contributes to the genetic progress that can be achieved and enables their owners to recover quickly.
4. 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.
5. Overgrazing makes rangelands increasingly suitable for browsing species such as goats.
6. The widespread decline in services supplied by governmental agencies encourages farmers to move from keeping cattle to goats.
7. Goats provide their owners with a broad range of products and socio-economic services and have played an important role in the social life of many people being used as gifts, dowry, in religious rituals and rites of passage (Peacock, 1996).

Goats, especially dairy ones, are an ideal species for poverty reduction and economic development for the poor in developing countries. Several reasons make goats particularly attractive for poverty reduction and improvement of family food security and livelihood of the poor in developing countries:

1. Goats are easily acquired by the poor as they require modest starting capital.
2. They can easily be tended by the weak, women or children.
3. They provide people by valuable nutrients.

4. Many people cannot drink cow milk as they are allergic to it. Several studies indicated that people with cow's milk allergy could tolerate goat's milk (Restani, 2004).
5. The growing demand for goat meat presents an opportunity for goat fattening.

Environmental Concerns

In several countries there is a justified concern about the damaging effect of goats on forests, trees, woodland and grazing. Therefore, goats have been banned in many regions (Çelik and Bayramoğlu, 2010). Heavy grazing by sheep and goats has led to the destruction of much of the herbaceous and woody vegetation on the non-cultivated land (Albareda, 1955). Atkinson (1964) described how feral goats have modified the vegetation in several New Zealand localities. It was also found that goats, among some other species, had destroyed many plant species and animals depending on them in some islands of the USA (Groombridge, 1992). In Australia, it was reported that goats contributed to environmental degradation (Ministry of Environment and Conservation, 2005). Domesticated goats have been observed to escape easily and to survive and reproduce in the wild. Therefore, the goat population in Australia is mostly feral. These feral goats can cause and contribute to overgrazing, especially in pastoral areas. They are unacceptable in areas dedicated to conserve flora and fauna. The severe damage that goats have caused in some regions is usually associated with high stocking density and mismanagement. Heavy goat damage is usually localized. Goats have a good appetite for and the ability to utilize effectively many trees and shrubs not available or not palatable to sheep and cattle. Therefore, they can be more damaging to perennial vegetation and soil stability. This is greatly realized during drought in arid zones, as goats have a reputation for being good survivors. Clearly, goats require careful management to avoid irreversible damage to the vegetation.

Abstract

This article offers information on the present status of goat populations and their productivity. The overview discusses number of goats in different parts of the world as well as the top countries having goats. The article also reviews the status of goat milk and meat production over the globe. In addition, breeding objectives and genetic improvement programs for milk and meat are discussed giving some examples of the reputable goat breeding projects. Several selection criteria serving the proposed breeding objectives are also suggested. Advantages of goat keeping and the reasons for their expansion are reviewed. Uncontrolled goat populations have contributed to serious environment degradation in several areas in the past, which serves as a reminder that goats require careful management to avoid irreversible damage to the vegetation.

Zusammenfassung

Perspektiven für die Ziegenhaltung in verschiedenen Regionen der Welt

Dieser Beitrag gibt eine Übersicht über die gegenwärtige Situation der Ziegenhaltung in verschiedenen Regionen der Welt und für die Produktion von Milch und Fleisch. Die globale Ziegenhaltung hat in den letzten beiden Jahrzehnten deutlich zugenommen, vor allem in Asien und Afrika, wo sie nicht unwesentlich zur Selbstversorgung ländlicher Familien beitragen. Die Bedeutung von Milch und Fleisch ist dabei sehr unterschiedlich.

Vorzüge der Ziegenhaltung gegenüber anderen Nutztieren werden herausgestellt und Zuchtziele für die Produktion von Milch und Fleisch an unterschiedlichen Standorten kritisch dargestellt. Systematische Zucht wird überwiegend in Europa und den USA betrieben, wobei eine effiziente Produktion von Milcheiweiß im Vordergrund steht. Für die Ziegenhaltung in Entwicklungsländern ist demgegenüber die Anpassungsfähigkeit an ungünstige Umweltbedingungen von allererster Bedeutung. Abschließend wird das Problem der Landschaftszerstörung durch Überbesatz und verwilderte Ziegenbestände eingegangen, das in einigen Fällen zum Verbot der Ziegenhaltung geführt hat.

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